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## Conference Programme

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| 09:45 - 10:15 | T1 - Plenary session - WG objectives and program strategy (Chair: P. Lionello) | T1.1 - Water budget of the Mediterranean Sea (WG1) 
A. Mariotti, S. Somot, W. Ludwig  
T1.2 - Continental hydrological cycle and water resources (WG2) 
I. Braud, A. Chanzy |
| 10:15 - 10:45 |                                                                                          |                                                                        |
| 10:45 - 11:15 | Coffee Break                                                             |                                                                        |
| 11:15 - 11:45 | T2 - Plenary session - WG objectives and program strategy (Chair: P. Drobinski) | T2.1 - Heavy precipitation and flash-flooding (WG3) 
G. Delrieu, A. Montanari, E. Richard, R. Romero  
T2.2 - Intense sea-atmosphere interactions (WG4) 
K. Beranger, C. Estournel, B. Ivaneev-Picek, S. Josey, K. Lagouvardos  
T2.3 - Social and vulnerability and adaptation capacity (WG5) 
M.C. Llasat, C. Lutoff, I. Ruin |
| 11:45 - 12:15 |                                                                                          |                                                                        |
| 12:15 - 12:45 | Lunch                                                                    |                                                                        |
| 14:00 - 14:15 | T3 - Plenary session - Science talks (Chair: M. Gacic)   | T3.1 - Recent changes in Mediterranean Sea water cycle 
A. Mariotti  
T3.2 - Calculating the water and heat balances of the Eastern Mediterranean basin using ocean modeling and available meteorological, hydrological and ocean data 
M. Shaltout, L. Arneborg, A. Omstedt  
T3.3 - Numerical estimate of river discharge in the Mediterranean basin 
M. V. Struglia, G. Pisacane  
T3.4 - Lagrangian monitoring of the Mediterranean thermohaline properties and currents: Past results and future plans 
P.-M. Poulain |
| 14:15 - 14:30 |                                                                                          |                                                                        |
| 14:30 - 14:45 |                                                                                          |                                                                        |
| 14:45 - 15:00 |                                                                                          |                                                                        |
| 15:00 - 15:15 | T5 - Heavy Precipitation, flash-floods and floods (Chair: S. Davolio) | T3.5 - Cb-TRAM: Tracking and monitoring severe convection over the Mediterranean from onset over rapid development to mature phase using multi-channel Meteosat SEVIRI data 
A. Tafferner, C. Forster, T. Zimmer  
T3.6 - Analysis of storm structure, motion and interaction with the drainage basin properties for selected extreme flash floods in the Mediterranean area 
M. Borga, P. Tarolli, D. Zoccatelli, F. Marra  
T3.7 - Measurement of alpine precipitation using an X-band polarimetric radar 
A. Berne, M. Schneebeli, S. Jolivet  
T3.8 - Shallow Orographic Convection contribution to the water resources in Mediterranean 
A. Godart, S. Anquetin, E. Lebois, J. D. Creutin |
| 15:15 - 15:30 |                                                                                          |                                                                        |
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| 15:45 - 16:00 |                                                                                          |                                                                        |
| 16:00 - 17:00 | Poster session and coffee break                                           |                                                                        |
| 17:00 - 19:00 | PW1 - Parallel Working sessions                                           |                                                                        |
|            | PW1.2 - Long-term hydrometeorological observations (LOP-EOP): meteorological and hydrological sites and networks, satellite products (Chairs: E. Anagnostou, G. Delrieu, G. Liberti) |                                                                        |
|            | PW1.3 - Links with international organisation and funding agencies (Chairs: I. Ruin, E. Grunfest) |                                                                        |
### Wednesday, 9 June 2010

**W1 - Plenary session - Science talks**

#### Intense air-sea exchanges *(Chair: S. Sofianos)*

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| 08:30 - 08:45 | **W1.1** - A refined Cyclogenesis tracking climatology in the Mediterranean for characterisation and predictability perspectives of autumnal intense wind events  
B. Joly, P. Arbogast |
| 08:45 - 09:00 | **W1.2** - Complex properties of the Bora wind  
I. Stiperski, B. Ivančan-Picek, V. Grubišić, A. Bajić |
| 09:00 - 09:15 | **W1.3** - Rapid upper ocean responses to intense meteorological events in mesoscale ocean-atmosphere regional modelling  
C. Lebeaupin Brossier, K. Béranger, P. Drobinski |
| 09:15 - 09:30 | **W1.4** - QuickSCAT Observations of Extreme Wind Events over the Mediterranean and Black Seas during 2000-2008  
T. Chronis, V. Papadopoulos |

#### Heavy Precipitation, flash-floods and floods *(Chair: V. Grubišić)*

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S. Mariani, M. Casaioli, B. Lastoria, A. Orasi, F. Catini |
| 09:45 - 10:00 | **W1.6** - Collection of witness reports and evaluation of prediction tools for flash flood events  
J. J. Gourley, J. M. Erlingis, D. P. Jorgensen, Y. Hong |
| 10:00 - 10:15 | **W1.7** - Use of regional distributed hydrological modelling approaches for the design of catchment experimental set up within HyMeX  
I. Braud, S. Anquetin, H. Roux, O. Vannier, M. M. Maubourguet, P. Viallet, B. Boudevillain, D. Dartus, J. D. Creutin |
| 10:15 - 10:30 | **W1.8** - Atlantic precursors of Mediterranean cyclones: modeling at kilometer scale  
F. Pantillon, J.-P. Chaboureau, C. Lac, P. Mascart |
| 10:30 - 11:00 | **Coffee Break**                                                                         |

**W2 - Plenary session - Science talks** *(Chair: A. Montanari)*

#### The continental hydrological cycle and related water resources

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P. Lionello, L. Congedi |
| 11:15 - 11:30 | **W2.2** - Land biogeoophysical variables of the Mediterranean basin: to what extent can ERA-I be used to drive land surface models?  
C. Szczepań, J.-C. Calvet |
| 11:30 - 11:45 | **W2.3** - Use of HYPROM to assess the Moraca river water potential  
G. Pejanovic, M. Vujadinovic, S. Nickovic, V. Djurdjevic |
| 11:45 - 12:00 | **W2.4** - Precipitation Retrieval from Satellite within EUMETSAT’s H-SAF  
A. Mugnai, S. Dietrich, V. Leviziani, D. Casella, E. Cattani, F. Di Paola, M. Formenton, S. Laviola, P. Sanò |
| 12:00 - 12:15 | **W2.5** - All of the former Global Energy and Water-cycle Experiment (GEWEX)  
S. Williams, S. Benedict |

#### Societal and economic impacts *(Chair: C. Llasat)*

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J.-P. Naulin, O. Payrastre, E. Gaume, G. Delrieu, P. Arnaud, C. Luttof, B. Vincendon |
| 12:30 - 12:45 | **W2.7** - Consequences of the climate change on water scarcity in the Mediterranean basin  
H. Nassopoulos, P. Dumas |
<p>| 12:45 - 14:00 | <strong>Lunch</strong>                                                                                   |</p>
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| 14:00 - 14:20 | **W3.1** - SOP/EOP Implementation Plan - Overview for the Eastern Mediterranean Target Area  
E. Anagnostou |
| 14:20 - 14:40 | **W3.2** – SOP/EOP Implementation Plan - Overview for the Adriatic Target Area  
M. Borga, B. Ivanean-Picek |
| 14:40 - 15:00 | **W3.3** - SOP/EOP Implementation Plan - Overview for the Northwestern Mediterranean area  
V. Ducrocq, G. Boni, A. Parodi |
| 15:00 - 15:12 | **W3.4** - Boundary layer balloons in the Mediterranean  
C. Basdevant, A. Doerenbecher, P. Drobinski, P. Durand, C. Fesquet, A. Vargas, N. Verdier |
| 15:12 - 15:24 | **W3.5** - Observations and products available from the Lightning Observation Task Team during HyMeX  
| 15:24 - 15:36 | **W3.6** - LAM-EPS activities: common scientific interests for HyMeX and TIGGE-LAM  
L. Descamps, A. Montani, T. Paccagnella |
| 15:36 - 15:48 | **W3.7** - HyMeX database  
L. Fleury, K. Ramage, J.-L. Boichard, G. Brissebrat, S. Cloché, L. Mastrorillo |
| 15:48 - 16:00 | **W3.8** - Data Management needs in Hydrometeorological Institutes  
T. Roschier, J. Ikonen, A. McDonald |
| 16:00 - 17:00 | **Poster session and coffee break** |
| 17:00 - 19:00 | **PW2 - Parallel Working sessions** |
| 17:00 - 18:00 | **PW2.1** - Instrument deployment design over the TAs during SOP/EOP: mobile platforms (aircraft, balloons, radar..)  
(*Chairs: C. Flamant, A. Vargas, K. Friedrich*) |
| 18:00 - 20:00 | **PW2.2** - Instrument deployment design over the TAs during SOP/EOP: ocean and air-sea fluxes  
(*Chairs: I. Taupier-Letage, H. Giordani ?, R. Bozzano*) |
| 20:00 - 22:00 | **PW2.3** - Modelling of the continental surfaces  
(*Chairs: M. Borga, I. Braud, A. Montanari*) |

*Conference diner*
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<td>M. Turco, M. C. Llasat, P. Quintana Seguí</td>
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<td>11:00 - 13:00</td>
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<td>Regional climate modelling</td>
<td>(Chairs: P. Ruti, S. Somot)</td>
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<td>13:00 - 14:15</td>
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IV Workshop

HyMeX
HYdrological cycle in Mediterranean EXperiment
8-10 June 2010
Area della Ricerca CNR
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Water budget of the Mediterranean sea
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Recent changes in Mediterranean Sea water cycle

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An observational analysis of Mediterranean Sea water cycle variability based on recently available datasets provides new insights on the long-term changes which affected the region since the 1960s. Results indicate an overall increase in evaporation during 1958-2006, with a decrease up until the mid-1970s and an increase from thereon. Precipitation variability is characterized by substantial interdecadal variations and a negative long-term trend. Evaporation increase, primarily driven by SST variability, together with precipitation decrease resulted in a substantial increase in the loss of fresh water from the Mediterranean Sea toward the overlying atmosphere. An increase in fresh water deficit is consistent with observed Mediterranean Sea salinity tendencies and has broad implications for the Mediterranean water cycle and connected systems. These observational results are in qualitative agreement with simulated Mediterranean Sea water cycle behavior from a large ensemble of CMIP3 models. However, simulated anomalies are about one order of magnitude smaller than observed.
Calculating the water and heat balances of the Eastern Mediterranean basin using ocean modeling and available meteorological, hydrological and ocean data

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This paper aims to analyze Eastern Mediterranean water and heat balances by using a one basin ocean model with vertical resolution coupled to gridded meteorological data for a 53 years period (January 1958 to June 2009). The work represents the initial phase in our research regarding the climate change of the Mediterranean.

The study will follow similar approach that has been studied within the BALTEX program for the Baltic Sea including modeling and closing the water and heat balances. The model is based on one-dimensional equation of momentum, heat and salt conservation. Turbulent exchange model is modeled as a two-equation model of turbulence.

The exchange through Sicily strait connecting Eastern basin with Western basin is also added to the model. The forcing data is taken from the NCEP metrological data base, the SAGE river runoff data base and bathymetric from the British Oceanographic Data Center. Modeling result is validated with independent data base of salinity and temperature observations available from National Oceanographic Data Center.

The results showed that surface calculated long-term temperature and salinity follow the observations with a bias of -0.4°C and -0.004 psu respectively. Monthly and yearly cycle of temperature and salinity are well simulated. Observed and calculated TS structure is in good agreement, indicating that air-sea interaction, diapycnal mixing and deep mixing are well modeled. From these calculations the water and heat balances are calculated and the results will be presented during the conference.
Numerical estimate of river discharge in the Mediterranean basin.

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We present the numerical diagnostic tool IRIS (Interactive RIver Scheme, Pisacane and Struglia, 2010) which can be used for the evaluation of river discharge from modelled runoff fields both for present climate and future scenarios. IRIS covers the entire Mediterranean basin, and it is apt to estimate monthly river discharge from total runoff fields computed by any climate model. The advantage of using IRIS mainly resides in the fact that it uses an independent working grid on which to interpolate input fields and calculate area integrals, thus assembling available catchment reconstruction and model domain information in an extremely manageable way. IRIS can therefore be effectively included in the post-processing procedure of any regional model in order to support the integrated analysis of the Mediterranean water budget. Due to its low numerical cost, IRIS is apt to provide a large number of monthly discharge time series so as to build ensemble statistics for the Mediterranean rivers. It can be straightforwardly extended to other areas.
Lagrangian monitoring of the Mediterranean thermohaline properties and currents: past results and future plans

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The surface circulation of the Mediterranean Sea has been monitored by means of satellite-tracked drifters since the 1980s as part of various scientific and operational (military) projects. Likewise, the Mediterranean intermediate currents and thermohaline properties (temperature and salinity) have been sampled with profiling floats since the late 1990s and have continued until now as part of Argo.

These Lagrangian datasets are described and used to study the spatial structure and temporal evolution of the Mediterranean over the last two decades. First, trajectories of drifters and floats, often superimposed on satellite images of sea surface temperature, chlorophyll concentration and sea level anomaly, provide a qualitative description of the Mediterranean dynamics. Second, pseudo-Eulerian statistics are computed to quantify the mean currents and their variability, and the corresponding kinetic energies. Inter-annual and seasonal variabilities are discussed, as well as the long-term trends in temperature and salinity in selected Mediterranean basins.

Plans for the continuation of pan-Mediterranean Lagrangian observations coordinated at international level are discussed. The importance of such observations for scientific programs such as Hymex and operational oceanography projects (MOON) is explained.
The SMOS mission 6 months after launch: possibilities to study the water cycle in the Mediterranean region

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The European Space Agency’s Water Mission, otherwise known as the Soil Moisture and Ocean Salinity Mission (SMOS) launched a minisatellite in November 2, 2009. SMOS single payload, an interferometric microwave radiometer, shall provide global observations of soil moisture and ocean salinity to improve our understanding of the Earth’s hydrological cycle. One of the highest priorities in Earth science and environmental policy issues confronting society today is to understand the potential consequences resulting from modification of the Earth’s water cycle due to climate change. The influence of increases in atmospheric greenhouse gases and aerosols on atmospheric water vapour concentrations, clouds, precipitation patterns and water availability must be understood in order to predict the consequences for water availability for consumption and agriculture. In a warmer climate, increased evaporation may well accelerate the hydrologic cycle, resulting in changes in the patterns of evaporation over both ocean and land, and an increase in the amount of moisture circulating through the atmosphere. Many uncertainties remain, however, as illustrated by the inconsistent results given by current numerical weather and climate prediction models regarding the future distribution of precipitation.

It is evident that insufficient data are available until now to help improving our scientific knowledge and understanding of the processes influencing the water cycle. Thus, ESA, the French Space Agency (CNES) and Spanish Centre for Development of Industrial Technology CDTI have teamed up to address this key scientific challenge by delivering a fundamentally new satellite tool to realise these new global datasets. The resulting data from regular and consistent measurements will be used to improve our understanding of the way in which both the time-varying distribution of soil moisture and ocean salinity regulate the water cycle of our Blue Planet.

SMOS is an exploratory mission. It is the first time that an interferometric radiometer, the same approach as used in radiotelescopes, is put on a satellite to observe the Earth. A huge effort has been done at European level both to develop and implement the novel technology and to design the data processing steps to transform the recorded brightness temperature into the required geophysical variables. The technical limitations do not allow SMOS to go below 30-50 km in spatial resolution and 3 days in temporal sampling for soil moisture, and 100-200 km, 10-30 days for salinity.

At the end of the mission commissioning phase, 6 months after launch, the instrument has shown to be very stable and perform above specifications. We will be soon in a position to start assessing the feasibility of SMOS products to contribute to the study of the water cycle in a small basin like the Mediterranean.
A Regional Earth System Perspective on the Water Budget over the Mediterranean Catchment Area.

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We present a quantitative analysis of the water content in the atmosphere, soil and ocean over the Mediterranean catchment area. The Regional Earth System developed by ENEA-ICTP, the PROTHEUS system, is an optimal modelling tool for this purpose as it explicitly accounts for the various components of the hydrological cycle and their interactions. In particular, the PROTHEUS system provides a reliable description of high resolution sea surface temperature and wind fields over the ocean, in close agreement to observations thereby providing a reliable description of air-seas fluxes (particularly the latent heat flux).

In this analysis, all the terms of hydrological cycle are computed for different simulations performed by an implemented version of PROTHEUS with interactive river runoff. To assess model performances we show 1951-2050 simulation, driven at the lateral boundaries by ECHAM5-MPIOM global simulation included in the IPCC-AR4, compared against control simulation driven by ERA40, and observational datasets.

The modelling tools presented in this work will also contribute to the Med-CORDEX activities.
Climate change in the Mediterranean Region: results from a global AOGCM coupled with an interactive high-resolution model of the Mediterranean Sea

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In this work we present and discuss the results obtained from a set of present and future climate simulations performed with a high-resolution model able to represent the dynamics of the Mediterranean Sea. The ability of the model to reproduce the basic features of the observed climate in the Mediterranean region and the beneficial effects of both atmospheric improved resolution and interactive Mediterranean Sea are assessed. In particular, the major characteristics of the variability in the Mediterranean basin and its connection with the large-scale circulation are investigated. Furthermore, the mechanisms through which global warming might affect the regional features of the climate are explored, focusing especially on the characteristics of the hydrological cycle.

The model used is the CMCC-MED model, developed under the framework of the EU CIRCE Project (Climate Change and Impact Research: the Mediterranean Environment), which provides, for the first time, the possibility to accurately assess the role and feedbacks of the Mediterranean Sea in the global climate system. CMCC-MED, in fact, is a global coupled ocean-atmosphere general circulation model (AOGCM) coupled with a high-resolution model of the Mediterranean Sea. The atmospheric model component (ECHAM-5) has a horizontal resolution of about 80 Km, the global ocean model (OPA8.2) has horizontal resolution of about 2° with an equatorial refinement (0.5°) and the Mediterranean Sea model (NEMO in the MFS implementation) has horizontal resolution of 1/16° (~7 Km) and 72 vertical levels. The communication between the atmospheric model and the ocean models is performed through the OASIS3 coupler, and the exchange of SST, surface momentum, heat, and water fluxes occurs approximately every 2 hours. The global ocean-Mediterranean connection occurs through the exchange of dynamical and tracer fields via simple input/output operations. In particular, horizontal velocities, tracers and sea-level are transferred from the global ocean to the Mediterranean model through the open boundaries in the Atlantic box. Similarly, vertical profiles of temperature, salinity and horizontal velocities at Gibraltar Strait are transferred from the regional Mediterranean model to the global ocean. The ocean-to-ocean exchange occurs with a daily frequency, with the exchanged variables being averaged over the daily time-window.
The impact of climate change on the hydrometeorological extremes in Northeast of Spain

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Our ultimate objective is to generate regional scenarios with statistical downscaling in the Northeast of Spain, to focus on extremes and to analyze the impact of climate change on the water resources. In order to achieve this aim some preliminary steps are necessary.

To better understand the climatology of past extremes and to set up a base to develop regional climate scenarios we have analyzed a subset of the precipitation and temperature indices defined by the Expert Team on Climate Change Detection and Indices. These indices are calculated from the best available gridded datasets, that is, the new, recently developed (Herrera et al. 2010), dataset of daily precipitation namely SPAIN02 (regular at 0.2° horizontal resolution, around 20 km) and the daily gridded dataset for temperature E-OBS (Haylock et al. 2008). Besides we have analyzed two high quality stations: a reference series for Barcelona and for Tortosa. The trend analysis has been done following the method described in Kiktev et al (2003), in which the significance (and also the field significance) of the trends are estimated by a Circular Block Bootstrap method. Our analysis of the temperatures in the Northeast of Spain indicates a clear signal of increase, coherent to the observed global warming (IPCC, 2007). Instead, since a rather controversial picture appears in the studies on the precipitation trend, a greater effort has been done for this variable. The analysis has been done for each point of the dataset in the region and the average of them as representative of the entire Catalonia. In order to analyze the influence of the length of the series as well as the departure point, 24 series have been built, shifting the staring year of the series. Although no general trends are found, two exceptions are noteworthy. Firstly, a significant local increase in the longest dry period index; around 30% of the area has an increase of around 2 day/decade. Secondly, the summer series of the precipitation intensity has a field significant dipolar trend pattern; slight negative trend in the inland part, around -0.5 mm/decade and a positive trend pattern along the coast, around 1 mm/decade.

Other preliminary step was a review of the large published literature on the downscaling methods resulting in a little consensus among such studies to the choice of atmospheric predictor variables for precipitation downscaling: this task is still a challenge, at least in the Mediterranean regions. Some tests with a statistical downscaling procedure based on an analogue technique have been done using the reanalysis fields as predictors in order to calibrate the model and quantify its error. The downscaled temperature, with the air temperature at 850 hPa and mean sea level pressure (ERA40) as predictors, indicate quite good results. Also the downscaled rain occurrences shows some amount of skill but an extra effort it is necessary to solve the underestimated rainfall amounts. Another strategy it is to apply the method developed by Boé et al. (2006) since it allows having a more physical understanding, compared to the analogs method, and it maintains the spatial coherence of the predictand field. To study the impact of climate change on the hydrological
extremes, a new gridded dataset will be build using the SAFRAN analysis system (Durand et al, 1993, Quintana-Seguí et al., 2008). This dataset will contain precipitation, temperature and the other near-surface atmospheric variables necessary to force the SURFEX surface model, which contains the ISBA surface scheme (Noilhan and Planton, 1989, Noilhan and Mahfouf, 1996, Boone et al. 1999). The SAFRAN database will be compared to Spain02 and E-OBS using the already described methodology. Then, it will be used as observational database to apply the downscaling methods developed, to be able to force SURFEX in the future and obtain future scenarios of soil wetness and runoff generation. The acquired knowledge on the different downscaling methods available will allow to take uncertainties into account.
Water budget of the Mediterranean sea

POSTERS

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The downscaling of ERA-interim data (1989-2008) using the non-hydrostatic Weather Research and Forecasting (WRF) model at 50 km resolution has been conducted over the Mediterranean area. This simulation will be part of an ensemble of simulations performed in the framework of the coordinated Med-CORDEX project.

This study presents the comparison of this 20-year simulation with available observations such as gridded CRU data, meteorological stations, satellite, buoys... A special focus is given to the representation of the inter-annual and intra-seasonal variabilities of temperatures and winds. First interpretations of possible biases will be presented.

After the simulation's evaluation, the scientific exploitation of this run will focus on two main objects which are:
- the regional winds and associated ocean/atmosphere exchanges and their impact on oceanic convection
- the relation between droughts and canicular events.

In the next few months, the same configuration of WRF will be used for future climate projections runs. This simulation is a first step in the study of the predictability of this area.
Adriatic – Ionian Interaction: The Bimodal Oscillating System (BiOS)

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Ionian Sea circulation variability shows a peculiarity that distinguishes it from the rest of the Mediterranean; the prevalent variability in the Ionian occurs at decadal scales, while the rest of the Mediterranean shows the most prominent variance at seasonal scales. Decadal variability in the Ionian was documented either from remotely sensed sea surface topography and SST or from in situ data. The basin-wide upper-layer circulation is characterized by decadal inversions. The prevalence of decadal over seasonal variability was explained in terms of the Adriatic-Ionian interaction manifesting in the Bimodal Oscillating System (BiOS). Upper-layer circulation inversions are triggered by internal vorticity sources due to the contribution of the tube stretching mechanism and the baroclinic source. The internal sources are associated with the outflow of the Adriatic Dense Water having thermohaline properties that vary on decadal scales. The wind influence in generating these circulation variations is often of the secondary importance. Variations of the horizontal circulation pattern in the Ionian are associated with prominent vertical movements of the nutricline. This then brings into the Adriatic waters of varying nutrients content, determining the degree of fertilization of the basin.
Aerosol extinction from N$_2$ and O$_2$ Raman signals, aerosol backscatter, and water vapour profiling with a monochromator based Raman LIDAR

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We have used the Raman LIDAR technique to measure aerosol and water vapour profiles over the city of Murcia (Southeastern Spain, 37º 59’ N, 1º 8’ W), applying the method proposed by Ansmann. It allows the independent determination of particulate matter extinction coefficients from N$_2$ and O$_2$ Raman shifted backscattered light, and by combining these two profiles, wavelength dependence can be estimated.

These results are afterwards combined with H$_2$O Raman shifted echoes and elastically backscattered light to obtain respectively water vapour profiles and the aerosol backscatter coefficient.

Our system has the particularity of being equipped with a diffraction grating monochromator and a wide spectral response photomultiplier, allowing us to tune Raman echoes at any wavelength between 300 and 850 nm. We irradiate with a Nd:YAG Q-switched laser delivering 280 mJ at 355 nm with a shot frequency of 10 Hz. Backscattered light is collected using a 35.5 cm diameter Schmidt-Cassegrain telescope attached with optic fiber to the monochromator. Signal is acquired using a Licel transient recorder with a spatial resolution of 7.5 meters. We detect sequentially elastic backscattered light and Raman echoes at 376 nm (O$_2$), 387 nm (N$_2$) and 408 nm (H$_2$O).

Our algorithms have already been tested in the framework of SPALINET, the Spanish Advanced LIDAR Network.
Analysis of GPS water vapor variability over Morocco

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An analysis of precipitable water vapor (PWV) variations from Global positioning system (GPS) data has been carried out on a short and long term over Morocco. We have used 16 continuous operating GPS stations over Morocco. After derivation of the atmospheric total delay from the GPS data raw processing, it was converted into PWV content using surface pressure and mean atmospheric temperature. For the long term comparison, the analysis was based on 3 continuous stations (Rabat, Ifrane and Tetouan) in Morocco and one Canary Island station (Mas Palomas) in conjunction with radiosonde data (at three of these sites) and NCEP analyses and reanalyses for the period between 2001 and 2007. The intercomparison reveals an overall dry bias in the radiosonde data, up to -6 Kg/m\(^2\) depending on site and season, and a diurnal variation of the bias. The NCEP operational analysis shows overall a smaller bias, while NCEP reanalysis II exhibits strong seasonal variations in the bias. The mean seasonal cycle of PWV, precipitation, surface meteorological parameters and moisture flux profiles are described. They reveal distinct climatologic features at the different sites, related to large scale atmospheric circulation and associated moisture advection.

In a short temporal scale, GPS observations were used to estimate the integrated water vapor during a heavy precipitation event. Preliminary comparison results with radiosonde and the Moroccan operational analysis shows a bias less than 1.5 kg/m\(^2\) and a positive bias around 2 kg/m\(^2\) respectively. The overestimation of the operational analysis might be due to a lack on humidity information, the presence of biases in assimilated humidity data and/or to difficulties for the model analysis to reproduce these heavy precipitation events. As major perspective of this study is the assessment of operational atmospheric analysis during specific weather events using both post-processed and real time GPS solutions.
Contribution to the Mediterranean Sea water and heat budget definition: links between the Tyrrhenian and the Liguro-Provencal subbasins

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One of the Target Areas (TA) that have been defined in the HyMeX framework is the north-western Mediterranean, where all the intense hydrometeorological phenomena of interest for HyMeX occur (heavy precipitation, flash-flooding, cyclogenesis, dense water formation and deep ocean convection). The monitoring of the exchanges through the Corsica Channel is a fundamental task for the quantification of the heat and salt import from the Tyrrhenian Sea towards this TA and thus to the dense water formation site. The transport in the Corsica Channel has been monitored since July 1985 with a sub-surface mooring, which measures currents and temperature at different depths, in order to permit the detection of the exchanges both in the surface and the deep layers. In the deep layer, the mooring is also equipped with a high quality CTD probe, to detect the hydrographic variability in correspondence to the LIW layer. Furthermore, hydrographic campaigns are planned every six months. In the central Liguro-Provencal basin the DYFAMED data are collected (CTD casts) on a monthly basis since 1995. Both data sets constitutes a main tool for the assessment of the heat and water budgets determination of the TA.

The Corsica Channel is representative of the exchanges between the Tyrrhenian and the Liguro-Provencal basins and is particularly sensitive to the winter cooling occurring in the latter and the unbalance of the winter air-sea exchanges, significantly different in the two subbasins. While the Liguro-Provencal basin is characterized by intense air-sea fluxes, which may induce deep water formation processes, the Tyrrhenian Sea, less concerned by the Mistral events, experiences significantly lower air-sea interactions. The mean transport through the channel and its variability have the same order of magnitude (0.49±0.42 Sv). The current, flowing almost permanently from the Tyrrhenian to the Liguro-Provencal basin, has a clear seasonal cycle, with high values in winter and almost negligible values in summer. The seasonal cycle is quite regular and explains a large percentage of the observed variability. The interannual variability related to the winter periods (the colder the winter, the higher the transport) is remarkable: the higher transports observed during the 1980s were significantly reduced during the 1990s. There are evidences of a possible influence of the NAO on the Mediterranean circulation, through its influence on winter atmospheric conditions in the Liguro-Provencal basin and thus on the air-sea exchanges, which are very active in this region. A comparison between the winter transport in the Corsica Channel and the NAO winter index shows that negative NAOI values correspond to higher values of the transport from the Tyrrhenian to the Liguro-Provencal basin. Conversely, if the NAOI is very positive, the transport through the channel records the lowest values. Comparing the time series at 400 m (along the path of the LIW) in the Corsica Channel and in the Liguro-Provencal basin (DYFAMED) we may observe lower temperature (and salinity) values in the latter, due to the mixing of the LIW along its path. The most striking feature is that there is a similar long-term oscillation in both time series, with increasing temperature until 2004, followed by a sharp decrease until spring 2006. Finally, the...
return of a warming period in the intermediate layer started in May 2006 in the Corsica Channel and one month later at the DYFAMED station (June 2006). Interestingly, both records at 400 m (Corsica Channel and DYFAMED) reached their absolute maximum and their absolute minimum in a time period of two years (from 2004 to 2006), suggesting dramatic changes occurring in recent years (Schroeder et al., 2006, 2008; Marty and Chiaverini, 2010).

In the framework of HyMeX, the assessment of the variability of the mass, heat and salt fluxes through this channel towards the Liguro-Provencal basin, and its effects on the DYFAMED observations will be able to:

- give insights to teleconnection patterns that may be important for the north-western Mediterranean Sea (WG4)
- contribute to the definition of the Mediterranean sea water and heat budgets, in particular for the Target Area of the north-western Mediterranean (WG1)
- give insights to the interannual variability of the deep water formation in this region (WG4)
- contribute to the “long-term observing periods”, LOP (WG1)
Development of a high resolution regional coupled ocean-atmosphere model for seasonal prediction and climate studies at IC³

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The Catalan Institute for Climate Studies (IC³) was created in July 2008 with the main goal of evaluating, understanding, and predicting climate variability and change and their impact at both global and Mediterranean scales. One of our first objectives is to develop a high resolution coupled ocean-atmosphere model for the Mediterranean area. To this end we’ve started to work on the ocean component of the system that will provide the high resolution Sea Surface Temperature (SST). We are currently building a configuration of the ROMS code able to reasonably resolve the Mediterranean mesoscales. Our current configuration has a horizontal spatial resolution of 1/16° by 1/16° (~ 6 km) and 72 uneven vertical levels, does not include the Black Sea and has an Atlantic Box that extends until 20ºW. For the initial tests we are using COADS monthly climatologies with a spin up of 10 years although we plan to use forcing fields from the ECMWF. Presently, there are not available observations of ocean dynamics (velocity and vorticity fields) at such high spatial resolutions for validating the model. Therefore, we have developed a system to recover the 2D surface velocity field at spatial resolutions of the order of 10 km from a single SST image based on our previous work on Surface Quasi-Geostrophic dynamics. We are currently validating this approach using ADCP measurements and drifting buoys observations.
Diurnal cycle of cloud cover in COSMO-CLM over the Mediterranean Basin

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Clouds form an important factor in the climate system; they affect the climate system in many ways: the energy budget and the hydrological cycle are closely linked with clouds. On the other hand clouds are considered to be the largest uncertainty in climate modelling and are furthermore challenging to detect. The Mediterranean region is an area of strong contrast in atmospheric conditions, concerning land and water surfaces with seasonal and daily cycles. For climate models it is therefore essential to reproduce these variations in order for being able to deliver useful climate projections.

Focusing on the Mediterranean, two satellite-derived cloud products by ISCCP (International Satellite Cloud Climatology Project; http://isccp.giss.nasa.gov) and CM-SAF (Satellite Application Facility on Climate Monitoring; www.cmsaf.eu) were used to evaluate the regional climate model COSMO-CLM (www.clm-community.eu) driven by ERA-Interim reanalysis data with regard to the diurnal cycle in total cloud cover.

Whereas mean values and diurnal cycles over water are reasonable reproduced by the model, bigger differences between the satellite-derived cloud products and the regional climate model arise over land areas. There, COSMO-CLM is not able to model the distinctive cloud diurnal cycles with afternoon maxima, observed by both satellite products in summer.
Ensemble-based mesoscale data assimilation and 3D scanning lidar operations: Proposed Contributions of University of Hohenheim to HyMeX SOP 2012/13

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The proposed contributions of University of Hohenheim to the HyMeX SOPs in 2012 – 2013 comprise the operation of a special suite of active remote sensing instruments at a field site in Corsica and data assimilation activities. We propose to move two 3D scanning lidars to Tollare, Corsica (43°00'25"N; 9°23'17"E): a water vapor differential absorption lidar (DIAL) and a temperature rotational Raman lidar. Both instruments provide a unique combination of accuracy and resolution with respect to water-vapor and temperature measurements even during daytime. For instance, both have the capability to resolve the entrainment zone, the strength of the inversion, and to determine profiles of turbulent quantities. At the same site, the scanning Doppler lidar of Karlsruhe Institute of Technology shall be located. The simultaneous operation of the three scanning lidars will allow for a highly interesting set of synergetic data products, e.g., latent and sensible heat fluxes. The third instrument of University of Hohenheim is a vertical pointing X-band radar with a disdrometer. Details of these instruments can be found in the HyMeX instrument catalogue.

The Ensemble Transform Kalman Filter (ETKF) of the Weather Research and Forecasting model (WRF) – potentially hybrid with the WRF 3DVAR/4DVAR – will be used for impact and predictability studies with respect to high-impact weather events. It is envisioned that this data assimilation system will be operated on the convection-permitting scale leading to an improvement of the understanding of processes evolving during the life-cycle of, e.g., Mediterranean cyclones. Furthermore, new techniques for ensemble generation including uncertainties of the boundaries will be investigated.

For Intensive Observation Periods (IOPs) within the SOP, dedicated ensemble forecasts will be performed. In regions where forecasts predict a cyclone development a few days in advance, a high resolution probabilistic WRF simulation may provide information to refine the mission planning. After the SOP, selected cases will be re-simulated with an even higher resolution and more observations to better understand the internal structure and the evolving processes in such high-impact weather systems.
Establishing an international network of ground-based microwave radiometers for operational retrievals of atmospheric temperature and water vapour.

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This presentation illustrates the efforts, objectives and overarching goals leading to the establishment of an international network of ground-based microwave radiometers (MWRnet). Ground-based passive microwave radiometers (MWR) observations exhibit a high potential for observing the essential climate variables water vapour and “cloud parameters” (i.e. cloud liquid water path) and prove very useful in augmenting regular upper air soundings towards a high temporal resolution of temperature and humidity profiles of the troposphere with special emphasis on the boundary layer. In this respect they are not only valuable for climate applications, but also for weather forecasting and data assimilation.

Currently, ground-based observations of downwelling microwave radiance are performed at numerous sites in Europe by MWRs. Despite the high potential of MWR for weather, climate and propagation condition monitoring, there is lack of coordination, standardization, and data harmonization and sharing, causing underutilization of the MWR potential. The MWRnet objective is to coordinate the exchange of science knowledge, state-of-the-art technology, measurement practices and data in the MWR operator and user community. Specifically it will foster the cooperation of instrument experts, manufacturers, retrieval algorithm developers and data users in the climate and weather forecasting community working and participating in diverse European and international R&D institutions.

MWRnet will establish an international operational network with common use of measurement and calibration procedures, formats, quality control, good practice software and data. The MWRnet objectives are pursued through the following tasks:

- review the state-of-the-art and discuss user needs for diverse user communities
- establish reference protocols for calibration, quality control, operations, and data formatting
- coordinate harmonization, archiving, and sharing of past and future observations and products
- induce the use of well documented MWR observations and products (brightness temperature \((T_b)\), integrated water vapour \((I_WV)\), liquid water path \((LWP)\), temperature \((T_z)\), and humidity profiles \((H_z)\)) in meteorology and weather forecasting, climatology, data assimilation, satellite validation, radio-propagation science, radio-astronomy, etc ...).

The establishment of MWRnet will guarantee easy access to:

- accurate measurements for atmospheric and boundary layer research \((I_WV, LWP, T_z)\)
- real-time monitoring of key meteorological variables \((T_z, H_z, I_WV, LWP)\)
- long-term time series of key climatological variables \((T_b, I_WV, LWP)\)
- data assimilation in numerical weather prediction models \((T_b, I_WV, T_z)\)

MWRnet will be able to foster the participation of ground-based microwave remote sensing measurements to large scale transnational experiments and international projects (i.e. HyMeX) and to connect with larger international programs (i.e. GRUAN).
Estimating the Mediterranean Sea Water and Heat Budgets: uncertainties in the observed estimates and in the Regional Climate Models

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The Mediterranean Sea can be considered as a thermodynamic machine that exchanges water and heat with the Atlantic Ocean through the Strait of Gibraltar and with the atmosphere through its surface. Considering the long term mean Mediterranean Sea Water and Heat Budgets (MSWB and MSHB), the Mediterranean basin loses water and heat through its surface with an excess of the evaporation over the freshwater input (precipitation, river runoff, Black Sea input) and an excess of the heat lost (net long-wave radiation, the sensible heat flux and the latent heat flux) over the net short-wave radiation.

Over a long-period of time, these losses are compensated by a net water and heat transport through the Gibraltar Strait. The MSWB and MSHB partly drive the Mediterranean Sea water mass formation and therefore a large part of its thermohaline circulation. This could even have an impact on the physical characteristics of the Atlantic thermohaline circulation through the Mediterranean Outflow Waters which outflow into the Atlantic ocean at a depth of about 1000 m. From a climate point of view, the MSWB and MSHB act as water and heat sources for the Mediterranean countries and then play an important role on the water resources of the region and on the localized intense precipitation events.

The regional physical characteristics of the Mediterranean basin (complex orography, strong land-sea contrast, land-atmosphere coupling, regional winds, cloud-radiation interaction, air-sea coupling, relative importance of the river inflow, Gibraltar Strait constraint and complex ocean bathymetry) strongly influence the various components of the MSWB and MSHB. Therefore, estimating and modelling the mean behaviour, the interannual variability, the extremes and the trends of the MSWB and MSHB in the context of the climate change is a challenging task of the HyMeX project.

In a first step, we propose to assess the current observed estimates of the components of the MSWB and MSHB over multi-decadal periods of time. Those estimates are established using satellite or in-situ products. The goal is to define the best estimate of those terms and the uncertainty range associated. The following datasets are analyzed in our study: NOCS, ISCCP2, AJONC, HOAPS-G, OAFLUX, IFREMER, Stanev et al. 2000, Ludwig et al. 2009.

The observed estimates are compared to the ERA40 and ERAInterim reanalyses. In a second step, we investigate some key scientific issues of the regional modeling of the Mediterranean Sea Water and Heat Budgets using a wide range of Regional Climate Model (RCM) simulations performed at Météo-France/CNRM-GAME using the RCM ALADIN-Climate (in the frame of the French ANR-MEDUP project) or in the frame of European intercomparison projects with other RCMs (FP6-ENSEMBLES) or coupled atmosphere-ocean RCMs (FP6-CIRCE).
All the simulations are driven by reanalyses (ERA40 and ERAinterim). The basin-scale and multi-decadal averages are studied as well as the interannual variability and the spatial extremes. In addition to the added-value of the RCMs compare to the large-scale forcing, the addressed questions are the impact of:

- the RCM horizontal resolution (50 km versus 10 km)
- the size of the RCM domain
- the use of the spectral nudging technique
- the regional air-sea-river coupling
- the choice of the lateral forcing (ERA40 vs ERAInterim)
- the choice of the RCM (ENSEMBLES, CIRCE)
Evaluation and comparison of regional climate models over the Iberian Peninsula


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Different relations between parameters involved in both water and energy land surface budgets are computed from daily ERA-Interim data for the months of July (representative of the dry season) and November (representative of the wet season) in the period 1989-2008 over an area within the Iberian Peninsula covering most of Tajo and Guadiana basins (from 40.5N to 37.5N, and from 7.0W to 2.0W).

The main objective of this work is to use the obtained relations for the evaluation and comparison of regional climate models (RCMs) participating in the ENSEMBLES project. This approach was first proposed by Betts (2004) for comparing and evaluating global climate models. He proposed the assessment of model surface components as a system with widely connected components. In this way, models are compared among themselves and evaluated against observational data.

The work is mainly focused on the goodness of the representation of physical surface processes and their feedbacks. The obtained relationships among different parameters are therefore considered as imposed restrictions by physical processes which can be used to evaluate RCMs.
We present a study on the characteristics of the sea breeze flow at a coastal site located at the southern tip of Italy, in the centre of the Mediterranean basin. This study is finalized to add new data on breeze circulations over a narrow peninsula and unique experimental coastal site located about 500 m from the coastline in a flat area but also influenced by the complex orography of the region. We analysed two years of hourly data of wind speed and direction, temperature, radiation and relative humidity from a surface meteorological station and one year of wind profiles by a radar located at and compiled the seasonal climatology of the sea-land breeze circulation.

Results show that breezes dominate the local circulation and play a major role for the local climate. They are modulated by the season, namely the sea-land temperature difference and the large-scale flow. In particular, we find that sea breeze and upslope flow fully develop in summer daylight hours while land nocturnal breeze fully develops in fall and winter. For the analyzed period, spring shows the largest influence of synoptic-scale circulations.
Ground-based and satellite observations of column water vapour in the central Mediterranean: spatio-temporal variability

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The information content of a synergistic analysis of total precipitable water vapour (TPWV) from ground based and satellite observations in the Mediterranean is investigated. The study focuses on the description of spatial and temporal variability of water vapour. Ground based measurements of total precipitable water vapour, TPWV, are carried out with a Sun photometer since 2001 on the island of Lampedusa (35.5°N, 12.6°E), in the central Mediterranean sea. The data are acquired with a 15 seconds - 1 minute time resolution. Satellite measurements of TPWV are obtained merging processed passive microwave radiometer data from TMI and AMSR-E. The dataset consists of at least two observations per day in non-raining conditions mapped on a regular grid of 0.25°x0.25°. A preliminary comparison of the ground-based and satellite datasets reveals a difference (ground-based underestimates satellite TPWV) by about 15-20%.

This difference is probably due to inadequate correction for the aging of the radiosondes used to calibrate the Sun photometer observations. However, no long-term temporal drifts are present in the ratio between the TPWV time series. The ground-based and spaceborne datasets are used jointly to investigate the spatial and temporal variability of TPWV in the central Mediterranean. The analyses of spatial correlation suggests that TPWV measurements at Lampedusa are representative, at least in terms of temporal variability, of the Southern sector of the central Mediterranean, and of a larger portion of the basin in Autumn. Beside the observed bias, discrepancies in the description of the TPWV diurnal cycle from the datasets are also observed.
Impact of the Mediterranean Sea Surface Temperatures from a Weather Regimes Classification Approach

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Weather Regimes (WR) have been defined over the Euro-Mediterranean region [60W-60E; 15N-70N] from May to October season using the daily Sea Level Pressure, 700 hPa geopotential height and specific humidity from ERA-interim dataset over the period 1989-2008. Computations are based on a neural network classification technique referred to as Self Organizing Maps and the WR produced can be used by the community for comparison with other periods, projection onto model outputs, seasonal prediction, or teleconnection studies.

This work particularly examines the relationship between Mediterranean Sea Surface Temperatures (SST) and European and West African rainfall through the WR classification. Our results suggest that changes in particular WR frequencies associated with anomalous Mediterranean SST can account for part of interannual rainfall variability.

Thus during years of anomalous positive (negative) Mediterranean SST, both higher frequencies of occurrence of WR related to negative (positive) summer NAO-like pattern and less frequent WR related to positive (negative) summer NAO-like pattern are attested in July and August respectively (hereafter SN- and SN+). This is associated with a zonal symmetric pattern, consistent along the middle troposphere, i.e. a low pressure anomaly centered over 50N-20W and Eurasia (Greenland) and a high pressure anomaly centered over Iceland (central Europe) for SN- (SN+) WR. Rainfall anomalies associated with SN- (SN+) WR are positive (negative) over West Africa and presents a dipole-like pattern over Europe. Another striking characteristic of SN- (SN+) WR is southeastward (southwestward) surface anomalous winds flowing from (to) the Atlantic ocean at 20N and therefore able to enhance (weaken) wet convection over Africa and influence onto the humidity advection over Europe.

The relation between WR and Mediterranean Sea suggests that temperature anomalies could be a precursor in the change of frequency of SN- and SN+ WR and therefore impacts on rainfall. Atmospheric General Circulation Model (AGCM) simulations in the AMMA-EU project framework are also analysed by projecting the WR onto the control run and specific sensitivity experiments in order to discern i) how the state of the art models reproduce the WR and ii) the physical mechanisms associated with SN- and SN+ patterns.
Impact of the parameterisation of the bottom friction on the deep convection and general circulation of the Mediterranean Sea

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A mesoscale ocean model of the Mediterranean Sea is developed in context of the SiMED and MORCEMED projects. The MED12 model is based on the NEMO code (Madec, 2008) and the standard ORCA grid with an horizontal resolution of 1/12° (6km at 46°N to 8km at 30°N). The ocean model is forced by daily fluxes and winds from ARPERA, which is a downscaling of ERA40 using ARPEGEClimat model (Herrmann and Somot, 2008). The horizontal resolution of ARPERA fields is about 50km. The initial conditions are provided by the MEDATLAS climatology (Rixen et al. 2005). The tide energy is provided by the MOG2 model from LEGOS and is particularly high in the Strait of Gibraltar and in the Gulf of Gabès. It is a part of the bottom friction parameterisation.

We compare two sensitivity experiments using or not the parameterisation of the average tide energy effects. The studied period is 1998-2008. The results show significant differences in the intensity of the deep convection events, in particular in 2006 in the Gulf of Lions. For this event, the results are compared with glidertracks and deep moorings. The general circulation of the Atlantic Water is modified in the Mediterranean Sea. The intermediate circulations in the Strait of Gibraltar and in the Strait of Sicily are compared to recent observations (Millot, 2006; Gasparini et al. 2006).
Influence of the Atlantic-Pacific interbasin connection on the Mediterranean summer precipitation

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The Mediterranean summer response to the Equatorial Mode is non-stationary, being different before and after the late-70s climate shift. Between these two periods, changes in the different tropical ocean basins, as well as in the interactions among them, have been also reported. In this work we explore the nature of this change in the European response to the Equatorial Mode by performing a set of simulations with the Speedy AGCM, prescribing 1950-2000 observed SSTs in the different tropical ocean basin, as well as in the whole tropics. In order to assess the importance of the local SSTs in the Mediterranean response, the same simulations have been re-done with the Speedy model coupled to a Slab Ocean Model in the North Atlantic and Mediterranean oceans. The results point to the whole tropical ocean as the responsible for the atmospheric response observed in the Mediterranean in summer, being the ocean-atmosphere interaction a key factor in the accurate modulation of the response.
Large-scale atmospheric response to eastern Mediterranean summer SST anomalies

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Recent studies have shown that anomalous state of the eastern Mediterranean Sea strongly influences the summer West African monsoon system, not only enhancing the humidity content of the lower troposphere but also forcing circulation anomalies. Observations and modelling experiments are analysed in order to give evidences of a large-scale atmospheric response associated with those Mediterranean surface anomalies. Results support the hypothesis of a hemispheric pattern initiated in the Mediterranean basin, pointing out both a local baroclinic response and a barotropic circumglobal circulation. This atmospheric teleconnection pattern extends to the entire Northern Hemisphere midlatitudes, reflecting the waveguide effect of the westerly jets. The remote impacts present, however, a nonlinear signature: warm conditions influencing on northern Europe and Euro-Asia, whereas cold conditions impacting more on the North Pacific basin. A linear behaviour is found upon a regional impact over north-eastern African continent. These results emphasize the importance of the Mediterranean Sea both as local and large-scale predictor, hence for the success of seasonal forecasting skill.
Long-term monitoring of the hydrographic properties of water masses in the Adriatic Sea

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The time series analysis of physical and chemical parameters in the northern (Senigallia – Susak Island transect) and middle (Jabuka depression area) Adriatic Sea allowed highlighting and better understanding the anomalies in physical processes such as seasonal and interannual changes in temperature, salinity, density, dissolved oxygen and nutrients. The two data sets’ analysis has pointed out some features of the ten-year climate anomalies recently observed in the northern Adriatic Sea. One of this is the average winter heating of the sea surface. A connection may be established with the Eastern Mediterranean Climatic Transient which started in the mid-eighties and caused substantial changes in the circulation and water masses’ properties. Subsequently, since 1999 it has been noticed that the Adriatic Sea is once again the largest producer of deep water of the Eastern Mediterranean. These evidences confirm the importance of monitoring these easily accessible sites to examine the oceanographic interannual variations in the Adriatic basin.
Mechanisms leading to rainfall anomalies in the Mediterranean region

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In the Mediterranean, the winter rainfall is three times larger than summer rainfall, in fact the rainfall cumulated between September and May accounts for more than the 80% of the annual precipitation. This is because, in the dry season, the rainfall originates in sporadic, localized convective systems, with scarce accumulation. Whereas, during the rainy season, the weather systems originate over the Atlantic, which is a vast source of moisture. The weather patterns are determined by the polarity of the NAO, which is positively correlated with rainfall in north Europe, and negatively correlated with the rainfall in south Europe. This index is characterized by the simultaneous strengthening and weakening of the Iceland low pressure system and Azores high. The NAO persistency is determined by the sea temperature and by the sea-ice/continental snow cover, its spectrum is slightly red, with preferred long periods, although these periods are not sufficiently well defined.

Aloft a north-easterly jet, called Atlantic jet, separates the two elements of the NAO pressure dipole. This jet, maintained by the thermal contrast between the cold polar region and the relatively warm ocean, catalyzes the pattern of the travelling disturbances. The vertically integrated water vapour flow is controlled by this tilt, when it is large, the NAO is positive, and most of the Atlantic moist air is diverted towards north Europe, when the tilt is small, the NAO is negative, and a fraction of the Atlantic moist air is diverted towards the Mediterranean region. The Atlantic storm track favours north Europe, from December till March it rains 30% more in the region positively correlated with NAO (north Europe) than in the region negatively correlated with NAO (south Europe). It follows that the annual rainfall is sizeable smaller in south Europe, making the Mediterranean a region prone to a drought risk. The rainfall distribution in North Europe is mainly related to the tilt of the Atlantic jet, whereas the rainfall distribution within the Mediterranean is determined by the position of the Atlantic jet relatively to the position of the African jet. In fact, it is the cross jet ageostrophic flow which generates the CAPE in the PBL through the thermal advection; in addition the lifting of this air is favoured by the advection of vorticity aloft. This mechanism favours the rainfall in the west Mediterranean in fall, in the east Mediterranean in winter, and in the central basin in spring. The seasonal rainfall anomalies are also related to this mechanism, for instance, when the fall jetstream configuration is similar to the winter one the west basin is relatively dry and the east basin is wet.
Modelling the entire range of the water exchange variability through the Strait of Gibraltar

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The water exchanged through the Strait of Gibraltar determines one of the main components of the Mediterranean water cycle. The exchange varies on a wide range of frequencies, exhibiting tidal, meteorological, seasonal, and interannual variability. Tides account for nearly half the net Atlantic Ocean-Mediterranean Sea exchange due to the correlation between tidal currents and the depth of the interface between the inflowing and outflowing water masses. The inadequate representation of the entire frequency band of the water exchange, and in particular the tidal frequency in a Mediterranean circulation model might lead to an incorrect estimation of the net exchange through the Strait. Here we present the first results obtained running a Mediterranean model that solves the entire range of the water exchange variability. This is achieved by means of both the inclusion of tidal forcing and the use of a non uniform horizontal grid that reaches a resolution of about 1/200° x 1/200° in the Strait.
Monitoring and modeling the dynamics of the Aegean-Levantine basins

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A series of CTD cruises and profiling float deployments reveal an interesting and complicated pattern of the Aegean Sea circulation, dense water formation and exchange with the adjacent (Levantine and Black Sea) basins. The analysis of the collected data set showed a remarkable difference of the Θ-S characteristics along the main north-south axis of the Aegean’s Archipelagos, attributed to the circulation pattern and intrusion of water masses from the Levantine and Black Seas, creating a strong thermohaline front which bounds the convection area in the central Aegean. The combination of the high salinities of the surface waters with the enhanced winter buoyancy loss makes this area favorable for dense water formation, considering both shelf and dense water formation at the plateaus and depressions.

The results are combined with numerical model experiments implemented with the Aegean-Levantine Eddy Resolving Model (ALERMO). Based on the ALERMO modeling/forecasting system and using the ARPERA atmospheric forcing, climatological and interannual simulations are carried out, in order to quantify the hydrological cycle and heat budget of the region, their effect on the circulation and water mass formation and the influence of extreme event variability.
Observationally based regional (Mediterranean area) characterization of spatial and temporal variability of water vapour.

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Preliminary results obtained from a series of on-going analyses aimed to characterize the temporal and spatial variability scales of atmospheric water vapor over the Mediterranean Sea are presented. The main objectives of such characterization are to give a regional and observationally based statistical description of atmospheric water vapor variability and to identify, if any, specific characteristics of the Mediterranean Sea compared to similar mid-latitude Oceans.

The characterization is based on the analyses of observations from a wide variety of sensors selected on the basis of availability of statistically significant dataset and sampling characteristics consistent with the objective of the analyses. In particular, results are shown derived mostly from the analyses of:

- radiosounding from a selected set of WMO operational stations as obtainable from standard archives (e.g. IGRA).
- ship based radiosounding from the ASAP programme.
- a limited (2002 to date) set of sounding from the coastal station of Pratica di Mare (WMO station #16245, 41.67 N, 12.45 E, 35 m a.s.l) for which original 2” to 10” time sampling sounding data are available.
- Total precipitable water (and other geophysical products) from the TMI (1997 to date) and AMSRE (2002 to date) MW radiometers as processed by the Remote Sensing System (www.ssmi.com).

The specific issues addressed are:

- Space/time variability characteristics/scales.
- Vertical structure and its variability including: correlation between water vapour density at different levels, occurrence and characterization of mid-troposphere anomalous distributions,
- Characterization of the relationship between Sea Surface Temperature and atmospheric water vapour.
- Diurnal cycle.
- Representativity of observations from coastal site for open sea description.

Application of the results of the study are foreseen from the observational point of view in the definition of sampling strategies (from intensive observation campaigns to operational networks) and evaluation of derived errors. From the atmospheric numerical modeling point of view, the information obtained from this study can used for statistical validation of numerical models, optimization of the assimilation of water vapour observations as well as in the development (for example definition sub-grid PDF’s for large scale atmospheric circulation models).
Polarimetric radar observations of orographic impact on mesoscale precipitation events

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High-impact weather such as heavy precipitation and flooding is one of the most threatening natural hazards in the Mediterranean region. Since the Mediterranean is surrounded by mountain barriers like the Alps, the Dinaric Alps, the Pyrenees, the Iberian Peninsula or the Atlas mountains, interactions of the low-level flow with orographic structures can trigger deep convection or enhancement of precipitation. Small scale orographic features can lead to strong local enhancements and local flash flood events. Polarimetric Doppler weather radars provide a number of observations which are relevant for the investigation of the microphysical and dynamic structures in extreme mesoscale precipitation events. With a polarimetric weather radar it is possible to study microphysical structures using a hydrometeor classification scheme. Thus, more insight into the mechanisms leading to heavy and long-lasting precipitation is possible. Further, polarimetric weather radar allow for improved rain rate estimation and an estimation of the shape of the rain drop size distribution. Doppler measurements can provide estimations on the wind field and flow structure.

If the observations of two or more Doppler radars are combined it is possible to estimate the 3-dimensional wind field in the overlapping region. Wind field estimates are not only possible within precipitation, but also in clear-air echoes which are frequently observed with C-band weather radars in the vicinity of the radar (typically up to 50 km range).

It is proposed to deploy DLR C-band polarimetric Doppler weather radar POLDIRAD in one of the target regions in the Mediterranean region like coast of Catalonia, Cevennes/Nimes, Corsica, or Adriatic coast of Croatia.
Precipitable water content from ground-based sun/sky radiometer measurements: development of a new in-situ procedure.

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Precipitable water content from sun-photometric direct solar irradiance measurements, taken at the 940 nm wavelength during clear sky conditions, is retrieved by a new in-situ technique. In order to be started, the in-situ procedure needs at least one week of independent measurements of precipitable water content (such as those by radiosondes, microwave radiometers or GPS) taken over a large range of solar zenith angle simultaneously with radiometric measurements, but a methodology was also set up for the cases where such independent measurements are not available. In these cases the procedure was started using monthly estimates of precipitable water content derived from surface observations of relative humidity, pressure and temperature. The procedure is applied to the summer-time data-set recorded in 2007, 2008 and 2009 with sun/sky radiometers PREDE, located at the San Pietro Capofiume station in the Po valley, and in Rome Italy. The proposed technique brings improvement and innovation that arise from the capability of retrieving the best values of constants \((a, b)\), characterizing the atmospheric water vapour transmittance in a way that reduces simulation errors and potentially contains information on seasonal changes in vertical profiles of temperature, air pressure and moisture occurring at each measurement site. Time-patterns and absolute values of the precipitable water content retrieved using the in-situ procedure with the San Pietro Capofiume dataset, were found to be in good agreement with MODIS retrievals and radiosonde measurements, showing high correlation coefficients within the 0.8 - 0.9 range and low percentage median differences, varying between 7% and 13%.

The presented technique is a preliminary development of the retrieval procedure providing the columnar water vapour content from measurements performed with PREDE sun/sky radiometers employed as standard instruments in the SKYNET network.
PROMES-MOSLEF: An atmosphere-ocean coupled regional model. Coupling and preliminary results over the Mediterranean basin

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Over the last year, in the frame of the Spanish project MERCATOP, the regional atmospheric climate model PROMES and the finite element semi-Lagrangian ocean model MOSLEF have been integrated in a unique system named PROMES-MOSLEF. OASIS3 coupler has been used as grid interpolator, inter-model communicator and inter-language communicator to link these two models. Currently, the system can be run in four different modes: atmosphere mode, ocean mode with climatological atmospheric feeding, ocean mode with regional modelling atmospheric feeding, and atmosphere-ocean coupled mode. Following MedCordex specifications, the first simulations using the system PROMES-MOSLEF have been focussed in the Mediterranean basin and the ERA-Interim period. In this work preliminary results obtained by using the system are shown and a comparison of those simulations is also presented.
Radiative fluxes, water vapour, clouds and aerosols observations at the island of Lampedusa

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The ENEA Station for Climate Observations on the island of Lampedusa (35.52°N, 12.63°E, 40 m a.s.l., www.palermo.enea.it/Lampedusa) is the Southernmost atmospheric site in the Mediterranean Sea within the HyMEx project. The station is operational since more than 10 years.

Several instruments are routinely operative at the Station. Beside standard meteorological sensors, Sun photometers (also allowing the retrieval of column water vapour), ultraviolet and visible spectrometers, chemical analyzers (for ozone and greenhouse gases concentrations), a sky imager, a microwave profiler, an aerosol lidar, shortwave and longwave radiometers allow a long-term monitoring of the atmospheric composition and radiative fluxes. In addition, water vapour vertical profiles may be retrieved using radiosondes and a Raman lidar.

The time series of shortwave and longwave fluxes, column water vapour, aerosol and cloud optical depth, will be presented and discussed. The radiation flux measurements allow the determination of some key terms of the hydrologic budget at the sea surface.

This study represents an example of contributions that the Lampedusa site can provide during both Enhanced Observation Period and during the intensive campaigns (Special Observation Period).
Sea level rise over the Mediterranean: present climate and scenario simulations

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A regional atmosphere-ocean coupled model (the Protheus system) has been used to estimate sea level rise in the Mediterranean basin. A present climate simulation has been forced by ERA40 covering the period 1958-2001. Another simulation has been forced by the coupled model ECHAM5-MPIOM for the period 1951-2000 and under the scenario SRES A1B for the period 2001-2050. The present climate simulation has been verified in terms of temperature and salinity against observed data, showing good performances both in the mean values and in the variability. Halosteric and thermosteric components have been computed and the total steric sea level has been compared with satellite data. The comparison with altimeter data has been done for the whole Mediterranean and for sub-basins, the capability of the system to reproduce the inter-annual variability of the sea level has been verified. Data from the scenario simulation have been used to evaluate long term trends for the XX and XXI centuries.
Teleconnections between the Atlantic Niño, WAM and Mediterranean variability in coupled global models

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In order to explore the relationship between Tropical Atlantic Niño-West African Monsoon system and the Mediterranean summer variability, results of two different versions of the Met Office Hadley Centre climate model (HadGEM1 and HadGEM2) are analyzed, and compared with observational results. Both models show a coupled mode of co-variability between tropical Atlantic SST and WA precipitation that resembles the observed one, relating Atlantic Niño-like SST anomalies with a dipole of anomalous precipitation between the Gulf of Guinea and Sahel regions. A regression of the SST-expansion coefficient onto the Mediterranean SST shows anomalies of opposite sign from those of the tropical Atlantic Ocean. The maximum loading of these Mediterranean anomalies move from the western part of the basin at the end of the spring, to the eastern basin at the end of the summer season. These results are in agreement with the relationship between the Atlantic Niño-WAM system and Mediterranean observed during the last decades of the 20th century, after the 70's.
The Climate Shift and the Climate Variability in the Mediterranean region

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The so-called “climate shift” (CS) has been defined as a dramatic change between 1976-77 in the basic state of the tropical Pacific and in the ENSO\(^1\) dynamics. Nowadays, the 1976-1977 shift is interpreted as a phase change in a decadal scale oscillation (the Pacific Decadal Oscillation, PDO) lasting from about 1976 to 1988. However, several changes in the global climate have been reported after the CS; as changes in the air-sea interactions and in the tropical and extra-tropical teleconnection patterns.

The climate variability of the Mediterranean area is influenced by the North Atlantic Oscillation (NAO), which frequency and positive phase intensity have suffered an increase after the CS, without precedents in the instrumental period, and in coincidence with extreme drought conditions in the Mediterranean region. These results remark the non-stationary variability of the NAO and the existence of changes in the underlying dynamics. In addition, Tropical Atlantic Variability (TAV) and ENSO have also shown to exhibit a strong and non-stationary influence in the Mediterranean basin, with maximum correlations at the beginning of the twenty century and since the CS, in concordance with the Atlantic Multidecadal Oscillation (AMO) evolution. A recent singular discovery shows the influence of the Atlantic Niño on its Pacific counterpart, from the end of the 60’s, remarking the increasing importance of the TAV on the global climate and on the observed change, from the 70’s, in the global teleconnections.

In this work, a gridded monthly terrestrial gauge-based precipitation is used to investigate the precipitation variability over Europe and their links to the CS and the multidecadal variability. In this way, an empirical orthogonal function (EOF) analysis has shown a very different behaviour of the first mode of the winter, spring, and autumn seasonal interannual precipitation variability over Europe before and after the CS. In winter, results suggest an important influence of the PDO and AMO in the observed changes of EOF1 before (1950-1970) and after (1979-1999) the 70s, so it seems that the natural multidecadal variability could alter the teleconnection mechanism associated with the precipitation in Europe. To study the multidecadal modulation of the interanual rainfall variability modes, global precipitation analysis products are used for the whole 20\(^{th}\) century, analysing these modes taking or not into account the influence of the AMO and the PDO. Also, the Global Warming (GW) SST signal is considered, based on yearly averaged global SST, which is a good approximation for the observed forced signal. To achieve a better understanding of the teleconnections linked to these changes, and its possible link to the SST variability, a long set of simulations with a General Circulation Model (AGCM), run with observed SSTs, has been also analysed for the same time period.

\(^1\) ENSO: El Niño-Southern Oscillation.
The MedCLIVAR project: a powerful networking scientific programme for promoting the research on the Mediterranean Climate.

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Sponsored by the European Science Foundation and endorsed by CLIVAR programme, MedCLIVAR (Mediterranean Climate Variability and Predictability) project started in May 2006 and will continue until May 2011.

The peculiar geographical location and the topographical features of the Mediterranean area makes it a region which is very sensible to global climate change. The environmental, societal and economical implications related to Mediterranean climate has produced a growing interest in understanding that, encouraging initiatives and research activities. The main goals of MedCLIVAR programme include reconstruction of Mediterranean climate past evolution, description of patterns and mechanisms characterizing its space-time variability, and identification of the forcing parameters responsible for the observed changes. Emphasis has been put on identification of trends present in observational records, on climate predictions under future emission scenarios and on the study of the occurrence of extreme events, closely related to climate variability and change, and of their climate change impacts.

The networking capabilities of MedCLIVAR has put together all expertises in different research sectors and create a forum where to interchange the results and facilitate the synergy. The programme includes the organization of workshops, schools, a scientist exchange program and dissemination of scientific information. Moreover, MedCLIVAR is establishing a systematic archive of observations and model simulations of the Mediterranean Climate, in order both to share these data within the scientific community and to ensure their availability beyond the duration of the project.
Upstream wind field conditions in the western Mediterranean basin monitored by a network of wind profiler radars.

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A network of UHF-VHF wind profilers will be set up on the Mediterranean French coast, in order to describe first the inland and offshore dynamical conditions with the aim of studying the dynamics linked with the initiation of strong rainfall and flood events, and second the inland conditions of air-sea exchanges in case of Mistral or Tramontana winds as well as coastal dynamics. The purpose of this proposal is to extend this wind profilers network to a larger Mediterranean basin involving the French coast, Corsica and Balearic islands, able to provide mesoscale conditions above the Mediterranean sea over a long period extending over one or two years.

To evaluate the capabilities of the radar network, a preliminary work has been performed with MESO-NH numerical model through 3 simulations of heavy rainfall events that occurred during September 2002, October 2007 and September 2009 over respectively the Gard area (south of France), Corsica island and Marseille (south of France): the individual vertical profiles of wind provided by the model for selected sites are used to simulate radar profiles. An optimal interpolation procedure based on these radar-like profiles was applied to different scenario of networks. The retrieved regional horizontal divergences/vorticity as well as the 3D winds are compared to the model output, on the equivalent areas.

This comparison spans 10 days, for 2 cases on 3, which allows surveying the upstream conditions before the strong rainfall events. The computation between the raw 2D simulated wind fields and the network 2D wind fields show that i) the network is able to restore the model fields, ii) the network filters local perturbations (coastal effects for instance).

The network will provide long term observations of upstream conditions over the basin that will be coupled, during the intensive observation periods, to aircraft measurements that will measure dynamics and thermo-dynamics over the area and provide the spatial variability inside the network. The network will also provide mean trajectories and dispersion plumes: the former will be compared to the constant volume balloon trajectories, in case the balloons over fly the network.

The network implementation is planned to last a long period which will be a mean to fulfil some objectives of HYMEX as well as some CHARMEX objectives (gas and aerosol transport) programmes.
Use of CALIPSO lidar observations to characterize and evaluate the cloudiness simulated by the WRF model over the Mediterranean area: methodology and diagnostics

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Non-hydrostatic mesoscale models are more and more used for regional climate modelling studies because of the limitations of global circulation models (GCMs) and the increase of computing performances. Following the emergence of this new activity, the development of adapted methods of validation is needed to check the ability for a model to have a correct radiative budget (for good reasons), which is of high importance for regional climate studies. In particular, clouds are the primary modulators of this budget and still constitute the main source of uncertainty, at least in GCM estimates (Randall et al., 2007). With area limited models, we do not know ‘a priori’ which configuration (i.e. parametrizations, modelling strategies (nudging, regular re-initializations)...) will be the best suited to offer a good representation of cloudiness at regional scales.

New space-borne active sensors make it possible to observe the three-dimensional structure of clouds with good spatial and temporal coverages. However, to make the comparison between modeled clouds and these observations meaningful, it is necessary to take into account the effects of spatial resolution and active signal attenuation. Here, we use CALIPSO lidar observations together with a lidar simulator to evaluate the cloudiness simulated by the Weather Research and Forecasting (WRF) model over the Mediterranean region because of the high vulnerability of this area.

The aim of this study is i) develop a method of comparison well suited for all regional climate studies (i.e. a few ten of km resolution and month to decadal periods) as already done for GCMs (Chepfer et al., 2008); ii) to identify potential recurrent errors in the simulated atmosphere over this area for different seasons; iii) to assess the sensitivity of results to the choice of parameterizations and modelling strategies regarding the biases from observations.

This poster presents the lidar simulator and preliminary results of comparisons. The first stage of the analysis focuses on the cloud occurrence discrepancy between observations and model for the three classes of clouds (low-level, middle and high clouds).
Cb-TRAM: Tracking and monitoring severe convection over the Mediterranean from onset over rapid development to mature phase using multi-channel Meteosat SEVIRI data

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Cb-TRAM is a fully automated tracking and nowcasting algorithm. Intense convective cells are detected, tracked and discriminated with respect to onset, rapid development, and mature phase. In addition, short range forecasts are provided. The detection is based on Meteosat SEVIRI (Spinning Enhanced Visible and Infra-Red Imager) data from the broad band high resolution visible, infra-red 6.2 µm (water vapour), and the infra-red 10.8 and 12.0 µm channels. Areas of convection initiation, of rapid vertical development, and mature thunderstorm cells (cumulonimbus Cb) are identified. The tracking is based on geographical overlap between current detections and first guess patterns of cells detected in preceding time steps. The first guess patterns are obtained with the aid of an image matching algorithm providing complete fields of approximate differential cloud motion. Based on this so-called pyramid matcher also nowcasts of motion and development of detected areas are provided. Examples of application are presented for thunderstorm detection and tracks over the Mediterranean, the figure below for 4 June 2007 is one of it.

Reference:
Analysis of storm structure, motion and interaction with the drainage basin properties for selected extreme flash floods in the Mediterranean area

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Storm structure, storm motion and their interaction with the drainage basins properties play an important role in shaping flood response. With this paper, we examine these characteristics for selected extreme flash flood events.

High-resolution radar observations and raingauge data have been collected for ten flash floods occurred in the Western Mediterranean Region (Spain, France and Italy) in the frame of the HYDRATE EU project. First, the space and time structure of the rainfall observations are examined by using geostatistical analysis. Variograms are used to quantify the spatial structure of rainfall at various temporal aggregations.

Then we use an extension of the method developed by Woods and Sivapalan (1999) to evaluate the dependence of the catchment flood response on the space-time interactions between rainfall, runoff generation and routing mechanisms.

This framework focuses on the first and second temporal moments of the flood response, which are used as a surrogate for time to peak and shape of the flood wave.

The impact of drainage network properties, storm spatial structure and storm motion (and their interactions) are evaluated for the ten flood events, providing a metric to assess the relative contribution in shaping the flood response for extreme runoff events. Implications concerning the monitoring requirements in the frame of the flood risk management activities are discussed.
Measurement of alpine precipitation using an X-band polarimetric radar

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Precipitation is the driving force of natural hazards and water resources in mountainous regions. In these regions, the spatial and temporal variability of precipitation is amplified by the complex interactions between the rugged topography, the atmospheric dynamics and the cloud microphysics. In addition, snowfall is a significant if not the dominant type of precipitation. These characteristics make difficult the quantification of precipitation in mountainous regions.

In order to improve the estimation of alpine precipitation using weather radar, a field campaign has been organized in Davos, Switzerland, during the winter 2009-2010. First, an X-band dual-polarization Doppler radar system has been installed at about 2150 m of altitude, collecting 3D high-resolution measurements of precipitation. Two sites distant of about 5 km have been instrumented: weather stations (providing wind speed an direction, temperature, pressure, solar radiation and humidity), precipitation gauges (heated rain gauges, snow pillow) and disdrometers (Parsivel and video-disdrometer). In addition, daily manual observations of the snow height and density were performed at one of the two sites.

This contribution presents the field campaign (and the issues encountered), some of the data collected so far, and some preliminary analyses.
Shallow Orographic Convection contribution to the water resources in Mediterranean

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Molinié et al. (2010) analyzed extreme rainfall rates at different accumulation periods (hourly to daily time steps) over the French Mediterranean region. Up to 100-year return-values are obtained from the long-term hourly rain-gauge database of OHMCV\(^{2}\). Results show very different patterns of rainfall statistics across accumulation time steps. For a daily time scale, the relief significantly influence the statistics, whereas for the hourly time step, no specific signature is observed. Moreover, the rainfall intermittency is found lower in the mountainous area than in the piedmont and plain areas. These results invite to understand how convection properties determine these space and time features of rain variability. Miniscloux et al. (2001) demonstrated that, during Mediterranean storms, shallow banded convection is persistently established over prevailing locations in mountainous areas like the Cévennes – Vivarais region in France. The intensity produced by these rain bands is moderate, around 10mm.h\(^{-1}\). Nevertheless, the resulting cumulated rainfall can be large when the bands are associated with a stationary flow that depends on the synoptic-scale steadiness. Bands are oriented parallel to the flow (Gysi, 1998; Anquetin et al., 2003) and they are associated with shallow convection: the vertical extension of the clouds does not exceed 6km as deduced from the vertical profiles of radar reflectivity. Numerical studies have already been carried out to bring to the fore spatial and temporal characteristics of such rain bands and to identify their necessary synoptic triggering ingredients. This paper points out the contribution of the precipitation associated to shallow convection to the rainfall regime of the Cévennes – Vivarais region. A specific weather class that purely corresponds to shallow convection is proposed by Godart et al., 2009a-b. The evaluation of its occurrence during the 1976 – 2006 period shows that the contribution of the shallow orographic convection yields up to 20% of the total rainfall and in some locations can reach 40%. This result encourages the deployment of a specific observation device to better document this type of convection during the HyMeX campaign.

References


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\(^{2}\) OHMCV is a long term observatory of Mediterranean hydrometeorology located in the Cévennes Vivarais Region (France)
Verification of an integrated meteo-marine modeling chain with quantitative and qualitative methods

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ISPRA, the Institute for Environmental Protection and Research (former APAT, Agency for Environmental Protection and Technical Services) runs operationally since 2000 an integrated meteo-marine forecasting chain, named *Sistema Idro-Meteo-Mare* (Hydro-Meteo-Marine Forecasting System – SIMM), formed by a cascade of four numerical models, telescoping from the Mediterranean basin to the Venice Lagoon, and initialized by means of analyses and forecasts from the European Centre for Medium-Range Weather Forecasts. The operational integrated system consists of a meteorological model, the parallel version of the BOlona Limited Area Model (BOLAM), coupled over the Mediterranean sea with the WAM model, a high-resolution shallow-water model of the Adriatic and Ionian Sea, namely the Princeton Ocean Model, and a finite-element shallow-water model for the Venice Lagoon, aimed to forecast the acqua alta events. In addition, the physically based, fully distributed, rainfall-runoff TOPKAPI model has been integrated into the system, coupled to BOLAM, over two river basins, located in the central and northeastern part of Italy, respectively. However, at the present time, this latter part of the forecasting chain is not operational and it is used in a research configuration.

The whole system is presently undergoing a thorough upgrade and development process, including so far the parallelization and implementation of the most recent BOLAM version; major configuration (e.g., increase of the BOLAM resolution) and hardware enhancements and improvement of the marine segment are instead planned for the present year. The new BOLAM version (operational since October 2009) replaces the old model parallelization (referred to as QBOLAM), which was tailored in the late nineties for the massively parallel supercomputer Quadrics. Major improvements in the code include convection, radiation, boundary-layer and soil parameterization schemes, explicit advection of five hydrometeors and a more precise advection scheme (namely the Weighted Average Flux).

A first set of verification studies on the upgraded SIMM model chain is presented here to give a primary evaluation of the added value provided by the new implementation with respect to the old one. These include both the assessment of the SIMM performance over selected case studies and the verification of the meteorological model outputs (mainly precipitation) by means of quantitative and qualitative techniques. A multi-method approach is applied to the latter study in order to give a physical interpretation of the verification results; whilst in the case-study approach satellite imagery and ground-based observations are employed to investigate the error propagation along the model chain. Case-study events have been selected to cover a relatively wide range of hazardous weather situations, concerning both the atmospheric and the marine phenomena involved.
Collection of witness reports and evaluation of prediction tools for flash flood events

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This study presents a strategy for collecting unique information about flash flooding at high resolution based on public survey questions. The Severe Hazards Analysis and Verification Experiment (SHAVE), which has been in operation at the National Severe Storms Laboratory (NSSL) in Norman, OK, USA during the summers since 2006, employs a team of undergraduate students to poll the public about impacts related to hail, wind, and now flash floods. This talk describes the criteria used to initiate the flash flood survey, the specific questions asked and information entered to the database, and then provides an analysis of results for flash flood data collected during the summer of 2008. In addition to providing unique insights into the details of flash flood impacts (e.g., severity with respect to residents’ stream proximity and local terrain slope), the SHAVE data have been combined with automated discharge measurements and spotter reports from the US National Weather Service to provide an evaluation of the tools used by NWS forecasters to warn the public about impending flash floods.

It is envisioned that the data collection strategies used by SHAVE could complement observations collected during a field experiment. There is also an opportunity to expand the scope of SHAVE to include questions related to human behavior during flash flood events.
Use of regional distributed hydrological modelling approaches for the design of catchment experimental set up within HyMeX

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Flash floods represent the most destructive natural hazard in the Mediterranean region, causing around one billion Euros worth of damage in France over the last two decades. Flash floods are associated with extreme and rare rainfall events and usually occur in ungauged river basins. Amongst them, small-ungauged catchments are recognized as the most vulnerable to storm driven flash floods. In order to limit the damages to the population, there is a need to improve our understanding and the simulation tools for these events. In order to provide information over a whole region, hydrological models applicable at this scale, and able to take into account the spatial variability of rainfall and catchment characteristics, must be proposed. This paper presents such a regional distributed approach applied to the 8-9 September 2002 extreme event which affected the Gard region in the south-east of France. In order to identify the variables and catchment characteristics which require improved knowledge, two distributed hydrological models were set up on a set of catchments, with sizes ranging from 2.5 to 99 km². The models differ in terms of spatial discretization and process representation. They were forced using radar data with a 1 km² spatial resolution and 5 min time step. The model parameters were specified using the available information, namely a digital terrain model and a soil data base. The latter provides information about soil texture, soil porosity and soil depths. Soil hydraulic properties were defined using pedo-transfer functions. Data from a post-flood field survey of maximum peak discharge were used to assess the quality of the simulations. A reasonable agreement between modeled and observed values was obtained. Sensitivity studies were then performed to assess the respective impact of rainfall estimation and soil variability on the simulated discharge. The analysis shows that rainfall remains the first controlling factor of flash flood dynamics and that high resolution spatial and temporal data are required in order to properly simulate peak discharge and flow dynamics for a range of scales. The river bed roughness also influences the peak intensity and time. Soil spatial representation is shown to have a significant role on runoff coefficients and on the spatial variability of saturation dynamics. For some catchments, the impact of soil properties on the simulated discharges was of the same order of magnitude as the impact of the rainfall estimation. The results were very similar for the two distributed models, despite their difference in structure. They show that the poor knowledge of soil properties, mainly soil depth, initial soil water content and saturated hydraulic conductivity is detrimental to robust estimation of discharge.
A better knowledge of these variables is therefore recommended. In particular soil depth is required. Post field estimation of peak discharge were very valuable for the regional assessment of the methodology, but must be complemented with data of the whole hydrographs to reduce the uncertainty in flow dynamics and runoff production. Effort towards improved quantitative rainfall estimation using a network of radars must also be continued.

The results of the study are used in the design of the future HyMeX experiment, aiming at improving the Mediterranean water balance and the knowledge of extreme events. A strategy based on gauged nested catchments is set up. Detailed measurements of the water balance (discharge, soil moisture, evapotranspiration) are proposed on small catchments of about 1 km$^2$ in order to improve the process understanding.

An intermediate scale is defined for catchments of about 100 km$^2$ with distributed hydrometry, based on Large Scale Image Velocimetry to tackle the change of scale problem. Finally, operational data are used at larger scale of about 1000 km$^2$. These data will also be useful to propose improved modelling tools applicable on ungauged catchments.

The modelling approach is currently enriched to provide continuous simulations in order to study the sensitivity of the hydrological response to initial conditions. These results will be used to determine where observations of soil moisture offer the best potential for improving our understanding.
Atlantic precursors of Mediterranean cyclones: modeling at kilometer scale

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Mediterranean cyclones, and the disasters they potentially result in, are still poorly predicted by operational models for medium-range weather forecasts. Among other factors, the presence of an upper-level trough, originating from the North Atlantic Rossby wave, is a crucial ingredient for the development of such a cyclone. Moreover, it plays an important role in the starting of extreme precipitation events. During the extra-tropical transition of a tropical storm in the North Atlantic, the Rossby wave is itself poorly forecasted. Describing the complex interaction between the storm and the Rossby wave in this situation is still a challenge for operational models. In particular, an insufficient spatial resolution is responsible for a poor representation of strong diabatic effects in clouds. A model with a kilometer resolution allows the use of an explicit convection. It may therefore improve the description and understanding of the extra-tropical transition of a tropical storm, as well as its interaction with the Rossby wave. Thus, a better location of the upper-level trough downstream should follow, and the predictability of any potential Mediterranean cyclone should be enhanced.

This study focuses on the impact of the extra-tropical transition of hurricane Helene on the Mediterranean storm which occurred in South-East Italy on September 26th 2006. This storm was absent in operational forecasts at d+3. On these forecasts, the upper-level trough did not interact with a preexisting surface low which resulted into the storm. This situation is modeled with Meso-NH, the meso-scale non-hydrostatic research model of the French community. Simulations use a domain encompassing both the Mediterranean and the North Atlantic, and start from the ECMWF analysis on September 23rd 2006. They are compared to ECMWF analysis of the subsequent days and to ECMWF forecasts from the same starting date. Microwave observations from the space-borne instrument AMSU-B are also used to better analyze the convection patterns. Runs at 24 km resolution represent the extra-tropical transition of hurricane Helene slightly better than ECMWF forecasts, which use a similar spatial resolution. However, they do not predict the Mediterranean cyclone downstream. Runs at 4 km resolution give the most realistic modeling of the interaction between hurricane Helene and the Rossby wave. Still, the development of the Mediterranean storm remains very sensitive to the precise location and depth of the upper-level trough on Italy.

These high-resolution simulations on large grids take profit of a new generation of supercomputers for intensive parallel calculation recently acquired by the GENCI-CINES (Grant 2010-01-569). This work is done in the framework of the HYMEX and T-NAWDEX programs.
The DTS-MEDEX-2009 campaign

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The Data Targeting (DT) method as a way to improve the forecasting of high impact weather has been already tested in some experiments in the past, even including Mediterranean cases (North-Atlantic TReC 2003, Eurorisk-Preview 2008), but the DTS-MEDEX-2009 campaign is the first campaign in which the DT method has been used to face Mediterranean high impact weather events only, without reference to other regions. For that reason, apart from being an important stage in the MEDEX development, this campaign can provide significant learning for the use of the DT method with operational radio-soundings (and AMDAR) in other Mediterranean campaigns, HYMEX EOP in particular. The DTS-MEDEX-2009 campaign has covered from 1st October to 20 December 2009. During this period 132 Mediterranean cases of high impact weather have been selected; in association with them, 484 extraordinary radio-soundings have been launched from 50 upper-air stations, located in 15 countries. Funding and operational facilities were provided by EUCOS and the software was the Data Targeting System (DTS) developed at the ECMWF for the Eurorisk-Preview 2008 campaign. Although specific studies on the impact of the extra-observations on the forecasting are needed to evaluate the goodness of the method, some preliminary indications about the relative potentiality of this impact can be obtained from examining the frequency of extraneousoundings from different areas and upper-air-stations around the Mediterranean, in connection with the location of the target areas, that is, the areas in which high impact weather was foreseen.
A flash flood early warning system based on hydrometeorological simulation of ensemble weather forecasts

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Focus of this work is to test a hydrometeorological simulation framework for a flash flood early warning system based on probabilistic weather forecasts. Limited area Ensemble Prediction System (LEPS) provided by the COSMO Consortium are used as meteorological inputs into a distributed hydrological model. Initial conditions are taken from the coarser, 5-km operational run of the European Flood Alert System (EFAS) of the European Commission. When a signal for possible flash flooding is detected across Europe, a catchment simulation is run on a fine spatial scale (1 km grid resolution). Forecasted ensemble hydrographs, with lead time of 5.5 days, are estimated and results are compared to a reference climatology run. Coherent reference climatology is obtained through hydrological simulation of a continuous meteorological dataset based on 30-year COSMO-LEPS hindcasts. This is particularly useful for flash flood events, as they often take place in small watersheds, where no gauge measurement is available.

Continuous simulations are carried out over a 17-month time span for a Swiss catchment and prediction skill is evaluated for different forecast lead time. The concept of persistence of meteorological forecasts is also tested as a way to improve the detection of severe events.

First results look promising for a future operational implementation of a flash flood early warning system at the European scale. However, further analyses and comparisons with observed events is recommended, as particular care is to be put in the choice of alert thresholds.
Cloud-Resolving Ensemble Simulations of Mediterranean Heavy Precipitating Events: Uncertainty on Meso-Scale Initial Conditions vs Uncertainty on Lateral Boundary Conditions

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This study considers the short-range kilometric scale forecasts of Mediterranean intense rainfall events and aims at assessing the three major sources of uncertainty for a limited-area model: the uncertainty on synoptic-scale and mesoscale initial conditions, the uncertainty on lateral boundary conditions and the modeling errors in the physical parameterizations and dynamics. For that purpose, methods of generation of ensembles are developed and used to quantify these uncertainty sources and identify the meteorological processes that govern convective-scale predictability of Mediterranean heavy precipitation events based on the fine-scale atmospheric model AROME.

The ensembles are evaluated both over a 31-day period from 6 October 2008 to 5 November 2008, and for two case studies of heavy rainfall events which occurred over Southern France during that period: 21-22 Oct. 2008 and 1-2 Nov. 2008. The methodology is to separately study the impact of uncertainty on synoptic-scale lateral boundary conditions and meso-scale initial conditions.

To quantify the impact of uncertainty on lateral boundary conditions, the first ensemble uses the global short range ensemble forecast of Météo-France, called PEARP, to provide different coupling conditions to the AROME members. The second ensemble assumes perfect lateral boundary conditions and uses an ensemble data assimilation technique. The assimilation of randomly perturbed observations through the AROME 3D-VAR data assimilation scheme samples the analysis error and produces different initial conditions for each member. Further research on meso-scale initial conditions address the case of regions lacking observations (mainly the mediterranean sea in these experiments), through the assimilation of virtual observations.

As part of the TTM1a, this work aims at the development of an experimental high resolution Ensemble Prediction System before the observational phases of the HyMeX project in 2012-2013.
Impact of radar data assimilation on WRF simulations of the Aniene flood

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A study of the Aniene flood, in the urban area of Rome, is performed using Monte Midia Radar data to improve high resolution initial conditions. The radar site is at the border between the Abruzzo and Lazio regions in Central Italy. Mt. Midia top height is at 1760 m and covering most Central Italy, including the urban area of Rome.

Aniene flood occurred during May 20-22, 2008 causing severe damages. The meteorological structure was characterized by a deep cyclone impinging on the Tyrrhenian sea for almost two days. During the event radar detected either local convection northern of Rome and moderate rain east of Rome lasting for several hours. High resolution simulations using WRFV3 model are performed; to the aim of improving the Initial Conditions radar data have been assimilated using 3DVAR. Sensitivity tests to different set of Initial Conditions are performed using either ECMWF analyses and ‘warm start’. Moreover, ‘ad hoc’ radar reflectivity coefficients for the Monte Midia radar have been used to analyze their impact in the model forecast. Finally, to objectively identify the best IC statistical indicators are used as FBIAS, RMS and EQTS for the accumulated precipitation.
08/08/08: the olympic storm event and its implications about severe weather

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An unusually severe storm hit the Friuli Venezia Giulia region (hereafter FVG), northeastern Italy, in the late evening of the 8th August 2008. Noticeable damages (and two casualties) resulted from this storm, in particular in the town of Grado (GO), in prevalence due to very strong wind gusts (up to 45.3 m/s).

This work aims to classify the event in terms of its mesoscale structure through the analysis of a mesonet of about 30 stations measuring 5 minutes meteorological data, the OSMERARPA Fossalon C-band Doppler radar data, the Udine-Campoformido radiosounding data and the Eumetsat MSG images. Moreover numerical simulations have been provided using different LAMs (WRF, ALADIN, MOLOCH), whose outputs have been compared in order to find out limits and good performances and to better understand the synoptic and mesoscale patterns associated to this event.

The results of the analysis highlight that the storm structure had many elements in common with the “bow echo” convective system scheme, which includes mesovortex dynamics that led to water- and land-spouts in addition to strong linear winds. The role of the strong gusting winds has been treated by considering that a density current sloping downhill from the Alps short before the storm could have acted as a high momentum - high static stability flow injected inside a preexisting thunderstorm, generating a strong low level outflow by vertical momentum transfer and negative buoyancy acceleration (similar to the well known “rear inflow jet” mechanism). Some theoretical considerations about the characteristics and the role of such a density current have been considered.

The second part of the work collects 5 different simulations performed by 3 high resolution LAMs: WRF (two different versions initialized by GFS and ECMWF), ALADIN (initialized by ARPEGE) and MOLOCH (initialized by ECMWF). The results show that models generally fail to reproduce the proper intensity of the storm, probably due to the lack of preexisting convection in the simulations during the afternoon and early in the evening. Nevertheless, the density current has been observed and the wind pattern seems to be well simulated.
A fundamental predictability study of orographically modified convection

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Precipitation is known to be strongly influenced by the presence of orography, which acts as a forcing at the lower boundary, affecting both the dynamics and the thermodynamics of flows. The issue of how moist convection reacts to the presence of orography and particularly how this affects the predictability of convective rainfall needs to be measured in a general way. Therefore, we propose a general framework in which to study the fundamental predictability of severe convective events in the presence of orography, in order to quantify the internally generated variability of the convective field. Even if weather forecasts and particularly ensemble forecasts could exactly simulate the large-scale flow fields, there is still much remaining uncertainty owing to the intrinsically chaotic behavior of the moisture and cloud fields themselves (Buzzi et al., 1998). It is this second source of uncertainty that we are trying to quantify.

The study is based on an initial study of P. Cerlini and Kerry A. Emanuel (Cerlini et al., 2005) where, given the lack of predictability studies of convection at these spatial scales (2 km), a general framework has been developed that is able to identify the principal mechanisms of convection responsible for the distribution of variance of the precipitation fields.

Starting from the work of Islam et al. (1993), which quantified the predictability of space-time averages of mesoscale precipitation, our goal was to quantify the internally generated variability of the rainfall field and to further perturb it with an orographic forcing and calculate the effect of this forcing on the predictability of convective rainfall. In order to have a general framework inside which to study convection, we want our simulations to be independent of initial conditions. Then the statistical equilibrium (Emanuel, 1994) of a clouds field with the large-scale forcing on a suitable domain in time and space has been simulated, measuring the rainfall rate and its variance around a stable equilibrium value.

A stable balance has been found between the surface fluxes and the imposed radiative cooling of the troposphere. After the cloud field reaches equilibrium, a stable state for the horizontally averaged rainfall rate has also to be found. As a measure of the natural variability of the convective rain, a normalized variance of the convective rainfall field, defined as the actual variance divided by the total domain averaged rainfall rate, has been computed as in Islam et al. (1993). The limit of this normalized surface variability is how close the prediction error will be to the large scale average: the closer this limit, the larger the prediction error of this particular average space and time scale.

To assess the effect of mountains on this equilibrium and on the rainfall field, a simple analytical 2-D mountain ridge has been implemented. Specifically, depending on the mountain geometry and on the atmospheric parameters (such as wind), several possible interactions between the convective field and orography could be investigated with respect to the impact they have on the precipitation variance.
A Mediterranean atmospheric observatory in Corsica within the framework of HyMeX and ChArMEx


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In the western Mediterranean basin, Corsica is at a strategic location for oceanographic and atmospheric studies in the framework of the Mediterranean projects HyMeX and ChArMEx. The development of a multi-site instrumented platform located on this island is the core of the project CORSiCA (Corsican Observatory for Research and Studies on Climate and Atmosphere-ocean environment). Several measurement sites are planned in various places in Corsica, but the main site gathering the largest panel of measurements will be located near Ersa at the northern tip of the island (Cap Corse).

This area is relevant for many reasons: it is open to the Gulf of Genoa and is not impacted by local and regional anthropogenic inputs. In the close area of Ersa, five sites are particularly interesting: the Semaphore du Cap Corse belonging to the French Navy, the wind-mill farm on the mountain crest, two sites at Centuri and Tollare, and the Giraglia island. Contacts and partnerships have been established with local partners in Corsica: Departmental Centres of Météo-France (CDM 2B and CDM 2A), OEC (the Corsica environmental office, a regional agency co-funding the CORSiCA observatory), the University of Corsica, Qualitair Corse (the local air quality agency) and STARESO (Station de Recherches Sous-marines et Océanographiques, an oceanographic station...
located on the west coast of Corsica). CORSiCA will be operated for the HyMEx and ChArMEx Long Observation Period (LOP), Enhanced Observation Period (EOP) and Special Observation Periods (SOP). In addition, this observatory will also be of interest for the MERMEx experiment (Marine Ecosystems Response in the Mediterranean Experiment). Furthermore, it will be supported by the MOOSE network (Mediterranean Ocean Observing System on Environment) to maintain long-term observations of key atmospheric parameters on this site. In the present communication we will expose the scientific objectives and we will describe the type of instrumentation and observations that have been proposed for a deployment at CORSiCA. Updated informations dedicated to the CORSiCA observatory can be found on the web: http://www.aero.obs-mip.fr/spip.php?article658. All atmospheric and oceanographic initiatives in Corsica are welcome to join the project.
A microphysical study using radar/satellite data and WRF/MM5 high resolution model simulations for two events: Deep convection in the tropical area and a storm in the Mediterranean area.

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A microphysical study has been performed using two different events to the aim of better understanding the dynamics and triggering factors leading to the development of storms. It is known that at high resolution, when the convection is explicitly resolved, the microphysics directly control the development of convection and so the evolution of the storm.

The first event is a deep cyclone, located in the northern tropical part of Australia (Hector, one of the highest storm in the world) and the second one a Mediterranean storm. The investigation has been performed using the observed data from radar e/o satellite, like TRMM Precipitation Radar, TRMM Microwave Imager, CLOUDAT and C-band Radar.

We focused on the vertical distribution of hydrometeors both the static part (cloud ice and cloud water) and the precipitating one (rain, graupel and snow). We compared the observations with the high resolution outputs from the new generation mesoscale model WRF (Weather Research and Forecasting), analyzing the impact of a two moment parameterization. The results suggest that the model well reproduces the dynamics of the events; but the comparison with observations shows a discordance in reproducing the microphysics for amount of hydrometeors. In addition a further comparison has been performed with the high resolution MM5 simulations; on the contrary, MM5 shows a good model ability in reproducing the microphysics for both the amount and the vertical distribution of hydrometeors.
A network of disdrometers to investigate the variability of the raindrop size distribution

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The microstructure of rainfall, and the raindrop size distribution (DSD) in particular, is controlled by the interactions between cloud microphysics and atmospheric dynamics. It is highly variable in space and time over a large range of scales. This variability is a source of uncertainty in the quantitative interpretation of weather radar measurements in terms of rain rate, the variable of interest for many applications. In particular, the variability of the DSD at the radar pixel scale is not well documented and influences the Z-R relationship.

A network of 16 optical disdrometers (Parsivel from OTT) has been deployed over EPFL campus during the last year. All the “disdrometric stations” are autonomous, power being supplied by solar panels and data being collected by radio modem and GPRS. The real-time access to the data is very helpful for early detection of possibly malfunctioning sensors and for data archiving. This network and its components are presented in this work, as well as preliminary analyses of the variability of the DSD at such a small scale (about 1 km²) as sampled by the network.
Aerosol/cloud interactions in the Western Mediterranean during HYMEX

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Investigating aerosol/cloud interactions in the Western Mediterranean provides for some unique and interesting scientific opportunities, but with significant challenges. Of particular interest for this region is the ability to study these interactions for a variety of aerosol and cloud regimes. Compared to most investigations that have occurred in Maritime climates, this region experiences higher aerosol optical depths, warmer SSTs, more complex heating and humidity profiles, stronger mixing and entrainment of aerosols into all layers of a cloud. However these complex environmental conditions makes analyzing these interactions extremely difficult because of variations in liquid water path and radiative effects. Hence, rather than studying how aerosols impact cloud albedo and life time we will focus more on the relationship between aerosols and Cloud Condensation Nuclei/Ice Condensation Nuclei (CCN/ICN) for improving model parameterizations. This task will be carried out in close cooperation with TTM1c (Improvement or parameterizations for high-resolution models using dedicated SOP/EOP observations).

This task relies on observations which will be conducted at ground and onboard research aircrafts over different time frames: (i) Observations conducted during SOP and dedicated to process and closure studies to characterise the aerosol cloud interactions; (ii) Observations conducted during EOP dedicated to establish the spatial and temporal variability of CCN and their impacts on cloud properties.

The objectives are:

- To characterize the spatial distribution of cloud condensation nuclei available for cloud interactions (time scales, fraction of total CCN originating from various sources: desert, volcanoes, sea, fires, biogenic and anthropic sources) under spring and autumn conditions;
- To relate the in-situ measurements to remote sensing observations;
- To compare and/or verify critical measurements that control the role of aerosols in cloud formation.

The means will be:

- the physical (size distribution) and chemical characterisation of aerosol particles and their ability to form cloud droplets from direct activation (CCN measurements) and cloud characterisation (droplet size distribution, cloud residues) along aircraft flights
- the monitoring of CCN/CN and their vertical extension using a LIDAR and in-situ instrumentation network.
An analysis of cyclones in relation with intense precipitation events in the Mediterranean region

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In this study the link between severe precipitation events and cyclones over the Mediterranean region is explored. The analysis considers the second half of the 20th century. Data for the analysis of the cyclones are provided by the ERA-40 (ECMWF Re-Analysis) dataset for the period 1958-2002. Data for the analysis of daily precipitation are provided by the ECA (European Climate Assessment, hosted at Royal Netherlands Meteorological Institute, KNMI) dataset. This study confirms over the whole basin previous results, that were limited only to the west Mediterranean region, showing the presence of cyclones when intense precipitation occurs. A tracking algorithm is used for following the whole development of cyclones and shows a major difference between north-western stations, where systems are either of Atlantic origin or secondary cyclone associate with the passage of major cyclones north of the Mediterranean basin, and eastern station, where cyclones producing intense precipitation are generated inside the basin itself. Many severe precipitation in the southwestern Mediterranean stations are associated with cyclones that are generated over northern Africa. The link between intensity of the cyclone and of the produced precipitation presents important differences across the basin.
Analysis of radar quantitative precipitation estimates for medium-size catchment spatial scale

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The observation of precipitation is still a key issue in meteorological and hydrological modelling. Rain gauge networks are the mostly considered source of rainfall quantitative measurements, despite the difficult reconstruction of precipitating patterns. Great improvements will derive by radar quantitative estimations at high temporal and spatial resolution and the merging of both type of instruments.

The radar quantitative precipitation at ARPA-SIMC is computed from reflectivity which undergoes a process to remove the main known problems affecting rainfall estimates: anomalous propagation detection and beam blocking correction algorithms have been added to the clutter removal based on doppler filter and on climatological clutter maps. A scheme of vertical profile of reflectivity reconstruction is applied to estimate precipitation at the ground. A Marshall-Palmer Z-R relation is used to obtain rainfall rates which are utilized to compute hourly cumulated precipitation by an advective algorithm that takes into account the precipitating system movement.

Preliminary statistical studies show good agreement between radar and rain gauges observations at the scale of radar coverage (range 125 km). An additional investigation focuses on applications over smaller spatial scales, such as dimensions typical of medium-size catchments, in order to evaluate the impact on hydrological predictions. Radar hourly precipitation is also tested as an input for a distributed rainfall-runoff model to simulate a flood event on the Reno river basin, located in Northern Italy (Apennines).
Assimilation of polarimetric radar observations with the Arome model

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Since a few years, some national weather services have begun (or planned) to upgrade their radar networks to dual-polarization capabilities. For instance, France is now equipped with 10 polarimetric radars (out of 24) and more radars will be upgraded in the near future. This choice is primarily motivated by the need to improve the overall quality of existing radar products such as quantitative precipitation estimation.

Besides their roles in data quality controls, dual-polarization observations also provide additional information with respect to conventional reflectivity about hydrometeors, such as size, shape, etc. It is thus of great interest to use these data to initialize high-resolution atmospheric models in order to improve their initial states and subsequent forecasts. In particular, most of the benefit is expected to be on very short-term quantitative precipitation forecasts, the accuracy of which is crucial for flash-flood prediction.

In this study, the operational limited-area French model Arome is used to investigate the potential benefit of the assimilation of polarimetric observations. The Arome model is operated at 2.5-km horizontal resolution with an explicit representation of deep convection. The Arome assimilation system is of three-dimensional variational (3DVar) type, with a typical refresh period of 3 hours. Though hydrometeor contents are predicted by the forecast model through its bulk microphysical scheme, they have not been included in its assimilation system control variable, and they are currently simply passed on from the background state to the analysis without being altered.

In the last decades, a significant effort has been put on the use of dual-polarization measurements to identify hydrometeors, and current research also addresses the derivation of quantitative information, e.g., hydrometeor contents, from these measurements. All this work paves the way for a direct assimilation of hydrometeor contents retrievals. This is done in this study in a simple way: hydrometeor contents are directly modified after the 3DVar analysis step according to polarimetric observations, and the resulting model state is used as initial conditions for the following forecast.

Results will be shown for a case of heavy precipitation that caused floods and mud slides on 21-22 October 2009 over southeastern France.
Background Error Statistics at convective scale in precipitating areas: 
the challenge of including hydrometeors

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Several cloud analysis and nowcasting systems have reached operational status, but their forecasts are only useful for a very few hours. On the contrary, Numerical Weather Prediction (NWP) models at convective scale can directly represent cloud structures with appropriate micro-physical parameterizations and yield forecast that may be valid over longer ranges. NWP however requires a proper initialization which is achieved through the use of data assimilation (DA) techniques designed to incorporate information retrieved from the observation into the model.

Research on quantitative precipitation forecasting makes use of various DA algorithm, including three- and four-dimensional variational data assimilation and the ensemble Kalman Filter (EnKF). Key characteristics of our particular application are the nonlinearity of cloud processes and the complexity of microphysical parameterizations necessary to get a good forecast. Within the frameworks, it is necessary to get better knowledge on the statistical structure of background errors.

The EnkF directly samples the background error covariances over an ensemble, at the expense of getting generally noisy results. On the contrary, the background error covariances for 3D and 4D-Var methods is generally designed as a sequence of operators acting on a reduced set of control variables. The idea of this work is to better understand what challenges are implied by the inclusion of hydrometeors in the control variable.

The methodology is to use a convective scale EnKF on which 3D-Var like Background Error Statistics are computed. To account for flow-dependence at a first order level, statistics are computed separately in precipitating and non-precipitating areas. Preliminary results for the Background Error Statistics of hydrometeors will be discussed, and application to convective scale forecasting over HyMex will be considered.
Classifying severe rainfall events over Italy by hydrometeorological and dynamical criteria

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Abstract: Raingauge data over Italy for the period January 2006 to February 2009 has been used to classify severe rainfall events into two types using a recently developed methodology. The types are defined as either long-lived and spatially distributed (Type I), if lasting more than 12 hours and larger than 50x50 km\textsuperscript{2}, or brief and localized (Type II), if having shorter duration or smaller spatial extent. A total of 81 events were identified, with 51 classified as Type I and 30 as Type II.

The work presented here examines the hypothesis that the two types of event are associated with different dynamical regimes distinguished by differing degrees of control of convective precipitation by the synoptic-scale flow. For each of the 81 events, a timescale for convective adjustment was computed, based on gridded hourly precipitation rates derived from the raingauge data and ECMWF analysis (ERA-Interim) of convective available potential energy (CAPE).

Values of the convective adjustment timescale, tc, shorter than 6 hours indicate convection that is responding rapidly to the synoptic environment (equilibrium), while slower timescales indicate other, presumably local, factors dominate. It was anticipated that tc > 6 hours would correspond to the brief and localized Type II events, while tc < 6 hours would indicate Type I events. This hypothesis was largely confirmed, with 45 of 51 Type I events having timescales shorter than 6 hours, and 20 of 30 Type II events having timescales longer than 6 hours.
Comparison of LAPS analyses with EUMETSAT products for the characterization of cloud cover and instability indices in Mediterranean tropical-like cyclones

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The frequent and comprehensive data collected by geostationary satellites, such as the SEVIRI instrument on board Meteosat Second Generation (MSG), and their derived meteorological products are very important for the weather forecasters for the fast recognition and successful prediction of dangerous weather phenomena such as severe storms.

Recently, NOAA’s Local Analysis and Prediction System (LAPS) has been modified in order to ingest MSG data. The software tool, based on open source codes for geolocation and geographical information systems, has demonstrated a great flexibility. The performance of LAPS in reproducing cloud products such as cloud mask, cloud top height and cloud cover has been evaluated by comparing these products with those provided by EUMETSAT within the Satellite Application Facility on Support to Nowcasting (SAFNWC). Results show an overall good agreement (Conte et al. 2010).

LAPS atmospheric instability parameters were calculated in occasion of tropical-like cyclones recently developed in the Mediterranean basin. Such parameters were compared with the corresponding indices calculated by tools developed at EUMETSAT and based on MSG data.

EUMETSAT instability indices are appropriate to reproduce the large-scale patterns, but they are less useful at smaller scales, as a consequence of the coarse horizontal resolution and the absence of data below clouds. Such limitations are compensated by the LAPS analyses, which provide high-resolution instability indices, but in a limited region, even under overcast conditions. A preliminary qualitative analysis suggests that EUMETSAT and LAPS instability indices agree well in the free-cloud areas covered by both products, suggesting that they can be considered as complementary tools.

References
Dual polarization radar observations of precipitation events in the area of Rome

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The area of Rome represents a unique site for studies on Mediterranean precipitation both for the availability of instrumentation and for its position in the Mediterranean basin. The radar meteorology group of CNR-ISAC of Rome manages the coherent C-band Doppler dual polarization radar Polar 55C. The radar has been working since 2001 at the Rome ISAC site, located 30 km northeast from the coast of the Tyrrhenian Sea and 20 km southeast of Rome downtown (41°50’24” North, 12°38’50” East, 102 m asl). Polar 55C can observe precipitation over the farthest part of the Tiber basin, the urban area of Rome, the Appennin Range (where snow precipitation can occur during winter season), and a significant portion of the Tyrrhenian Sea. In the current configuration, Polar 55C can measure radar reflectivity factor, differential reflectivity, Doppler velocity, Doppler spectrum and differential phase shift. Polar 55C can play a key role in the study of the interaction between the local and the mesoscale circulation and for the observation of meteorological events involving the city of Rome. Being a research radar, it is operated according to scientific objectives, that can range from radar applications to hydrometeorological modelling of urban and rural areas to the ground validation of precipitation satellite measurements.

Studies on quantitative precipitation estimation are focused on dual polarization radar techniques. Within the coverage area of Polar 55C radar is the network of telemetered raingauges and hydrographs managed by Servizio Idrografico Regionale (the regional hydrologic service) of the Lazio regional government. Average spatial density of the network raingauges is 1 per 100 km\(^2\) and become quite dense within the historic center of Rome. Most of the raingauges have a 5-minutes time resolution and some of them have a resolution of 1 min.

In the year 2008 several interesting case studies have been observed by Polar 55C. Some of them will be discussed to highlight the use of dual polarization techniques to overcome critical aspects of radar rainfall estimation. Example concerns also the analysis of the scaling properties of rainfall in space by using data from the raingauge network and Polar 55C over the area of Rome. The aim is the identification of spatial scaling regimes, their ranges of validity, and the evaluation of the corresponding scaling properties and the dependence structure of rainfall (time and space correlation between time series for different time scales).
Effects of slope length and rain intensity variations on surface runoff: experiments and modeling in the Pradel OHMCV Super Site

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Soils respond to intense rains by producing surface runoff which contributes to river flow. Specific discharge is known to decrease with the size of watersheds which implies internal re-infiltration processes. In this study, two possible causes of re-infiltration are examined through rain simulation experiments: the effect of slope length on steady regime runoff and the rain intensity variations. Results tend to show that, in the case of intermittent rain, significant re-infiltration occurs between showers. On the other hand, no effect of slope length on steady regime runoff was found. Rain intensity variations had a lesser influence when mean intensity increases. When runoff occurs, the infiltration flux was found to increase with increasing rain intensity contrary to the classical Horton infiltration theory. This was attributed to the role of surface microrelief. A modeling approach based on a simple statistical simulated microrelief rather than a complete description of microtopography and coupled with an elevation-dependent hydraulic conductivity gave satisfaction in reproducing the observed runoff hydrographs.
Evolution and growth of perturbations in a convection-resolving model

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A breeding technique is used to estimate the linear and non-linear evolution of small perturbations in the convection-resolving, non-hydrostatic atmospheric model MOLOCH. The model is run at about 2.3 km resolution for an episode of heavy convective precipitation and flood affecting north-eastern Italy. Perturbation growth is characterized by estimating the doubling time. Linearity indicators are used to estimate the time period of validity of the tangent linear approximation. Planned development of the work concerns the possibility of controlling error growth by assimilating appropriate observations.
Exploring some uncertainties of flash-flood simulations with ISBA-TOPMODEL coupled system on Cévennes-Vivarais watersheds.

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The French Cévennes-Vivarais region has been identified as a key site to instrument and study during the HyMeX EOP/SOP. Indeed, this region is prone to flash floods during the fall season. Those particularly dangerous floods are caused by heavy rainfall events that occur over some small to medium basins. Flash-flood forecasting depends on several factors that interact each others and impact the hydrological response of the Mediterranean basins to a heavy precipitation event. First, the hydrological response is sensitive to the soil moisture initial state which is not well known, in particular due to the representativeness problem of the soil moisture measurements. Another key factor is the spatial and temporal distribution of surface rainfall. Moreover, not only the uncertainties on the initial conditions and rainfall affect the predictability of the simulated discharge, but also the model errors have to be taken into account. Several uncertainties have thus to be considered to build an ensemble hydro-meteorological forecasting system for flash-flood forecasting.

The hydrological model used in this study is the ISBA-TOPMODEL system which was developed within the framework of the GMES/PREVIEW project to simulate the Mediterranean flash-floods based on high-resolution meteorological forecast. ISBA-TOPMODEL has been calibrated for four watersheds of the Cévennes-Vivarais region (Ardèche, Cèze, Gardons and Vidourle) with areas ranging between 550km² and 1500km². A sensitivity study to the initial soil moisture conditions has been carried out for the flash flood event of 5 to 9 September 2005 within the framework of the MEDUP (MEDiterranean Uncertainties Propagation) project. We tested several initial soil moisture conditions produced by the ISBA model using different configurations of this model. Besides, as a first step to investigate about uncertainties coming from the hydrological model, we varied the ISBA-TOPMODEL coupling time steps. Also the rainfall uncertainty propagation into the hydrological modeling was studied using some meteorological outputs of the AROME French convective-scale operational model of Météo-France. Results of the ISBA-TOPMODEL driven by the deterministic AROME forecasts showed that the location of the heaviest rain with respect to the catchments is crucial. To go toward a more probabilistic approach, the hydrological coupled system was driven by an ensemble AROME rainfall forecast on two events that occurred in October and November 2008. The results of this quite computationally expensive method are compared to those of a cheaper one which consists in introducing perturbations in the deterministic AROME rainfall forecast.
Flash flood prediction for ungauged catchments

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Flash flood is a very intense and quick hydrologic response of a catchment to rainfall. This phenomenon has a high spatial-temporal variability as its generating storm, often hitting small catchments (few km²). Data collected by (Gaume et al. 2009) about 500 flash floods over the last 50 years showed that they could occur everywhere in Europe and more often in the Mediterranean regions, Alpine regions and continental Europe. HYMEX project is about such extreme events occurring in the Mediterranean region. It aims at a better understanding and quantification of the hydrological cycle and related processes in the Mediterranean with emphasis on high-impact weather events. Given the small spatial-temporal scales and high variability of flash floods, their prediction remains a hard exercise as the necessary data are often scarce. Flash flood prediction on ungauged catchments is one of the challenges of hydrological modelling as defined by (Sivapalan et al. 2003). Several studies have been headed up with the MARINE model (Modélisation de l’Anticipation du Ruissellement et des Inondations pour des évèNements Extrêmes) for the Gard region (France), (Braud et al. 2010), (Castaings et al. 2009). This physically based spatially distributed rainfall runoff model is dedicated to flash flood prediction. This study aims at finding a methodology for flash flood prediction at ungauged locations in the Cévennes-Vivarais region in particular.

The regionalization method is based on multiple calibrations on gauged catchments in order to extract model structures (model + parameter values) for each catchment. Several mathematical methods (multiple regressions, transfer functions, krigging…) will then be tested to calculate a regional parameter set. The study also investigates the usability of additional hydrologic indices at different time scales to constrain model predictions from parameters obtained using these indices, and this independently of the model considered. These hydrologic indices gather information on hydrograph shape or catchment dynamic for instance. Results explaining global catchments behaviour are expected that way. In a multi scale point of view, regional characteristics about catchments geomorphology or rainfall fields’ statistics should provide useful insight to find pertinent hydrologic response indices. These considerations with physically based distributed modelling may bring better understanding on flash floods generating mechanisms and catchment responses.

References:
Forecasting of large scale circulations propitious to Mediterranean Heavy Precipitating Systems with an operational ensemble prediction system at Meteo France

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The CYPRIM French national project has provided a climatological based definition of two classes of Large Scale Circulations (LSCs) propitious to the occurrence of HPEs. The classes were built with a clustering technique applied on the ERA40 reanalysis for the geopotential height at 500hPa and compound with specific patterns of the moisture flux at low levels. Reciprocally, the events that are suitable with these atmospheric parameters, correspond to HPEs with a 70% success rate, and represent 25% of the whole set of HPEs. At the start, this methodology has been designed to be applied on climatic scenario simulations, but we present here an alternative experiment for which we consider the presence of LSCs patterns in ensemble forecasts. We examine the potential of this technique to qualify the severity of the case with a larger anticipation than what could be determined only the interpretation of the forecast output. Moreover, using an ensemble prediction system contribute to quantify the uncertainties propagated by the method. We present the results of this experiment framework of several noteworthy cases of southern France HPEs.
Heavy precipitation systems observation at high resolution using Doppler Polarimetric measurements obtained with the \textit{FM-CW} TARA radar

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One of the main objectives stated by the HYMEX White Book is to improve the estimation and forecast of Heavy Precipitation Events (HPE) over the Mediterranean region. HPEs result from a complex interaction of multiscale atmospheric processes which are, nowadays, still difficult to comprehend in models. As stressed by WG3, high-resolution observations inside precipitation systems are currently missing for the validation and improvement of parameterization of physical processes involved in HPEs (microphysical processes, turbulence…).

At the Delft University of Technology, the ground-based profiling TARA radar (Transportable Atmospheric Radar) combining Doppler and Polarimetric capabilities is being used for retrieval techniques which are currently tested in order to characterize the microphysical (particle type, orientation and size distribution) and dynamical (3D motion of the particles) characteristics of precipitating convective systems. By simultaneously performing high resolution Doppler and Polarimetric measurements at two polarization states, accurate spectral polarimetric parameters ($s\text{Zhh}$, $s\text{Zdr}$, $s\text{Ldr}$…) can be computed and used to derive information on the axis ratio (from dual-polarization) versus the size (from Doppler velocities) of the cloud and rain particles being probed.

TARA is an S-Band radar which allows measurements from any type of precipitation and ice / mixed-phase clouds. Therefore, TARA is suitable for the observation of different meteorological situations such as orographic precipitations, frontal and mesoscale convective systems.

The TARA radar was already part of the COPS (Convective and Orographically-induced Precipitation Study) measurement campaign in summer 2007. The advantage of combining TARA with other ground-based devices for the determination of the life cycle and internal dynamics of precipitation systems was demonstrated.

For the above-mentioned reasons, the settlement of such a radar within the HYMEX campaign would be of great help in answering the key scientific questions WG2-SQ1 and WG3-SQ2 presented in the HYMEX White Book within working group 2 and 3 respectively.
Hi-resolution observational capabilities dedicated to the severe weather monitoring of the Greek peninsula.

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Joint research efforts by the Hellenic National Meteorological Service (HNMS), the Hellenic Center for Marine Research (HCMR)-Department of Inland Waters and National Aeronautics and Space Administration (NASA) are proposed as the basis for significant advancement of continental/oceanic water cycle and extreme weather monitoring capabilities over the Greek peninsula. HNMS currently operates a network of six C-band Doppler (WSR-74M/TDR 43-250K/ DWSR 2501) radars (from which two operate in dual-polarization), and two S-band Doppler (WSR-74M). The nominal operational long range is 250 km and the short one is 150 km for the C-bands and 400 km is the long range for the S-bands. In addition, HNMS has successfully installed and is currently operating the first Lightning Mapping Array (LMA) over Southeast Europe. The network’s observational capabilities enable the lightning monitoring at high spatial and temporal resolutions over Greece and surrounding waters.

The LMA consists of 8 Precision Lightning Sensors (PLS) with an external component (antenna, GPS) and the post-processing unit (the PLS HYMEX 4th Workshop, Bologna, Italy, June 8-10, 2010 receiver). The LMA detection (retrieval) method is based on the widely used Time Of Arrival (TOA) method while both Cloud-to-Ground (CG) and Cloud-to-Cloud (CC) location along with their respective polarities and peak currents are routinely recorded. Complementary to the aforementioned, the co-deployment of the Passive Acoustic Listeners (PAL) at selected HCMR’s Poseidon buoy mooring sites presently allows the continuous retrieval of oceanic precipitation and surface wind. An additional key parameter that controls the regional water cycle and potential storm severity is the water vapor availability within the planetary boundary layer. Recent advancements in the satellite retrieval techniques enhance the approximation of surface mixing ratio via the synergistic usage of the MSG-SEVIRI, available observations originating from various platforms (e.g. radiosondes, satellite profiles of specific humidity/air temperature) as well as numerical modeling (i.e. radiative transfer).

The current joint HNMS-HCMR-NASA research focuses on both the now-and fore-casting applications such as 1) radar-based estimation and validation (disdrometer/PAL) of rainfall rate (lowest averaged four elevations), product which is further introduced in the surface hydrological modeling and flood risk assessment of targeted basins 2) lightning/precipitation (off line) assimilation in short-term forecasting applications 3) severe weather alert via the polarimetric (microphysical) characterization of electrified clouds 4) effects of strong/electrified convection in...
the upper tropospheric water vapor 4) the study of intense air-sea interaction regime in terms of continuous MSG retrieved surface mixing ratio. All the highlighted applications are currently being tested based on historical test-cases that involve transient weather extremes over the Greek peninsula. Within the HyMeX framework, this intra-institutional research initiative and observational capabilities will effectively enhance the understanding of critical compartments of the water cycle. Furthermore, the herein proposed effort and research activities can potentially act as a more HYMEX 4th Workshop, Bologna, Italy, June 8-10, 2010 responsive tool in the severe weather short term forecast over an area where few years ago, observations where sporadic at best.
Historical flash flood impact in Mallorca and its future evolution

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The paper analyzes the flooding impact in Mallorca from an historical perspective since the Xxth century and with a focus in the latests events and its future evolution related to population growth and urban expansion.
ICT-based hydrometeorology science and natural disaster societal impact assessment: DRIHMS project contribution


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In the Lisbon strategy, the 2005 European Council identified knowledge and innovation as the engines of sustainable growth and stated that it is essential to build a fully inclusive information society. In parallel, the World Conference on Disaster Reduction (Hyogo, 2005), defined among its thematic priorities the improvement of international cooperation in hydrometeorology research activities.

This was recently confirmed at the joint press conference of the Center for Research on Epidemiology of Disasters (CRED) with the United Nations International Strategy for Disaster Reduction (UNISDR) Secretariat, held on January 2009, where it was noted that flood and storm events are among the natural disasters that most impact human life. Hydrometeorological science has made strong progress over the last decade at the European and worldwide level: new modelling tools, post processing methodologies and observational data are available.

Recent European efforts in developing a platform for e-science, like EGEE (Enabling Grids for EsiencE), SEEGRID- SCI (South East Europe GRID e-Infrastructure for regional e-Science), and the German C3-Grid, provide an ideal basis for the sharing of complex hydrometeorological data sets and tools. Despite these early initiatives, however, the awareness of the potential of the Grid technology as a catalyst for future hydrometeorological research is still low and both the adoption and the exploitation have astonishingly been slow, not only within individual EC member states, but also on a European scale.

With this background in mind, the goal of the Distributed Research Infrastructure for Hydro-Meteorology Study (DRIHMS, co-Founded by the EC under the 7th Framework Programme) project is the promotion of the Grid culture within the European hydrometeorological research (HMR) community through the diffusion of a Grid platform for e-collaboration in this earth science sector: the idea is to further boost European research excellence and competitiveness in the fields of hydrometeorological research and Grid research by bridging the gaps between these two scientific communities.

Furthermore the project is intended to transfer the results to areas beyond the strict hydrometeorology science as a support for the assessment of the effects of extreme hydrometeorological events on society and for the development of the tools improving the adaptation and resilience of society to the challenges of climate change.

The methodology of DRIHMS is to convene two small meetings of expert groups, involving the proposers and invited experts, in the first case from the HMR community, and secondly from the ICT sector. The work of these groups will be supplemented by surveys and questionnaires, where
input from the broader communities is sought, leading to a draft version of a white paper delineating a new strategy for Grid and other e-science technologies in hydrometeorology. An open conference will be organized, supplemented by web-based communication, to discuss the results of the consultation phases and the draft version of the white paper with the stakeholders. This presentation will be devoted to provide an overview of DRIHMS ideas, of the potential connections with the HyMeX project and to present the preliminary results of the DRIHMS HMR survey.
Idealized numerical study of Mediterranean heavy precipitating events: identification of favouring ingredients

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During the fall, in the western Mediterranean region, Heavy Precipitating Events (HPEs) frequently occur and can cause torrential rain and flash-floods. They are often generated by Meso-scale Convective Systems (MCSs) which are back-building phenomena with a continuous convective cell renewal. The meteorological ingredients favouring these MCSs are quite well-known: a slow-evolving synoptic environment associated with conditional convective instability, low-level moist flows from the sea and an orographic barrier. Moreover previous studies have identified the three main mechanisms of deep convection triggering and maintaining of such event as low-level convergence, orographic forcing and Low-Level Cold Pool (LLCP). Understanding how these ingredients impact the mechanisms combination and interaction to produce more or less precipitation with different locations of MCSs (over the mountain, upstream over the plains or the Sea) is still an open question. This study focuses over Southeastern France, which is the most affected area of this country. It contributes to address this question, based on high-resolution idealized simulations of MCSs over this region, for which the intensity of the flow, the environmental humidity and the orography alternatively vary. To identify the prominent mechanisms, Lagrangian backward trajectories and Eulerian passive tracers are used and budgets are also performed to highlight the water vapour role in the intensification of MCS precipitation.

The location and intensity of the Mediterranean quasi-stationary MCSs do not depend on an unique combination of deep convection triggering mechanisms. Thus the environmental characteristics impact on the deep convection mechanisms and consequently on the behaviour of the MCS. Slower flow speeds or dryer environments generate a quasi-stationary MCS over the sea. In these cases, deflection around the relief is larger and in turn increases the low-level convergence over the sea. Due to under-saturated lower-levels, precipitation can more easily evaporate and form a LLCP which acts in lifting the low-level moist and instable air masses at its leading edge. Orographic forcing becomes predominant for faster or moister flows, thus the system settles over the mountain range and its precipitation intensity is strongly related to the low-level water vapour supply. This study helps to identify the impact of environmental ingredients on the behaviour of MCSs and define regions and mechanisms that are important to better document during the HyMeX Special Observation Period.
Lightning activity and precipitation in South of France from August to December between 1992 and 2008

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The relationships between lightning and precipitation have been investigated in South of France in preparation to the SOP1.n of the HyMeX experiment. The studied area centered on (4.5° E; 44° N) ranges from -100 km to 120 km in the East direction and from -50 km to +140 km in the North direction, and the whole data set covers 5 months (August to December) over 17 years (1992 to 2008). Provided by the METEORAGE cloud to ground flashes (CG) detection network, lightning activity is analyzed in terms of CG flash density and positive CG percentage (relative to the total CG activity) on a regular 2.5-km mesh grid. Precipitation records are studied based on 1-h rain accumulation provided by METEO-FRANCE rain gauge network. Several CG lightning hot spots have been identified in the SOP1.n area: between Aubenas and Vallon-Pont-d’Arc, close to Alès, around Nîmes, and over the Mont Ventoux. The precipitation reports are currently analyzed for these specific hot spots in terms of temporal series in presence or not of CG lightning activity, as well as diurnal and seasonal cycles of CG lightning and precipitation. Present study focuses also on the relationship between CG lightning and precipitation versus altitude, especially in the Cévennes-Vivarais region (1 km of resolution).

The results show that CG lightning activity increases to a maximum at mid height of the relief in August and decreases further at higher altitudes. From September to December, no maximum is observed and the CG lightning activity decreases as soon as the altitude is about the third of the average maximum altitude of the studied area. Precipitation behavior is currently being investigated within the same area.
Lightning activity in relation to thermodynamics, dynamics and microphysics in storms over Paris region

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Lightning activity produced by storms is related to their thermodynamics, dynamics and microphysics. PEACH (Projet d’Electricité Atmosphérique pour la Campagne HyMeX) proposes to investigate this issue as part of the global HyMeX project. One of the goals is to contribute to heavy precipitation forecast and/or to develop tools to help in rainfall estimation, by using the lightning activity.

The purpose of the study we are currently carrying out on the Paris region (region chosen for the diversity of available data), is to build analysis methods to highlight links between lightning, thermodynamics, microphysics and heavy precipitation. We focus on several events of 2009 which presented some interest in a sustained lightning activity and during which some experimental data on intra cloud (IC) sources activity were available. During the days 24/08/2009 and 07/10/2009 storm activity crossed Paris region from south-west to north-east. These 2 situations were quite different. The former presented several small cells which merged leading to 2 distinct convective systems identifiable between 11:00 and 22:00 UTC. The second presented a large system composed by 3 cells at beginning which merged quickly in one cell between 15:00 and 21:00 UTC. For these two days, the links between cloud-to-ground (CG) lightning activity (LF data from METEORAGE network) and cloud top temperature (infrared channel between 10.5 and 12.5 µm from METEOSAT Second Generation (MSG)) are analyzed. The first results show that the lightning activity generally tends to precede the maximum of the area covered by the coolest temperatures. The new products on 3D restitution of reflectivity factor and dynamics issued from the French Doppler radar network ARAMIS are used in association with the CG lightning activity. So, several aspects of the correlations between CG lightning activity parameters (rate, location, polarity) and radar reflectivity are considered. Especially, the association of the CG flashes with the reflectivity factor is estimated versus time and height in the thundercloud. The role of the cell merger process is found resulting in an intensification of the CG lightning activity. Next steps are to study in a first time, the links with microphysics (issued from dual polarimetric C-band Doppler radar of Trappes) and, in a second time, all these links with the VHF sources activity including all flashes (CG and IC) issued from an interferometer system (LS8000 developed by Vaisala).

All these data will be available during HyMeX campaign and will allow analyzing the storms in Mediterranean region with methods developed in this study on Paris region to highlight links between lightning activity and others processes related to different kinds of storms. The results will be used to improve the understanding of intense precipitating systems and to find a representation of heavy precipitations to enhance their predictability.
Lightning measurements and its application for severe storm detection and nowcasting

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This study demonstrates some aspects of thunderstorm detection and nowcasting with relevance to the HyMeX project objectives. Lightning is closely related to thunderstorm microphysics and dynamics and, thus, connected to a variety of severe weather elements like heavy rainfall, hail, downbursts, gust fronts etc. The LINET lightning detection network offers high stroke detection efficiency and a CG/IC discrimination based on VLF/LF measurements of lightning emissions. In combination with polarimetric radar observations it is possible to infer the temporal evolution of radar-derived properties like graupel, ice, rain and hail content, cloud top height, or Doppler velocity patterns in connection with lightning parameters like stroke and flash rates, CG or IC fractions, or polarity of the events. The graupel-ice region of the storms is found to be the preferred IC location region rather than the hail core itself.

The combined lightning-radar information is used in case studies of convection for looking at the processes associated with severe weather caused by thunderstorms. On the other hand, this information is used for tracking and nowcasting of convective cell development. A new thunderstorm tracker ec-TRAM (Tracking and Monitoring of electrically charged cells) has been developed in order to identify, track, and monitor thunderstorms by combining the information of independently tracked radar and lightning cells. LINET lightning cells are identified and tracked, based on spatially and temporally clustered lightning frequency maps. Radar cells are identified and tracked, based on high-resolution two-dimensional ground precipitation scans, which also are used for nowcasting of convection.

The tracking procedure also allows for setting up a cell inventory which enables a statistical investigation of cell parameters and their correlations (like relations between lightning and ground precipitation).
Meteohydrological modeling and monitoring in Liguria (TA NW Mediterranean sea)

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The Liguria region, located in the North-Western Mediterranean, is the small area of Northern Italy where the southern Alps and the northern Appenines link themselves creating a mountainous chain near the sea. Catchments extension goes from few km² to a maximum of 1600 km² (Magra River); floods and flash-floods occur due to heavy rain.

For meteo-hydrological purposes, the aims of Liguria Regional Agency for Environment Protection (ARPAL) are: meteorological forecast, real-time observations and discharge measurements in order to obtain the rating curves for most of the stream level gauging stations.

Several catchments are almost widely monitored both for "classic" meteorologic and hydrologic parameters (precipitation, air temperature and moisture, wind, solar radiation, barometric pressure, stream level and discharge), and data can be used for HyMeX purposes, especially for high resolution ensemble hydrometeorological modelling.

The poster shows how operational ARPAL activity almost matches some aims of HyMeX, and shows also what could be improved during HyMeX both for observational and modelling systems (especially for coupled ones) and for the improving of hydrological models performance.
Meteo-hydrological predictions: testing different ensemble approaches

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For medium-sized catchments, characterized by short response times, hydrological predictions have to rely on quantitative precipitation forecasts (QPFs) issued by meteorological models. Although meteorological predictions are becoming more and more accurate, QPFs are still affected by errors which can be relevant at the scales of interest for hydrological purposes. In order to represent the uncertainty inherent to QPFs, the ensemble forecasting approach is becoming a common practice for operational hydrological predictions. This approach provides multiple precipitation scenarios to be used as the input for a hydrological model. The hydrological model propagates the uncertainty in the flood forecasts, providing a more informative and probabilistic hydrological prediction.

In the present study, two different ensemble approaches are tested in a real-time configuration:

1) A multi-model forecasting system based on four mesoscale models (BOLAM, COSMO, MOLOCH and WRF), implemented at different horizontal resolutions, ranging from 8 to 2.5 km.

2) The COSMO-LEPS (Limited-area Ensemble Prediction System) ensemble, an operational limited-area forecasting system based on the COSMO model, run at 10 km resolution and driven by the ECMWF Ensemble Prediction System.

The forecast hourly rainfall fields are then used to drive the distributed rainfall-runoff model TOPKAPI.

Preliminary results concerning a recent severe episode affecting the Reno river basin, located in Northern Italy (Apennines), are analyzed and compared in terms of precipitation and discharge predictions.
Modeling long-lasting deep convective systems over sea in the Mediterranean basin

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Long lasting deep convective storms are of particular interest because of their potential damaging power. Many studies, analysing the dynamical characteristics of these precipitating systems, highlighted their stationary behaviour as one of the most important dynamical feature along with their cloud microphysics properties. Every single long lasting convective system is responsible of large rainfall amount and can produce casualties and hazards over a large area. The quasi–stationary characteristic is a consequence of interaction between large and local scale atmospheric–oceanic circulation. Only properly defined model settings, both in dynamical and thermo–dynamical numerical schemes, were able to reproduce such a multi–scale interaction.

Three different fall - winter storms occurred in the Tyrrhenian and Ionian Sea have been analysed and shown using a non – hydrostatic, high resolution numerical model (the Regional Atmospheric Modelling System – RAMS) forced with global atmospheric model and remote sensed sea surface data. The RAMS model was set with a very high horizontal and vertical resolution: 2km grid spacing and a stretched vertical spacing (from 22 m, near surface, to 1200m, in the troposphere). The large scale atmospheric forcing was provided by the NCEP – NCAR Reanalysis – II dataset, and a telescopic nested sequence of model domains was adopted for feeding the finer grid domain, of 30km and 8km of horizontal grid spacing respectively. Observed sea surface temperature (SST) data from MODIS sensor was used in order to provide a detailed description of vapour exchanges between sea and atmosphere.

High-resolution RAMS model simulations have shown a good representation of atmospheric dynamical evolution of such severe convective systems and, in particular, of the low level integrated moisture transport. Using the detailed parameterisation scheme for cloud microphysics dynamics, the model reproduced quite accurately these convective storms events. In particular location, cloud top properties and rainfall amount were well represented. The stationary phase was reproduced even if its duration was shorter with respect to available observations.

Common dynamical features, from this study, were identified as potential factors for localizing and sustaining stationary convection over sea: dynamical instabilities produced by the interaction between stationary large scale circulation and surrounding environment (like neighbourhood mountain ridges) as triggering mechanism, wind shear and positive anomalies of sea surface temperatures to sustain convection.
Numerical Simulations of Conditionally Unstable Flows over a Mountain Ridge

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Numerical simulations of conditionally unstable flows impinging on an idealized mesoscale mountain ridge have been performed with an explicitly resolving cloud model. These idealized simulations allow the investigation of the solution precipitation characteristics as a function of the prescribed environment. The numerical solutions were first carried out for different uniform-wind profiles impinging on a bell-shaped ridge 2000 m high and for intermediate-to-high values of Convective Available Potential Energy (CAPE). In the experiments with weaker environmental wind speeds (2.5 m/s), the cold-air outflow, caused by the evaporative cooling of rain from precipitating convective cells, is the main mechanism for cell redevelopment and movement; this outflow produces new convective cells near the head of the up- and down-stream density currents, which rapidly propagate far from the ridge, so that no rainfall is produced close to the ridge at later times.

For larger wind speeds (10, 20 m/s), there is less time for upwind, evaporation-induced, cold-pool formation before air parcels reach the ridge top and descend downwind and so the (statistically) steady rainfall tends to be concentrated near the ridge top. Further experiments with different ridge heights and half-widths were carried out in order to analyze their effect on the distribution and intensity of precipitation.

Dimensional analysis suggests a functional dependence of the maximum (nondimensional) rainfall rate on three parameters, related respectively to the triggering and the orographic forcing of convection and to the ratio of the advective to convective time scales. If we extend that analysis in order to include experiments corresponding to a wider range of CAPE, it is found that the low-CAPE, moderate-wind experiments do not fit the functional dependence for rainrate amount and location proposed for larger CAPE and that two additional nondimensional parameters should be taken into account.
Planetary boundary layer of the urban area of Rome: High resolution model simulation (WRF) and ground based observations.

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A planetary boundary layer (PBL) study is performed with the aim of better understanding the leading factors on dynamics in urban areas, since urbanization significantly affects local thermo dynamical conditions and PBL evolution.

The new generation model WRF has been used to reproduce the circulation in the urban area of Rome. The ability of the model to simulate the characteristics of the urban PBL is tested by comparing model results with observations coming from several instrumentations such as LIDAR, SODAR, sonic anemometers and soundings measurements. A further comparison is performed with the mesoscale model MM5.

A sensitivity study is performed using different PBL parameterizations for wind, temperature, turbulent fluxes, PBL height and water vapor content; a tendency of the model in underestimating vertical motions has been highlighted. A partial correction on model errors is reached by coupling PBL schemes with a urban canopy surface scheme, whose impact on local and non local PBLs has been studied both in the standard configuration and by introducing a more detailed land-use map on Rome area. The study has been performed using different events of the typical meteorological scenarios of the urban area.
Post-food field surveys: an efficient way to gain experience on flash floods
methodology and illustrations

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Post-event surveys and investigations are one way to gain experience on natural hazards. The importance of the systematisation and standardisation of such investigations and re-analysis is progressively recognised in all the geophysical sciences as shown by the growing number of scientific papers and programs on the subject. But how to proceed in the case of flash floods? Actually, space and time scales of occurrence of flash floods, combined with the space and time scales of conventional measurement networks of rain and discharges, make these events particularly difficult to observe in instrumented catchments. What type of data should be collected, for what type of analyses, and to explore which particular issues? To give a first answer to these questions, a methodology for post-flash flood field investigations has been developed under the EC FLOODsite project and tested under the EC HYDRATE project. The documentation of flash floods urges post-event survey strategies encompassing indirect reconstruction of peak discharges, field observations of the geomorphic processes associated to the flood, and interviews of eyewitnesses. The usefulness of post-flood surveys having been clearly demonstrated during these previous research programs, these investigations have been included in the observation strategy proposed for the HYMEX project.

The principles of the post-flood survey methodology will be shortly presented and its possible outcomes will be illustrated on the basis of some flash floods recently analysed within the EC HYDRATE project.
Rainfall reanalysis in the Cévennes-Vivarais region, France

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As part of the activities of the Cévennes-Vivarais Mediterranean Hydrometeorological Observatory (OHM-CV; http://www.lthe.fr/OHM-CV/index.php), a project aimed at establishing a 10-year rainfall reanalysis in a 32000-km² region prone to heavy precipitation events (HPE) and flash floods (FF) is carried out at LTHE. The radar and raingauge datasets are collected from operational services (Météo France, Service de Prévision des Crues du Grand Delta and Electricité de France) since 2000. As an inherent difficulty of such reanalysis exercises, there is a considerable evolution of the observation systems, notably the radar operating protocols and data processing, during the considered period.

Radar data processing is therefore performed from the raw volume data, when available, using a developmental processing system called TRADHy (Traitements Régionalisés et Adaptatifs de Données radar pour l’Hydrologie; Delrieu et al. JAMC 2009, 48, 1422-1447). TRADHy allows for correction of range-dependent errors related to the relief (ground clutter and screening) and the vertical profile of reflectivity (VPR) conditioned on rain types (convective, stratiform). Unbiased rainfall estimates are obtained by optimizing effective reflectivity-rainrate (Z-R relationships) using raingauge measurements at the event time scale (Bouilloud et al. J. Hydrol. 2010; DOI: 10.1016/j.jhydrol.2010.02.035). In case volume data are not available for the VPR inference, idealized VPRs are optimized as well by accounting for the 0°C isotherm altitude during the considered rain event.

Establishment of reference rainfall is critical to assess the error model of the radar rainfall estimates. Reference rainfall is derived from raingauge data in a geostatistical framework. First, an in-depth critical analysis of the raingauge data is performed by studying the raingauge variogram and the radar-raingauge time co-fluctuation. Then, anisotropic Kriging allows for rainfall estimation for hydrological meshes which size ranges from 1-100 km². The Kriging estimation variance is used to select the most reliable rainfall estimates to be used as reference values. In a further step, the radar-reference residuals are modeled and conditioned on various factors such as the rainrate, the integration time step, the radar range and the rain types following the methodology developed by Kirstetter et al. J. Hydrol, 2010 (DOI: 10.1016/j.jhydrol.2010.01.009).

The proposed poster will present the overall methodology and illustrate some key-points and recent results mostly related to the error modeling over a range of spatial and temporal scales. The reanalysis is hoped to be ready for dissemination to the HyMeX scientific community by 2012.
Rainfall regimes in the Cévennes-Vivarais target area for HyMEx

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A climatological study of the rainfall intensity at different time steps (accumulation periods) has been conducted in the Cévennes-Vivarais region, an HyMEx target area. The goal is to characterize the common rainfall events and the mechanisms responsible for their amplification toward extreme events.

This study lies on the relatively dense raingage network (station mean inter-distance between 5 and 8 km) providing a 15-year long hourly and a 52-year long daily database. The seasonal evolution of rainfall amounts and of daily non-null intensities show that the fall season is the one during which the highest rainfall amounts and daily intensities are yielded. The rainfall amount is very well correlated with the relief elevation while the non-null rainfall intensity is anti-correlated specially at the shortest time step. The strongest infra-hourly storms of size around 20km occur North of the study area over the Rhône river valley during summer. They display a very marked diurnal cycle including a maximum at the end of the afternoon.

The common daily rainfall (median in a statistical sense) are maximum over the Cévennes-Vivarais mountain ridge. Two well defined spots (Mont Aigoual and Serre de la Croix de Beauzon) received the highest median daily intensity.

Daily rainfall patterns are characterized by a distance of de-correlation around 25 km.

Comparatively to the highest of the common hourly rainfall intensities, the extreme ones are very different. Their size is higher, their location is different (extreme hourly rates occur over the Gard region), and according to the literature, the forcing mechanisms are different.

The daily rainfall extremes have features similar to the highest of the common daily rainfall rates. They occur at the same place but produce far more rainfall, around 600mm/day against less than 10mm/day for the maximum of the median rainfall rates.

A preliminary but not published study has shown that the shift from common to extreme daily rainfall rates could be due to a tiny change in the vertical wind profile which produce has heavy consequences. The HyMEx program should provide the opportunity to observe these phenomenas through the project dedicated to shallow convective clouds producing rainbands and the implementation of a high resolution network of rainfall sensors.
RainMusic multi-instrument precipitation analysis: Application to the VOLTAIRE and MAP D-PHASE case studies

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In the past, verification and diagnostic studies of precipitation fields have seldom been performed over the Mediterranean basin area and in those few cases, only over land, because of the sparseness of available in situ observations. Even if surface weather observations from synoptic, climatological, precipitation and/or agriculture networks represent the more accurate estimation of the weather state, they only provide non-uniformly distributed point-value measures. Ground-based weather radars and meteorological satellite-borne instruments provide indeed a gridded possible alternative, at least in terms of coverage, to the traditional surface.

It must be also recalled that when verifying discontinuous atmospheric fields, with a high variability in space and in time (e.g., precipitation), or when comparing forecasts with observations available over highly variable areas, the approach employed to analyze observations is not a minor detail. On the one hand, there is the so-called “grid point” approach that consists in interpolating forecast data on the station locations. On the other hand, there is the so-called “grid box” approach, which consists in analyzing the observations to the same grid as the forecast, or, more in general, over a coarser verification grid, by computing an observational objective analysis. However, when the goal of the verification is the assessment of the spatial match between forecasts and observations, the latter should be preferred, since it better represents the grid-scale quantities predicted by the model and it has the advantage to be less statistically influenced by the non-uniformly distribution of the observation stations.

Taking into account the two aforementioned issues, the recently-developed RainMusic procedure has been applied to intense precipitation events to provide a reliable and more representative precipitation observational analysis to be used in verification study. The procedure combines precipitation estimated by different instruments – rain gauges, weather radar and, when available, satellite – using innovative algorithms based on block-kriging and a Bayesian combination by means of the Kalman filter. The application of the RainMusic procedure to the VOLTAIRE (Cyprus, 5-6 March 2003) and the MAP D-PHASE case studies (Northern Italy, 25-28 September an 22-25 November 2007), with an evaluation of the scales present in the observational fields compared to those present in the corresponding forecasts (from the ISPRA’s BOLAM model), are shown here.
Real time high-resolution forecast support for the HyMeX Special Observing Period: deterministic and ensemble strategies.

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High-resolution modelling tools, resolving explicitly atmospheric deep convection, will be a key component of Météo-France real-time support to the HyMeX Special Observing Period. The operational non-hydrostatic AROME model (horizontal resolution 2.5km) with 60 vertical levels, directly coupled to the ARPEGE global model, will be run on two dedicated domains covering the area of interest during HyMeX:

- the AROME_WMED domain (640x960 points) encompassing the whole western part of the Mediterranean Sea will be used for deterministic forecasts.
- the smaller inner AROME_NWMED domain (384x400 points), extending from Corsica/Balearic islands to Southern France, will be used for the ensemble forecast. In order to deal with the forecast uncertainty, the ensemble strategy takes into account uncertainty on synoptic-scale lateral boundary conditions and uncertainty on the mesoscale initial conditions.

AROME model (for both domains AROME_WMED and AROME_NWMED) has its own assimilation cycle based on a 3d-variational data assimilation scheme; all conventional data, as well as radar (reflectivity, Doppler radial winds) and satellite radiances, are assimilated at a high temporal frequency (3 hours). Structure functions (B-matrix) have been computed for each domain according to a meso-scale ensemble approach.

AROME_WMED and AROME_NWMED simulations of the 18-19 February 2010 case study, corresponding to a rapidly deepening and moving pressure low in the HyMeX domain, are discussed and evaluated.
Regional flood frequency analyses in the Mediterranean area involving extraordinary flood events at ungauged sites


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This talk presents a method for using major flash flood events occurred at ungauged catchments to reduce the uncertainties in estimating regional flood quantiles. This is a methodological contribution for a better description of the flash flood hazard based on a more efficient valuation of the various sources of possible information.

The method is based on standard regionalization methods assuming that the flood peak distribution rescaled by a site-dependent index flood is uniform within a homogeneous region. A likelihood formulation and a Bayesian Markov Chain Monte Carlo (MCMC) algorithm are used to infer the parameter values of the regional distributions. This statistical inference technique has been selected for its rigorousness – various hypotheses are explicitly formulated in the likelihood function, its flexibility as for the type of data that can be treated, and its ability to compute accurate estimates of the confidence intervals for the adjusted parameters and for the corresponding flood quantiles.

The proposed method is applied to two data sets from the South of France that consist of series of annual peak discharges at gauged sites and estimated peak discharges of extreme flash flood events that have occurred at ungauged sites. The results suggest that the confidence intervals of the quantiles can be significantly narrowed down provided that the set of ungauged extremes is the result of a comprehensive sampling over the selected region. This remains valid, even if the uncertainties in the estimated ungauged extreme discharges are considered. The flood quantiles estimated by the proposed method are also consistent with the results of site specific flood frequency studies based on historic and paleoflood information.

The content of this talk is developed in a recently published paper:
Relationships between High Precipitation Events (HPEs) and upper-level dynamics in a semi-idealized atmosphere.

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Southern France is prone to devastating flash-floods during the fall season. The warming and moistening of the boundary layer through sensible and latent heat fluxes from the warm sea is known as an efficient mechanism for convective destabilization and further production of heavy precipitation. However the triggering of convection usually requires preexisting synoptic-scale.

The role of the warm advection at low levels, induced by a broad synoptic-scale low over the western Mediterranean sea, as well as the presence of a cold cut-off low at mid and high levels, were highlighted as the main synoptic-scale ingredients for the development of severe convection.

The demonstration of such a relationship can be given by sensitivity studies of HPEs forecast to the presence of some upper-level Potential Vorticity (PV) features. These studies usually consist in removing PV features from a reference simulation. Here we suggest to build up an idealized initial state without any synoptic-scale feature. Then, PV surgery consists in adding PV anomaly with a full control of shape, location and amplitude to the idealized initial state. A first result is that location and intensity of HPEs are dependent on the upper-level PV features and thus that diagnoses of the interaction between simulated convection and upper-level forcing are easier to interpret. Finally, we are also addressing the links between the shape of the initial synoptic features and the persistence of the southerly flow over the western Mediterranean that is in itself crucial for the HPEs.
Research Activities at CIMA Foundation and contributions to task teams activities

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Changes in the state of the Environment that are of the greatest interest to CIMA are those that reduce or destroy (even temporarily) the availability of resources; they create a strong demand for “civil protection” resulting in conditions of “need” or “poverty, perceived by man as “disasters”. This demand concerns the mitigation of the consequences on the population of these alterations to the environment.

The mitigation of the effects of disasters can be achieved through the identification and understanding of the causes and of the underlying chemical and physical processes. This is why research at CIMA Foundation is particularly devoted to the observation of the environment using the most advanced technologies available and to the reproduction of observed phenomena with physical or numerical models. To achieve its targets, research at CIMA Foundation, focuses on several topics. Among them those potentially related to HyMex project are: Predictability of meteorological extremes, Modelling and prediction of floods and droughts, Observation of hydrometeorological variables, Data fusion and Data assimilation.

CIMA Foundation is also leading the FP7 project DRIHMS (Distributed Research Infrastructure for Hydro-Meteorology Study) that aims at the promotion of the Grid culture within the European hydrometeorological research (HMR) community through the diffusion of a Grid platform for e-collaboration in this earth science sector.

In this framework possible contributions of CIMA Foundation to HyMex consist in: i) a contribution to the validation of probabilistic flash flood forecasting chains, using the operational probabilistic flood forecasting system already implemented on the basins of Liguria Region, possibly extended to other testcases to accomplish this task an EOP is needed over different test sites; ii) a contribution to the implementation of data assimilation techniques in hydrological models and the evaluation of the related benefits, this goal being more related to the use of information from different sources for a SOP; iii) a contribution to the implementation of data fusion techniques for Quantitative Precipitation Estimation from raingauge, radar and satellite taking benefits of Mt. Settepani Meteorological Radar; iv) a contribution to the analysis of the predictability of extreme meteorological events using high-resolution modelling of selected case studies.

The activities on the testcases will be carried out using the CIMA Foundation database of meteorological observations, as well as data from some hypermonitored watersheds managed by the Agency for Environmental protection of the Liguria Region.
Rossby wave tracking applications for predictability studies

F. Grazzini

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Rossby waves play an important role in the transport of heat and momentum between subtropical and polar regions both in the troposphere and the lower stratosphere. Rossby waves propagates, via downstream development, through wave packets. These can travel, in particular circumstances, over long distances, teleconnetting remote regions of the atmosphere. Previous studies have shown that some severe weather events like the Elbe flooding case of August 2002 (Grazzini and van der Grijn 2002) and heavy precipitation events over the Alps (Martius et al. 2006b, Grazzini 2007), occurred in association with prominent Rossby waves trains travelling from remote distances.

The predictability of this kind of high impact weather is then closely related with the ability of numerical models to represent triggering and propagation of upper-level Rossby wave-trains. With the aid an objective tracking algorithm, described in by Grazzini and Lucarini (2009), we investigate the predictability of Rossby wave trains, analysing operational scores of ECMWF global model conditioned to the presence of wave trains. Further we applied the tracking algorithm to the ECMWF monthly forecast system (VAREPS).

With a generation of an ensemble of Rossby wave train tracks we assess the potential to exploit the range predictability of the extended-range forecast.
Sensitivity simulations of the 12–13 November 2004 heavy precipitation event over southeastern Italy

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This study examines the results of different WRF and MM5 simulations of a heavy precipitation event that affected southeastern Italy during 12 and 13 November 2004. The episode lasted for more than 24 hours and featured two large rainfall peaks, with values up to 250 mm in one day, recorded in two different phases over distinct sub-regions. The event was characterized by some mesoscale features observed in other Mediterranean heavy precipitation episodes. In particular, a low level jet favored convection and associated heavy precipitation, maintaining a convectively unstable environment and advecting moist air masses at very low levels during the whole event; the passage of an upper-level short-wave trough favored the formation of a mid–low level weak cyclone that initially concentrated precipitation in the first rainfall maximum area, and subsequently caused the shift of the precipitating systems towards the second rainfall maximum area. Different runs are performed by varying initial and lateral boundary conditions provided by ECMWF analysis and forecast data, and changing the convective schemes active on the external domain. All numerical experiments are able to reproduce large precipitation amounts, thus catching the severity of the event, although significant variability in the precipitation patterns is found, especially for the second phase of the event. Specifically, discrepancies in initial and boundary fields affect the simulation of the mid–low level weak cyclone deepening, location, and timing, altering the associated convective precipitation distribution.
The Cévennes-Vivarais Mediterranean Hydrometeorological Observatory

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The Cévennes-Vivarais Mediterranean Hydrometeorological Observatory (CVMHO, http://www.lthe.fr/OHMCV/index.php) is an Observation Service of INSU/CNRS and OSUG (Observatoire des Sciences de l’Univers de Grenoble) dedicated to hydrometeorological extremes (heavy precipitation events –HPE–, floods and flash floods, droughts) in the Mediterranean. It was established in 2000 and implements detailed observations of both hydrometeorological and societal processes in the Cévennes-Vivarais region, France. This area is subject to HPEs and flash floods that occur mostly during the autumn season.

Due to its vulnerability, the Cévennes-Vivarais region is already well equipped with operational hydrometeorological observation systems operated by Météo France, the flood forecasting Service (SPC Grand Delta) and Electricité de France (EDF). The operational observations are complemented with research instrumentation including currently: 1) 2 disdrometers located in Gard and Ardèche regions; 2) a GPS network dedicated to vertically integrated water vapour measurements; 3) 3 Large-Scale Particle Imagery velocimetry (LS-PIV) devices for local remote sensing of rivers; these devices are installed so far over already gauged stations on Ardeche catchment; 4) a network of so-called hydrological and hydrogeological super-sites aimed at understanding the hydrological response of typical Cévennes landscapes: mountains, piedmont and karstic areas; 5) sociological monitoring is performed in the Gard Department about mobility, alert systems and the role/use of media during crisis. The CVMHO teams have organized their contributions to the first HyMeX EOP into six research projects:

1. Knowledge and predictability of heavy precipitation events in Southeastern France (PI: Véronique Ducrocq, CNRM)
2. Shallow convection and orographic precipitation in the Cévennes (PIs: Sandrine Anquetin (LTHE) and Joël Van Baalen (LaMP))
3. Impact of rainfall variability and soil moisture redistribution on the continental hydrological cycle and the genesis of flash floods in the Cévennes region (PIs: Christophe Bouvier (HSM), Isabelle Braud (Cemagref), Guy Delrieu (LTHE))
4. Karst hydrosystems: water resources and flood dynamics (PI: Hervé Jourde, HSM)
5. Vulnerability and social adaptation in the Gard department (PIs: Céline Lutoff (PACTE) and Isabelle Ruin (LTHE))
6. Multi-disciplinary post-event surveys following major hydrometeorological events (PIs: Eric Gaume (LCPC) and Lorenzo Marchi (CNR Padova))

CVMHO will continue to collect, critically analyse and elaborate the operational hydrometeorological datasets (raingauge networks, ARAMIS weather radars, discharge stations). It is foreseen to extend the data collection to the Languedoc-Roussillon region. CVMHO will contribute to the definition and the coordination of the observation systems to be deployed by the various TTOs, especially the meteorological, hydrological and sociological observation systems required for projects 1, 2, 3 and 5 over the Ardèche and Gardon pilot-sites. This covers both scientific and logistic aspects. CVMHO will organize scientific meetings and encourage scientific cooperation within the CVMHO teams and with other teams, especially at the international level.
The WAVATEB Project: Water Vapour Transport in the Ebro Valley during HyMeX experiment

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Analyses of atmospheric water flux divergence for the Mediterranean confirm that the vapour moisture enters the Mediterranean area through the western and north-western boundaries. The moisture transport is mainly zonal in winter, according to the classical winter-time large-scale weather regimes in this area. The Iberian Peninsula represents the Western border of the Mediterranean basin through which water vapour transits. In the Iberian Peninsula surface circulation is basically configured by five different patterns; Continental, Maritime, Iberian, Mediterranean and Local. Maritime and Continental flux represent about 50% of the situations along the year.

Those kinds of fluxes cause wind surface circulation that enters into the Mediterranean Sea. The surface circulation is, in that case, characterized by the channelling of winds along the Ebro Valley. During steady Continental flux, Cierzo and Tramontana winds can be produced. Total water vapour annually injected through the Ebro valley into the Mediterranean Sea boundary layer represents an essential term of the humidity transport over the Mediterranean basin. This term is basically determined by the transport of water vapour along Ebro Valley produced under the meteorological situations previously described.

The project presented is mainly based on the use of the experimental data gathered by: (a) Surface networks of meteorological and GPS stations that allow determining the total water content (PWV) found in the vertical of the GPS instrument (b) Synoptical network of radiosounding and (c) HYMEX profiler network that together allow establishing vertical profiles of wind and water vapour contents. In this frame, in addition to the Basque Met Office profiler implemented at Bilbao, at the entrance of the Ebro valley, we plan to buy another profiler, to put at the valley exit (to this aim we are about to make a proposal- the PYNETEO project - to CTP)

The method proposed here is based upon the use of all the experimental data collected by the networks previously presented. This information can be combined with the results of meso-meteorological integrations carried out by means of one numerical model. In our case we propose the use of WRF model in order to define the fields of wind and specific humidity in the study area. Data from GPS stations, meteorological stations, profilers and radiosoundings can be used to correct vertical profiles of wind and specific humidity modelled by the WRF model. From those final corrected profiles, it is proposed to evaluate the mean vertical moisture flux \( Q = \int_p (q/g) V \, dp \). Those \( Q \) data could be used to determine total flux of water vapour exiting the Ebro Valley.

During the enhanced observing period of HYMEX the \( Q \) data would represent an essential term of the humidity transport over the Mediterranean basin, in the perspective of quantifying the humidity amount likely to feed intense rainfall events observed in the nearest regions.
Towards a mesoscale Ensemble Prediction System for the north-western Mediterranean

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During the last 15 years ensemble weather forecasting has made substantial progress and has proved its skill in forecasting probabilities of relevant weather events. More recently, the development and growing use of high-resolution, convection-permitting, models has significantly increased the potential of atmospheric modeling. However, this opens new questions regarding the representation of initial and model uncertainties. In the framework of the French project MEDUP and in preparation of the forthcoming Hydrological Cycle in the Mediterranean experiment (HyMeX), several preliminary studies have been carried out aiming at a better understanding of the predictability of Mediterranean intense events and a better quantification of their forecast uncertainties. Different methodologies have been investigated including perturbed initial conditions and perturbed physical parameterizations. This presentation focuses on the physical parameterizations and especially the parameterizations associated with the cloud microphysics. A first ensemble was designed by varying the tunable parameters of the microphysical scheme within their admitted range of variation whereas in the second ensemble the tendencies of the microphysical processes were randomly perturbed. The results are analyzed and assessed for various episodes of heavy precipitation which recently occurred over south-eastern France.
Uncertainties in short-term forecasts of a Mediterranean heavy precipitation event: Assessment with satellite observations

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The uncertainties in short-term forecasts of a 5-day episode of heavy precipitation in south eastern France were investigated. The episode took place from the 19-23 November 2007 resulting in 400 mm of precipitation in certain areas. It was fairly typical of events known as Cevenoles that frequently affect the region. The ability of the model Meso-NH to capture the localization and magnitude of the precipitation was evaluated against measurements by a network of rain-gauges over France. Because of the Mediterranean origin of the air, the simulations need to be assessed over the sea. This can only be achieved with satellite observations. For that purpose, satellite brightness temperatures from Advanced Microwave Sounding Unit (AMSU), Special Sensor Microwave Imager (SSM/I), and Meteosat Second Generation (MSG) were compared with those simulated by the model.

Three sets of 24-h Meso-NH simulations were built that differed in their initial and boundary conditions. Simulations which were initialised from the large-scale operational analyses provided by either the ECMWF or ARPEGE assimilation systems, failed to capture the intensity of precipitation associated with convective events, and overestimated the amount of precipitation when the conditions were not convective. In contrast, simulations starting from the mesoscale analysis of the French operational mesoscale model ALADIN, were more successful in forecasting rain occurrence and amount. This was due to a better prediction of the intensity of the surface wind over the sea during the stratiform regime and a more timely onset of convection over the sea. Further experiments from a different set of oceanic conditions showed almost no impact on precipitation forecasts.
Uncertainty reduction of the hydrological river stage forecasting during flash flood events

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Forecasts produced via hydrological models are typically in the form of time series of estimates. Unfortunately, these estimates are not error-free such that it becomes important to describe model outputs in terms of probability distributions, by which it is possible to quantify flood forecasting uncertainty. The most natural approach to incorporate flood forecasting uncertainty into a simple decision scheme is the Bayesian utility function approach.

The aim of the present work is the development of a Bayesian model, which enables the uncertainty reduction in the river stage forecasting. In all Bayesian inference problems the first step is to define the prior probability density function; the time evolution of a river stage is here considered as a Markov process, where at a given time the hydrological state is described by an autoregressive model. The likelihood function usually provides information inferred by experimental data. In this work experimental data are instead represented by the hydrological discharge predictions, taken as “pseudo measurements” of future values of the river stage and obtained introducing in the TopKapi model the meteorological limited-area model COSMO-LEPS rainfall predictions as input.

However, the river stage modelling is an extremely hard challenge, because it is the overall effect of several physical processes correlated among them, but which can be modelled only in an approximate way. At a given instant model error is strongly related to how far model and system are evolved in the state space. Model errors have been therefore represented by a second autoregressive model. A stationary Kalman Filter has been hence applied in order to determine the ‘a posterior’ estimate. Then, the autoregressive coefficients have been estimated every hour by a smoother, which takes into account the last observations of the river stage.

The principal shortcomings for the use of the Kalman filtering are two. The first is related to the actual possibility to know the statistical properties of the probability distributions. The sampling estimates of the first two moments of the error statistical distribution can be accurate only in the case of a stationary stochastic process, while it is evident a strong e terschedasticity in the river stage behaviour, principally due to input errors related to rainfall forecasting. The second difficult concerns instead the typical property of the Kalman filter, which produces the estimate with the smallest variance. This property could not fit correctly when the tails of the error statistical distribution are heavier than a normal distribution with the same mean and variance. This is the reason because we have decided to use a $H^\infty$ filtering. In fact, for $H^\infty$ filtering it is not required any assumption about the error distribution and the minimization problem becomes equivalent to find a minimax estimator, whose maximum risk is lower or equal to the risk of any other estimator. In this work the $H^\infty$ filtering has been developed as a generalization of the Kalman filtering.

For the Reno mountain sub-basin some results relative to the flood event occurred from 30th November to 2nd December 2008 are reported for the measurement station Casalecchio Chiusa.
X-band and C-band radar differential phase measurements for rainfall estimation: analysis of co-located measures during a convective precipitation event in Piemonte

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Polarimetric radar capabilities are increasingly spreading from research to operational systems. Arpa Piemonte manages a mobile fully polarimetric X-band radar since 2007. The radar acquires data in Carmagnola (TO), close to Torino in Po valley at 233 m. a.s.l. At the site, two tipping-bucket raingauges (1-minute data resolution), one automatic weather FD12P sensor and one disdrometer are also co-located. The X-band radar has also perfect visibility toward Bric della Croce (TO), the operational polarimetric Doppler C-band radar. Several relevant case studies of stratiform and convective precipitations have been yet recorded. The analysis of data collected during a convective rain episode, occurred on 1st July 2009, is here presented.
IV Workshop

HyMeX
HYdrological cycle in Mediterranean EXperiment

8-10 June 2010
Area della Ricerca CNR
Bologna, Italy

Intense air-sea exchanges
ORALS
A refined Cyclogenesis tracking climatology in the Mediterranean for characterisation and predictability perspectives of autumnnal intense wind events.

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Most of Mediterranean intense wind events (IWE), which take part of high impact weather phenomenology of the region, mainly occur just in the vicinity of high dynamical cyclone activity. Despite the interaction with the orography, a few cyclones climatology have provided consistent spatial and geophysical features of environments propitious to IWE (Ayrault,1998, Jansa et al. Trigo et al.).

The ECMWF Reanalysis ERA-Interim with higher horizontal resolution and a 4D-var assimilation system delivers a novel framework suitable with the Mediterranean particularities. Thus we built a refined cyclone climatology based on a tracking algorithm of relative vorticity maxima at 850hPa designed by Ayrault applied on the Interim Reanalysis. The purpose of this classification is to characterize the properties of the intense cyclones classes that affect the western Mediterranean area.

The result is a dataset of tracks defined as a finite series of successive positions of the vorticity maxima. From this dataset, we are able to draw the mean distributions of relevant parameters characterizing the cyclones such as like life duration, growth rate, birth location, as well as parameters from the environment of the tracks like wind intensity.
Complex properties of the Bora wind

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Bora, a gusty cold downslope north-easterly air flow blowing over the sea from the lee side of the Dinaric Alps, is among better known Adriatic winds. When Bora spreads over the Adriatic Sea it leads to formation of alternating jets and wakes and related zones of strong lateral shearing, provoking vigorous Adriatic response. The most severe Bora is found beneath the southern slopes of Velebit, where complex orography is an important factor causing great horizontal and vertical wind speed variability over a relatively small area. One of the most pronounced spatial variabilities of Bora is present in the Zadar region.

The complex bora flow structure is investigated by means of very high-resolution numerical simulations carried out with the NRL COAMPS model with the aim of identifying reasons for the strong spatial variability of the bora flow in the wider Zadar region and uncharacteristically weak winds in the city of Zadar during bora episodes. The numerical model results are verified against the available surface and upper-air observations. The bora flow is characterized by a synoptically-induced critical level and several temperature inversions defining the upstream flow layer. In the lee of the highest portion of the Southern Velebit terrain a hydraulic jump forms, downstream of which a pronounced highly unsteady wake gets established over the Zadar peninsula. The wake is influenced by both the changes in the upstream atmospheric structure and the diurnal boundary-layer evolution. During the most developed phase, in the late morning, the wake scales the length of the entire Zadar peninsula and extends up to the critical level. At the surface, a wake vortex develops as the flow reverses in the wake centerline. In the evening hours, large amplitude trapped waves form on top of the jump, inducing boundary layer separation and rotor formation. Sensitivity experiments, conducted to examine the effects of the Zadar peninsula topography and the height of Southern Velebit on the structure of bora, show the influence of Velebit being particularly strong, governing the onset and strength of the bora. The terrain of the Zadar peninsula is also shown to influence the characteristics of the developed bora flow, especially the location of the flow separation point and the strength of the rotor flow.

At the current resolution, the operational numerical weather prediction models, while quite capable of predicting the general conditions for the onset and development of bora, are unable to simulate the small-scale details shown here. Given the potential hazards associated with this small-scale structure, our study emphasizes the need for development of high-resolution forecasting products in order to better quantify the air-sea exchanges, as well as products for aviation in the coastal Croatia and in other similar locations with strong downslope winds and rotor development.
Rapid upper ocean responses to intense meteorological events in mesoscale ocean-atmosphere regional modeling

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In this study, we consider the rapid upper ocean response under strong wind and intense precipitation events over the Mediterranean Sea in the mesoscale regional ocean model NEMOMED12. First, the downscaling of the NCEP reanalyses over the full Mediterranean basin with the WRF model between August 1998 and July 1999 with a 20km-resolution is used to drive the NEMOMED12 model with a 1/12\(^{\circ}\) resolution in perpetual mode. We first conduct a detailed evaluation of the air-sea fluxes of heat, freshwater and momentum obtained in the atmospheric simulation. Through budgets, we examine the seasonal variations of each forcing components and their high frequency variability linked to intense meteorological events. Through horizontal distribution over sea, we identify the areas where the most intense air-sea energy exchanges occur.

Then, we evaluate the benefit of a higher resolution (6.7km resolution) over the North-Western Mediterranean and of a higher temporal resolution (from daily to 3-hourly) in the regional atmospheric model to well represent these intense weather events, considering their little spatial extent (100km for strong coastal winds, 50-200km for mesoscale precipitating systems), their short duration (1 to 5 days) and their high temporal variability.

Finally, we estimate the ocean response under these situations in the mesoscale regional ocean model and its sensitivity to the space-time resolution of the atmospheric forcing. A special focus on the rapid freshening under strong precipitation and on upwellings and ocean mixed layer cooling and deepening during intense coastal wind situations will be presented during the workshop.
QuickSCAT Observations of Extreme Wind Events over the Mediterranean and Black Seas during 2000-2008.

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Nine years (2000-2008) of QuickSCAT hi-resolution (12.5x12.5 km) surface wind observations are employed in order to identify seasonal means and extreme (gale-force) events over the Mediterranean and Black Seas. The Gulf of Lyon and the Aegean Sea are the regions with the highest sustained wind magnitudes throughout the year. Conversely, the lowest winds are found over the Tyrrenian, the northern Adriatic and the eastern Black Seas. During winter, the Gulf of Lyon and the Aegean portray mean wind magnitudes ranging from 10 to 17 m/s. During summer, the Aegean Sea portrays the highest wind magnitudes over the entire study area (9 to 12 m/s). The lowest wind magnitudes during summer are encountered over the Tyrrenian, northern Adriatic, eastern Black and eastern Mediterranean Seas (3 to 6 m/s).

Each QuickSCAT observation exceeding 20 m/s is considered an extreme event. For all registered extreme events during 2000-2008, we calculate a) 2-D map of seasonal frequency occurrence and b) the histograms of wind directions for 10 sub-regions encompassed in the study area (Gulf of Lyon, Balearic Sea, Ligurian Sea, Tyrrenian Sea, North African coast, Adriatic Sea, Ionian Sea, Aegean Sea, Eastern Mediterranean and Black Seas).

Results pertaining to the frequency occurrence show coincidence between high (low) seasonal mean and extreme event frequency occurrence for the areas such as the Gulf of Lyon and the Aegean Sea (Tyrrenian/southeastern Black Seas). In addition, it is shown that for several cases (Gulf of Lyon, Aegean Sea), the dominant wind direction of extreme events substantially differentiates from the seasonal mean wind directions. Finally we investigate the linearity of extreme event occurrence in terms of mean wind speed climatology over the 10 subregions encompassing the study area.
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POSTERS
Characteristics of the wavenumber spectral decay of the near surface wind kinetic energy in the Mediterranean Sea

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The actual origin of the wavenumber spectral decay $\gamma$ of the wind kinetic energy (KE) is still an open question, despite the existing theoretical formulations and the works with experimental data, mainly carried out in the troposphere and over open oceans. Satellite scatterometer measurements have been also sporadically used to evaluate the KE spectral decay over the open oceans. In this work we show the results of the analysis of more than ten years of 12.5 km resolution QuikSCAT scatterometer data over the Mediterranean sea, aimed to get the mean characteristics and the time evolution of the KE decay. An innovative methodology to compute the wavenumber spectra over domains with complex topology has been used (Continuous Wavelet Transform) and a quantitative approach to estimate $\gamma$ and the spectral ranges associated has been developed. Results indicate the presence of three spectral ranges from 1300 km to 3200 km, from 40 km to 1300 km, and below 40 km, all showing different spectral decays and time variability. The results and the basic questions they raise will be discussed.
Contributions of atmospheric and oceanic conditions to the exceptional 2005 event of deep water formation in the Northwestern Mediterranean basin

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During winter 2004-05, a spectacular convection event occurred in the Northwestern Mediterranean basin (NWMED), associated with an exceptionally large convection area and Western Mediterranean Deep Water (WMDW) warmer and saltier than usually. Explanations were proposed tentatively, relating the unusual characteristics of this event to the Eastern Mediterranean Transient (EMT) or to the atmospheric conditions. They could however not be supported until now. We performed realistic numerical simulations in order to assess the respective contributions of atmospheric and oceanic conditions to this event. First, a control simulation of the Mediterranean circulation was performed for 1961-2006. It reproduces correctly the long-term evolution of the Mediterranean Sea, the EMT, and the 2005 convection event in the NWMED. Results of sensitivity simulations suggest that the WMDW characteristics are mainly related to the autumnal heat and salt contents of the water column in the convection region before the convection event. The weakness of the NWMED winter buoyancy loss since 1988 prevented strong convection to occur during the 90's, enabling heat and salt contents to increase and inducing the change of WMDW characteristics observed in 2005. The intensity of convection appears to be related equivalently to the atmospheric conditions during the convection and to the pre-convection stratification of the water column. Finally, the EMT potentially doubled the volume of WMDW formed in 2005 by inducing a deepening of the heat and salt maxima that weakened the pre-convection stratification.
Marine Atmospheric Boundary Layer Observations over the Mediterranean Sea

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The height and the vertical structure of the Marine Atmospheric Boundary Layer (MABL) plays a fundamental role in the characterization of the lower troposphere. Among the different techniques used to determine this height, the most widely employed is based on the analysis of atmospheric profiles obtained by radiosoundings. Nonetheless, radiosounding measurements over open sea are scanty and, as a consequence, the knowledge of the MABL is often based only on numerical model outputs or parameterizations which need few measured parameters as inputs.

The results obtained from the analysis of more than 100 radiosonde measurements performed over the Mediterranean Sea in the years from 2001 to 2007 are shown. The measurements have been achieved by using a Vaisala radiosonde system mounted on board of the R/V Urania of the Italian National Research Council during several cruises mainly carried out in the Ligurian and Thyrrenian Seas in different periods.

Furthermore, a comparison between the layer’s height and its temporal evolution deduced by radiosonde and celiometer measurements done during the LASIE experiment (Ligurian Sea, 16-22 June 2007) is also shown.

Among the other relevant results, the performed analysis also revealed the presence of a lower inversion that might be due to a residual layer or a boundary layer developed over land and advected over the sea.
Meteomarine observations from a buoy in Ligurian sea (TA NW Mediterranean sea)

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The Gulf of Genoa is a crucial area for meteorological forecast due to the interaction between air-masses at different atmospheric levels, the sea and the orography. It is well known that mid-latitude cyclones, entering in Western Mediterranean sea, produce storms of strong intensity especially in the Gulf of Genoa.

For that reason the regional weather service of Liguria (ARPAL CFMI-PC) in summer 2010 will deploy a meteorological buoy in the Gulf of Genoa for marine and weather measurements.

The buoy, a OCEANOR Wave Scan, will be moored at lat 43° 55’ 18” and lon 008°10’ 50”, SE-ly the cape of Capo Mele at 80 m sea dept. In Capo Mele is also present a weather station (WMO code LIMU).

The buoy will measure weather parameter like surface winds with a couple of anemometer (one of them a wind sonic), air temperature, pressure and humidity. The buoy will also measure sea parameters like wave (height, period direction and spectral parameters), currents and temperatures (up to the bottom of the sea).

Only a set of measurements will be available on the web hourly but the entire data set could be available for the partners of Hymex Project and other measurements could be implemented on the buoy, according to the Hymex requirements.
Meteorological and Marine Time Series Collected Offshore in the Ligurian Sea

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Continuous meteo-marine environment monitoring represents one of the main topics in models developing and in the analysis of climate changes. The space-time scale of the phenomena to be investigated, the need of resources in terms of researchers and equipped vessels and adverse meteo-marine conditions make difficult collecting long time series of data over the ocean. Fixed or floating installations in general, and buoys in particular, are the only means for in situ collection of data series over long periods of time even under heavy sea conditions.

In the Ligurian Sea, the off-shore W1-M3A system acquires long time series of meteorological and marine measurements since February 2000. This observing system is composed by one fixed station, the ODAS Italia 1 multi-sensor spar buoy and a sub-surface mooring line close to the buoy. A small laboratory unit is on the top of the buoy and a trellis hosts a complete set of meteorological sensors and the antenna for the data telemetry. Marine sensors are installed along the buoy body at different nominal depths (0, -6, -12, -20, -28, -36 m) providing a high vertical sampling resolution of the ocean surface layer. The acquired data are transferred in near-real time to the receiving station ashore.

The sub-surface mooring is equipped with an upward looking 300 kHz RDI ADCP and with marine sensors distributed from 100 down to 1000 meter water depth.

Data collected by the observing system are used to study the surface processes driving the evolution of the atmospheric boundary layer vertical structure and of the surface ocean as well as to validate both model outputs and remote sensed data.

The presentation will focus on the observatory description and on the most recent and relevant results achieved by using the acquired data.
Storm surge modelling in the Mediterranean Sea with focus on the Italian coast

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The Mediterranean storm surge modeling system \textit{Kassandra} has been developed. It consists in a finite element hydrodynamic model (SHYFEM), including a tidal model, in a third generation finite element spectral wave model (WWM), fully coupled to the hydrodynamic model and using as input surface data (wind and pressure) obtained from a suite of meteorological models.

The numerical grid of the hydrodynamic and wave models covers the whole Mediterranean Sea with about 140,000 triangular elements having a resolution that varies from 15-20 km in the open sea, to 5 km in coastal areas and to 1.0 km along the Italian coast. The meteorological model chain comprises the global model GLOBO (resolution of 40 km, six days of forecast), the hydrostatic model BOLAM (resolution of 11 km, three days of forecast), covering most of the Mediterranean Sea, and the non-hydrostatic model MOLOCH (resolution of 2.3 km, two days of forecast) which covers the Italian peninsula.

Model performance has been evaluated comparing the simulated water level and wave characteristics against observation database. Tidal harmonic analysis has been performed on both modeled and observed water level in order to validate the model for both the tidal and the storm signals. The hindcast results show that the run with tide and with wave is more accurate than the conventional method (surge plus tide independently) in predicting the total water level along the Italian coast.

A set of additional simulations has been performed in order to investigate the influence of the resolution in the meteorological forcing. The use of a high resolution meteorological model increase significantly the performance of the modeling system in simulating both the storm surge and the wave characteristics.
The CNR-ISMAR network of meteorological stations and marine observatories in the Northern Adriatic Sea

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The Adriatic Sea is one of the close sub-basins of the Mediterranean identified in the HYMEX Science Plan as a target area for the sea water budget estimation. The northern part of this basin is affected by strong winds and precipitation events, associated with the passage of atmospheric fronts. The most common strong wind events are associated to the continental north-easterly Bora wind, responsible for the formation of dense water.

CNR-ISMAR operates several meteorological and meteo-marine stations in the Northern Adriatic region, that were set up in different times and with different purposes, answering the demand of specific projects and local societal needs. These purposes include the definition of climate variability and its impact on biodiversity, an integrated approach to coastal zone management and a problem-solving approach in partnership with industry.

Meteorological stations are located both onshore and inland in the Gulf of Trieste, in the lagoon of Venice and in the harbour of Ancona. Meteo-marine installations are offshore Trieste (Paloma mast), in the harbour of Trieste, in the Gulf of Venice (Acqua Alta platform), offshore the delta of Po river (S1 buoy), offshore Rimini (E1 buoy) and Ancona (TeleSenigallia mast).

Most of the data acquired by the network are collected in near real time by the receiving stations, quality checked and processed to produce graphs and tables that are disseminated through the ISMAR web site. Meteorological data and sea temperatures at discrete depths along the water column, including the surface, are collected by all the installations. Moreover, Acqua Alta, S1 and E1 buoy provide salinity records, too. Precipitation data over the sea are collected by Acqua Alta and Paloma.

The data from the CNR-ISMAR network can contribute to the study of the Adriatic target area by:

- documenting the trends and the anomalies in the long-term observation period, such as anomalies in the wind field and heavy precipitation or changes of sea water characteristics;
- improving the database of the precipitation over the sea, offering an aid to the validation of models or of the new satellite-based products;
- providing elements to estimate the heat fluxes at the sea surface, and to identify the events able to induce dense water formation;
- providing in-situ data of temperature and salinity to be assimilated in numerical models.
WRF Model and ASAR-retrieved sea surface wind field comparison in a case study over eastern Mediterranean sea

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Synthetic Aperture Radar (SAR) imagery usually detects well the signatures of coherent atmospheric structures, due to the modulation of the sea surface roughness induced primarily by the interaction between the wind flow and the orography and by the spatial structure of the marine atmospheric boundary layer itself. In the present study, the wind field derived from an Envisat Advanced SAR (ASAR) image has been analyzed and compared with those simulated with the Weather and Research Forecasting (WRF) model over an area located in the eastern Mediterranean Sea, southward and eastward of Crete island. This is a region subject to complex wind patterns, due to the interaction of the almost steady northerly Etesian wind with the orography of the islands in the region.

The ASAR Wide Swath image analyzed covers an area of about 400 km by 400 km with a spatial resolution of about 150 m by 150 m (pixel of 75 m by 75 m). Thus, the extracted wind field can have an exceptionally high resolution, appropriate for investigating the mesoscale phenomena on the marine atmospheric boundary layer. The ASAR derived wind field has been extracted with a methodology based on the 2-D Continuous Wavelet Transform, suitable to isolate the backscatter patterns on the base of energy and scale considerations.

WRF model simulations have been performed using three 2-way nested domains, the inner one covering the area of interest with a resolution of 1 km. Simulations using different diffusion and boundary layer parameterization schemes have been tested in a case study corresponding to mountain lee waves detected in the ASAR image. The 10 m wind fields are compared each other and with those retrieved from the ASAR, both quantitatively and qualitatively, in order to analyze the correspondence of observed and simulated wind structures.
Do regional climate models reproduce the spatial distribution of monthly precipitation in the Mediterranean region better than global models?

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In this study we analyze the monthly temperature and precipitation fields of Regional climate models (RCMs) used in the ENSEMBLES project that cover the whole Mediterranean region and compare them with the global climate models (GCMs) providing the initial and boundary conditions. Precisely the GCMs ECHAM5 and HADCM3Q0 have been compared to RegCM, HIRHAM, REMO, RACMO, RCA (driven by ECHAM5) and to PROMES, CLM, HadRMQ0, HIRHAM, RRCM (driven by HadCM3Q0).

The CRU (Climate research Unit) monthly climatology (1961-1990) is used for model validation over land, and NOCS precipitation (National Oceanographic Center Southampton) for validation over sea. RCMs are expected to produce more accurate results than GCMs, because of their higher resolution, which plays an important role in general, and particularly over regions with complex morphology such as the Mediterranean region.

However, these results show that the RCM monthly climatologies do not necessarily improve with respect to coarser GCMs and that model errors present large variability along the annual cycle.
Land biogeophysical variables of the Mediterranean basin: to what extent can ERA-I be used to drive land surface models?

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The HYMEX TTM3b action is related to hindcast runs over the Mediterranean basin. The land component of this action will consist in building climatologies of land surface variables (e.g. soil moisture, evapotranspiration, optionally LAI and carbon fluxes), and (optionally) river flow, over the whole Mediterranean basin. This modelling exercise has to be coupled with the use of in situ and satellite data for verification. A number of biogeophysical variables (soil moisture, leaf area index) can be observed from space and simulated by land surface models. CNRM and ENEA (in collaboration with IPSL -LMD and LSCE-) will build climatologies of land biogeophysical variables, using land surface models forced by atmospheric reanalyses, and will compare the model climatology with available satellite and in situ observations. The ECMWF ERA-Interim global analysis will be used, together with a dynamical downscaling over specific areas.

In a first stage, CNRM has performed an evaluation of ERA-Interim over France, based on the high resolution (8km) SAFRAN atmospheric reanalysis. The ERA-Interim precipitation, incoming solar radiation (ISR), air temperature, air humidity, and wind speed, were evaluated. Also, interpolated in situ ISR observations were used in order to consolidate the evaluation of this variable. The daily precipitation estimates produced by ERA-Interim over France correlate very well with SAFRAN. However, the values are underestimated by 26%. A GPCP-corrected version of ERA-Interim is less biased (10-15%). The ERA-Interim estimates of ISR correlate very well with SAFRAN and with the ISR in situ observations on a daily basis. Whereas SAFRAN underestimates the ISR by 6-8 Wm$^{-2}$, ERA-Interim overestimates the ISR by 9-10 Wm$^{-2}$. Actions are needed in order to reduce these biases and the impact of using ERA-Interim in land surface models has to be assessed.
Use of HYPROM to assess the Moraca river water potential

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A numerical grid-point model, HYPROM, is applied to simulate a hydrological cycle during one year (2003) period in the Moraca river watershed. HYPROM is based upon fully dynamical system of shallow water equations, whereas velocity components and water height are prognostic variables. Friction slope is parameterized using unconditionally stable and numerically convergent implicit scheme. The model consists of two sub-models: two-dimensional representation of overland flow and one-dimensional river routing. HYPROM uses real topography, river routing and soil texture data (USGS datasets). It can be run on a small or large catchments, as well as for flash flood events and longer integrations. In this study, HYPROM is coupled with NMM-E, NCEP’s non-hydrostatical atmosphere model and NOAH land-surface scheme. NMM-E is integrated over limited area using initial and boundary conditions from ECMWF reanalysis.

During a six months pre-run (November 2002 – April 2003), the soil type is revised from the original dataset texture, “clay”, to “bedrock”, since the Moraca river watershed region is typically based on karst landscape conditions. Beside this, no other model calibration is done. The model discharge is compared to the measurements from the Podgorica water gauging station. An amplitude and time of all pick discharge are simulated by the model with quite high correlation coefficient of 0.91.
Precipitation Retrieval from Satellite within EUMETSAT’s H-SAF

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The EUMETSAT Satellite Application Facility on support to Operational Hydrology and Water Management (H-SAF) was established by the EUMETSAT Council on July 3, 2005 and started activity at the official date of September 1, 2005. The Italian Meteorological Service serves as “Host Institute” on behalf of 12 European countries. The Project Plan focuses on the generation of the following products for the European and Mediterranean regions:

- instantaneous and accumulated precipitation, including liquid/solid discrimination;
- soil moisture in the surface layer and in the roots region;
- snow parameters such as effective cover, wet/dry discrimination and water equivalent.

In addition to products development and generation, the project includes a products validation programme and a hydrological validation programme. The development programme duration is 5 years, ending on August 31, 2010. A follow-on Continuous Operations-Development Programme (CDOP) will start in September 2010 to provide long-term perspective (2010-2017) to the initiative.

Precipitation products are being generated according to algorithms developed by CNR-ISAC in collaboration with the international community, by exploiting the following satellites and instruments:

- MW conically-scanning radiometers (SSM/I and SSMIS) on LEO satellites (DMSP);
- MW cross-track scanning radiometers (AMSU-A and AMSU-B / MHS) on LEO operational satellites (NOAA and MetOp);
- VIS/IR imagers (SEVIRI) on GEO satellites (MSG).

These products are generated routinely at the Italian Centro Nazionale di Meteorologia e Climatologia Aeronautica (CNMCA), which is responsible of operational product generation and dissemination. Whilst precipitation products continue to be developed and improved, major focus is now on product validation. Products are generated in a pre-operational fashion, with a delay of few minutes to few hours from observation, depending on product and satellite data access. Access to products is currently limited to Institutions that participate in product development and/or validation activities. The emphasis of precipitation product generation in H-SAF is on near-real-time applications, as requested by the European hydrological community and, specifically in Italy, by the Civil Protection Department (DPC) – i.e., the Italian Agency which is responsible for disaster management. DPC is a major sponsor of the Italian participation to H-SAF, with increasing involvement in product validation and impact assessment activities.

We will present and discuss the basic algorithms for precipitation retrieval from satellite, that have been developed by CNR-ISAC. We will also discuss the activities that will be performed during CDOP in order to enhance and improve algorithms and processing schemes and extend them to satellites that will be operational in the 2010-2017 timeframe – with special emphasis on the GEO Meteosat Third Generation (MTG) satellite which is scheduled to be launched by EUMETSAT in 2016, and on the LEO Core Observatory of the Global Precipitation Measurement (GPM) mission which will launched by NASA and JAXA in 2013.
All of the former Global Energy and Water-cycle Experiment (GEWEX)

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Continental Scale Experiments (CSEs) have evolved to more complete Regional Hydroclimate Projects (RHPs) and new ones including HyMeX have been initiated. These efforts are being organized as part of the Coordinated Energy and Water-cycle Project under GEWEX, which is itself a core Project of the World Climate Research Program (WCRP). HyMeX and the other CEOP RHP’s are needed to understand and solve regional problems associated with improved climate prediction that encompass a range of practical and technical issues. Their work has also been designed to allow the results to be applied to larger scale up to global studies. In addition to the Regional Hydroclimate Projects, CEOP now includes groups focused on regional studies in cold regions, high elevations, monsoon, and semi-arid regions. These groups are further cooperating with crosscutting foci related to Water and Energy Budget Studies, Isotope and Aerosol studies and Extreme events.

CEOP will exploit this range of topics in unique ways that match the strengths and weakness of each community including the HyMeX community.
The continental hydrological cycle and related water resources

POSTERS
A innovative collaborative web framework to model the integrated water cycle: from coastal basin to shallow marine waters

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Water resources management in coastal regions presents an increasing challenge to policy makers, due to the complexity of the systems involved (groundwater bodies, surface waters, sea waters). The wise management of such environments requires an interdisciplinary approach to collect, analyze and efficiently use large amounts of heterogeneous data. The experience made during many European and National projects (CyberSAR, GRIDAS3) let us imagine that environmental sciences might draw a huge benefit from the use of WEB-based technologies, Geographical Information System (GIS), analysis tools, numerical modeling and collaborative computing.

In the presentation, we show the approach and the technologies we are adopting to develop a Collaborative Working Environment (WEB portal) accessible on the internet to meet the needs of the MOMAR (http://www.mo-mar.net/it/) and the EnviroGRIDS (http://www.envirogrids.net/) projects. EnviroGRIDS aims at building capacity for a Black Sea basin observation and assessment system supporting sustainable development. MOMAR aims at developing, using and adapting technologies, models and innovative monitoring strategies for the Tyrrhenian Sea. The portal will integrate tools to monitor and simulate the integrated water cycle combining numerical models (such as SWAT and GETM) within a experimental WEB framework largely based on the BASHYT technology (www.eraprogett.com/bashyt/). BASHYT integrates and expose on the WEB tools to analyze heterogeneous data, such as model results through the DPSIR (Driving Forces, Pressure, States, Impacts, Responses) rigorous methodological framework. SWAT is a semi-distributed watershed model to simulate the water cycle and the fate of sediments, nutrients (nitrogen and phosphorous) and pesticides. GETM is a 3D numerical model, simulating the most important hydrodynamic and thermodynamic processes in natural waters. The 2 models are being applied on a coastal area in the eastern part of Sardinia (Italy), where GETM is employed to model the estuary area of the Orosei gulf while SWAT is being applied on the Cedrino watersheds that discharges its waters on the underlying gulf.
A regional application of spatially distributed rainfall-runoff model for water resources estimation.

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Prediction in ungauged basins is an emerging need for identifying optimal water resources management strategies. To this end, the assessment of water resources availability is an essential requirement, which should be carried out in multiple river cross sections for the investigated catchment. However, river flow observations are rarely available for multiple sections along the river network.

A possible solution for obtaining a comprehensive assessment is to perform hydrological simulation, with the problem that most river sections are ungauged. Concerning this, spatially distributed models are a potentially valuable tool, in view of their capability of producing river flow simulations in internal river sections after having calibrated the related parameters at the closure section of the catchment. It is nevertheless true that distributed models are computationally intensive and therefore their application for performing long simulations is often problematic. We present a solution for performing computationally parsimonious spatially distributed hydrological simulations in multiple catchments and multiple river section in each catchment.

We believe it is interesting to note that the model parameters are invariant over the different catchment. Therefore we obtain a robust modelling approach, in view of the capability to calibrate the above parameters with respect to an increased set of river flow observations. The computational requirements are optimized by adopting a simplified flow routing scheme, which provides a reliable approximation when the time step of the simulation is longer that the concentration time of the basin (for instance, the daily time step for medium size catchments).

We present preliminary results obtained for two neighbouring river basins located in northern Italy, which prove the feasibility and robustness of the approach.
Climate data for hydrological modeling in the WASSERMed project

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The WASSERMed project (Water Availability and Security in Southern EuRope and the Mediterranean) will analyze, in a multidisciplinary way, ongoing and future climate induced changes in hydrological budgets and extremes in southern Europe, North Africa and Middle East under the frame of threats to national and human security. Five case study have been chosen in order to illustrate and represent situations which deserve special attention in due to their relevance to national and human security. Within WASSERMED, this study aims at collecting and processing results from existing model simulations (e.g. from PRUDENCE, ENSEMBLES) in the Mediterranean with special emphasis on precipitation and on the case study regions. The climate dataset that will be produced will provide a large spectrum of climate data and information, from which extract statistical information (e.g. the ensemble mean, an estimate of uncertainties related to model, outliers). The data will be validated by comparison with hydrological variables at sub-regional/basin scale. Results will be used to force an hydrological model for investigating impacts of climate and land use change at the regional scale and provide guidelines for adaptation strategies.
Dynamical and statistical downscaling of precipitation and temperature in a Mediterranean area

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In this study a comparison of temperature and precipitation obtained from a dynamical and a statistical downscaling model, for two 30 years long periods (1961-1990 and 2071-2100), is presented and discussed. Statistical downscaling is based on statistical relationships linking regional climate variables (predictands) to large-scale atmospheric variables (predictors). Such links are determined during an observational period, tested with independent data outside this period, and used for computing future climate projections. In this study Canonical Correlation Analysis (CCA) is applied, associated with a data pre-filtering obtained by a Principal Component Analysis (PCA). The dynamical downscaling simulations are carried out with the regional climate model RegCM. Both downscaling techniques are applied to ECHAM5 GCM output.

The study is focused on two regions of agricultural interest in the Mediterranean area and, in particular, Capitanata plane (Apulia) and Delia plane (Sicily), both positioned in South Italy. The analysis of the future local scenarios in these regions is crucial to evaluate the effect of climate change on local agriculture and can also provide a better understanding of the future climate in the South Mediterranean.
Hydrological cycle and extreme precipitation statistics over Croatia simulated with regional climate model

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The Regional Climate Model (RegCM) was used to dynamically downscale three realisations of present (1961-1990) and future climates (2011-2040, 2041-2070) as defined by EH5OM global climate model. For future climate the IPCC A2 emission scenario has been used. RegCM domain covered a large part of Europe and the Mediterranean basin with horizontal resolution of 35 km. For the part of the domain covering Croatia, simulated precipitation and runoff in present climate was compared with station data. Analysis included the comparison of modelled hydrological cycle as well as basic statistics of extreme precipitation events for present and future climate. RegCM3 was relatively successful in capturing contrasts between the continental and coastal parts of Croatia. The differences between simulated and station data vary in space and are seasonally dependent.
Hydrometeorological modelling of the Laurentian Great Lakes

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Environment Canada has been developing a community environmental modelling system (Modélisation Environnementale Communautaire – MEC), which is designed to facilitate coupling between models focusing on different components of the earth system. The ultimate objective of MEC is to use the coupled models to produce operational forecasts. MESH (MEC – Surface and Hydrology), a configuration of MEC currently under development, is specialized for coupling land-surface and hydrological models. MESH is being implemented for nowcasting and ensemble forecasting purposes on the Laurentian Great Lakes as part of the International Upper Great Lakes Study (IUGLS), which aims to improve water management in the upper Laurentian Great Lakes. Results from a five-year hindcast are presented, as well as preliminary results obtained when coupling the GEM atmospheric model, the MESH surface and hydrology and the NEMO ocean model in order to close the water balance of the Great Lakes basin.
Impact of the South Asian summer monsoon on the Mediterranean climate

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Methodology for the assimilation of regional climate model output in local climate change impact studies adopting physically-based models of eco-hydrological processes

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We present a methodology for local bias correction and local validation of climate model data against ground based observation of climate variables. General objective is to fill the gap between the resolution of state of the art RCMs and the resolution required for impact studies. In fact, the spatial resolution of RCMs is still unsuitable for local scale studies of eco-hydrological processes mainly due to land use and topography approximation. Local biases on temperature, net radiation, precipitation, relative humidity as well as wind fields, require additional post-processing before RCM output can be adopted as a forcing in process models for local impact studies. The methodology for the local projection of scenarios is based on a quantile variable correction supported by an incremental assessment using control simulations. The methodology has been applied for both dynamical (temperature and wind field) and non-dynamical fields (precipitation) of climatic variables supplied by the state of the art RCM PROTHEUS.

The developed case studies are in the regions of Lombardia and Puglia (Italy), respectively with high and low intra-node variability in the land surface fields, using high frequency point observations as reference data set.

We also adopt the comparative climate change impact method as a robust interpretation scheme of both RCM downscaled projections and eco-hydrological alterations investigated with process model simulations.
Modelling interactions between surface and hydrosystems over the Crau Camargue region


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The Crau-Camargue region located in southern France offers an important diversity of natural and agricultural ecosystems. As in many other Mediterranean coastal regions, the human influence has strongly modified the watercycle (river embanking, irrigation practices, groundwater consumption…), and an important impact of future climatic and environmental changes is expected, through the modification of precipitation and runoff regimes, sea level rise, and modification of soil and water uses associated to the decrease of water resource availability. Since several years, various research projects were conducted on this area with the main objective to better understand the functioning of these ecosystems.

The poster presents the different subjects investigated by the EMMAH team and the various measurements performed on the fields. Tools were developed to represent the main processes occurring at the surface, including evapotranspiration, crop functioning, and the relationships with hydrological processes. Approaches are based on the use of models applied at various scales, combined with remote sensing data and ground measurements.

These models aim to estimate hydrological balance, groundwater recharge, evolution of surface and groundwater salinity and to improve crop and water resources management in this region.
The effect of indiscriminate and spectral nudging on regional climate modeling

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In this work, we consider the effect of indiscriminate and spectral nudging on the large and small scales in a regional climate model (RCM). This effect is studied by using the “perfect model” approach which consists in running a global high-resolution “Big-Brother” model to produce a high-resolution reference data-set. Then, the small scales existing in that reference data-set are filtered out to generate a low-resolution data-set. These fields are used, finally, to drive another instance of the model (“Little-Brother”) running at the same resolution as ”Big Brother”. This setup mimics the configuration used for regional climate modeling.

We use this approach in two different modeling systems:

1. idealized simulations are performed with a two layer quasi-geostrophic Limited Area Model (LAM) on the beta-plane driven at its boundaries by the «global » version with periodic boundary condition.

The study shows that the effect of indiscriminate nudging on fine scales is very influenced by the predictability time. In fact, when the nudging time is very small compared to the predictability time, the model reproduces only the large scale used to force the model. In the other hand if the nudging time is very large, both large and fine scale are poorly reproduced by the model. The nudging time that minimizes the error at both the large and small scales is reached for a nudging time close to the half of the predictability time.

For spectral nudging, the optimum nudging time should be close to zero since spectral nudging does not affect the smalls scales. However the driving large-scale fields are generally provided at much lower frequency than the model time step (e.g, 6-hourly analysis) with a basic interpolation between the fields. Because of this interpolation, the optimum nudging time differs from zero, however remaining smaller than the predictability time.

2. similar simulations are conducted with a real RCM, here the Weather Research and Forecasting (WRF) model, over the Mediterranean region. We investigate in this full-blown model the relationship between predictability and an optimal nudging time.
The ISAC-CNR micrometeorological base and database in Lecce

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The micrometeorological base of CNR-ISAC in Lecce, South-East of Italy, is active since 2002, in collecting experimental data about surface-atmosphere transfer of momentum heat and water vapour. It operates in a periurban site inside the Salento University campus and has been improved along the past years in terms of active sensors to give a quite complete description of the soil-atmosphere vertical transfer. It is composed by a 16 m mast with fast response (eddy correlation) instrumentation and an ancillary automatic meteorological station collecting also soil data at 2 levels depth. Fast response data are pre-processed in half-hour averaged statistics.

All collected data are available in a web database (www.basesperimentale.le.isac.cnr.it) where they can be visualized or downloaded. A real time automated connection between the base and the database is also in progress. At present the Lecce data base is also a pilot reference structure for the Climate Change Section of the CNR-DTA GIIDA project (National Research Council - Earth and Environment Department, Interdisciplinary and Interoperational Management of Environmental Data), aimed to build a spatial data infrastructure between different CNR-DTA structures collecting environmental data.

This will allow easier search and availability for a great deal of environmental information in terms of data associated to international quality standards and metadata systems (GEOSS, GMES, INSPIRE).
The water cycle at large scale over West Africa: an updated view from the AMMA project

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The large-scale water cycle of West Africa results from the interplay of various coupled ocean-atmosphere-land surface processes that are representative of the tropical climate. The efficiency of these processes in controlling the advection of atmospheric humidity and its transformation into precipitation, and the destiny of rain water over land, are crucial aspects of the West African monsoon (WAM). Water budgets provide a methodology to address the question of the strength of the processes active in the water cycle. Unfortunately, few studies considered this approach in the past because of lack of observations and large uncertainties in the models over Africa. This study reviews the knowledge of the large-scale continental water budget of West Africa before AMMA and presents results achieved recently in the framework of AMMA. It covers mainly the timescales from intra-seasonal to inter-annual.

First, a new, advanced and comprehensive, atmospheric water budget dataset is set up for the period 2002-2007. It combines evapo-transpiration from AMMA Land surface Model Intercomparison Project (ALMIP), rainfall from TRMM 3B42 satellite product and PWV tendency from ERA-Interim reanalysis. Atmospheric moisture flux convergence (MFC) is determined as a residual from budget equation. The ALMIP simulations provide also estimates for the surface fluxes, runoff, soil moisture tendency, and net radiation. This so-called "hybrid dataset" corresponds to the most accurate produced so far at the regional and monthly scales over Africa. The functioning of the hydrological cycle of continental West Africa is analyzed. It is shown that the region is a moisture source during the dry season and a sink during the wet season and that the balance is close to zero in the Sahel (\(E = P\) at annual scale).

The relationship between evapo-transpiration and precipitation is found to be very different between the Sahel where it is nearly linear and the regions more to the South where runoff has a significant contribution. Strong spatial and temporal correlations are found between precipitation and moisture flux convergence from daily to interannual time-scales over the region. This correlation is increasing from the Sahel to the Guinean region. In the Soudanian and Sahelian regions, precipitation and net radiation at the surface appear as strong controlling factors of evapo-transpiration. In the Guinean region this link is relaxed while atmospheric dynamics more strongly drives precipitation.

In a second step, water budgets from NWP model systems are used, in which all the terms are either simulated or combined with analysed variables (PWV and MFC). Water budgets from seven different reanalyses and operational products from ECMWF, NCEP and Meteo-France are inter-compared and evaluated with the hybrid dataset. Budget closure and pertinence of budget terms are
examined. They reveal significant deficiencies in the water cycle modelled by all NWP systems. Among the deficiencies, some could be identified in the model physics (mainly in the convection schemes and parameters controlling the radiation scheme) and in the initialisation of soil moisture. Feedbacks on dynamics and hence on MFC are evidenced. Computational (sampling) errors when calculating MFC from gridded data and the impact of radiosondes humidity biases are also highlighted.

This work provides some tracks for improving NWP models and proposes a general methodology for computing hybrid water budget which are also of interest for the Mediterranean region and may be applied in the framework of HYMEX.
Theoretical and experimental researches of seismo-electric effect in rocks

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The fluid in pores of saturated porous media is not ideal dielectric. It dissociates itself into the anions and the cations. As a result, a double electrical layer with some density of dipole moment can appear on the border between the solid and liquid phases. The liquid phase, moving relative to the solid phase can seize charged particles. In consequence there appears the relative motion of oppositely charged ions and this, according to the laws of electrodynamics, is the electromagnetic emission.

The relative motion of the opposite charges is possible not only for the surface between solid and liquid phases, but also in the liquid phase. The dissociated ions have various masses, therefore, when the elastic wave propagates, they move with different speeds. As a consequence we have the opposite relative movement of oppositely charged ions which leads to electromagnetic radiation. The phenomenon of the emergence of electromagnetic emission caused by mechanical excitation is known as the seismo-electric effect of the second kind.

As a base for the mathematical simulation of seismo-electric effect the mathematical model of saturated porous media is taken, where all pores are interconnected, and a fluid can move freely in the intergranular space. In order to determine the intensity of electromagnetic emission of charged particles a formula of the dipole radiation is used. According to this formula, the radiation intensity of charged particles is directly proportional to the square of their acceleration. The field of velocity and acceleration in a porous medium is determined by the method of the theory of stochastic functions.

Theoretical researches show that the intensity of electromagnetic emission will be directly proportional to the sixth power of its frequency.
Uncertainties associated to the representation of surface processes in impact studies. A study in the Mediterranean area.

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In the framework of the assessment of the impact of climate change, the uncertainty associated to the direct effect of CO₂ on plant physiology was seldom addressed, while some other sources of uncertainties have been more studied, such as those related to climate modeling or the downscaling method. A few studies are available at global or continental scale. The purpose of this study is to quantify this effect in a regional study focused on the Mediterranean area of France. The Safran-Isba-Modcou chain was used. This chain is composed of a meteorological analysis system (SAFRAN), a land surface model describing the exchange with the atmosphere (ISBA) and a hydrogeological model (MODCOU), and has already been used in many studies in France.

The present study focuses on the uncertainties related to the representation of carbon cycle and the photosynthesis in the surface model. Two versions of ISBA were used and compared. The standard version simulates the mass and energy exchanges between the continental surface (including vegetation and snow) and the atmosphere. In this version, the LAI (Leaf Area Index) is provided by the ECOCLIMAP2 database and the vegetation is divided into 12 types. The A-gs version accounts for the process of photosynthesis taking into account the vegetation assimilation of atmospheric CO₂ concentration, and simulates the evolution of the biomass and the LAI.

The domain studied is the French Mediterranean basin, in which a sub domain was defined (latitude < 45 °N et height < 1000m) in order to identify the low land area pertaining to a Mediterranean climate. The study focuses on the impact of the climate change on the surface variables (LAI, water balance) and the discharges. The periods chosen to compare the changes are the end of the 20th century (1995-2005) and the end of the 21st century (2090-2099). A first comparison is made for the present climate between the versions of model and the observations of discharges, using two type of meteorological forcing : SAFRAN and data from a continuous high resolution climate scenario, based on the scenario A2, with a coupled atmosphere-mediterranean sea GCM. This scenario was further downscaled to the resolution of the study (a grid mesh of 8x8 km), using a quantile-quantile correction method.

Concerning the present climate, the comparison shows a delay of the development of the vegetation simulated by ISBA-A-gs causing an underestimation of evaporation and an overestimation of discharges in the spring compared to the observations and the standard version of ISBA. In future climate, the explicit response of vegetation to the CO₂ concentration of the ISBA A-gs version gives an different answer on the surface water budget and flow from the standard version of ISBA. This difference is especially visible in the southern area, the impact on the flow is increased and impact on evaporation is decreased, showing the interest of using a CO₂ responsive version of ISBA for impact studies.
Prediflood: A French research project aiming at developing a road submersion warning system for flash flood prone areas

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Accurate flood forecasts are crucial for an efficient flood event management. Until now, hydro-meteorological forecasts have been mainly used for early-warnings in France (Meteorological and flood vigilance maps) or over the world (Flash-flood guidances). Forecasts are generally limited to the main streams covered by the flood forecasting services or to specific watersheds with particular assets like hydropower dams which are in most cases well gauge river sections, leaving aside large parts of the territory.

Distributed hydro-meteorological forecasting models, able to take advantage of the now available high spatial and temporal resolution rainfall measurements, are promising tools for anticipating and quantifying the consequences at the ground of storm events all over a region. They would be very useful, especially in regions frequently affected by severe storms with complex spatio-temporal patterns. They would provide the necessary information for flood event management services to identify the areas at risk and to take the appropriate safety and rescue measures: prepositioning of rescue means, stopping of the traffic on exposed roads, determination of safe accesses or evacuation routes.

Some preliminary tests conducted by the LCPC within the European project FLOODsite have shown encouraging results of a distributed hydro-meteorological forecasting model. It seems possible, despite the limits of the available rainfall measurements and the shortcomings of the rainfall-runoff models, to deliver distributed forecasts of possible local flood consequences – road submersion risk rating at 2500 different locations of the Gard department in the tested case - with an acceptable level of accuracy. The PreDiFlood project (http://heberge.lcpc.fr/prediflood/) aims at consolidating and extending these first results with the objective to conduct pre-operational tests with possible end-users at the end of the project.

Such a tool will not replace, but complement existing flood forecasting approaches in time and space domains, short term forecasting at a regional scale, that have not been covered until now. It will produce a completely new type of forecasts and the usefulness of such data for the emergency services for their real-time decision making will be assessed within the project. Beyond the direct operational objectives, this project aims at demonstrating, on a specific application – the now-casting of road submersion –, the possibilities and also the limits and hence the needed improvements of tools that are still underused: high spatial and temporal resolution rainfall measurements including radar quantitative precipitation estimates but also precipitation now-castings, rainfall-runoff models and the recent knowledge acquired on flash-floods consequence evaluation as well as event management.
Consequences of the climate change on water scarcity in the Mediterranean basin

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The main purpose of the study is to evaluate the impacts of climate change on water resources while taking into account man-made reservoirs and changes in reservoir operating rules. Mediterranean basins are already characterized by an important temporal and spatial variability of water resources, and climatic models, despite the uncertainty, are indicating a change in precipitation regime with an increased drought risk. The regional assessment of change in water scarcity prevents using detailed data at the water basin level. Instead a generic model is constructed, based on information available at a regional scale. The steps of our methodology are:

1. Localisation and projection of water demands
2. Localisation of reservoirs and computation of available water quantity at each site
3. Determination of links between reservoirs and demands
4. Determination of operating rules

All the existing reservoirs are localized on the basis of the International Commission of Dams and Reservoirs. Runoff is taken from the outputs of climatic models from the European program CIRCE. Sub-basin flow accumulation zone of each reservoir is determined based on a Digital Elevation Model (hydro1k), and the available quantity of water at each site is computed.

On the demand side, domestic water use, cooling of power plants for electricity production, manufacturing and irrigation demands are taken into account. Future domestic demand is computed based on exogenous scenarios of population and wealth changes, using the WATERGAP2 methodology. For cooling and manufacturing processes, scenarios of modification of electricity production and added value are assumed, as well as water use intensities based on historical data and scenarios of technological progress, still using the WATERGAP2 methodology. In the case of irrigation, current irrigated areas, taken from the Global Map of Irrigation Areas and current productions, taken from agromaps are used. Crops phenology is determined based on the growing degree days method and irrigation is set to the quantity of water needed to fill the deficit between evapotranspiration and effective precipitation.

To determine the links between supply and demand, in absence of precise informations, a cost minimisation is performed. Each demand is associated with a reservoir, and the cost corresponding with this link takes into account the distance between the demand and the reservoir stream, and the height climbed up along the path to stream. The total cost is minimized, while checking that the mean demands may be satisfied by the mean runoff in the resulting network.

Operating rules are determined by minimizing the risk of non satisfaction of forecasted demands. For reservoirs in series, first upper demands are satisfied and the most downstream reservoir is first emptied. For reservoirs in parallel, a fitted generalization of the space rule is used, such that the probability of spill is minimized.
Evolution of cropping systems as affected by climate change (CLIMESCO)

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The climatic change induced by the global warming is expected to modify the agricultural activity and consequently the other social and economical sectors. In this context, an efficient management of the water resources is considered very important for Italy and in particular for Southern areas characterized by a typical Mediterranean climate in order to improve the economical and environmental sustainability of the agricultural activity. Climate warming could have a substantial impact on some agronomical practices as the choice of the crops to be included in the rotations, the sowing time and the irrigation scheduling. For a particular zone, the impact of climatic change on agricultural activity will depend also on the continuum “soil-plant-climate” and this continuum has to be included in the analysis for forecasting purposes.

In this paper, a three-year Project, funded by three Italian Ministries (University, Agriculture and Environment) and involving Italian Research Institutions of Agricultural National Council, Research National Council and Universities is illustrated. The Project is structured in four workpackages (WP): (1) Identification of homogeneous areas, (2) Climatic change, (3) Optimization of water resources and (4) Scenarios analysis. Starting from informations deriving from WP1 concerning two area located in Southern Italy (Apulia and Sicily regions), WP2 will provide temperature, precipitation and radiation scenarios according to several forecasted of greenhouse-gases emission by using the General Circulation Models (GCM) and to estimating local weather forecast for several decades at daily scale comparing two method of downscaling. Within the WP3, several researches at field scale will be carried out to investigate for the optimization of several irrigation variables using water resources of different salinity and quality.

An other important issue of this WP will be to parameterize the simulation models about crop growth and photosynthesis translocation, soil water fluxes and solute transport. With the conclusive WP4, using the information deriving from previous WPs, simulations will be effectuated at field and regional scale by using numerical models for simulating crops and cropping systems in order to evaluate the effects that the future climatic scenarios will have on crop yields and to individuate the best agronomical strategy to optimize the use of water resources.

The principal goal of this work is to show the principal results that we are obtaining regarding the impact of climate change on agricultural activity and how it is possible to adapt the cropping systems in order to reduce the expected negative consequences of climate change.
Socio-Hydro-Meteorological approach of mediterranean flash flood risk

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According to the IPCC, flooding is the most widespread serious potential impact of climate change on human settlement. Vulnerability to floods can be thought as a function of exposure and adaptive capacity, and all three entities have been increasing in many areas. Therefore, in order to inform decision-makers, it is crucial to better understand what are the vulnerability factors but also to what extend individuals and societies are capable to adapt their way of life to their changing environment. In this perspective, flash flood events offer a good example of the kind of extremes that our societies may have to face more often in the future. Characterized by their suddenness, fast and violent movement, rarity and small scale, they are particularly difficult to forecast accurately and leave very little lead-time for warnings.

In this context, our interdisciplinary team conducts research focusing on individual and human organization responses to warning and crisis situations by using a comprehensive, coupled natural—human system approach over time and space scales. The objective is to understand i) what cognitive and situational factors help individuals and communities to shift from normal daily activities to adapted crisis response and ii) what is the dynamic of this process compared to the one of the natural phenomenon. In this regard, our research learned both from individual perception and behavioral intent survey (“what if” type of survey) than from actual behavioral data gathered in a context of post-event investigations.

This investigation leads us to stress the specificity of small catchments, which are more dangerous both in hydrological and human terms. The new approach developped also highlights the need for a broader thinking of post-event investigations and analyses. Usually these analyses further our knowledge within the discipline studied and provide evaluations upon which various types of mitigation and loss reducing practices can be based. Trans-disciplinary contributions are still rare and they tend to be focused temporally, spatially, or institutionally. This modest contribution to linking social sciences and geophysics shows what may be the benefice of expanding those discipline-specific boundaries.
Statistical distributions of wildfire in Corsica: a multifractal approach

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This study investigates the Promethee database which reports real wild fires occurred in Mediterranean regions of France since 1973. We focus on the statistical features of fires distributions in Corsica using the multi-fractal formalism: in this framework, we investigate the scale dependency of the fires occurrence probability for every month of a given year. Indeed, the multifractal approach yields to scale the probability \( p(\varepsilon) \) of fire occurrences over \( N \) separated regions \( \Delta \) of size \( \varepsilon \) by computing the function \( \Phi_\Delta(q, \tau) = \left( \sum_{i=1}^{N} p^q \varepsilon^{-\tau} \right) \) and also by assuming that, for fine enough partitions, this function \( \Phi_\Delta \) collapses onto a single constant value. Applied to the Corsica region, this formalism describes the coexistence of two fractal distributions of length scales characterized by two exponents \( \alpha_1 \) and \( \alpha_2 \) in probability power-laws, \( p(\varepsilon) \sim \varepsilon^\alpha \).

Two numerical algorithms are developed and benchmarked for investigating the behavior of \( \Phi_\Delta \) at fixed size \( \varepsilon \) and fixed “density” \( p \), respectively. Results exhibit a significant evolution in the phase transition rendered by the \((q, \tau)\) distribution. Peculiarly, preeminence of the one to the other power law in the \( p(\varepsilon) \) distribution is shown to be dependent on seasonal effects, closely related with the water cycle during a year over the concerned territory. These preliminary results underline the great opportunity to correlate the fire occurrence distributions to the rainfall distributions, if available, for Corsica and others Mediterranean regions.
Boundary layer balloons in the Mediterranean

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BAMED (Balloons in the Mediterranean) is a French project lead by the LMD/IPSL, in collaboration with CNES and CNRM-GAME. This project is supported by the CNES/TOSCA and INSU/LEFE. BAMED aims at preparing the deployment of in-situ drifting observing platforms on-board of pressurized balloons to be deployed during HyMeX Special Observing Periods (SOPs). This preparation includes the development of a new generation of balloons at CNES and an event-oriented launch procedure to optimize the observing resources. As a consequence BAMED substantially contributes to the TTO1-b.

In the frame of HyMeX, our interest focuses on the prediction of high impact weather events such as heavy precipitation (HPE), windstorms or regional strong winds (e.g. mistral), together with their predictability. For instance, some of these phenomena are poorly predictable, especially when considering the forecast range implied by both the field logistics and the drifting nature of the observing platform in question. These considerations naturally address adaptive observation issues.

BLPBs are Boundary Layer Pressurized Balloons designed to drift at constant density above the sea and collect pressure, temperature and humidity data. The Aerocippers are marine platforms that drift at the sea surface and collect flux data in addition to pressure, temperature and humidity. During the Autumn SOPs, both the BLPBs and the Aerocippers are expected to benefit the prediction of HPEs because they will disseminate in near-real time, the in-situ measurements they will collect in the oceanic boundary layer. Such data are currently lacking in operational weather prediction systems. Such deployment may be considered as upstream, as the key feature to observe is not in the heart of the event itself, but before.

During the late winter SOP, focusing on regional wind events, these platforms will contribute to the monitoring of the preconditioning and triggering of deep ocean convection.

For all these platforms, the Mediterranean basin is closed. As a consequence, the date and coastal location of the launch has to be thoroughly chosen in order to let the balloons drifting towards the area of interest, especially prediction-related sensitive areas. Possible launching sites have been evaluated through trajectography and adaptive observation studies on a selection of typical Mediterranean cases.

We will present an update on the BAMED project and show a selection of results from the aforementioned studies.
Observations and products available from the Lightning Observation Task Team during HyMeX


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(10) NMT, USA
(11) NOA, Greece
(12) LTHE, France
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The detection of the lightning activity allows the tracking and the monitoring of thunderstorms. Lightning detection is instantaneous, can be delivered in real time and location of the lightning flashes can be obtained over the entire HyMeX domain, i.e. the entire Mediterranean basin. The Lightning Observation Task Team (LOTT) will record and analyze the total (intracloud (IC) and cloud-to-ground (CG)) lightning activity with the use of 5 different Lightning Locating Systems (LLSs): the long-range ATDnet and ZEUS networks, the short-baseline LINET and Euclid networks, and a VHF mapper (either the New Mexico Tech Lightning Mapping Array or the ONERA PROFEO system). These different lightning detection networks are operated according to different principles and provide observations of different processes occurring during the life of a flash. All instruments will be operated during the SOP1.n, while during the EOP and LOP all LLSs but the VHF lightning mapper will be available.

The different LLSs as well as their detection principles will be briefly presented. Spatial coverage of the LLSs and location accuracy will be presented. Cases of Mediterranean lightning activity as reported by the different LLSs will be described in order to present the typical observations that will be made available to the HyMeX participants. Different products will then be introduced like flash rate or flash density. We will then present the type of analysis that LOTT will be performing in the frame of the HyMeX project.
LAM-EPS activities: common scientific interests for HyMeX and TIGGE-LAM

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TIGGE-LAM is aimed to coordinate LAM EPS contribution to the THORPEX Interactive Grand Global Ensemble (TIGGE) and to the THORPEX-Global Interactive Forecast System (GIFS).

One of the main objectives of TIGGE LAM is to support and foster research on LAM EPS, related to improve the predictability of High Impact Weather events (HIW), also by coordinating and stimulating the participation to different projects and initiatives.

Specific actions should be organized at regional level due to the regional nature of LAM EPS and also to the specificity of the different types of HIW. In this sense, HyMEX is an excellent opportunity to coordinate some LAM EPS research to improve the predictability of the HIW affecting the Mediterranean basin and to quantify the uncertainty associated to their prediction.

This 4th HyMEX workshop represents a very good environment to discuss and define common activities reflecting both HYMEX and TIGGE LAM priorities.
HyMeX database

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Promoting and monitoring data exchange is a central issue in multidisciplinary and international scientific projects. A successful data management and distribution system includes the adoption of a concerted data policy, and the development of storage procedures and interfaces meeting scientist’s requirements and facilitating communication between researchers from different disciplines. HyMeX project consists of long term monitoring of environmental parameters, intensive field campaigns, use of satellite data and modelling studies. Therefore HyMeX database will incorporate various dataset types (local observation time series, satellite products, model outputs…) from different disciplines, either present or historical, either operational or research. It will include a meta-catalogue referencing datasets stored in the HyMeX database as well as datasets stored in other databases (historical observatories, satellite data centres…). The meta-catalogue will provide information characterizing the data and detail data access ways.

IPSL and OMP data centres are setting up a complete data management system. It is composed of different parts:
- a metadatabase complying with international standards;
- distributed databases where data are homogeneized and converted into standard formats;
- a user-friendly data request interface that allows to easily access all the metadata and data wherever they are stored.

Before accessing data, any user has to register and sign the HyMeX data and publication policy to be endorsed by ISSC. The policy defines the mutual rights and duties of the data users and producers. In particular, HyMeX data policy only covers the use of data in the framework of HyMeX scientific objectives. Commercial use and exploitation of HyMeX data and redistribution of data to a third party are prohibited. Direct contacts and co-authorships between data producers and users are strongly recommended.

In 2010, HyMeX database team’s objectives are the design and development of the complete system, the identification of data to be stored together with the different HyMeX Working Groups, and the data policy writing together with the ISSC.
Data Management needs in Hydrological Services

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The Impacts of weather on societies is growing due Climate Change. Societal Infrastructure is becoming more vulnerable to weather and water, which generates needs to improve meteorological and hydrological services. The services itself must be easier to use, faster to produce, and have more information, but it is highly important to have more accurate forecasts. When the forecasting time step is getting shorter and as well the forecasting grid denser, it is needed to have more observations with shorter time interval. When the observation data amount is growing, it is needed to have data management to take care of securing quality and archiving the data as well maintaining the observation networks.

The use of the observation data can be divided into two categories: operational and statistical use. For operational use the latency (collecting data from station to the database and ready to use) is the most critical value, for example in flash-flood cases. Another important issue is to have real-time quality control to secure quality of the data. For statistical usage the quality and consistency of the data are the most important values. For both uses the reliability of the data flow from station to database is highly important.

There are many tools and ways how to solve data management issues, so this study tries to draw the overall picture of the data management challenges and give general requirements and suggestions how to handle the issue.
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