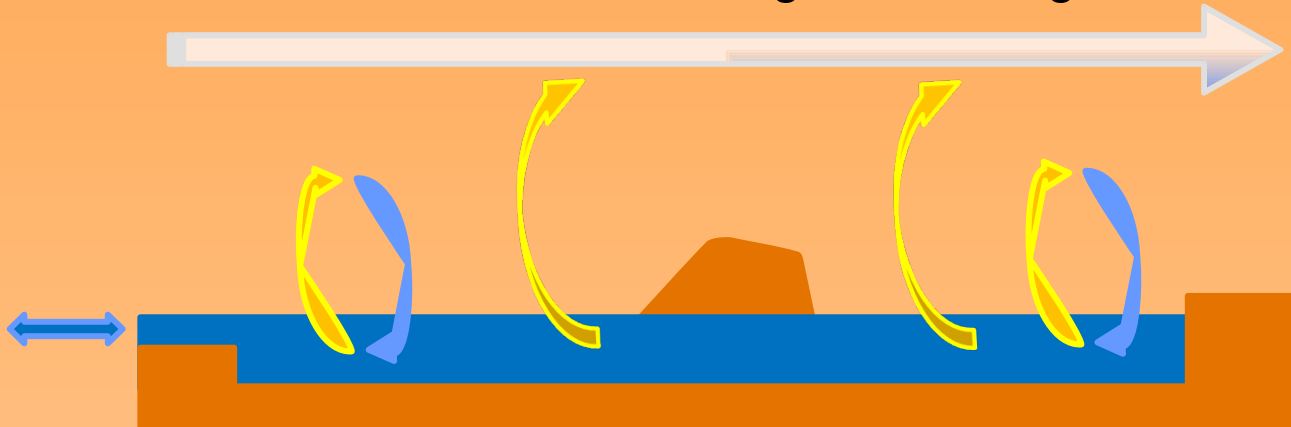


A Regional Coupled System for climate change assessment in the Mediterranean region: the CIRCE experience

PM Ruti, V Artale, S Calmanti, A Carillo, G Pisacane, A Dell'Aquila, G Sannino, MV Struglia, F Giorgi, and X Bi



Hymex Crete
1-4 June

Outlook

- From CIRCE to Hymex
- The Protheus System
- ERA40 simulation
- Scenario

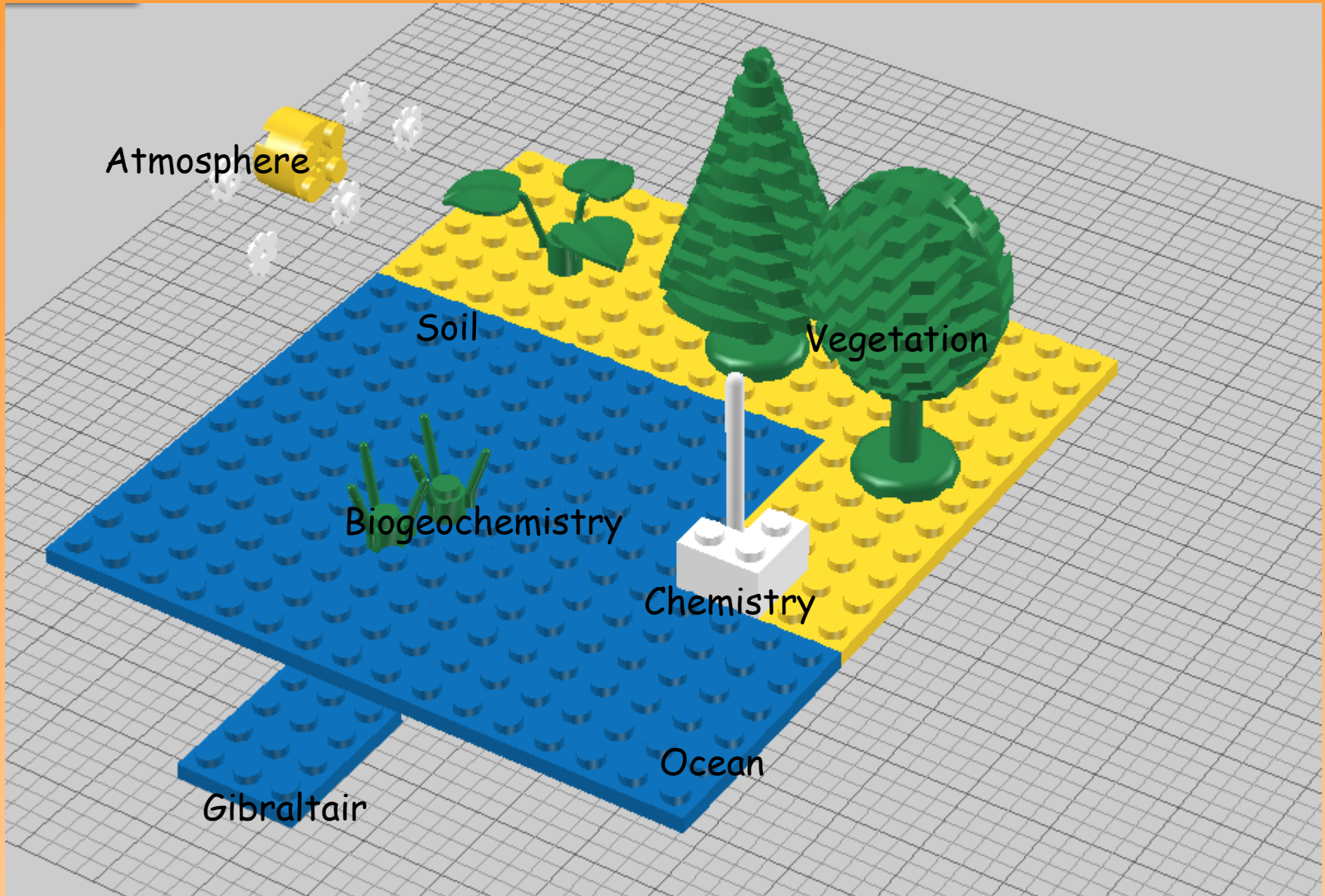
Outlook

- From CIRCE to Hymex
- The Protheus System
- ERA40 simulation
- Scenario

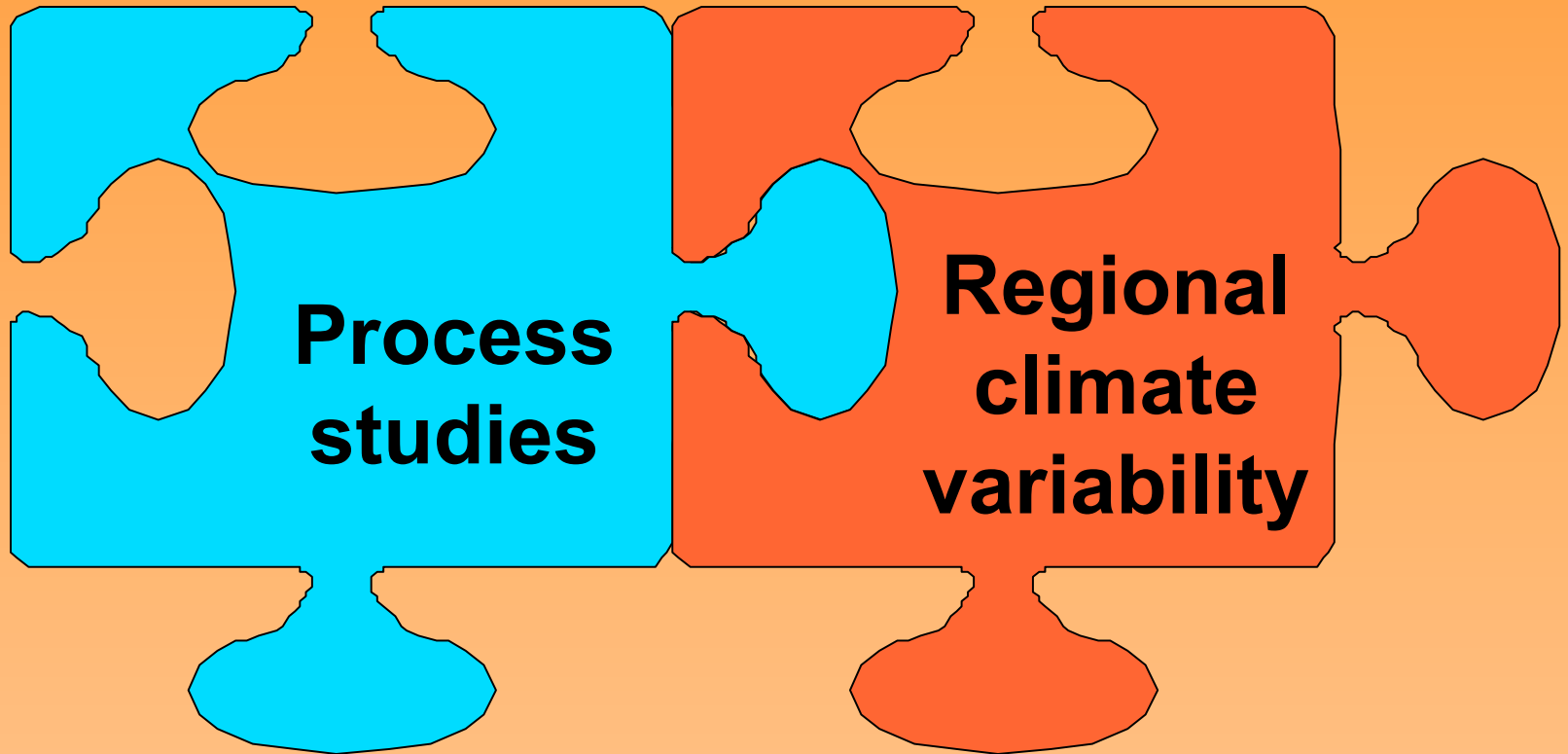
CIRCE – EU, RL2

- Regional coupled models + GCM with MedSea (LMD, MPI, ENEA – RCM), (CNRM, INGV, LMD – GCM+MedSea)
- ERA40 simulations (available)
- Scenarios - A1B

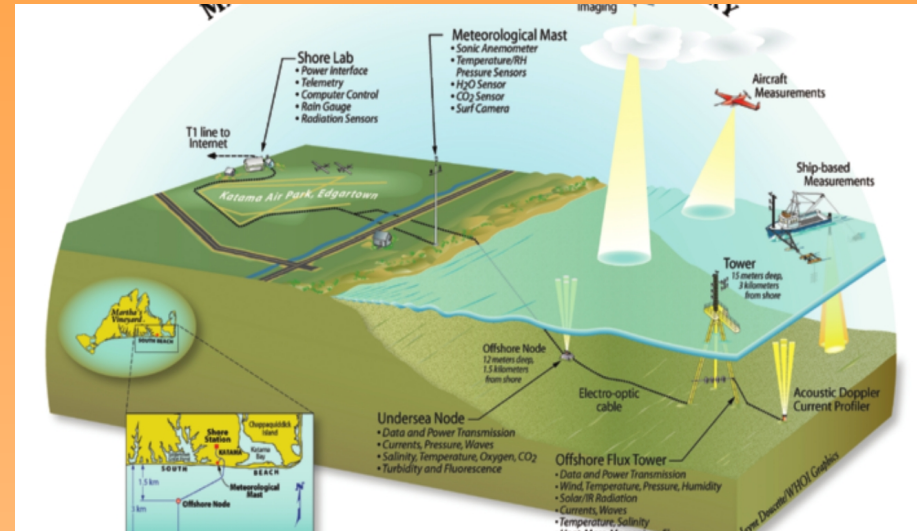
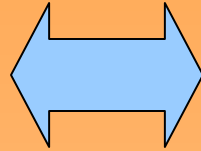
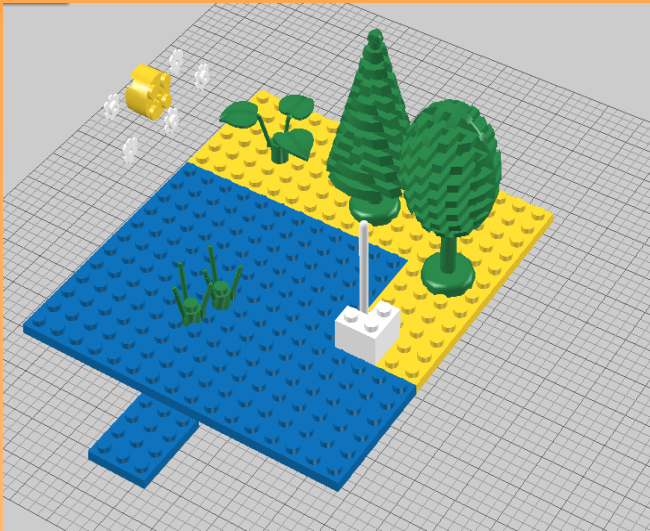
From CIRCE to HYMEX



From CIRCE to HYMEX



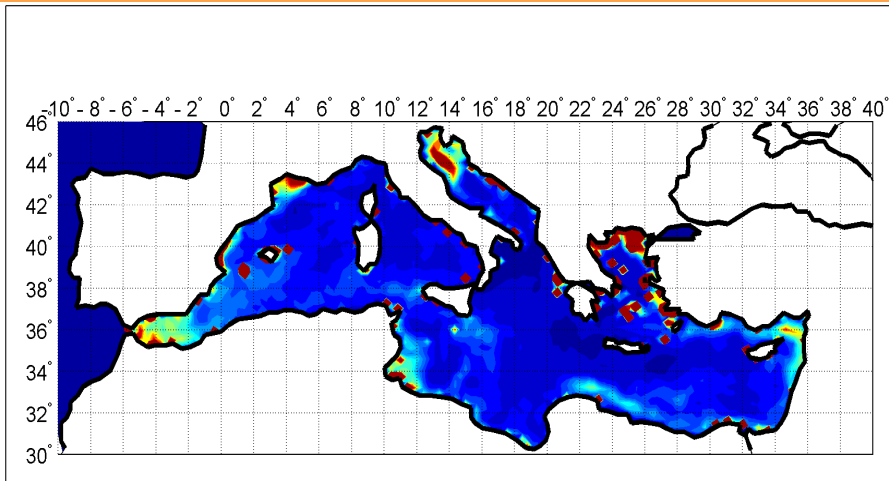
From CIRCE to HYMEX



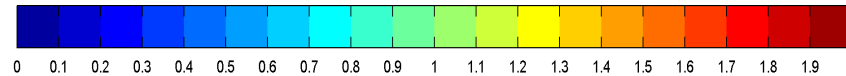
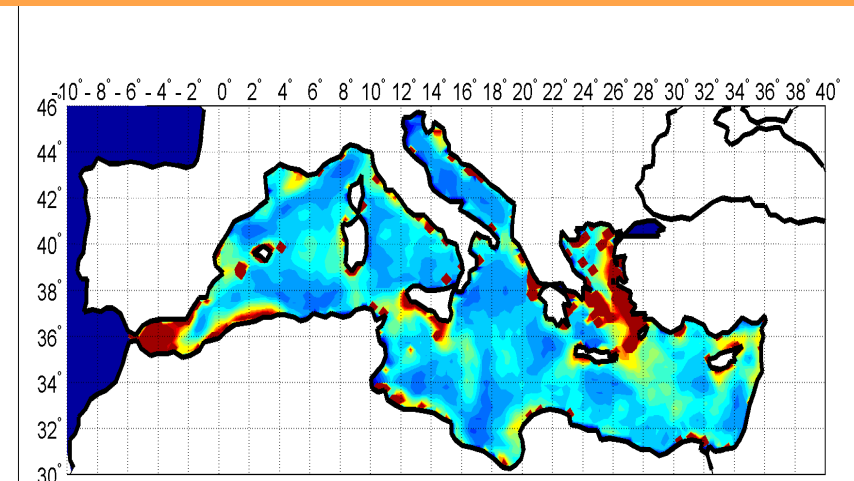
From CIRCE to HYMEX

SST intra-seasonal var ratio OBS/MOD

DJF



JJA



AR5 Scenario

1) AORCM (atmosphere 30 Km) – CIRCE – A1B

2) Med-CORDEX – RCP new scenario

- New AR5-GCM evaluation
- Stream1 50 km (ARCM, ORCM, AORCM)
- Stream2 15-30 km (AORCM)

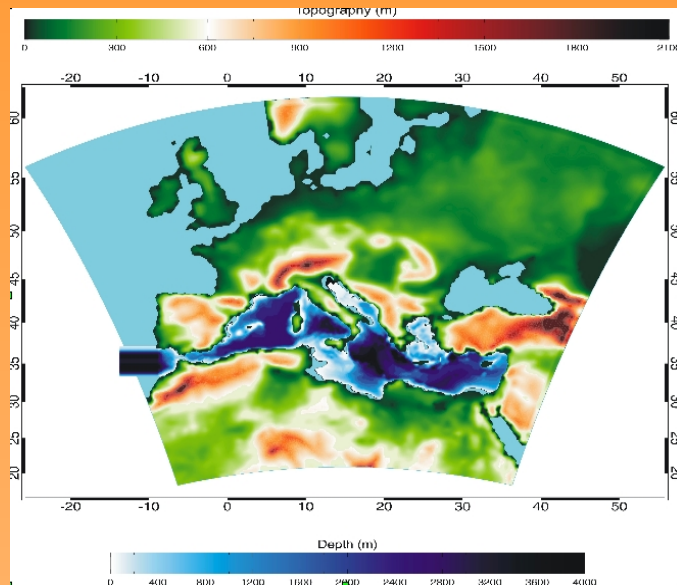
3) COMBINE – Decadal prediction (AR5) – Stream2 15-30 Km

4) Grand Ensemble

Outlook

- From CIRCE to Hymex
- The Protheus System
- ERA40 simulation
- Scenario

The PROTHEUS System



Coupled Model Configuration

Atmosphere:	RegCM3	18 vertical levels 30 Km horizontal resolution
Land Surface:	BATS	+ <i>Interactive Runoff</i>
Coupler:	OASIS3	
Ocean:	MITgcm	42 vertical levels 1/8°x1/8° horizontal resolution

RegCM is developed and maintained at ICTP (Trieste)

Oceanic boundary layer: Zeng et al., 1998

Cumulus parameterization: Grell, 1993

Lateral BC: 6-hourly, 12-points slice nudging (exp. method)

Landuse Model: BATS
Landuse types: 20

Interactive Runoff: TRIP database and IRIS numerical scheme

MITgcm Developed by Marshall et al. at MIT.

Horizontal diffusivity and viscosity: biharmonic ($1.5 \times 10^{10} \text{ m}^4 \text{ s}^{-1}$).

Vertical eddy-viscosity: laplacian (diffusivity: $3.0 \times 10^{-5} \text{ m}^2 \text{ s}^{-1}$ at the surface; $1.0 \times 10^{-7} \text{ m}^2 \text{ s}^{-1}$ at the bottom).

Viscous coefficient : $1.5 \times 10^{-4} \text{ m}^2 \text{ s}^{-1}$.

Outlook

- From CIRCE to Hymex
- The Protheus System
- ERA40 simulation
- Scenario

VALIDATION: Present Climate Simulation

Lateral BC: ERA40 reanalysis 1958-2000 (climatological river runoff)

SST (Atlantic Box): Met Office - Global Sea Ice Coverage and Sea Surface (GISST) Temperature data

Ocean initialization: MEDATLAS Climatology at rest; relaxation of SST and SSS during the first 6 years of simulation

Comparison with :

- Stand-alone configuration of the atmospheric model RegCM3 (forced by GISST data),
- ERA40 Reanalysis,
- Observational datasets (OISST, HOAPS, CRU; GPCP).

An Atmosphere-Ocean Regional Climate Model for the Mediterranean area: Assessment of a Present Climate Simulation

ARTALE V., CALMANTI S., CARILLO A., DELL'AQUILA A., HERRMANN¹ M., PISACANE G., RUTI PM.,
SANNINO G., STRUGLIA MV

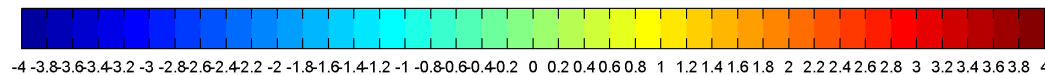
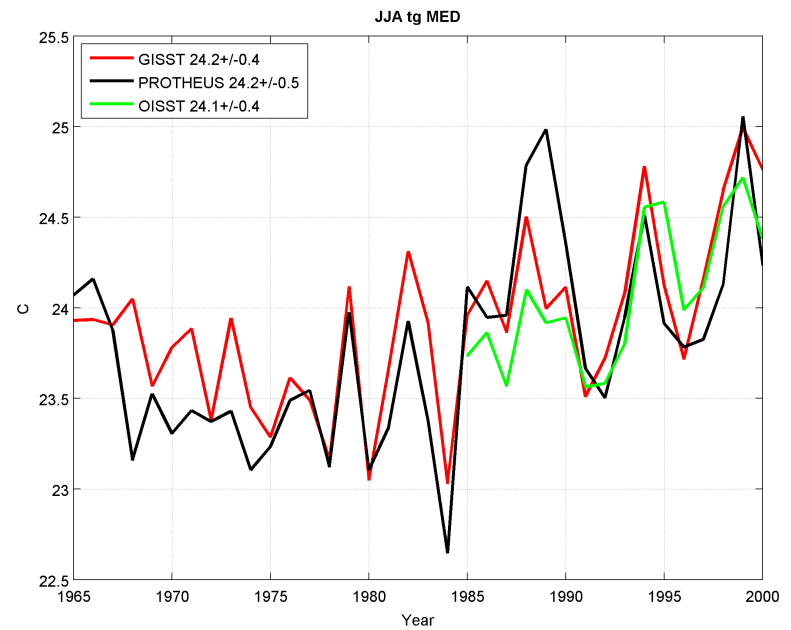
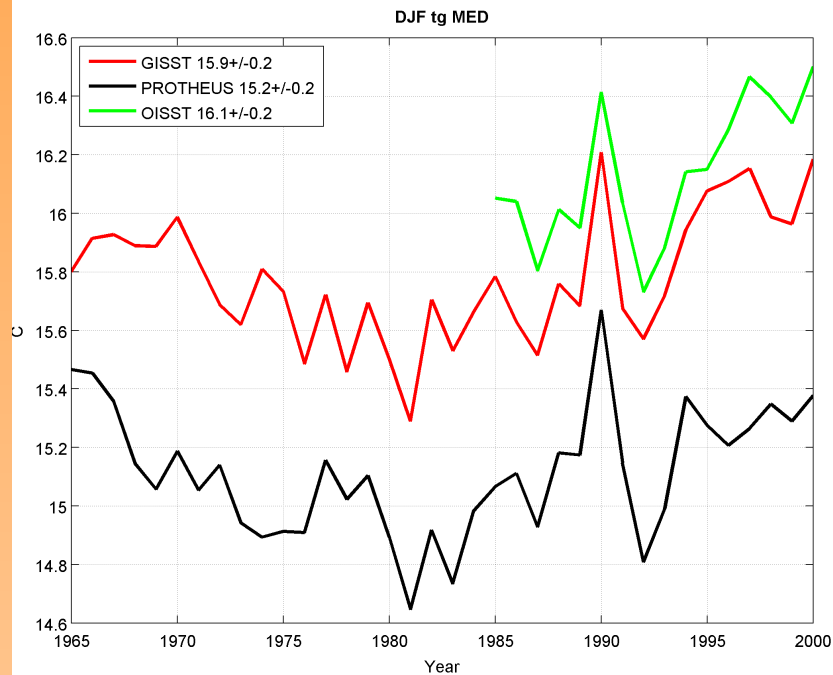
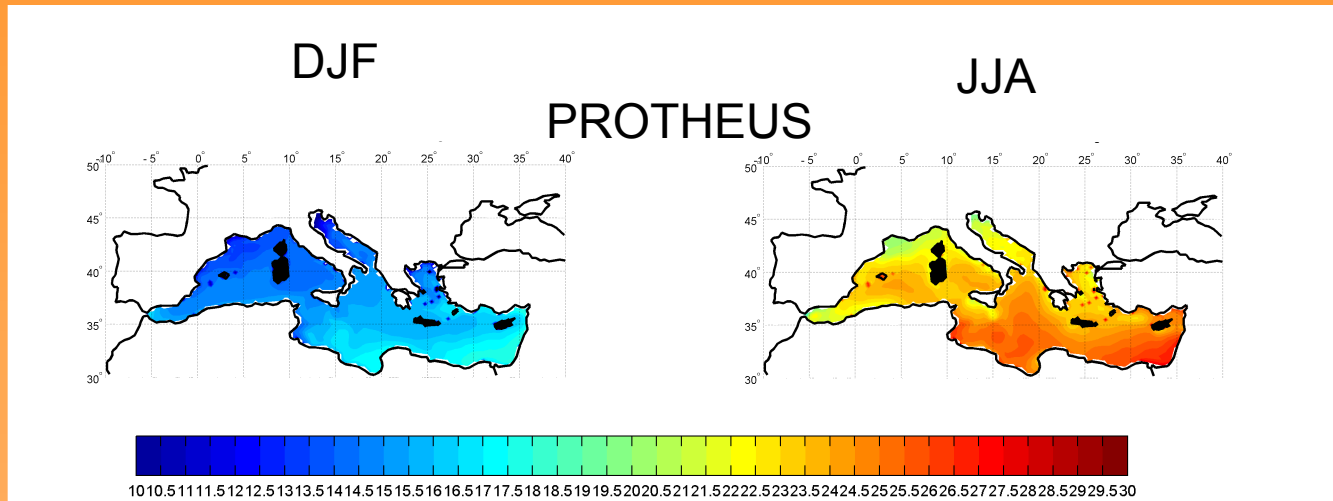
ACS/CLIM-MOD, ENEA, Roma, Italy ,

GIORGI F., BI X., PAL² J.S., RAUSCHER S.,

ABDUS SALAM ICTP, TRIESTE, ITALY

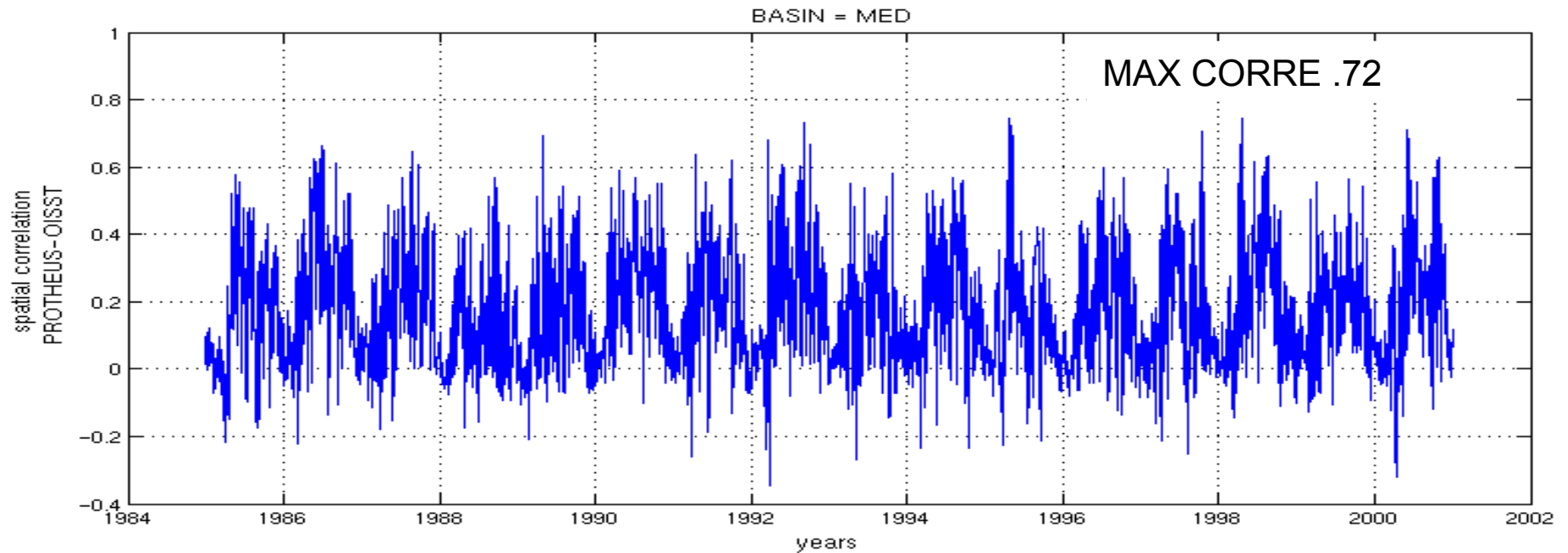
THE PROTHEUS GROUP

Present Climate Simulation : PROTHEUS SST CLIMATOLOGY vs. Observations

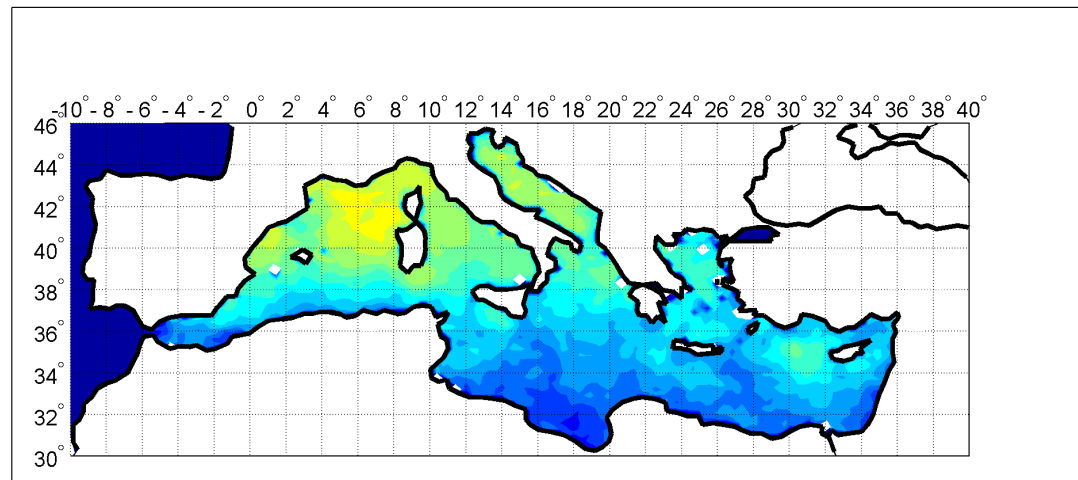


Present Climate Simulation : PROTHEUS SST CLIMATOLOGY vs. Observations

SPATIAL CORRELATION PROTHEUS-OISST 1985-2000



CORRELATION tg PROTHEUS-OISST ANN 1985-2000



TEMPORAL CORRELATION

PROTHEUS-OISST 1985-2000

Present Climate Simulation : Precipitation over land CLIMATOLOGY

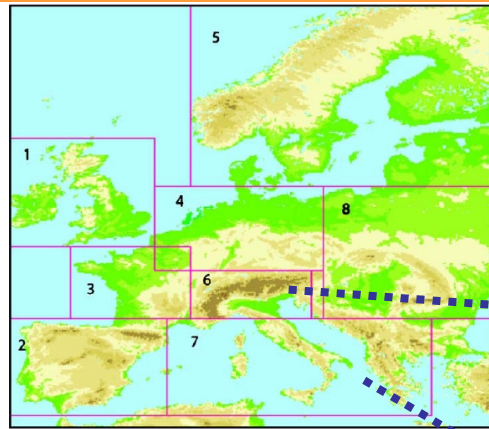


Fig. 4 European sub-areas

Area	West	East	South	North
1 (BI) British Isles	-10	2	50	59
2 (IP) Iberian Peninsula	-10	3	36	44
3 (FR) France	-5	5	44	50
4 (ME) Mid-Europe	2	16	48	55
5 (SC) Scandinavia	5	30	55	70
6 (AL) Alps	5	15	44	48
7 (MD) Mediterranean	3	25	36	44
8 (EA) Eastern Europe	16	30	44	55

ERA40

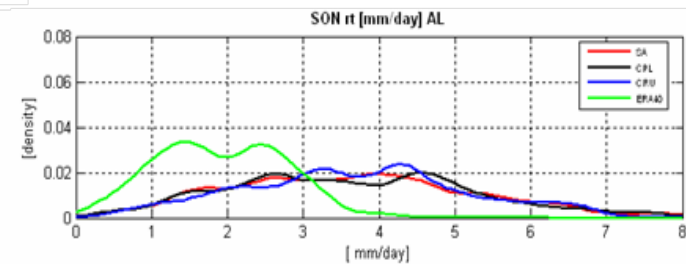
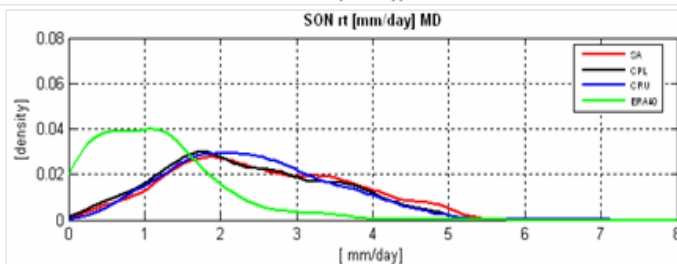
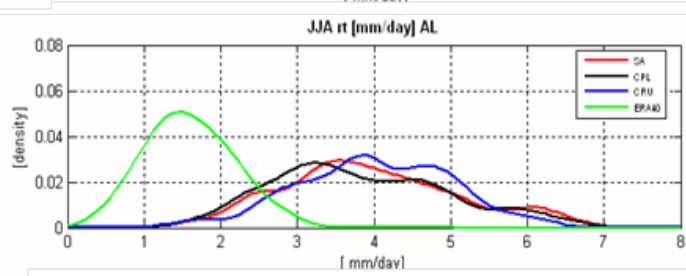
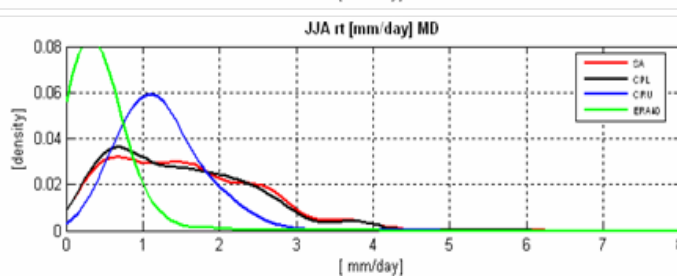
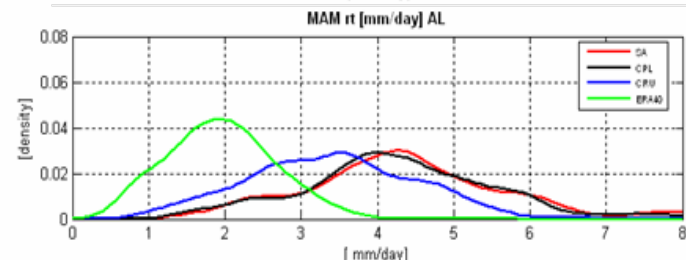
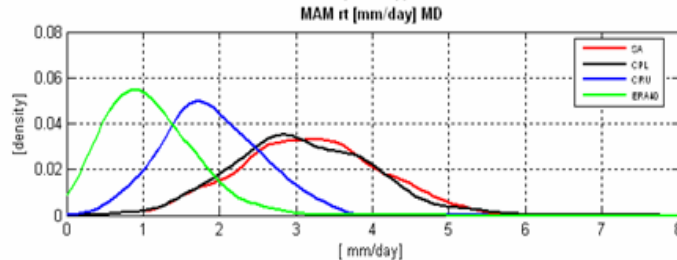
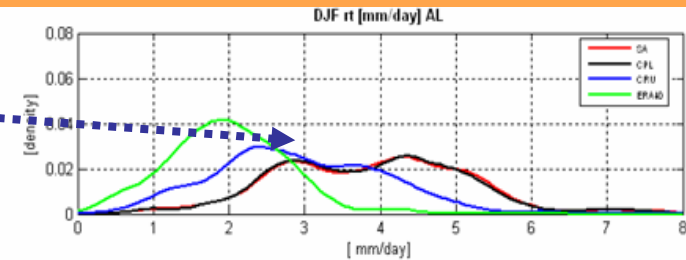
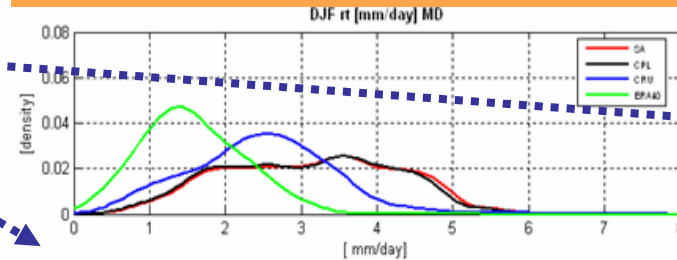
CRU

PROTHEUS

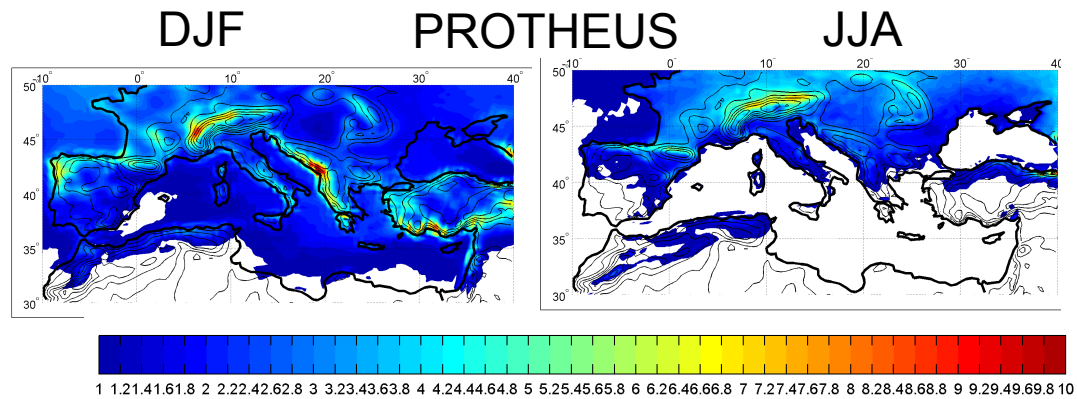
RegCM-SA

MD

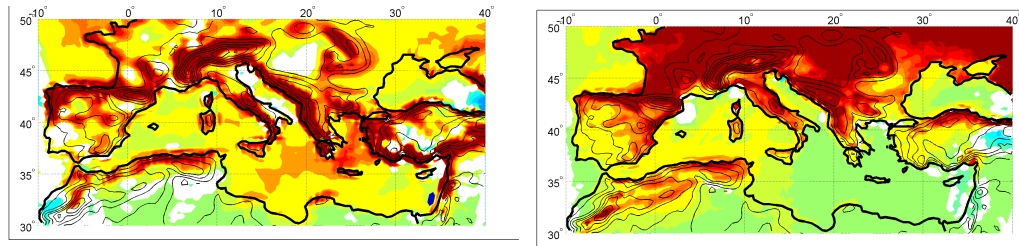
AL



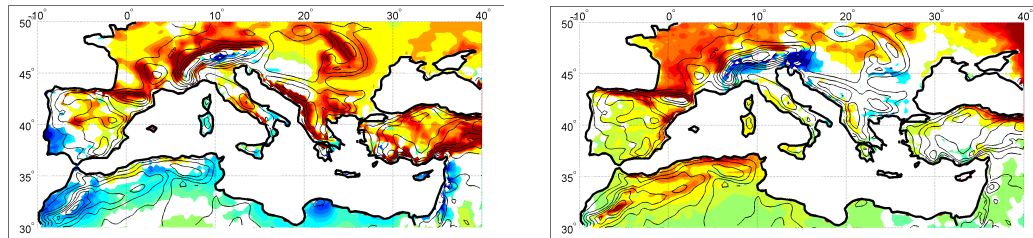
Present Climate Simulation : Precipitation CLIMATOLOGY



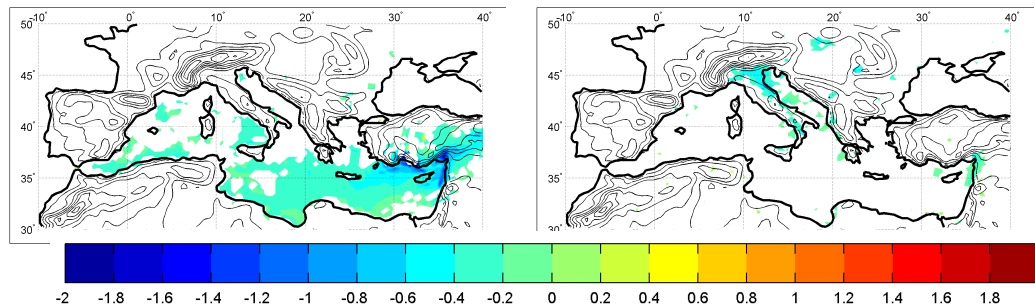
PROTUEUS –ERA40



PROTUEUS –CRU

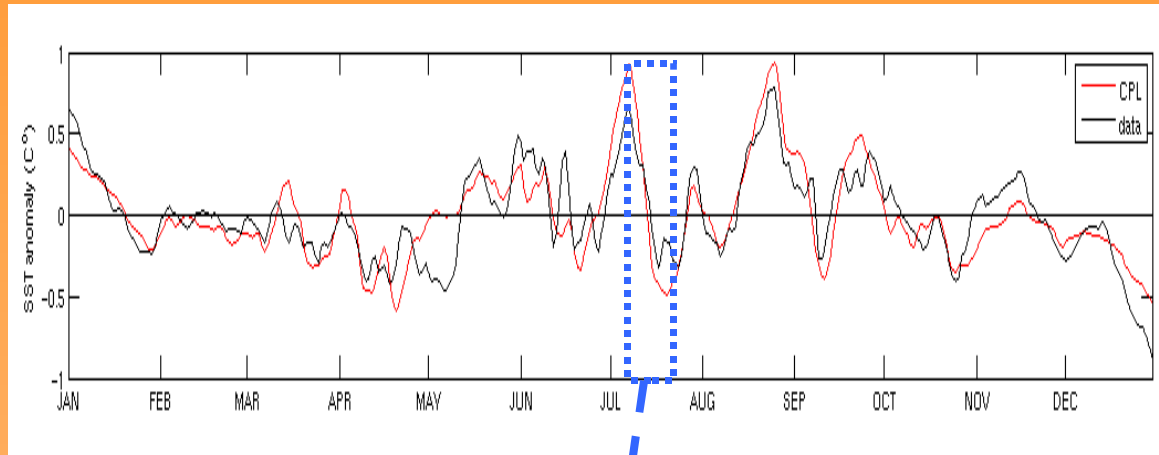
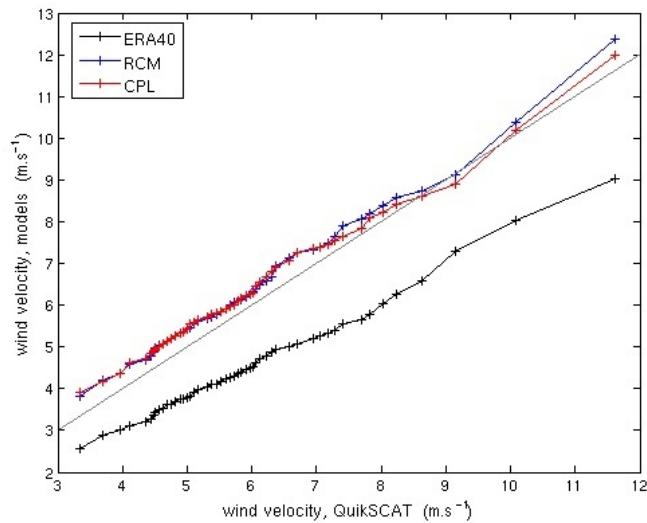


PROTUEUS –RCM stand-alone



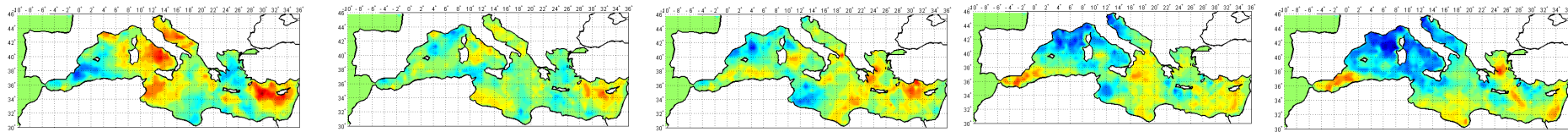
Present Climate Simulation : A single year case study

The 2000

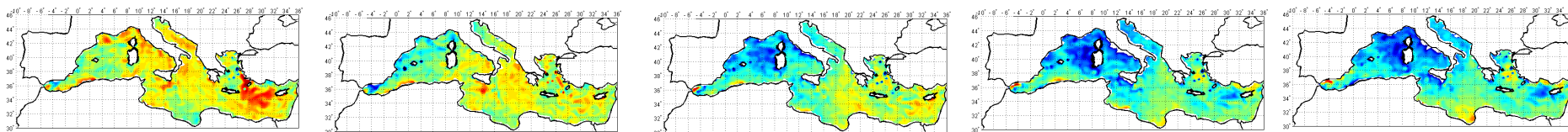


Time series of 2000 **SST anomalies** for the CPL simulation (red line) and satellite observations (black line). Values are averaged over the whole basin.

OISST



PROTHEUS



9-7

11-7

13-7

15-7

17-7

Present Climate Simulation : Major results

- 40-year simulation driven by ERA40 reanalysis at BC
- Realistic features reproduced (atmospheric circulations, land surface climate, ocean SST, ocean surface circulations and air-sea fluxes)
- The coupling does not affect the bulk characteristics of the atmospheric model
- The coupled model is capable of significantly improve the description of air-sea interactions in terms of sensible and latent heat, especially at small scales and for intense events

Outlook

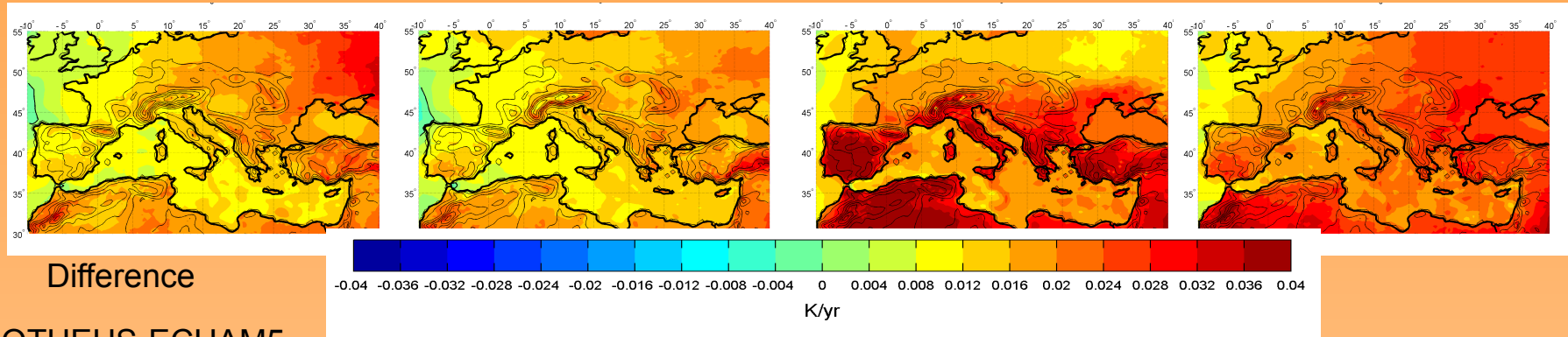
- From CIRCE to Hymex
- The Protheus System
- ERA40 simulation
- Scenario

SCENARIO Simulation: preliminary analysis

- Several Scenario Simulation planned (METEO-FRANCE, ECHAM5-MPIOM,...)
- **Simulation already performed:** 1951-2050 ECHAM5-MPIOM at BC (20c3m for 1951-2000 and SRESA1B for 2001-2050), at the moment ARPEGE simulation is running
- Comparison with the corresponding global simulation

PROTHEUS
trend

Trend Analysis :Surface Temperature



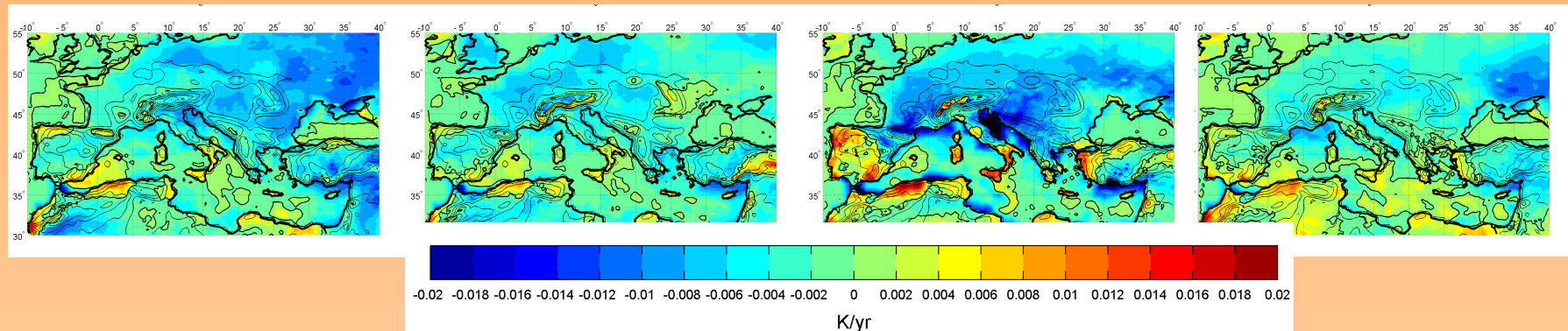
PROTHEUS-ECHAM5

DJF

MAM

JJA

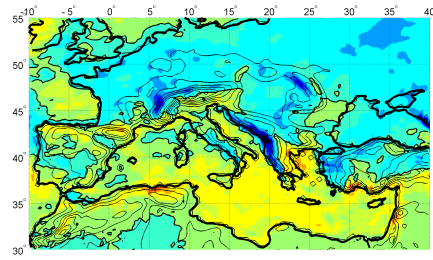
SON



SCENARIO Simulation: preliminary analysis

PROTHEUS
trend

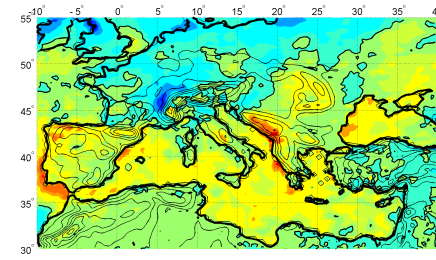
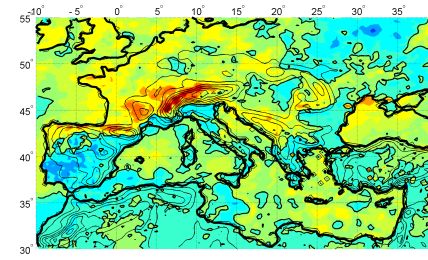
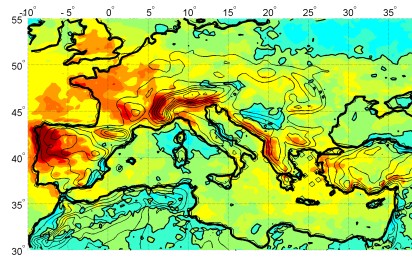
DJF



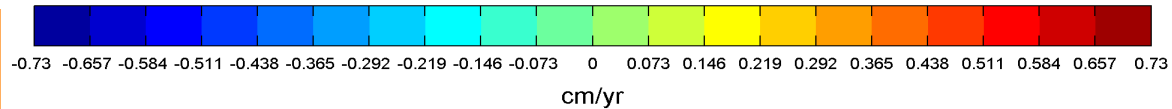
E-P FLUX TREND
MAM

JJA

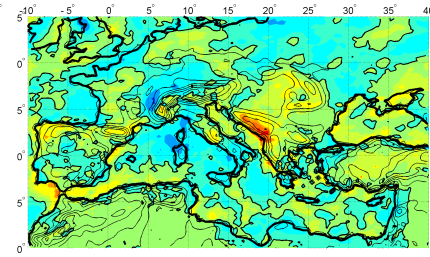
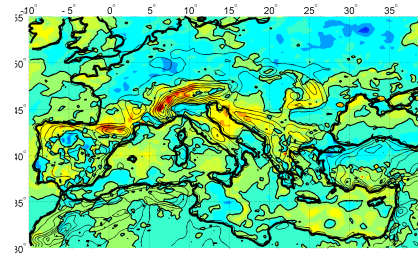
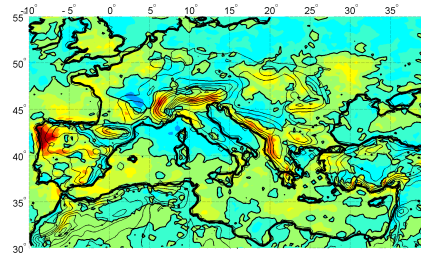
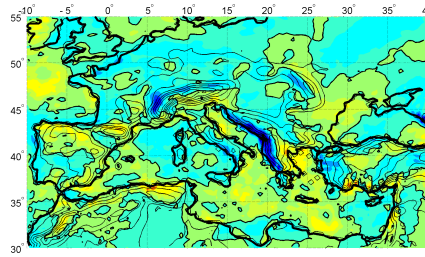
SON



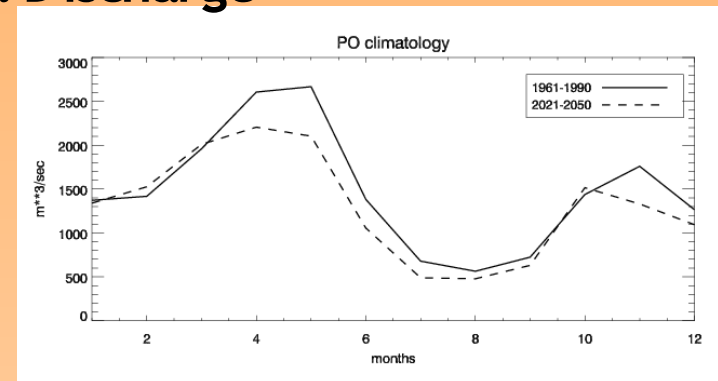
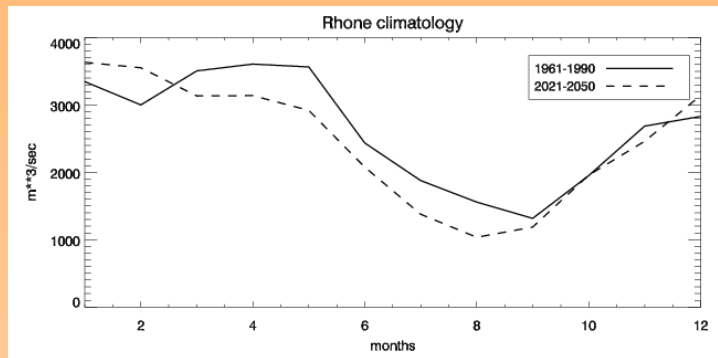
Difference



PROTHEUS-ECHAM5

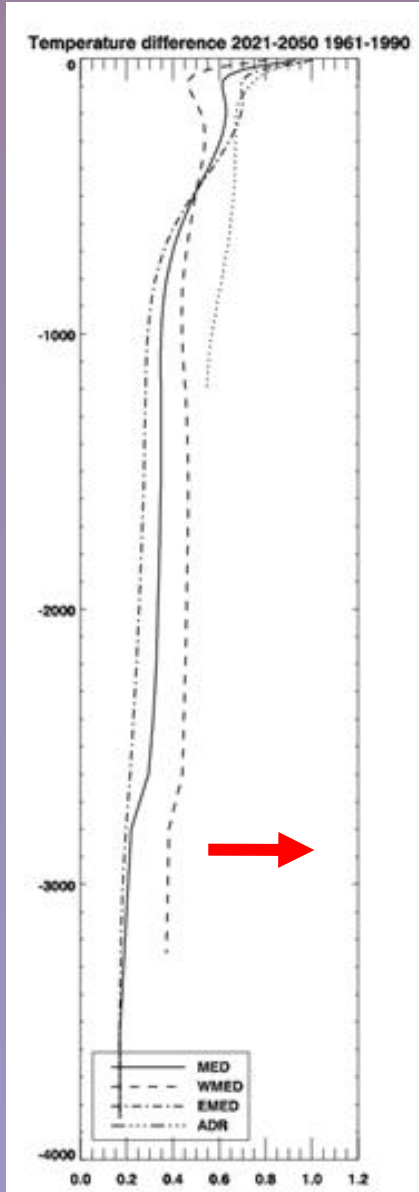


Climatological Discharge



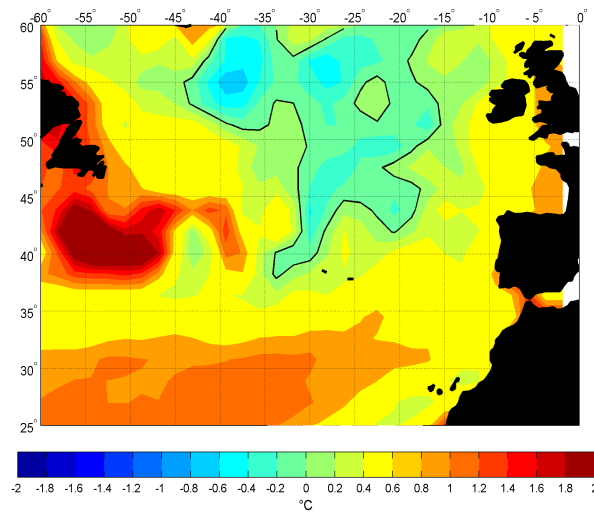
SCENARIO Simulation: preliminary analysis

TEMPERATURE

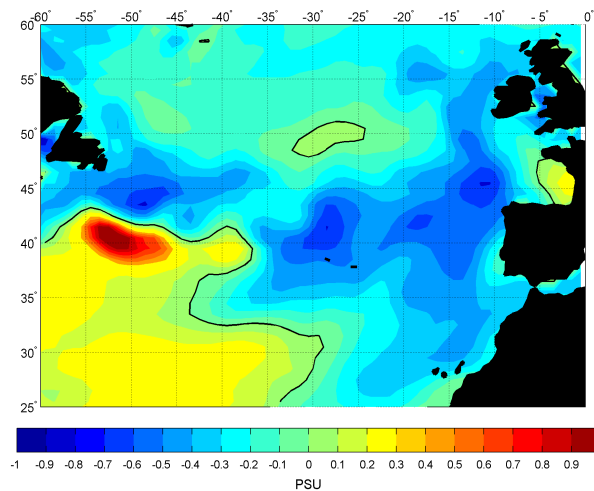


Oceanic Global Driver: Difference 2021-50 / 1961-90

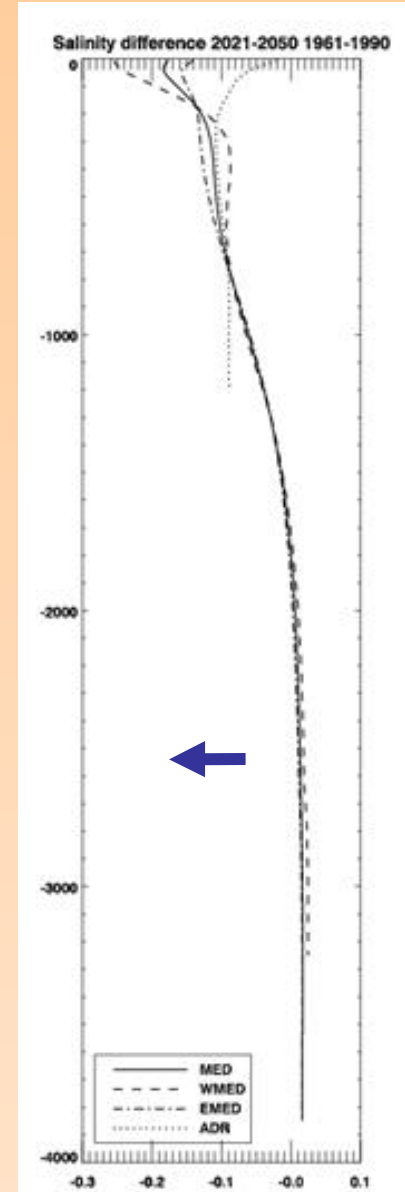
GLOBAL ECHAM5-MPIOM ts; DIFFERENCE 2021-2050 / 1961-1990



TREND GLOBAL ECHAM5-MPIOM so 2021-2050 / 1961-1990



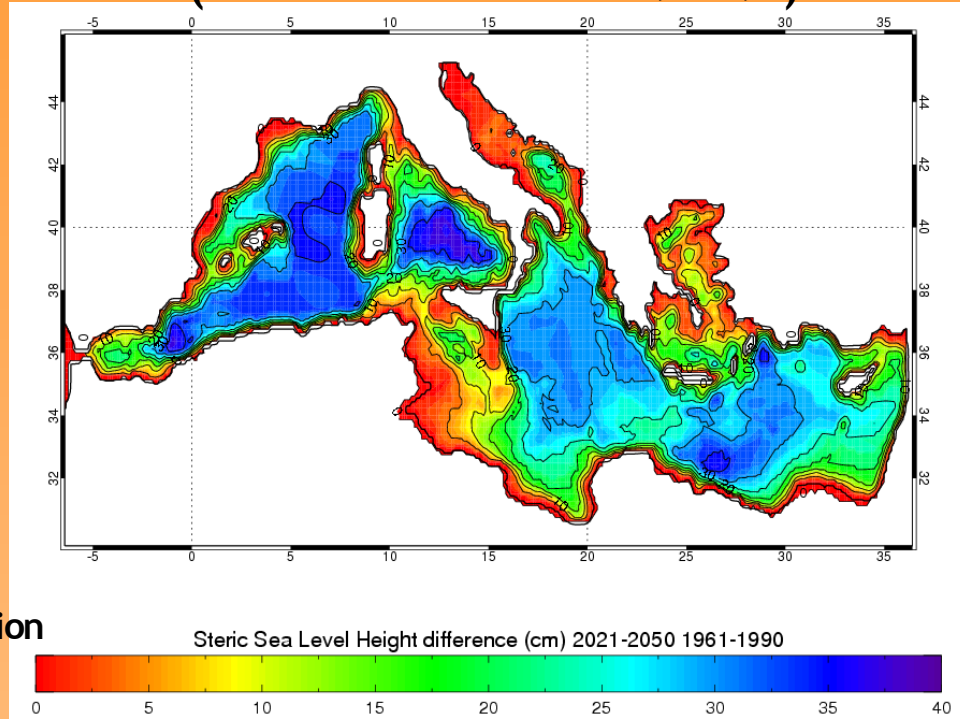
SALINITY



SCENARIO Simulation: preliminary analysis

Steric Sea Level Changes

(Difference 2021/50 - 1961/90)



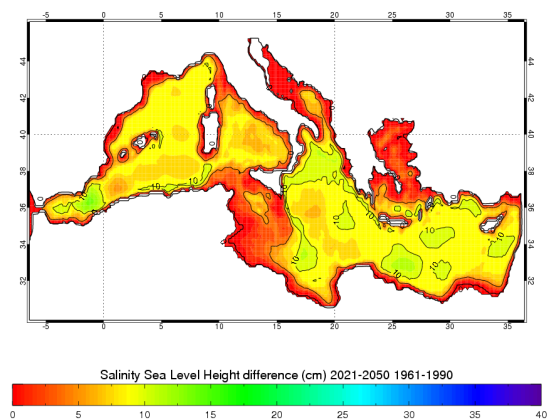
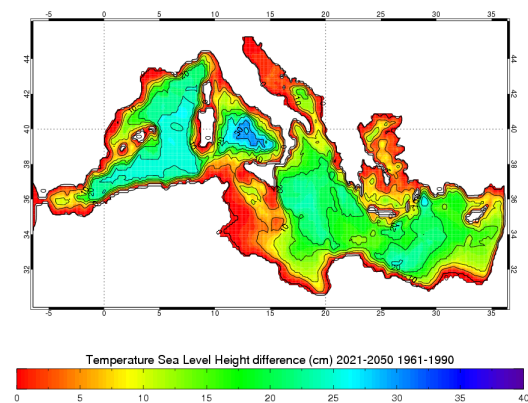
Marcos, Tsimplis and Somot, 2008

Temperature Contribution

Salinity Contribution

Sea Level Height

Sea Level Height



Preliminary analysis first SCENARIO Simulation:

Major results

- Simulation: 1951-2050 ECHAM5-MPIOM at BC (20c3m for 1951-2000 and SRESA1B for 2001-2050)
- Upward trend in Surface Temperature detected in PROTHEUS Scenario simulation
- Trends in PROTHEUS significantly lesser than the corresponding ones in the global simulation, especially over the sea and over mountain regions
- Strong seasonality in PROTHEUS E-P surface flux trend and, consequently, in river discharges
- Sea level changes detected (steric sea level rise)