Boundary layer BAlloons in the MEDiterranean (BAMED)

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Introduction

BAMED objectives :

Develop new aerostats to be deployed during the field phase of HyMeX as well as numerical tools for the optimization of these deployments.

➡ Improve the knowledge and the prediction of weather phenomena with strong societal impact (**heavy rains and flash floods** and wind storms during the **fall**-winter) in the Mediterranean.

Numerical tools :

- balloon's observation simulator developed at LMD/IPSL (VASCO, AMMA...).
- a targeting guidance tool developed at the CNRM (adaptive observation).

Aerostats (partly) built and operated by the CNES :

- boundary layer pressurized balloons (BLPB).
- Aeroclipper (surface layer balloon)
- driftsonde (stratospheric balloon)

Adaptive observation

HyMeX

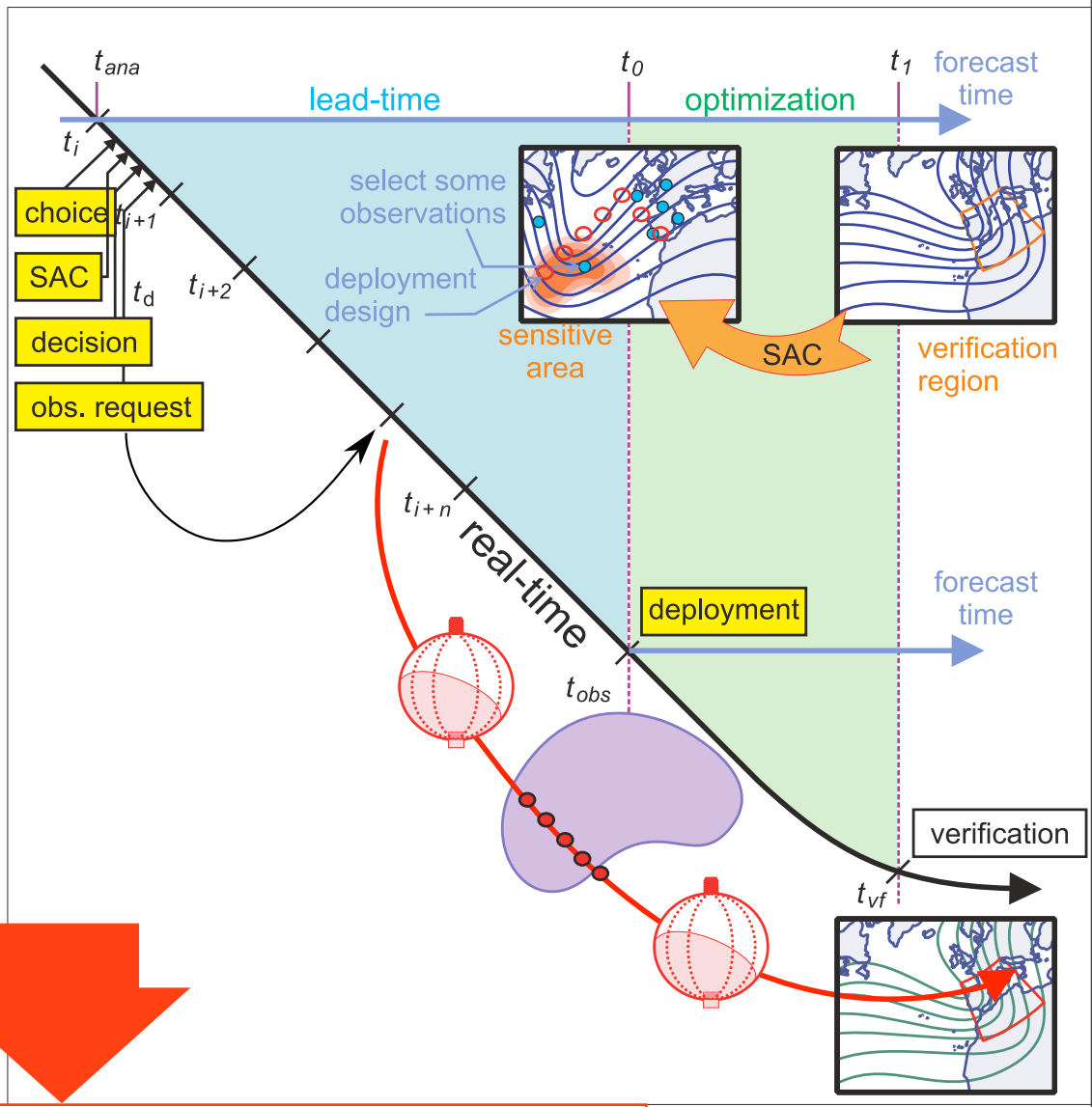
BAMED

Principle:

Improve locally the quality of forecasts by deploying supplementary observations to be assimilated in the analysis from which the forecast originates.

KFS (Kalman Filter Sensitivity), one technique among others (4) :

- adjoint-based technique developed at Météo-France.
- computes a sensitive area to help the design of supplementary deployments.
- predicts the uncertainty reduction due to the addition of observations with respect to the routine observation system.



Sample the sensitive and affected areas with the drifting platform.

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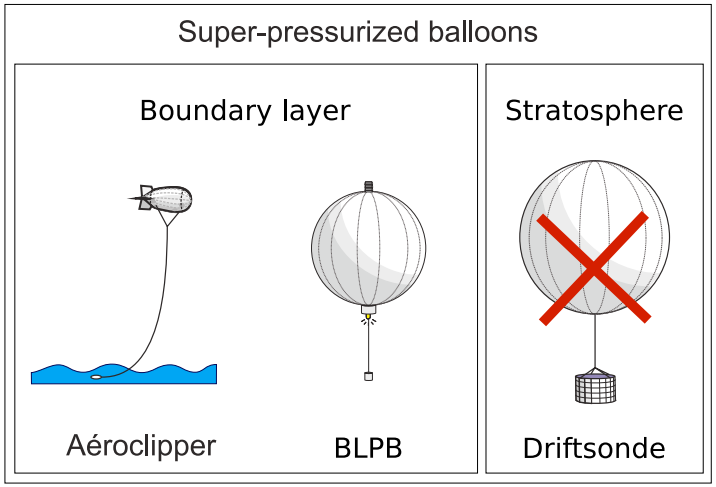
Aerostats deployment

Driftsonde : Abandoned because of technical limitations (new gondola not ready yet).

BLPB : Quasi-lagrangian flight at constant level pressure. 850 or 925 hPa ? launching sites ?
Trains of BLPBs to increase in-situ measurement (sensitive and affected areas).



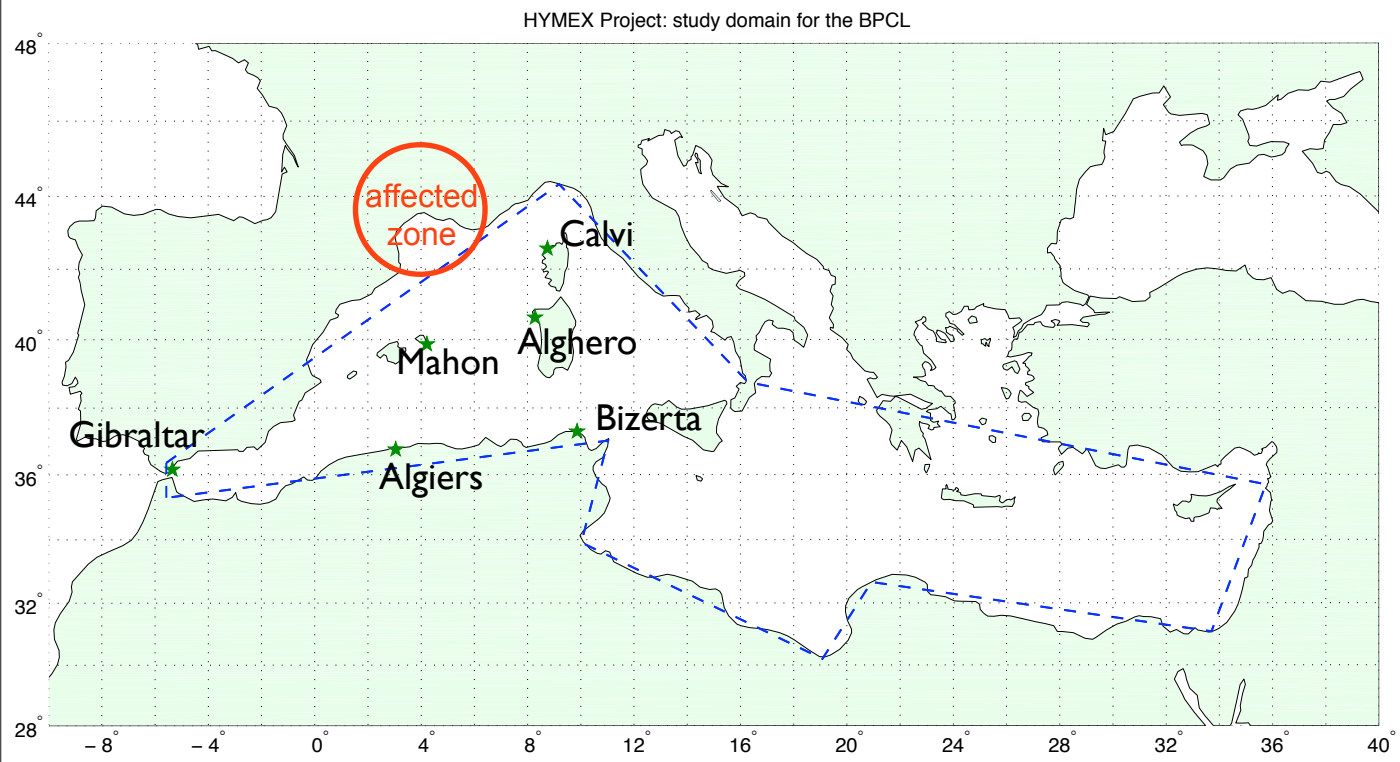
Aeroclipper : surface layer balloon (relative wind).
“indirect” estimation of air-sea fluxes from measurements of mean parameters in the surface layer (Duvel *et al.*, 2009).
Sample the convection area.

The prediction of balloon trajectories is critical, the place and time of launch is crucial for the “control” of the trajectories.

Trajectography study

HyMeX

BAMED



- **15** heavy precipitation events (HPE) studied with the ECMWF analysis data.
- **6** launching sites, **2** pressure level (850 et 925 hPa).
- Systematic launching of balloons (**8/day**) around the HPEs (7 days before, during the event and 2 days after).

Statistical analysis

Launching site	Pressure level (hPa)	mean/median flight duration (hrs)
Algiers	850	**31.2** / 22.3
	925	**36** / 24.3
Bizerta	850	33.6 / 21.6
	925	36 / 24
Calvi	850	26.4 / 13
	925	32.5 / 16.1
Gibraltar	850	16.8 / 8
	925	14.4 / 8
Mahon	850	**36** / 24
	925	**40.8** / 28.8
Alghero	850	**40.8** / 21.6
	925	**45.6** / 31.2

More “good” balloons from Mahon, Alghero and Algiers, about 40% (not shown).
No clear dependence on the pressure level.

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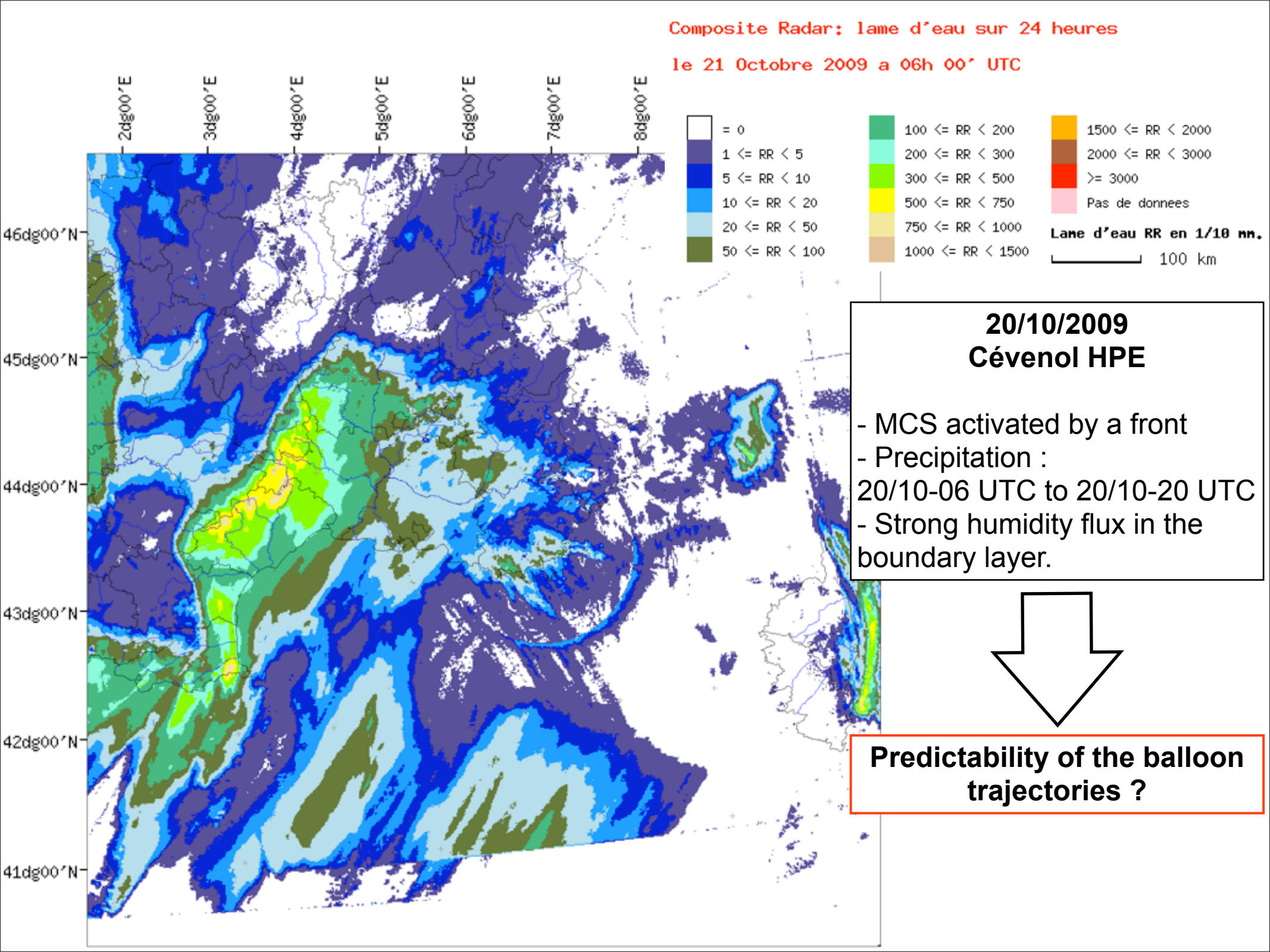
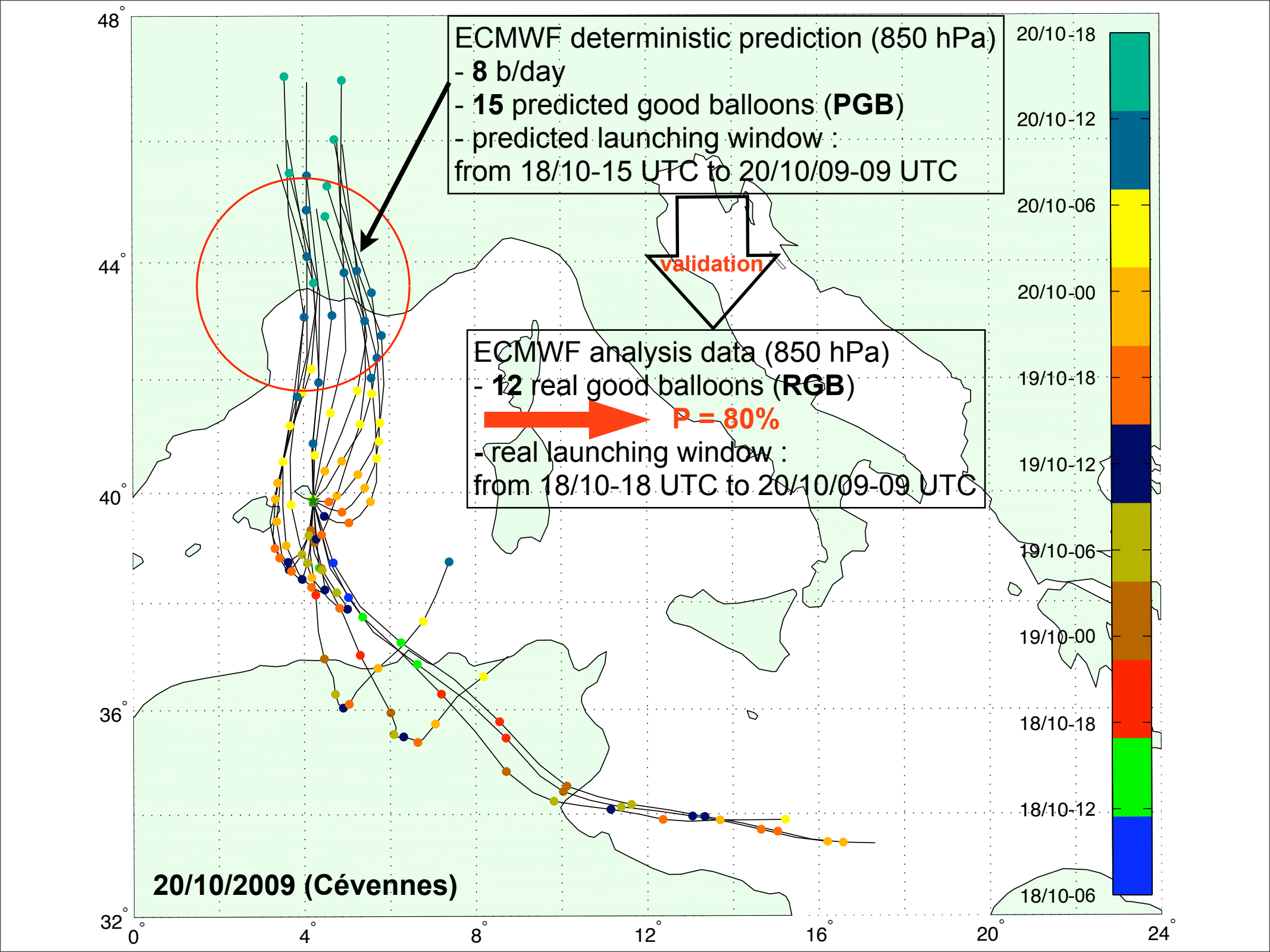


20/10/2009
Cévenol HPE

- MCS activated by a front
- Precipitation :
20/10-06 UTC to 20/10-20 UTC
- Strong humidity flux in the boundary layer.

Predictability of the balloon trajectories ?

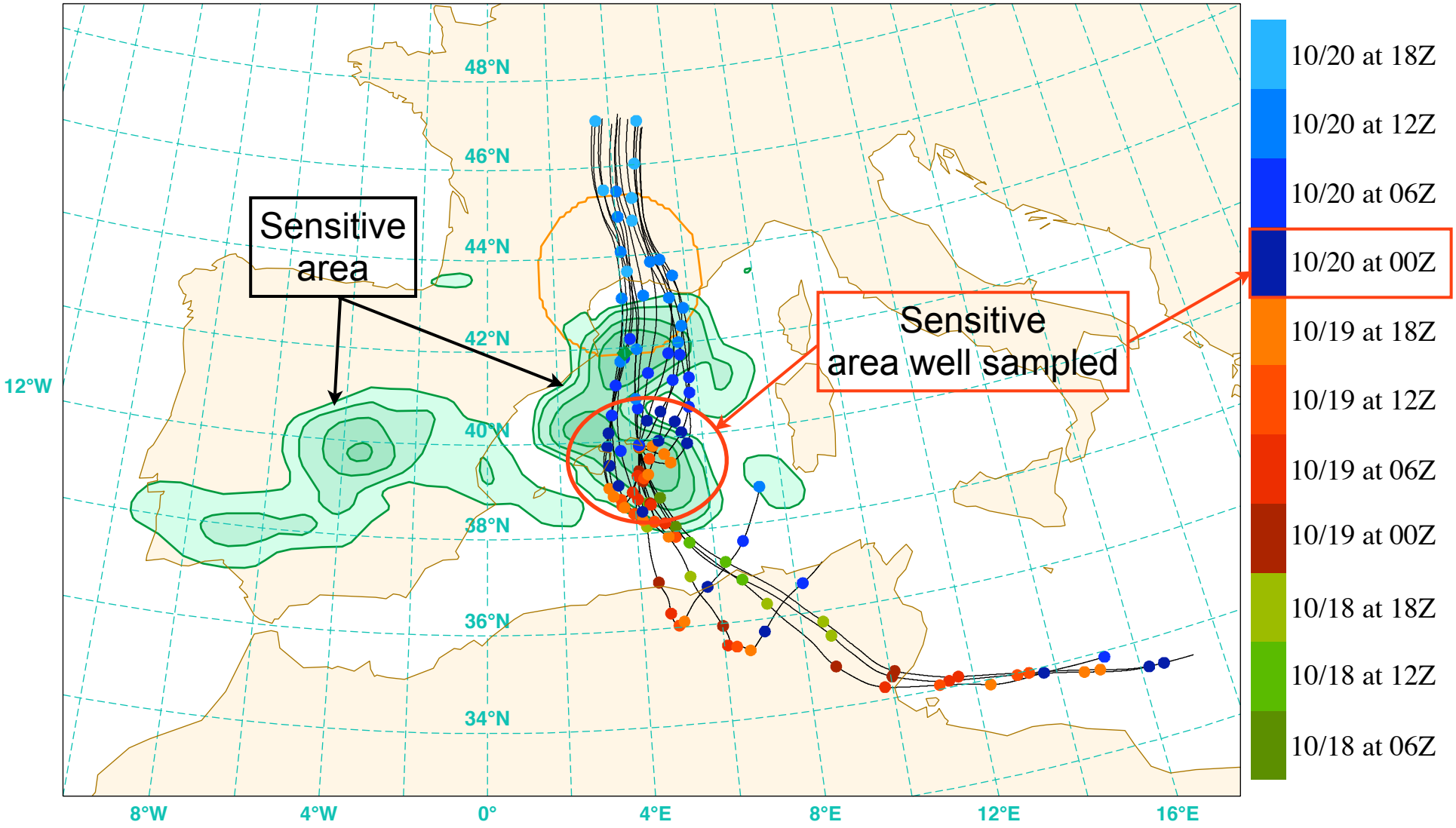

ECMWF deterministic prediction (850 hPa)
- 8 b/day
- 15 predicted good balloons (PGB)
- predicted launching window :
from 18/10-15 UTC to 20/10/09-09 UTC
validation
ECMWF analysis data (850 hPa)
- 12 real good balloons (RGB)
P = 80%
- real launching window :
from 18/10-18 UTC to 20/10/09-09 UTC
20/10/2009 (Cévennes)
48°
44°
40°
36°
32°
0°
4°
8°
12°
16°
20°
24°
20/10-18
20/10-12
20/10-06
20/10-00
19/10-18
19/10-12
19/10-06
19/10-00
18/10-18
18/10-12
18/10-06

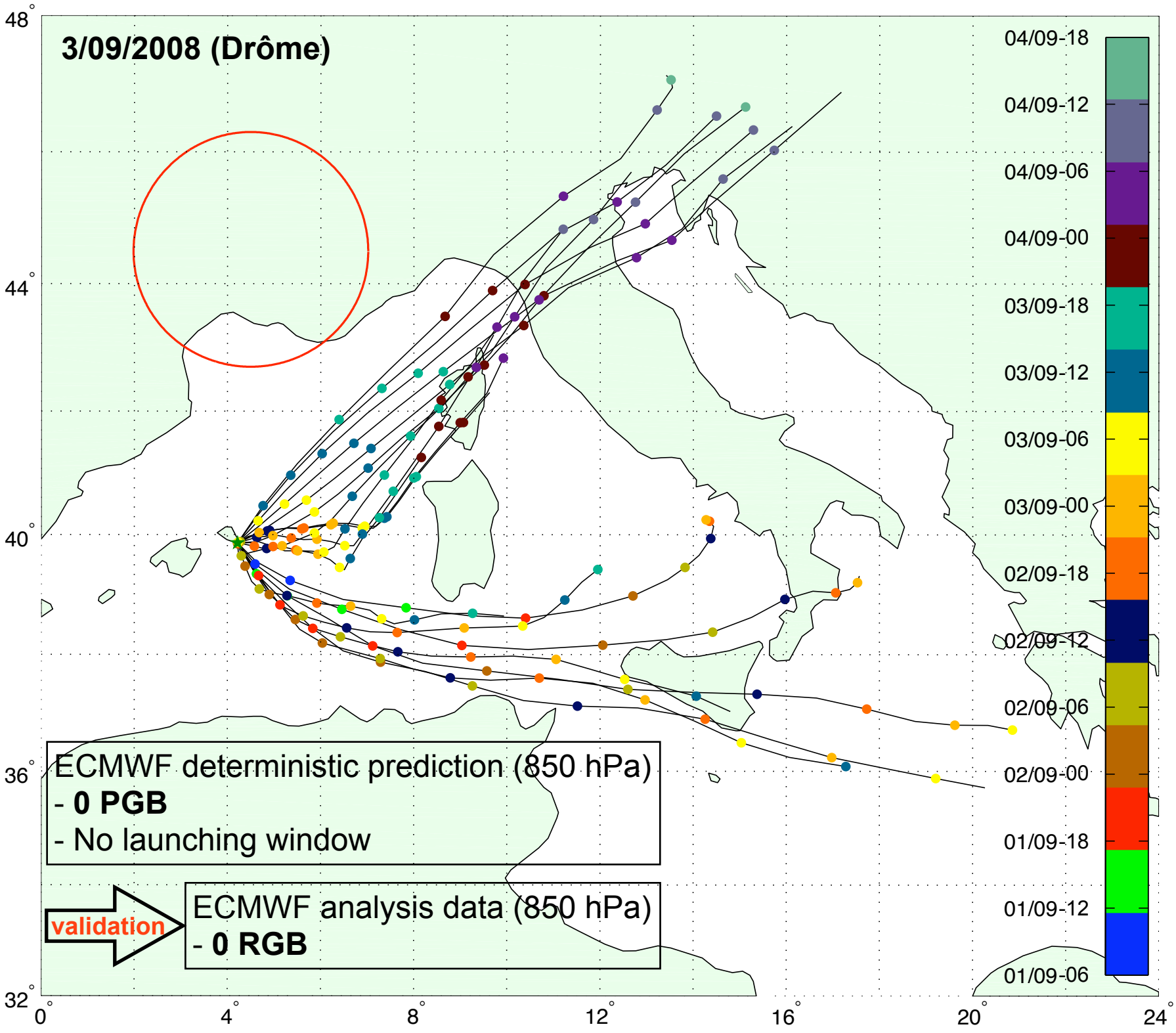
Base: 2009/10/17 @ 12

Tt: 2009/10/20 @ 00 / Vt: 2009/10/20 @ 18

Sensitivity in BL (total energy, lead = 60, opti = 18)

Shading: areas of 400, 200, 100, 50 × 10^3 km^2



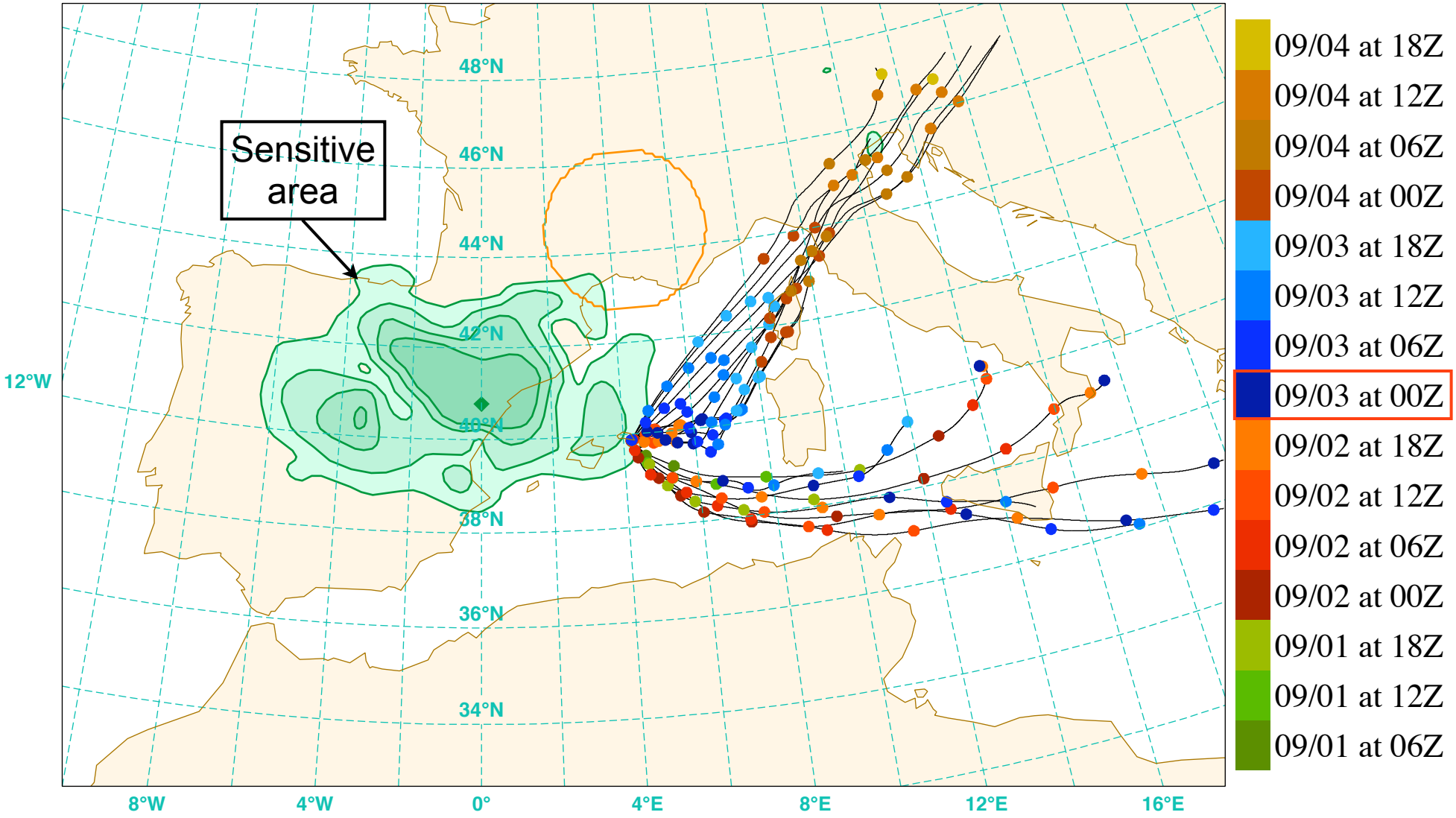

3/09/2008 (Drôme)
48°
44°
40°
36°
32°
0°
4°
8°
12°
16°
20°
24°
04/09-18
04/09-12
04/09-06
04/09-00
03/09-18
03/09-12
03/09-06
03/09-00
02/09-18
02/09-12
02/09-06
02/09-00
01/09-18
01/09-12
01/09-06
ECMWF deterministic prediction (850 hPa)
- 0 PGB
- No launching window
validation
ECMWF analysis data (850 hPa)
- 0 RGB

Base: 2008/08/31 @ 12

Tt: 2008/09/03 @ 00 / Vt: 2008/09/03 @ 18

Sensitivity in BL (total energy, lead = 60, opti = 18)

Shading: areas of 400, 200, 100, 50 × 10^3 km^2



Trajectories predictability

HPE	850 hPa			925 hPa		
	Algiers	Mahon	Alghero	Algiers	Mahon	Alghero
22/09/92		86%			83%	46%
13-14/10/95	100%	100%	25%		100%	38%
12-13/11/99	100%	93%	73%	100%	83%	100%
8-9/09/02		82%		70%	67%	
1-3/12/03	83%	94%	100%	100%	79%	100%
5-9/12/05	85%	90%	100%	91%	81%	100%
12/08/08				25%	83%	
03/09/08						
20-21/10/08		100%		67%	100%	
01/11/08	50%	75%		100%	100%	50%
26/12/08			100%			
18/09/09	67%	100%		25%	100%	
08/10/09		100%		33%	100%	
20/10/09	91%	80%			92%	
22/10/09	100%	80%		60%	100%	

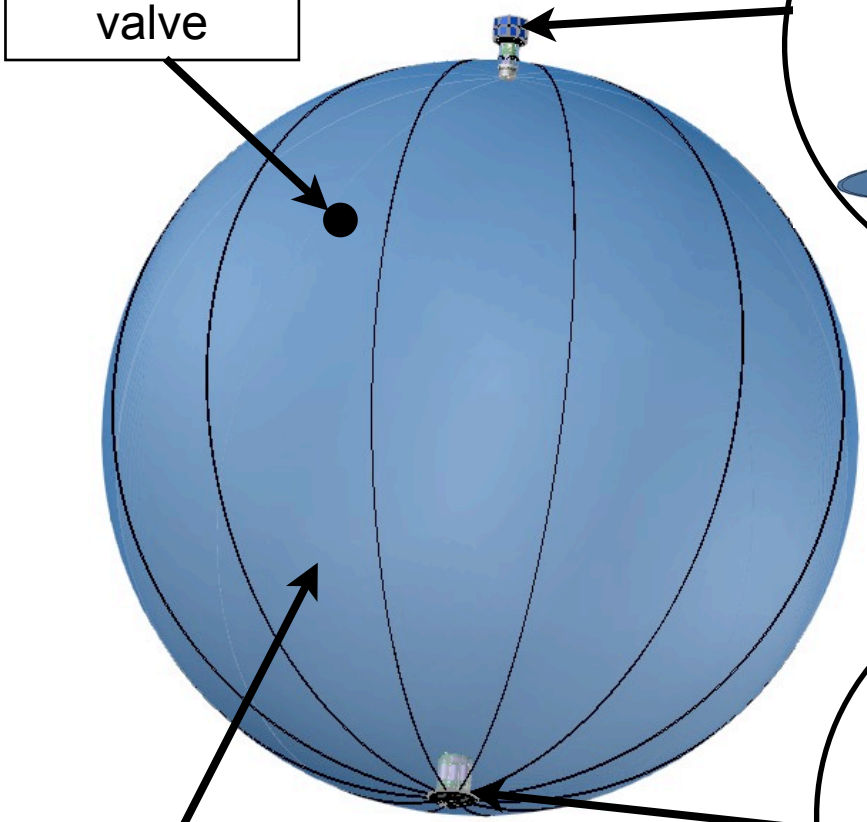
RGB not predicted
No PGB nor RGB
P=0%
25% ≥ P > 0%
50% ≥ P > 25%
75% ≥ P > 50%
100% ≥ P > 75%

Mahon is the best site for investigated HPEs (fall season) : good agreement between predictions and analysis, greater launching windows (not shown).

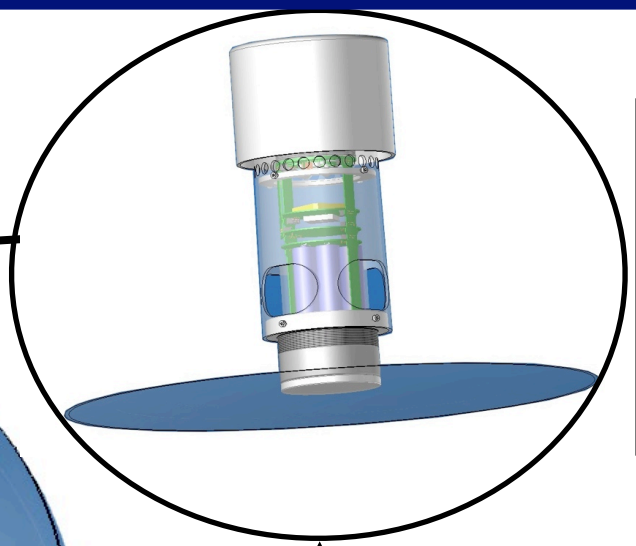
Aerostats developments

BLPB

security valve

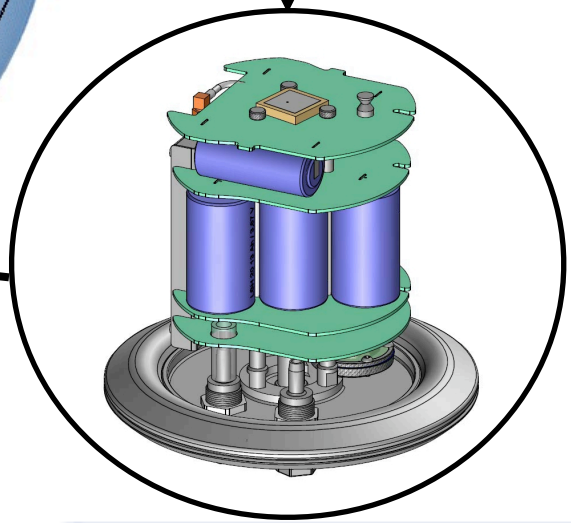


hydrophobic treatment



Instrumentation gondola :
- data sampling and storage:
Pressure (± 1hPa)
Temperature (± 0.5°C)
Relative Humidity (± 2.5%)
+ GPS positioning (<6m,<11m)

Radio Communication



Housekeeping gondola :
- batteries.
- iridium modem and card.
- safety system control.

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HyMeX

Aerostats developments

BAMED

Aeroclipper

Atmospheric gondola
T, RH, P, Relative Wind
Onboard computations

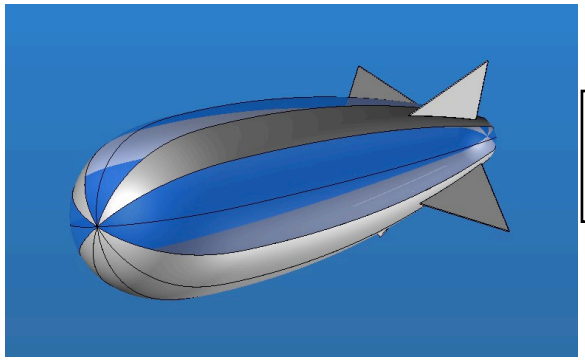
Science positioning and transmission (GPS, ARGOS)

Security positioning and transmission (GPS, ARGOS)

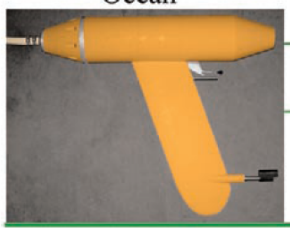
Tension (computation of height)

Measurement of ocean surface fluxes
- evaporation is crucial.
- indirect calculation.

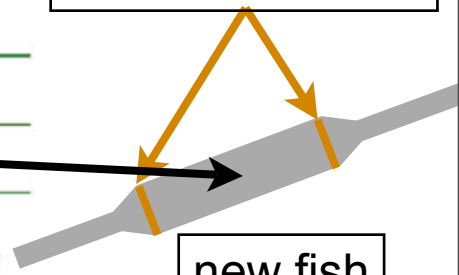
Ocean gondola
SST ~~S~~ ~~S~~ ~~Speed~~



Mix polyamide/polyester and polyurethane

Gondolas	Sensors	Accuracy
Atmosphere		
	Sonic anemometer	2%
	Thermometer	0.2 K
	Hygrometer	1.5%
	Barometer	0.3 hPa
Ocean		
	~~K~~	0.2 ms^{-1}
	Temperature (10-cm depth)	0.1 K
	Temperature-salinity (40-cm depth)	0.01 K 0.15 PSU

conductive metal



new fish

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Conclusion

- Mahon appears to be the best site to launch BLPBs during the fall SOP1s (september-october), HPEs investigation. The balloon trajectories are well predicted.

- The specifications for quality measurements will be implemented by the CNES, together will a real-time data transmission procedure.

Perspectives

- Interface adaptive observation tool with the balloon's observation simulator in back-trajectory mode (possibility of a second launching site).

- Investigate the winter season (SOP2s, wind storms).

- Atmospheric community is interested in testing the BLPB and Aeroclipper in DAS prior to the SOPs. The "test phase" of BLPB at the end of 2011 may be an opportunity.