HyMeX

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CNRM-GAME, Météo-France & CNRS

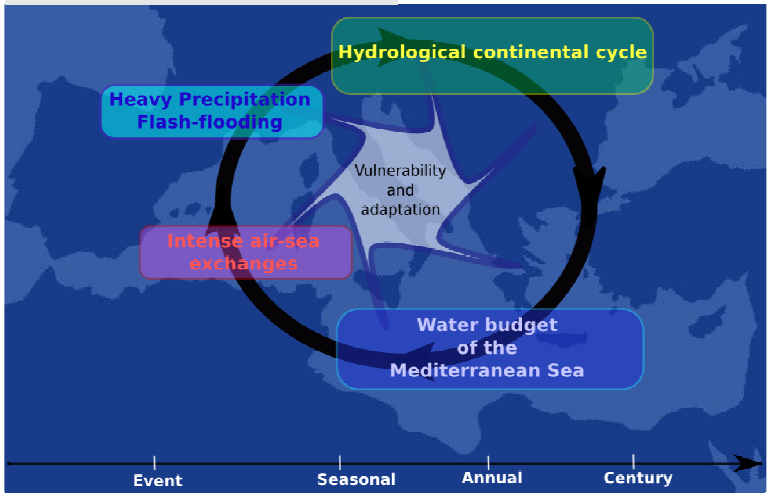
Objectives & Science Topics

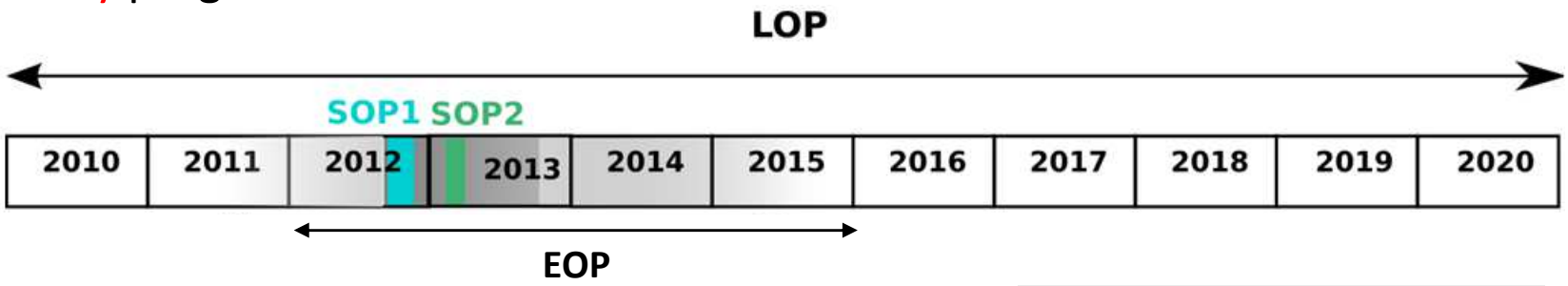
➲ to improve our understanding of the *water cycle* with emphases on the *predictability* and *evolution* of *high-impact weather events*

➲ to evaluate the *social and economical vulnerability* to extreme events and the *adaptation capacity*.

➲ A three-level nested observation approach over the 10-y program:

The five science Topics





EOP/SOP over Western Med

EOP/SOP over Eastern Med ?

Drobinski, P., Ducrocq, V., Alpert, P., Anagnostou, E., Béranger, K., Borga, M., Braud, I., Chanzy, A., Davolio, S., Delrieu, G., Estournel, C., Filali Boubrahmi, N., Font, J., Grubisic, V., Gualdi, S., Homar, V., Ivančan-Picek, B., Kottmeier, C., Kotroni, V., Lagouvardos, K., Lionello, P., Llasat, M. C., Ludwig, W., Lutoff, C., Mariotti, A., Richard, E., Romero, R., Rotunno, R., Roussot, O., Ruin, I., Somot, S., Taupier-Letage, I., Tintoré, J., Uijlenhoet, R. and Wernli, H., 2014: HyMeX, a 10-year multidisciplinary program on the Mediterranean water cycle, *Bulletin of the American Meteorological Society,* 95, 1063-1082.

Facts and figures

- ~**300 peer-reviewed articles** in scientific journals contributing to HyMeX

  List of publications at: www.hymex.org/?page=publications

- Coordination of **4 special issues** in international journals:

Results of SOP1 data analysis in the Quaterly Journal of the Royal Meteorological Society

« Flash floods, hydro-geomorphic response and risk management » in the Journal of Hydrology

Regional climate modelling in Climate Dynamics

Dense water formations in the North Western Mediterranean: from the physical forcings to the biogeochemical consequences in the Journal of Geophysical Research ocean-atmosphere

- Training & young scientists:

  More than **75 PhD** (incl. on-going PhDs) contributing to HyMeX, **110 MSc** students

  23 Post-docs and research associate fellowships

  Contribution to 4 summer schools

- HyMeX data

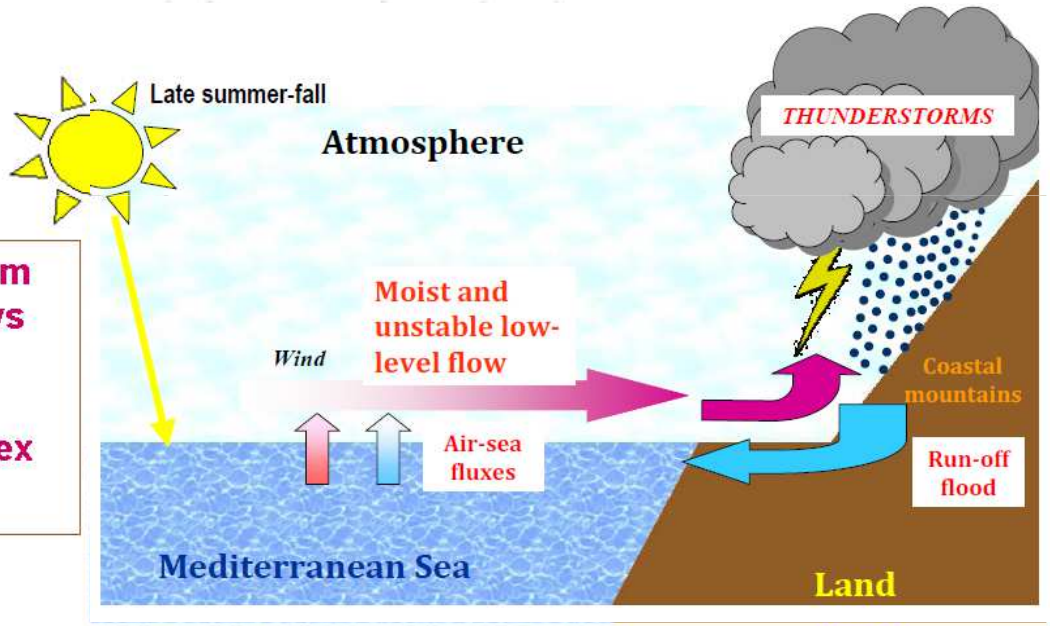
  ~500 datasets in MISTRALS/HyMeX database (http://mistrals/sedoo.fr/hymex)

- HyMeX fundings : ~14 M€

SOP1
A multi-disciplinary field campaign

SOP1 (5 Sept. - 6 Nov. 2012)
Heavy precipitation and flash-flooding

the microphysics and dynamics of precipitating systems leading to HPE



the upstream marine flows and their interaction with complex terrain

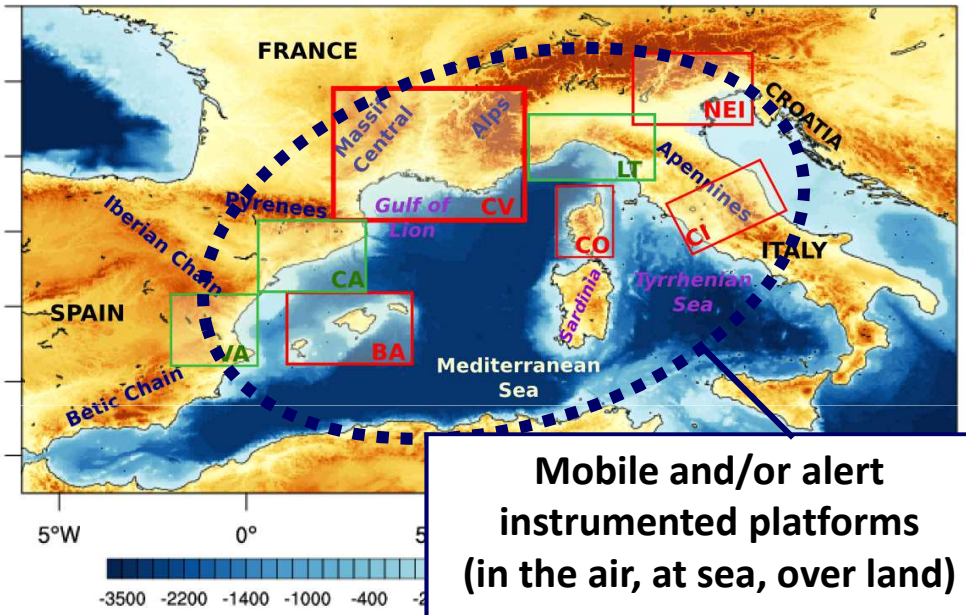
The distributed hydrological response of the Mediterranean watersheds

the air-sea exchanges and ocean mixed layer prior and during HPE

Ducrocq, V., et al, 2014: HyMeX-SOP1, the field campaign dedicated to heavy precipitation and flash flooding in the northwestern Mediterranean, *Bulletin of the American Meteorological Society,* 95, 1083-1100.

SOP1
A major international field campaign

Site with HyMeX instruments



Mobile and/or alert instrumented platforms (in the air, at sea, over land)

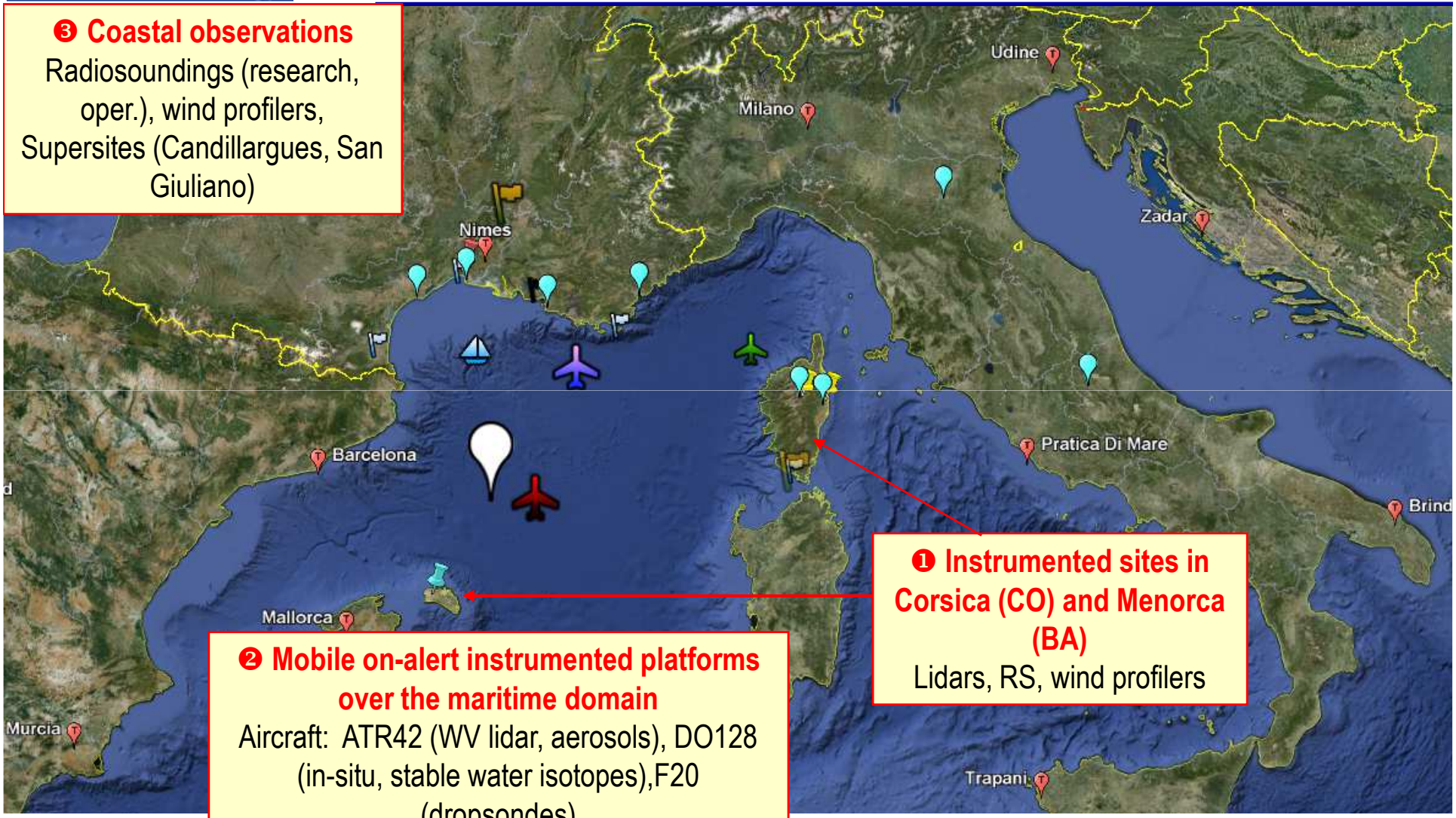
~200 instruments deployed
~300 scientists on the field

SOP1 brings observations over the sea and of precipitating systems forming over the sea and affecting the coastal areas

Ducrocq, V., et al, 2014: HyMeX-SOP1, the field campaign dedicated to heavy precipitation and flash flooding in the northwestern Mediterranean, *Bulletin of the American Meteorological Society,* 95, 1083-1100.

Upstream Marine flows

❸ Coastal observations
Radiosoundings (research, oper.), wind profilers, Supersites (Candillargues, San Giuliano)



❶ Instrumented sites in Corsica (CO) and Menorca (BA)
Lidars, RS, wind profilers

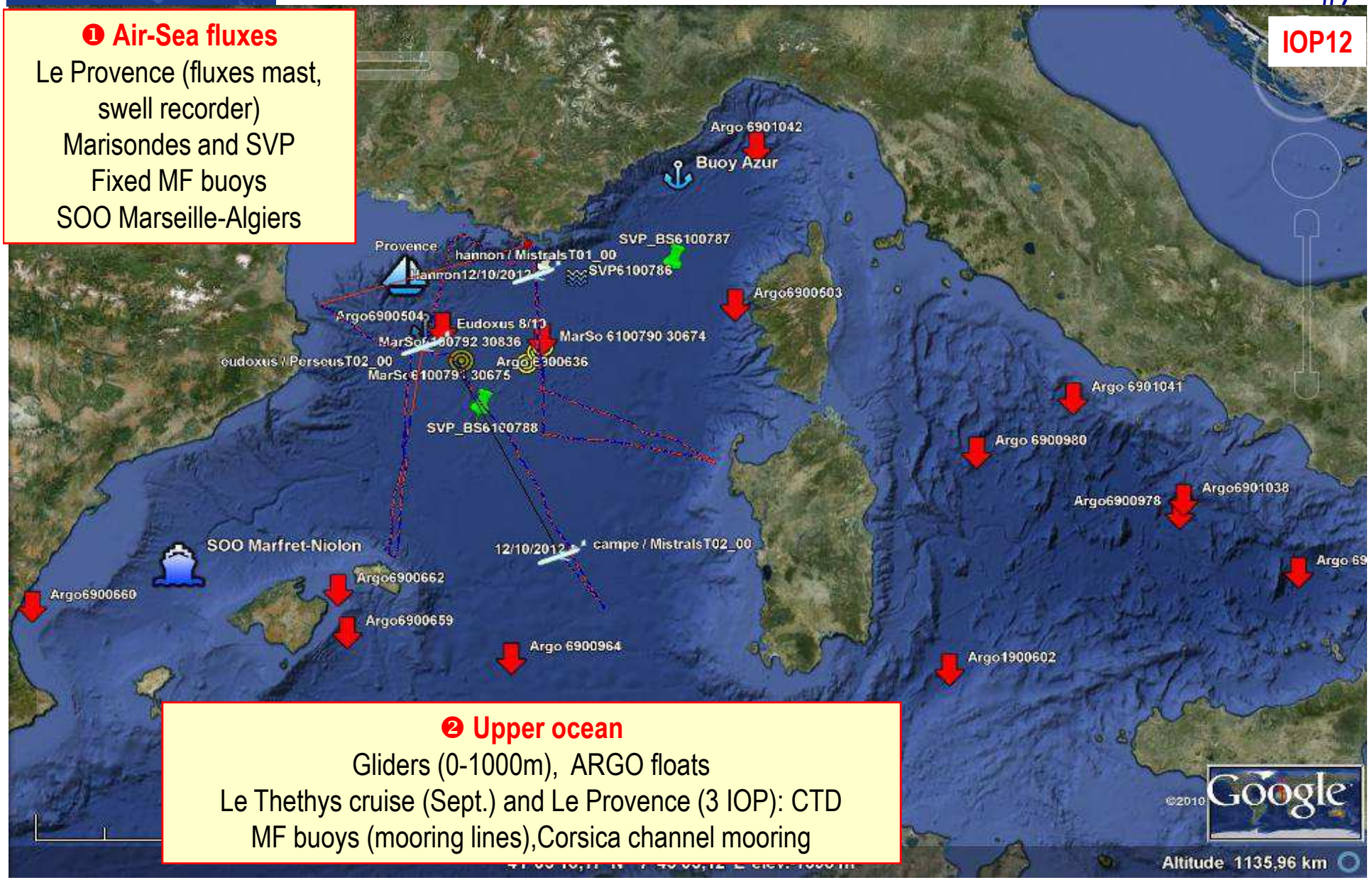
❷ Mobile on-alert instrumented platforms over the maritime domain
Aircraft: ATR42 (WV lidar, aerosols), DO128 (in-situ, stable water isotopes),F20 (dropsondes)
Boundary layer balloons
Le Provence (RS)

Mediterranean Sea

#7

❶ Air-Sea fluxes

Le Provence (fluxes mast, swell recorder)
Marisondes and SVP
Fixed MF buoys
SOO Marseille-Algiers



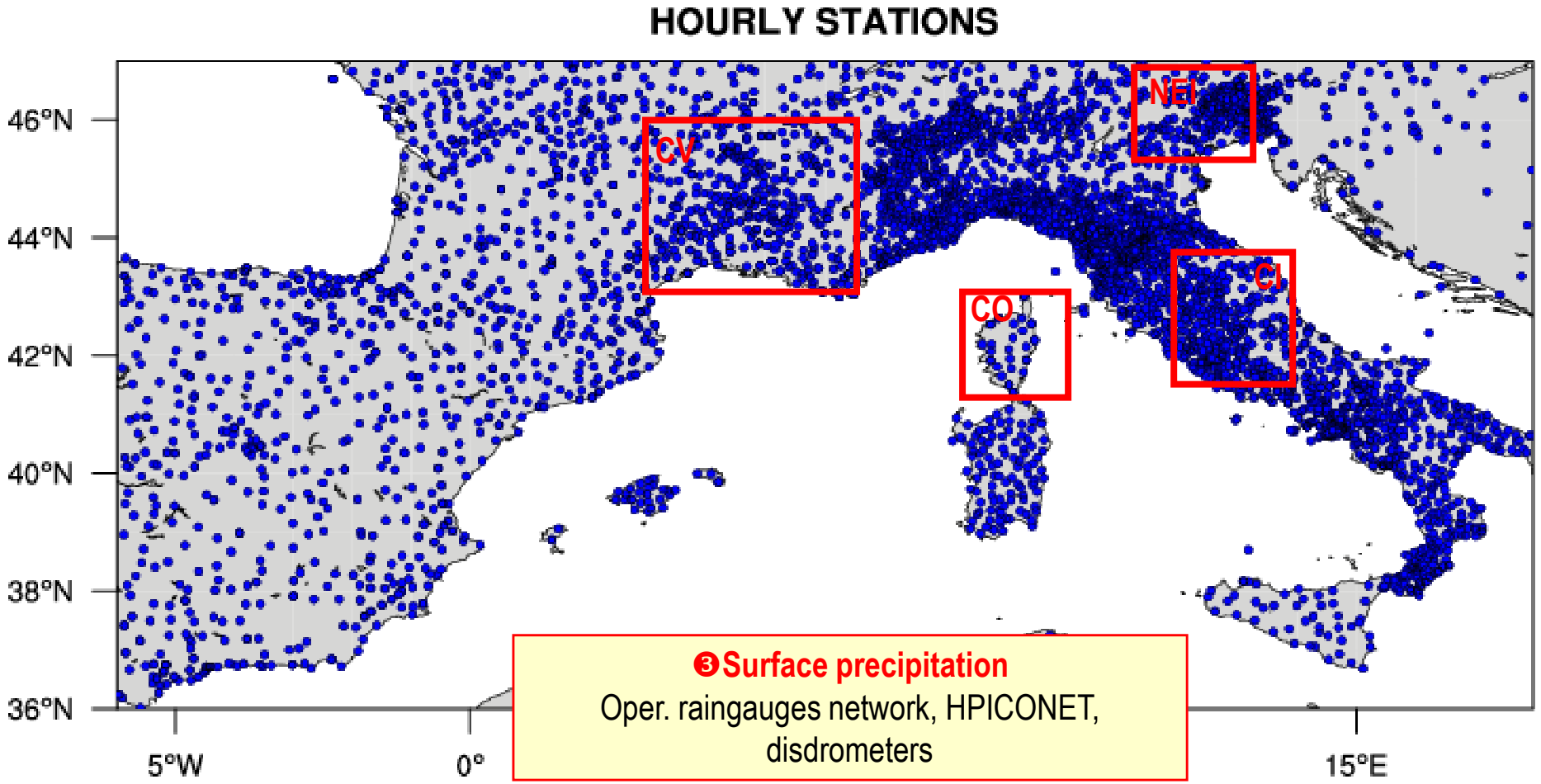
❷ Upper ocean

Gliders (0-1000m), ARGO floats
Le Thethys cruise (Sept.) and Le Provence (3 IOP): CTD
MF buoys (mooring lines),Corsica channel mooring

Precipitating systems

❶ Microphysics and circulation within precipitating systems
F20 (cloud radar, microphysics probes)
Operational radars (Doppler, polarimetrics)
4 instrumented sites : CV, CI, CO, NEI

❷ Electrical activity precipitation
Lightning Mapping array, field mill, … in CV



❸Surface precipitation
Oper. raingauges network, HPICONET, disdrometers

Hydrological measurements

➢Nested-catchment instrumentation

❶ medium/large watersheds (transfer in river and flooding)
Discharge and precipitation estimation
Gard, Ardèche

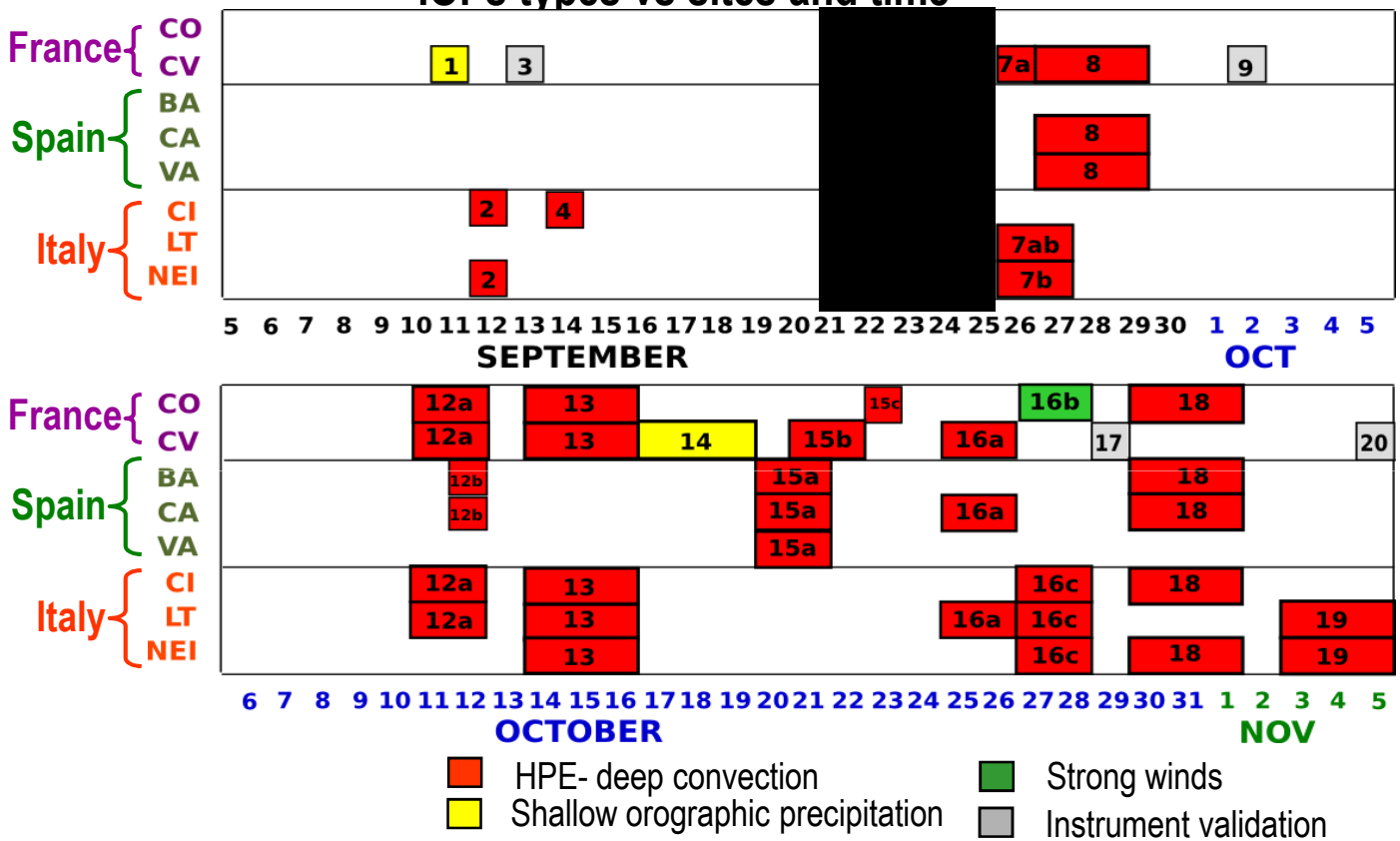
❷ small watersheds
Distributed hydrology observations over
discharge, infiltration, soil moisture
Valescure, Tourgueuille, Avene, Auzon

❸ Hillslope (process understanding on runoff generation and concentration)
Soil moisture, infiltration, stable water isotopes, geochemistry

The Field Campaign execution and coordination

The Intense Observation Periods (IOPs)

IOPs types vs sites and time



⇨ 16 IOPs dedicated to HPE

⇨ Severe events with fatalities and damages

The Aircraft Missions

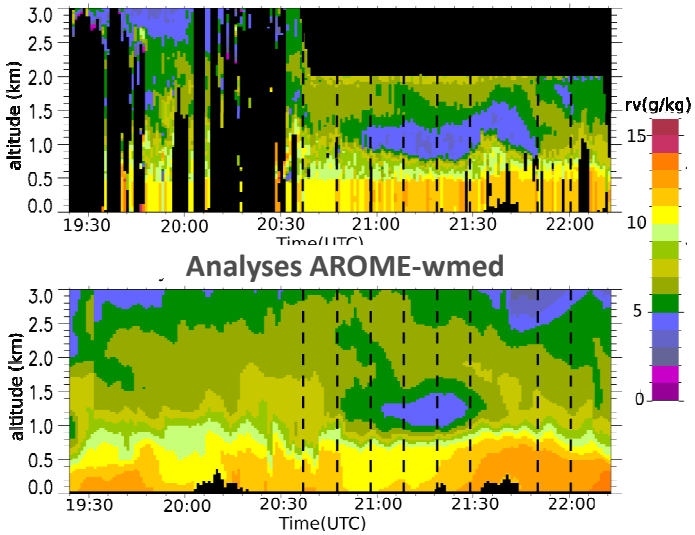
251 Flight hours:

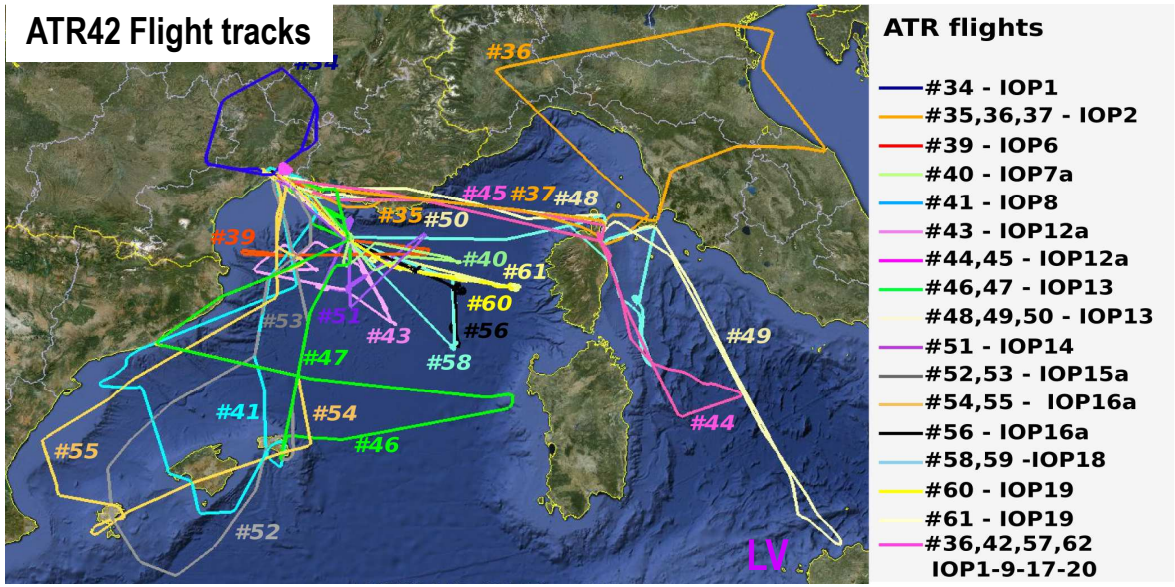
△Conditions for airborne Lidar: without low-level clouds

- ❑ SAFIRE/ATR42: 87 h
  - ⇨ Survey of the upstream flow

Payload : WV Leandre II Lidar, aerosols, turbulent air-sea fluxes

Vapeur d'eau- vol Montpellier-Ibiza
Lidar aéroporté LEANDRE2 à bord de SAFIRE/ATR42





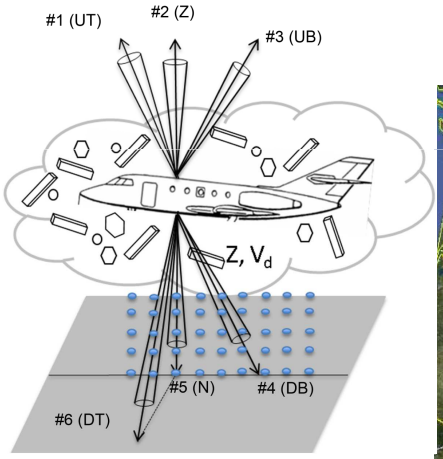
The Aircraft Missions

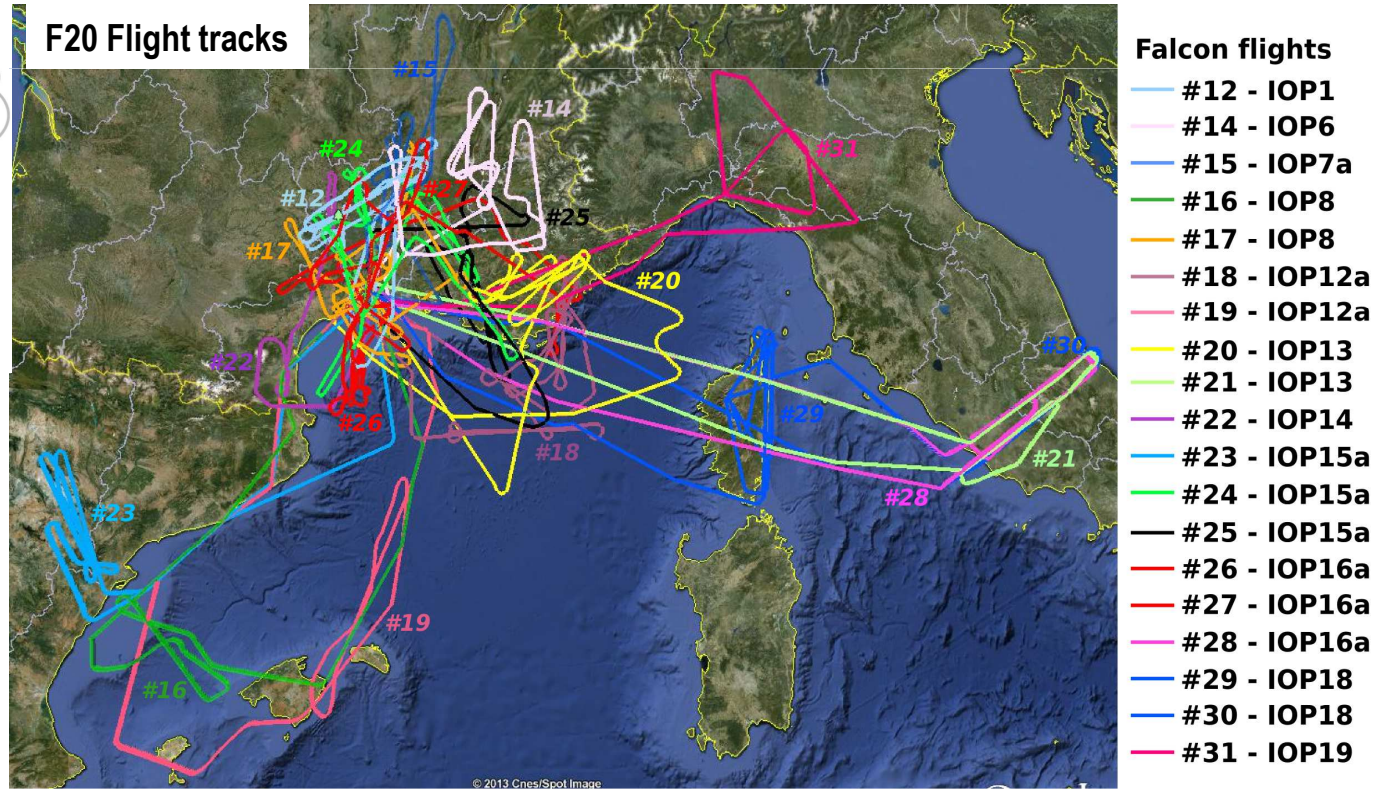
251 Flight hours:

△Conditions for F20 mission: within convective systems

- ❑ SAFIRE/F20: 69 h
  - ⇨ Dynamics and microphysics within precipitating systems

Payload :cloud radar, cold microphysics probes, dropsondes launched over the Sea





Le Provence missions

➢3 missions :

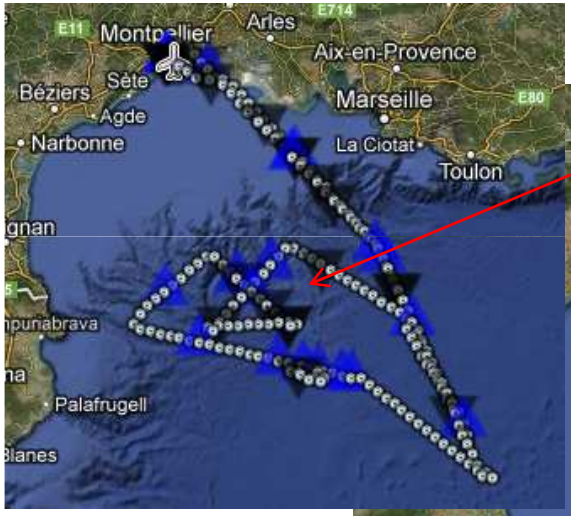
IOP7a – 25-26 sept. Loc: 5.5 E/42.5 N

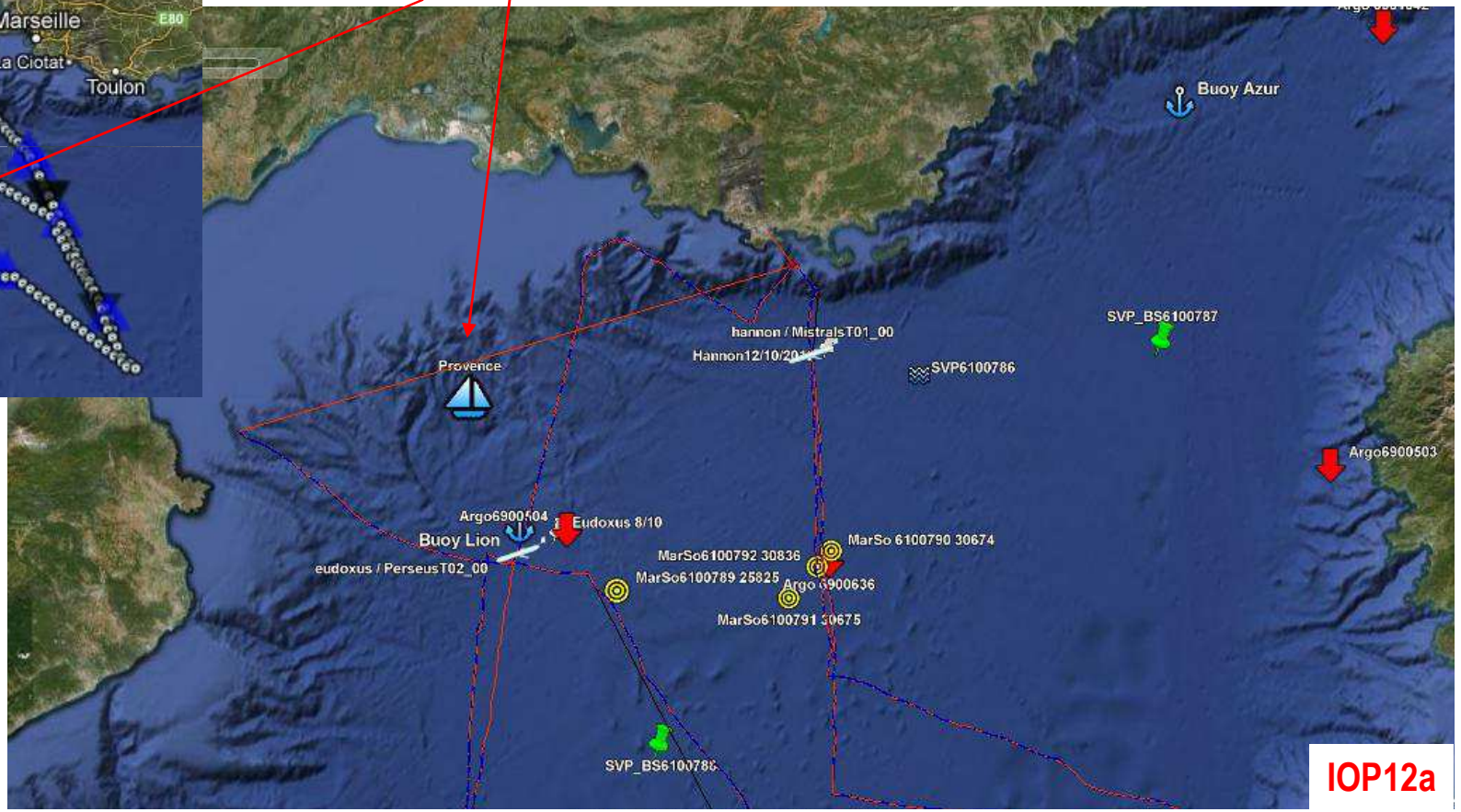
IOP12a – 11-12 Oct. Loc: 4.5 E/42.5 N

IOP16a – 25-27 Oct. Loc: 4.5 E/42.5 N

△**Conditions for ship at sea : calm sea state**

ATR42 flux measurements over Le Provence





IOP12a

Radiosoundings

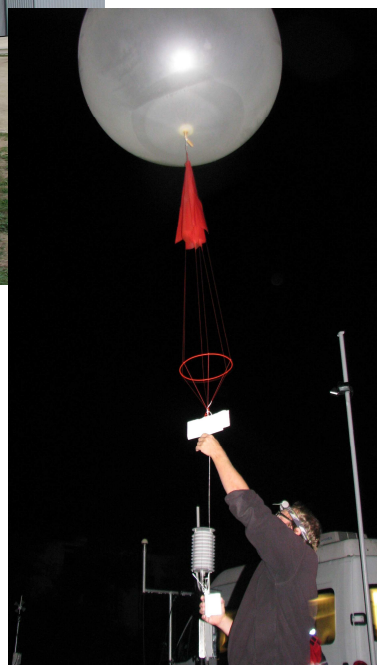
About 850 radiosoundings

From HyMeX sites:

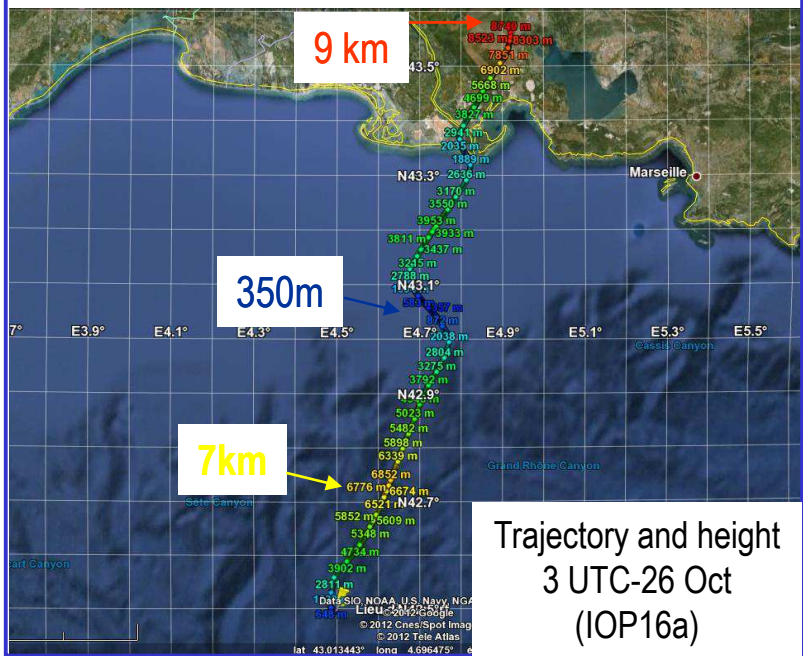
~ 250 RS in Corsica (San Giulano, Corte)

~160 RS along the French coast (Vias, Candillargues, Marseille, Fréjus)

~15 RS in Bologna, L'Aquila, Campoformido

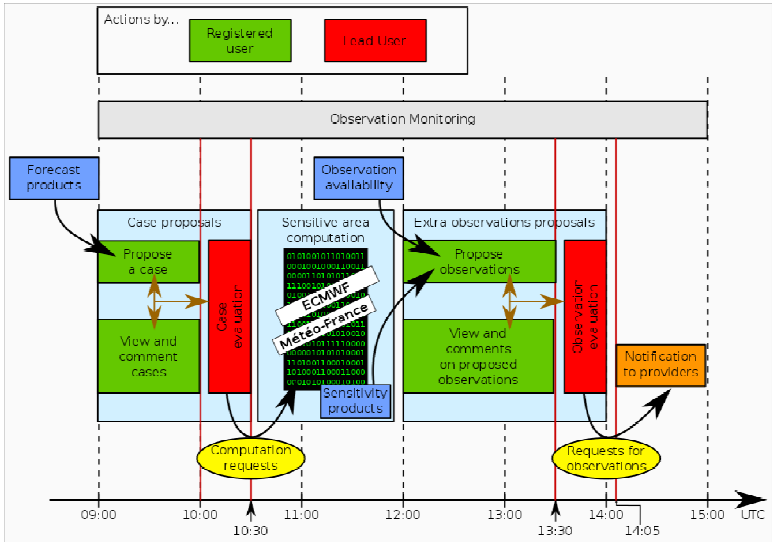


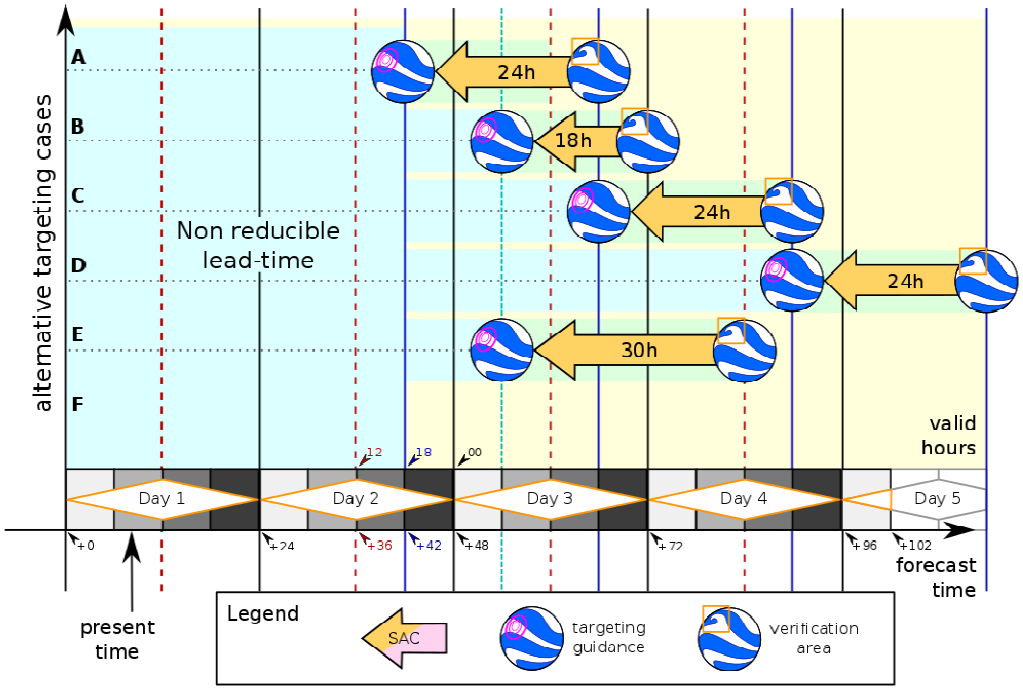
~ 30 RS from Le Provence

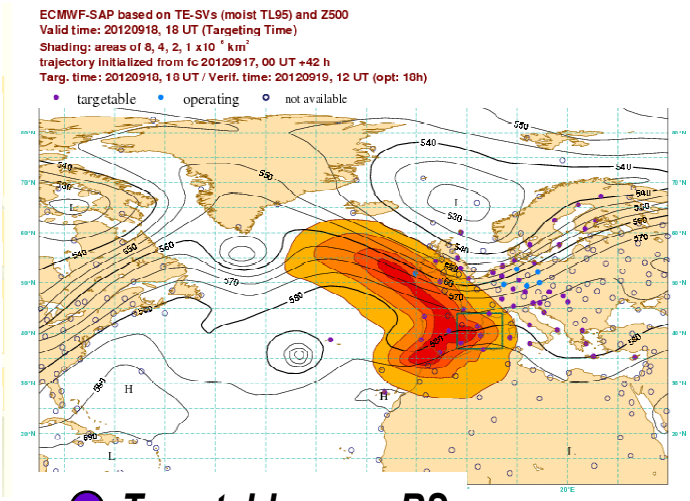


Trajectory and height
3 UTC-26 Oct
(IOP16a)

DTS use for SOP1







● ***Targetable oper RS***

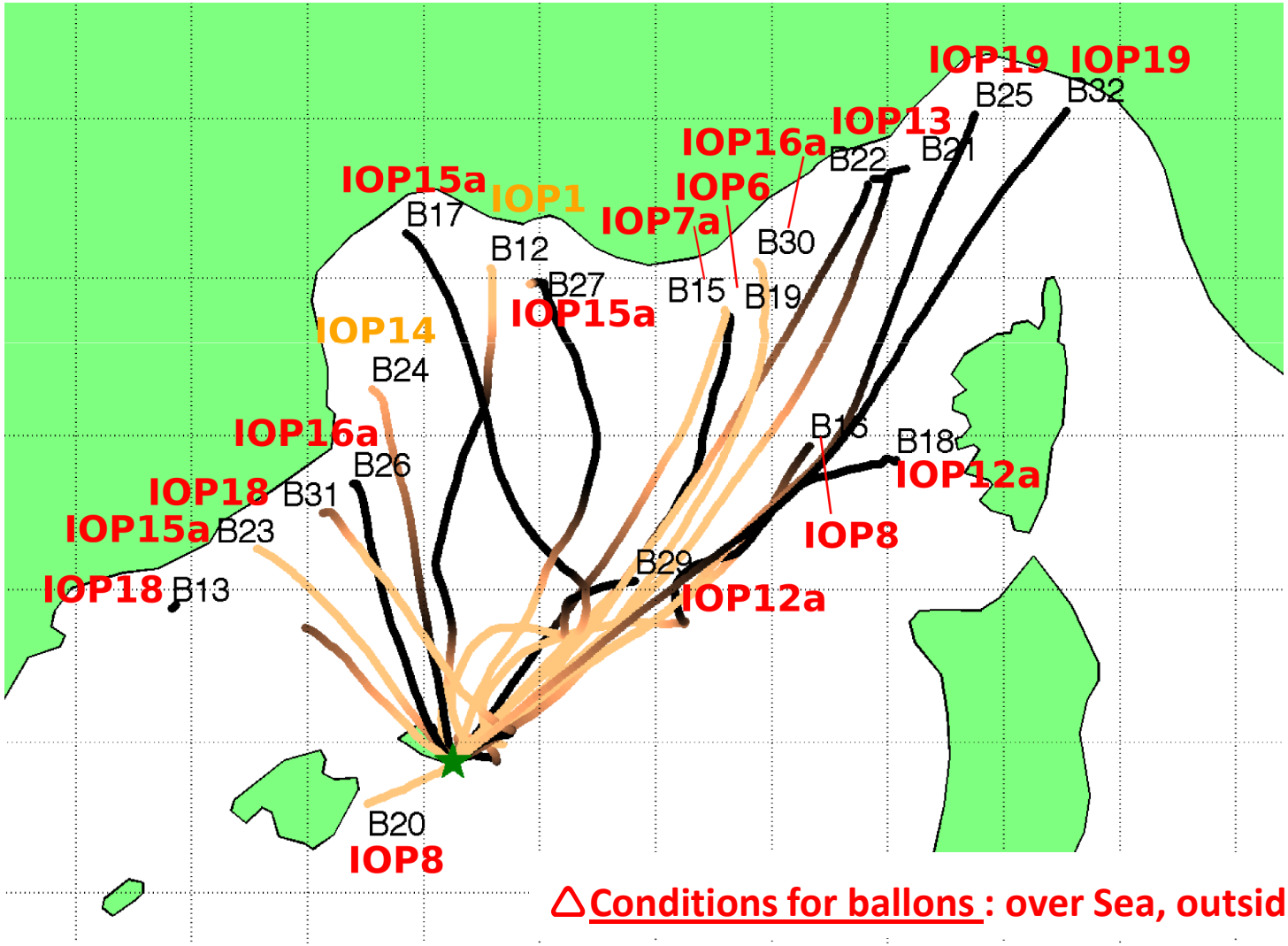
From 5 to 22 September: Atlantic ridge

Sensitive regions located in North Atlantic, upstream of the Atlantic ridge and to a lesser extent, to the west and south-west of the Iberian Peninsula, and over the Western Mediterranean (see Figure 3.6a), in a NW-SE pattern.

403 additional oper soundings at 06 & 18UTC (EUCOS) using the DTS system

Balloons

- 19 Boundary layer Balloons launched from Mahon



△Conditions for ballons : over Sea, outside rain

The HyMeX Operation Center (HOC)

The HyMeX Operation Center (HOC) was located in La Grande Motte, close to the French research aircraft base at Montpellier airport and the Candillargues supersite.

A coordination team composed of:
Scientific Director, Operation Director, Scientific Secretary, forecaster, PI aircraft, PI ocean, PI precipitation, PI Hydrology, PI winds, PI air-sea fluxes, Logistics Coordination, Informatic support

The field campaign coordination

Main challenges:

- **Aircraft:** take-off time for day D and flight plans to be decided day D-1 before 11h ⇨ forecast of location and precise timing of deep convection 24-48h in advance
- **Le Provence:** Sea state (calm) to be forecasted 72h-48h in advance
- **Balloons:** 24-48h forecast of balloon trajectories: exclusively over the Sea and free of precip
- **Radiosoundings:** Not forget the short DTS deadlines !

⇨ A dedicated Météo-France forecaster at HOC with a Météo-France forecaster workstation (SYNERGIE)

⇨ Morning daily briefing 7/7, in visioconference with L'Aquila, Palma, Mahon, San Giuliano, Toulouse.

⇨ Several dedicated NWP systems for the SOP (AROME_WMED over the whole Western Mediterranean up to 48h, WRF for Italy,…):

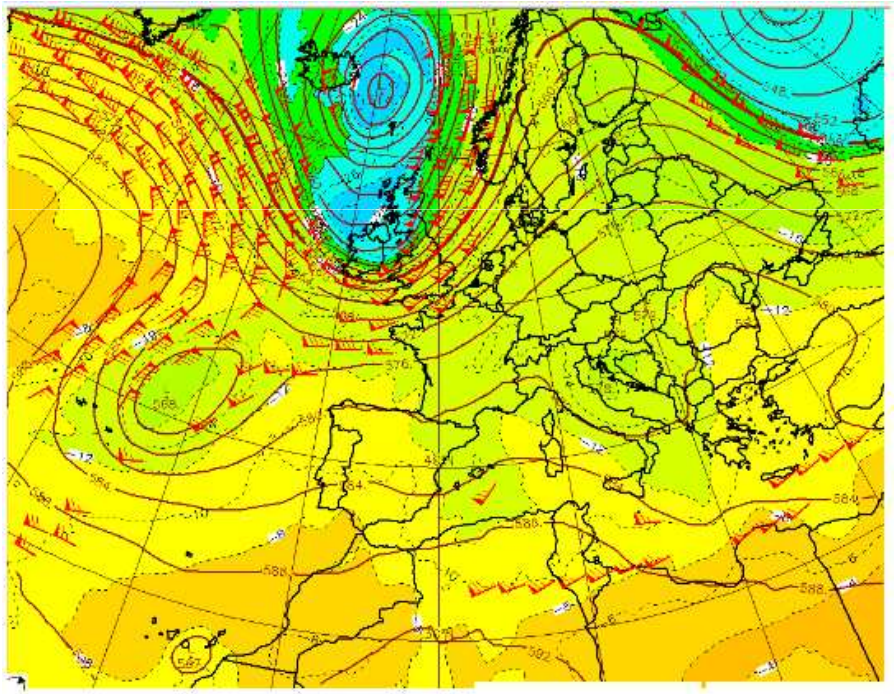
25 output models available on the SOP website

The First IOPs

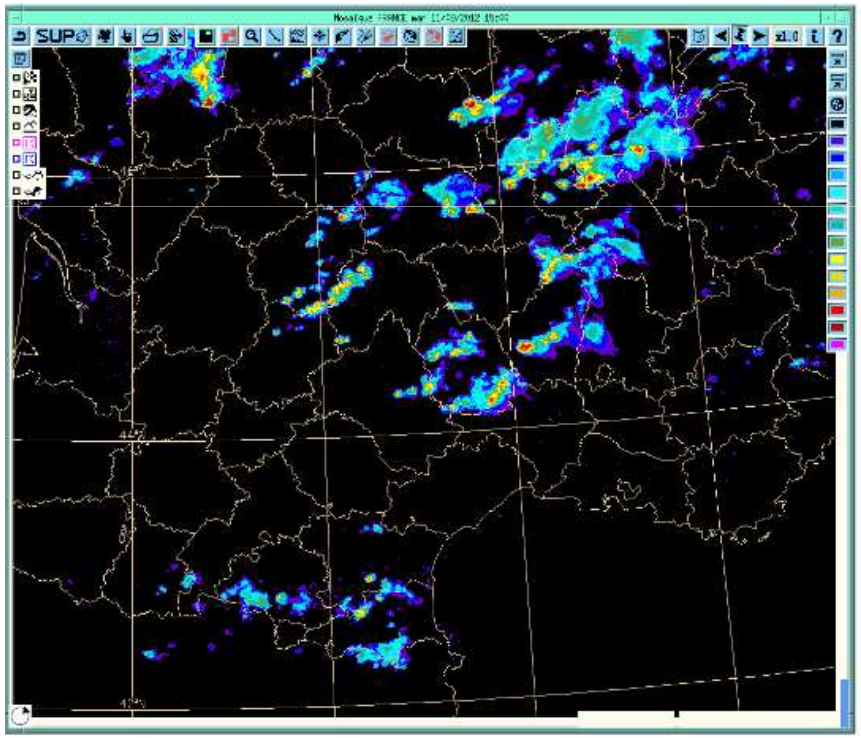
From 5 to 20 Sept.

IOP1 : 11 Sept 2012 – shallow orographic convection over CV

A cold front crossed Northern France from the Channel Sea to the Alps. This front was associated with a large scale dynamic trough which evolved into a deep cut-Off during the night of Thursday 13 September between Corsica and western Italy



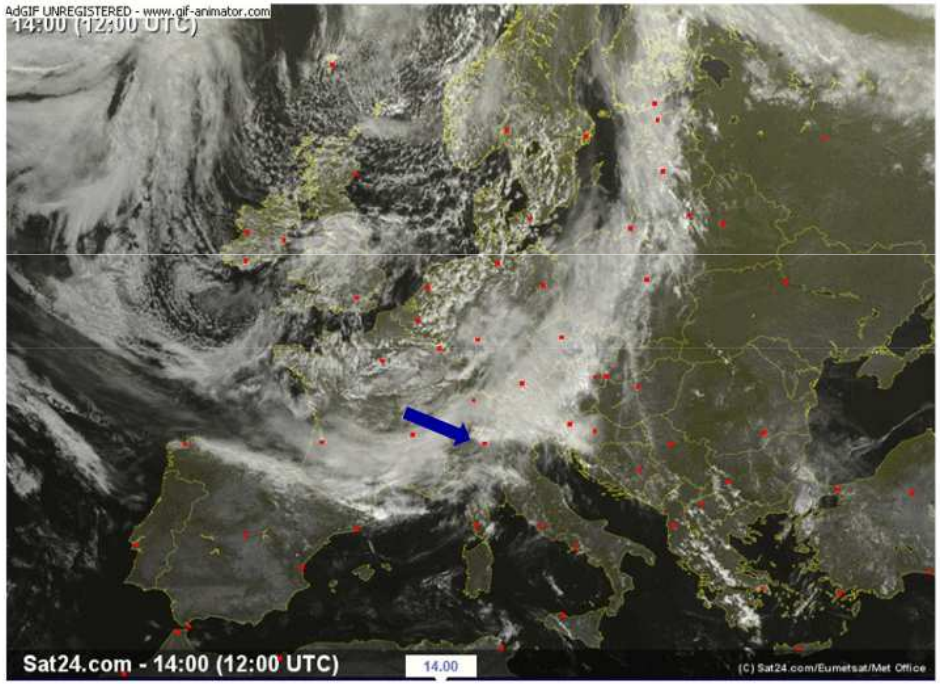
Synoptic view from the ARPEGE analysis, for 00UTC, September 11: temperature and geopotential at 500hPa, and wind (over 60kts) over the 1.5PV surface.

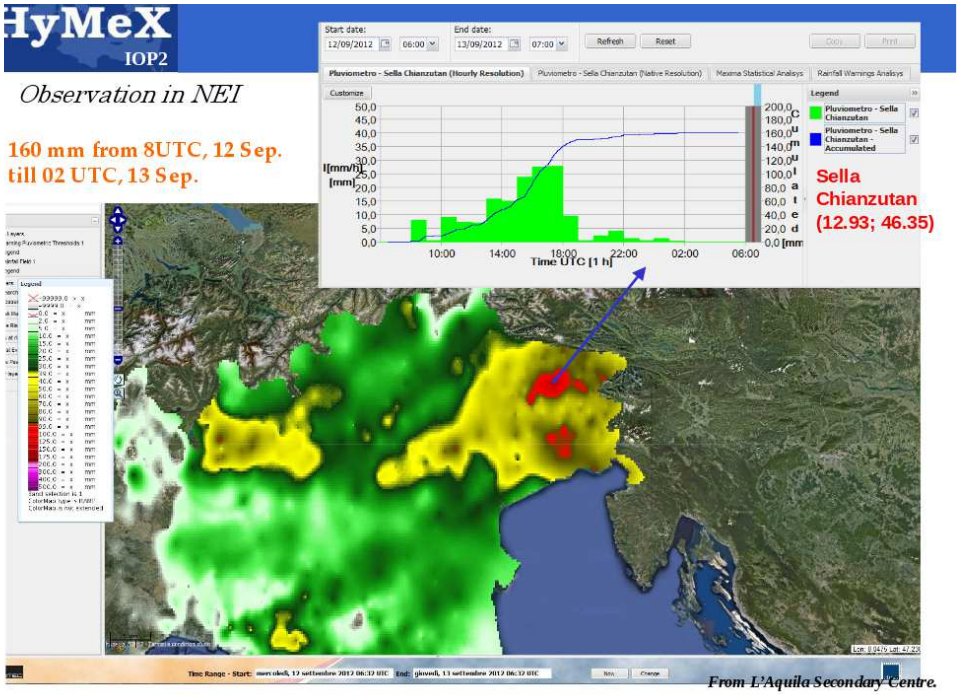


Reflectivities from the Météo-France composite, Tuesday 11, 15 UTC

IOP2 : 12 Sept 2012 – Heavy precipitation over NEI

The trough extending from Northern Europe to France moved eastwards.The associated cold front extended from Northern Germany to Northern Alps in the morning

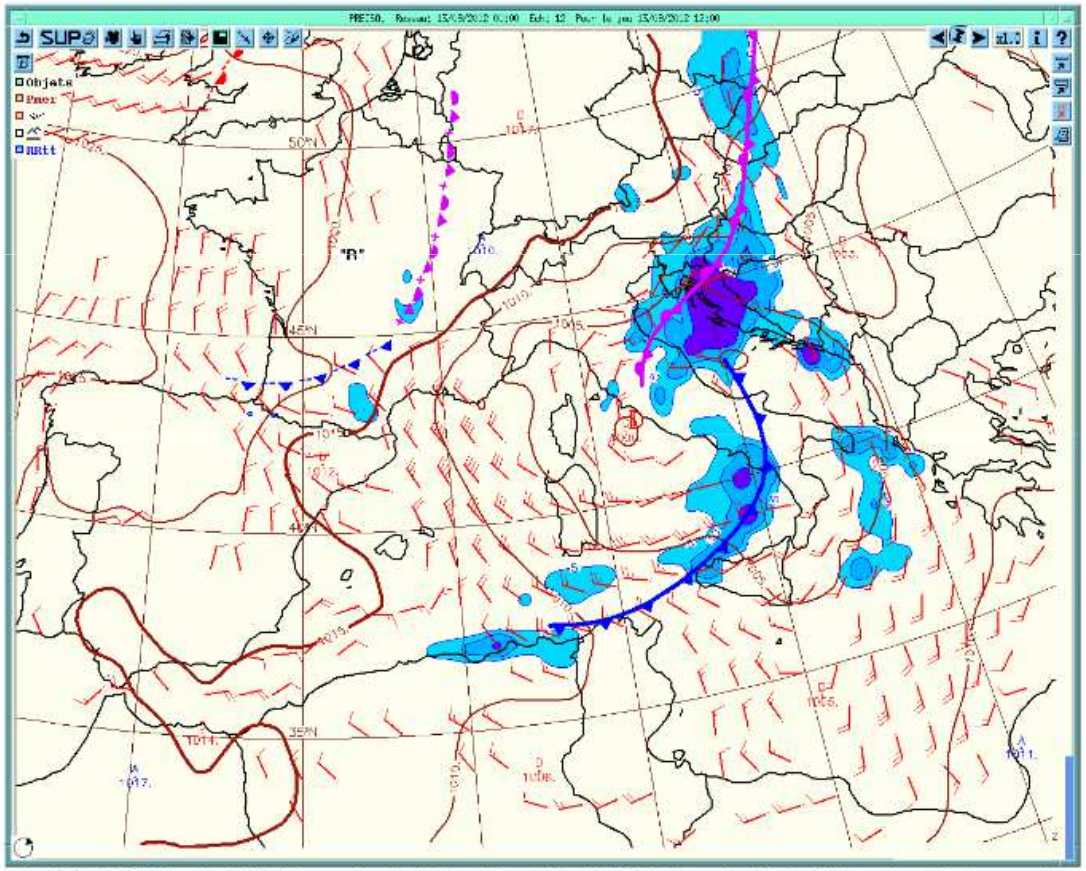




IOP3

IOP3 : 13 September 2012 - Lidar validation flight over CV

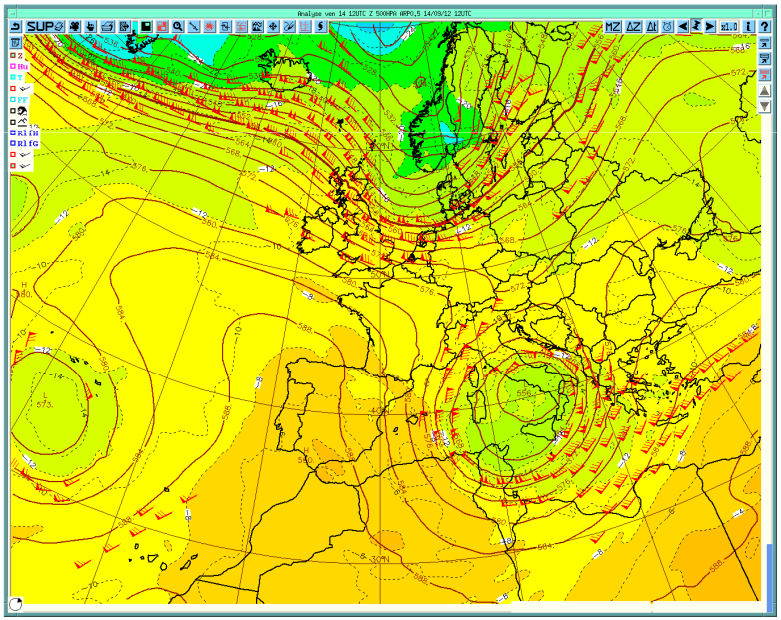
Clear sky conditions - mistral

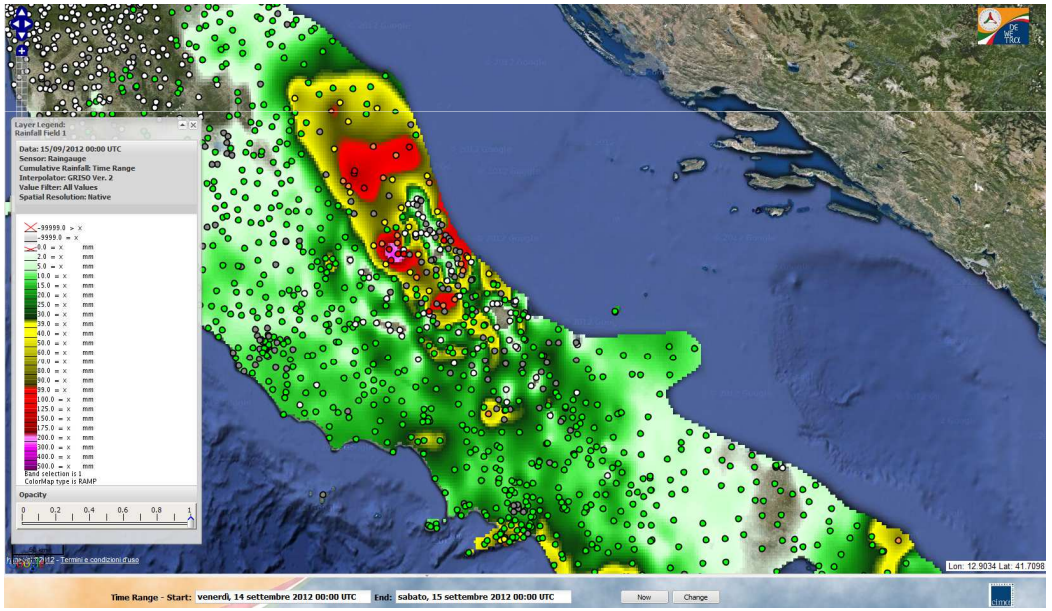


Fronts and ARPEGE 6h rainfall (5 mm threshold) + 10m Wind (10 kt threshold) for Thursday 13 September, 12 UTC

IOP4 : 14 September 2012 – Heavy precipitation over CI

A cut-off isolated over medium-level low Tyrrhenian moved slowly south-east inducing instability over central and southern Italy, with intense phenomena over the Adriatic Sea. In the low levels, there were a persistent low in Tyrrhenian Sea and shallow low deepening over the Italian coast of the Adriatic Sea.



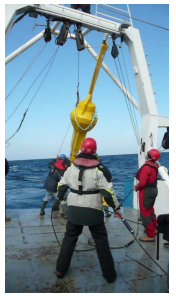


Synoptic view from the ARPEGE analysis, for 12UTC, September 14 (BT: 12 UTC): temperature and geopotential at 500hPa, and wind (over 60kts) over the 1.5PV surface.

Thanks !

Scientists on the field

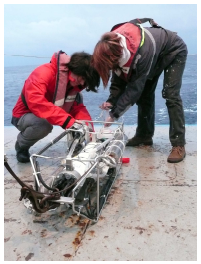















The field campaign website

A dedicated website (sop.hymex.org) with a lot of observations and model forecasts for: (i) real-time operations coordination; (ii) post-SOP analyses (model evaluation, IOP studies,…)

<< October 2012 >>

	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30	31			

- Home
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    - Daily Meeting Report
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    - Data Targeting System
    - Forecast Charts
    - MF regional forecast
  - Marine reports
  - Other reports
    - Forecaster's corner
    - IOP Information
- Models
- Observations

Facility status Form

Reports				
Daily reports	Daily Meeting Report IOP Overview Summary	Facility status Data Targeting System	Forecast Charts MF regional forecast	
Marine reports	Bulletins HOC	Bulletins Large Méd. Occ.	Weather bulletin METAREA3	Bulletins Cote
Other reports	Forecaster's corner	IOP Information		
Models				
Atmospheric models	Model Schedule Convection-permitting models	Convection-parameterized models Intercomparison	Transport	
Hydrological models	ISBA-TOPMODEL	CHYM Alarm map	Rainfall expected on catchments	SIM
Ocean models	Mars	MFS	Mercator	Symphonie
Observations				
MCS tracking				
Satellite products	Visible Brightness Temp.	Dust composite Clouds Composite	Flux Cms MODIS Chlorophyll-a	Sea Surface TRMM Rain
GPS				
Radars	European composites Operational radars composite	Single operational radars 3DRadar products	Micro Rain Radar Research radars	
Discharges	Gazel/Claduègne	French catchments	Spanish catchments	
Lightning	EUropean Cooperation for LIghtning Detection Lightning Mapping Array	Lightning Location Network (LINET) LLS Catalonia	ZEUS	
Surface stations	Hu2m T2m	V10m Raingauges	RainGauges HPiconet Drop Size Distribution	TH
Radiosoundings	Operational RS	SOP RS(Corte, San Giuliano)	SOP RS(CNRM)	
BLP Balloons	Predicted trajectories Google Predicted trajectories	Simulated Vertical Soundings Atmogrammes	Observations	
Wind profilers	UHF	VHF	Sodar (Candillargues)	

Conclusions

➢ The field campaign has been successful regarding:

- the number of events observed: 23 IOPs, with 16 IOPs dedicated to HPE over Italy, France and Spain.
- the variety of events: convective and squall lines, V-shape quasi-stationary MCS, tornado, orographic precipitation, cyclogenesis,…

and with different levels of predictability that allow both (i) IOP process studies and (ii) predictability studies (model improvement, data assimilation), by synergistic use of SOP1 observations and models

➢ Difficulties encountered:

- strong limitations imposed by the French Air Traffic Control, but impacts attenuated thank to a dedicated controller and military zones (D54) over the Sea.
-installation of the wind profilers in BA impossible although all our efforts, but an interesting alternative has been found
- few flash-flood events over the CV watersheds, but EOP on-going…

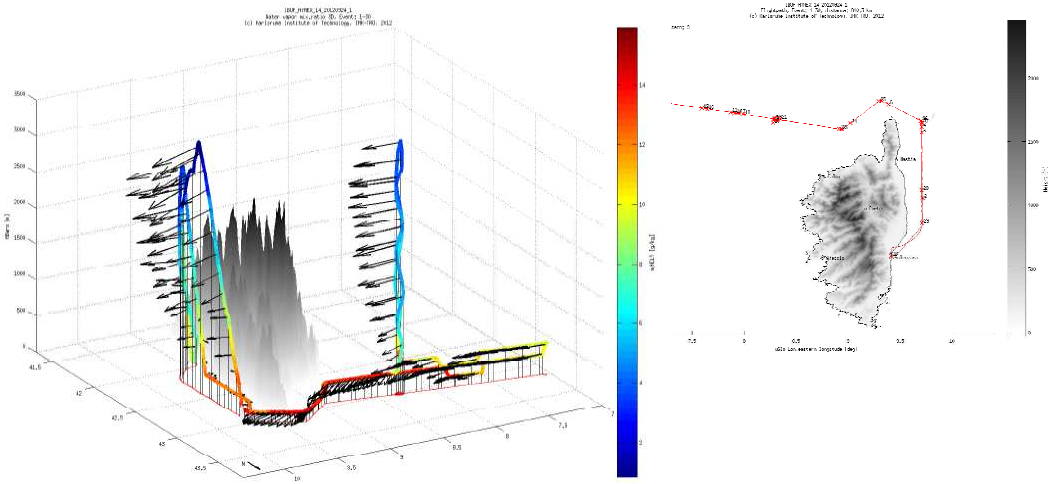
The Aircraft Missions

251 Flight hours:

- **KIT/DO128: 95 h (11 Sept.-11 Oct.)**

⇨ **over and offshore Corsica**

Payload : air-sea fluxes, stable water vapour isotopes



+ T-NAWDEX flights : 32h (11-20 Oct.)