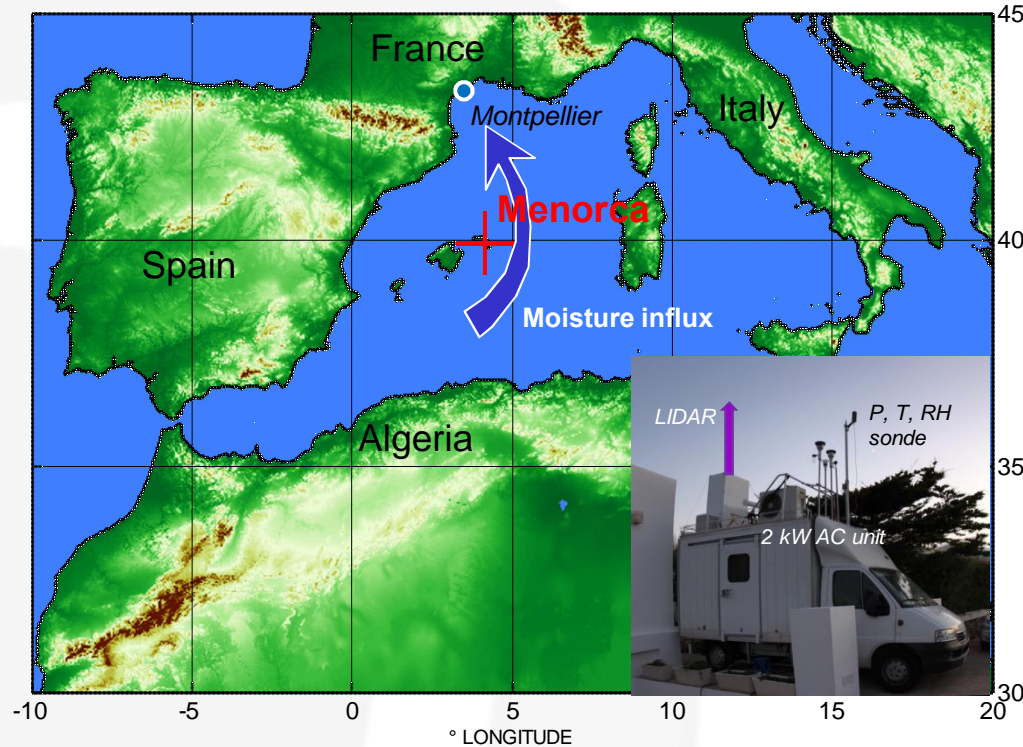


HyMeX SOP1, Fall 2012



Ground station for monitoring and characterization of atmospheric moisture in the center of the Western Mediterranean basin.

Coherence between multi-instrument and multi-model atmospheric moisture retrievals in the framework of the HyMeX-SOP1

Patrick Chazette(1), Cyrille Flamant(2), Xiaoxia Shang(1), Julien Totems(1), Jean-Christophe Raut(2), Alexis Doerenbecher(3), Véronique Ducrocq(3), Nadia Fourrié(3), Olivier Bock(4), and Sophie Cloché(5)

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- (2) Sorbonne Universités, UPMC Université Paris 06; Université Versailles St-Quentin; CNRS/INSU; LATMOS-IPSL, UMR 8190, 75005, Paris, France.
- (3) Centre National de Recherches Météorologiques - Groupe d'études de l'Atmosphère Météorologique (CNRM-GAME), UMR 3589 Météo-France & CNRS, Toulouse, France.
- (4) IGN LAREG, Univ. Paris Diderot, Sorbonne Paris Cité, 75013 Paris, France.
- (5) Institut Pierre-Simon Laplace, LMD, Ecole Polytechnique, Palaiseau, France.

Funded by the IODA-MED Grant ANR-11-BS56-0005, the MUSIC Grant ANR-14--CE01-01 & MISTRALS

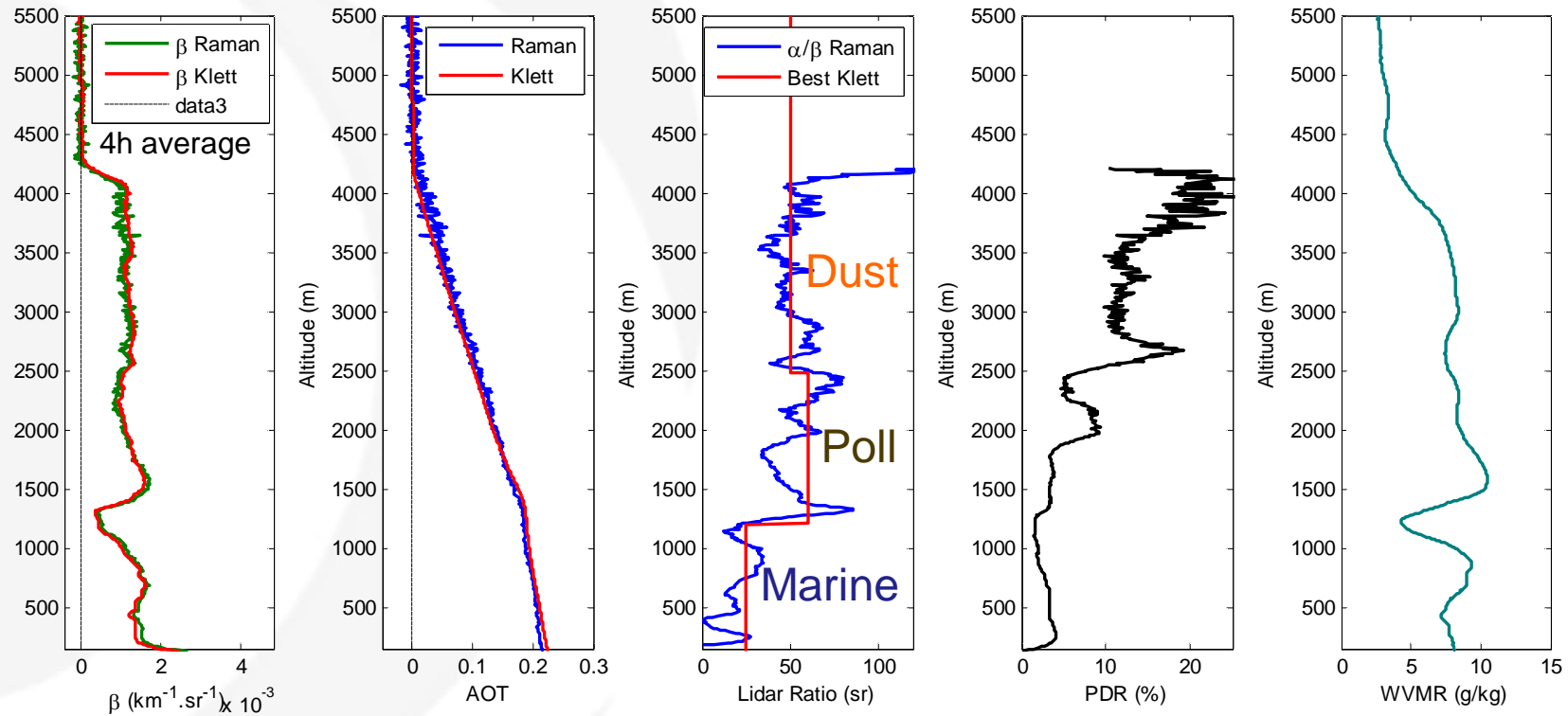
WALI : transportable Water vapor & Aerosol Lidar

4 modular channels:

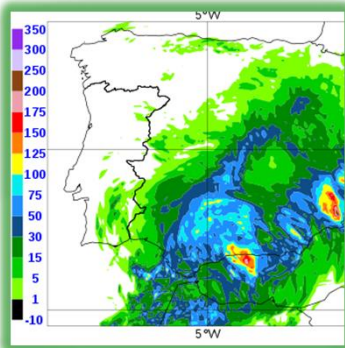
- Elastic (co- and cross-polarized) at 355 ± 0.1 nm
- N₂ Raman at 387 ± 0.05 nm
- H₂O Raman at 407 ± 0.05 nm

- " Versatile, eyesafe
- " Refractive telescopes (150 mm) => high transmittance, optical stability
- " Large FOV (3 mrad) => low overlap (~100 m when best focus)
- " WVMR up to ~10 km range in 20 min during night-time

Chazette et al., AMT, 2014



Intercomparison strategy



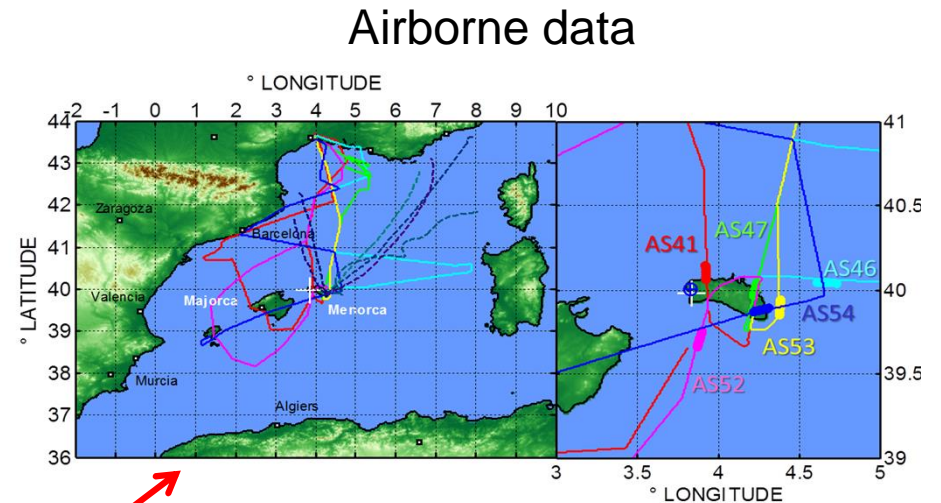
AROME-WMED (HyMeX)
Dedicated NWP model

Model developed and run by Météo-France, for the HyMeX program (extreme precipitation prediction)



WRF
Open access NWP model

Model run by J-C Raut with fine modelization of the boundary layer processes



Airborne data

WALI

Space-borne products

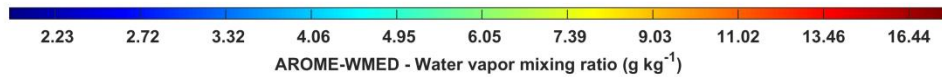
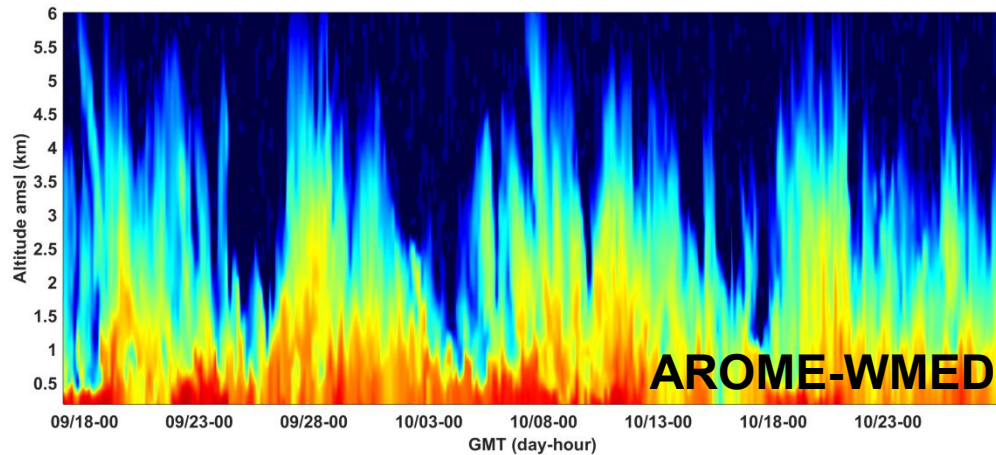
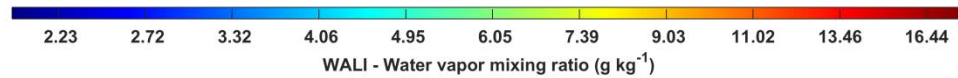
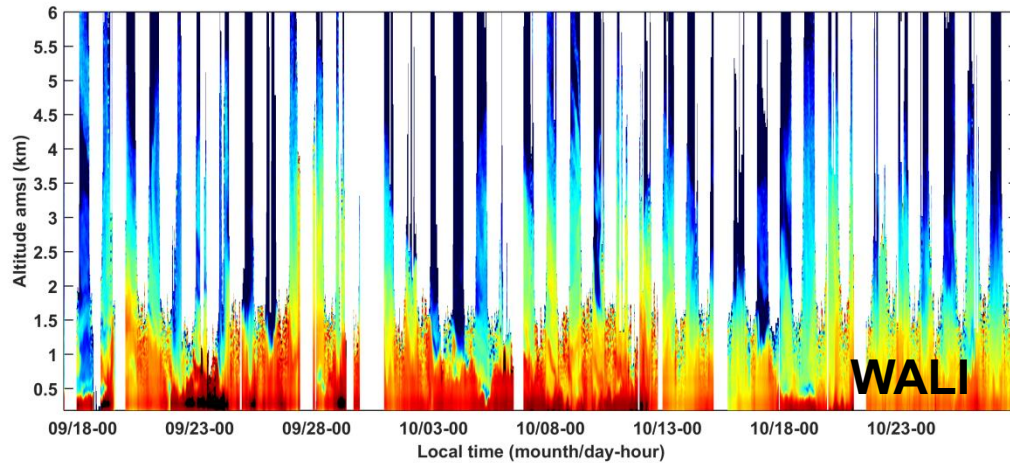


IASI & AIRS
Infrared Spectrometer

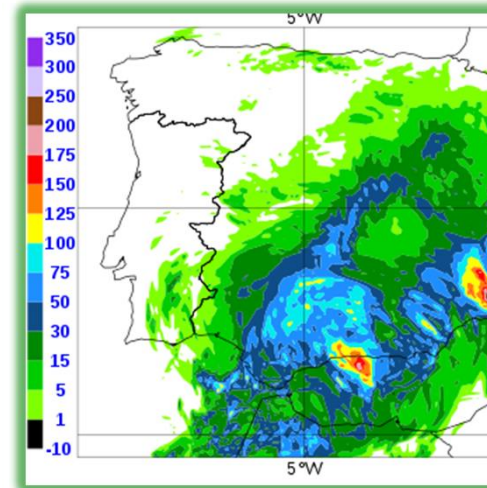
MODIS

Water vapor profiles with low resolution, constrained by weight functions of spectral channels

AROME-WMED vs WALI



Is this well reproduced by models?



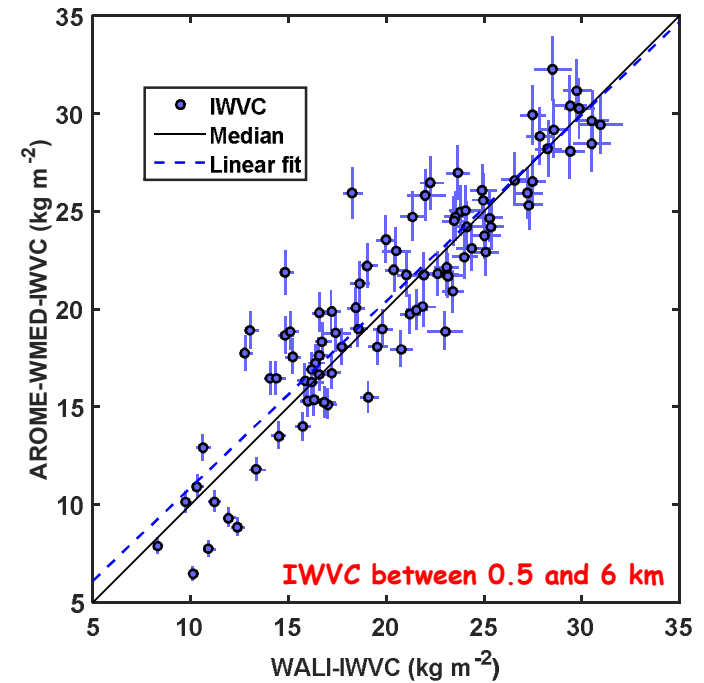
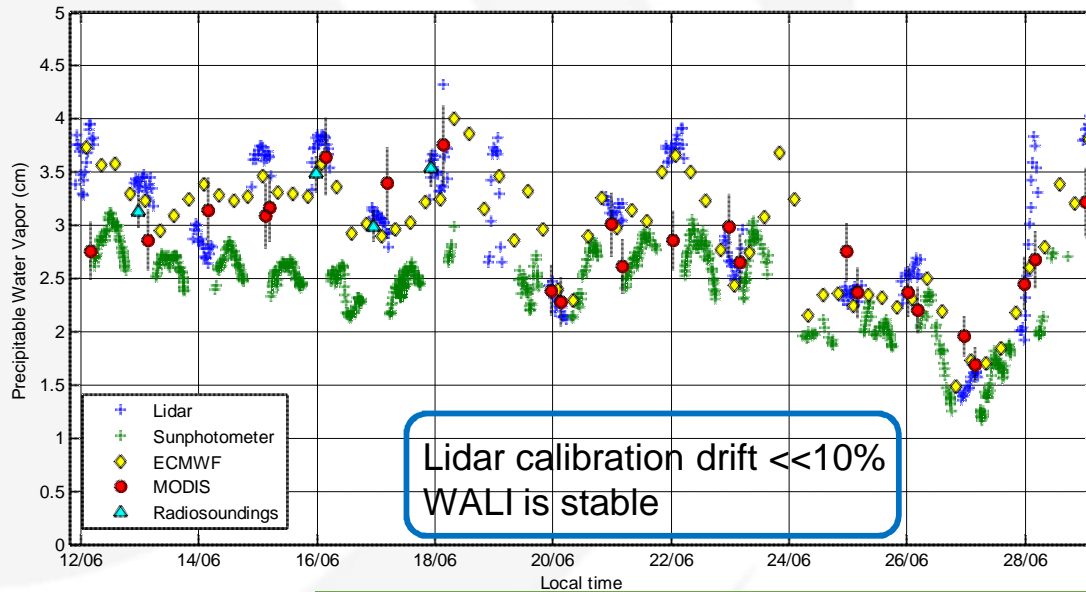
AROME-WMED (HyMeX)
Dedicated NWP model

Model developed and run by
Météo-France, for the HyMeX
program (extreme precipitation
prediction)

NWP and research models vs WALI: IWVC

Table 5: Statistics on the comparison between the integrated water vapour content derived from lidar measurements and others data set (GPS measurements, AROME-WMED, ECMWF and WRF models). The Pearson coefficient r^2 for the different linear fits is also given.

	Altitude range (km)	Slope	Bias (kg m ⁻²)	RMSE (kg m ⁻²)	r^2	Number of samples
GPS	0.5-6	1.0	5.1	1.5	0.93	284
AROME-WMED	0.5-6	0.95	1.3	2.3	0.84	92
	1.5-6	1.00	0.8	1.5	0.91	92
ECMWF	0.5-6	0.84	2.3	2.1	0.84	48
	1.5-6	0.89	1.2	1.3	0.91	48
WRF	0.5-6	0.88	3.3	1.8	0.88	1057
	1.5-6	0.95	1.8	1.4	0.91	1057



	Rel bias	Rel std
Sunphoto	-24%	25%
ECMWF	-1.4%	5.3%
MODIS	0%	15%
RadioSound.	-3%	4%
TOTAL	-0.8%	11%

Underestimation for sunphotometer retrievals of IWVC

NWP and research models vs WALI: profiles

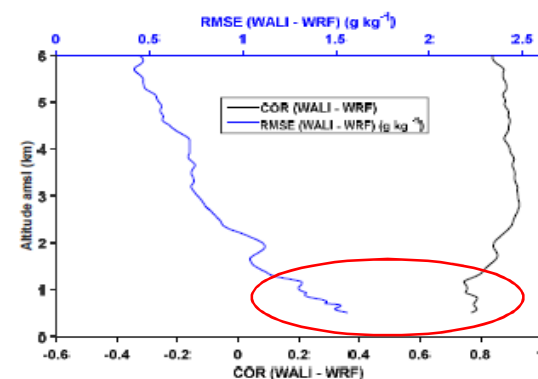
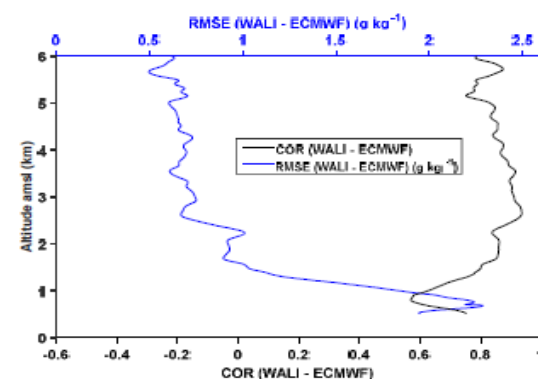
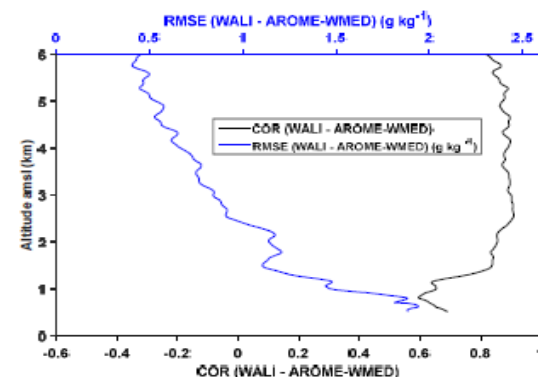
WVMR profiles

Table 6: Scores of inter-comparisons of WVMR retrieval by WALI and AROME-WMED (WALI – AROME-WMED), and WALI and ECMWF (WALI – ECMWF). The results are given during night-time for several atmospheric layers, in terms of correlation (COR) and root mean square error (RMSE).

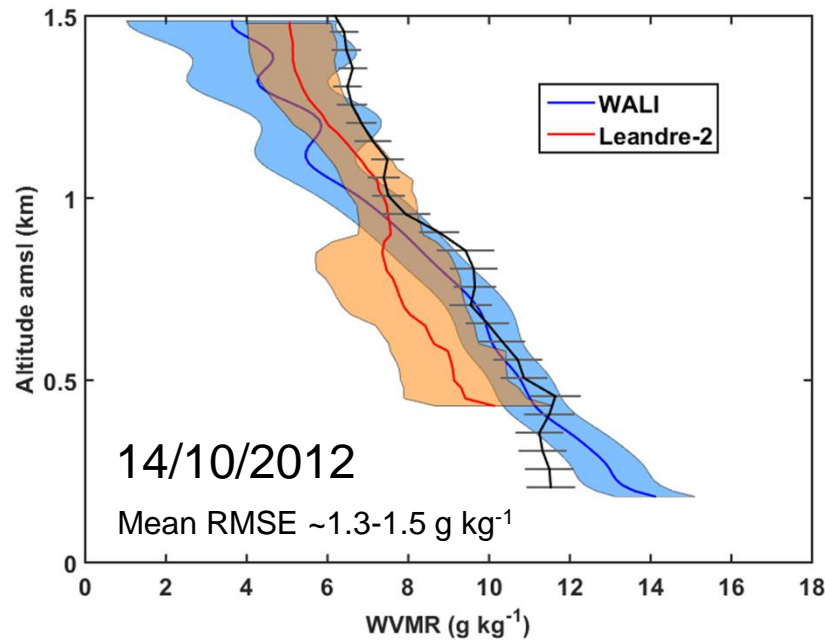
Altitude Range (km amsl)	COR			RMSE (g kg^{-1})		
	WALI-AROME-WMED	WALI-ECMWF	WALI-WRF	WALI-AROME-WMED	WALI-ECMWF	WALI-WRF
0.5-1.5	0.68	0.68	0.78	1.59	1.78	1.33
1.5-3.0	0.87	0.88	0.88	1.06	0.86	0.96
3.0-6.0	0.88	0.85	0.89	0.62	0.66	0.62
0.5-6.0	0.84	0.83	0.87	0.99	1.01	0.88

- WRF slightly better than AROME WMED when compared to WALI, especially in the lower levels
- Lack of proper moisture constraint at the surface?

Chazette et al., 2015a
QJRMS SOP 1 Special Issue



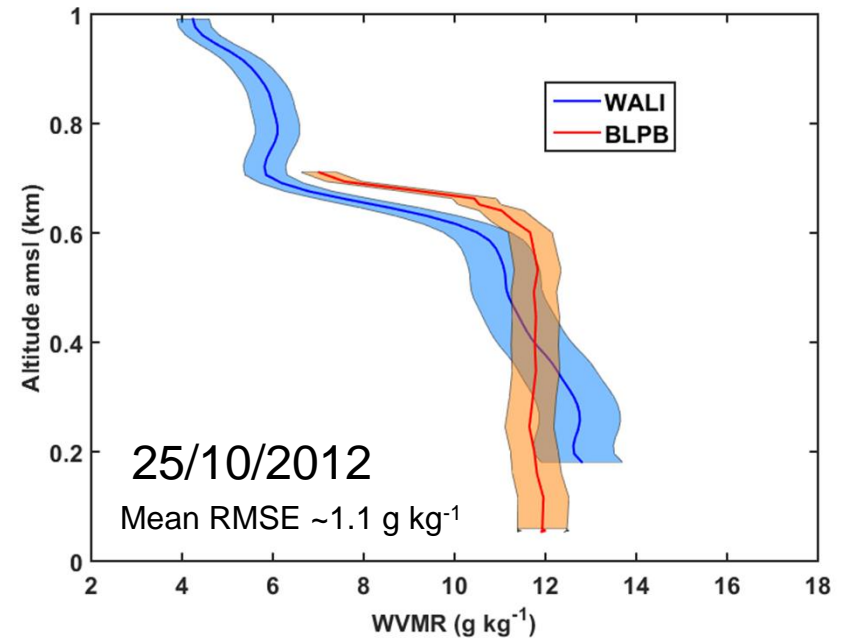
Airborne measurements vs WALI



Boundary Layer Pressurized Balloons (BLPB)

Balloon case (BC)	Date	RMSE (g kg^{-1})
		WALI-BLPB
BC0	26/09/2012 0157 UTC	0.8
BC4a (event 4)	11/10/2012 0202 UTC	1.2
BC4b (event 4)	14/10/2012 0814 UTC	1.3
BC5 (event 5)	18/10/2012 0255 UTC	0.9
BC6a (event 6)	25/10/2012 2100 UTC	1.1
BC6b (event 6)	26/10/2012 0536 UTC	0.9

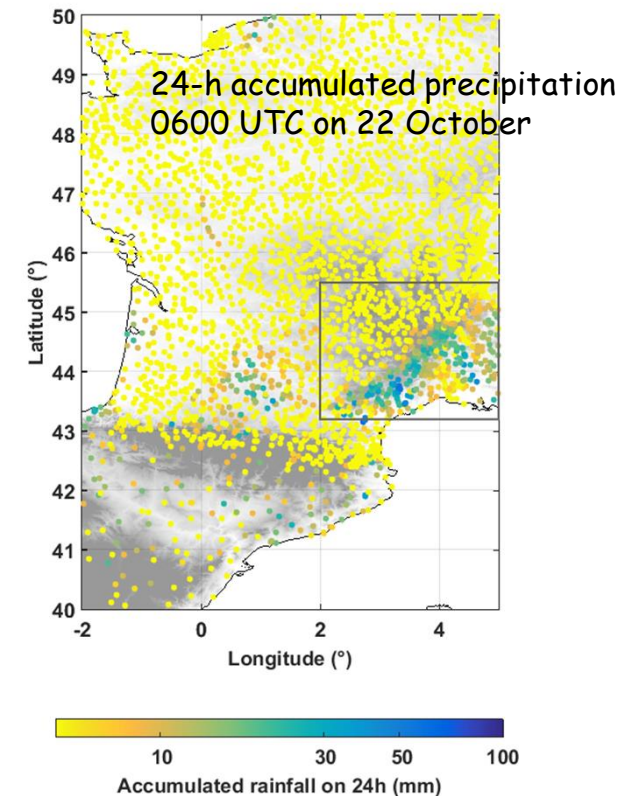
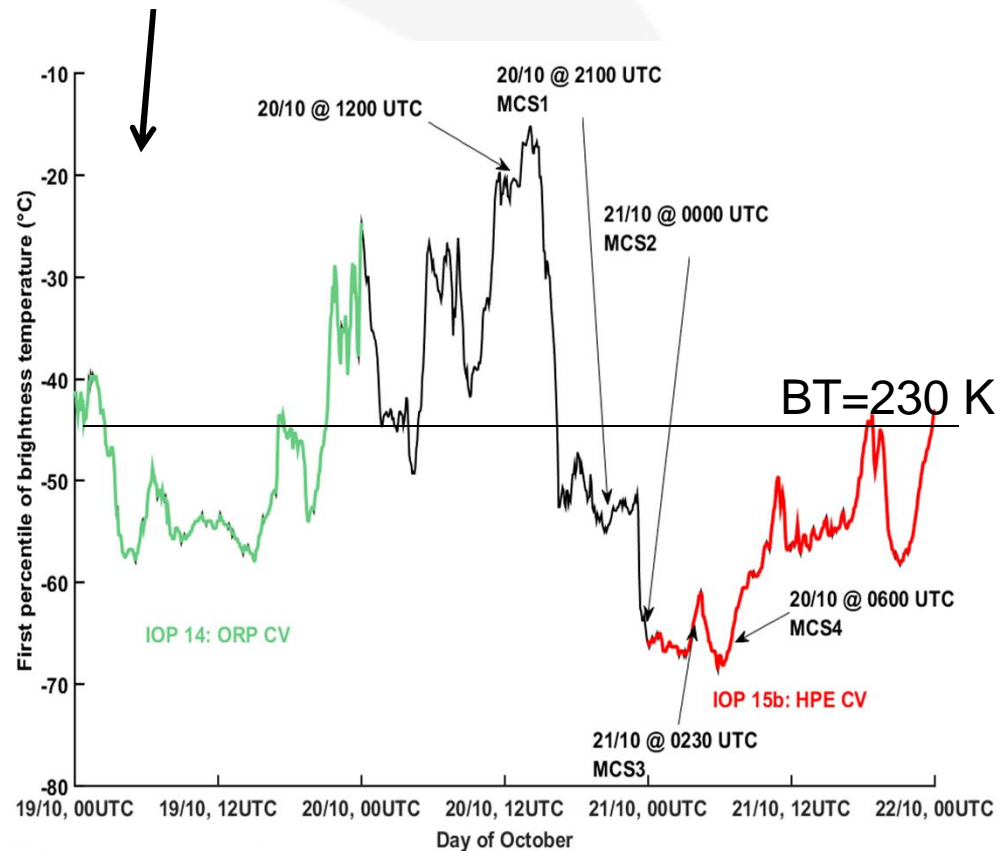
Aircraft case (AC)	Date	Profiles acquired time (hhmm UTC)			RMSE (g kg^{-1})		
		LEANDRE 2		In situ probes	In the immediate vicinity of Menorca		
		100 km leg	10 km leg		WALI - LEANDRE 2	WALI - in situ	LEANDRE 2 - in situ
AC2 (event 2)	28/09/2012 : AS41 landing	1603-1620 <i>1500</i>	1619-1620	1618-1633	3.1	2.2	4.7
AC4a (event 4)	14/10/2012 : AS46 landing	1105-1122 <i>1200</i>	1120-1122	1113-1135	1.3	0.6	1.2
AC4b (event 4)	14/10/2012 : AS47 take-off	1255-1312 <i>1200</i>	1310-1312	1305-1326	1.3	1.0	1.5



Combining moisture datasets

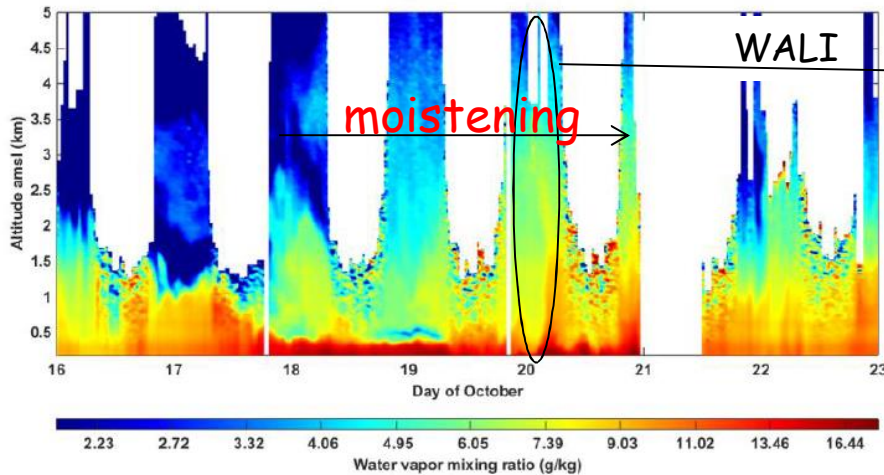
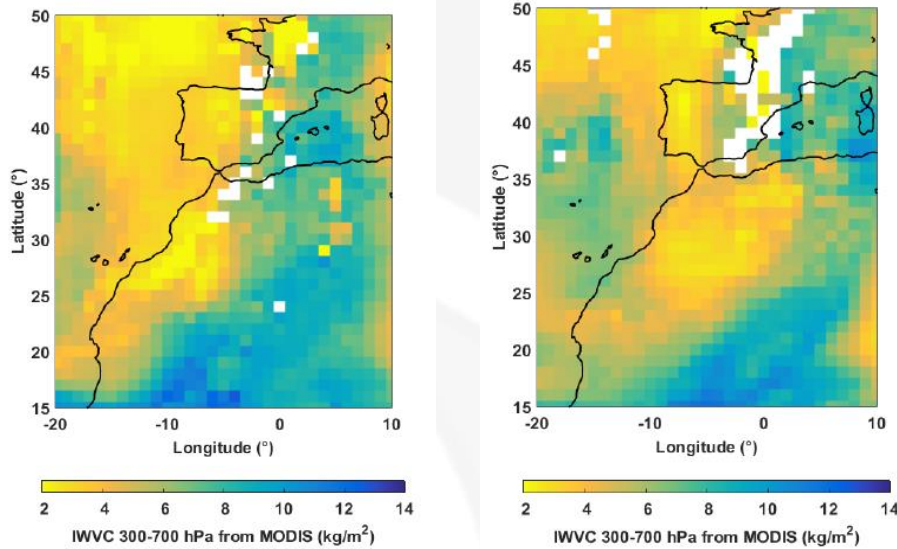
HPE over the CV area during IOP 15b

Temporal evolution of the $10.8 \mu\text{m}$ channel SEVIRI-derived brightness temperature over the Cevennes-Vivarais region ($2\text{-}5^\circ \text{ E}$ and $43.2\text{-}45.5^\circ \text{ N}$).

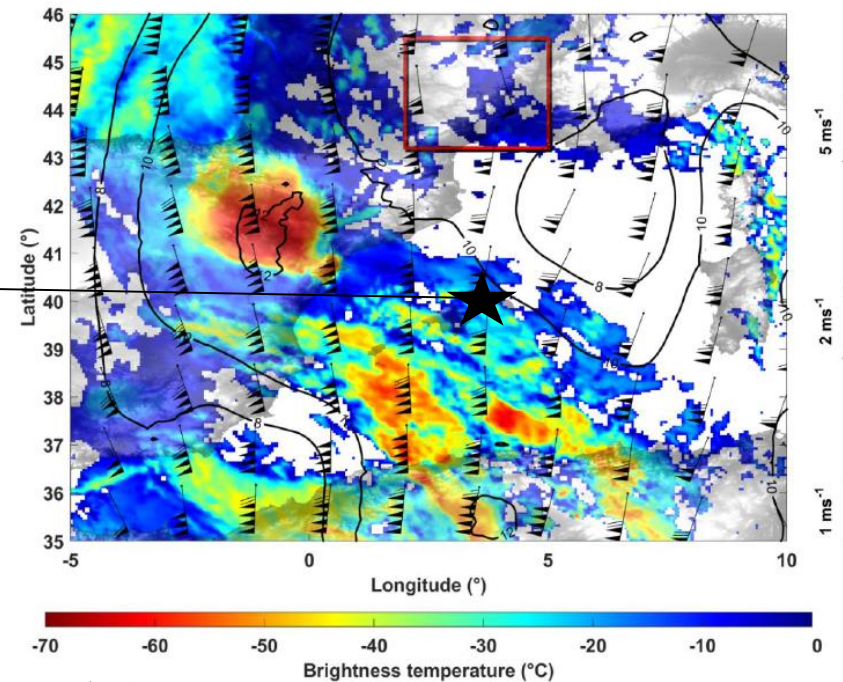


Combining moisture datasets

MODIS IWVC 700-300 hPa: 19 & 20 October 2012



- Transport of moisture between 700 and 300 hPa from WA (observations and models)
- Tropical plume co-located with storm track (SEVIRI imager)
- Vertical structure of the plume documented by WV lidar WALI



MSG/SEVIRI
0600 UTC
20 October 2012

Main highlights

- ✓ Good agreements between lidar, airborne & balloon-borne WV measurements
- ✓ Good agreements between lidar & GPS and NWP and research models
- ✓ Combination of space-borne and ground-based remote sensing water vapour observations as well as mesoscale models show moist tropical plumes ahead of cold fronts that may impact HPEs in the western Mediterranean (at least IOP 15b).
- ✓ The existence of the moist filament over the western Mediterranean is certainly favourable for the development of deep convective systems, as the moistening in the lower level will help overcome convective inhibition and produce strong updrafts.

Further activities:

- The contribution of the MCSs to the moistening of their environment is an open question that will be investigated in forthcoming studies.
- The presence of moist tropical filaments and their possible spatial coincidence with well-defined storm tracks and near surface convergence lines over the western Mediterranean should also be investigated for other HyMeX IOPs.