An update on cloud dynamic and microphysics products derived from RASTA measurements during HYMEX-SOP1

Julien Delanoë, Jean-Paul Vinson, Christophe Caudoux, Marie Ceccaldi, Emmanuel Fontaine, Alfons Schwarzenboeck, Cyrille Flamant

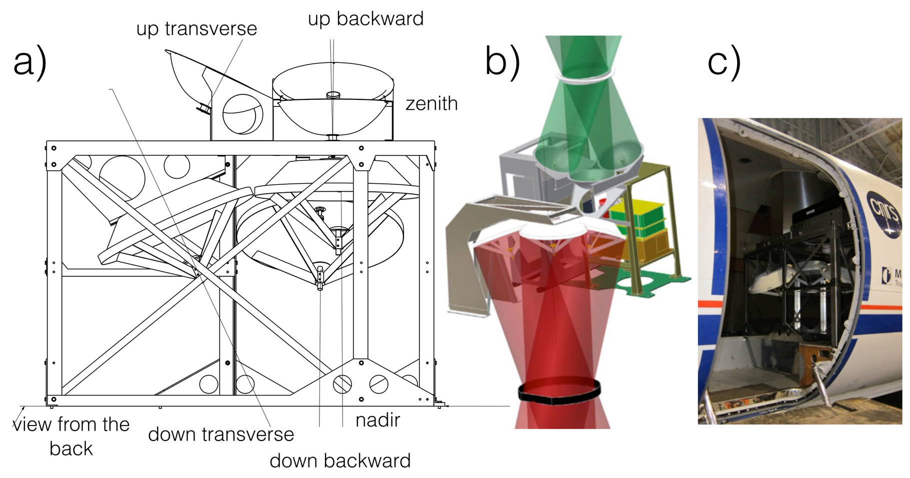
An update on cloud dynamic and microphysics products derived from RASTA measurements during HYMEX-SOP1

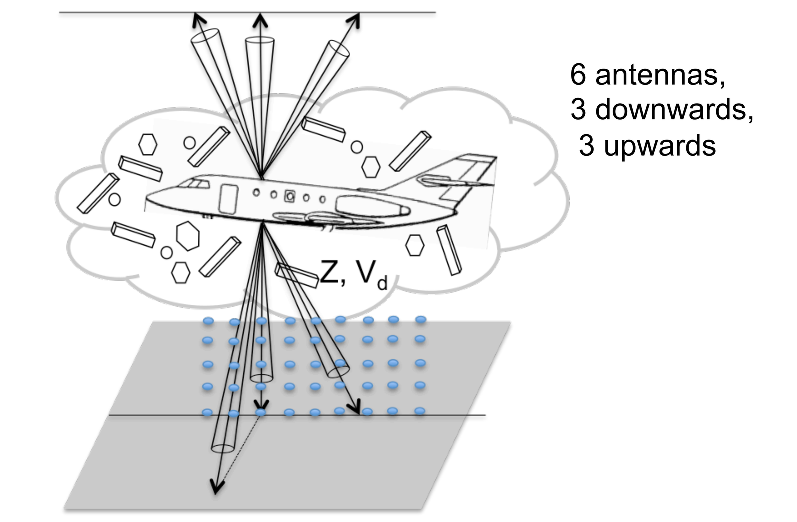
Julien Delanoë[1], Jean-Paul Vinson[1], Christophe Caudoux[1], Marie Ceccaldi[1], Emmanuel Fontaine[2], Alfons Schwarzenboeck[2] and Cyrille Flamant[1]

[1]Laboratoire ATmosphère, Milieux, et Observations Spatiales (LATMOS), France

[2]Laboratoire de Météorologie Physique (LaMP), Université Blaise Pascal/CNRS/OPGC, Aubiére, France

RASTA instrument





Airborne cloud radar at 94 GHz (sensitivity ~-30dBz)

Doppler: it measures targets velocity of a sampled volume

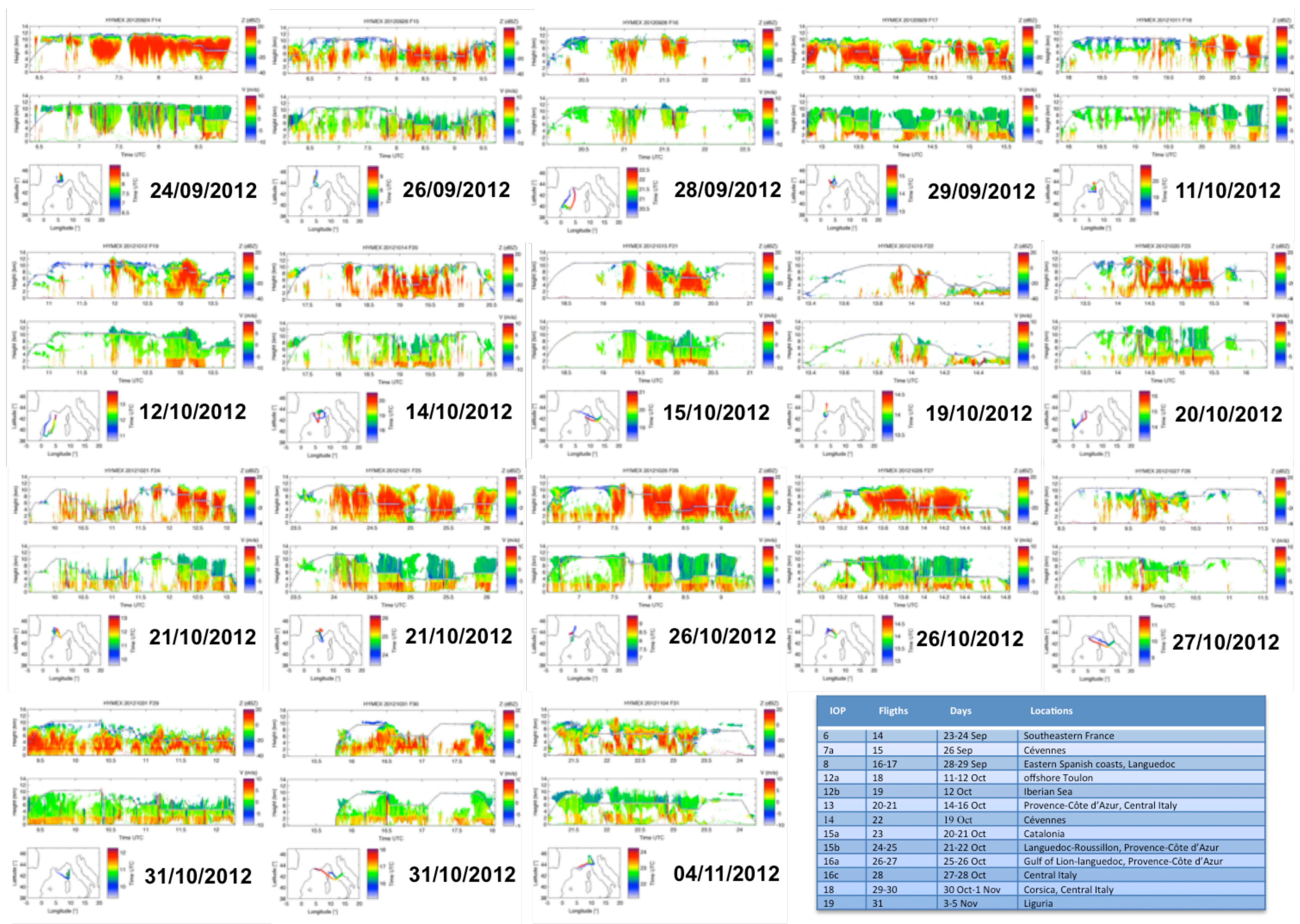
Why several antennas?

Measure Doppler velocity along 6 different directions => cloud wind retrieval (WIND): U, V, W+Vt

Microphysical information (retrieve ice cloud properties) is retrieved combining the terminal fall velocity and the reflectivity (RadOnvar)

HYMEX context

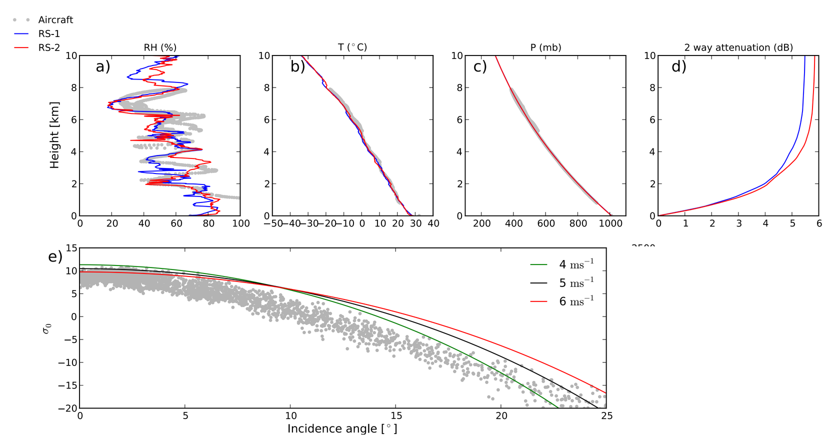
The airborne 95GHz cloud radar RASTA was operated on-board the Falcon 20 during HyMeX SOP1.1 (September/October 2012). In addition to the radar, state of the art in-situ microphysical probes, such as CDP, 2DS, CPI, PIP, and Robust probe were deployed to characterize bulk and individual hydrometeor microphysics. The underlying idea was to combine radar and in-situ measurements to infer cloud processes that originate precipitation. The spatially limited detailed cloud description using in-situ measurements can be extended to the area covered by the radar.



IOP	Fligths	Days	Locations
6	14	23-24 Sep	Southeastern France
7a	15	26 Sep	Cévennes
8	16-17	28-29 Sep	Eastern Spanish coasts, Languedoc
12a	18	11-12 Oct	offshore Toulon
12b	19	12 Oct	Iberian Sea
13	20-21	14-16 Oct	Provence-Côte d'Azur, Central Italy
14	22	19 Oct	Cévennes
15a	23	20-21 Oct	Catalonia
15b	24-25	21-22 Oct	Languedoc-Roussillon, Provence-Côte d'Azur
16a	26-27	25-26 Oct	Gulf of Lion-languedoc, Provence-Côte d'Azur
16c	28	27-28 Oct	Central Italy
18	29-30	30 Oct-1 Nov	Corsica, Central Italy
19	31	3-5 Nov	Liguria

Calibration

RASTA nadir reflectivity is calibrated using the ocean surface return technique (Li et al. 2005). We use data collected during the MT-Maldives campaign on the 22nd of December 2011 above Indian Ocean. This flight was especially dedicated to the calibration of the radar as the aircraft was flown in clear sky area.



Two radiosondes were available before and after the 1:30 hour flight, Figures a, b, c represent the relative humidity, temperature and pressure profiles respectively. These profiles are used to calculate the two way attenuation at 94 GHz presented in panel d. Note that HYMEX and MT-Maldives system configurations were similar and therefore we use the same calibration constants.

Figure e illustrates the normalized ocean surface echo (σ0) as a function of the incidence angle once the nadir reflectivity has been calibrated and compared to simulated ocean returns for different wind speeds.

Products

One file per antenna (Instrument oriented)

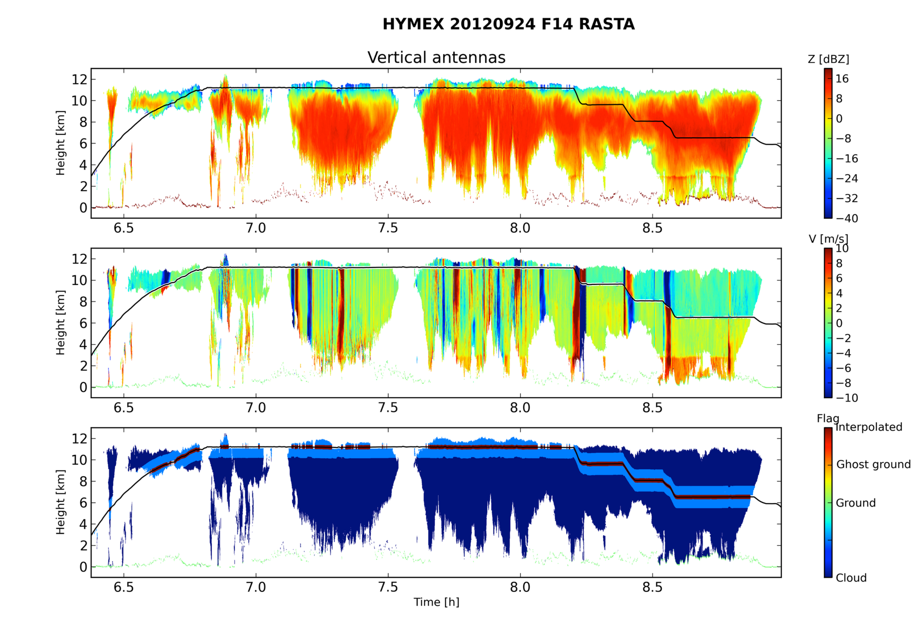
- L0 data (netcdf): file containing Z and Doppler velocity uncorrected. 1.2 s horizontal / 60 m vertical
- L1 data (netcdf): file containing Z (calibrated) and Doppler velocity uncorrected. 1.2 s horizontal / 60 m vertical
- L2 data (netcdf): file containing Z (calibrated) and Doppler velocity (unfolded) radar gates are geo-localised. Interpolation between upper/lower domain and correction of reflectivity near the aircraft

Multi antenna products (variational technique)

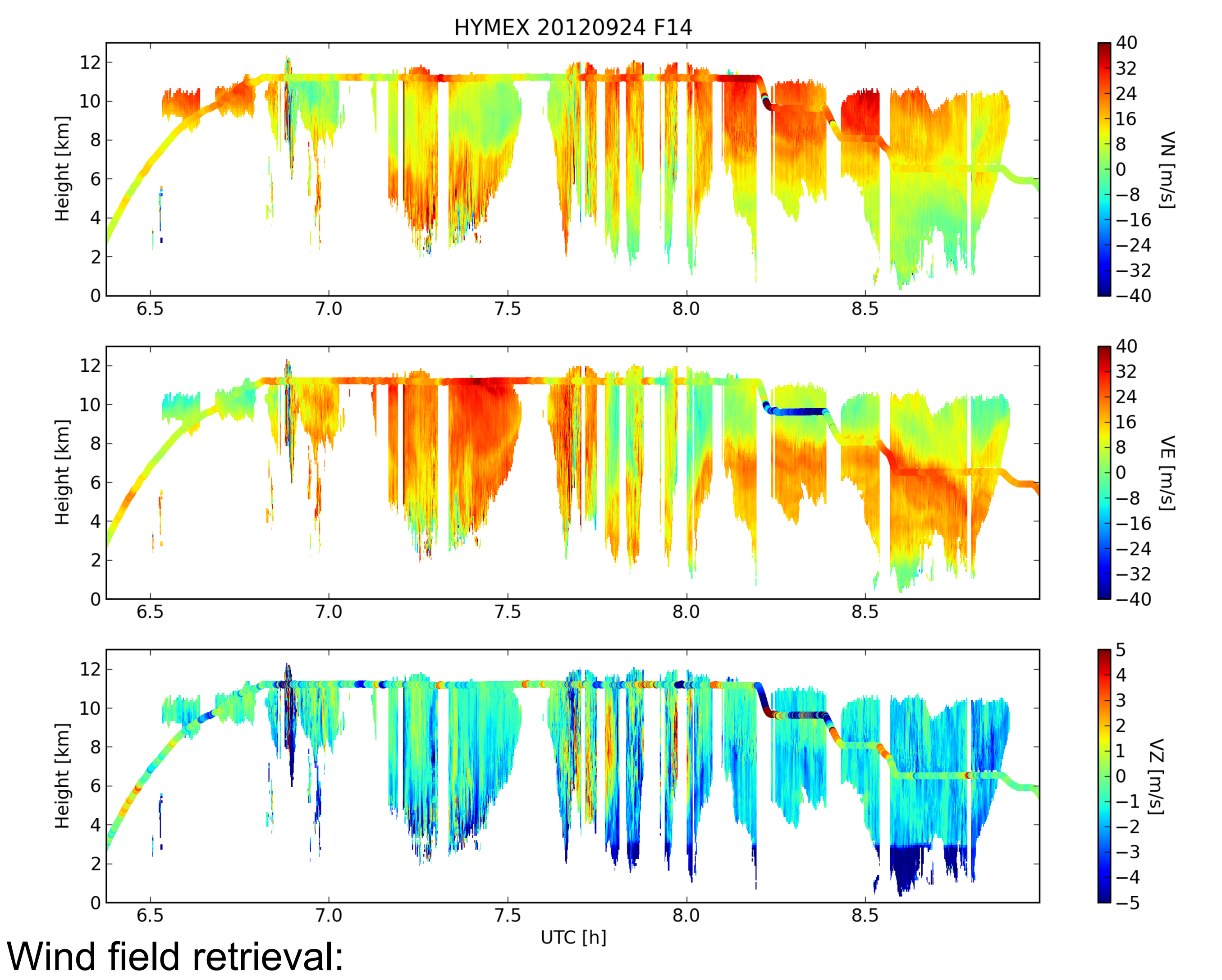
- 3D cloud WIND: re-gridded data 1.2 s horizontal /120 m vertical
- Ice cloud microphysics (IWC etc) 1.2 s horizontal /120 m vertical

Example of L2 data for nadir and zenith

- Top panel represents the calibrated/corrected reflectivity
- Middle panel represents the Doppler velocity (unfolded and corrected from aircraft velocity)



- Bottom panel shows the classification of the data (cloud, ground, interpolated reflectivity at aircraft altitude…)



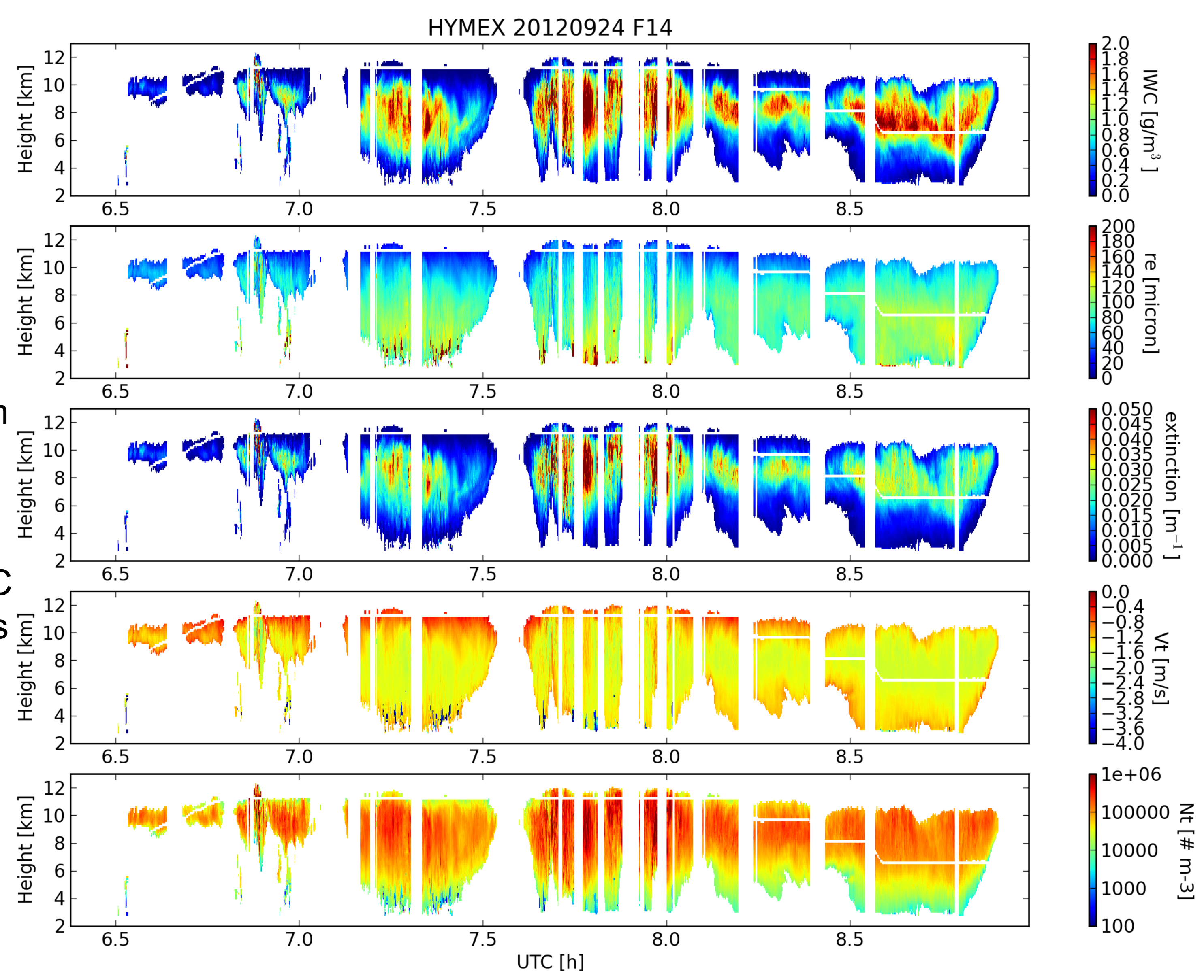
Wind field retrieval:

Dots at aircraft altitude correspond to in-situ measurements

Vz is the sum of the terminal fall velocity (Vt) and the vertical air motion (W), only W is available from aircraft in-situ measurements.

Microphysics: Variational technique (Radonvar): Vz+Z+Temperature => Dm (mean volume diameter), IWC and W Knowing a priori information derived from the microphysical probes.

Once we know Dm, IWC and W other parameters are calculated using parameterizations derived from in-situ measurements.



Related presentations and posters:

- **M4.3** - Intercomparison and evaluation of 3-D wind fields derived from airborne and ground-based radars during HyMeX, *O. Bousquet, J. Delanoë*
- **Th1.6** - Convection and extreme rainfall during the development of two intense Mediterranean cyclones in the HyMeX campaign, *E. Flaounas, V. Kotroni, K. Lagouvardos, C. Claud, J. Delanoë, C. Flamant, E. Madonna, H. Wernli*
- **P1.7**: ***A data assimilation experiment of RASTA airborne cloud radar data during HyMeX IOP16,*** *G. Saussereau, O. Caumont, J. Delanoë*
- **P2.11**: ***Verification of Meso-NH forecasts of cloud structure and water content against remote sensing Observations,*** *J.-P. Chaboureau, J. Delanoë*
- **Th1.2**: ***Deep convective clouds and convective overshootings characterization during HyMeX SOP1: a multi-instrument approach,*** *J.-F. Rysman, C. Claud, B. Funatsu, JP Chaboureau, J. Delanoë, O. Bousquet*