task2 – SOFOG3D

JULIEN DELANOË
SUSANA JORQUERA
PRAGYA VISHWAKARMA

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TASK-2 SOFOG3D

Fog retrievals based on remote sensing measurements

Sub-task 2.1: LWC and fog dynamics retrievals from radar and MWR **<= lead - LATMOS**

Sub-task 2.2: Closure analysis and retrievals assessment **<= lead - LATMOS**

Sub-task 2.3: MWR profiles retrieval constrained by radar LWC **<= contribution - LATMOS**

Sub-task 2.4: SEVIRI/MSG retrievals

Deliverables:

- **D2.1.1:** LWC profiles depending on different constraints from dedicated variational method
- **D2.1.2:** Dynamics of the fog layer from velocity azimuth display technique
- **D2.2.1:** Evaluation of radar LWC retrieval vs in-situ measurements
- **D2.2.2:** Improve radar forward model thanks to calibrated metallic targets
- **D2.3.1:** Improved MWR temperature and humidity profiles retrieved with cloud radar LWC
- **D2.3.2:** Feasibility study of cloud radar LWC assimilation within the MWR 1D-Var framework
- **D2.4.1:** Time series of 2-D maps of cloud classes using a classification adapted for fog and low stratus evolution tracking (e.g. separating core fog, dissipation fog, formation fog pixels)
- **D2.4.2:** Time series of fog evolution indicators, such as distance to fog boundaries, cloud albedo and evolution of brightness temperature of the different cloud classes.

Tasks status and next steps

Tasks	State
Installation and operation of instruments at the Supersite	Complete
Radar catalogue for the 3 radars	Complete
Processing of the whole radar database in vertical position (L1)	Complete
Radar BASTA-CNRM processing	Complete
Production of quicklooks and netcdf files	Complete
Website BASTA: Quicklooks availability	Complete
Development of a method for analyzing scan data	Complete
Radar scanner treatment and Quicklooks	Complete
L2a (Agen and Super site) sur FTP	Complete
Study: Radar coupling and fog detection	Complete
Study: Calibration transfer between radars	Complete
Study: Radar data and Radiometer data (Radiometer LWP co located with BASTA)	On-going
Balloon impact on the BASTA measurements	Complete

Next steps
• Pre retrieval: - Look at the results of the target - In-situ => radar forward model and evaluation of the one from literature
• How to use the scans for dynamic and 3D structure of fog?
• Retrieval: - Test the first version of the algorithm (Pragya's work) - Interaction with assimilation team
• Dynamic and microphysics analysis

DATA presentation and processing

Data Availability and Processing

RADAR	BASTA-mobile LATMOS (1s) BASTA-mini CNRM (1s) BASTA-mini LATMOS (1s)	BASTA-mini CNRM (0.5s) BASTA-mini LATMOS (0.5s/1s)	BASTA-mini LATMOS (0.5s/1s)
DATA ACQUISITION MODE	**Fixed Vertical**	**Scanning**	**Fixed Vertical**
SAMPLING MODE	12m5 25m 18km 100m 18km	12m5	25m
LEVEL OF DATA TREATMENT	L0: raw data L1: calibrated L2: combination of modes	L0: raw data L1: calibrated	L0: raw data L1: calibrated
PRODUCTS	Reflectivity profile Doppler Velocity profile	RHI MAPS/PPI	Wind

Data Processing

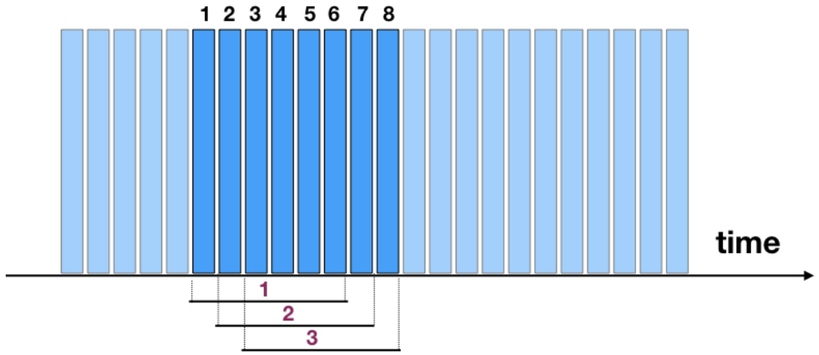
L0 → L1

Processing

- Post integration: Pulse pair technique

- Calibration: Calibration constant as a function of the transmitted power

Accumulate several profiles in order to reduce the background noise and increase sensitivity



L1 → L2

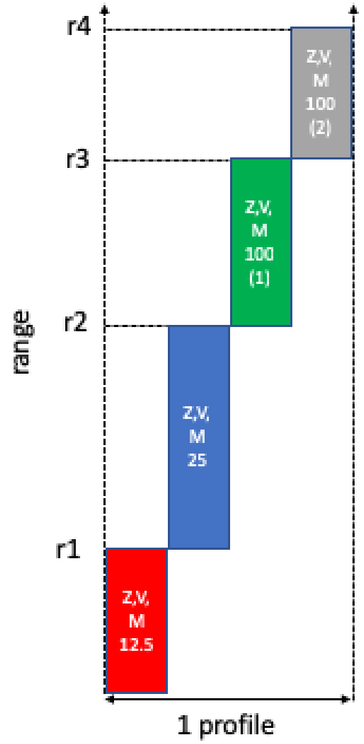
Processing

- Combination of modes and time integration

We cumulate 3 to 4 profiles to build a new profile:

- From 0 to r1 we use the 12.5m resolution
- From r1 to r2 the 25m resolution
- From r2 to r3 the 100m (18km) resolution
- From r3 to r4 the also 100m resolution.

Based on 4 profiles of 3s we will have one profile every 12s.

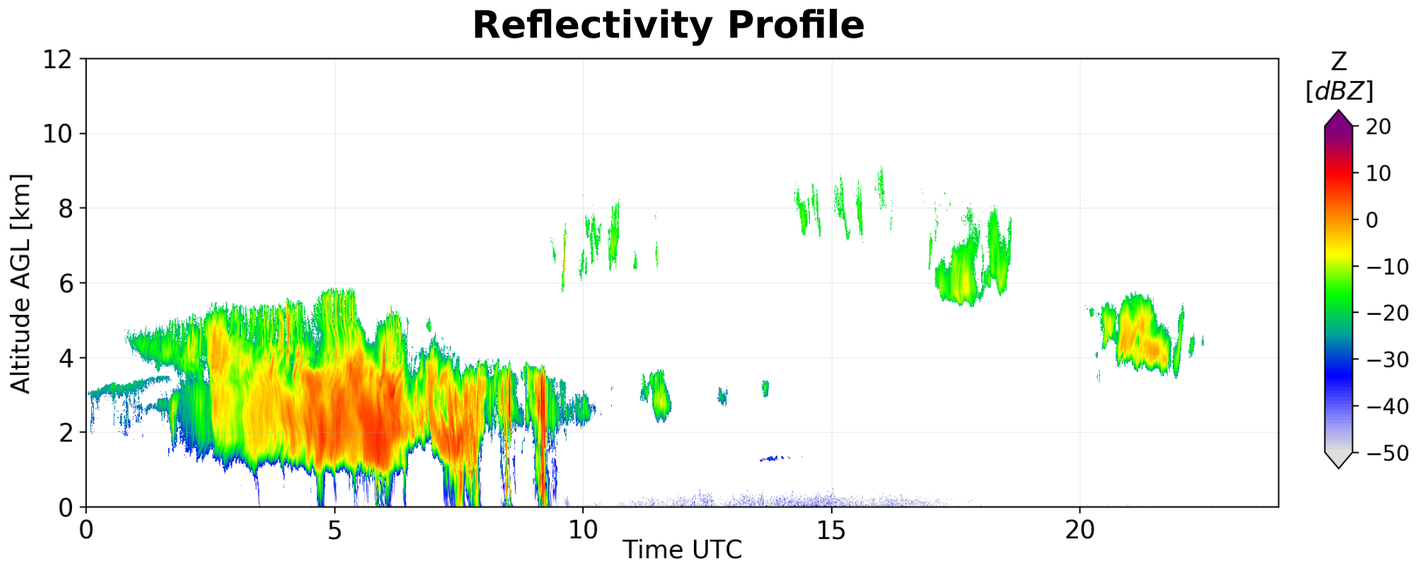


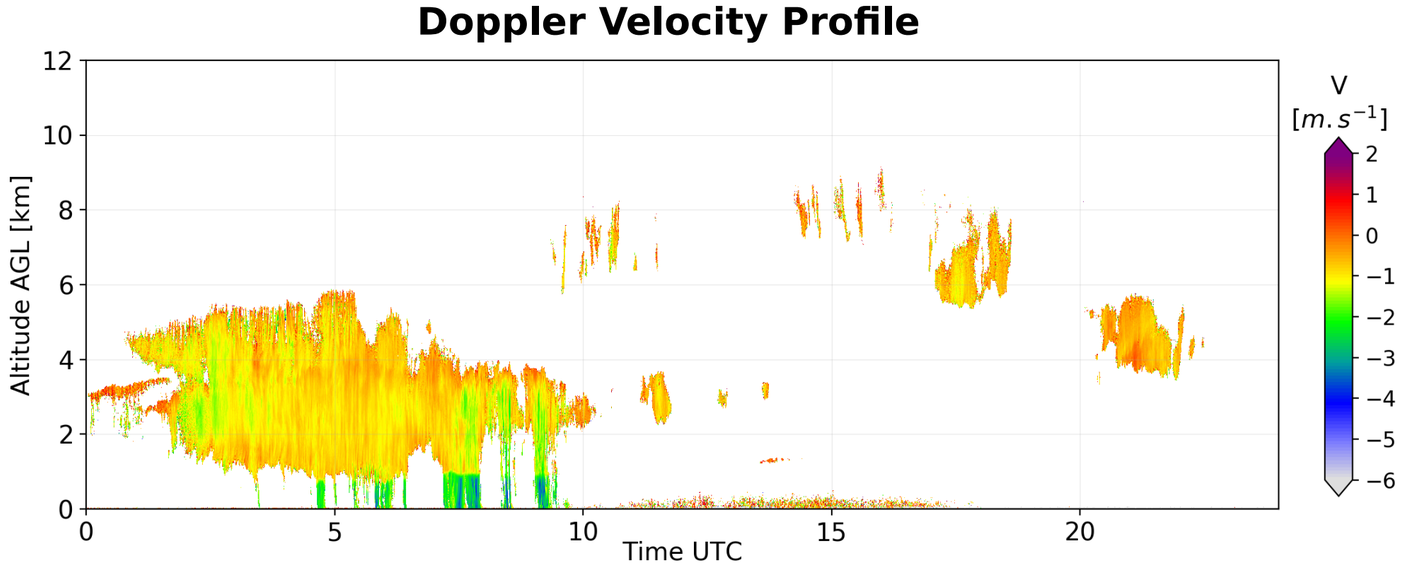
Products

Data acquisition mode:
Fixed Vertical

Products:
Reflectivity (Z) profile
Velocity (V) profile

Example:
BASTA mobile LATMOS
95 GHz Cloud radar
21/01/2020
Saint Symphorien



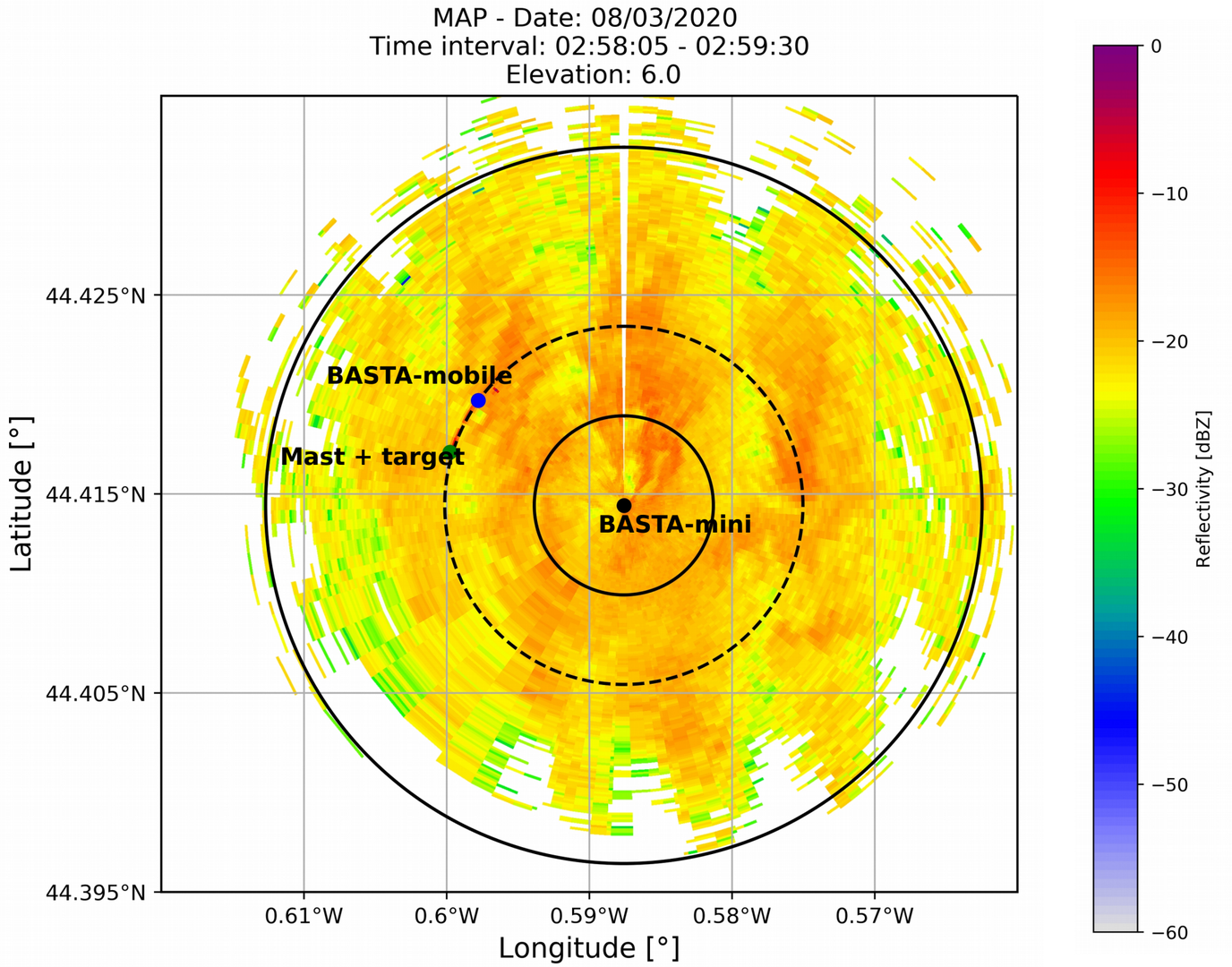


Products

Data acquisition mode:
Scanning

Products:
MAP/PPI – Plan Position Indicator
The radar holds its elevation angle constant and varies its azimuth angle.

Example:
BASTA mini LATMOS
08/03/2020
Super site



Products

Data acquisition mode:

Scanning

Products:

RHI– Range Height Indicator

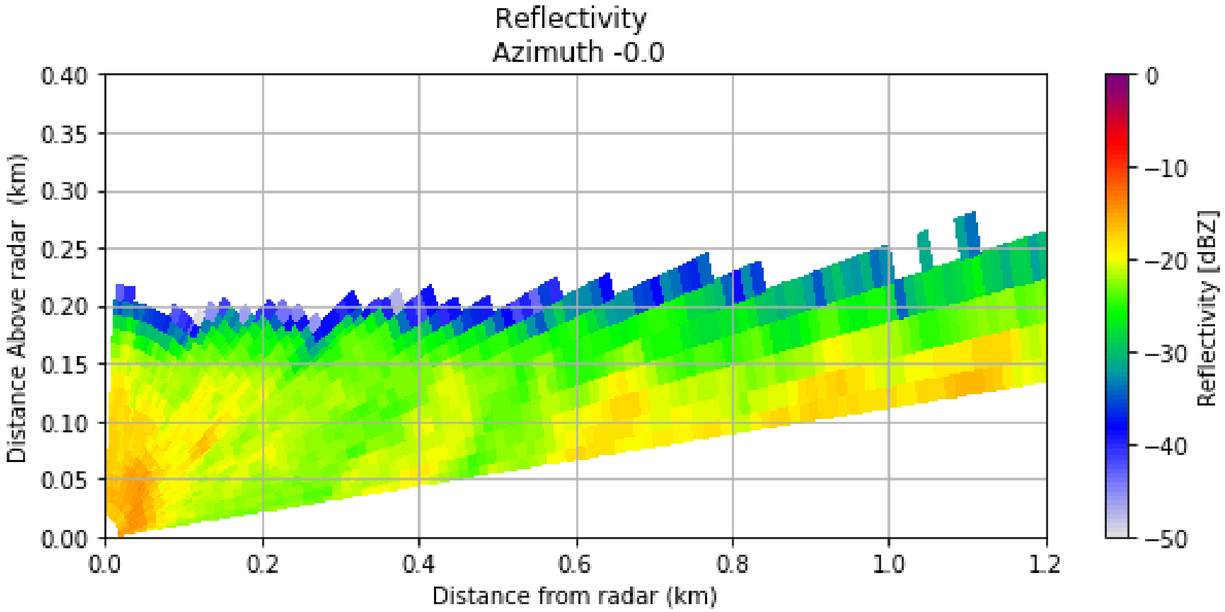
The radar holds its azimuth angle constant and varies its elevation angle.

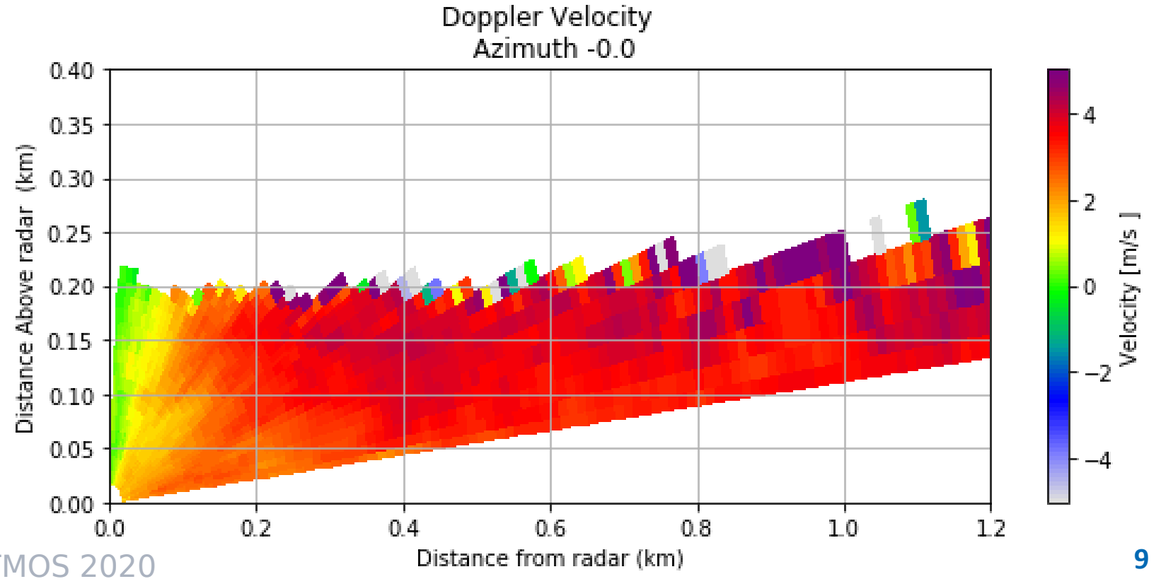
Example:

BASTA mini LATMOS

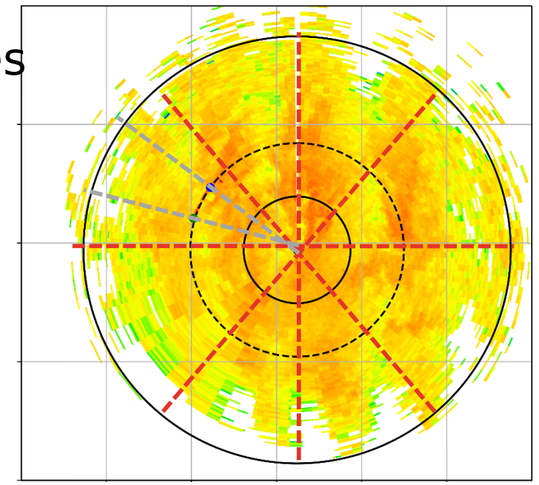
08/03/2020

Super site





RHI planes



Products

Data acquisition mode:

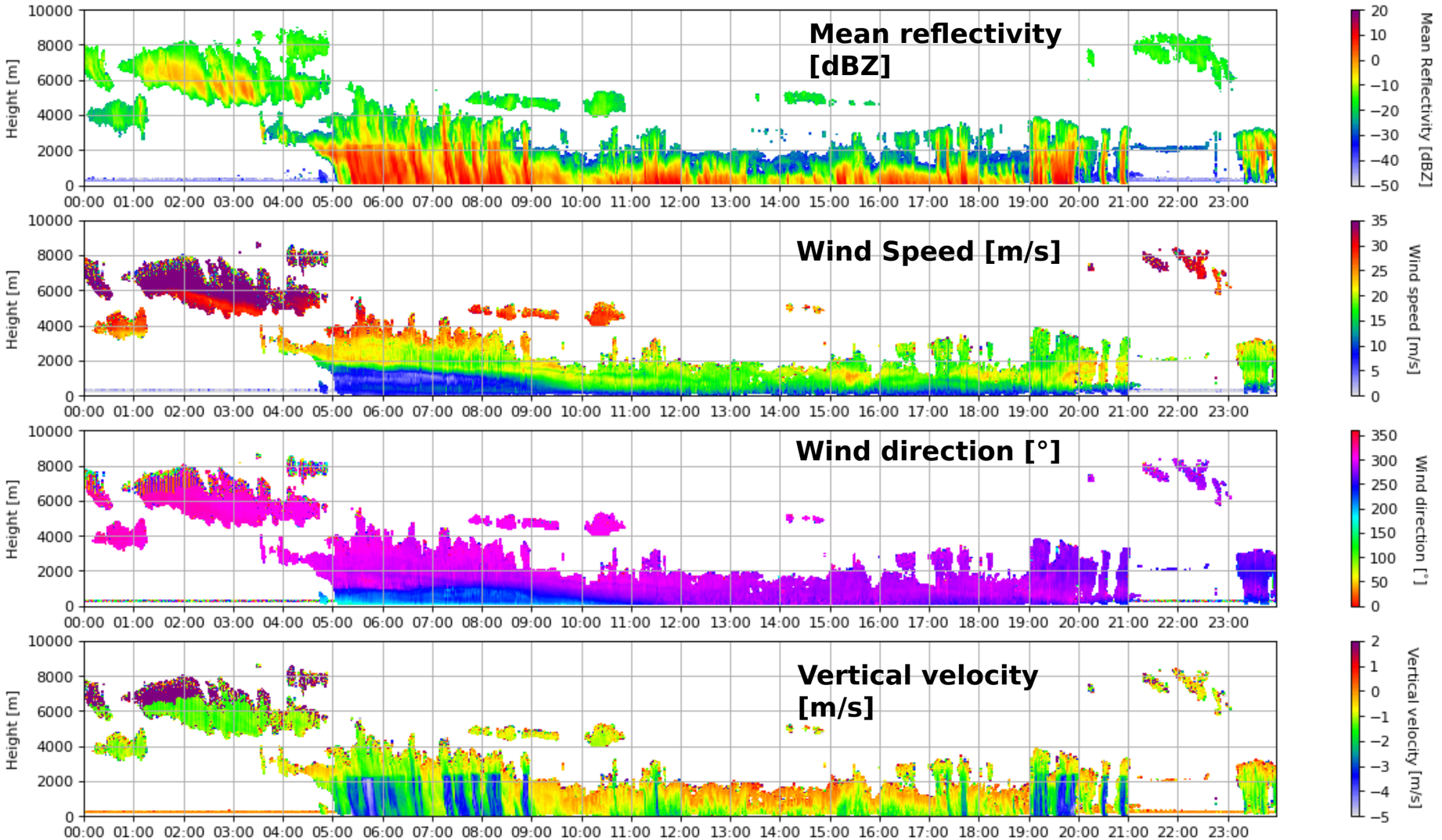
Fixed Vertical

Products:

Reflectivity
Doppler Velocity
Wind Speed
Wind direction

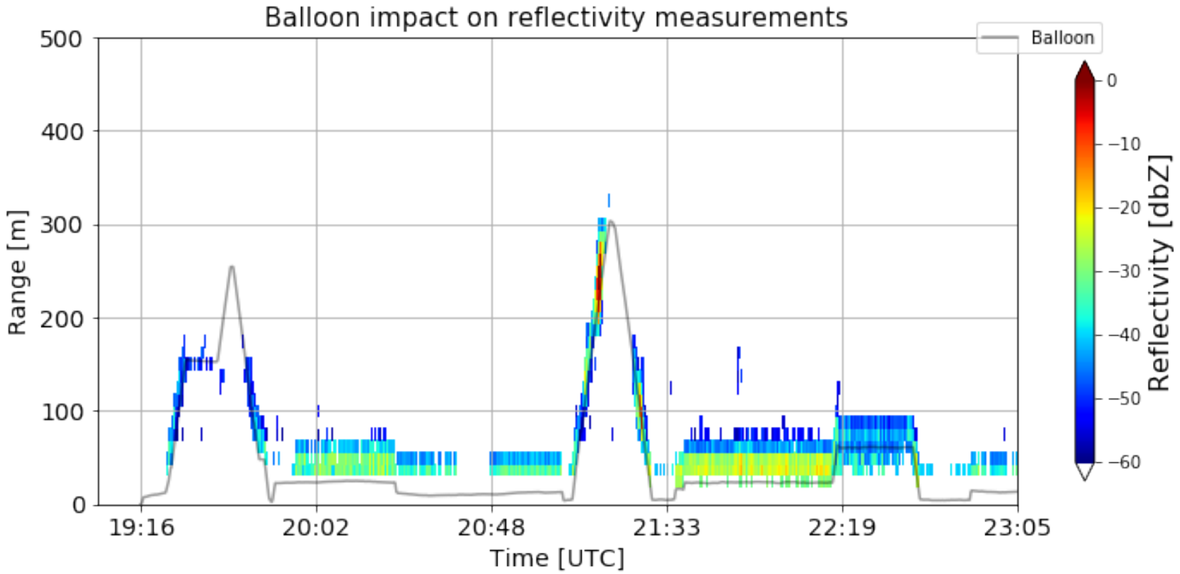
Example:

BASTA mini LATMOS
04/03/2020
Super site

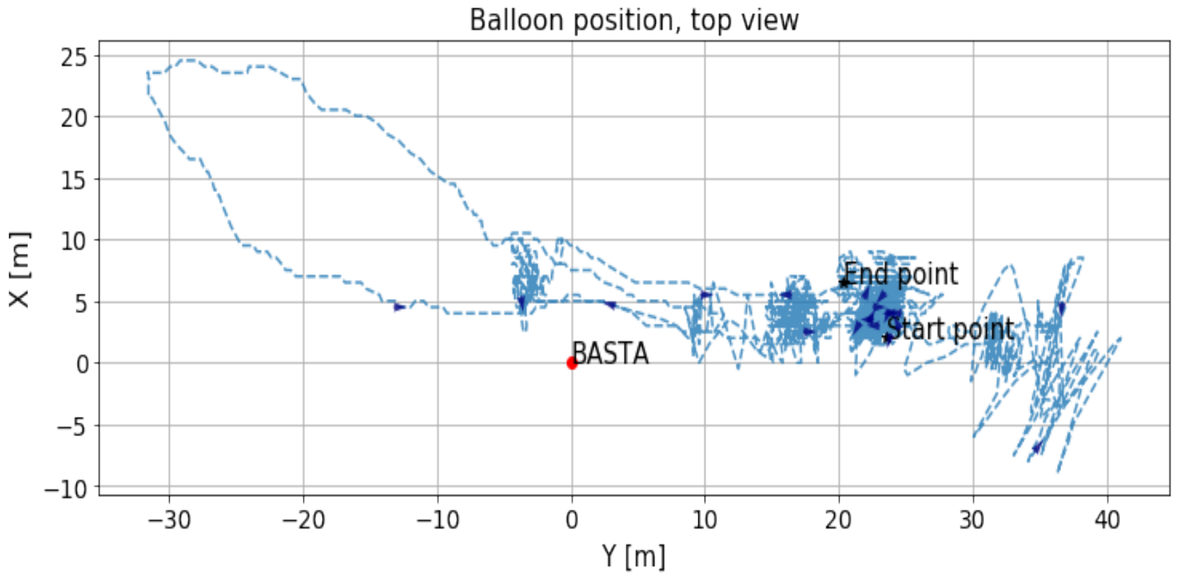


Balloon impact and treatment

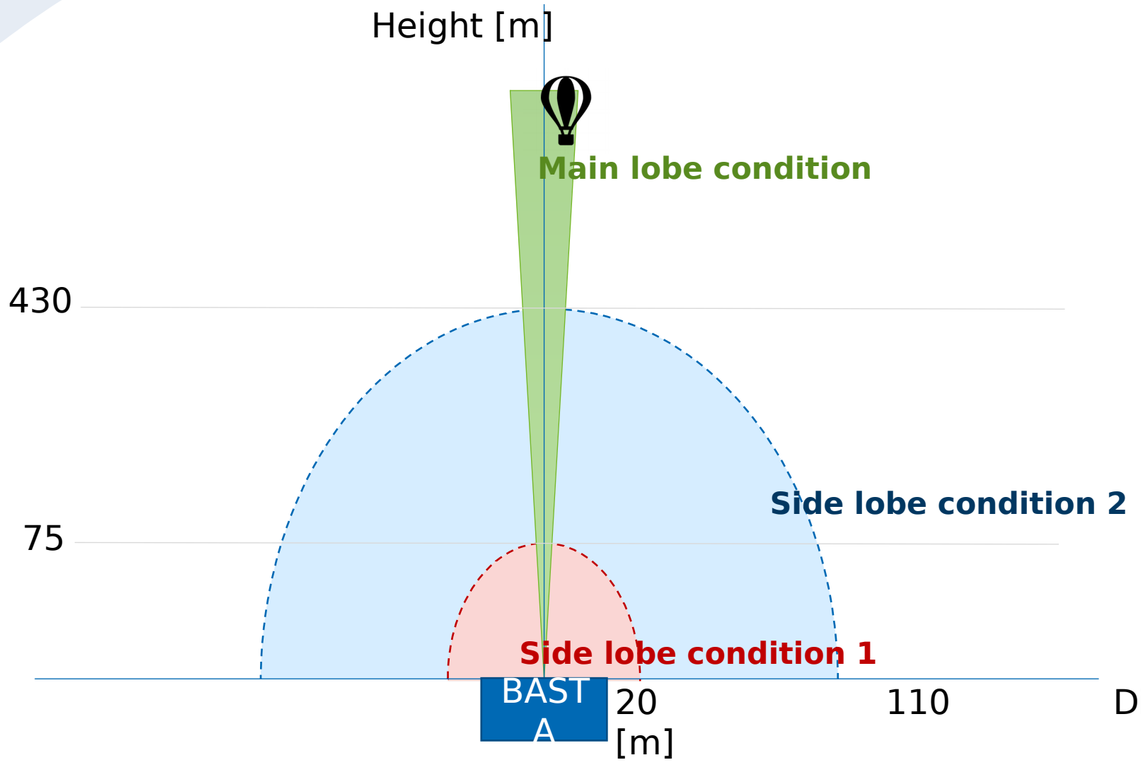
We can see the balloon impact on the radar reflectivity in a period without fog.



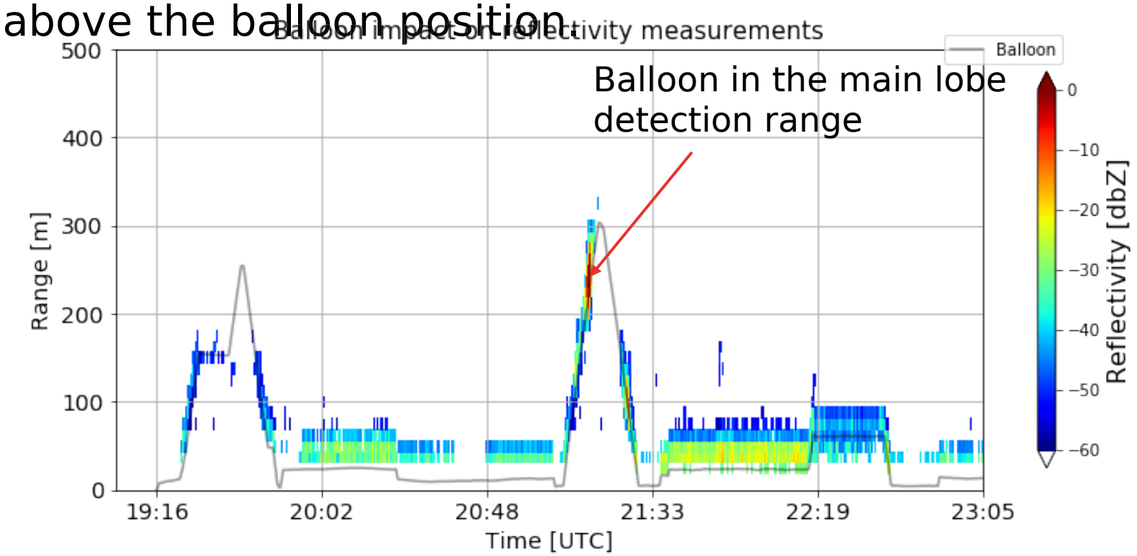
We can define areas where the balloon presence contaminates the vertical radar measurements.

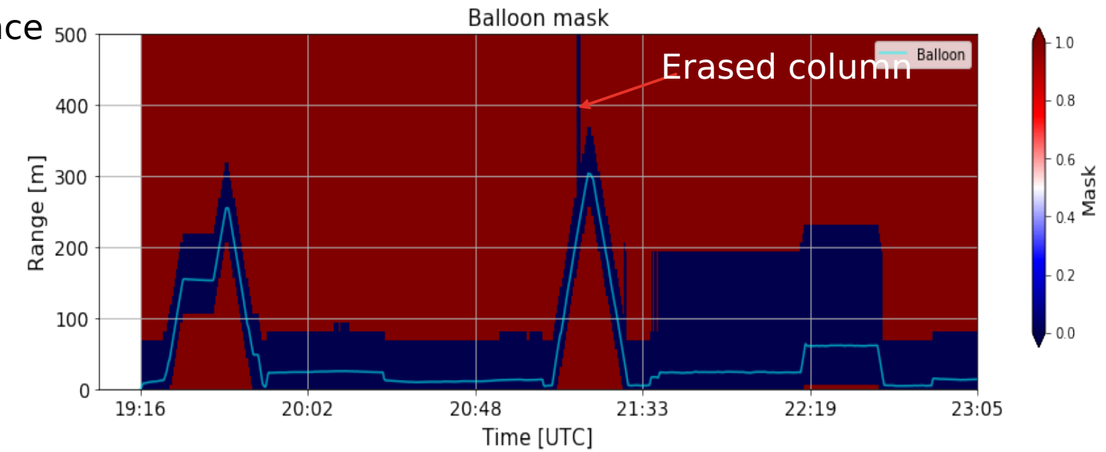


Balloon impact and treatment



Main lobe condition: If the balloon is within the *Main lobe detection range*, then we erase the column above the balloon position.

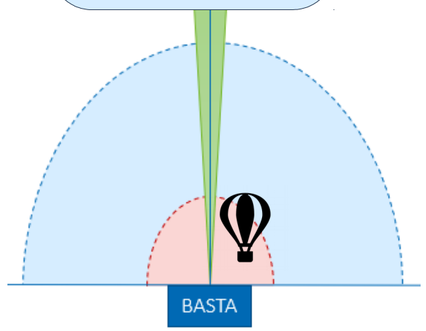




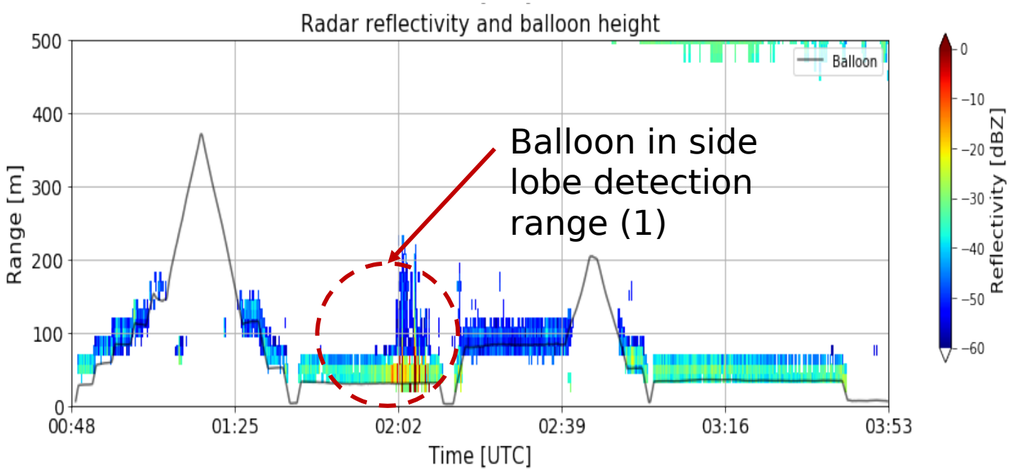
Several periods without fog were analyzed to calibrate the method and determine the limits for each condition.

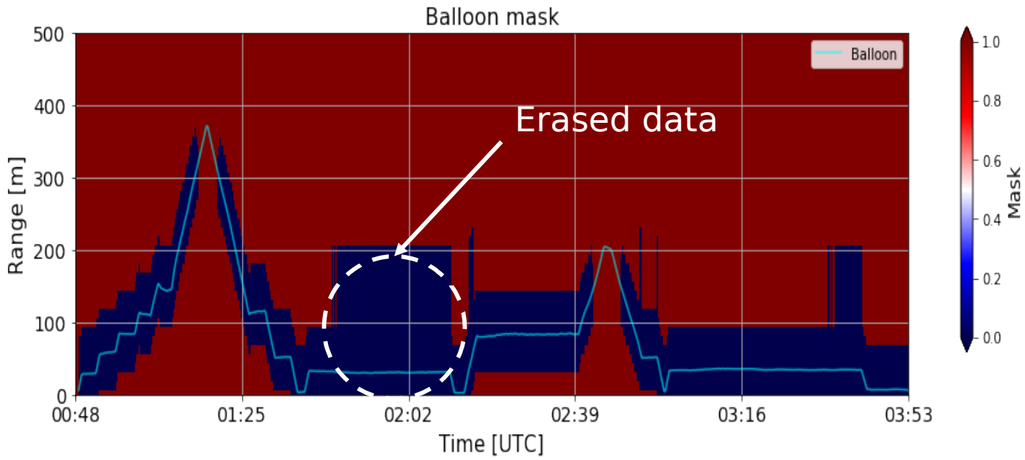
Balloon impact and treatment

SIDE LOBE CONDITION 1

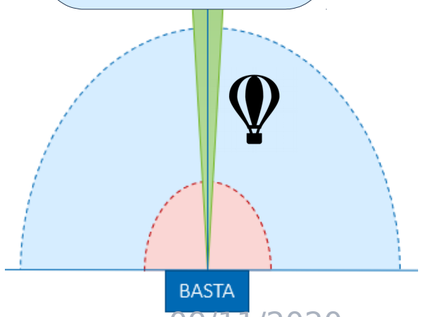


Side lobe condition 1: If the balloon is within the *Side lobe detection range 1* (the closest to the radar), then we erase data from the balloon position until 200m (16 gates) above.

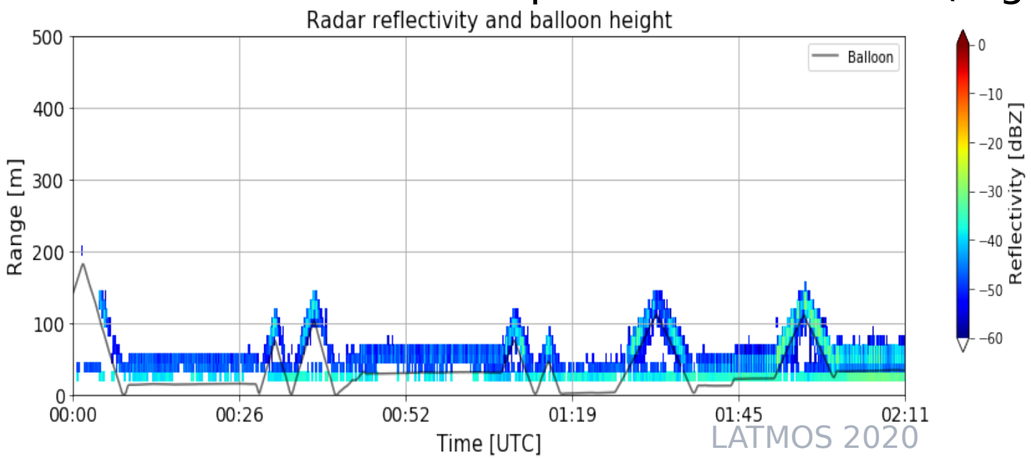


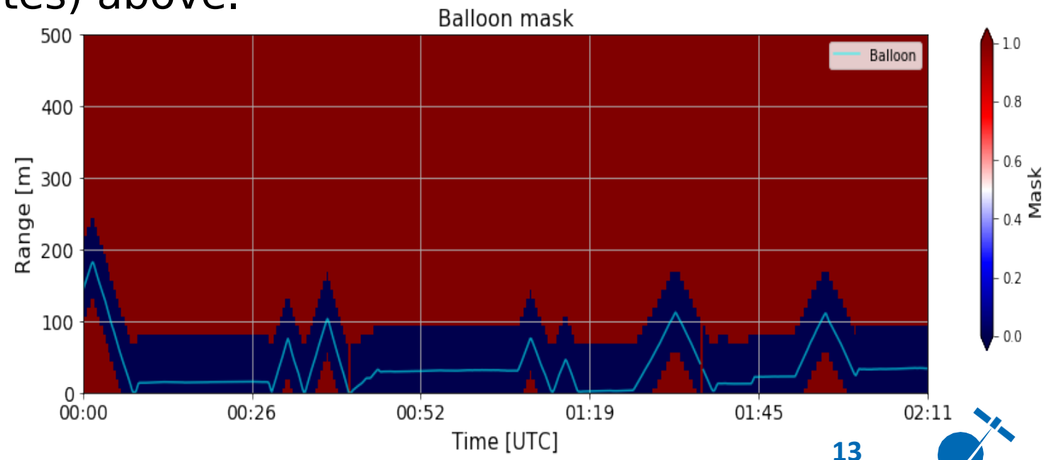


SIDE LOBE CONDITION 2



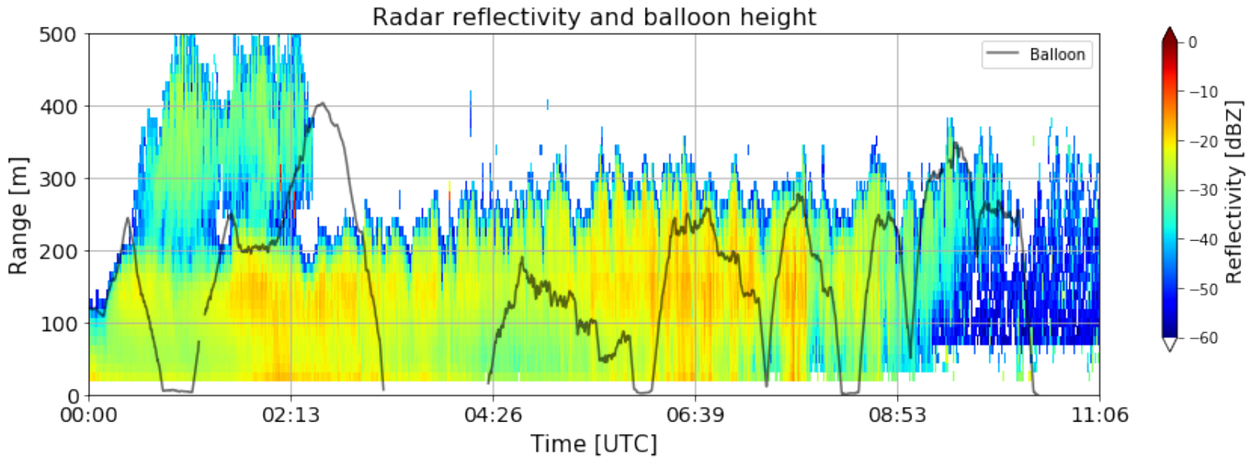
Side lobe condition 2: If the balloon is within the *Side lobe detection range 2*, then we erase data from the balloon position until 75m (6 gates) above.

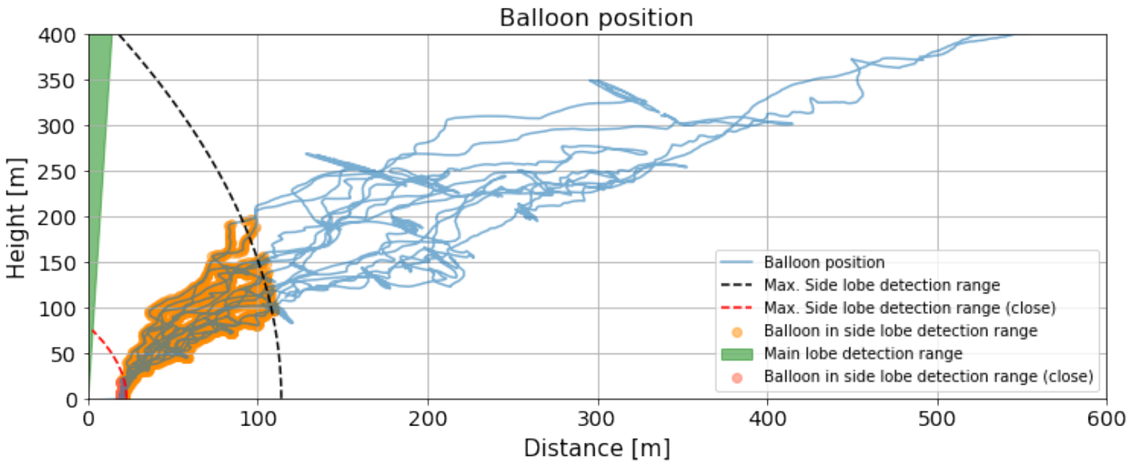




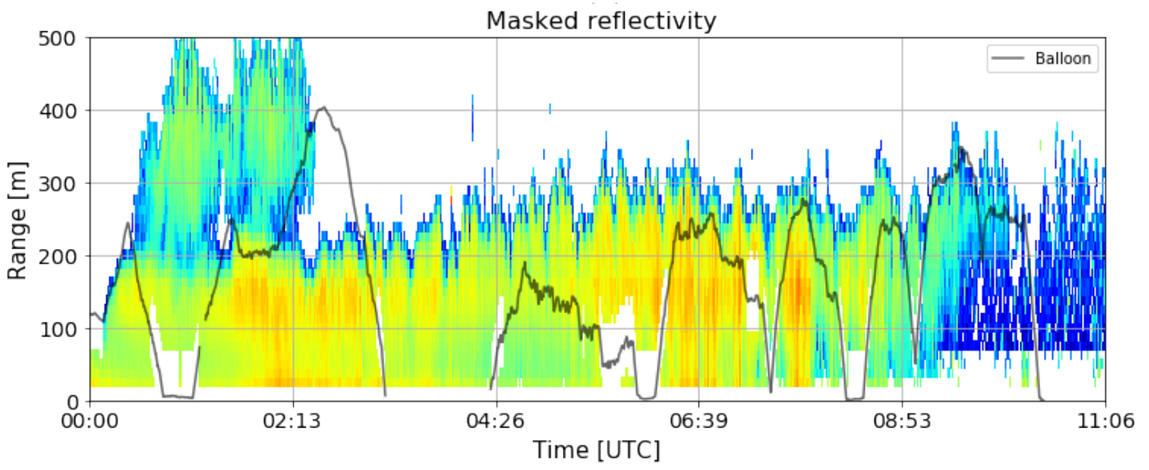
Results: POI 8th March 2020

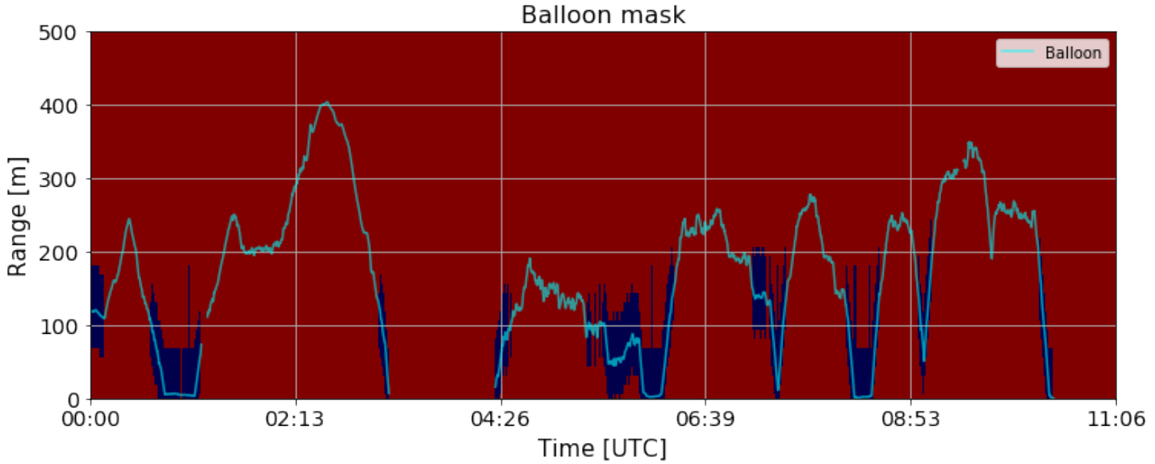
Radar reflectivity with L2 mask





Radar reflectivity with Balloon mask

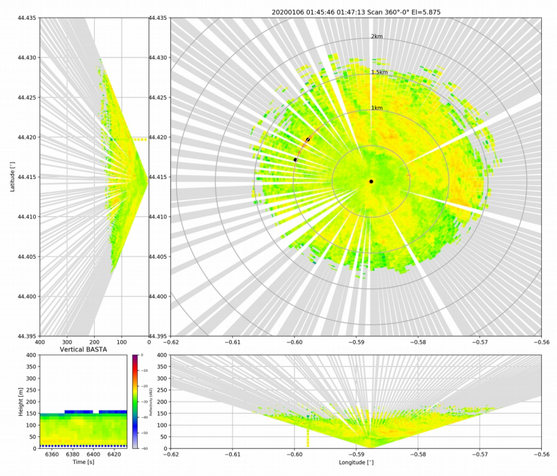




Retrieval development

Combination of 95 GHz cloud radar and MWR for Fog

Scanning BASTA SOFOG3D => 3D fog structure



Radar information
Vertical profile and 3D structure/dynamic

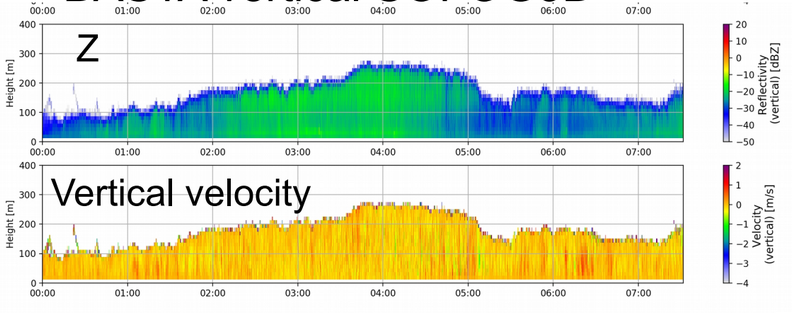
Radiometer information
LWP contraint

LWC profile and dynamic

LWC profile with better constraint and dynamic
Temperature & Humidity profiles : Improved cloud base inversion and humidity retrievals

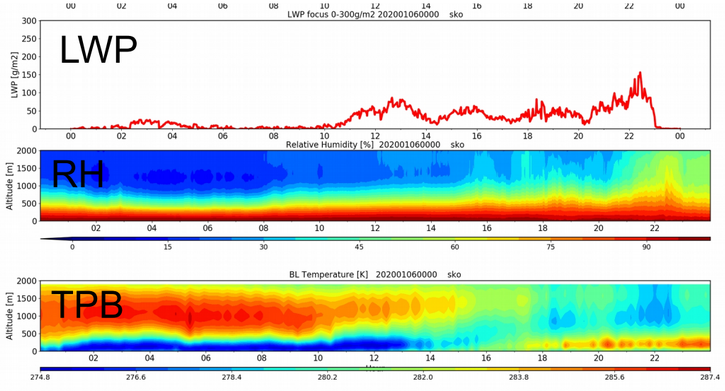
Temperature Humidity & Profiles

BASTA vertical SOFOG3D



Retrievals based on variational approach in development

HATPRO SOFOG3D



1st approach (more simple, should be operational fast) :

- account for attenuation
- dedicated forward model (devpt of new Z-LWC relationships)
- Z and MWR LWP included in the observation vector

2nd approach (developments necessary, more complex) :

- Z and MWR TB in the observation vector
- Constrained by a NWP model (currently the AROME model)
- Radar simulator and radiative transfer models used as forward models

LWC retrieval using BASTA(Z) and MWR(LWP)

- Z and LWC are related with a powerlaw equation

$$\mathbf{Z = a\ LWC^{b}}$$

$$\mathbf{\mathit{ln}Z = \mathit{ln}a + b{*}\mathit{ln}LWC}$$

- A retrieval algorithm with variational method to retrieve LWC and scaling factor lna.

$$Y = [lnZ_1, lnZ_2 \ldots, lnZ_n, lnLWP]$$

$$X = [lnLWC_1, lnLWC_2 \ldots, lnLWC_n, lna]$$

- Given Z and LWP information LWC in liquid cloud is retrieved by adjusting scaling factor for each profile.
- Apriori of *LWC* and *lna* is considered in the retrieval from empirical relation from literature.