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

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

# 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 Data Acquisition Mode

<table>
<thead>
<tr>
<th>Fixed Vertical</th>
<th>Scanning</th>
<th>Fixed Vertical</th>
</tr>
</thead>
<tbody>
<tr>
<td>12m5</td>
<td>12m5</td>
<td>25m</td>
</tr>
<tr>
<td>25m 18km</td>
<td></td>
<td></td>
</tr>
<tr>
<td>100m 18km</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

## Level of Data Treatment

<table>
<thead>
<tr>
<th>Reflectivity profile</th>
<th>Doppler Velocity profile</th>
<th>RHI Maps/PPI</th>
<th>Wind</th>
</tr>
</thead>
<tbody>
<tr>
<td>BASTA-mobile LATMOS (1s)</td>
<td>BASTA-mini CNRM (1s) BASTA-mini LATMOS (1s)</td>
<td>BASTA-mini CNRM (0.5s) BASTA-mini LATMOS (0.5s/1s)</td>
<td>BASTA-mini LATMOS (0.5s/1s)</td>
</tr>
</tbody>
</table>

09/11/2020

LATMOS 2020
Data 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.

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.
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
**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
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
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

Side lobe condition 1:

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.
**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:** 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 8\textsuperscript{th} March 2020

**Radar reflectivity with L2 mask**

**Radar reflectivity with Balloon mask**

**Balloon position**

**Masked reflectivity**

**Balloon mask**
Retrieval development
Combination of 95 GHz cloud radar and MWR for Fog

Radar information
Vertical profile and 3D structure/dynamic

Radiometer information
LWP constraint

LWC profile
and dynamic

LWC profile with better constraint
and dynamic

Temperature & Humidity profiles: Improved cloud base inversion and humidity retrievals

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

Retrievals based on variational approach in development
LWC retrieval using BASTA(Z) and MWR(LWP)

• Z and LWC are related with a powerlaw equation

\[ Z = a \ LWC^b \]

\[ \ln Z = \ln a + b \cdot \ln LWC \]

• A retrieval algorithm with variational method to retrieve LWC and scaling factor \( \ln a \).

\[ Y = [\ln Z_1, \ln Z_2, ..., \ln Z_n, \ln LWP] \]

\[ X = [\ln LWC_1, \ln LWC_2, ..., \ln LWC_n, \ln a] \]

• Given Z and LWP information LWC in liquid cloud is retrieved by adjusting scaling factor for each profile.

• Apriori of LWC and \( \ln a \) is considered in the retrieval from empirical relation from literature.