3D characterization of the fog microphysical properties during the SOFOG3D campaign and impacts on the fog life cycle: Observations and LES

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3D characterization of microphysical properties: observations and LES

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- **1st Part**: Data Analysis in order to document the fog microphysical properties

  Droplet size distribution (DSD) measured on 4 sites, tethered balloon, Unmanned Aerial Vehicles (UAV) …, synergy with Cloud Radar

- **2nd Part**: LES Simulations of the most documented IOP with Meso-NH thanks to grid-nesting up to 5m resolution

  Validation and sensitivity tests

- Process Studies to analyze the key processes that explain the microphysical evolution during the fog life cycle.

  Especially:
  - Impact of surface heterogeneities on the fog microphysical properties
  - Role of microphysics during the transition between an optically thin and thick fog.
  - Impact of entrainment and turbulent mixing at the top.
In Situ Microphysics : Plan

I) Optical Particle Counter

II) Overview IOP 11 and 14

III) Adding Turbulence Probe

IV) Data Analysis IOP 11 and 14
I) Optical Particle Counter

Overview:

- Welas and Fog Monitor on the ground
- Focus on Cloud Droplet Probe (CDP)
- Modified version for tethered balloon

Issue with the air sampling speed

CDP data analysis on IOP 11 and 14
Cloud Droplet Probe Description and Calibration

- Based on Mie Scattering
- Covers a diameter range from 2 to 50 µm
- Possesses 30 size classes
- Relevance of Calibration

CDP Components

- Rayleigh Scattering
- Mie Scattering
- Scattering larger particles

Mie Scattering

Calibration with pollen (20 µm) during IOP 11 (left) and IOP 14 (right)
II) Overview IOP 11 and 14

IOP 11 : 7-8th February 2020
Pressure Evolution

IOP 14 : 8-9th March 2020
Pressure Evolution

Radar Reflectivity from BASTA

Need to divide into ascents, descents and constant height sections
II) Overview IOP 11 and 14

Need to take wind speed into account, measured by the turbulence probe
Calculating a new air speed

- Initially: Constant air speed fixed to 10 m/s
- Reduce to 5 m/s to take wind speed into account

Concentration = \( \frac{N_{\text{particles}}}{V_{\text{sampling}}} \)

Where \( V_{\text{sampling}} = S_{\text{sampling}} \cdot V_{\text{air}} \)

With \( V_{\text{air}} = \begin{cases} 10 \\ 5 + FF_{\text{probe}} \end{cases} \)
IV) New Overview with wind speed taken into account

IOP 11 Overview

IOP 14 Overview
Filtering by Ascent and Descent : IOP 11

Liquid Water Content Vertical Profiles of all ascents and descents during IOP 11
Focus on one Consecutive Ascent/Descent: IOP 11

**Descent:** 01h25/01h41

**Ascent:** 01h40/2h03

**LWP ~ 10.7**

**LWP ~ 13.6**

Pressure Evolution
Filtering by Constant Height Section: IOP 11

Focus on Diameter

Focus on Liquid Water Content

POI 2020-2-8_21h56-7h28: Palier
Focus on two Constant Height Sections: IOP 11

**Constant Height Section 00h57/01h22**

**Constant Height Section 03h37/04h16**

Pressure Evolution
Filtering by Ascent and Descent: IOP 14

Liquid Water Content Vertical Profiles of all ascents and descents during IOP 14
Focus on one Consecutive Ascent/Descent: IOP 14

Pressure Evolution

- Ascent: 01h06/1h33
  - LWP ~ 23.8

- Descent: 00h24/00h49
  - LWP ~ 34.5
Filtering by Constant Height Section: IOP 14

Focus on Diameter

Focus on Liquid Water Content
Focus on two Constant Height Sections: IOP 14

**Constant Height Section 23h45/00h09**

**Constant Height Section: 01h38/02h08**

*Pressure Evolution*
Summary and Future Work

- **Summary:**
  
  - Need to take wind speed into account
  
  - Significant variability of the droplets distribution in a short time frame temporally (constant height sections) and vertically (ascents and descents)

- **Future Work:**
  
  - Data Analysis from IOP 6 (5 to 6th January 2020) with wind speed taken into account
  
  - Validation with other OPC on the ground (Fog Monitor/Welas and Visibilimeter) and aloft (45m high Tower)
  
  - Comparison with Liquid Water Path from the Microwave Radiometer.
  
  - Compute statistics on Tethered Balloon and Ground Measurements on the 4 sites in order to explore the microphysics 3D heterogeneities.