



**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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Supervision : F.Burnet, C.Lac

3D characterization of microphysical properties : observations and LES

FCPLR Théophane Costabloz. Supervision: F. Burnet, C. Lac

- 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

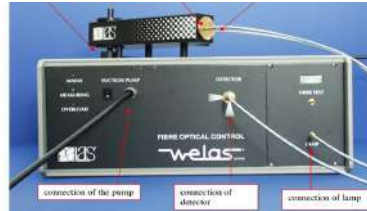
IV) Data Analysis IOP 11 and 14

I) Optical Particle Counter

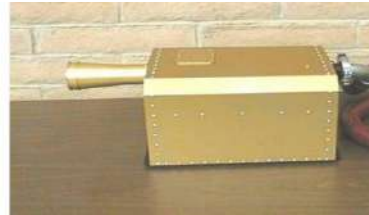
Overview :



Cloud Droplet Probe



Welas



Fog Monitor

- Welas and Fog Monitor on the ground
- **Focus on Cloud Droplet Probe (CDP)**
- Modified version for tethered balloon
➔ Issue with the air sampling speed

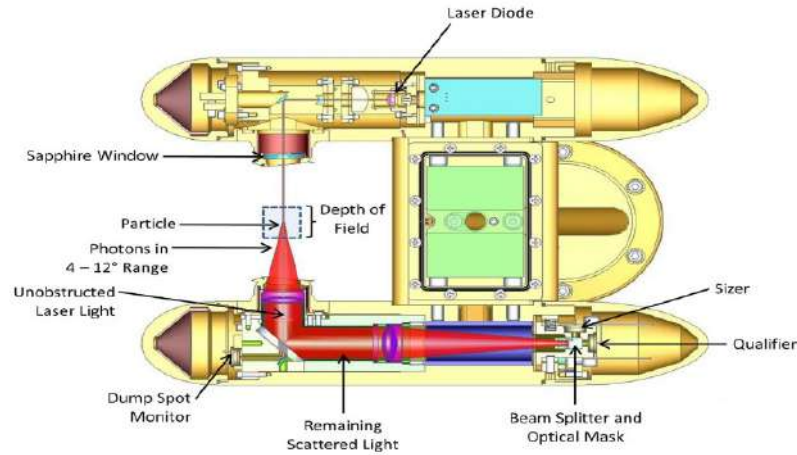


CDP on tethered balloon

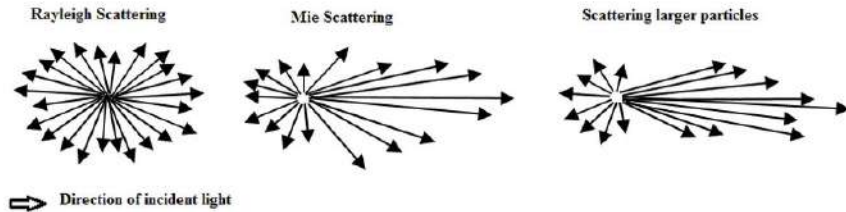
CDP data analysis on IOP 11 and 14

Cloud Droplet Probe Description and Calibration

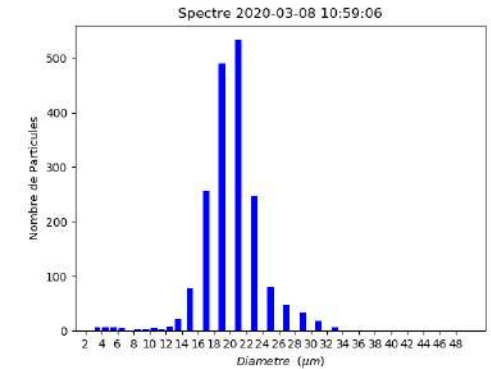
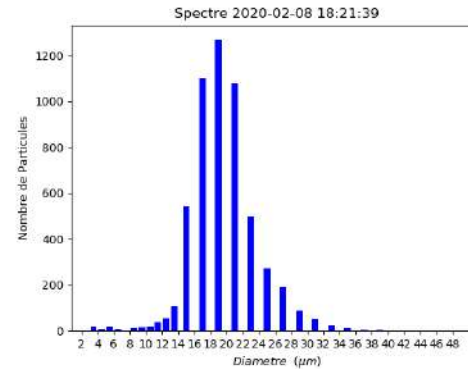
- Based on Mie Scattering
- Covers a diameter range from 2 to 50 μm
- Possesses 30 size classes
- Relevance of Calibration



CDP Components



Mie Scattering

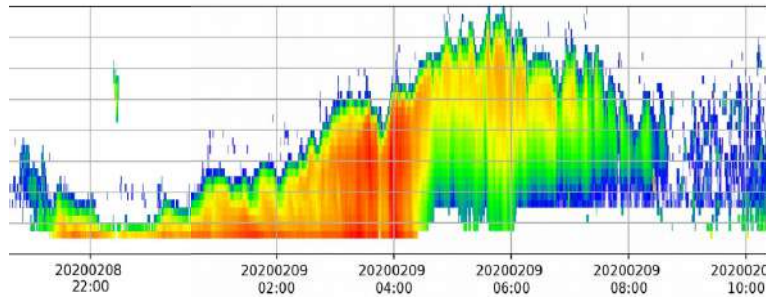
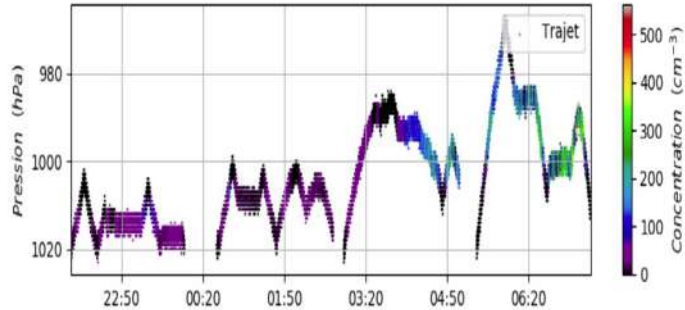


Calibration with pollen (20 μm) during IOP 11 (left) and IOP 14 (right)

II) Overview IOP 11 and 14

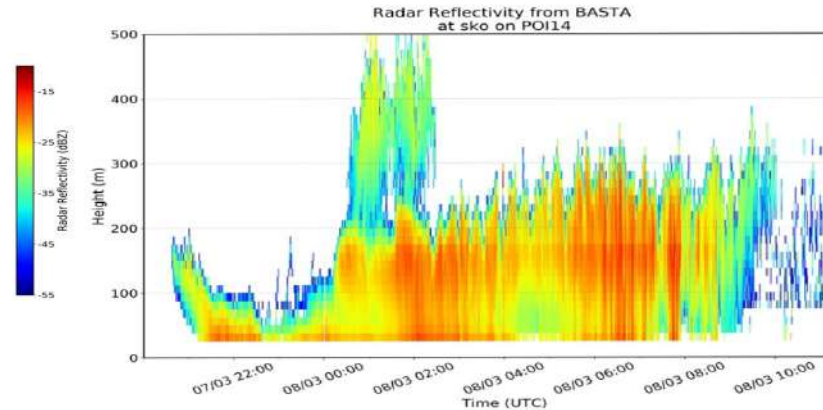
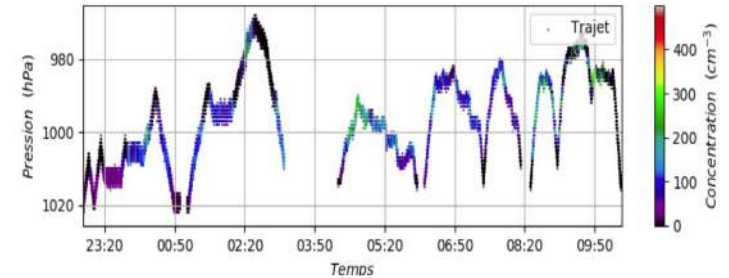
IOP 11 : 7-8th February 2020

Pressure Evolution



IOP 14 : 8-9th March 2020

Pressure Evolution



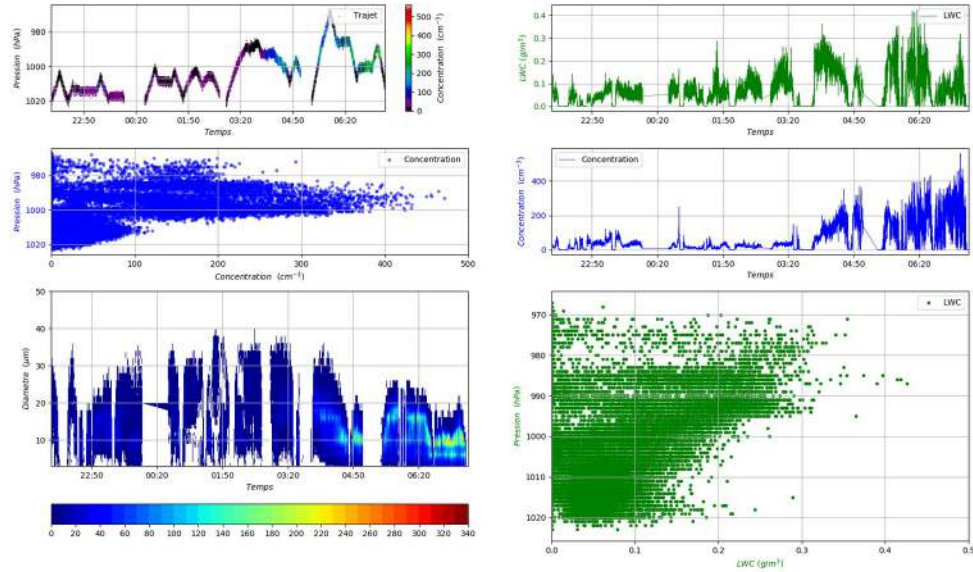
Radar Reflectivity from BASTA

➡ Need to divide into ascents, descents and constant height sections

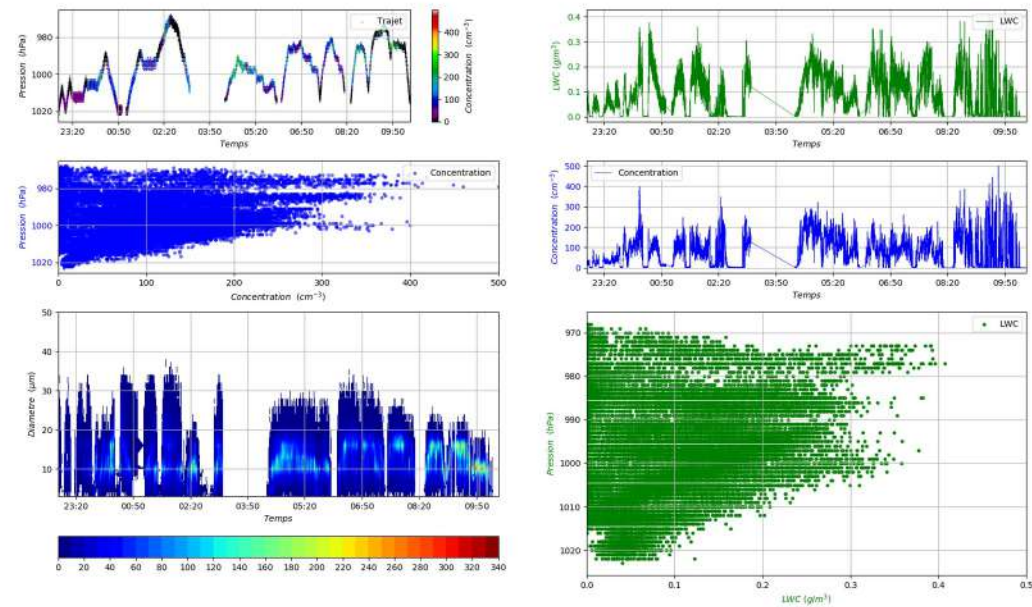
II) Overview IOP 11 and 14

POI 2020-2-8_21h54-7h28

POI 2020-3-7_22h52-10h24



IOP 11 Overview



IOP 14 Overview

➡ Need to take wind speed into account, measured by the turbulence probe



Tethered Balloon

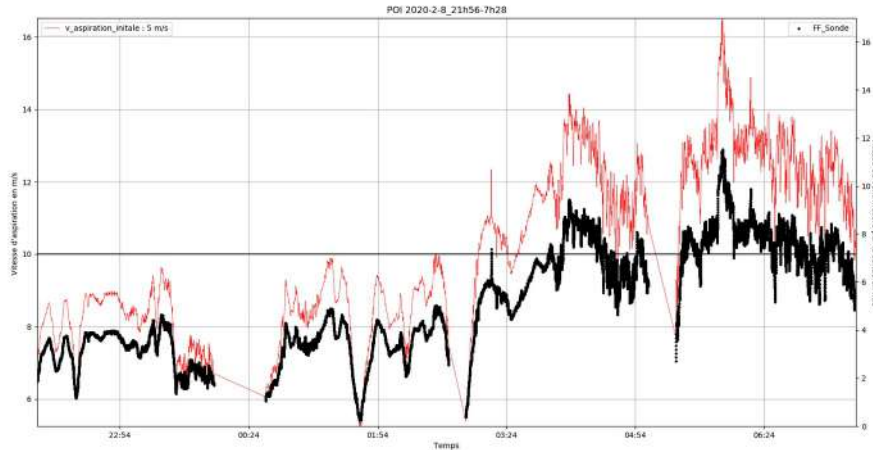
Calculating a new air speed

- Initially : Constant air speed fixed to 10 m/s

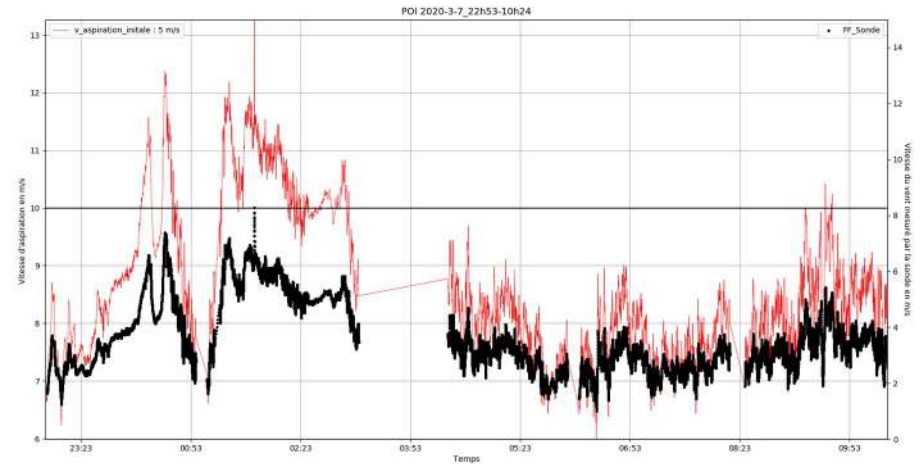
$$\text{Concentration} = \frac{N_{\text{particles}}}{V_{\text{sampling}}}$$

$$\text{Where } V_{\text{sampling}} = S_{\text{sampling}} V_{\text{air}}$$

$$\text{With } V_{\text{air}} = \left\{ \begin{array}{c} 10 \\ 5 + FF_{\text{probe}} \end{array} \right\}$$



IOP 11 : Wind and Suction Speed Evolution



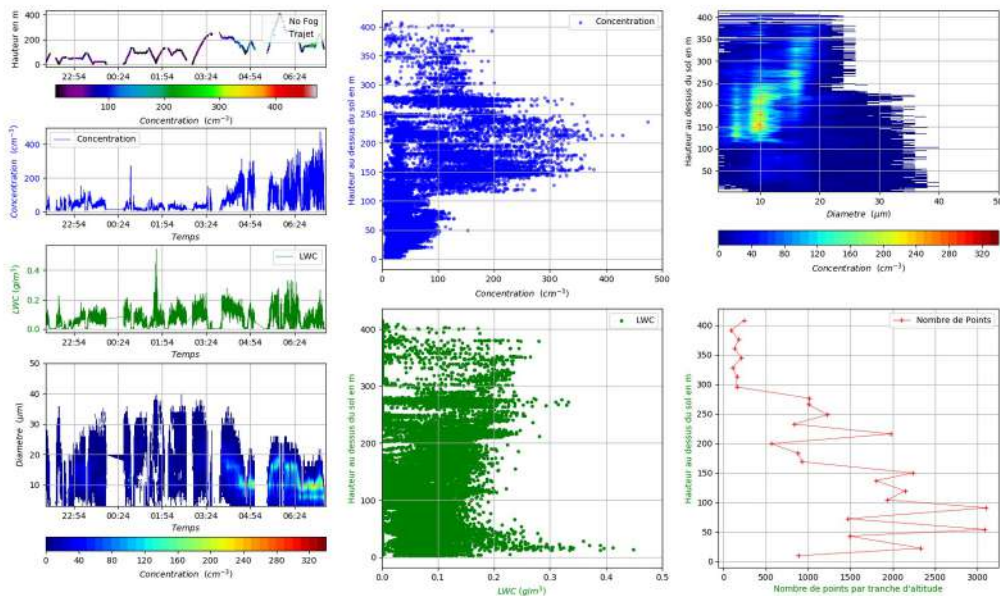
IOP 14 : Wind and Suction Speed Evolution

- Reduce to 5m/s to take wind speed into account

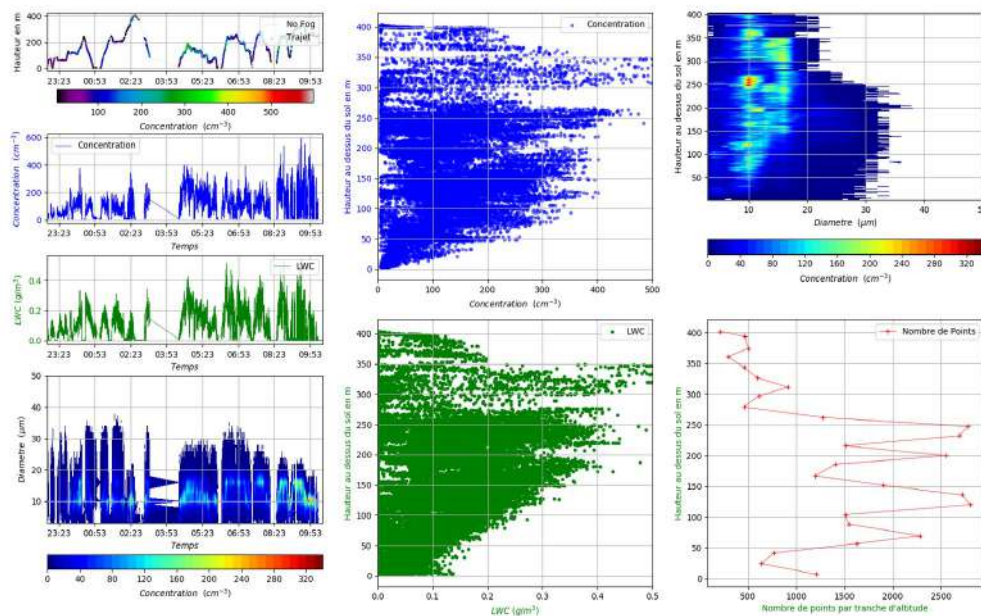
IV) New Overview with wind speed taken into account

POI 2020-2-8_21h56-7h28

POI 2020-3-7_22h53-10h24

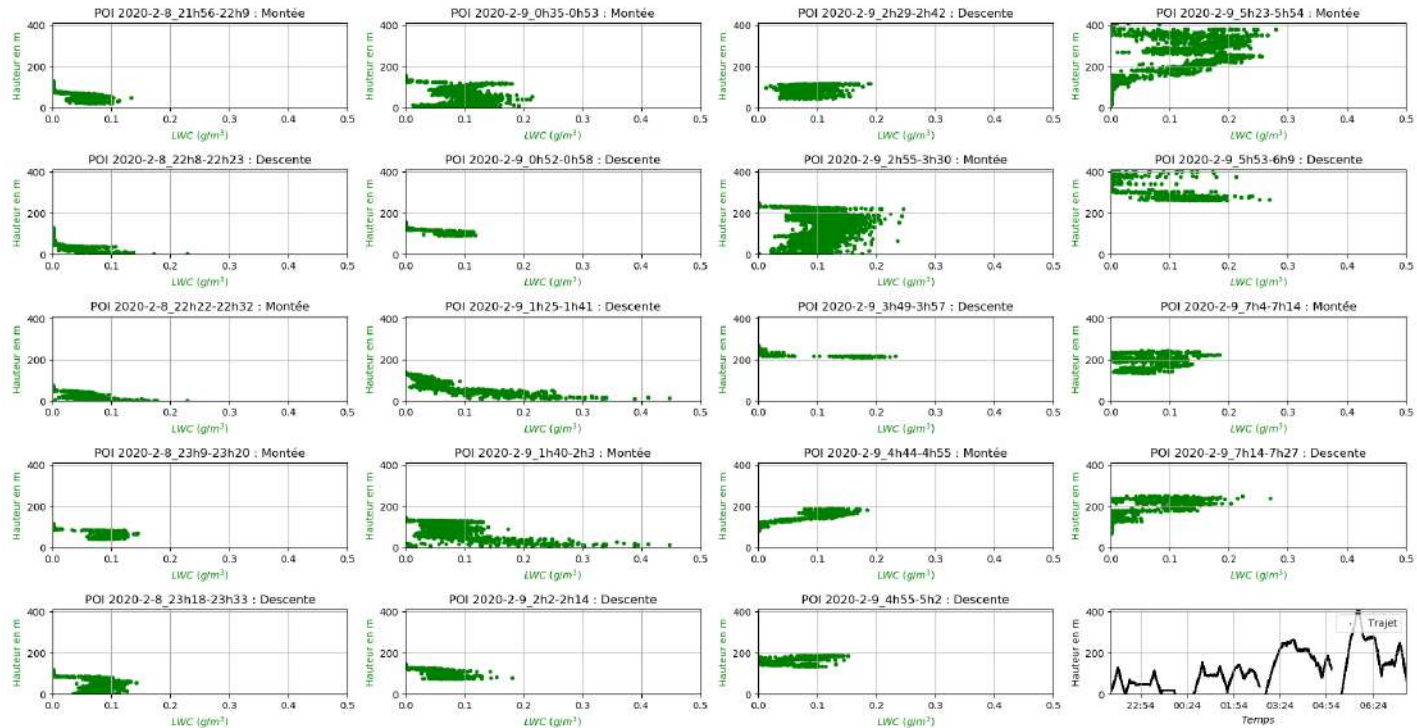


IOP 11 Overview



IOP 14 Overview

Filtering by Ascent and Descent : IOP 11

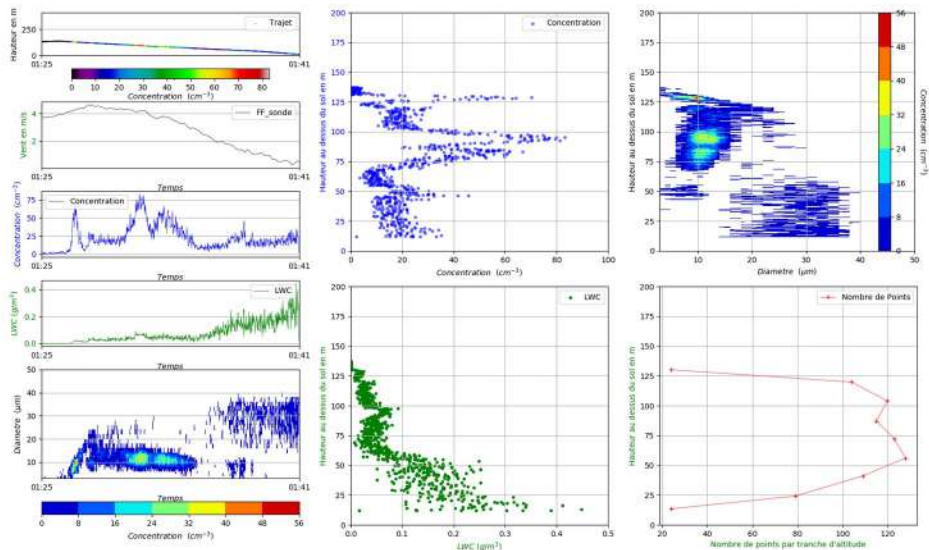


POI 2020-2-8_21h56-7h28

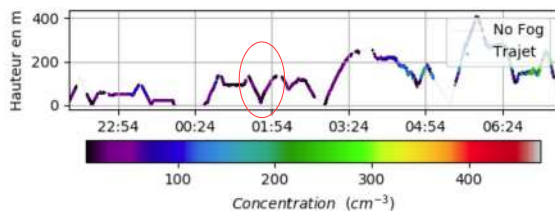
Liquid Water Content Vertical Profiles of all ascents and descents during IOP 11

Focus on one Consecutive Ascent/Descent : IOP 11

POI 2020-2-9_1h25-1h41
LWP ~ 10,7



Descent : 01h25/01h41

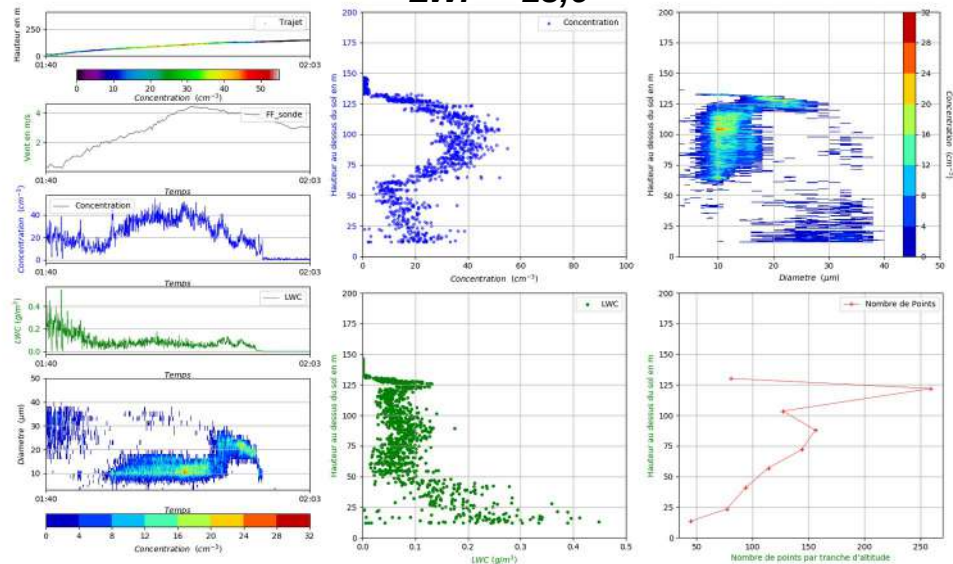


Pressure Evolution

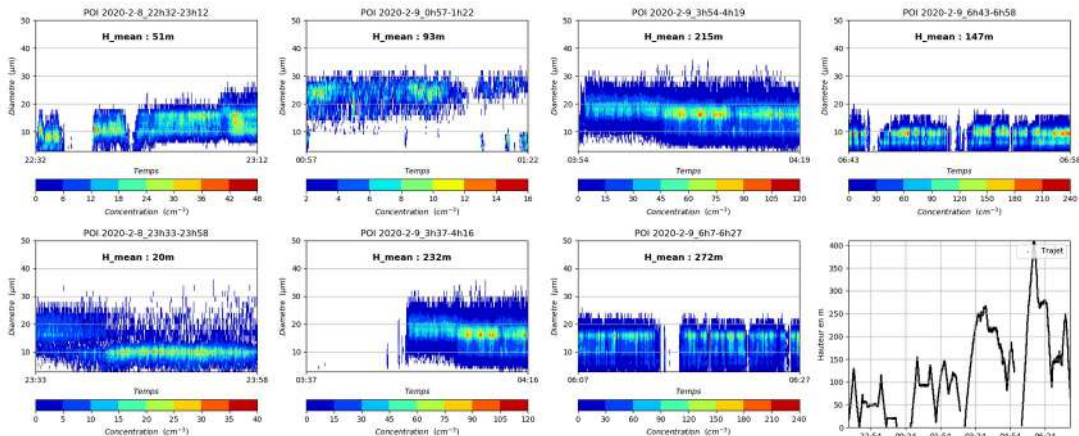
Ascent : 01h40/2h03

POI 2020-2-9_1h40-2h3

LWP ~ 13,6



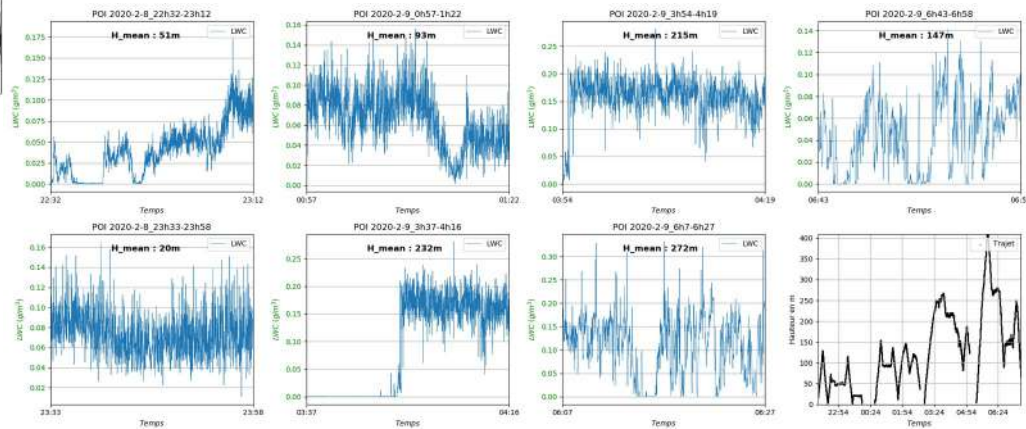
Filtering by Constant Height Section : IOP 11



POI 2020-2-8_21h56-7h28 : Palier

Focus on Diameter

Focus on Liquid Water Content



POI 2020-2-8_21h56-7h28 : Palier

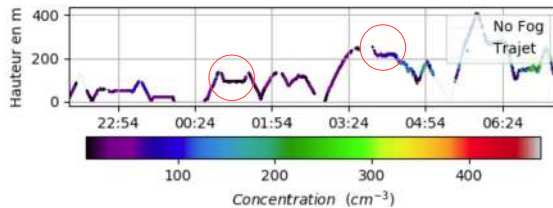
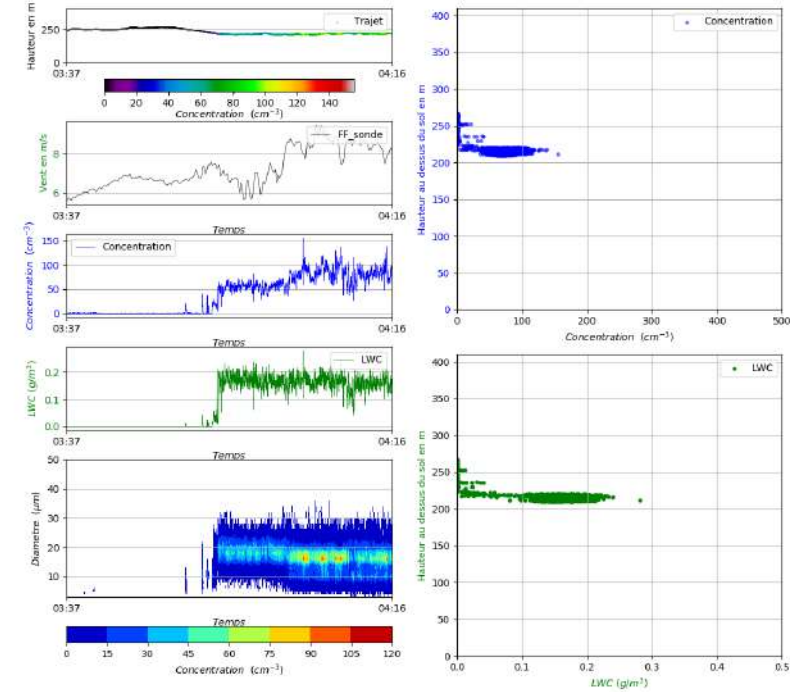
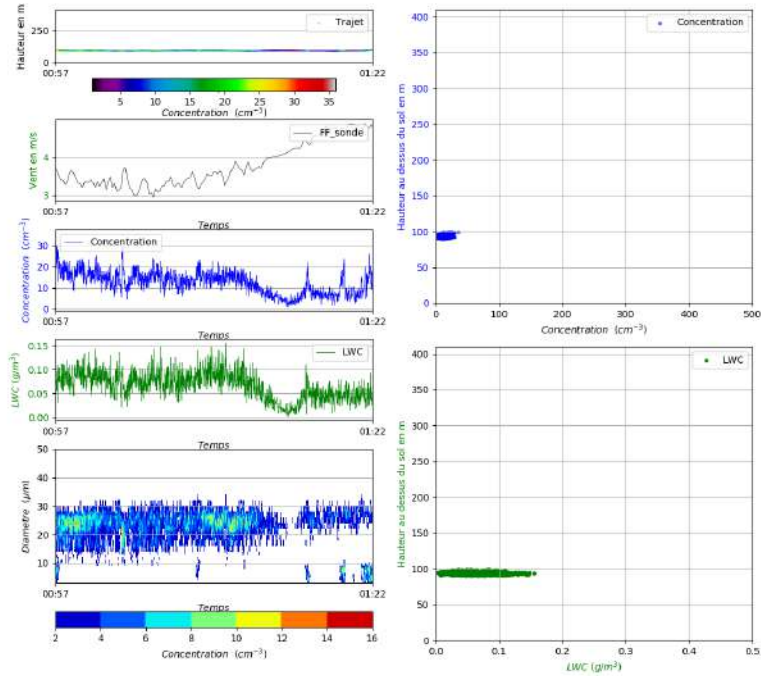
Focus on two Constant Height Sections : IOP 11

POI 2020-2-9_0h57-1h22

Constant Height Section 00h57/01h22

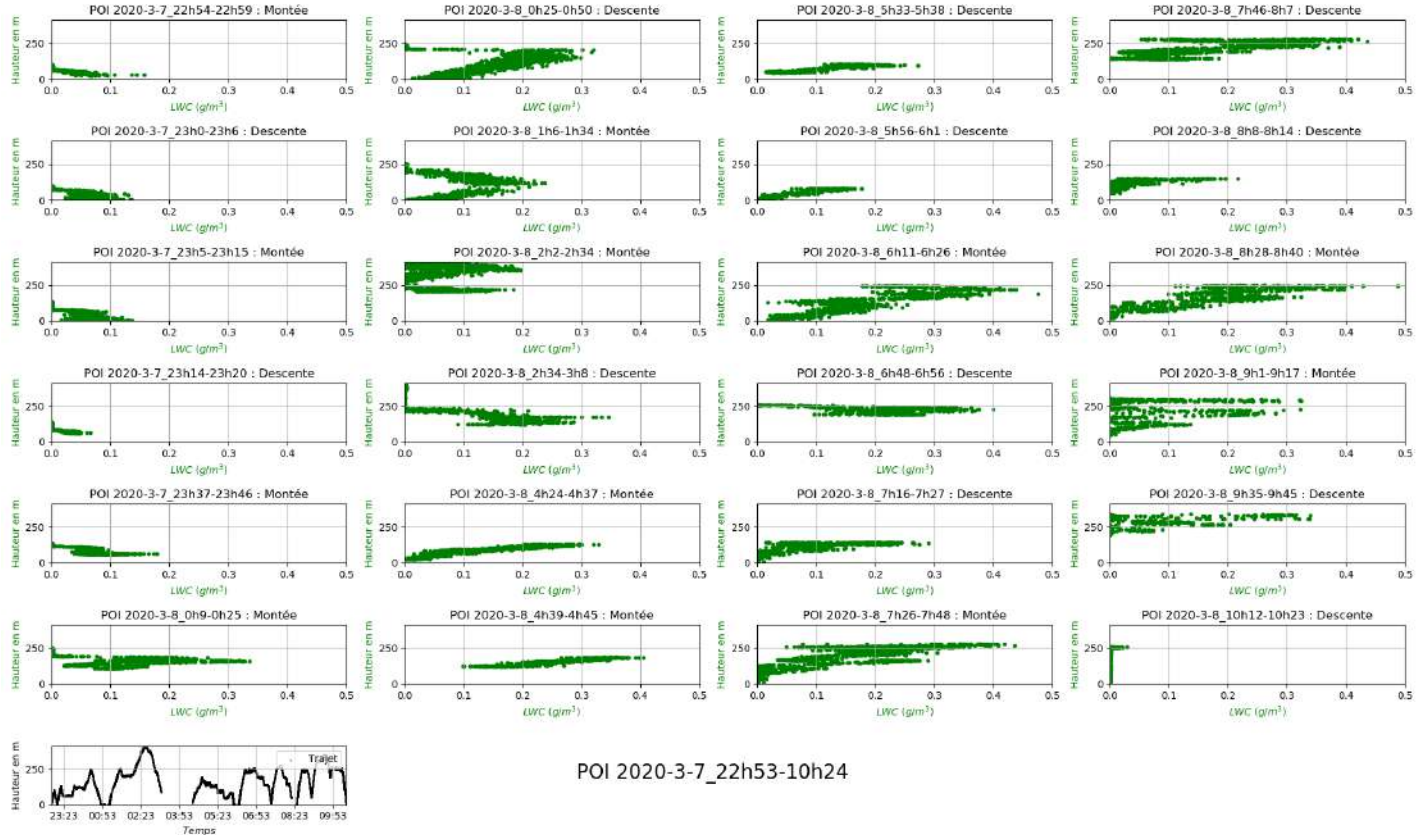
POI 2020-2-9_3h37-4h16

Constant Height Section 03h37/04h16



Pressure Evolution

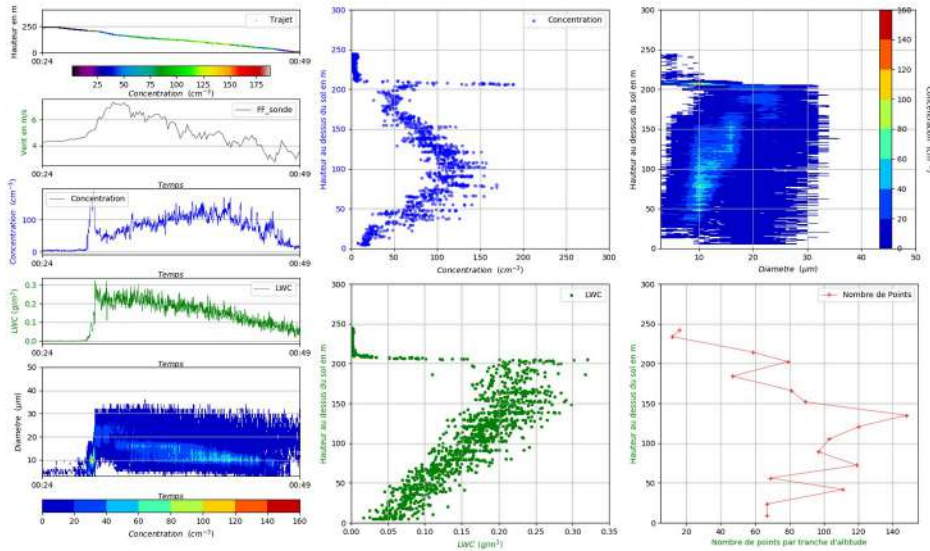
Filtering by Ascent and Descent : IOP 14



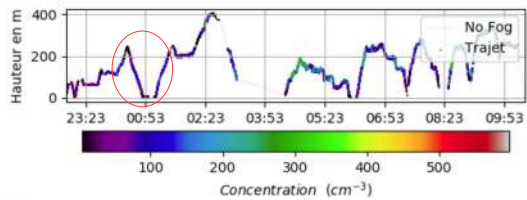
Liquid Water Content Vertical Profiles of all ascents and descents during IOP 14

Focus on one Consecutive Ascent/Descent : IOP 14

POI 2020-3-8_0h24-0h49
LWP ~ 34,5



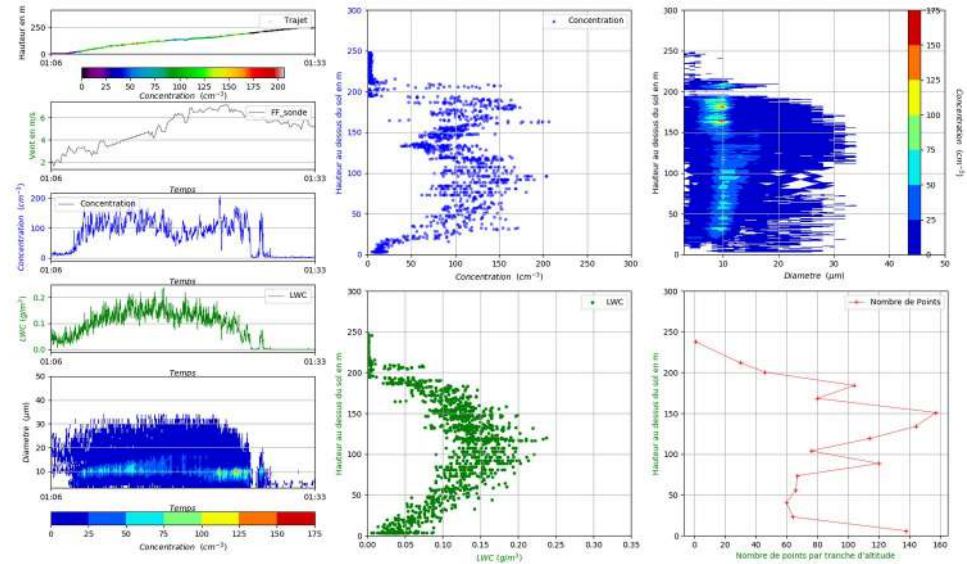
Descent : 00h24/00h49



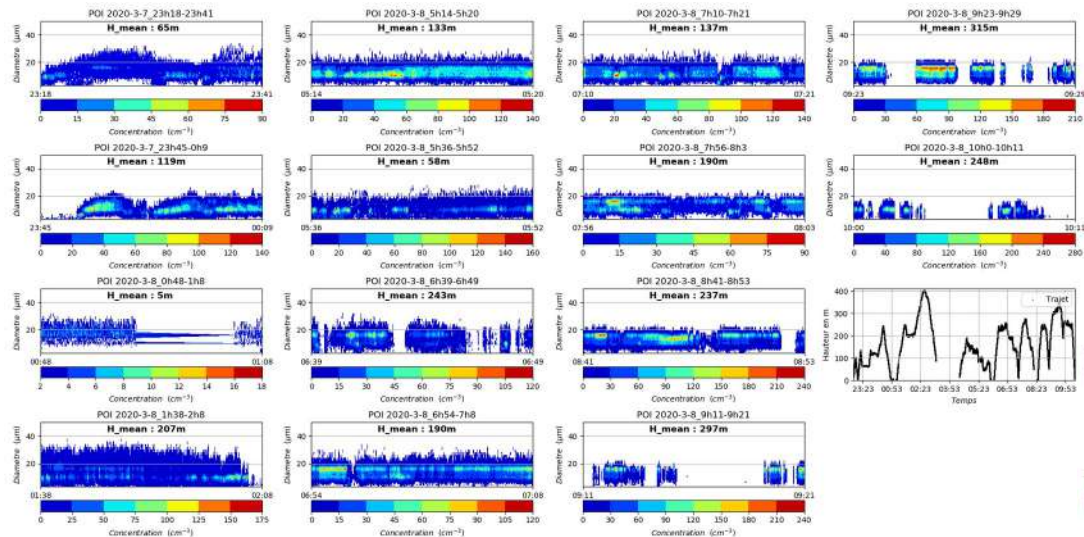
Pressure Evolution

Ascent : 01h06/1h33

POI 2020-3-8_1h6-1h33
LWP ~ 23,8



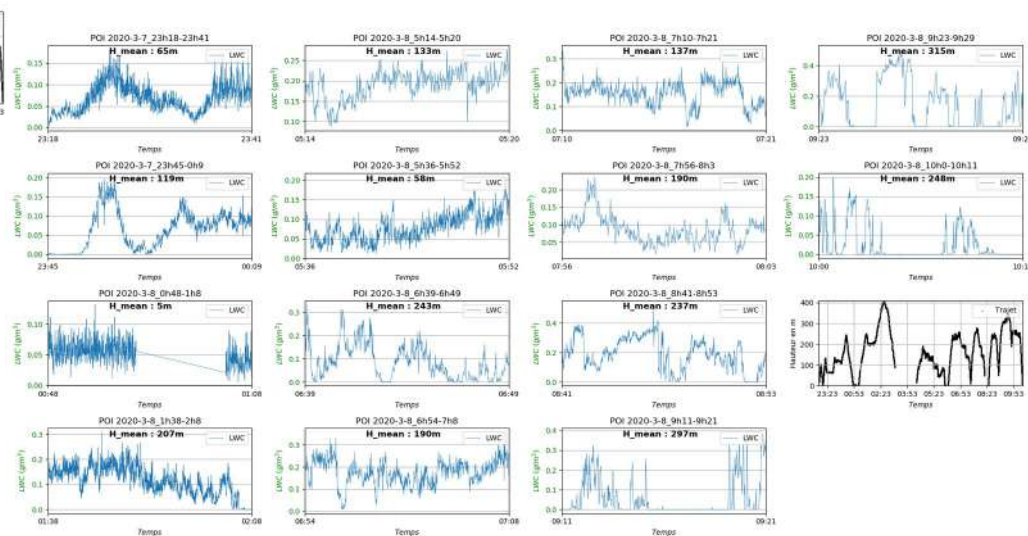
Filtering by Constant Height Section : IOP 14



POI 2020-3-7_22h53-10h24 : Palier

Focus on Diameter

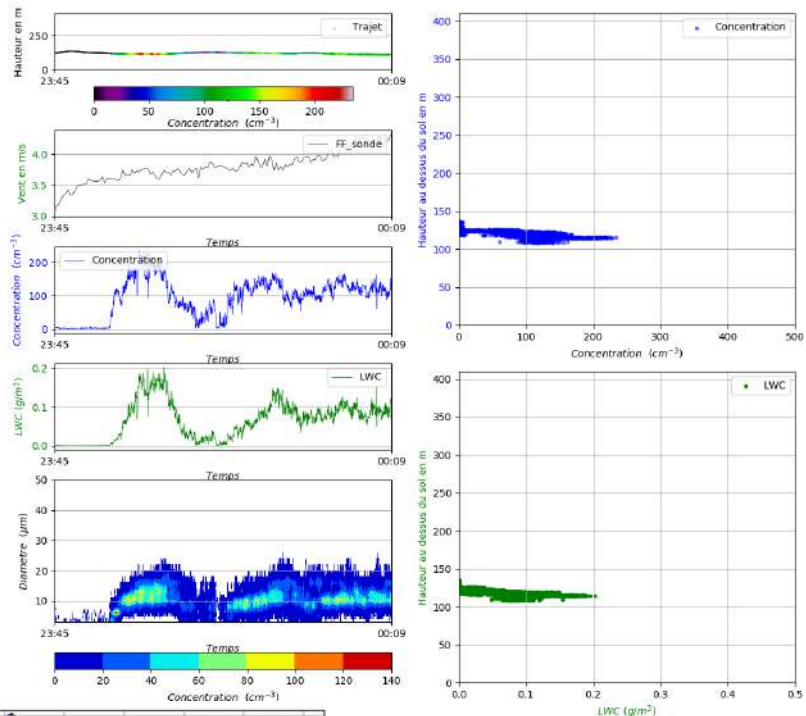
Focus on Liquid Water Content



Focus on two Constant Height Sections : IOP 14

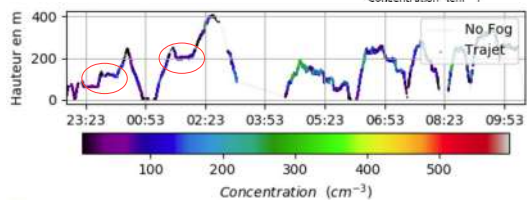
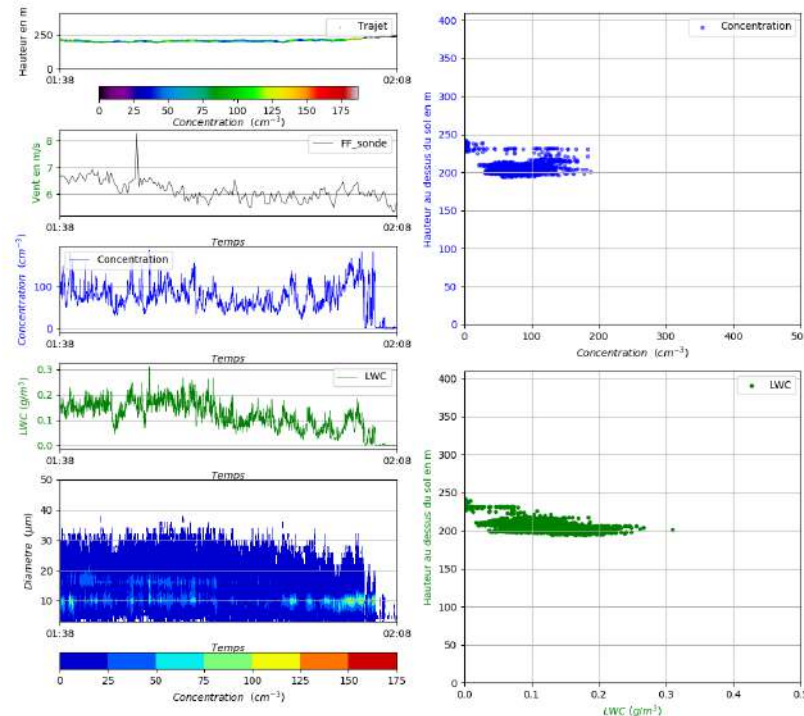
POI 2020-3-7_23h45-0h9

Constant Height Section 23h45/00h09



POI 2020-3-8_1h38-2h8

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.