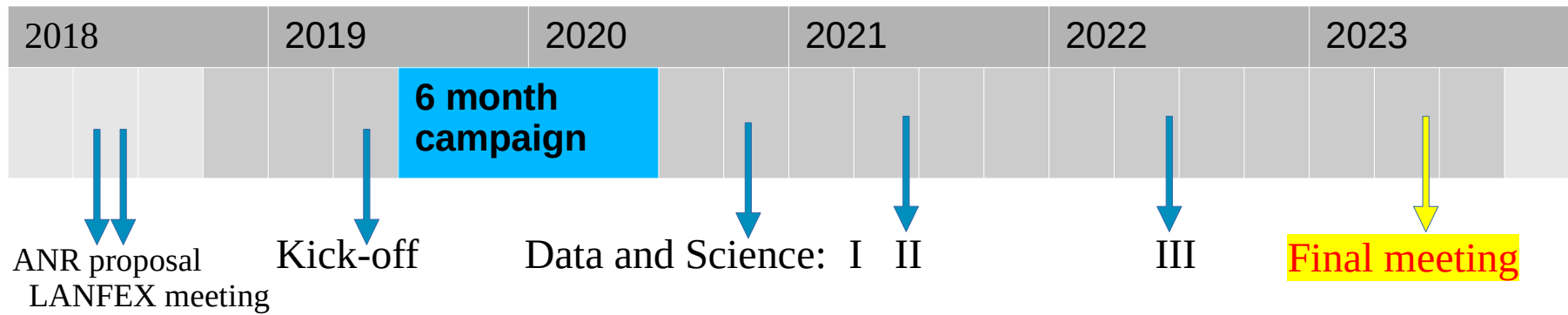# SOFOG3D Final Meeting

Main objective : review main results obtained so far and discuss plans for future projects.

- End of the project on Sept. 30, 2023

2018	2019	2020	2021	2022	2023

6 month campaign

ANR proposal
LANFEX meeting   Kick-off   Data and Science: I   II   III   Final meeting

— report of the project : what have we done ? deliverables status

— What to do after ? Data to work for 10 years … new projects ?

  ‣ Discussion session this afternoon (IFDA conference this summer)

- High **Impact of fog on transport :**
  — Specific research action started at Météo France (COP 2017-2021)
    ‣ **Development of a high resolution version of the NWP model AROME-500m**
  — **SOFOG3D field experiment and ANR project** :
    ‣ Evaluation of AROME-500 fog forecasts
    ‣ Improve our understanding of fog processes to derive refined parametrizations
       => **3D high resolution LES simulations & experimental studies**
    ‣ New data assimilation trials

SOFOG3D Final Meeting : Agenda

Main objective : review main results obtained so far and discuss plans for future projects.

- 9h30 : Intro - update on the project - F. Burnet (15')
        Update on the AERIS database – round table of data providers if needed.
- 9h45 : Task 1 report - F. Burnet (20)
- 10h05 : In situ microphysics and tethered balloon measurements - PhD T. Costabloz (30)
- 10h35 : Radiative closure - Intership A. Veau (15)
- 10h50 : coffee break (20)

- 11h10 : Observations of fog droplet deposition at Le Couye - J. Price (15)
- 11h25 : Radar measurements - Task 2 report - J. Delanoë (15)
- 11h40 : AROME forecast report - PhD S. Antoine /Y. Seity /R. Honnert (20)
- 12h00 : UKMO UM report - A. Mccabe / J. Price (20)
- 12h30 : lunch break (1h30)

- 14h00 : Impact of heterogeneities - M. Taufour (20)
- 14h20 : Contrasting the evolution of radiation fog over a heterogeneous region - J. Thornton (20)
- 14h40 : Task 3 report - C. Lac (10)
- 14h50 : Role of thermodynamics and turbulence processes on the fog life cycle – C. Dione (20)
- 15h10 : Fog formed by Stratus lowering - M. Fathalli (20)
- 15h30 : Task 4 report - M. Haeffelin / C. Lac (10)
- 15h40 : coffee break (20)

- 16h00 : **General discussion** :
        future analysis, prospective for future project and experiment (1h30)

https://bluejeans.com/407939251/1326

Review of the past year

- **Last Data and Science meeting III - 07/06/2022**
  - 12 talks ~ 25 people with ACCORD participants => see **http://www.umr-cnrm.fr/spip.php?article1086**
  - Data analysis : MWR network, Radar, aerosol and fog microphysics, LWC deposition at the MO site,...
  - Evaluation of AROME and UM models, 3D LES and heterogeneities, life cycle of developped fogs,...
- **1 PhD defense** (March 2023) : Salomé Antoine – **congratulations !!**
  - Improvement of fog forecast with AROME-500 (WAF-D-22-0071 - In review)
- **1 PhD in progress** (May 2024) : Théophane Costabloz
  - In situ microphysics and tethered balloon measurements
- **Post doc positions**
  - M. Taufour (12/2022) : 3D high-resolution LES with Meso-NH (C. Lac)
  - C. Dione (03/2023) : thermodynamics and turbulence processes on the fog life cycle (M. Haeffelin/ C. Lac)
  - M. Fathalli (11/2023) : St lowering fog (obs and simu) (F. Burnet / C. Lac / P. Martinet)
- **Master internship** : A. Veau : radiative closure (Q. Libois)
- **Conferences** : (please send me relevant info if any)
  - JSS 2022, EGU 2023, IFDA 2023, others ??
- **3 babies** : Agathe (P. Martinet), Hazel (J. Thornton) and Simeon (Q. Libois) - **congratulations !!**

Publication list

- **Already on-line published :**   (See **http://www.umr-cnrm.fr/spip.php?article1086)**

  — Bell A. et al. : An Optimal Estimation Algorithm for the Retrieval of Fog and Low Cloud Thermodynamic and Micro-physical Properties, AMT, 15, 5415–5438, 2022.

  — Marquet, P. et al. : conservative thermodynamic variables in data assimilation: a case study using ground-based MWR measurements, AMT, 15, 2021-2035, 2022.

  — Martinet, P., et al. : MWR data paper : Database of temperature, humidity and LWP retrievals from a fog dedicated network of ground-based MWR", Bull. of Atmos. Sci. and Technology, 3, 6 (2022).

  — Vishwakarma, P., et al. : Climatology of estimated liquid water content and scaling factor for warm clouds using radar–microwave radiometer synergy, AMT, 16, 1211–1237, 2023.

- **Submitted / In review :**

  — Antoine, S., et al. : Evaluation of an improved AROME configuration for fog forecasts during the SOFOG3D campaign. Weather and forecasting, WAF-D-22-0215, in review

  — Thornton, J., et al. : Contrasting the evolution of radiation fog over a heterogeneous region in south-west France during the SOFOG3D campaign. QJRMS, in review, 2023.

  — Dione, C., et al. : Role of thermodynamic and turbulence processes on the fog life cycle during SOFOF3D experiment, EGUsphere [preprint], ACP, 2023, just submitted.

- **In preparation :**

  — Impact of MWR assimilation on AROME fog forecasts : G. Thomas / P. Martinet

  — Microphysics vertical profile and thin to thick transition : T. Costabloz / F. Burnet

  — Impact of heterogeneity and high resolution Meso-NH simulations : M. Taufour / C. Lac

  — UKMO modelling work : A Mccabe et al.

  — Overview of the campaign and main highlights : F. Burnet / all PI

        => work on it this summer before IFDA conference => fall 2023

  — MWR retrieval inter-comparison : P. Martinet + Univ. Cologne

The database on AERIS

- **End of embargo in september** (data policy)
  - Open to everyone – no information of usage...
- **complete the database** and projet information
- https://sofog3d.aeris-data.fr/catalogue/
- AERIS contact : Damien Boulanger
  (damien.boulanger@obs-mip.fr)
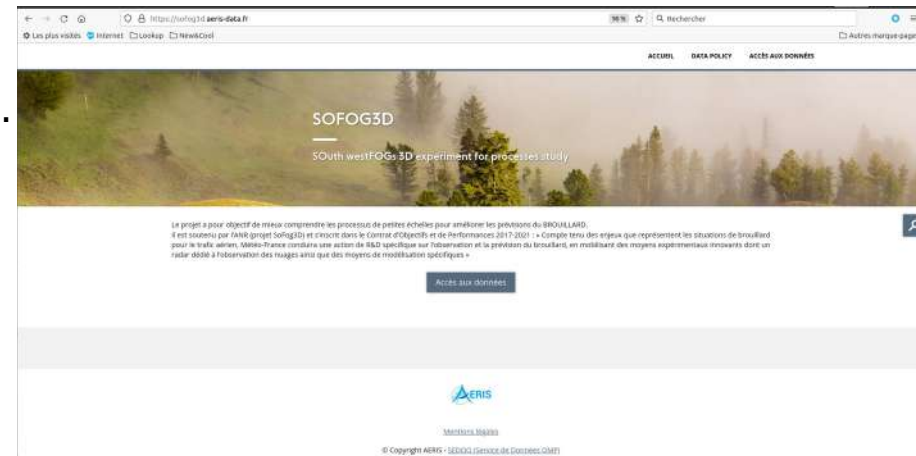
- Data deposit on the ftp site :
  => need to add __UUID at the end of the final repository name

- uuid provided by AERIS
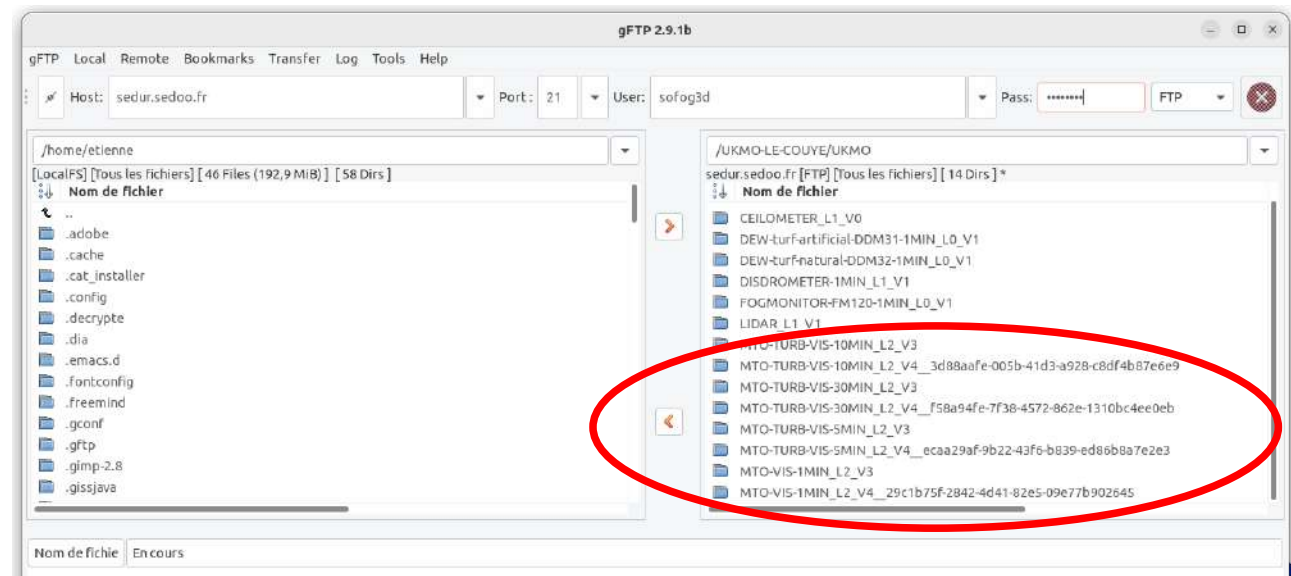
The database on AERIS

- Data deposit : need to add __UUID at the end of the final repository name

  => UUID is provided in the interoperability tab

Tethered balloon temperature bias

- Discrepancy between RS and tethered balloon temperature
- Comparison with reference probes in January : inside and outside
  => **underestimation of 2.2 C**
- But uncertainties still remains => Theophane talk

(J.C. Etienne - GMEI/TRAMM)
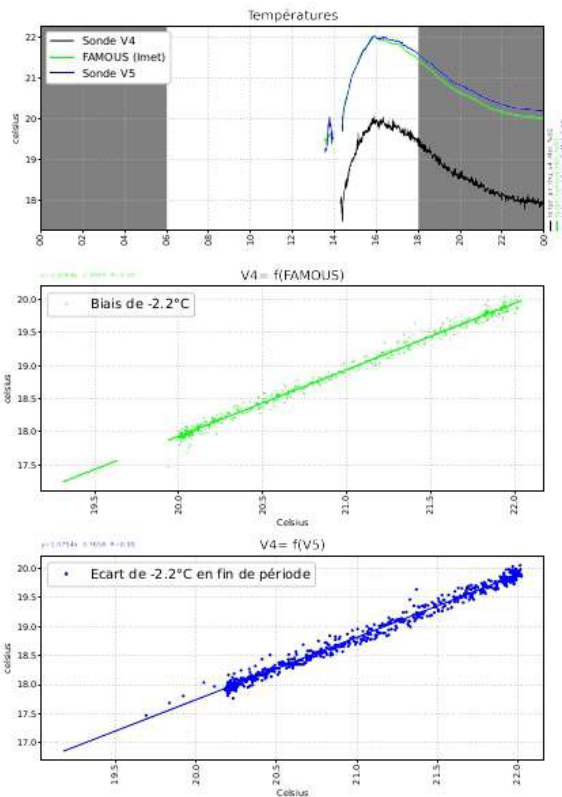
- Installation de la V4 et la V5 près du mât Météopole Flux.

- Mesure d'une t° tempé donnée par la sonde FAMOUS en plus de la Tempé de la sonde turbulente V5

- Fonctionnement de la V4 de 14h à 22h le 03/01/23 (arrêt dû à un pb batterie).

- Conditions froides et humides avec brouillard au petit matin (pas d'info sur le brouillard dans la plage de fonctionnement de la V4)
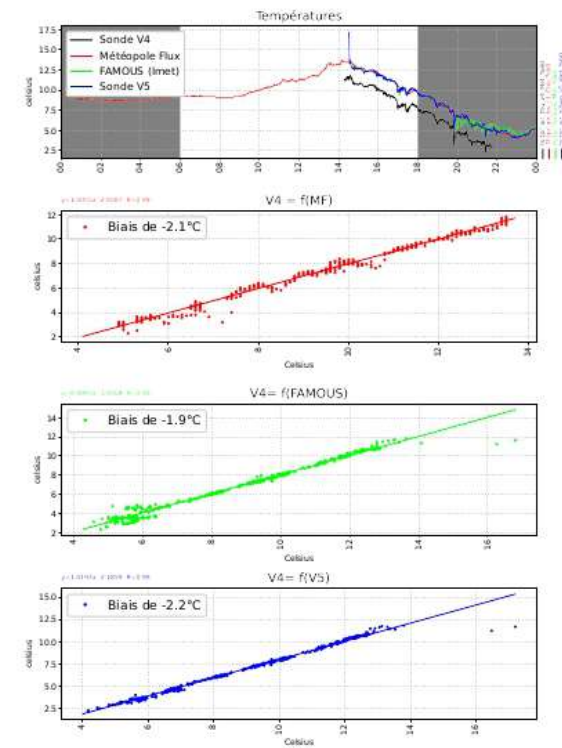
Dataset status - AERIS

Type of measurements	Datasets
Core surface meteorological data	CNRM stations (11 datasets) Météo-France network (3 datasets)
Visibility	CNRM stations (16 datasets) Météo-France network (1 dataset)
Present weather	CNRM stations (8 datasets)
Turbulence measurements	CNRM tethered Ballon (1 dataset) CNRM surface stations (2 datasets)
Sounding	CNRM tethered Ballon (1 dataset) CNRM radiosounding (2 datasets) Météo-France network radiosounding (2 datasets)
Cloud radar BASTA	LATMOS and CNRM BASTA (8 datasets for 3 sites) Vertical and scan
Microwave radiometer	RPG, MeteoSwiss, RPG, LAERO, UKMO, ONERA, CNRM Radiometers (52 datasets for 7 sites)

- **Available datasets :**
  - **129 today on AERIS** (a bit more on FTP site)
- **New datasets :**
  - V2 30 mn turbulence data MAIRE-SORE and JACHERE :
    - ▶ errors on TKE due to bad filtering of the wind
  - V4 10s meteo. data tethered balloon : **temperature bias +2.2 C**
    - ▶ but uncertainty remains … (new position of E. Moulin)
  - V3 turbulence data tethered balloon (impact on fluxes negligible)
- UKMO data uploading in progess (J. Thornton and J. Price) : need to correct some file names
- **Still missing / Data (re)-processing** :
  - tethered balloon :
    - ▶ cloud droplets and aerosols CDP + OPC + CCN (T. Costabloz, T. Bourrianne, C. Denjean)
      => **Validation still in progress** but CDP data provided for POI 11 and 14 for PhD studies
  - microphysics network : FM100/120, ~~WELAS~~, PVM-100 (T. Costabloz, F. Burnet)
    and aerosols at JACHERE site (T. Bourrianne, C. Denjean)
      => **Validation still in progress** : T. Costabloz and M2 Ines.
  - UAV data : M. Goret just arrived in November and PANAME 2023 => Not done yet
  - Lidar LB100 : new position of V. Unger => Not done yet

Task1 Report

- **Objectives and main scientific questions** of the ANR :

  — Provide a **3D characterization of fog layer properties** with detailed observations of dynamics, radiation, microphysics and surface fluxes

  — Processes study using **synergy between 3D high-resolution LES** and unprecedented detailed observations

    ‣ Dynamics : **impact of surface heterogeneities** on spatio-temporal fog variability

    ‣ Microphysics : **transition between thin and thick fog**, impact of aerosols

    ‣ **St to fog transition** : local processes or mainly driven by large scale conditions

  — **Data assimilation** of new local observations : MWR network and synergy with radar

- **Organisation** :

Planned Experimental strategy : KO meeting 2019

- 6 month experiment
- 3 nested domains
- Synergy in situ / teledetection
  => surface & vertical profiles


SOFOG3D final meeting, 12/06/2023

Observationnal set-up

- **MWR network :** 8 units on 6 sites (2 radars)

- **Surface network**

  — 17 stations with 2 50m-masts

  => contrast forest / open fields

- Fluxes, aerosols and microphysics, lidars...

- Tethered balloon, RS, UAV

SOFOG3D surrounding domain : 7 sites (+ 10 super-site)

=> sol : 2 stations UMKO + 5 stations SAMHA de 4M + tour du Nizan

AG GMEI 2020 – SOFOG3D – F. Burnet et al.

40 m

24 m

8m

Open fields

UAVs sampling

Forest slots
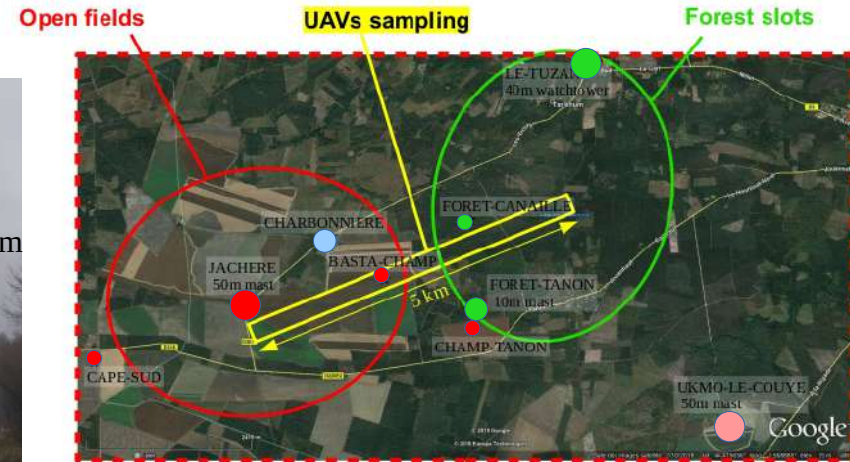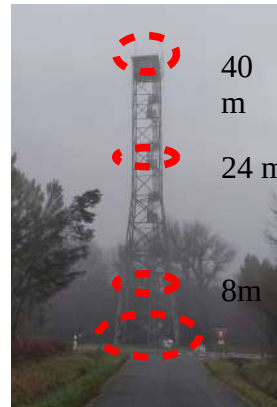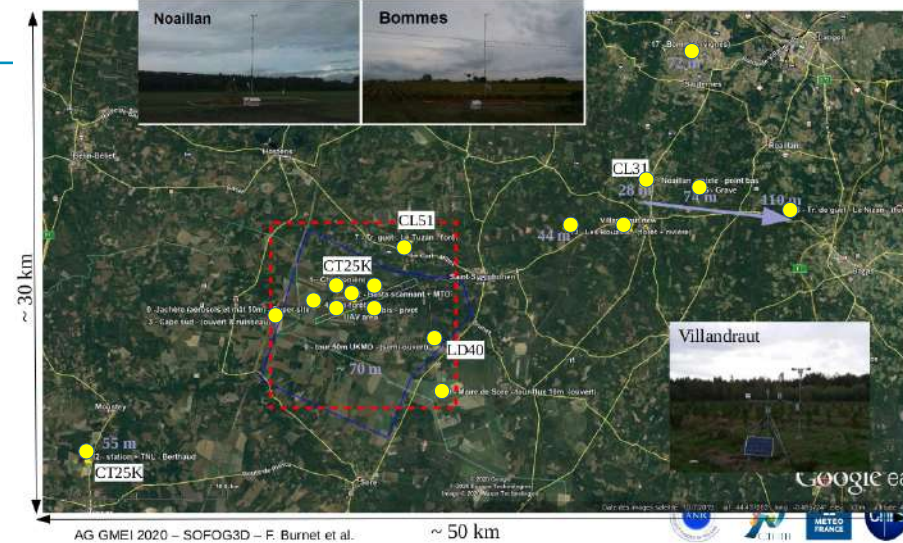
What didn't work - main difficulties

- **Amelie storm** 3/11/2019 **:** lost of the CNRM 50m mast

- Lost of the tethered balloon during Xmas foggy period

- **Instrumental failure** : young visibilimeter network (18 units)

- **UAV** : CNRM team involved in EUREC4A, MétéoMatics canceled

- Meteorological conditions at the super-site :

  — few developed fog, very few St lowering...

- Tethered balloon sampling strategy : aerosols / droplets / turbulence

- **Very ambitious field campaing** but not enough people...

  — delays in instruments deployment, monitoring and maintenance

  — conflict between long term measurements and IOP operations

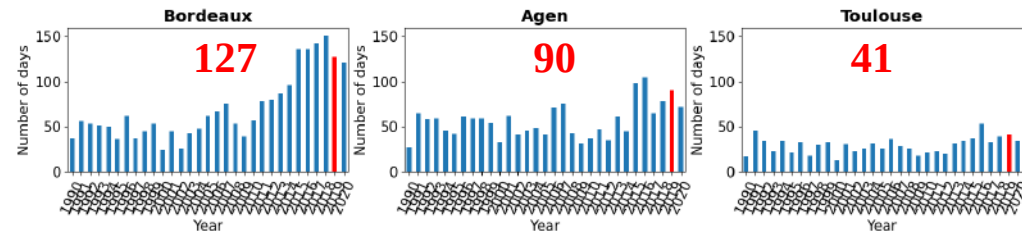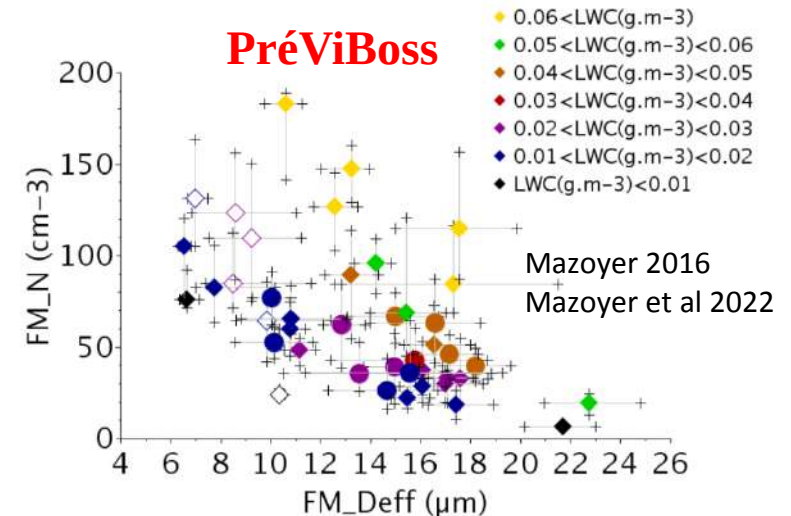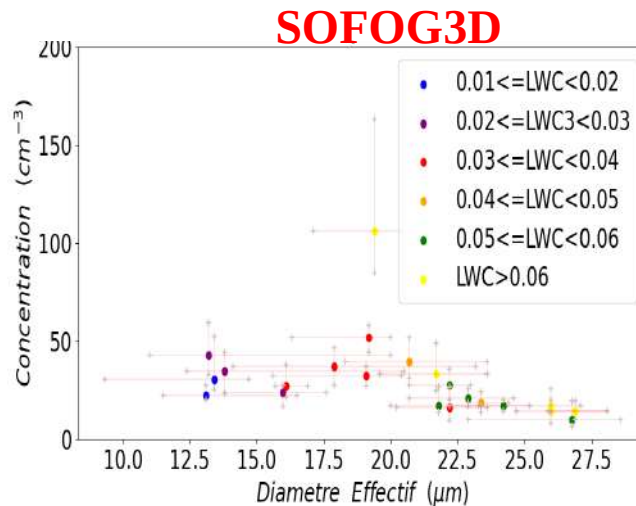 — visibility, welas, UKMO met. station, dew, aerosols,....
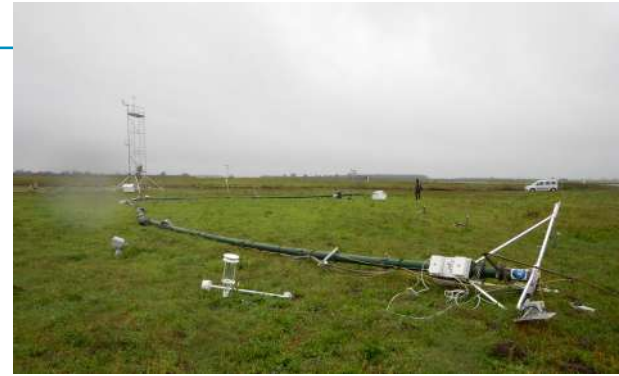
(M. Taufour)
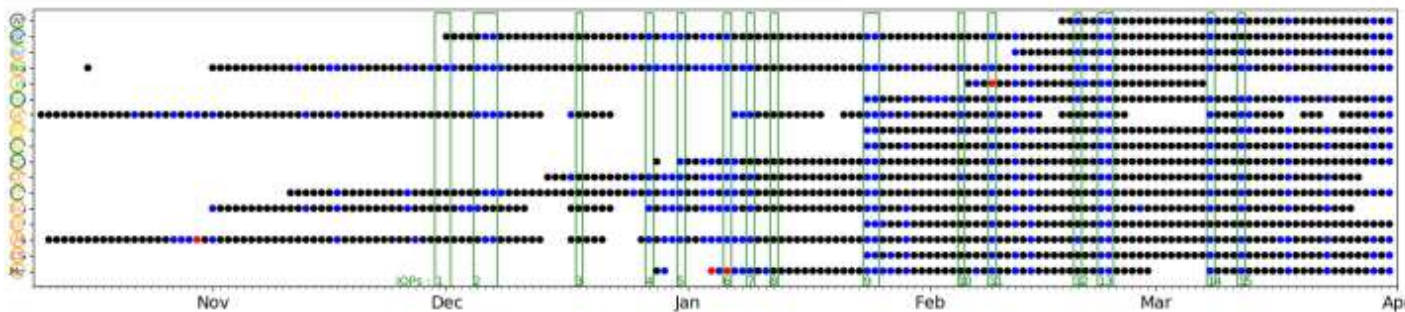
A succesfull experiment anyway :

(T. Costabloz)

- **30 fog events** at the super-site
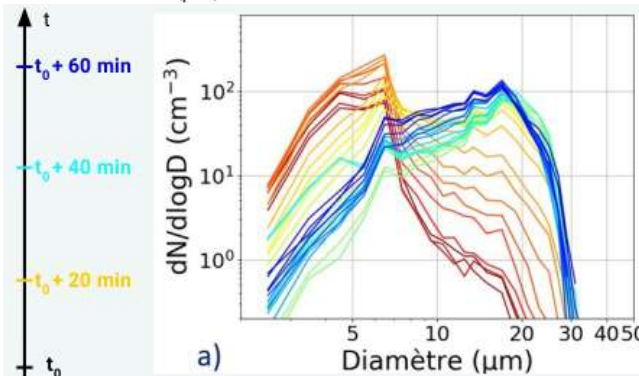 - AROME-500 evaluation
  - Impact of surface heterogeneities

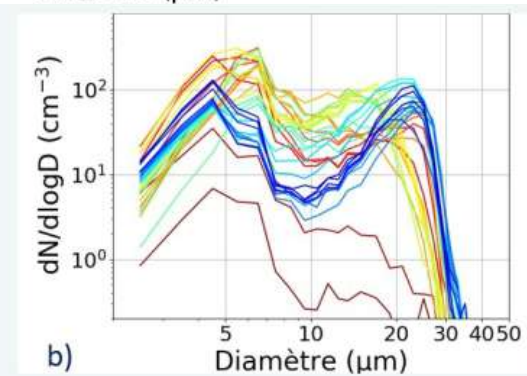- **Microphysics properties** at Jachère site : low CDNC of large doplets

SOFOG3D

PréViBoss

Mazoyer 2016
Mazoyer et al 2022

Many bimodal droplet size distributions

(I. Vongpaseut)
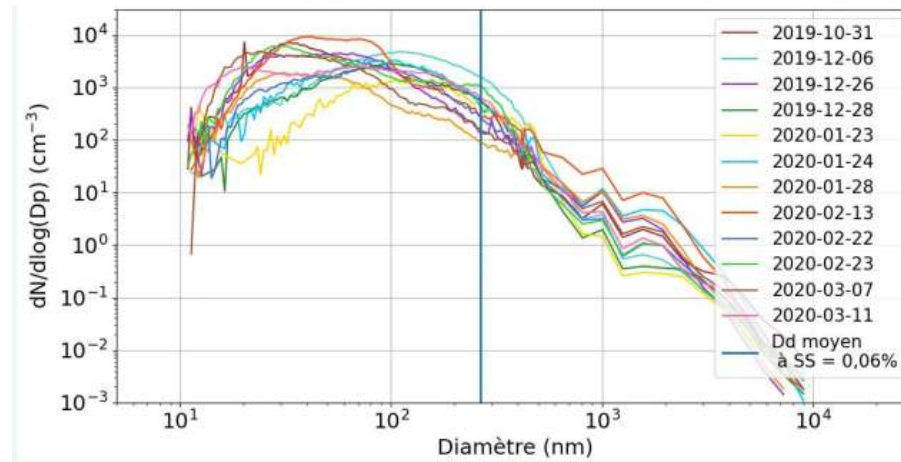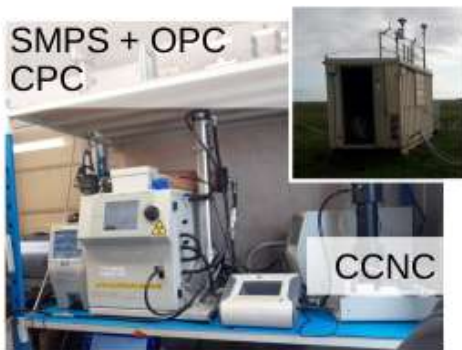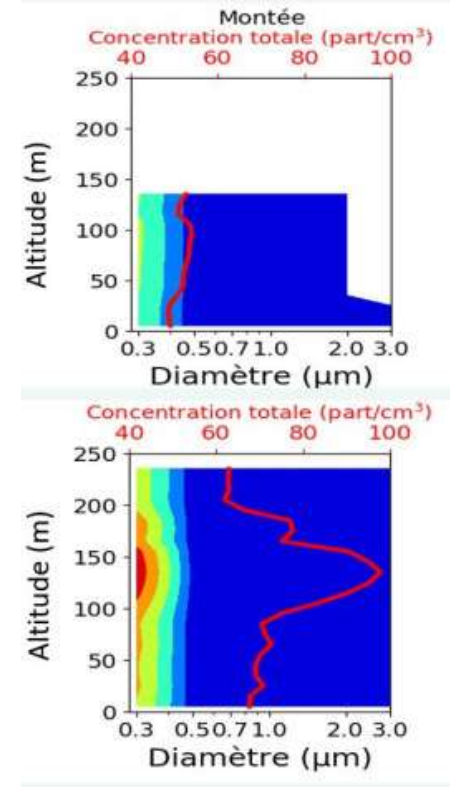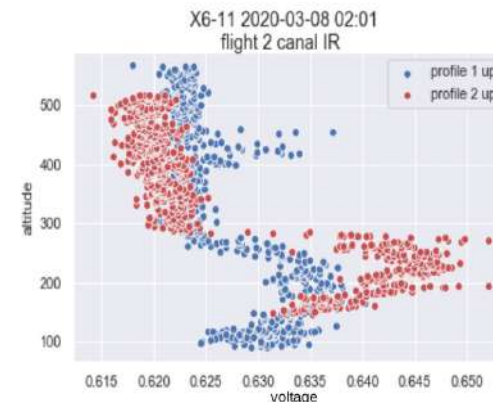

24/01/2020

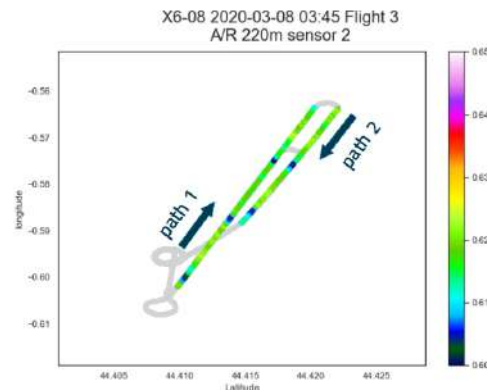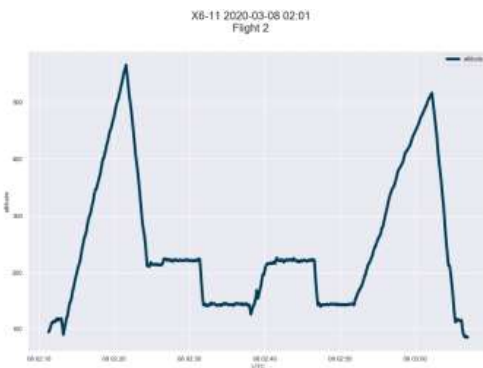23/02/2020

A succesfull experiment anyway :

- **Microphysics, radiatives and hygroscopic properties** of aerosols

    — low concentration ($\overline{Na} \sim 2500$ cm^{-3})   (C. Denjean)

    — $0.19 < \kappa < 0.38 \Rightarrow$ impact of organics

- **Turbulence and surface fluxes** >> LANFEX - (G. Canut)

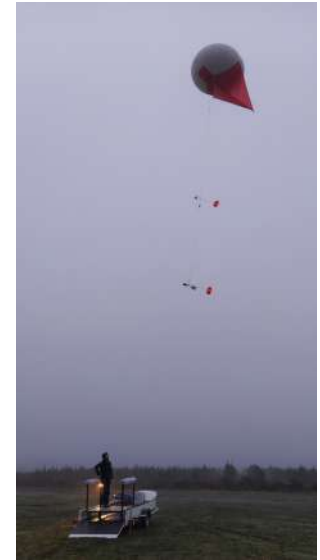- **7 IOP with UAV flights** - (G. Cayez / G. Roberts)

IOP overview : 01/12/2019 => 12/03/2020
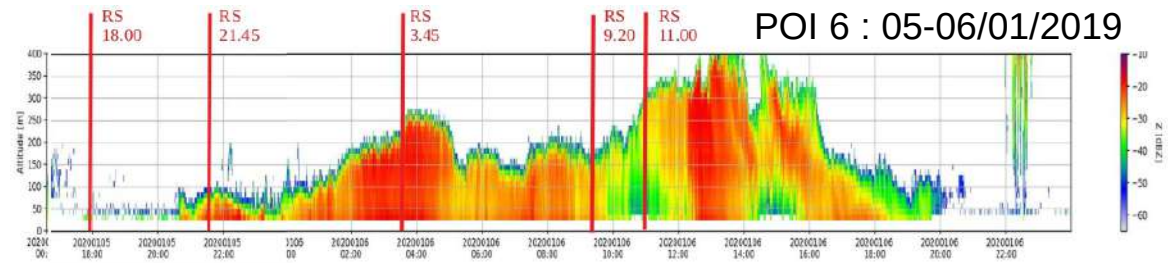
- **15 IOP => 20 nights of tethered balloon operations + RS:**

  — 5 without fog (or just mist)

  — 8 thin fogs with width H ≤ 50 m

  — 4 medium with 80 ≤ H ≤ 180 m   **15 fog events**

  — 3 thick H ≥ 200 m : **IOP-6, 11 and 14**

  5-6 Jan. (250m), 8-9 Feb. (250m) and 8-9 March (200m)

- **184 RS** over the whole domain

Agen: 52
St-Symphorien: 62
Toulouse: 37
Bordeaux :33
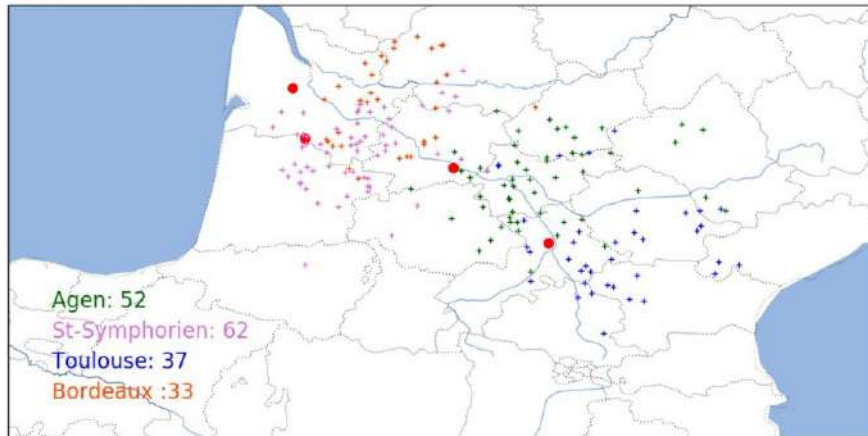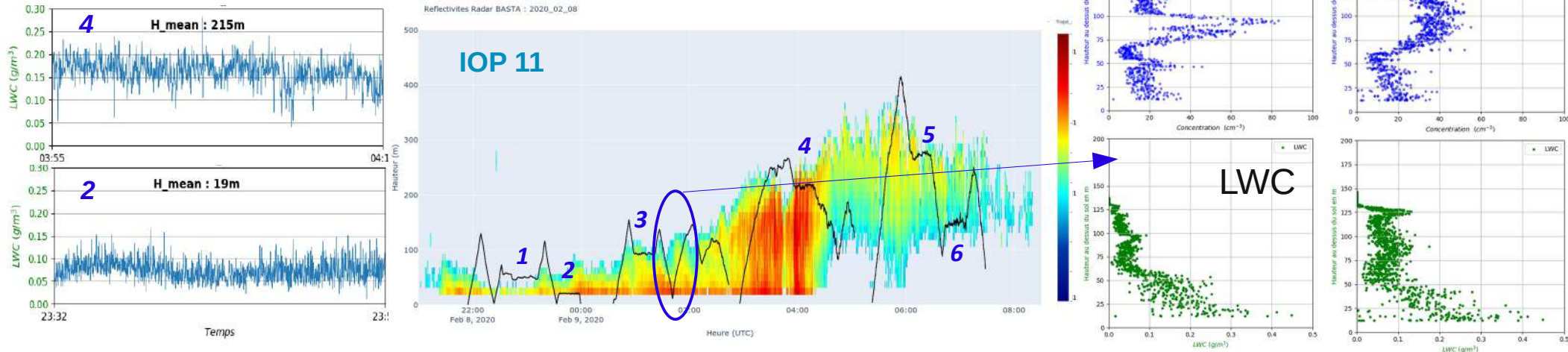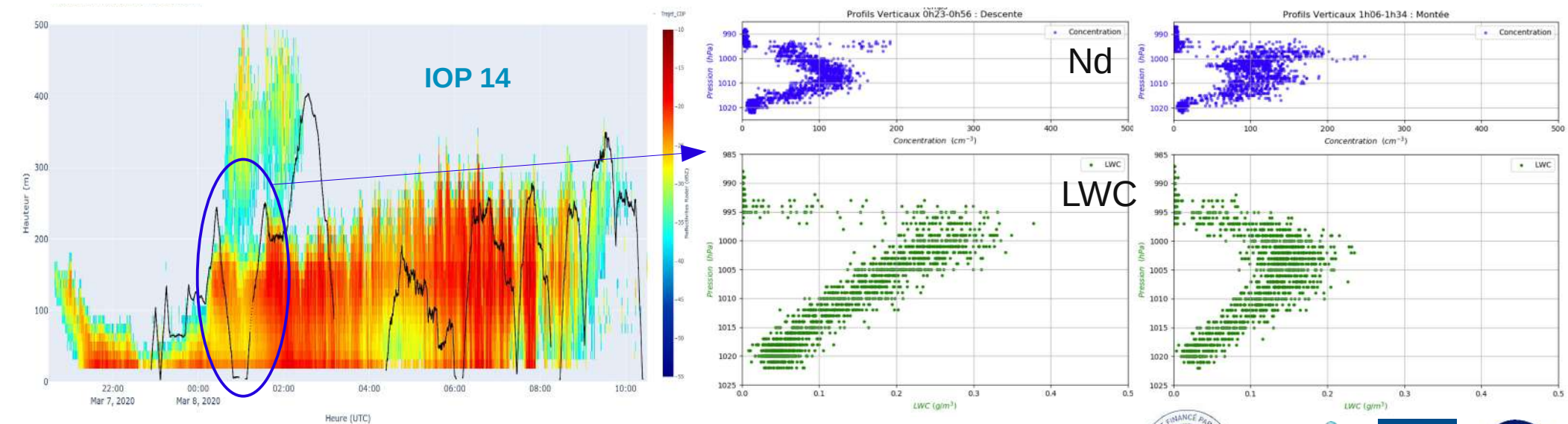
POI 6 : 05-06/01/2019
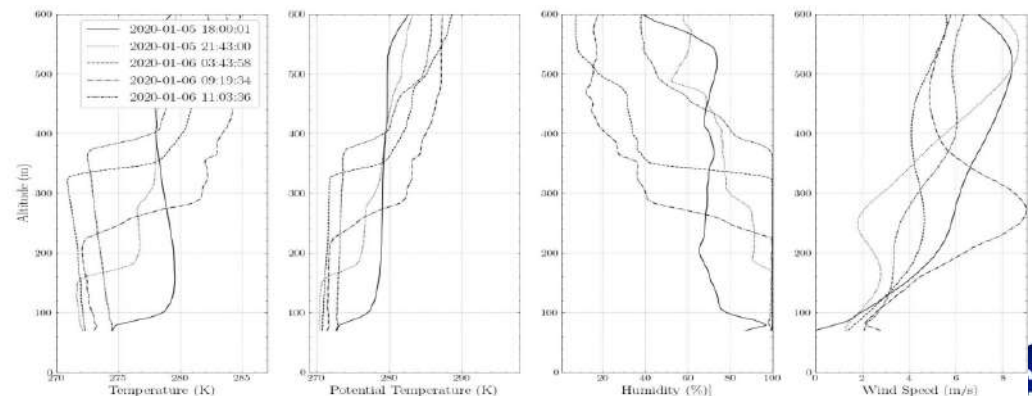
(A. Roy)

Vertical profiles of fog microphysics

- CDP below tethered balloon : contrast constant leg / profiles

- Life cycle and thin to thick transition

Remote sensing

- Cloud radar - Task 2 (J. Delanoë)
  - Reflectivity profiles, CTH
- MWR network - Task 5 (P. Martinet)
  - temp. and humidity profiles, LWP
  - LWP closure with CDP data
  - 1D-Var assimilation MWR/Radar (PhD A. Bell)
  - Assimilation trials AROME 3D-VAR (G. Thomas)
- Ceilometer : CBH et backscattering profiles
- V2 wind lidar : wind profile and TKE
- Aerosol lidar LB100 => not used
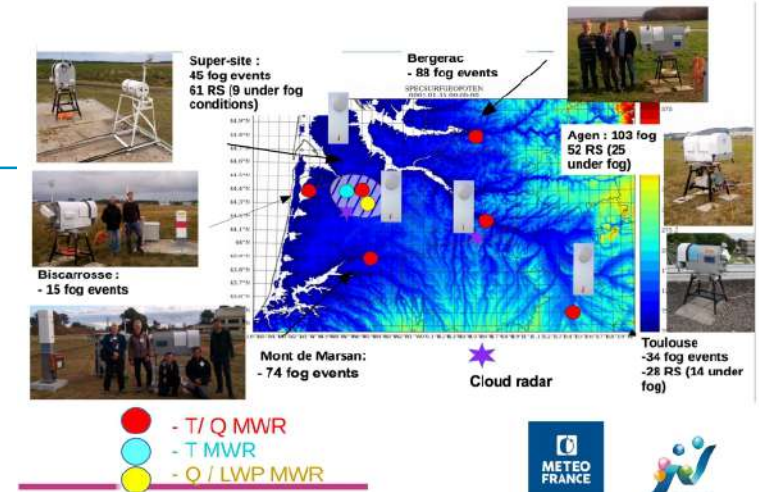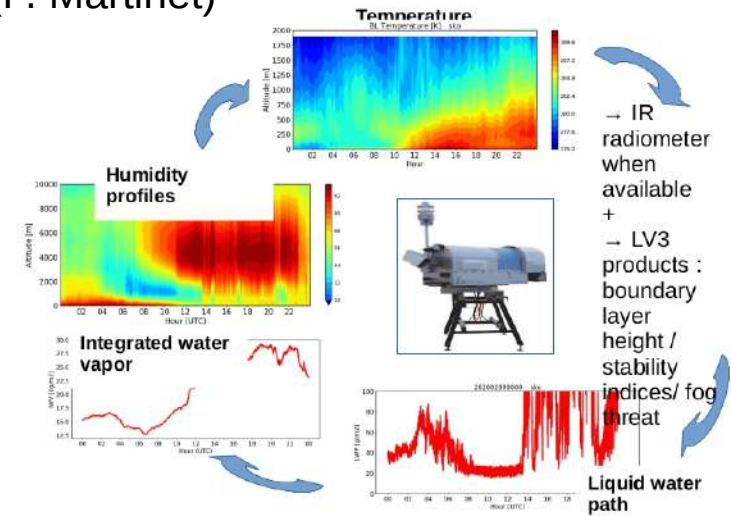
05/01 : Nocturnal jet stops the fog development
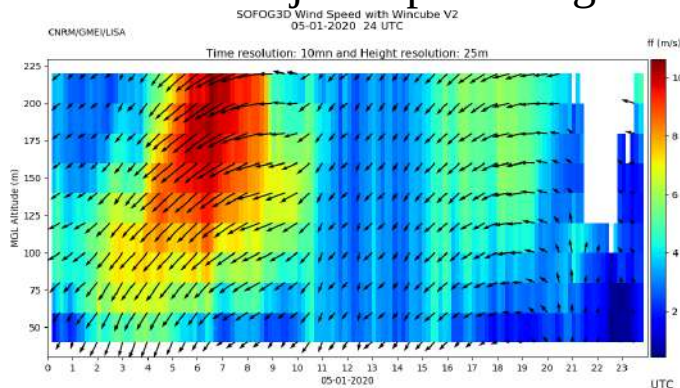
(P. Martinet)

Radar / radiometer synergy - Task5

- 1D-Var data assimilation of combined cloud radar Z and MWR BT

  (A. Bell, P. Martinet et O. Caumont) – Bell et al. ACP 2022
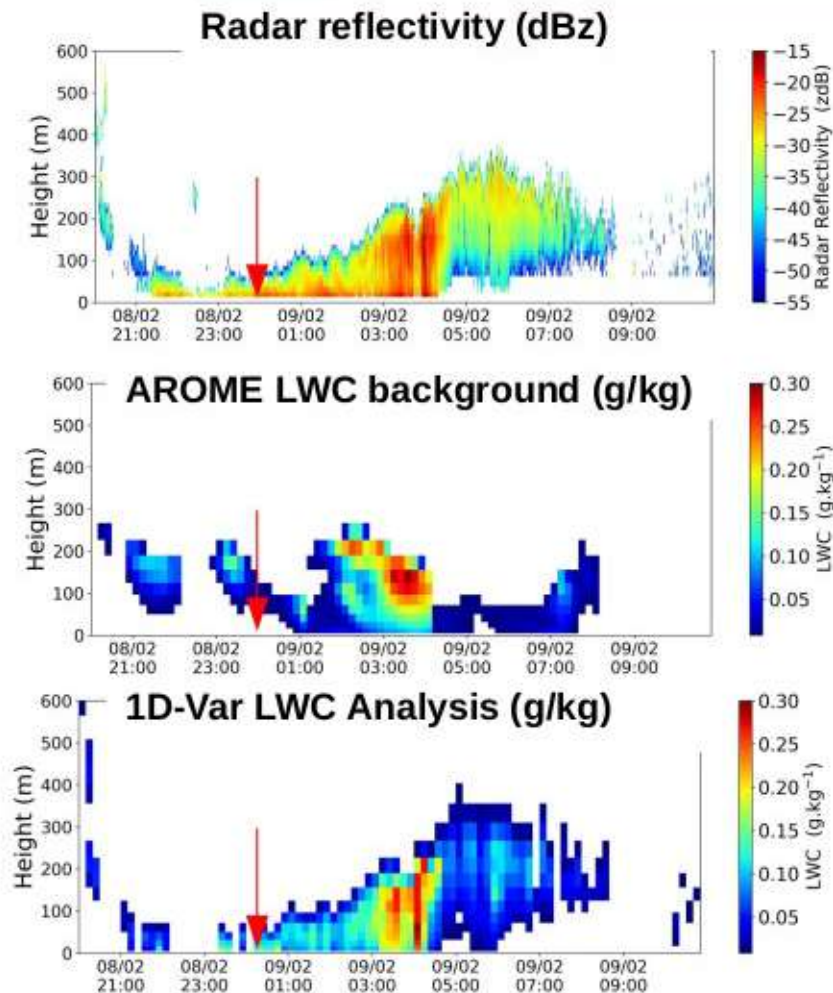
- Significant temporal and fog top heights errors in the AROME background profiles (nearest in time).

- 1D-Var retrievals much more **consistent** with the observed fog structures compared to the BASTA cloud radar.

- Good agreement between 1D-Var retrievals and in-situ CDP measurements

Task1 report – Deliverables

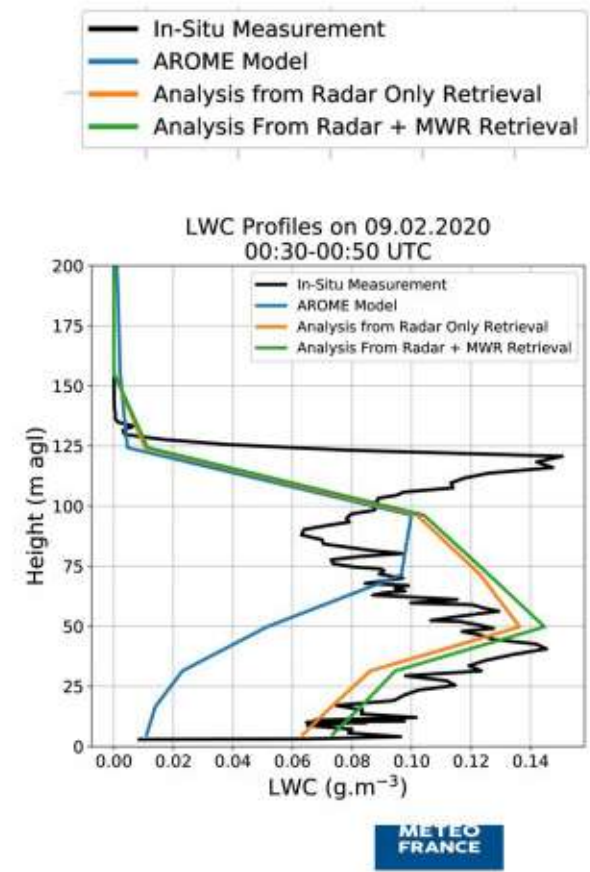|	
Sub-task 1.1 : Field campaign preparation	
Sub-task 1.2 : Field campaign	
D1.2.1 Conduct the six month field campaign with continuous monitoring and IOP operations	**Done**
D1.2.2 Database integrated in the AERIS web site at the end of the project	**In progress**
Sub-task 1.3 : in situ data analysis	
D1.3.1 Analysis of energy budget closure and impact of heterogeneities on the residual.	**Partialy done** – PFE L. Quinzain 2020
D1.3.2 Analysis of turbulence anisotropy parameter	**Not done** => LIAISE & MOSAI ANR data set
D1.3.3 Characterization of CCN activation spectra to prescribe CCN parameterization	**Done** – M2 S. Tinorua 2020, M2 I. Vongpaseut 2022
D1.3.4 Aerosol absorption properties within fog	**Partialy done** - M2 S. Tinorua 2020 Radiative closure – M2 A. Veau 2023
D1.3.5 Vertical profile of fog microphysics (droplet size distribution and LWC)	**Done** – PhD T. Costabloz Thin to thick transition
D1.3.6 Analysis of entrainment-mixing processes at fog top	**In progress** - PhD T. Costabloz

Summary

- 15 fog events sampled with the tethered balloon (20 nights of operations, 180 RS)

  => **3 main events (IOP 6, 11 and 14)** but many interesting thiner cases

- Despite technical failures and difficult weather conditions :

  — synergy 94 GHz radar, MWR and in situ profiling with microphysics and turbulence

  — volume sampling with scanning radar and UAV flights with ~5 km legs

  — MWR network (6 sites) for assimilation

  => **promising data set to document 3D heterogeneities and conduct process studies**

- large amount of data to process, validate and analyze... will take some time

- **Many thanks** to all people involved in preparation, forecasts, operations, processing....