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

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<tr>
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<th>2018</th>
<th>2019</th>
<th>2020</th>
<th>2021</th>
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<td><strong>6 month campaign</strong></td>
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<td>ANR proposal</td>
<td>Kick-off</td>
<td>Data and Science: I II III</td>
<td>Final meeting</td>
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- 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
SOFOG3D final meeting, 12/06/2023 - F. Burnet et al.
Review of the past year

- **Last Data and Science meeting III - 07/06/2022**
  - 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 developed 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](http://www.umr-cnrm.fr/spip.php?article1086))

- **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

- **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 remain => Theophane talk

- Installation de la V4 et la V5 près du mât Météopole Flux.
- Mesure d’une t° tempé 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

- **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 progress** (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

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<thead>
<tr>
<th>Type of measurements</th>
<th>Datasets</th>
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<tr>
<td>Core surface meteorological data</td>
<td>CNRM stations (11 datasets)</td>
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<td>Météo-France network (3 datasets)</td>
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<tr>
<td>Visibility</td>
<td>CNRM stations (16 datasets)</td>
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<td>Météo-France network (1 dataset)</td>
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<tr>
<td>Present weather</td>
<td>CNRM stations (8 datasets)</td>
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<tr>
<td>Turbulence measurements</td>
<td>CNRM tethered ballon (1 dataset)</td>
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<td>CNRM surface stations (2 datasets)</td>
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<tr>
<td>Sounding</td>
<td>CNRM tethered ballon (1 dataset)</td>
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<td>CNRM radiosounding (2 datasets)</td>
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<td></td>
<td>Météo-France network radiosounding (2 datasets)</td>
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<tr>
<td>Cloud radar BASTA</td>
<td>LATMOS and CNRM BASTA (6 datasets for 3 sites)</td>
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<tr>
<td>Microwave radiometer</td>
<td>RPG, MeteoSwiss, RPG, LAERO, UKMO, ONERA, CNRM Radiometers (52 datasets for 7 sites)</td>
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**June 2021**: 107 available datasets (W. Maurel)
**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**:

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<th>Timetable of the project:</th>
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<tr>
<td>Task 1: Field campaign and in situ data analysis</td>
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<tr>
<td>1. Preparation</td>
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<td>1.2 Field campaign</td>
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<td>1.3 In situ data analysis (CDD)</td>
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<td>Task 2: Fog retrievals based on remote sensing measurements</td>
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<td>2.1 Radar retrievals (CDD)</td>
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<td>2.2 Attenuation and closure study</td>
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<td>2.3 Improved MWR retrieval</td>
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<td>2.4 SEVIRI/MSG retrievals</td>
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<td>Task 3: 3D high resolution LES</td>
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<td>3.1: LES and validation (CDD)</td>
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<td>3.2: Impact of heterogeneities</td>
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<td>3.3: Impact of orography</td>
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<td>Task 4: Advanced process studies based on highly documented cases</td>
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<td>4.1 Transition thin/thick</td>
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<td>4.3: Ph D on St slowing</td>
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<td>4.2: Fog dissipation phase (CDD)</td>
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<td>Task 5: Data assimilation and forecast</td>
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<td>5.1 Observations preparation</td>
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<td>5.1 Assimilation trial (CDD)</td>
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<td>Final report</td>
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Planned Experimental strategy: KO meeting 2019

- 6 month experiment
- 3 nested domains
- Synergy in situ / teledetection

=> surface & vertical profiles

Field campaign:
- Fall-winter 2019/20 in the South West of France:
  Mont de Marsan: 80 events/year (340 h)
- Long term observation period:
  automatic systems: RADOME met. Network (50), mobiles met. stations (20), remote sensing, instrumented masts (flux, microphysics),...
- Intensive Observation Periods:
  radiosounding, tethered balloons, UAVs fleet

=> Objective: sample 10-20 events with favourable conditions

More images and details of the experimental strategy and field campaign are included in the document. The text suggests a focus on gathering data through various methods and observing conditions in the South West of France.
Observational 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
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 successful experiment anyway:

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

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

Many bimodal droplet size distributions

(T. Costableoz)

SOFOG3D

PreViBoss

Mazoyer 2016
Mázoyer et al 2022
A succesfull experiment anyway:

- **Microphysics, radiatives and hygroscopic properties of aerosols**
  - low concentration ($N_a \sim 2500 \text{ cm}^{-3}$) (C. Denjean)
  - $0.19 < \kappa < 0.38 \Rightarrow$ impact of organics

- **Turbulence and surface fluxes** $\Rightarrow$ 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 \( H \leq 50 \) m
  - 4 medium with \( 80 \leq H \leq 180 \) m
  - 3 thick \( H \geq 200 \) 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

(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)

SOFOG3D final meeting, 12/06/2023 - F. Burnet et al.
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
# Task 1 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. | **Partially 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 | **Partially 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 thinner 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....