ICE GENESIS
Project Overview

The project leading to this application has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 824310.

The Consortium

- 37 project partners
- 27 EU / 10 non-EU
- 10 countries

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ICE GENESIS project overview

Creating the next generation of 3D simulation means for icing

- **Duration:** From 1st January 2019 until 31st December 2022
- **Coordinator:** AIRBUS OPERATION SAS

- **Budget:**
  - Max EU Contribution: €11 964 300
  - Total Estimated Project costs: €21 984 549
  - Project effort in Person-months ~ 1858

- **Advisory board:** EASA, FAA, ADSE, AEROTEX,
  AIRBUS Defense&Space, CSTB, DAHER, EMBRAER,PIAGGIO, SAFRAN nacelles

ICE GENESIS project overview

Top level objective

The top level objective of the ICE GENESIS project is to provide the European aeronautical industry with a validated new generation of:

3D icing engineering tools
(numerical simulation and Icing Wind Tunnels capabilities)

addressing

Regulation CS25 Appendix C (well-known icing envionment)

Appendix O (SLD or Supercooled Large Droplet)

and snow conditions,

for safe, efficient and cost effective design and certification of future aircraft and rotorcraft.

Novelties in Europe : 3D ice scanning system
droplet temperature measurement
snow characterization and campaigns

ICE GENESIS project overview

Sub-objectives

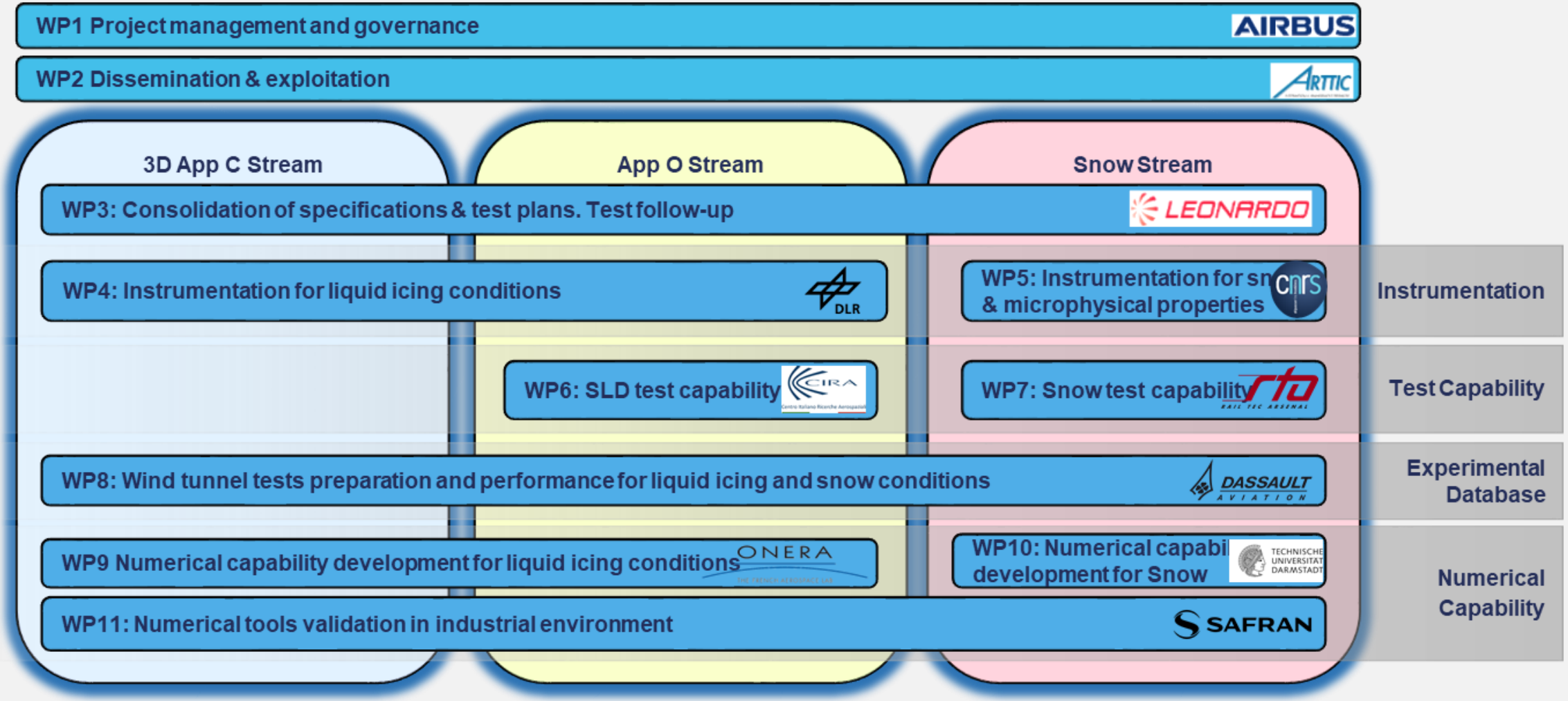
Obj#1: Improve and validate existing **3D numerical tools** to predict ice accretion in Appendix C, Appendix O and Snow conditions.

Obj#2: Upgrade and calibrate **icing wind tunnels** to allow reproduction of:

- **Supercooled Large Droplets (SLD) in FZDZ (Freezing drizzle) conditions**.
- **Snow conditions**
- Additionally, to **assess the potential of current icing wind tunnels to represent SLD in FZRA (Freezing rain) conditions**.

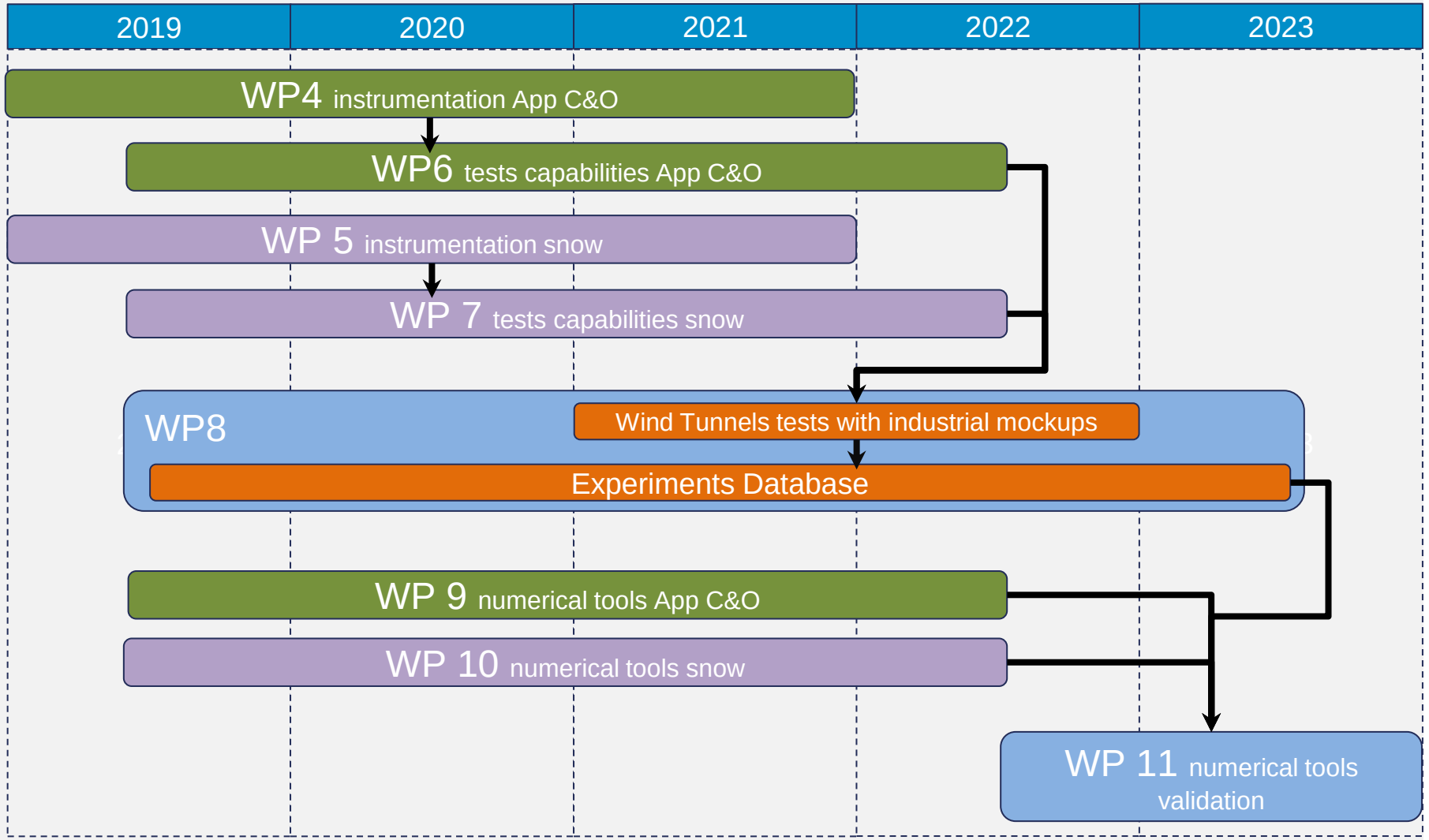
Obj#3: Build a **large scale experimental database** on representative 3D configurations to be used as a solid reference (“ground truth”) for future numerical tools validation.

ICE GENESIS Organisation



WP DEPENDENCIES

- Perform wind tunnel tests in liquid icing and snow conditions, in industrial environment (IWT and mockups)
- Provide searchable database of experimental results for validation of numerical tools



Snow Microphysical Properties

The project leading to this application has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 824310.

Overview

To secure future program development and certification, there is a **need to develop snow test and numerical capabilities** to de-risk engine system design before in-flight demonstration

- The available regulatory, research and guidance documents define approximations of snow conditions: At most, Advisory Circular (e.g. AC29-2C) defines minimum information on the temperature range to be considered [-4°C - +1°C] and a visibility criterion representative of snow water content (1/4-mile or 0,9g/m3).

⇒ Need for **characterization of falling snow conditions** to support development of Snow Test (WP7) and Numerical Simulation (WP10) Capabilities

Overview

Objectives within WP5:

- Assess / select the most appropriate **cloud microphysical instrumentation** to characterize snow icing conditions to support F/T and G/T measurements, and W/T calibration work
- Quantify **snow microphysical properties** (3D Christal size & mass, m-D relation, fractal dimension, differentiation dry and wet snow, number & mass size distributions, riming degree, drag coefficient) of individual snow crystals as well as entire snow crystal populations

Involved Partners:

- CNRS, EPFL, CAO, TSAGI, AIH, DLR

Tasks:

- Instrumentation assessment & selection for F/T measurements (**Task 5.1**) and G/T measurements and IWT calibration (**Task 5.2**)
- Ground Measurements (**Task 5.3**) and Airborne Measurements (**Task 5.4**) for snow particle characterization
- Quantification of Microphysical Properties (**Task 5.5**) of Snow

Overview

- **Complementary field campaigns** (aircraft & ground stations) gathering necessary expertise (skills, stakeholders in this field)

ATR42

SAFIRE ATR42

2 weeks campaign in 01/2021 representing **20F/H**

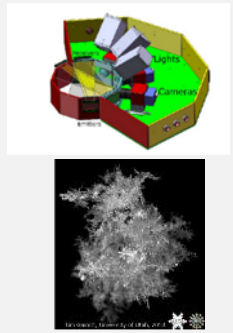
YAK-42D

YAK-42D "Roshydromet"

5 months campaign in 11/2020 – 03/2021 representing **50F/H**

Ground site: Remote Sensing & MASC

CNRS/EPFL Radar campaign during winter 2021 & collocation with ATR42



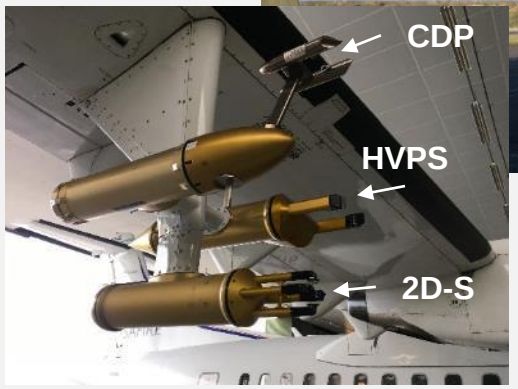
CNRS/EPFL MASC campaigns during winter 2020 and 2021

Overall: quantify the **microphysical properties** of Snow

Snow conditions of interest: **IWC > 0,9g/m^3 ;** **-10°C < OAT < +2°C**

ATR42 Field Campaign

- **ATR campaign: Period:** 19-30/01/2021; **Location**: 5 flights over Jura Swiss in **falling snow conditions;** 20 F/H; **Instrumentation**: cloud radars & in-situ microphysics (e.g. ice crystal imaging, droplet spectrometer, integral snow IWC/LWC measurements,…), thermodynamics



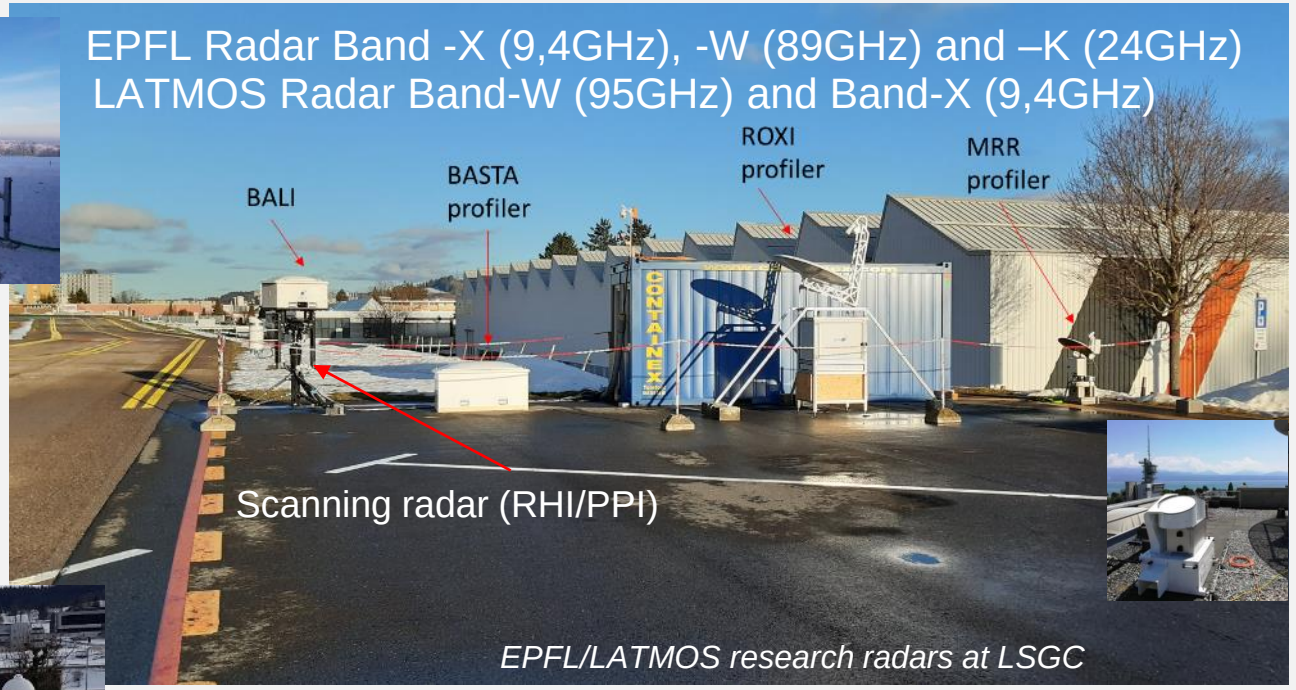
CDP [2-50µm] and Robust (TWC)
2D-S [10-1280µm]
HVPS [150-19200µm]

CIP [25-50µm]
PIP [100-6200µm]

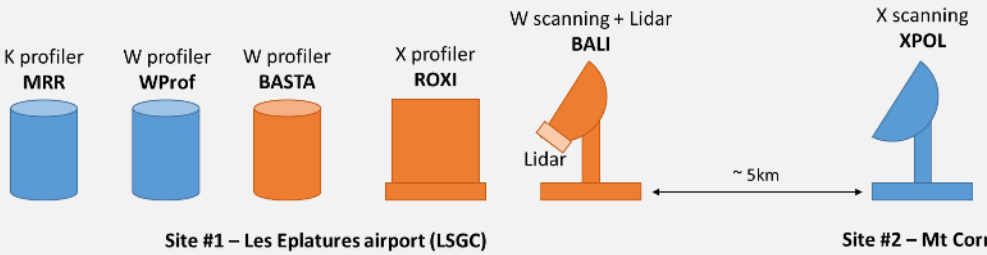
ATR42 Field Campaign

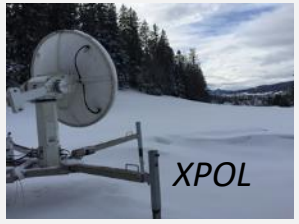
- EPFL/LATMOS **radars** and EPFL **MASC** installed at ground site (Les Eplatures / Swiss Jura)

MXpol – dual polarization RHI/PPI (Mont Cornu)



WProf





ATR42 Field Campaign

Miscellaneous

As a complement to the data collected by the research radars of LATMOS and EPFL, measurements from **Meteo France's operational C-band polarimetric radar in Montancy** will also be studied.

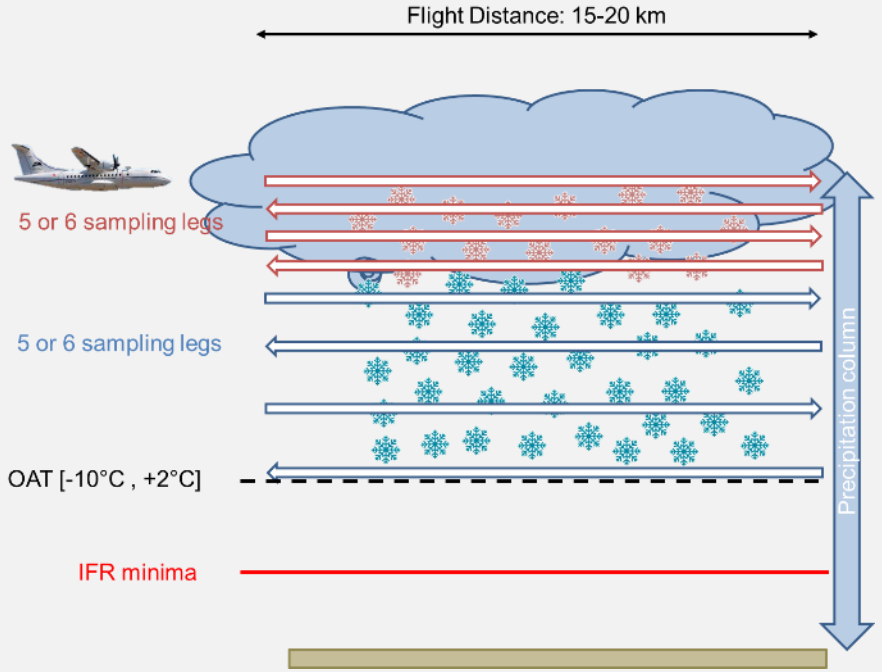
The dual-polarization and Doppler information will be valuable in the characterization of synoptic as well as microphysical processes.

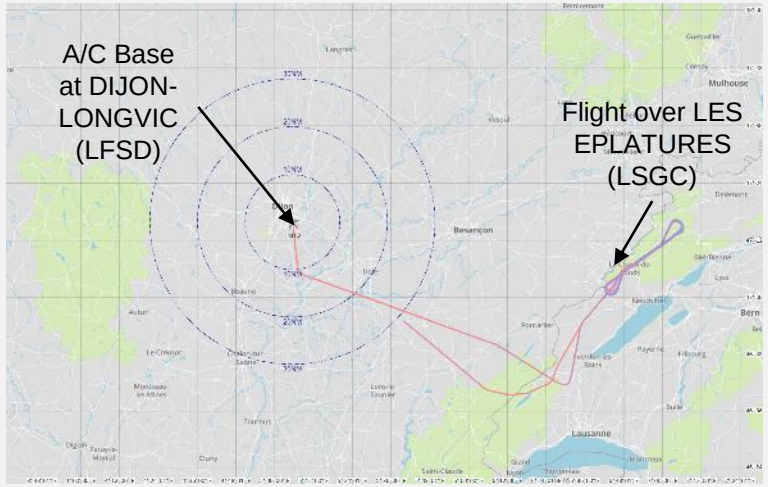
The **Global** Precipitation **Measurement (GPM)** mission is an international network of satellites that provide next-generation global observations of rain and snow.

GPM will be valuable in the characterization of synoptic context

ATR42 Field Campaign

Sampling Strategy



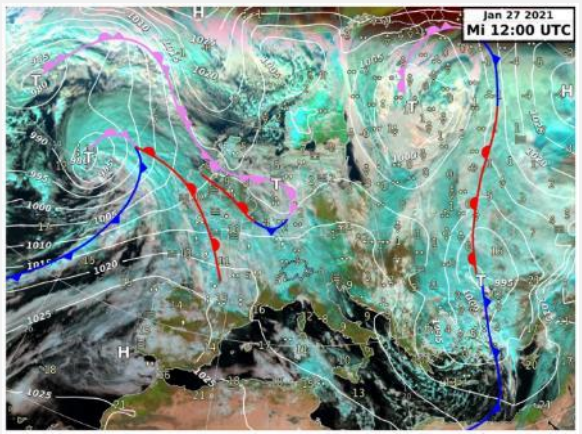


Typical Flight Track (27/01/2021)

Series of approach at Les Eplatures airport (30/01/2021)

ATR42 Field Campaign

Example of **Results** (F210006 on 27/01/2021) - **Weather Forecasting & Context**



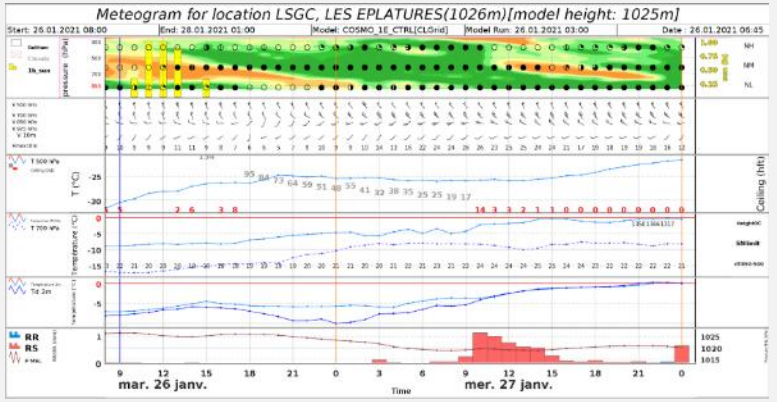
27th January 2021 surface analysis @MeteoSwiss

INP TOULOUSE ENM École Nationale de la Météorologie METEO FRANCE

Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

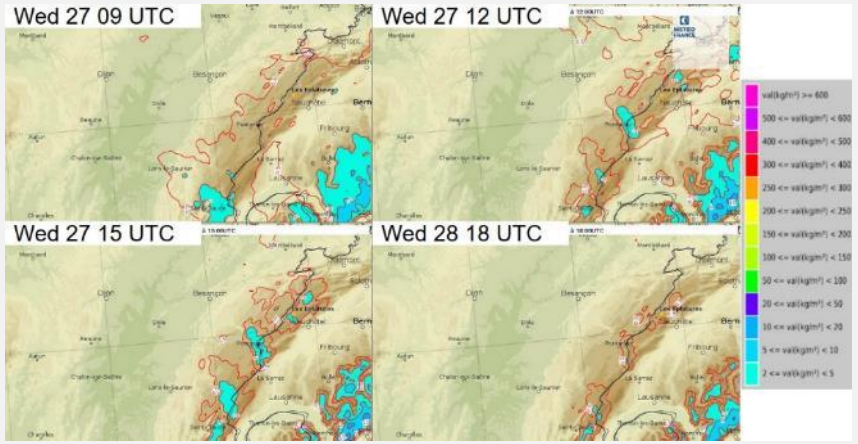
Département fédéral de l'intérieur DFI
Office fédéral de météorologie et de climatologie MétéoSuisse

MétéoSuisse



Forecast meteogram at LSGC, COSMO-1E @MeteoSwiss

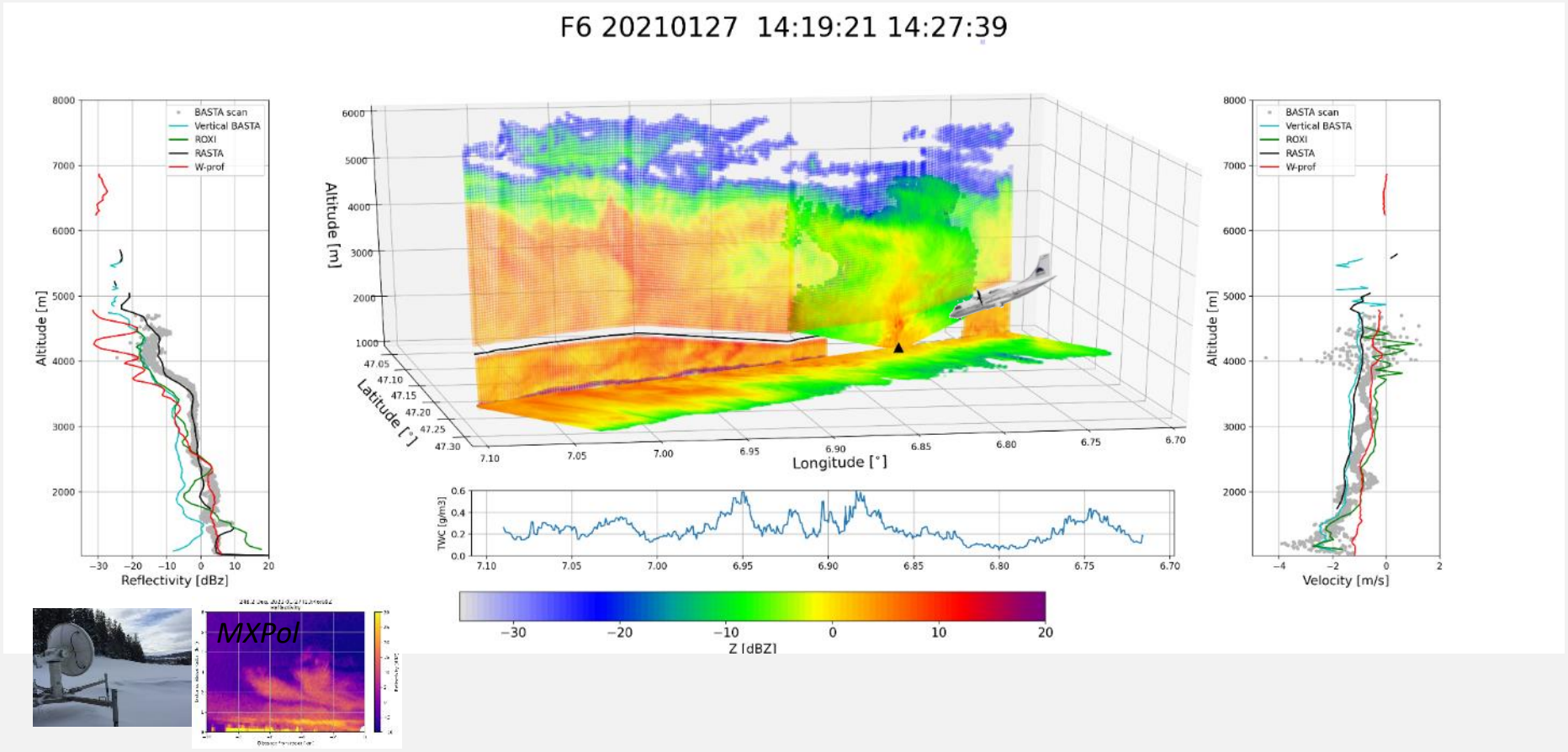
Forecast Hovmoller diagram, precipitation type, AROME @Météo-France



Precipitation type and quantities, AROME @Météo-France

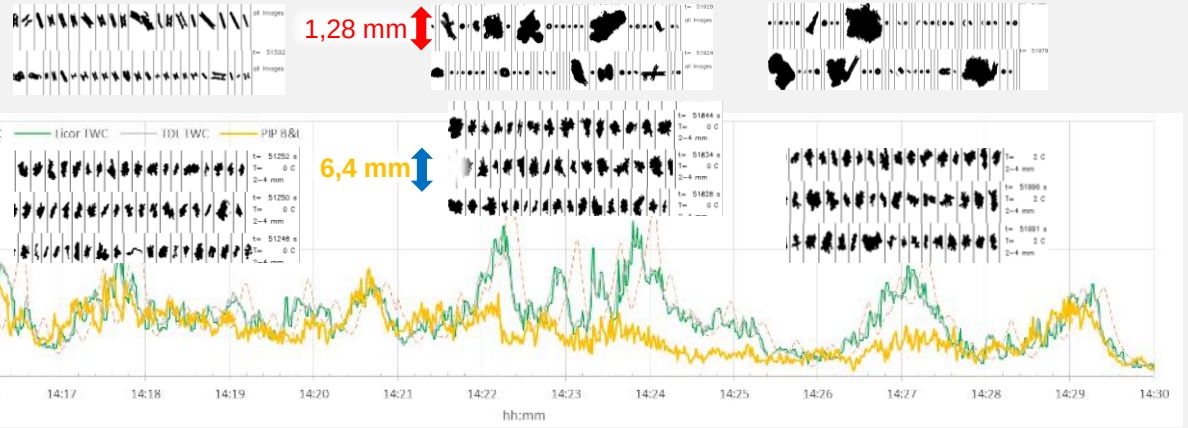
ATR42 Field Campaign

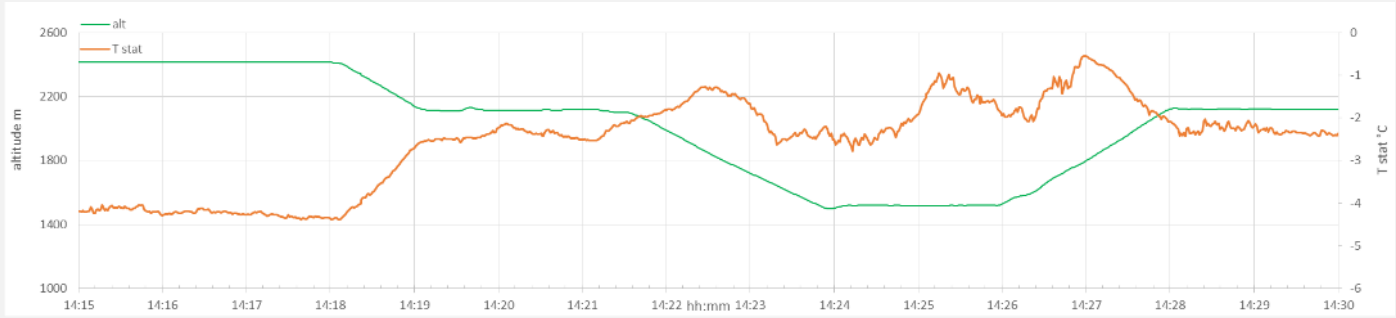
- Example of **Results** (F210006 on 27/01/2021) – **Overview and Radar Synergy**



ATR42 Field Campaign

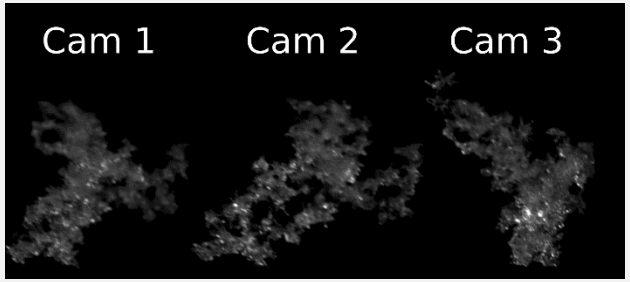
- Example of **Results** (F210006 on 27/01/2021) – **ATR-42 In-Situ Measurements**

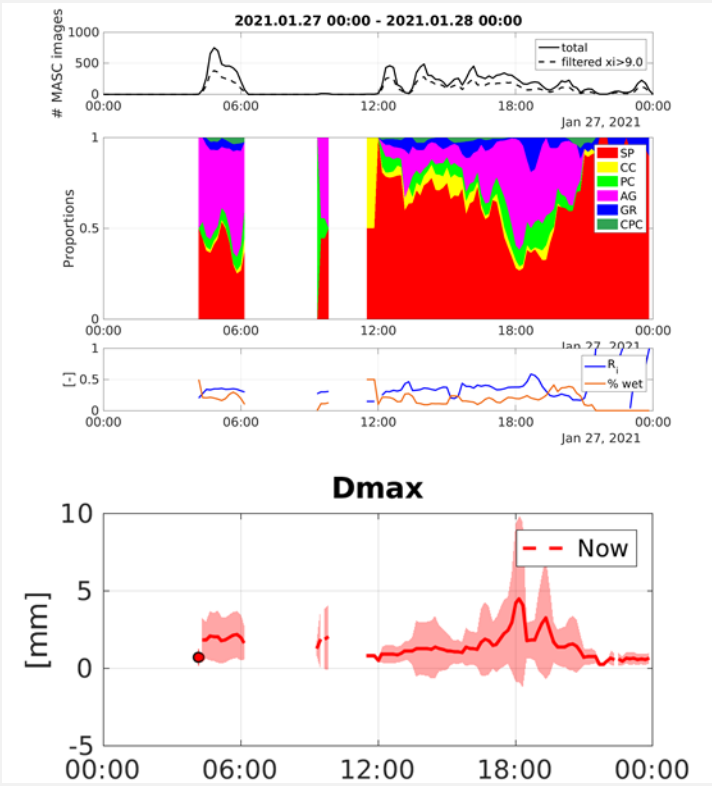




ATR42 Field Campaign

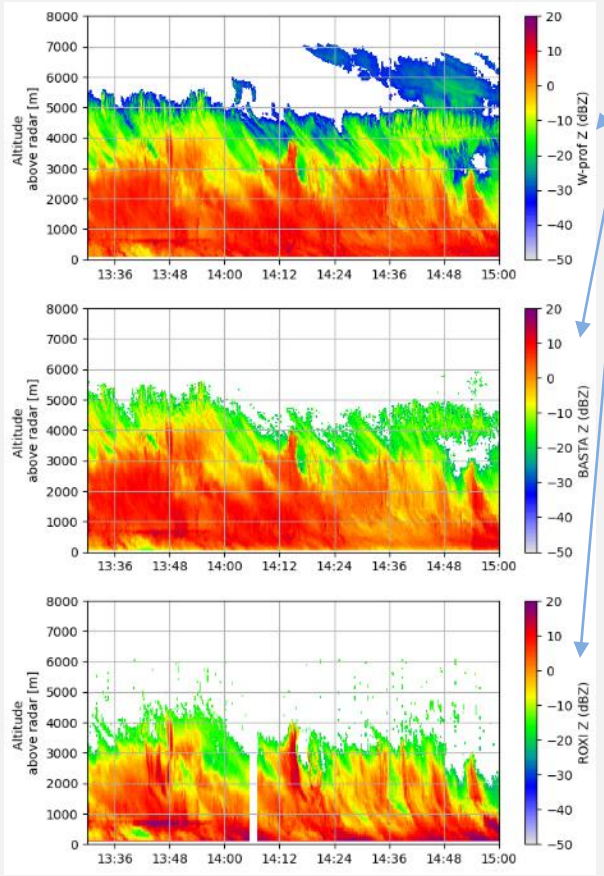
- Example of **Results** (F210006 on 27/01/2021) – **MASC** (ground site) snow crystal imaging



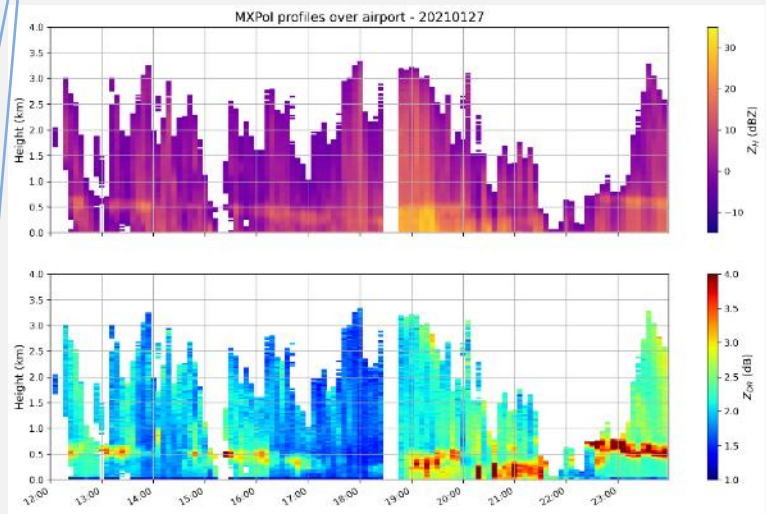


ATR42 Field Campaign

Example of **Results** (F210006 on 27/01/2021) – **Radars on ground**

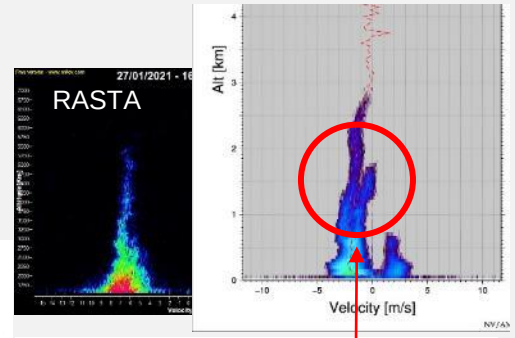


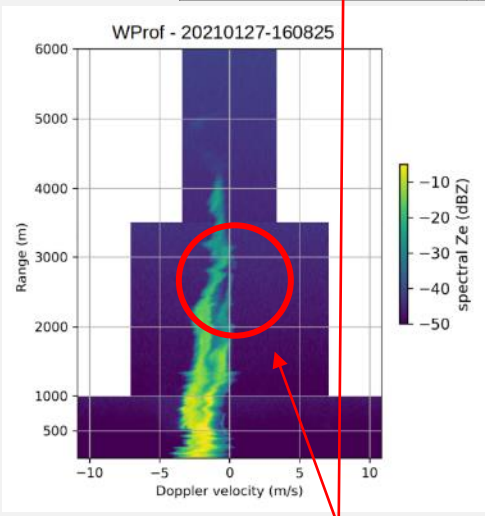
Consistency betw. 3 freq



Polarimetric profiles above airport

ROXI Xband





Spectral data: secondary ice generation?

ATR42 Field Campaign

Thank You to the whole Team

Thank you to Aude, Christophe, Josue, Simon and Valentin for providing Weather Forecast all along the campaign

Thank you to Les Eplatures airport for hosting the campaign

YAK42 Field Campaign

- **YAK42 F/T campaign**
  period: 11/2021 – 03/2021
  location: flights out of Moscow for **characterization of falling snow conditions**

- 50 F/H planned (6 Flights & 18 F/H completed) in snow conditions

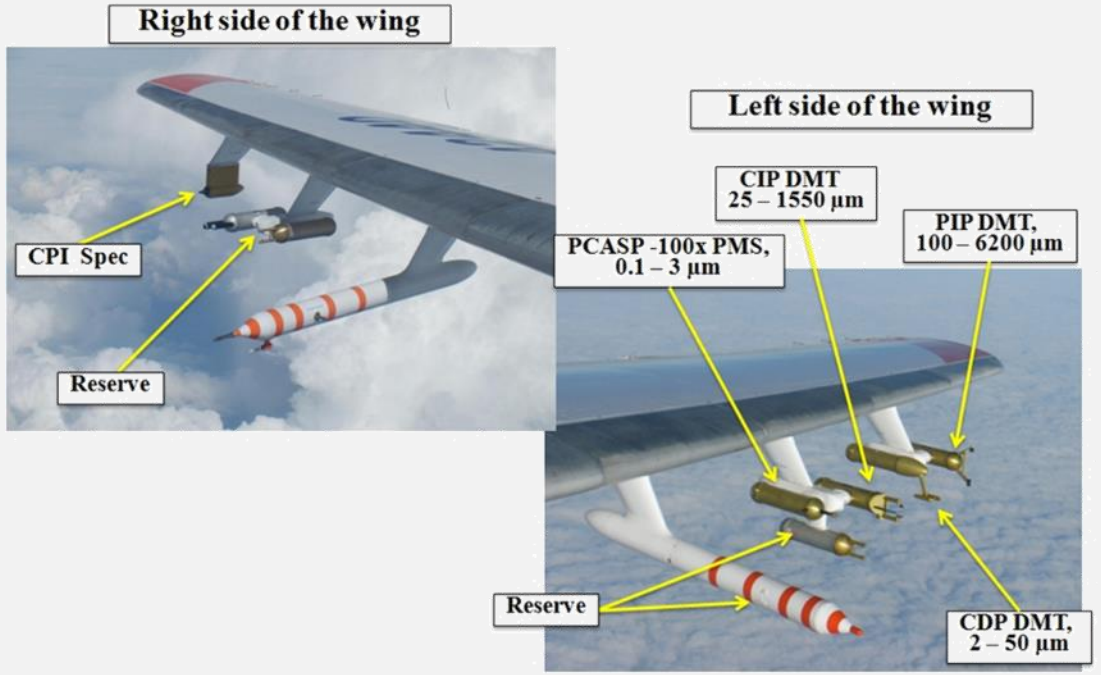
- A/C **instrumental payload**
  - Active remote sensing (X-band cloud radars)
  - In-situ microphysics instrumentation (e.g. CDP, CIP, PIP, Nevzorov,…)
  - Thermodynamics

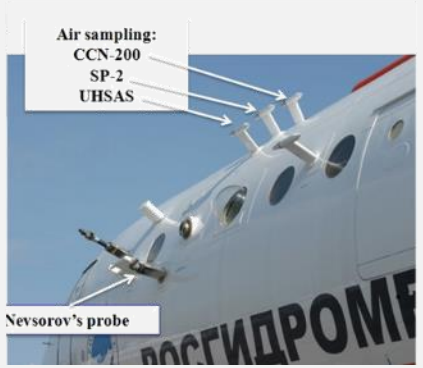
- **Snow conditions** of interest
  - IWC > 0,9g/m^3 ; -10°C < OAT < +2°C

-Crew – 3 members;
-Maximum flight level – 10200 m;
-Flight distance – 3500 km;
-Flight speed – from 350 up to 700 km/h;
-Maximum take-off weight – 57 tons;
-Onboard operators – up to 14 members.

ATR42 Field Campaign

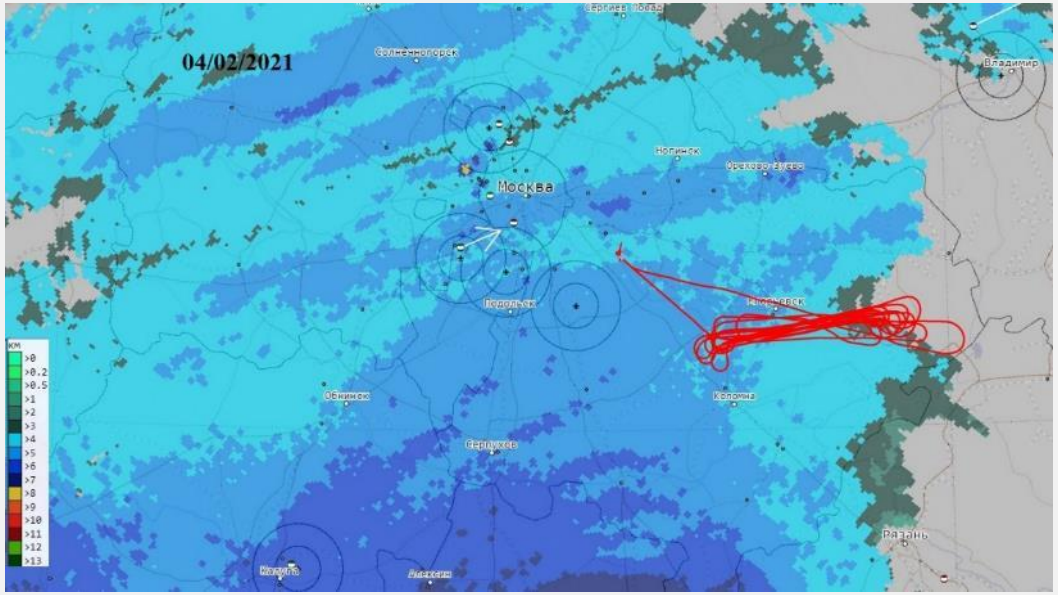
Instrumentation

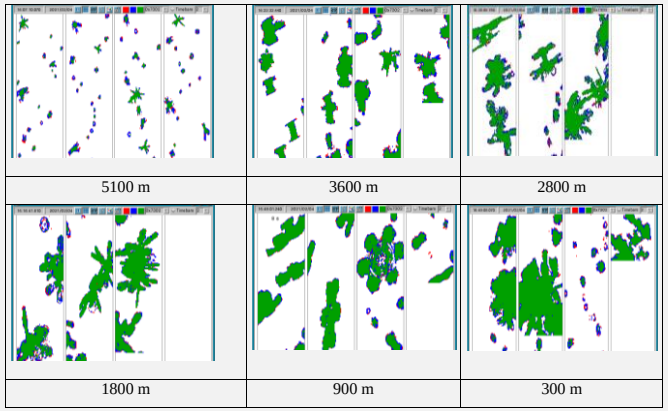




ATR42 Field Campaign

Example of Results: flight on 04/02/2021





YAK42 campaign until April 2021

Conclusion & Way Forward

- Valuable **falling snow data** gathered during winter 2020/21 for ICE GENESIS: **ATR-42**, **YAK42**, **ground site ‘Les Eplatures’** in situ & remote sensing measurements
- Data processing of new snow data
- **Snow properties retrieval**: m(D), C_{Drag}(D), 3D properties decsriptors, …: Important: **WP5/10 collaboration/synergy**
- Comparison/extension of actual knowledge on snow properties with new snow particle data
- **Natural snow properties compared to artificial snow** generated and caracterized within WP7

THANK YOU FOR YOUR INTEREST

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