Presented by

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Beyond HAIC

Beyond HAIC
Introduction

Top Level Objectives

•**To face challenges related to the evolution of regulation according to mixed phase and glaciated icing conditions** by characterising high IWC environments and developing the Acceptable Means of Compliance (test facilities and numerical tools),

•**To improve aircraft operation** by developing appropriate detection and awareness technologies to be fitted on aircraft and able to alert the flight crew when an aircraft is flying in and **to continuously enhance international flight safety**.

Duration & Budget

•Coordination: Airbus Operations SAS

•Duration: **54 months** project / August 2012 – January 2017

•Budget: 23M€

Technical Objectives

•**Characterise, optimize, enhance and select the most sophisticated cloud microphysics probes** to measure ice crystals conditions during flight tests and to calibrate icing wind tunnels.

•**Measure and characterise the microphysical properties of core or near-core regions of deep convective clouds**.

•**Upgrade European icing wind tunnels** to allow reproduction of mixed phase and glaciated icing conditions.

•**Understand and model involved physical phenomena** and **Develop numerical tools**

•**Develop and validate mixed phase and glaciated icing conditions awareness and detection technologies** to alert the crew

•**Assess the proposed mixed phase and glaciated icing environment as defined in Appendix D/P** and **provide recommendations to regulatory bodies.**

Partnership

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Beyond HAIC
Introduction

- Despite major progress already achieved as part of HAIC, in collaboration with HIWC, EASA-HighIWC and ICC, the challenging objectives set up at the beginning of the project can't be fully achieved.

- There is a need to secure research activities beyond HAIC while insuring continuity of the work

- International collaboration is welcomed
  - International technical expertise across multiple disciplines conducting research
  - International partnerships to leverage resources

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Beyond HAIC
Introduction

- 5 major topics
  - Instrumentation
  - In-situ detection
  - Spaceborne detection & nowcasting application
  - Numerical tools
  - Test facilities

- It is not expected to be able to set-up a large integrated project to address the remaining gaps
- Need to address the topics separately

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Beyond HAIC
Instrumentation

- Identify instrumentation characteristics that could lead to discrepancy between flight tests measurements and icing tunnel tests measurements (pending on ice crystals shape and flow characteristics)
- Intercomparison of technologies for flight test measurements and icing wind tunnel test measurements

➢ To assess tunnel calibration methods.

- HAIC WP15 Intercomparison of flight tests and icing wind tunnel tests instrumentation, to initiate investigation (start by early 2016)

- CIRA proposal "*Wind Tunnel Investigation on the Response Characteristics of Particle Spectrometers and TWC Devices in SLD Cloud Conditions*" is also an opportunity to move forward

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Beyond HAIC
In-Situ Detection

- HAIC SP4 « High IWC Detection & Awareness Technologies » aims at developping and validating in-situ detection technologies

- Performances should be demonstrated in representive environment thanks to Aibus A340 field campaign planned in January 2016

- However, there is a need for additional research in order to ensure compliance with industrial requirements in terms of operability, reliability, weight and cost,… and thus to demonstrate maturity for installation on-board commercial aircraft

➢ Follow-up as part of Cleansky 2 already planned (through call for proposal) with an expected start in Sep 2016

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Beyond HAIC
Spaceborne Detection & Nowcasting Application

- HAIC SP3 « Space-borne Observation & Nowcasting of High IWC Regions » aims at developping space-borne remote detection and nowcasting techniques to support flight test campaign(s) and ultimately provide near real-time weather data through ATM as being studied as part of SESAR.

- Strategy relies on a step-by-step approach
  - *1st step: HAIC / 1st generation to demonstrate feasibility*
  - 2nd step: product improvement (detailed requirements, POD improvement, FAR reduction, IWC estimation if possible, global product,…)
  - 3rd step: Integration into “weather on board” and SESAR

- 2nd step to be addressed through National funding (short term through DGAC) and European funding (mid term eg 2017)

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Beyond HAIC
Spaceborne Detection & Nowcasting Application

Objectives

In synergy with FP7 HAIC (High Altitude Ice Crystals) and EASA-HighIWC projects, the objectives are:

- To contribute to the characterisation of high IWC regions using advanced airborne and spaceborne remote sensors (eg RASTA, Clousat)
- To improve MET-FR Rapid Development Thunderstorm (RDT) product for detection of high IWC regions
- International collaboration is expected (NASA, NCAR, KNMI, UKMO, BOM)

These activities will pave the way towards operational remote high IWC long range detection system to support strategic pre-flight planning and in-flight re-planning.

WBS

- WP2.1: Management – CNRS/LA, Airbus
- WP2.2: GEO Spaceborne detection of High IWC regions – MET-FR
- WP2.3: LEO Spaceborne Characterization of High IWC regions – CNRS/LA, CNRS/LOA
- WP2.4: Airborne remote sensing and statistical characterization of High IWC regions – CNRS/LATMOS, CNRS/LaMP

Deliverables & Milestones

D2.1 / M06 / Progress report WP2 at M6

D2.2 / M12 / Progress report WP2 at M12

D2.3 / M18 / Final report WP2

M2.1 / M18 / RDT improvement (WP22)

M2.2 / M18 / High IWC climatology (WP23)

M2.3 / M18 / Characterization of High IWC regions (WP24)

Duration : 18months

Partnership & Budget

MET-FR ; CNRS/LaMP ; CNRS/ LATMOS ; CNRS/LA & LOA

Airbus / EYAK, EYAV: 50k€

Budget (gross): 750k€ / 50% funding

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Beyond HAIC
Spaceborne Detection & Nowcasting Application

Progress beyond the state of the art

Activities was initiated within the FP7 HAIC (High Altitude Ice Crystals, Aug 2012 – Jan 2017) project with the contribution of CNRS, MET-FR and KNMI.

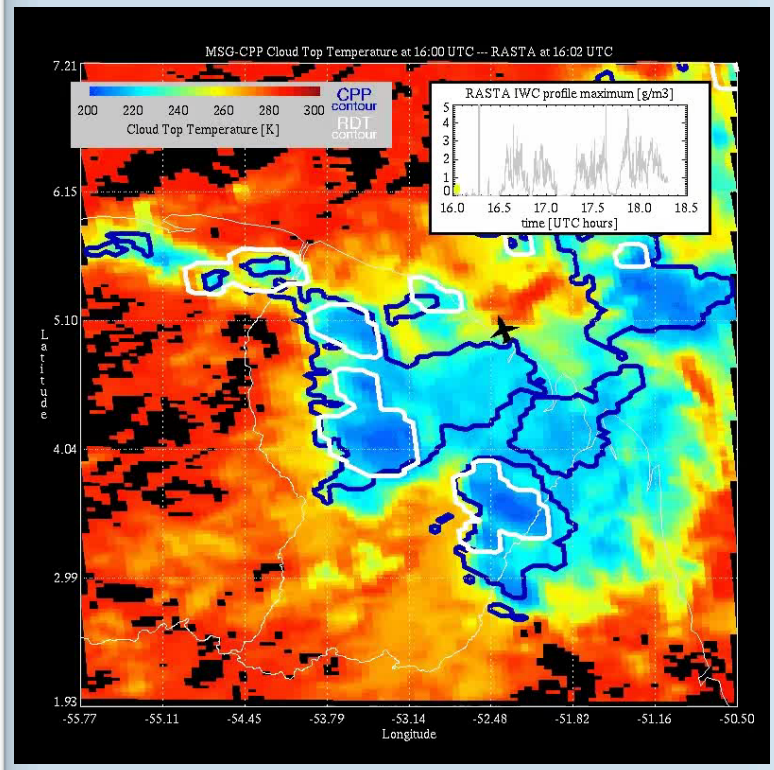
Development was supported by the conduction of two international campaigns over Darwin in Jan-March 2014 and over Cayenne in May 2015.

An additional field campaign is planned out of Indonesia in January 2016 with the Airbus A340 MSN1 flight test aircraft.

•GEO Spaceborne detection of High IWC regions – MET-FR: To secure and complement data analysis of existing F/T campaigns and improve RDT capability such as tracking of long lasting convection as a proxy for High IWC

•LEO Spaceborne Characterization of High IWC regions – CNRS/LA-LOA: To secure and complement data analysis of existing F/T campaigns and use A-Train/Cloudsat for preliminary set-up of global high IWC climatology

•Airborne remote sensing and statistical characterization of High IWC regions – CNRS/LATMOS, CNRS/LaMP: To secure and complement data analysis of existing F/T campaigns and further investigate statistical characterization of high IWC region using airborne remote sensing (RASTA). Conclusion will be communicated to EASA/FAA wrt the assessment of the App D/P



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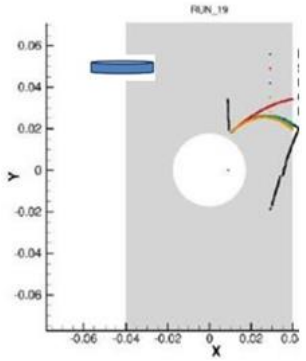
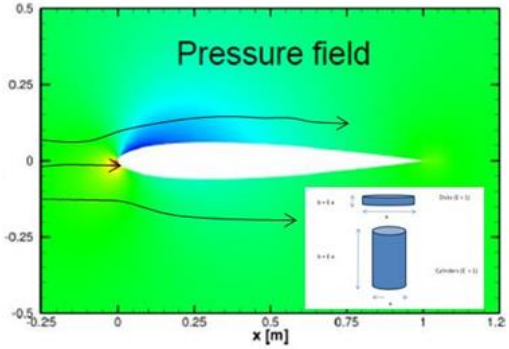
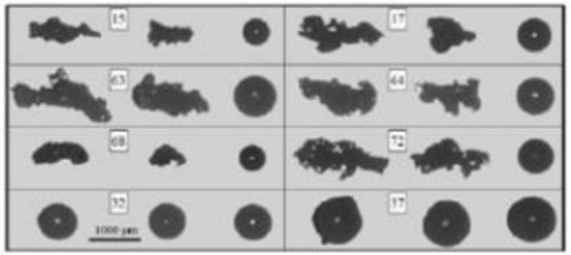
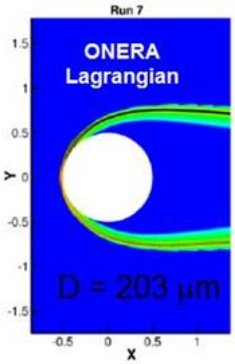
Beyond HAIC
Numerical Tools

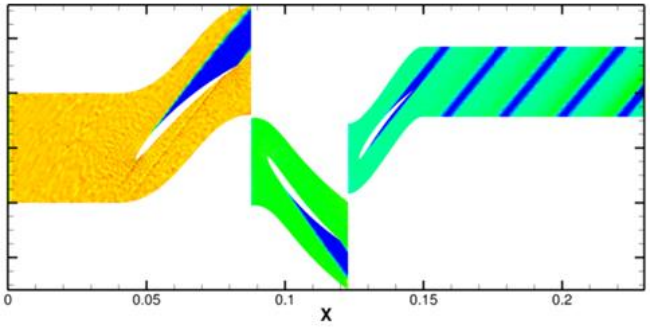
- HAIC SP6 « High IWC Tools & Simulation Development » aims at developing & validating **numerical capabilities** as **Acceptable Means of Compliance (AMC)** for the qualification and certification of future aircraft products (mainly probes and engines)

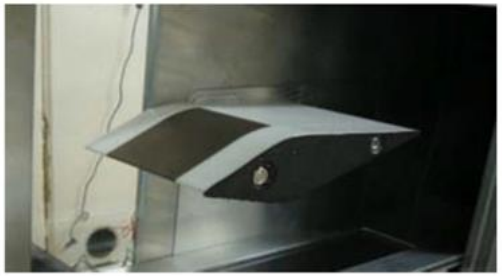












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Beyond HAIC
Numerical Tools

- Remaining gaps
  - *Dry wall impact model consolidation (very important for engine applications and for probe installation effects)*
  - Sticking efficiency model consolidation (very important for ice shape prediction and icing risk estimation)
  - Erosion model improvement / calibration (very important to avoid over-conservatism of the model predictions)
  - Accretion / Shedding model improvement
  - Trajectory and Accretion solvers improvements
  - Further assessment for engine and probes applications

- « High IWC Tools & Simulation » topic is considered as first priority
  - Submission to H2020 by 26/01/2016 within MG-3.1-2016 Addressing aviation safety challenges. EASA support is expected
  - ONERA lead with the involvement of TUD, TUBS, CIRA, TSAGI, AGI, Univ Twente and support from Airbus, Dassault-Aviation, SAFRAN, Rolls-Royce

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Test Facilities

- HAIC SP5 “High IWC Test Capability Enhancement” aims at improving test facilities for the simulation of mixed phase and glaciated icing conditions in order to be able to support methods & tools development and validation and to perform qualification of equipment in European facilities

- However, HAIC is focusing on small scale facilities and thus there is a need to upscale for engine applications

- Investigation on-going to include this topic as part of Cleansky 2.
- It is not expected to be able to start activities before end 2017 / beg 2018

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Beyond HAIC
Conclusion

- There is a need to secure research activities beyond HAIC while insuring continuity of the work

- A series of actions already launched
  - Instrumentation?
  - Spaceborne detection & nowcasting application
  - Detection technologies
  - High IWC numerical tools

- International collaboration is to be worked out
  - Short term (next few months): letter of support/interest
  - Mid term (Q1/Q2 2016): integrated work plan

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High Altitude Ice Crystals (HAIC, 314314)

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Project co-funded by the European Commission within the Seventh Framework Programme (2012-2016)

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