Canadian Aeronautics Networking Programme for Europe

Case Study - HAIC

High Altitude Ice Crystals

CANNAPE (Canadian Networking Aeronautics Project for Europe) is an EC-funded project, aimed at creating a platform for enhancing aeronautics and air transport research and development (R&D) cooperation between Europe and Canada, and to explore the potential for and, where appropriate, to promote the participation of Canadian stakeholders with their European counterparts in common activities.

The Build of Ice Crystals and Supercooled water at altitude can be extremely hazardous to the operations of aircraft. NRC sensor technology, enabling better detection of ice crystals on board aircraft, will be tested by the HAIC programme.

The Need

A key task within the EU FP7, High Altitude Ice Crystal (HAIC) project is to address the dangerous and costly challenges related to icing through the development and flight testing of ice crystal detection technologies. The need for this new detection capability is being driven by forthcoming international changes in airworthiness regulations. A key part of these new regulations is the requirement to address the problems some aircraft experience when encountering ice crystals. It has been recognized that an important factor is the ability to detect ice crystals, analogous to what is now utilized for supercooled liquid water icing conditions in the current regulations. NRC will support the program in addressing these critical challenge by working on:

1. The characterization of high altitude atmosphere (with flight tests to measure ice water content and ice mean mass diameters in high altitude clouds);
2. The development and implementation on aircraft of flight test instrumentation and detection means (i.e. probes or radars) to measure or detect glaciated and mixed phase icing conditions;
3. The development of ground level icing wind tunnels to allow reproduction of glaciated and mixed phase icing; and,
4. The modelling of ice accretion phenomenon, ice particles trajectories and validation to understand macro/micro-physic of this phenomenon and write accretion equations.

The Solution

The new regulations anticipated for 2014 will require engines and aircraft instruments to be certified against conditions representing ice crystal clouds. Complete and accurate characterization of ice crystal clouds in the atmosphere is a critical aspect of enabling the forthcoming new regulations. No current instruments can accurately characterize the atmosphere at present and HAIC is evaluating 6 candidate technologies, including an NRC technology, that could address this problem. To advance NRC's technology to TRL-6, the device will need to be flight qualified, fitted in an existing aircraft and validated in naturally occurring ice crystal clouds against conventional detection systems, a fairly expensive undertaking. HAIC will select 4 out of the 6 potential sensor technologies to be a part of a flight demonstration program with extensive instrumentations to quantify the ice crystal cloud. Such demonstration programs are often highly expensive, international in nature and well suited for an EU-Framework program with International participation.

In fact, since the late 1980' the NRC has been developing a sensor that detects airborne particles. It is this sensor that is being further refined for application not only as an ice crystal detector, but one that can detect sand and ash. Key attributes of this sensor is that it mounts flush to the fuselage so therefore does not increase the drag or become susceptible to foreign object damage or erosion. In addition, it is a passive sensor therefore requiring no electrical power. A critical advantage for NRC is that this sensor has already been tested in a high altitude wind tunnel and it has even taken flight on an NRC aircraft. Test results to date has confirmed that it has been effective in detecting ice crystals, sand and supercooled liquid water.

With its extensive icing expertise and world class research infrastructure that includes a number of wind tunnels, large engine test cells and the ability to test instrumentation on aircraft, NRC offers many competitive advantages to its collaborators on the HAIC project. It is expected that NRC will be making significant contributions to HAIC.

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CANNAPE Intervention:

There has always been a link between NRC and EU research organizations at the technical level. Having said that, CANNAPE played a key role in broadening this linkage to a significantly much wider group of EU R&D performers of icing research. CANNAPE's intervention led to the opening of the 5th call under FP7 within the High Altitude Ice Crystal project to include Canadian entities in the project, other than only in the United States. Follow-up discussions held at the first CANNAPE workshop in Paris in June 2011 helped to smooth the path for NRC inclusion in the project. In addition, the connections made as a result of CANNAPE with the EC helped pave the way in negotiating the bureaucratic challenges of becoming a non-EU partner in an EU project. This element proved to be important from an organizational perspective in ensuring NRC participation in the project.

Programme Aims:

Commercial aircraft have been experiencing in-service events while flying in the vicinity of deep convective clouds since at least the early 1990s. Heated probes and engines are the areas of air-craft most prone to mixed phase and glaciated icing threat. In anticipation of regulation changes regarding mixed phase and glaciated icing conditions, the HAIC project will provide the necessary Acceptable Means of Compliance (numerical and test capabilities) and appropriate ice particle detection/awareness technologies to the European aeronautical industry for use on-board commercial aircraft in order to enhance safety when an aircraft is flying in such weather conditions. HAIC will achieve high Technology Readiness Level (TRL6) for technologies (radar, detector) and capabilities (numerical models and tools, test facilities) developed as part of the project.

Expected Results:

The project is moving forward and the planned outcomes include the development of an ice crystal detector for aircraft applications attaining at least a TRL 5 level.

This technology will not only address forthcoming certification requirements for equipment manufacturers but will also be critical to identify, characterize and mitigate icing threats that can cause dangerous and costly challenges for aircraft operators and around the globe.

Aircraft will require certification against conditions representing ice crystal clouds from 2014.

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HAIC Programme Details

Programme Name: HAIC (High Altitude Ice Crystals)

Programme Cost: €22m, including an investment of $C400,000 from the NRC.

Duration: 4 years (October 2012 – October 2016)

HAIC Programme Participants

HAIC Partner	Country	HAIC Partner	Country
1 AIRBUS OPERATIONS SAS AI	France	21 INSTITUTUL NATIONAL DE CERCETARI AEROSPATIALE ELIE INCAS	Romania
2 AIRBUS OPERATIONS GMBH	Germany	22 Zodiac Intertechnique ZA-INT	France
3 AIRBUS SAS	France	23 METEO-FRANCE MET-FR	Canada
4 ARTTIC ARTTIC	France	24 NATIONAL RESEARCH COUNCIL CANADA NRC	Canada
5 ATMOSPHERE SYSTEMES ET SERVICES SARL	France	25 OFFICE NATIONAL D'ETUDES ET DE RECHERCHES AEROSPATIALES ONERA	France
6 Australian Bureau of Meteorology BOM	Australia	26 PIAGGIO AERO INDUSTRIES SPA PAI	Italy
7 AUXITROL ESTERLINE	France	27 ROCKWELL COLLINS FRANCE RCF	France
8 CENTRE NATIONAL DE LA RECHERCHE SCIENTI-FIQUE CNRS	France	28 KONINKLIJK NEDERLANDS METEOROLOGISCH IN-STITUUT (KNMI) KNMI	Netherlands
9 CENTRO ITALIANO RICERCHE AEROSPAZIALI SCPA CIRA	Italy	29 Science Engineering Associates, Inc SEA	United States
10 CRANFIELD UNIVERSITY CU	United Kingdom	30 SNECMA SA SNECMA	France
11 DASSAULT AVIATION SA DASSAV	France	31 STICHTING NATIONAAL LUCHT- EN RUIMTEVAART-LABORATORIUM NLR	Netherlands
12 DEUTSCHES ZENTRUM FUER LUFT - UND RAUMFAHRT EV DLR	Germany	32 TECHNISCHE UNIVERSITAET BRAUNSCHWEIG TUBS	Germany
13 DIRECTION GENERALE DE L'ARMEMENT/DGA ESSAIS PROPULSEURS DGA	France	33 TECHNISCHE UNIVERSITAET DARMSTADT TUD	Germany
14 EADS DEUTSCHLAND GMBH EADS IWG	Germany	34 THALES AVIONICS SA THAV	France
15 EASN Technology Innovation Services BVBA EASN TIS	Belgium	35 TUSAS-TURK HAVACILIK VE UZAY SANAYII AS TAI	Turkey
16 FEDERAL STATE UNITARY ENTERPRISE THE CENTRAL TSAGI	Russian Federation	36 UNIVERSITEIT TWENTE UTWENTE	Netherlands
17 GKN Aerospace Services Limited GKN	United Kingdom	37 VON KARMAN INSTITUTE FOR FLUID DYNAMICS VKI	Belgium
18 HONEYWELL INTERNATIONAL SRO HONEY-WELL	Czech Republic	38 HONEYWELL INTERNATIONAL INC HON-INC	United States
19 INSTITUT DE RADIOPROTECTION ET DE SURETE NUCLEAIRE IRSN	France	39 ROCKWELL COLLINS, INC. RC-INC	United States
20 INSTITUTO NACIONAL DE TECNICA AEROESPACIAL INTA	Spain		

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