2015 Ice Crystal Icing Research

Status Report: ICI Field Campaigns and NASA DC-8 WXR Research

Presented at: Friends/Partners in Aviation Weather

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Icing Crystal Icing (ICI) Field Campaigns

- Current lack of knowledge of ice crystal properties and mechanics of formation and extinction.
- Atmospheric research is needed in support of ice crystal engineering standards and simulation methods for MOC
- Atmospheric research is needed in support of mitigation strategies for the current fleet
  - On-board awareness technologies: reactive detection for identify and exit and on-board radar capability to identify ICI
  - Ice crystal weather tools development for diagnosing, nowcasting, and forecasting in support of avoidance strategies

HAIC-HIWC Collaboration

- European Commission High Altitude Ice Crystal and North American-Australian High Ice Water Content international collaboration to conduct atmospheric characterization of icing crystal icing (ICI) conditions

HAIC-HIWC Darwin Field Campaign (Jan-Mar 2014)

- Coordination resources
- Common regulatory and science objectives
- Data sharing and analysis

Number of Flights:	23
Number of flights with Appendix D/P cloud measurements:	16
Number of Oceanic MCS flights:	14 (88%)
Number Continental MCS flights:	2 (22%)
Number Isolated Cumulonimbus:	0
Number of Segments:	157
Total Distance in Segments (nm):	7648
Avg. length of Segment (nm):	36.5

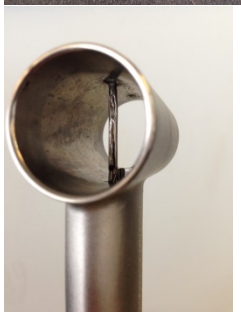
SAFIRE
Falcon 20GF

2D-S (10-100µm)

PIP (100µm-6.2mm)

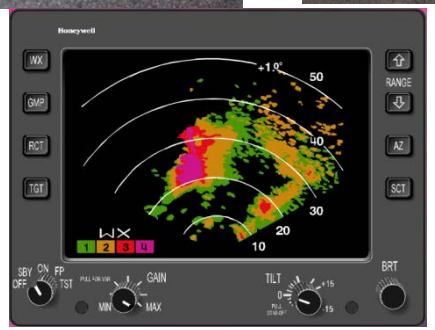
IKP2 (0 - 9g/m^3)

CDP2 (2 – 50 µm)



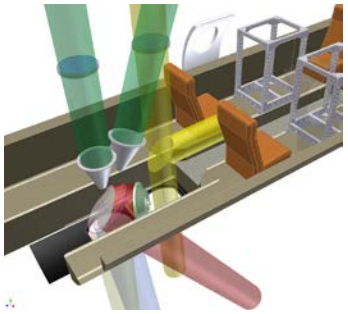
Hot wire Probe

Robust Probe



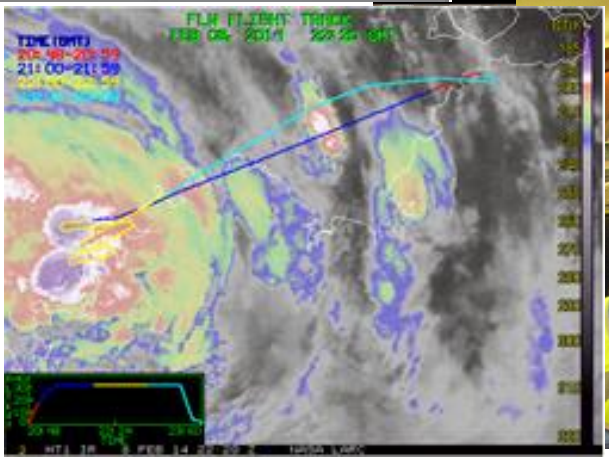
RASTA RADAR

Primus 660 RADAR



Darwin Field Campaign – ICI Research Flights

FS140018 - 3.4 F/H – Flight in system located North/West of Broome. 6 legs performed at FL310 / -30°C with sustained IWC at 1.0g/m3 and peaks from 1.5g/m3 to 2.5g/m3 (1 peak).



HAIC-HIWC Cayenne Field Campaign (May 2015)

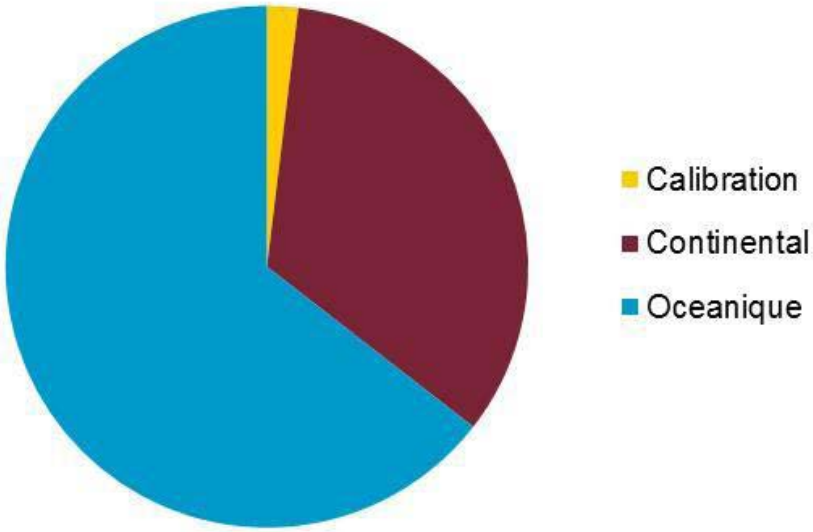
- Conduct a 3 weeks field campaign out of Cayenne, French Guyana to collect data in deep convective clouds.
- Satellite, and weather models & nowcasting tools used to determine test areas and to support post-test data analysis

- SAFIRE Falcon 20 aircraft equipped with active remote sensing (airborne Doppler cloud radar) and *in situ* microphysics probes – sample data at -50°C & -10°C Flight Levels
- NRC Convair 580 aircraft equipped with active remote sensing (airborne Doppler cloud radar) and *in situ* microphysics probes – sample data at -10°C Flight Level
- Honeywell B757 aircraft equipped with enhanced weather radar (WXR) to validate radar ice crystals awareness functions using other A/C in-situ measurements

Cayenne Field Campaign – Summary

- 19 flights performed
  - 1 A/C = 5 flights
  - 2 A/C = 8 flights
  - 3 A/C = 6 flights
- Data Analysis ongoing
- Should have enough -10C data for regulatory purposes
- Still need more -50C data

Partition of flight hours

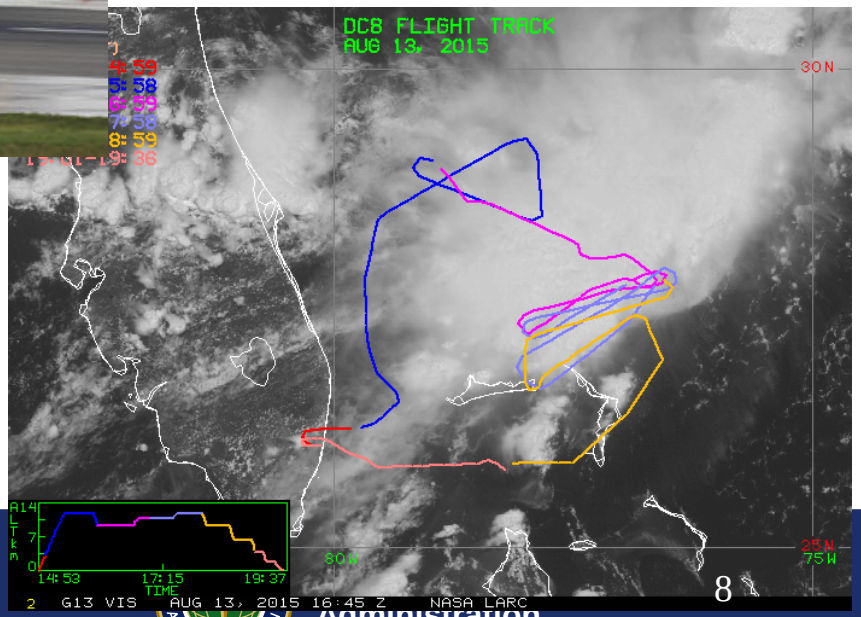


NASA ICI Flight Research - On-Board Wx Radar Project

Southern Florida; August 8 -29

- Goal: Develop WXR to identify HIWC conditions ahead of an aircraft
- Approach: acquire pilot weather radar data in MCS along with corresponding in-situ cloud physics data

- Data used to characterize response radar and develop and test HIWC identification algorithms
- Data augment database for Appendix D regulations and for certification and MOC



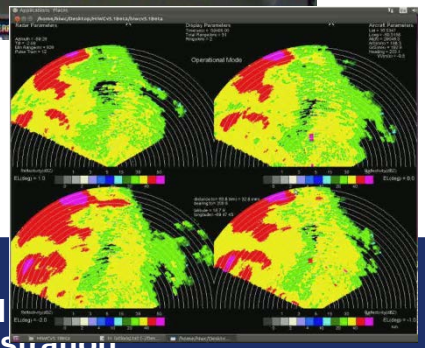
NASA DC-8 Instrumentation

PIP (100µm-6.2mm) 2D-S (10-100µm)

IKP2 (0 - 9g/m^3) CDP2 (2 – 50 µm)

Heated TAT and pitot collect ice

RDR-4000 RADAR



Concluding Remarks

- HAIC-HIWC international field campaigns: yielded extensive datasets; data now being processed and archived
  - Working to complete common analysis methodology
  - Completion of Darwin and Cayenne data by March 2016
  - ✓ Campaigns have provided substantial information to support evaluation for mitigation strategies of current fleet operations in high altitude ICI
    - Cockpit cues
    - On-board awareness technologies – detection and radar
    - Ice crystal weather tools development and evaluation
- NASA on-board radar project: acquired substantial data with range and duration on NASA DC-8. Data extensive and of high quality.
  - Processing and analysis of data just starting
  - Next steps: determine ability to adapt current on-board weather radar to provide useful information for avoidance