



HAIC/HIWC International Field Campaigns Summary

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HAIC/HIWC International Field Campaign

Content

- International Field Campaign Objectives
- Darwin International Field Campaign Overview
- Cayenne International Field Campaign Overview



HAIC/HIWC International Field Campaign

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- **International Field Campaign Objectives**
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HAIC/HIWC International Field Campaign

International Field Campaign Objectives

HAIC/HIWC international Field Campaign was set up to enhance knowledge of ice crystal icing in deep convective clouds and be able to assess future regulations.

The field campaign was the result of an **international collaboration** between the HAIC, EASA-HighIWC and HIWC projects and involved necessary **expertise** in a wide range of skills and the **main stakeholders** in the field, whether they were based in Europe, North America, Australia or Japan.

Industry Objectives

Industry Objectives	HAIC	HIWC	Priority
E1: Characterize 99th percentile TWC and particle size for FAA/EASA regulatory objectives	X	X	P0
E2: Flight-Deck Recognition of the High-IWC Environment Incl. IDS & WXR	X (partially)	X (partially)	P2
E3: Development of Tools to Nowcast the High-IWC Environment	X (partially)	X	P1



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International Field Campaign Objectives

Science Objectives

Science Objectives	HAIC	HIWC	Priority
S1: Characterize the microphysical and thermodynamic properties of core or near-core regions	X	X	P1
S2: Determine the small ice particle formation mechanisms and importance to bulk microphysical properties	X	X	P2
S3: Determine the temporal and spatial evolution of the mixed-phase	X	X	P2
S4: Validate and improve ground remote sensing algorithms of cloud properties		X	P2
S5: Validate and improve satellite remote sensing algorithms of cloud properties	X (partially)	X	P1
S6: Improve cloud resolving model simulations		X	P2
S7: 3D high-resolution characterization of the dynamical and microphysical properties of ice clouds (RASTA / T-Matrix)	X	X	P1



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Darwin International Field Campaign Overview

Approach

- Conducted a 9 week field campaign based in Darwin Australia to acquire data in deep convective clouds with the **primary objective to provide 99th percentile total water content statistics, as a function of distance scale**, to industry and regulators.
- Utilized the SAFIRE Falcon 20 aircraft equipped with active remote sensing (airborne Doppler cloud radar) and *in situ* microphysics probes
- Utilized satellite, ground-based radar and lightning networks, and weather models to determine test areas and to support post-test data analysis

Schedule:

Items	Schedule
Falcon 20 departure from Toulouse and arrival in Darwin	January 8 to January 12, 2014
Instruments installation, Power ON and Ground tests	January 13 to January 14, 2014
Start of the campaign	January 15, 2014
<i>Preliminary F/T in dry air and high IWC regions</i>	<i>January 15 to January 17, 2014</i>
<i>HAIC/HIWC Field Campaign</i>	<i>January 18 to March 14, 2014</i>
End of the campaign	March 14, 2014
Instruments unmounting	March 15 to March 16, 2014
Falcon 20 departure from Darwin and arrival in Toulouse	March 17 to March 21, 2014



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Darwin International Field Campaign Overview

Instrumentation

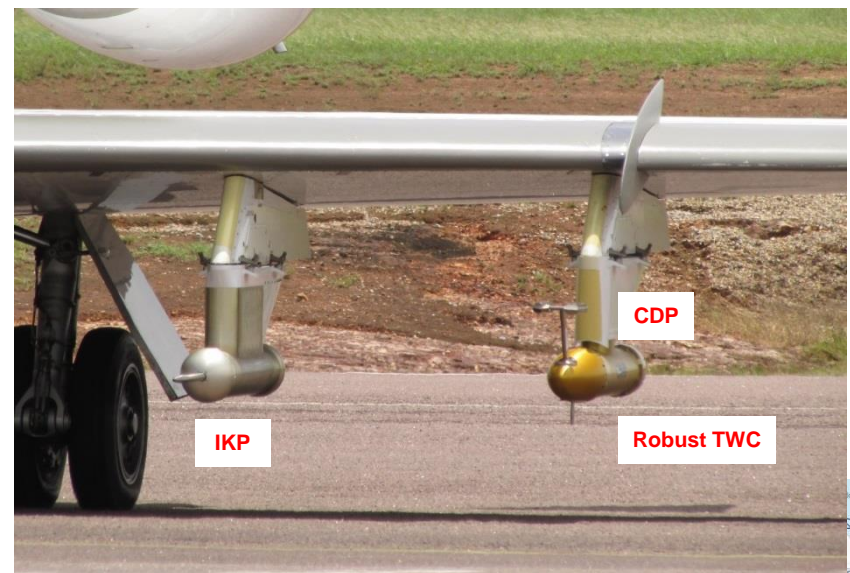
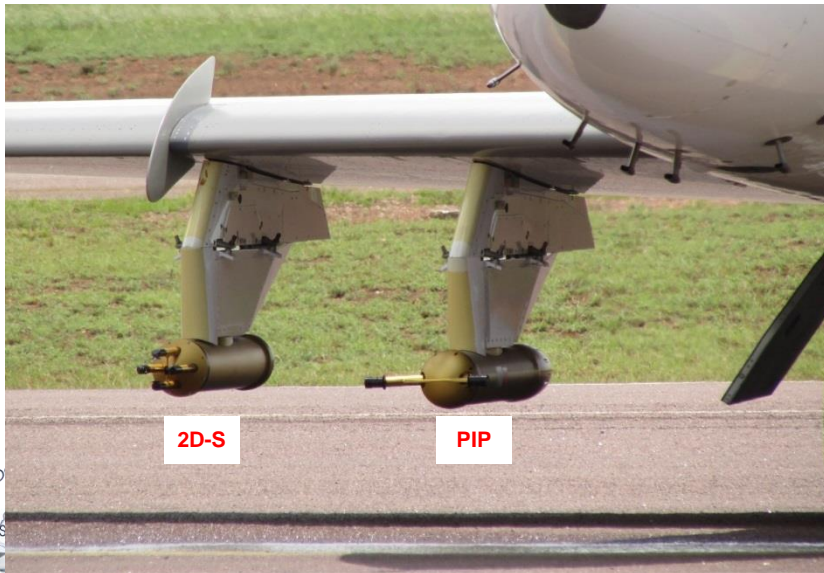
Particular instrumentation had been developed for HAIC/HIWC international field campaign.

	Belly Aperture	Under wing Pylon#1	Under wing Pylon#2	Cabin	Under wing Pylon#3	Under wing Pylon#4	Other
Baseline	SEA LWC Probe 	2D-S 10 to 1280µm  * 1 spare	PIP 100 to 6200 µm  * 1 spare	RASTA Radar  * No spare	IKP Ref TWC  * Spare components	CDP (2-50µm) Robust (TWC)  * 2 spares	AMPERA  * No spare
Alternate	SEA ICD * No spare			&	CPI Particles shapes  * 1 spare	CPSPD 2 to 50µm  * No spare	WSSI  * No spare
Alternate #2		CIP (back-up)	2D-P (back-up)	CAMERA in Cockpit	HSI Particles shapes  * 1 spare	SEA LWC Probe Or SEA ICD (Robust replacement)	CR-2  * No spare
							RICE LM5  * No spare

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Darwin International Field Campaign Overview

Test Aircraft: SAFIRE Falcon 20



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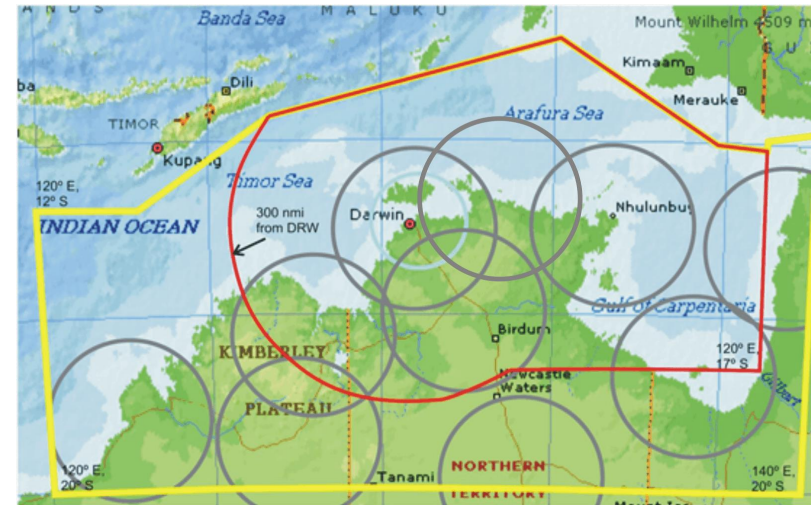
Darwin International Field Campaign Overview

Logistics

Operational Area:

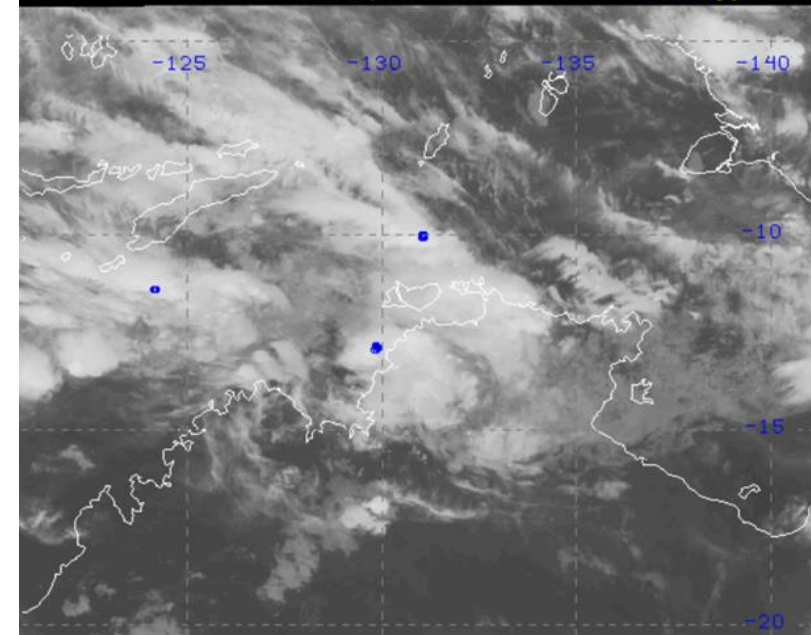
Observations Network:

- **Weather Radars:** A large BOM research and operational weather radars network including C-Pol research polarimetric weather radar
- **Satellite:** Primary source of satellite data was MTSAT-1R scans provided by JMA. For the field campaign, special 10 min rapid scan data was provided to support flight guidance and research.



MTSAT-1 OVERSHOOTING TOP DETECTION
JAN 31, 2014 19:00Z

NASA Langley



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Darwin International Field Campaign Overview

Schedule:

- Timeframe: January 16 to March 7, 2014
 - ▶ Campaign started as planned. All team members, equipment, and the Falcon 20 arrived in Darwin on time.
 - ▶ Significant monsoon conditions from start through mid February
 - ▶ Campaign ended 1-week early due to aircraft maintenance and forecasted waning storms



Flights:

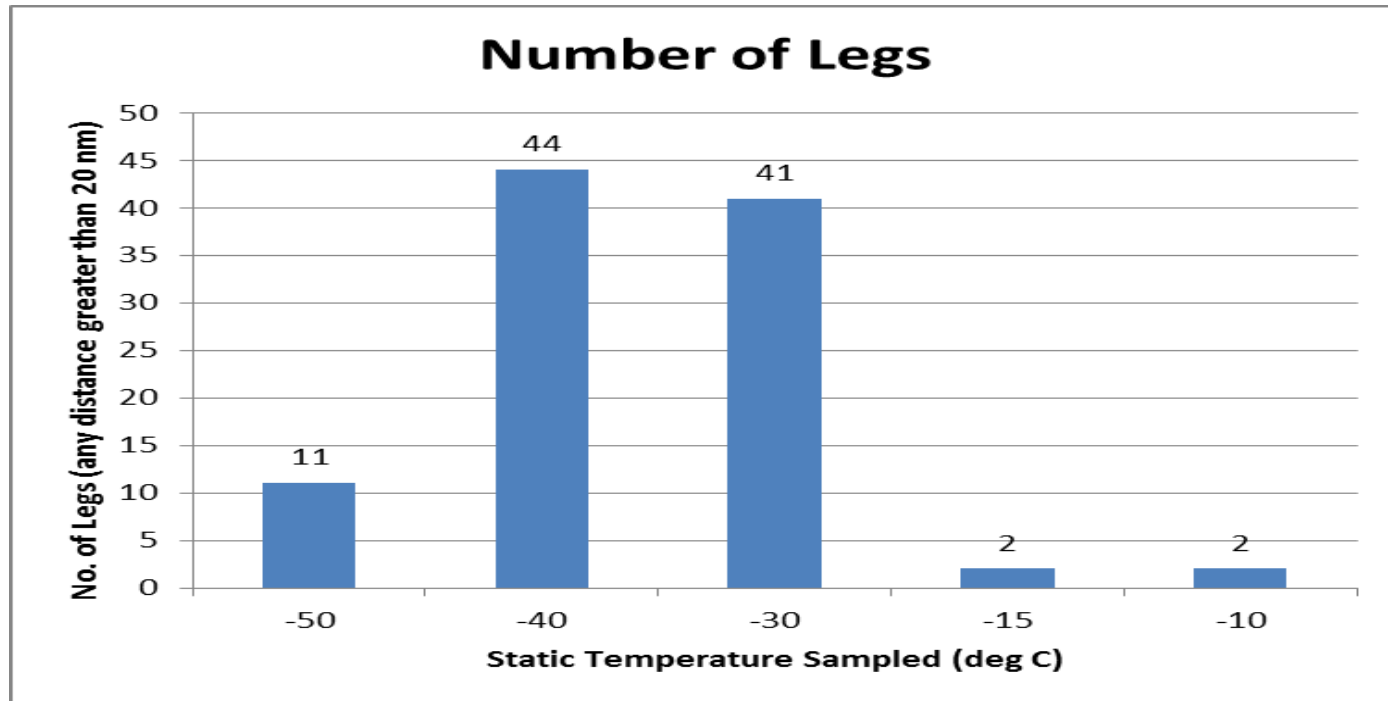
- Conducted 23 research and calibration flights
 - ▶ Used 72 of 150 flt-hrs budgeted for research flights

HAIC/HIWC International Field Campaign

Darwin International Field Campaign Overview

Data:

- Acquired cloud microphysical and remote sensing data during 100 level transects at various altitudes.
 - ▶ 11 legs at -50C; 44 legs at -40C; 41 legs at -30C; 4 legs at -15C/-10C
 - ▶ Required 100 transects of 20 nautical mile scale length at each of -50C, -30C , -10C altitude levels to achieve 99th percentile statistics



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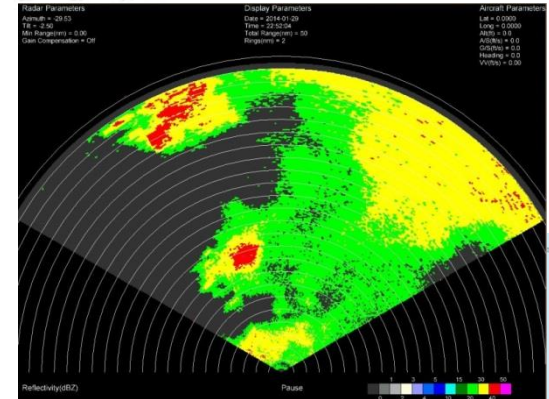
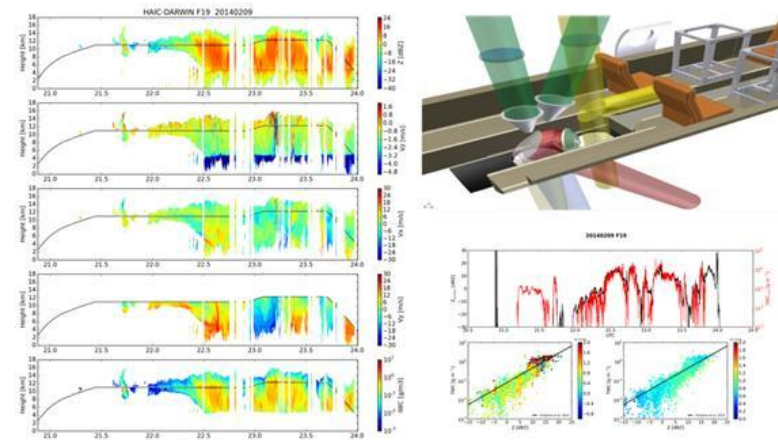
Darwin International Field Campaign Overview

Data sets include:

- TWC (IKP, Robust)
- Particle Spectra (CDP, 2D-S, PIP)
- Particle imaging (2D-S, PIP)
- Cloud Radar Reflectivity / Doppler Velocity (RASTA)
- Temperature, Water vapor, Altitude
- Pilot Wx Display (Primus 660)
- Satellite data
- Ground radar data
- Weather Model Output

Data Analysis On-going

- Multi-party effort:
 - ▶ FAA-sponsoring project scientist to work on IKP data set and TWC statistics
 - ▶ Europeans working particle spectra, Robust and RASTA radar
 - ▶ BoM working ground radar and RASTA
 - ▶ Many others working on other aspects



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Darwin International Field Campaign Overview

Conclusion

- 23 Flights and 72F/H achieved on site (target 150F/H)
 - ▶ High quality dataset
 - ▶ Oceanic convection at FL -30°C and -40°C, only few data at -10°C and -50°C
 - ▶ Most of the data acquired in MCS ~ 2-3 hours after peak intensity
- HAIC/HIWC Field Campaign terminated on 07-March 2014 in agreement with funding agencies (EASA, FAA, European Commission)
- A/C back in Toulouse on 21-March 2014 as planned

Way Forward

- Pursue post-treatment of all data collected during the international Field Campaign

As the objective to provide **99th percentile total water content statistics**, as a function of distance scale, was not reached for at least two flights levels, decision was taken to perform **a second campaign in May 2015 out of Cayenne, French Guyana** to complete the database.



Cayenne 2015 campaign was supported by the **HAIC, EASA-HighIWC and HIWC** research projects with the additional support of ICC.



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- **Cayenne International Field Campaign Overview**



HAIC/HIWC International Field Campaign

Cayenne International Field Campaign Overview

- Conduct a 3 weeks field campaign out of Cayenne, French Guyana to collect data in deep convective clouds with the **primary objective to provide 99th percentile total water content statistics, as a function of distance scale**, to industry and regulators.
 - ▶ Use the **SAFIRE Falcon 20** aircraft equipped with active remote sensing (airborne Doppler cloud radar) and *in situ* microphysics probes to sample $-50^{\circ}\text{C}/-10^{\circ}\text{C}$ Flight Level
 - ▶ Use the **NRC Convair 580** aircraft equipped with active remote sensing (airborne Doppler cloud radar) and *in situ* microphysics probes to sample -10°C Flight Level and vicinity of clouds
 - ▶ Use the **Honeywell B757** aircraft equipped with enhanced weather radar to validate radar ice crystals awareness function thanks to other A/C in-situ measurements



SAFIRE Falcon 20 (atmosphere characterization)



NRC Convair 580 (atmosphere characterization)



Honeywell B757 (weather radar)

Use satellite, ground-based radar, lightning networks, and weather models & nowcasting tools to determine test areas and to support post-test data analysis



HAIC/HIWC International Field Campaign

Cayenne International Field Campaign Overview

- The field campaign took place from **May 9, 2015 to May 29, 2015**
(1 month campaign)

Items	Schedule
Falcon 20 departure from Toulouse and arrival in Cayenne	May 3 to May 6, 2015
Instruments installation, Power ON and Ground tests	May 7-8, 2015
Start of the campaign	May 9, 2015
<i>Preliminary F/T in dry air and high IWC regions</i>	<i>May 9, 2015</i>
<i>HAIC/HIWC Field Campaign</i>	<i>May 11, 2015</i>
End of the campaign	May 29, 2015
Instruments unmounting	May 30, 2015
Falcon 20 departure from Cayenne and arrival in Toulouse	May 31 to June 3, 2015

A/C	Deployment	Flight Hours
SAFIRE Falcon 20	6-31 May 2015	102,4F/H including ferry flight → 59,4F/H on-site
NRC CONVAIR	6-29 May 2015	~45F/H on-site
HWL B757	14-30 May 2015	~35F/H on site

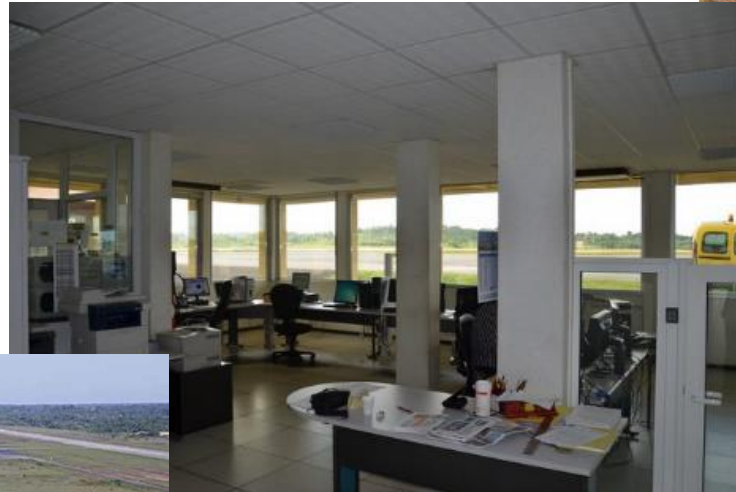


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Cayenne International Field Campaign Overview

- Logistics Challenge

- ▶ Falcon 20 located on the military side
- ▶ Convair and B757 located on civilian side (parking in front of the control tower)

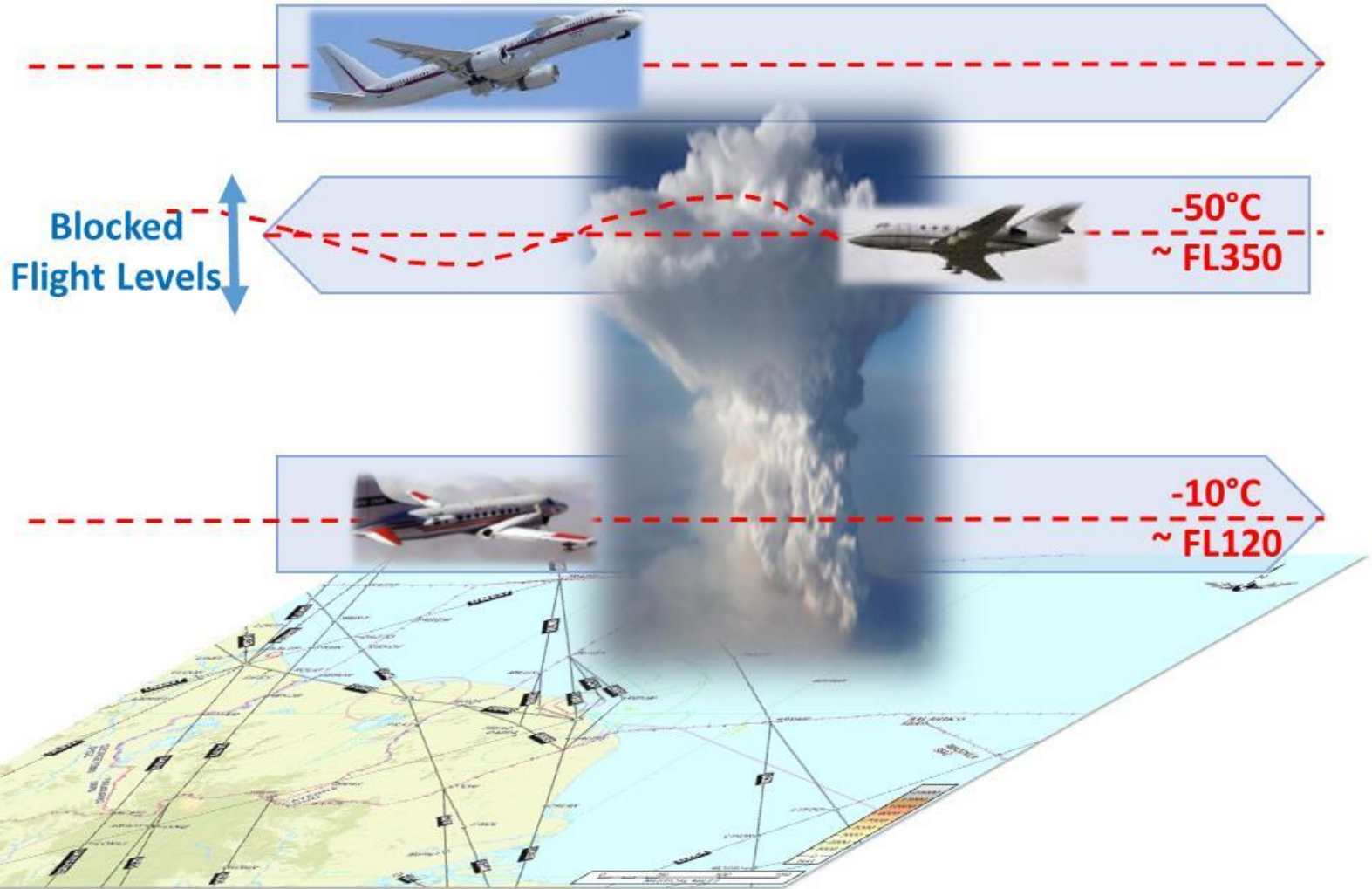


50 - 70 people
on site

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Cayenne International Field Campaign Overview

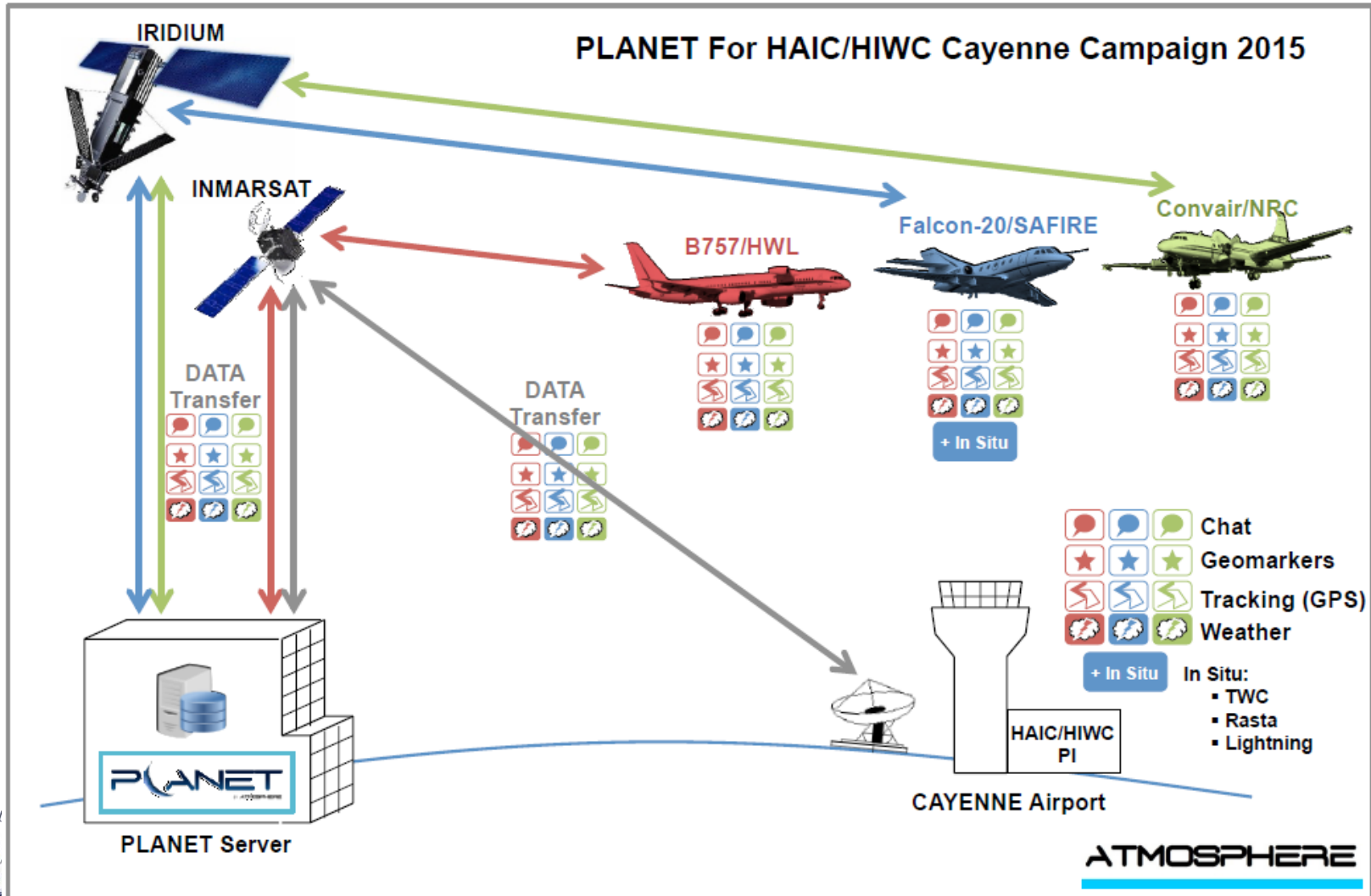
- Operations Challenge



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Cayenne International Field Campaign Overview

➔ PLANET Flight guidance tool adaptation for Cayenne 2015



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Cayenne International Field Campaign Overview

→ Intense and fruitful campaign which allowed collecting a large set of data to support regulatory objectives, science and the development of new ice crystals awareness system.

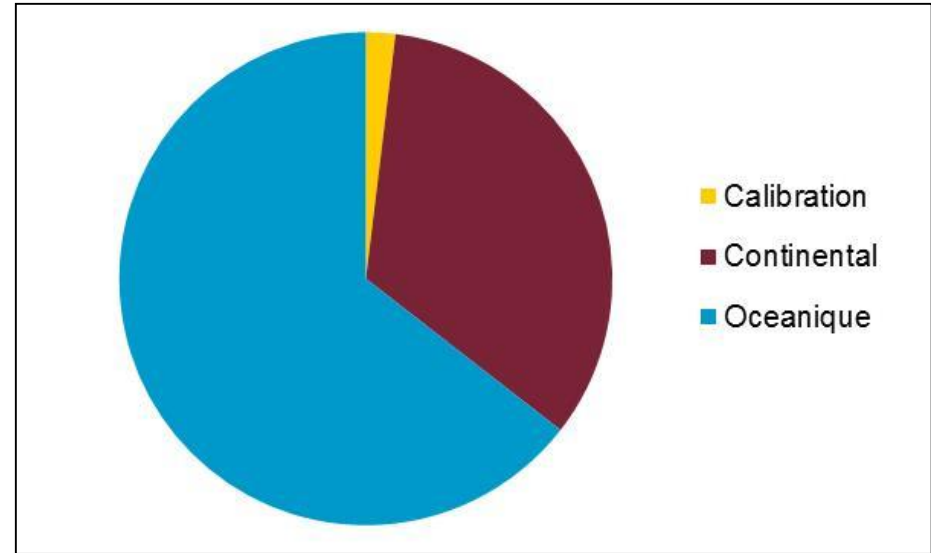
19 flights performed:

- 1 A/C = 5 flights
- 2 A/C = 8 flights
- 3 A/C = 6 flights

→ Large dataset collected
International collaboration for data
post-treatment (HAIC/HIWC)

Next Steps:

- Data Post-processing
- Assessment of the relevance of App D/P & Recommendations



Repartition of flights (Flight Hours)

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Thank you for your attention.

Questions?

