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HAIC-HIWC Science Meeting 9-12 November 2015 BoM, Melbourne, Australia

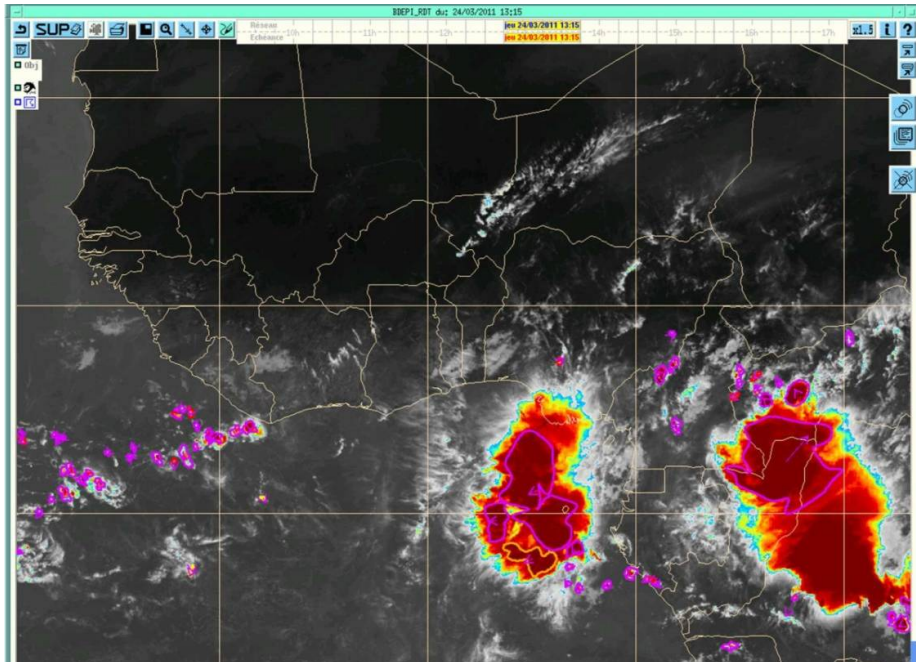
SP3: SPACE-BORNE OBSERVATION & NOWCASTING OF HIGH IWC REGIONS

High Altitude Ice Crystals
Contents

- Objectives
- Reminding the general strategy
- CPP (Cloud Physical Properties) products
- RDT (Rapidly Developing Thunderstorms) tool
- The A-Train Mission and the DARDAR product
- Assessing KNMI High IWC mask performances
- Assessing RDT performances
- Analysis of some Cayenne flights
- Preliminary inter-comparison of the products
- Preparation to HAIC 2016 campaign

SP3 Technical Achievements Focus
Objectives

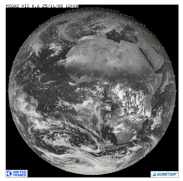
To develop **space-borne remote detection and nowcasting techniques of convective systems** to support the first (Darwin, 2014) second (Cayenne, 2015) and third (**Indonesia, early 2016**) HAIC flight test campaigns, and to ultimately provide near real-time weather data through ATM as being studied as part of SESAR



Deep tropical convective supercells processed by RDT

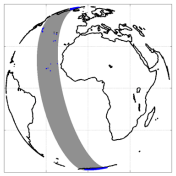
SP3 Technical Achievements Focus
Reminding the General Strategy

KNMI CPP
MET-FR RDT



GEO

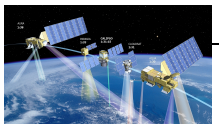
LEO



A-Train
(TRMM)

In-service event database → Cloud environment → ***space- at in-se ions ation***

Dedicated field campaigns → Cloud environment → ***space- at the ions ion***



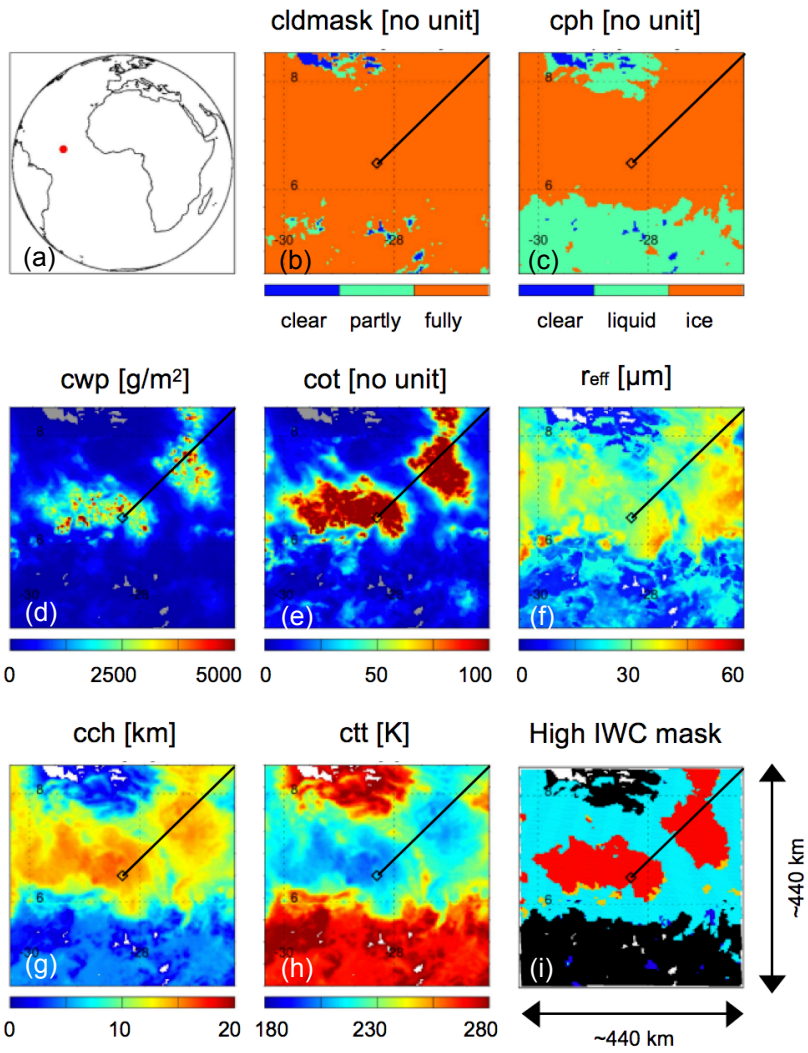
Clouds of interest as detected from active A-Train Sensors → Cloud environment → ***Signat space- able tions***

Adapt KNMI CPP & MET-FR RDT For Operational Applications

SP3 Technical Achievements Focus
CPP (Cloud Physical Properties) Products

Retrieval technique providing cloud properties

- EUMETSAT SAF “Climate”
- Applied on Meteosat Second Generation VIS and NIR channels
- Daytime products
- Retrieve the particle effective radius at cloud top, cloud mask, cloud top phase, cloud water path, cloud top height, cloud top temperature…
- Validated using ground-based and satellite observations
- Development, validation and operational implementation of VIS/NIR High IWC detection

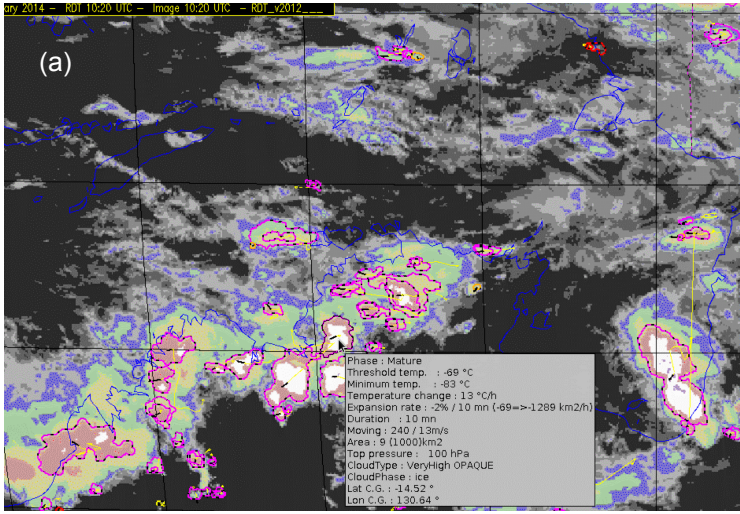


CPP products at the time of an in-service event

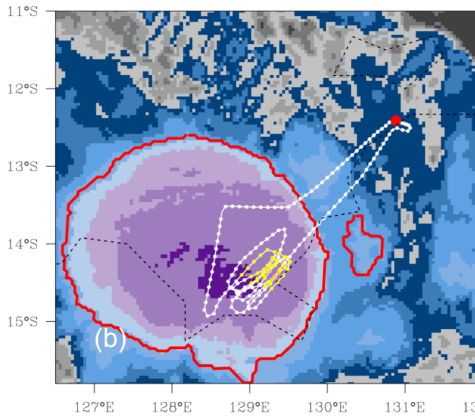
SP3 Technical Achievements Focus
RDT (Rapidly Developing Thunderstorms) Tool

Detection and tracking techniques of convective clouds

- EUMETSAT SAF “Nowcasting”
- Applied on Meteosat Second Generation channels
- Can be used with other GEO satellites
- Day & night products
- Identify convective and retrieve cloud top altitude, contour, level of maturity…
- Track identified cells
- Validated using ground-based lightning observations
- Development, validation and operational implementation of detection and tracking of High IWC cloud regions



Real time RDT product (top) and post-campaign HAIC/HIWC analysis (bottom)



SP3 Technical Achievements Focus
The A-Train Mission

Detection and characterization of the convective clouds

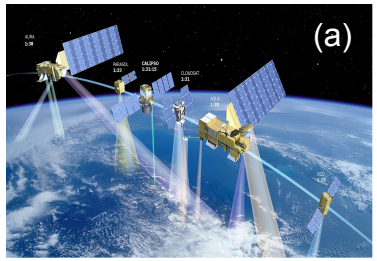
- Active techniques
  - Cloud radar, lidar
  - DARDAR products
- Passive techniques
  - Visible, IR and MW imagery
  - POLDER & MODIS products
  - AMSRE MW brightness temperatures
- Investigate specific VIS/NIR/IR/MW signatures of High IWC cloud region based on DARDAR IWC retrieval
- Support for the validation, training and improvement of SP3 algorithms

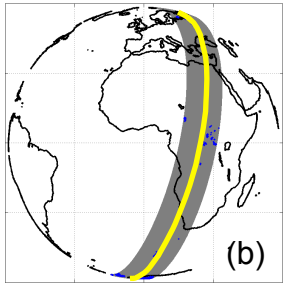
Instruments (1)	Available products
POLDER/Parasol MODIS/Aqua [Vis/NIR]	Cloudiness, cloud pressure, optical depth, albedo, particle size, particle thermodynamic phase,…
MODIS/Aqua [IR]	Cloudiness, cloud top temperature, cloud top altitude, emissivity, particle size,…
AMSRE/Aqua [MW]	Brightness Temperatures
Caliop/Calipso [lidar]	Optical depth, cloud depth, cloud particle phase,…
CPR/Cloudsat [cloud radar]	Cloud mask, classification, IWC, LWC, PSD,…

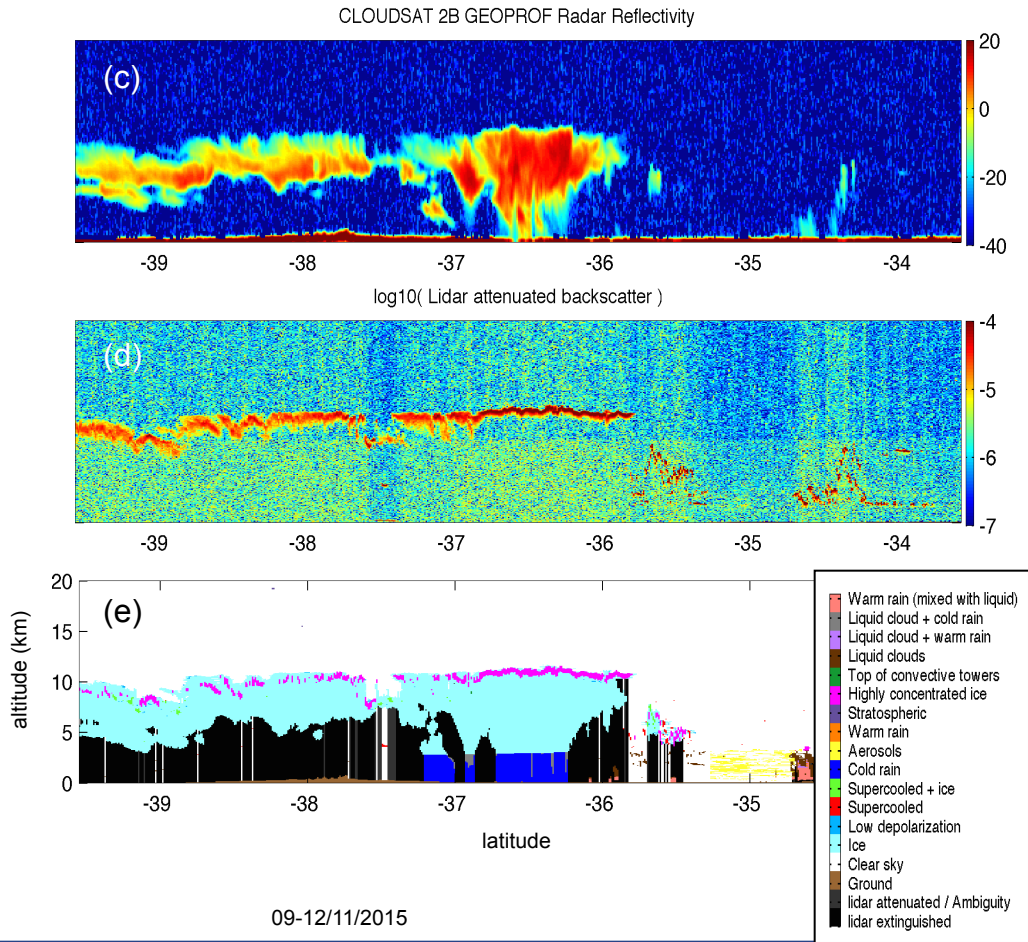
(1) Other missions are also considered like TRMM, GPM, Modis/Terra

SP3 Technical Achievements Focus
The DARDAR Product

- Combination of coincident radar (95 GHz) and lidar (532 & 1064 nm) space-borne A-Train observations sensitive to different properties of the clouds (phase, particle size distribution)
- Capability to retrieve the vertical distribution of IWC and r_e through a variational approach
- Capability to classify the cloud type at each altitude bin
- Always concurrent visible, infrared and microwave observations available of the A-Train mission
- Global coverage but small swath
- *RASTA mimics the A-Train radar*

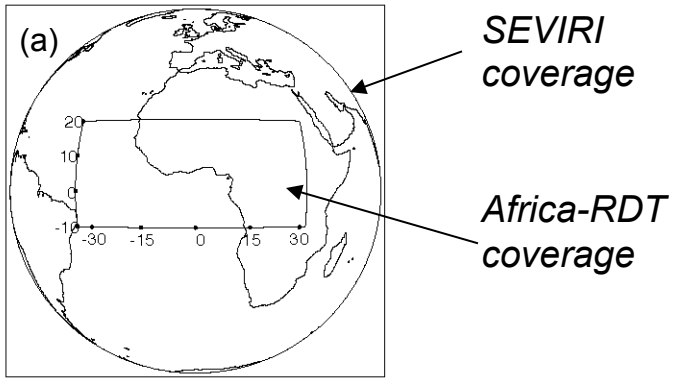




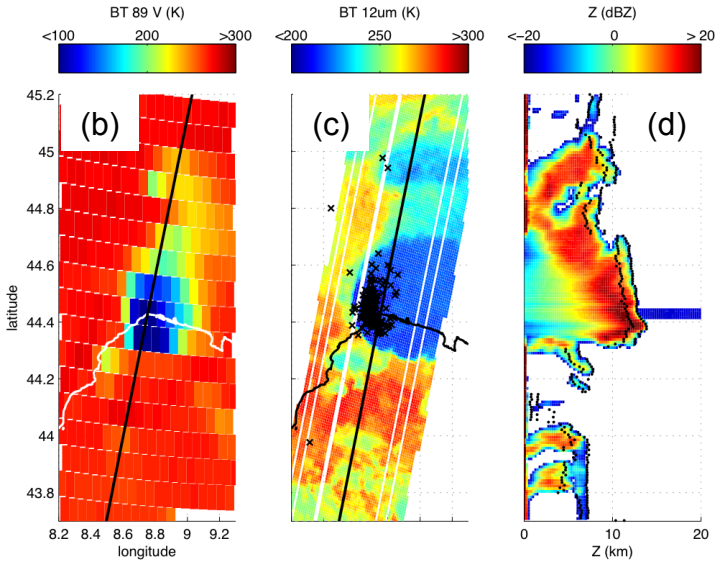


SP3 Technical Achievements Focus
A Strategy for Evaluation and Signature Investigation

- Selection of the DARDAR data for year 2008, day & night overpasses located in SEVIRI and Africa-RDT coverage areas
- Evaluation of the operational products:
  - Refinement and validation of KNMI High IWC mask
  - Assess the performances of RDT operated over Africa
- Exploring High IWC signature in concurrent passive visible, infrared and microwaves
  - Expand the DARDAR swath
  - Apply to other LEO missions
- Development of dedicated software to extract, plot and analyze the data
- Methodology discussed during the SP3 Live Data Analysis meeting (M32)



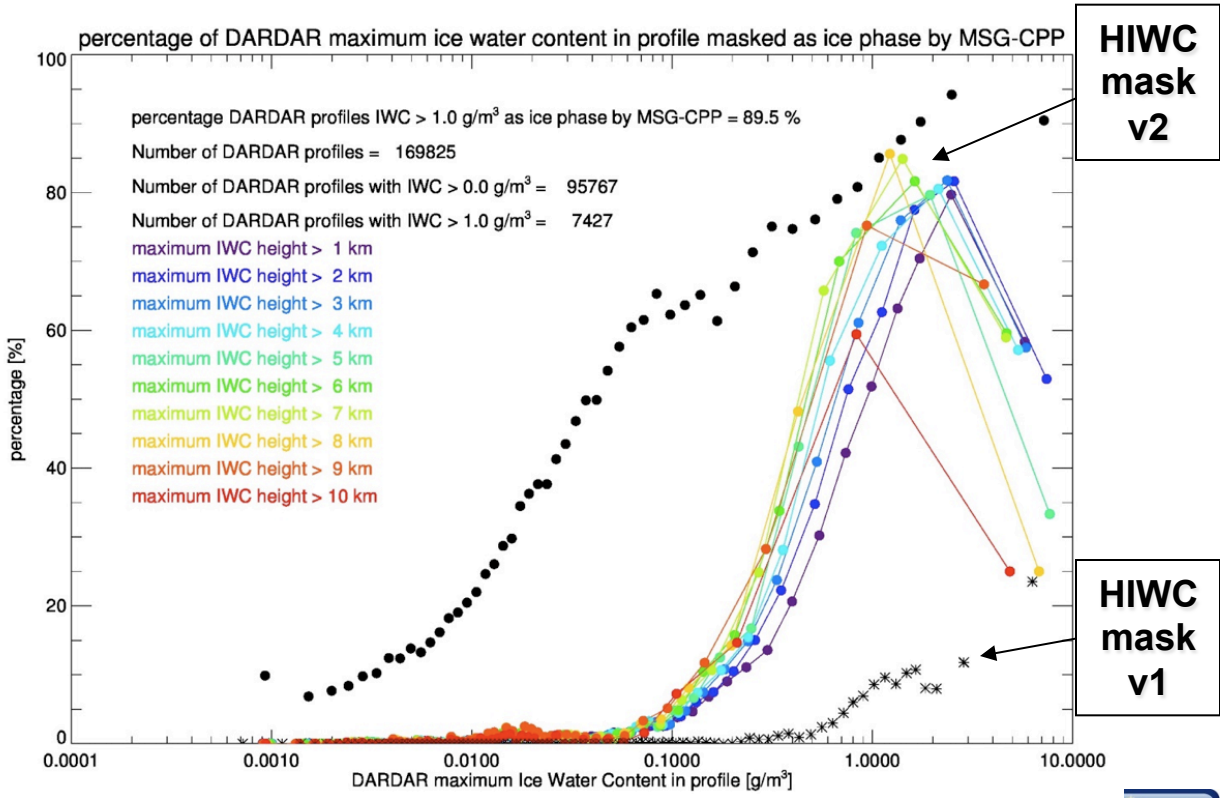
Example of A-train observations



SP3 Technical Achievements Focus
KNMI High IC Mask Algorithm Performances

- Two versions developed (trained on in-service events; trained on DARDAR)
- Rate of detection of the MSG-CPP HIGH IWC as function of the **maximum IWC in the DARDAR vertical profile** (same work performed with in-situ and RASTA records of HAIC-HIWC Cayenne 2015 campaign but not shown here)

Product	High IWC mask v1 (TRL3)	High IWC mask v2 (TRL5)
Cloud phase	Ice	ice
Effective radius	> 10 µm	No threshold
Condensed water path	> 1 kg/m²	> 0.1 kg/m²
Cloud Top Height	> 8 km	No threshold
Cloud Top Temperature	< 225 K	< 270 K
Cloud optical thickness	No threshold	< 20



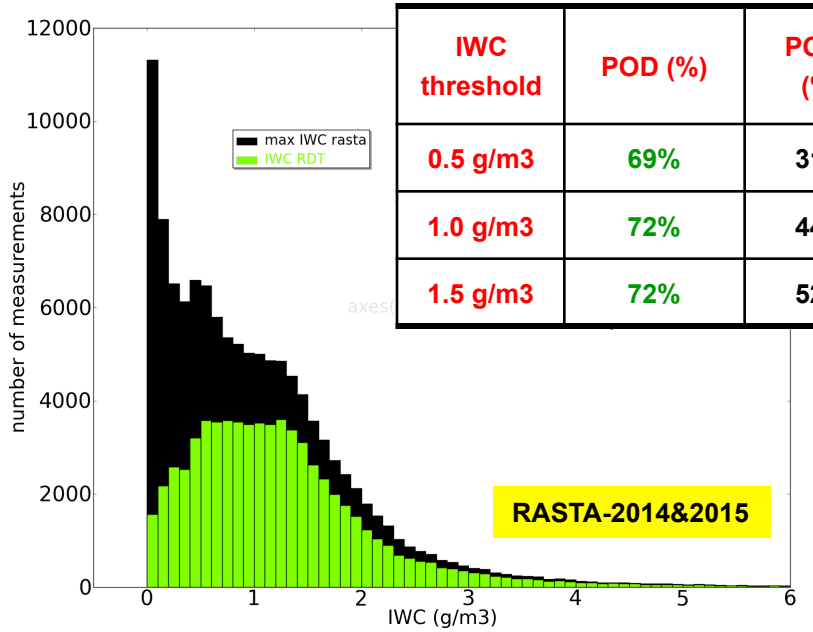
SP3 Technical Achievements Focus
MET-FR RDT Performances

	High IWC **YES**	High IWC **NO**
Inside RDT cell	**A [hit]**	**B [false]**
Outside RDT cell	**C [miss]**	**D**

Probability Of Detection
POD=A/(A+C)

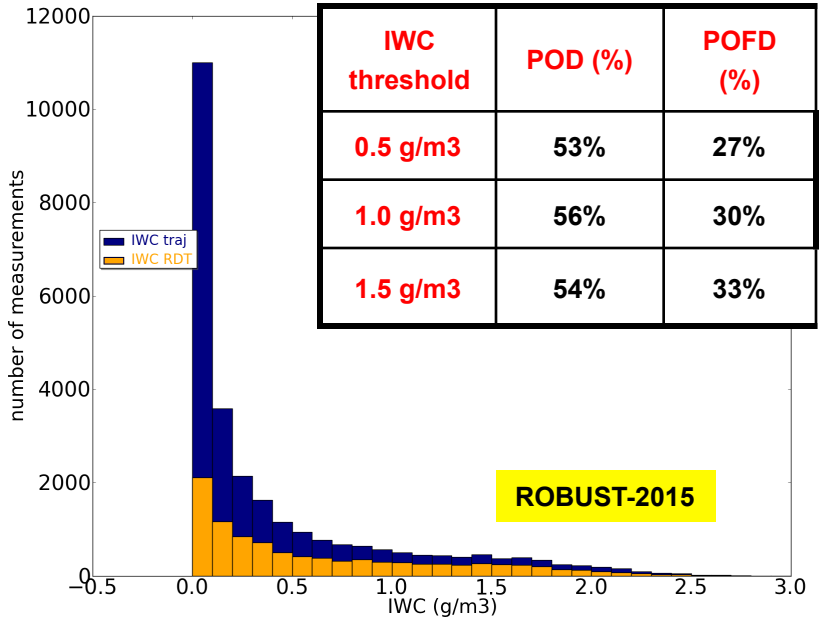
Probability Of False Detection
POFD=B/(B+D)

IWC from Rasta (all) - Cayenne&Darwin experiment - RDT closest image



IWC threshold	POD (%)	POFD (%)
0.5 g/m3	69%	31%
1.0 g/m3	72%	44%
1.5 g/m3	72%	52%

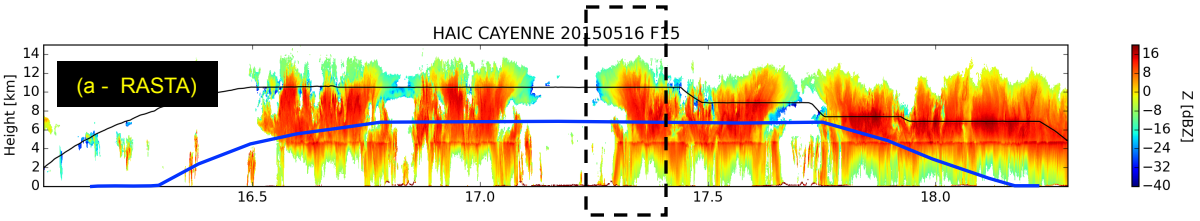
IWC from Robust (5sec) - Cayenne experiment - RDT closest image

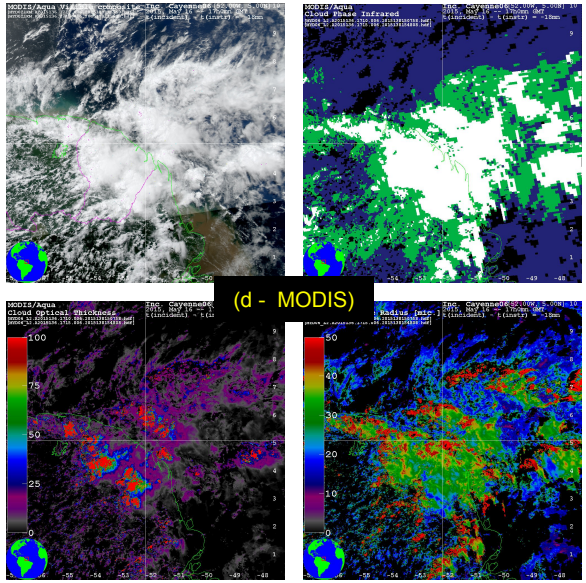


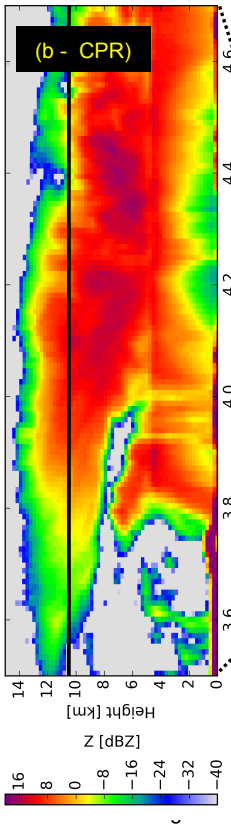
IWC threshold	POD (%)	POFD (%)
0.5 g/m3	53%	27%
1.0 g/m3	56%	30%
1.5 g/m3	54%	33%

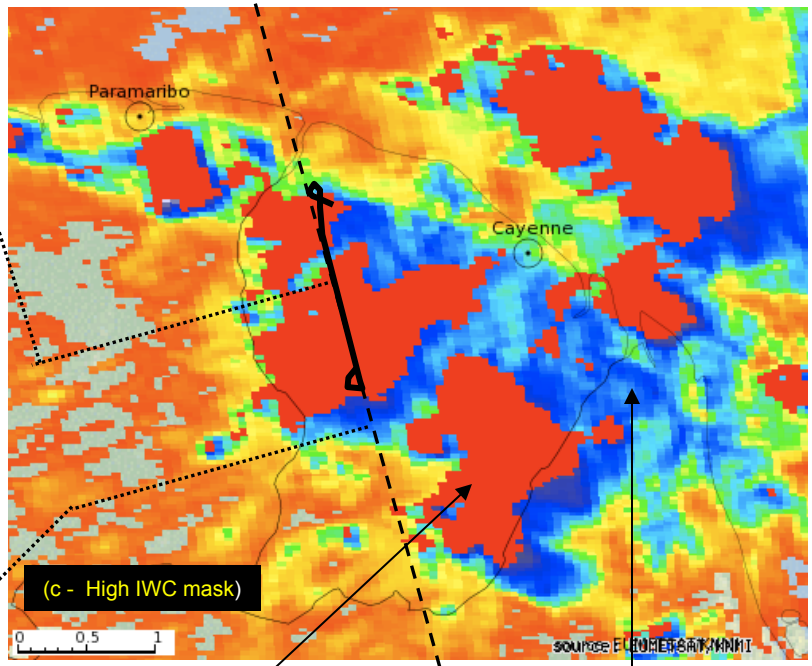
SP3 Technical Achievements Focus
Cayenne 2015 16 May 2015b Flight (1/2)

- Coordinated flights with A-Train overpass on 16 May 2015 @ 17:15 UT





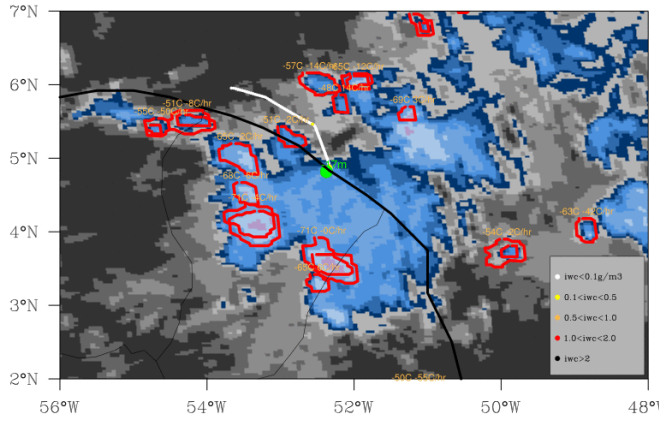




High IWC mask

Cloud top temperatures

(e - High IWC mask) 1600UTC



SP3 Technical Achievements Focus
Cayenne 2015 16 May 2015b Flight (2/2)

Parameters	Description
Weather description	Storms that developed along the coast line west of Cayenne and moved westward. Storms sampled after its motion away from Cayenne during their development.
Flight description	Falcon : 16:00-18:30 UTC; 10.6, 8.9, 7.4, 6.9 km height. Convair : 16:20-18:10 UTC; 6.8 km height. Cloudsat overpass at 17:48 UTC
Overview of SP3 products	High IWC region identified by KNMI product. Series of cells identified by RDT embedded in large cloud overcast.

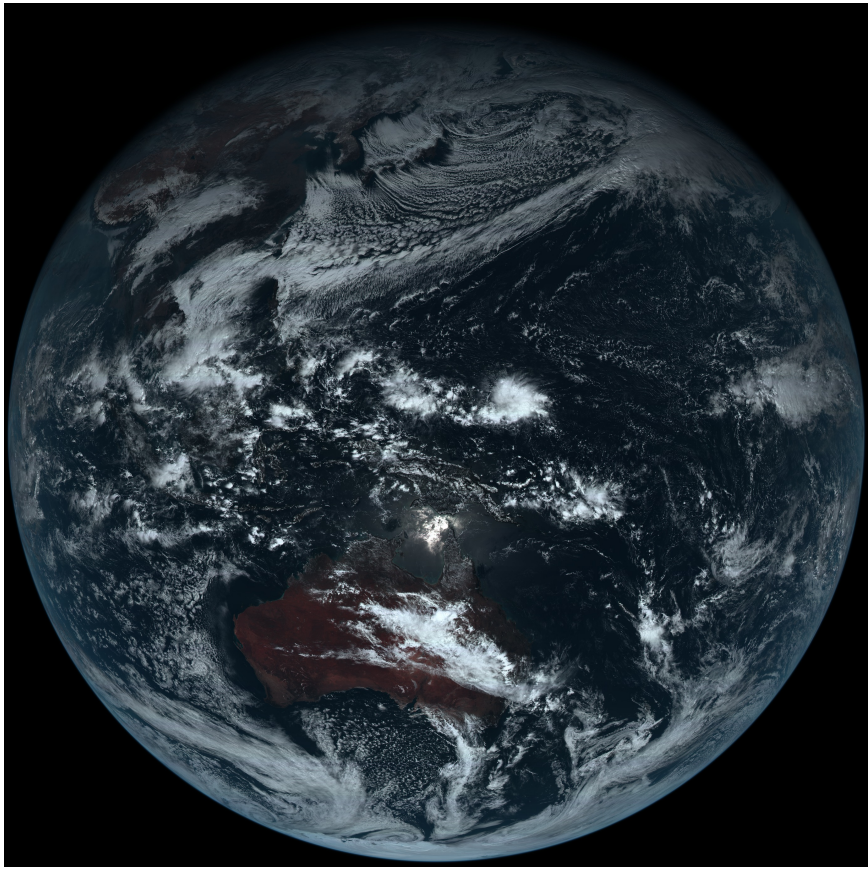
SP3 products, RASTA max IWC & F20 track

Consistent SP3 products relative to RASTA max IWC spatially and temporally

[animation]

SP3 Technical Achievements Focus
Preparation to HAIC 2016 Campaign

- Adaptation of SP3 algorithms to HIMAWARI data underway
- Operational displays similar to the ones applied during HAIC-HIWC Cayenne 2015 campaign and ready for **early December**
- SP3 wish list :
  - **Coordinate as much as possible AIRBUS flights according to scheduled satellite overpasses**
  - Explore specific cloud regions (e.g. cloud edges) for verification of SP3 products



HIMAWARI-8 - True-color composite

Conclusions and Way Forward

- Development of analysis methodologies and thorough satellite data investigations through strong interactions between HAIC SP3 partners
- Unprecedented campaign data for verification and validation of SP3 algorithms
- MSG-SEVIRI based high IWC mask and RDT shown to provide valuable information
- High IWC mask and RDT operationally available and successfully applied during 2015 Cayenne campaign
- On a good track for TRL6…
- Enhance international collaboration with Satellite workshop as first step
- Preparation to the last HAIC 2016 campaign

Thaicnks !!

High Altitude Ice Crystals (HAIC, 314314)

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