

Presented by

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HAIC/HIWC Science Team Meeting May 2016, 17th

Microphysics Update

High Altitude Ice Crystals

Contents

Work on several different subjects in parallel....

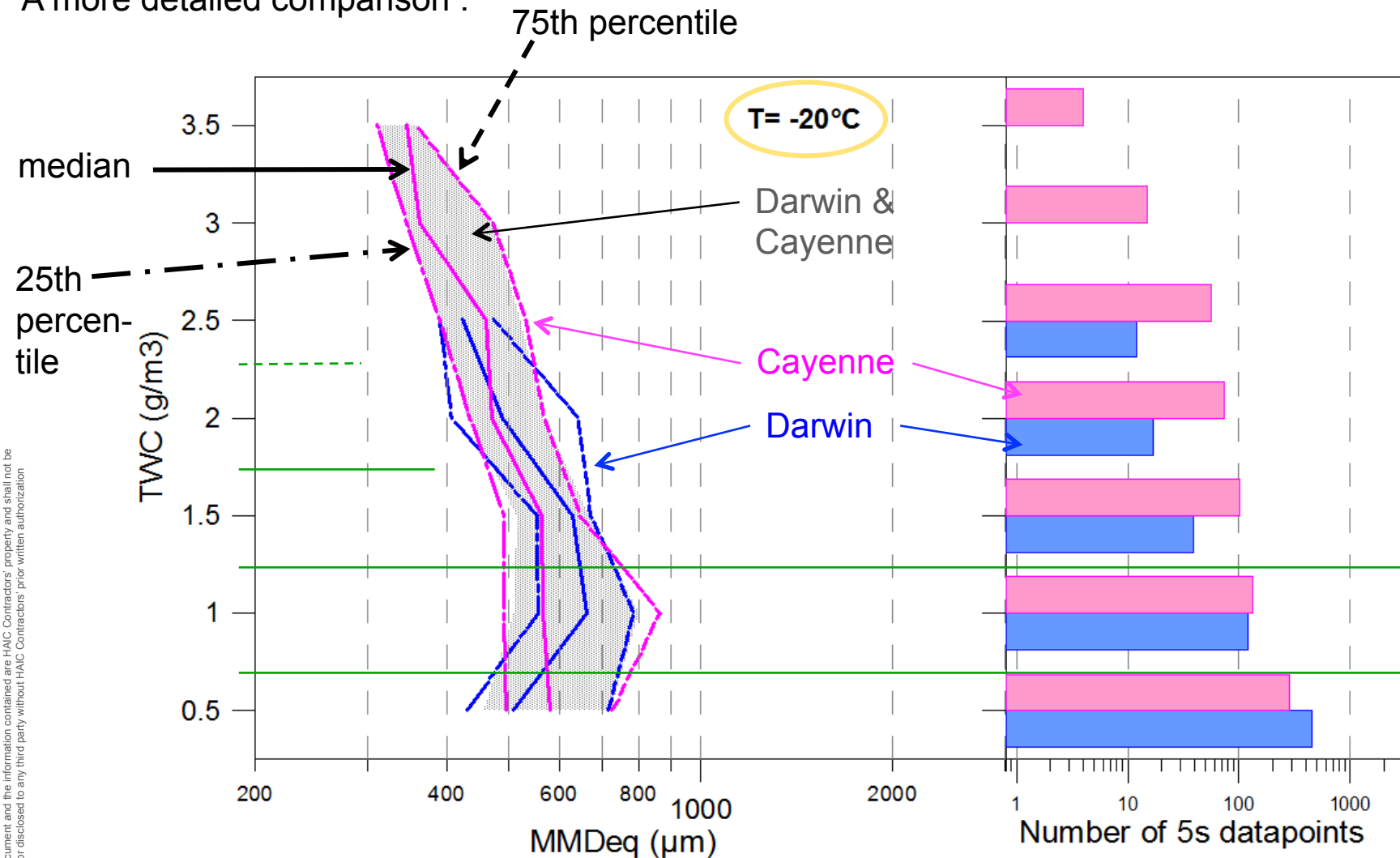
- Robust efficiency (cf. yesterday presentation)
- More detailed comparison of MMDs from Darwin & Cayenne
- Presence of liquid water in the dataset
- Graupel identification
- Dissemination activities

MMDs

Melbourne meeting :

➔ first results seem to show that Cayenne measurements are quite coherent with Darwin ones

A more detailed comparison :

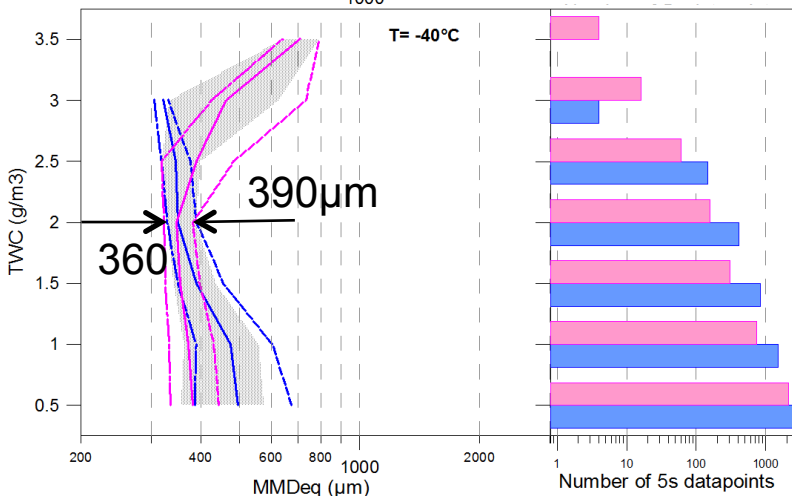
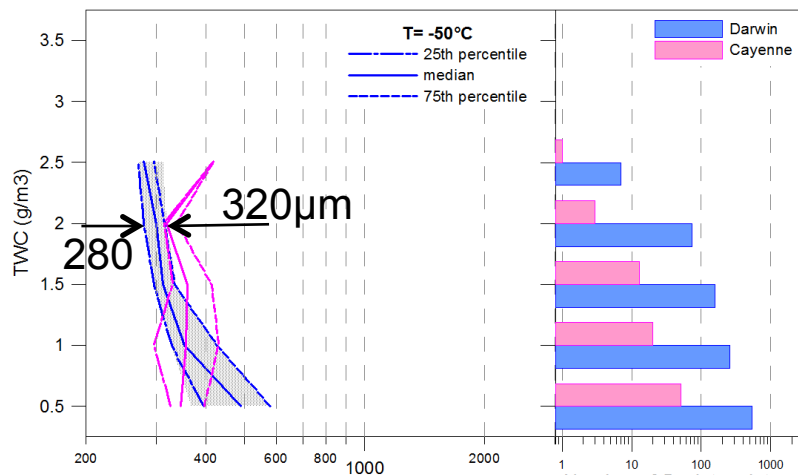


MMDs

Trends confirmed :

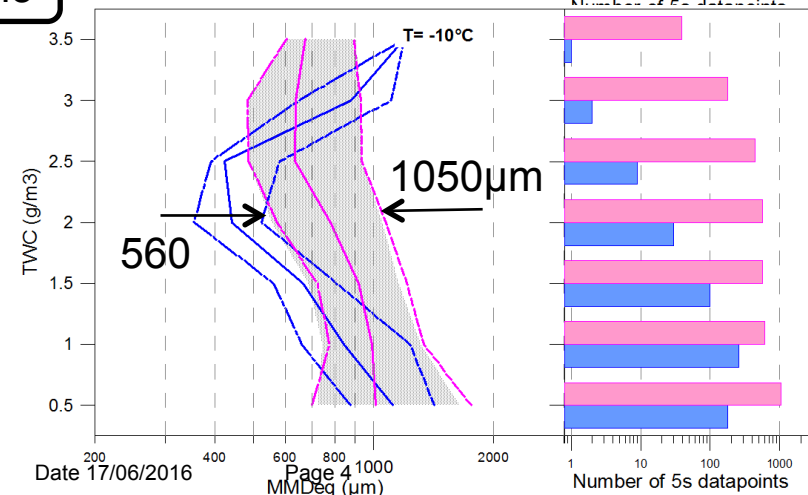
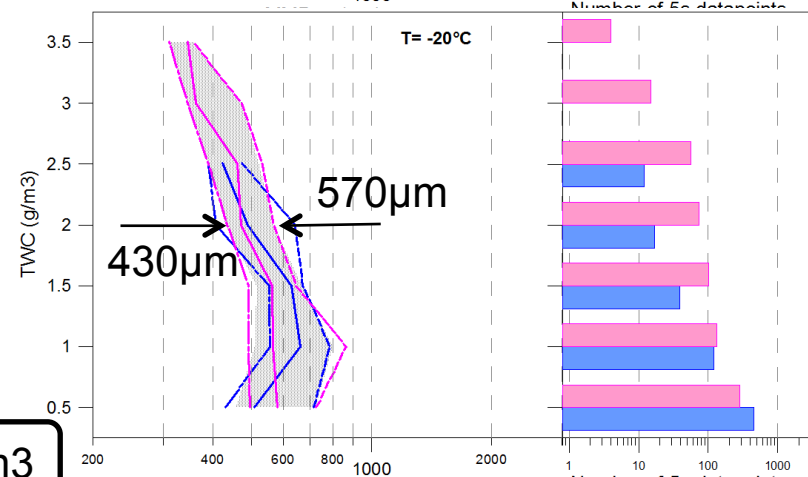
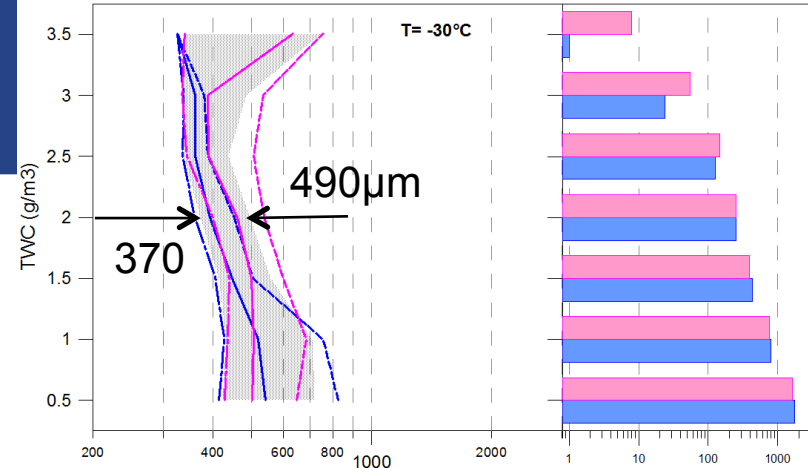
MMD decrease with TWC

MMDs decrease with lower temperatures.



HAIC – High Altitude Ice Crystals (314314)

TWC ~ 2g/m3



Date 17/06/2016

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MMDeq (μm)

Number of 5s datapoints

High Altitude Ice Crystals

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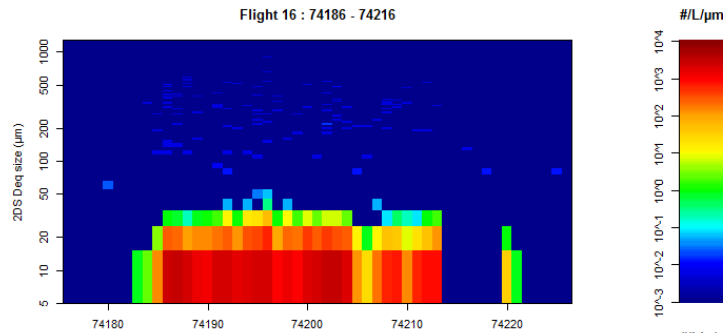
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- More detailed comparison of MMDs from Darwin & Cayenne
- **Presence of liquid water in the dataset**
- Graupel identification
- Dissemination activities

Liquid water ?

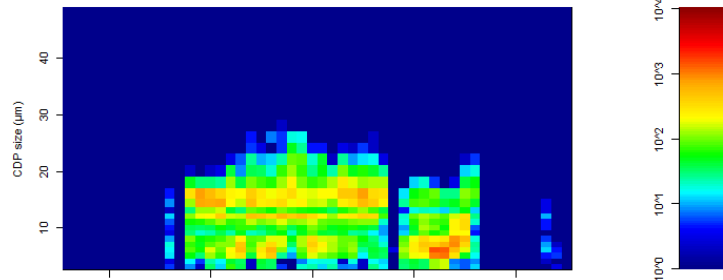
Method :

- identify flights parts with CDP total concentration exceeding 10 cm⁻³
- plot together CDP, 2DS, RICE, IKP, vertical velocity and temperature
- go manually through all events and decide for liquid water or not.

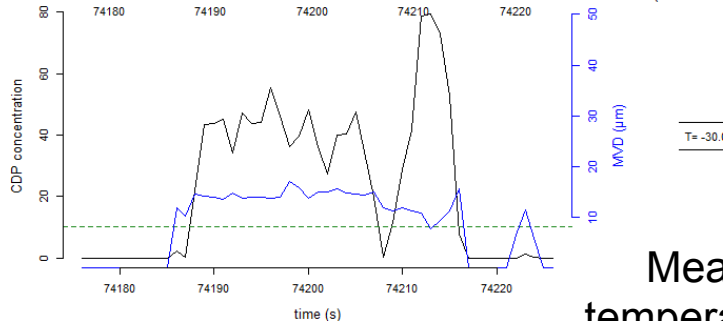
2DS
particle
size
distribution



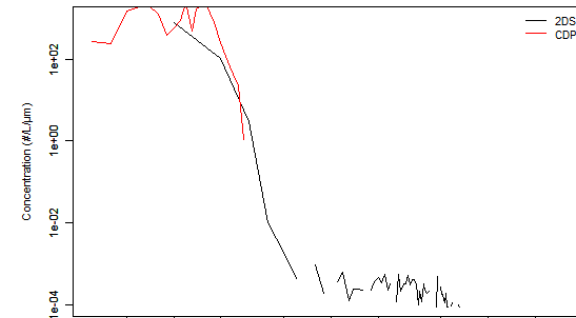
CDP
particle
size
distribution



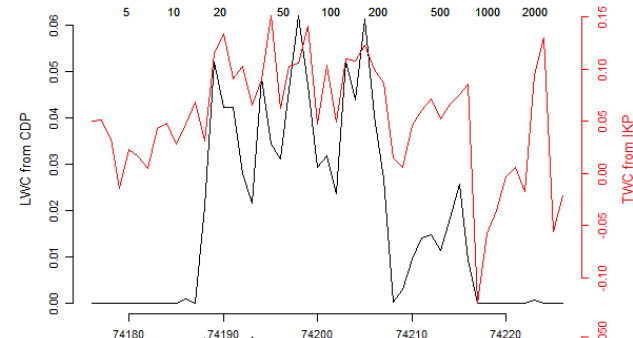
CDP total
concentration
and
MVD



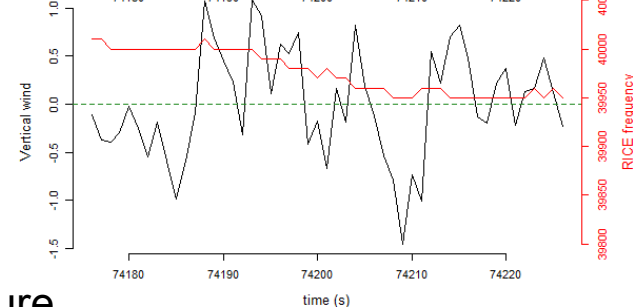
Mean
temperature



2DS &
CDP mean
PSDs



TWC from
IKP and
LWC from
CDP



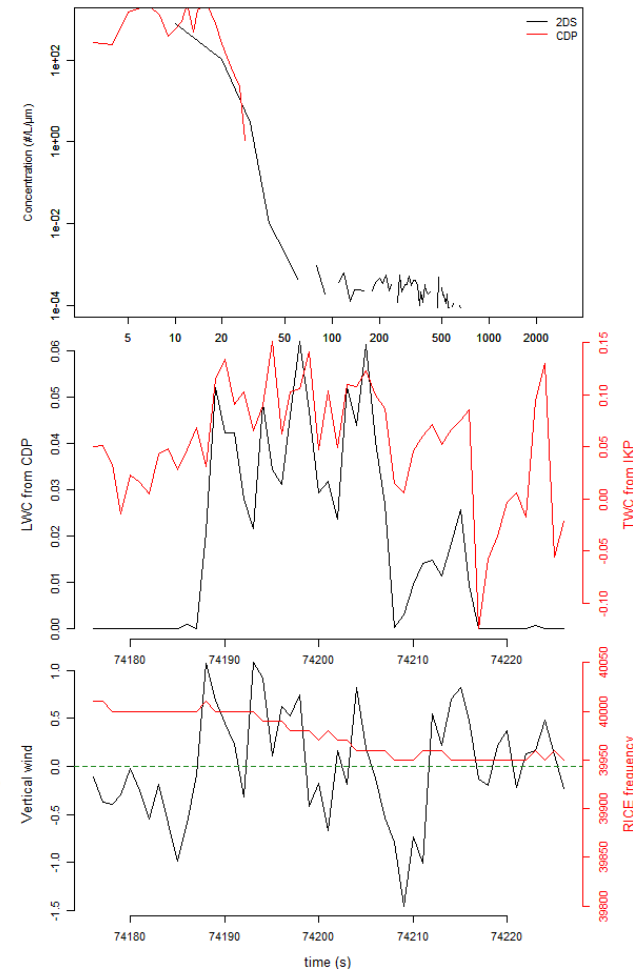
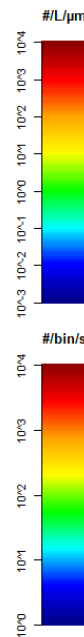
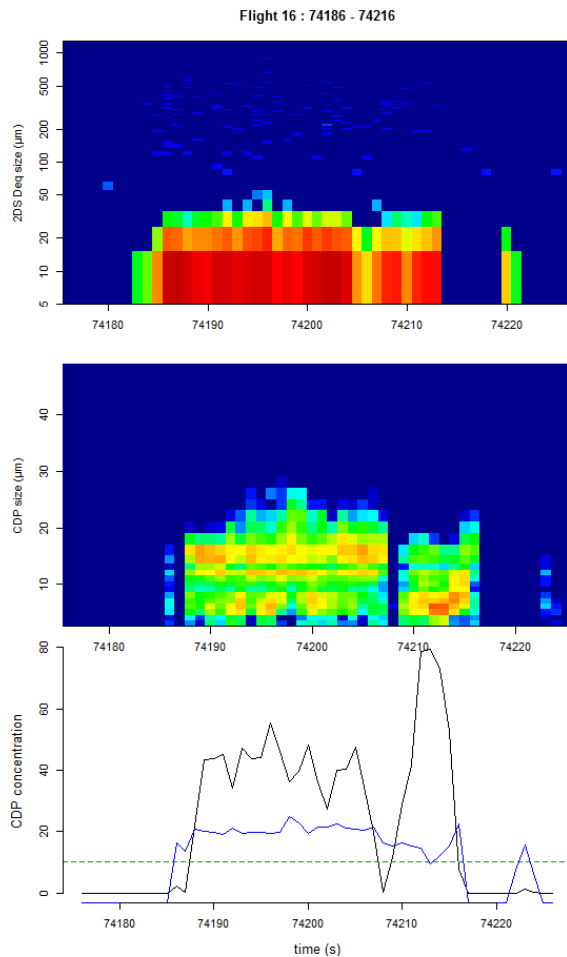
RICE
frequency
and vertical
velocity

Liquid water ?

2DS
measures
particle in
the
smallest
sizes

CDP
counts
only in the
smallest
bins

« low »
MVD



low TWC
from IKP

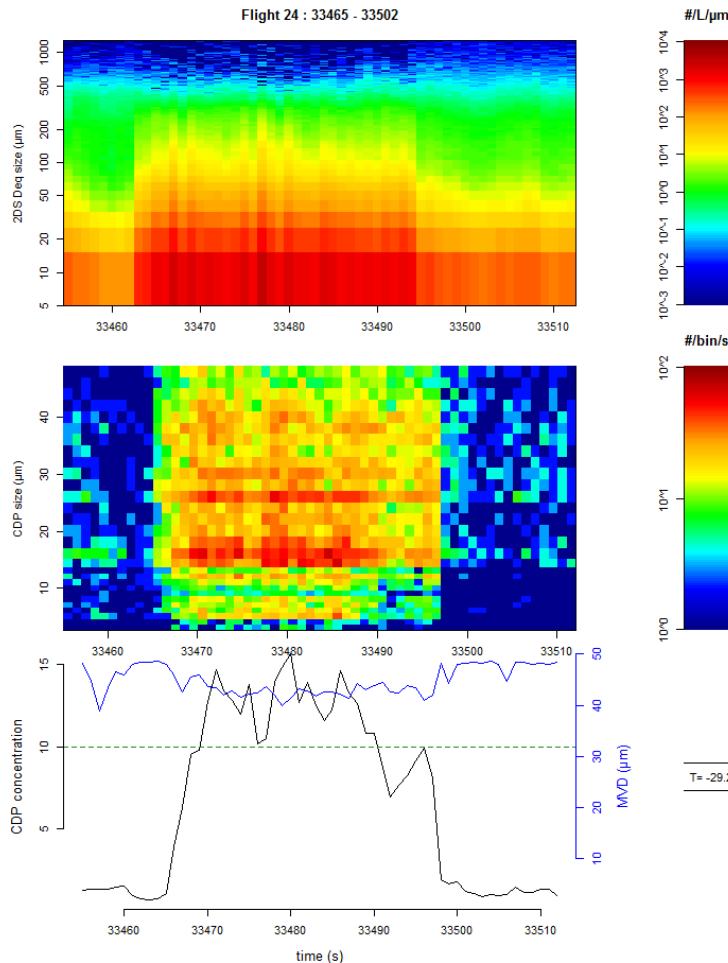
RICE
response

Vertical
wind mostly
positive

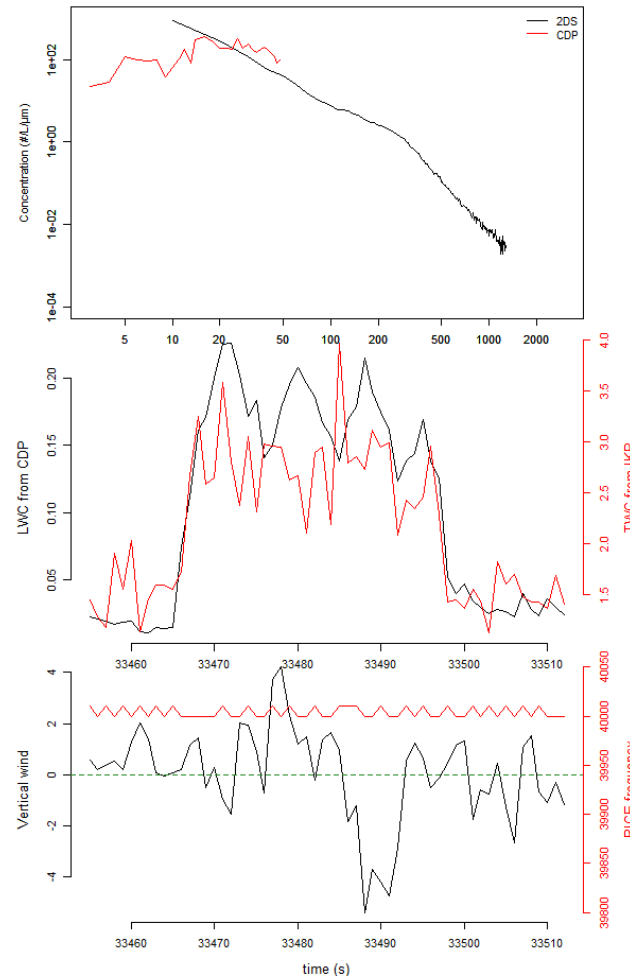
Clear case of **liquid water** at -30°C in the Darwin dataset

Liquid water ?

2DS
measures
particle in
the whole
size
range



« high »
MVD



Flat CDP
spectra

significant
TWC from
IKP

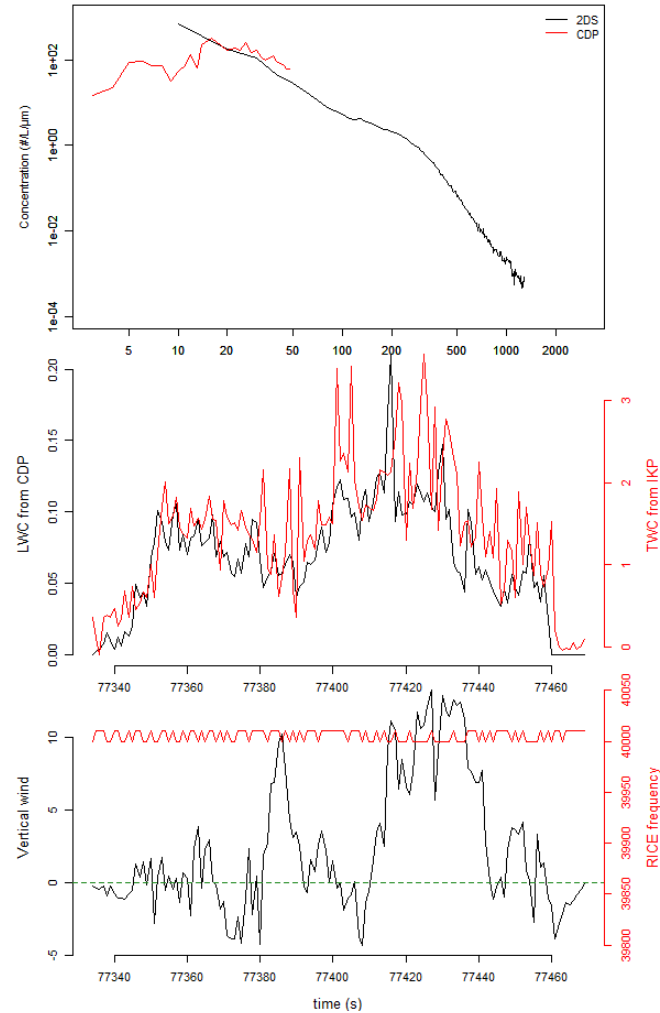
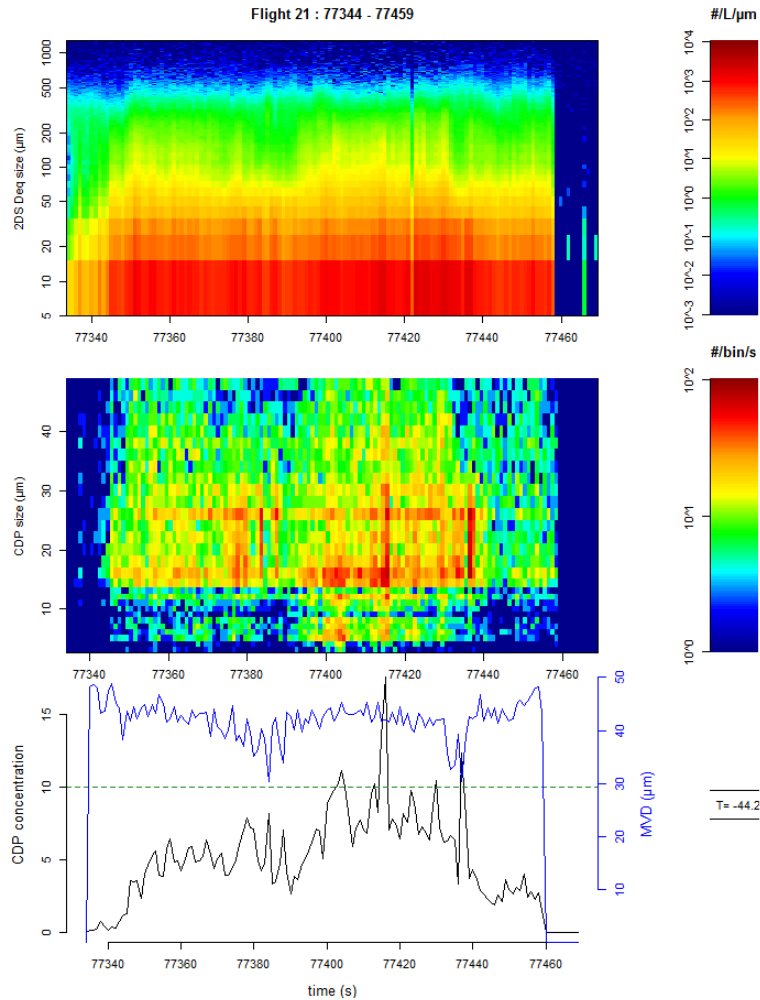
No RICE
response

Vertical
wind can
even be
negative

False CDP response to ice

Liquid water ?

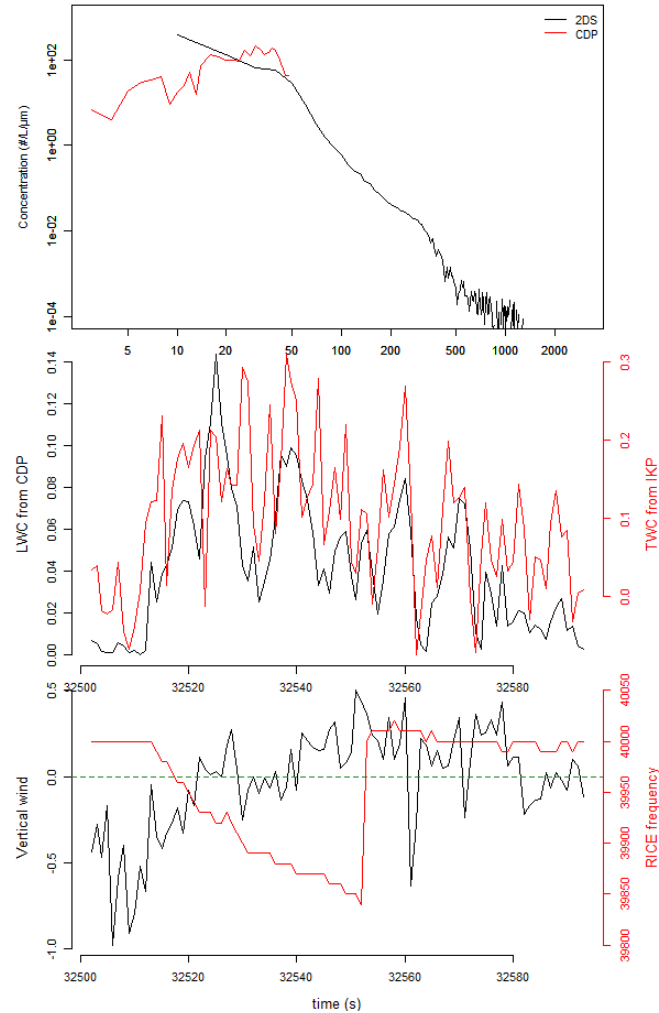
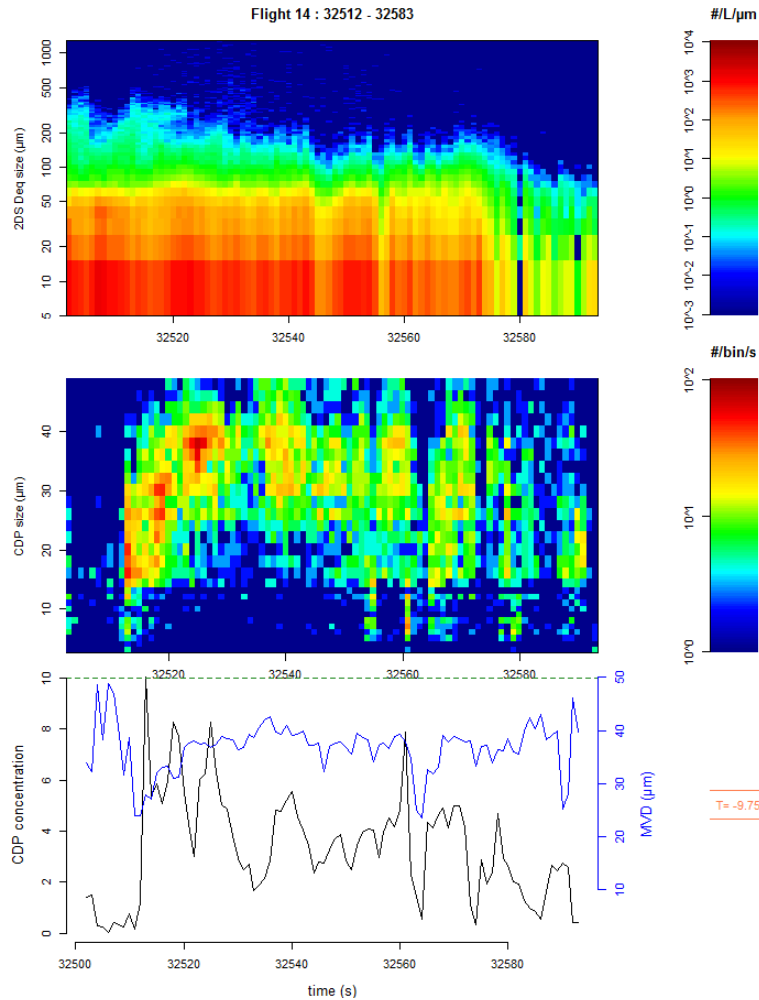
Ready ? It's your turn.



Liquid water or ice ?

Liquid water ?

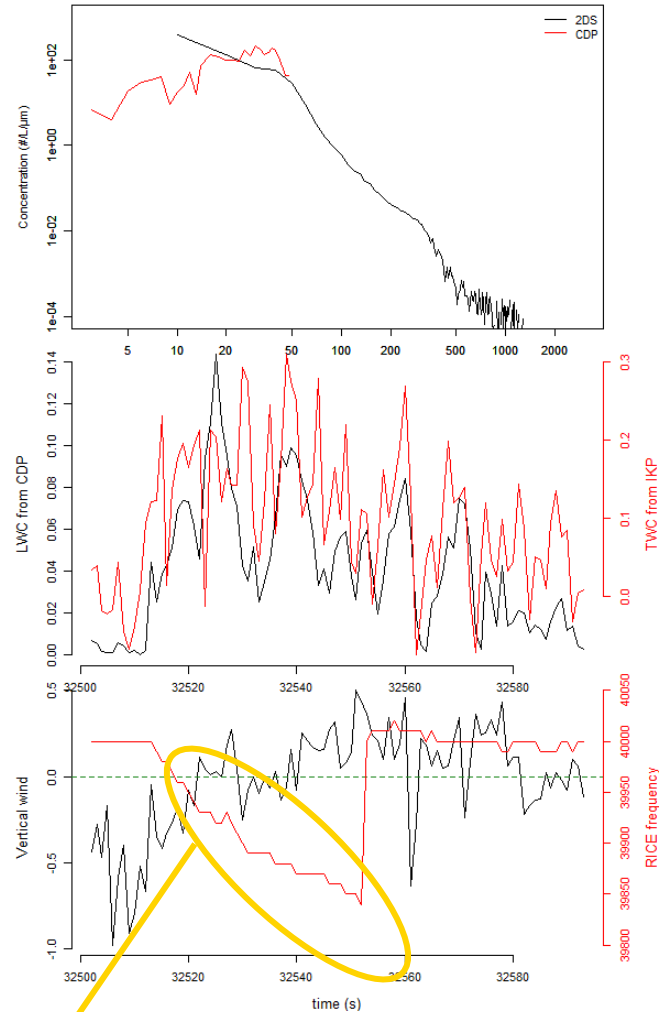
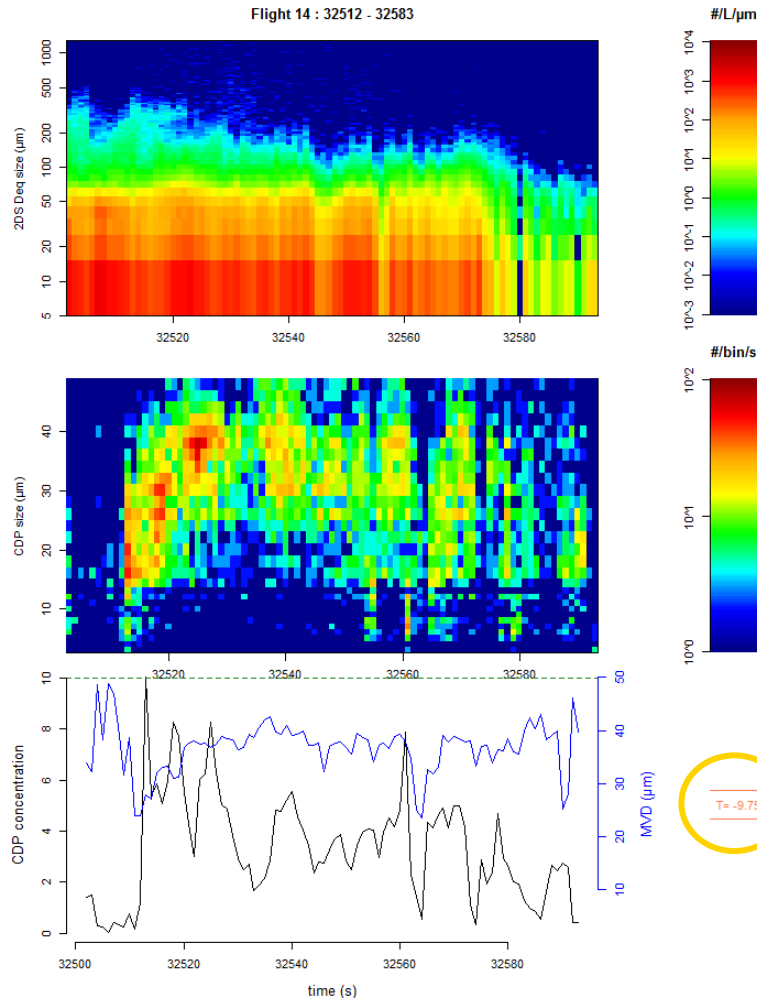
Ready ? It's your turn.



Liquid water or ice ?

Liquid water ?

Ready ? It's your turn.



➔ Method seems robust at low temperatures but caution should be taken at warmer temperatures !
!!

Probably liquid water at the begin of the event

Liquid water ?

Method :

- identify flights parts with CDP total concentration exceeding 10 cm⁻³
 - plot together CDP, 2DS, RICE, IKP, vertical velocity and temperature
 - go manually through all events and decide for liquid water or not.
-
- ➔ quite confident in the method at low temperatures (-30°C and below)
 - ➔ analysis is more difficult at -10°C
 - ➔ if doubts, assume liquid water in order to be sure that all liquid water cases have been removed for ice statistics
-
- ➔ Listing case of possible liquid water available on request

High Altitude Ice Crystals

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- Dissemination activities

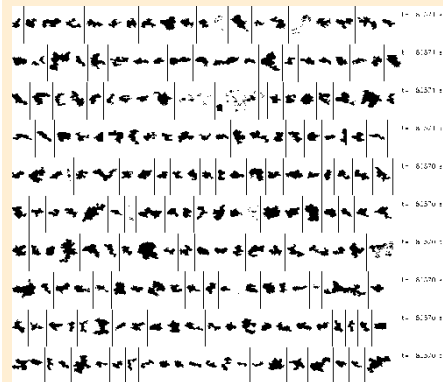
Graupel ?

➔ Work on an automatic graupel detection algorithm based on PIP images

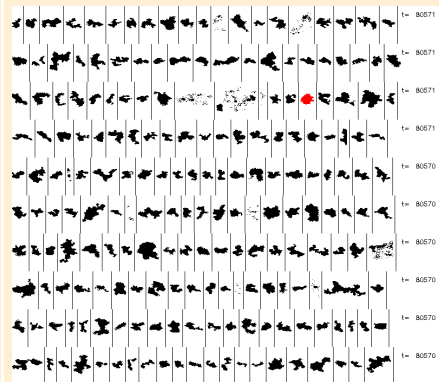
Test based on the study of the ratio : $R = A / \pi D_{max} \downarrow 12 / 4 = \text{area of the image} / \text{area of a circle of diameter } D_{max}$

Trace particles with $D_{max} > 2\text{mm}$ & $1 - \varepsilon \leq R \leq 1 + \varepsilon$

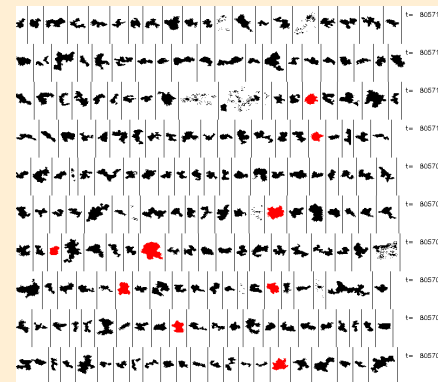
$\varepsilon=0.1$



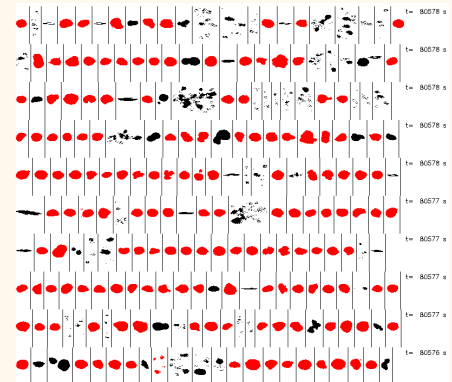
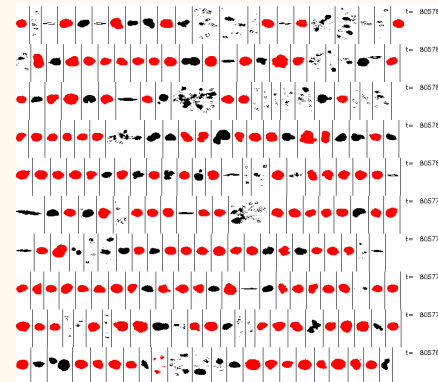
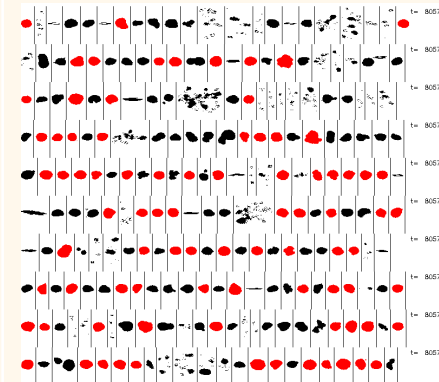
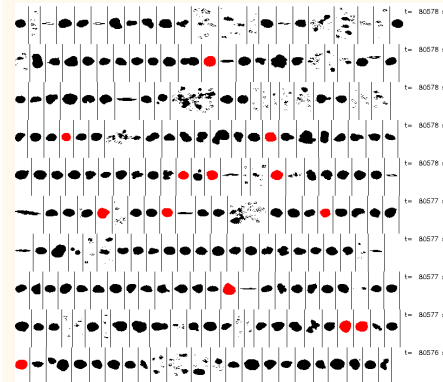
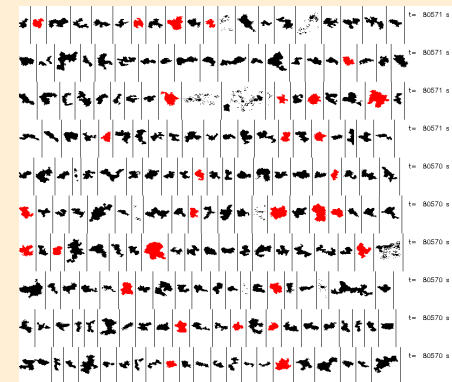
$\varepsilon=0.15$



$\varepsilon=0.2$

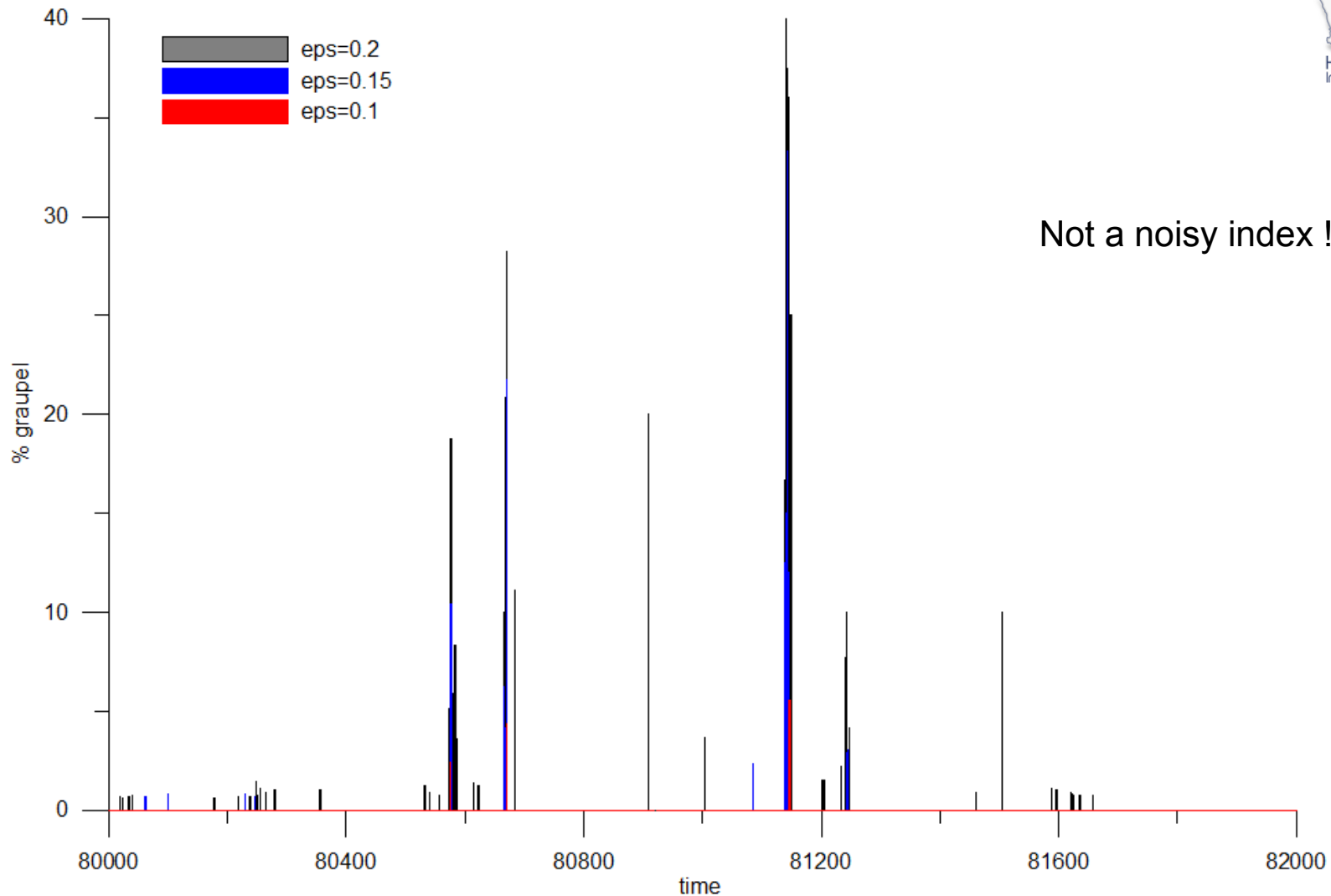


$\varepsilon=0.25$



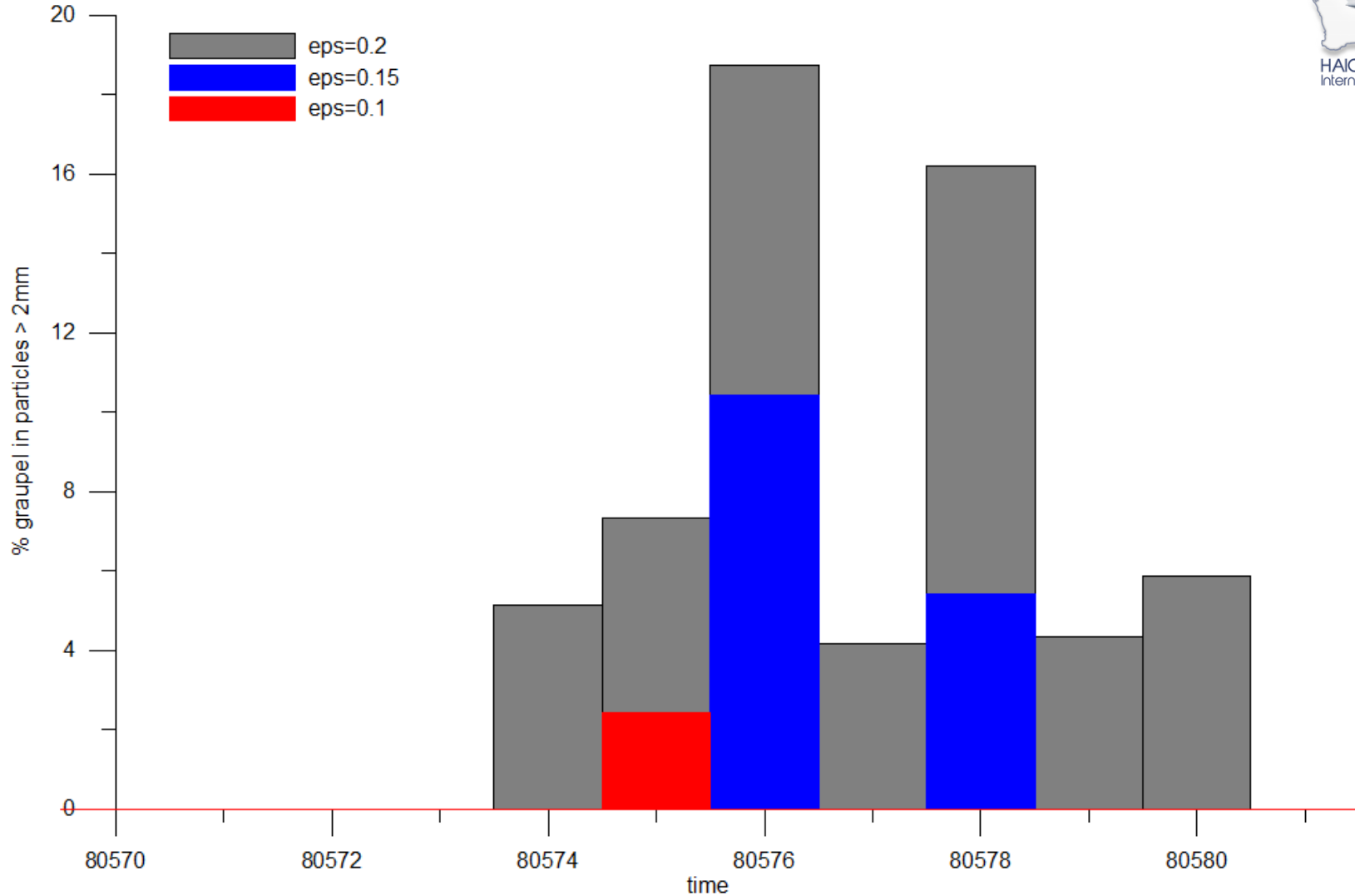
Graupel ?

Work on an automatic graupel detection algorithm based on PIP images
Results for Darwin flight 23



Graupel ?

Work on an automatic graupel detection algorithm based on PIP images
Results for Darwin flight 23



Graupel ?

Work on an automatic graupel detection algorithm based on PIP images

Test based on the study of the ratio : $R = A / \pi D_{max}^2 / 4$ = *area of the image / area of a circle of diameter D_{max}*

Trace particles with $D_{max} > 2\text{mm}$ & $1 - \varepsilon \leq R \leq 1 + \varepsilon$

- ➔ The parameter R gives a clear response (almost on/off)
- ➔ $\varepsilon = 0.2$ could be a first candidate
- ➔ More validation to be performed to look for possible false alarms or missing case
- ➔ Go on with comparison with RASTA measurements

➔ List of graupel cases available on request

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Dissemination activities

			Status
Journal of Atmospheric and Oceanic Technologies	Ice crystal sizes in High IWC clouds, part 1	Leroy et al.	Review received, corrections send
	Ice crystal size in High IWC clouds, part 2	Leroy et al.	Review received, under correction
EGU – April 2016	HAIC/HIWC field projects : characterizing the HIWC environment	Leroy et al.	Oral in session AS1.5 « aviation meteorology »
	Determining ice water content from 2D images	Leroy et al.	Poster in session AS3.3 « Ice particles »
	Retrieval of ice crystals' mass from IWC and PSDs : an optimization approach	Coutris et al.	Poster in session AS3.3
AIAA – June 2016	HAIC/HIWC field campaigns : specific findings on ice crystal characteristics in HIWC cloud regions	Leroy et al.	Oral + technical paper

Dissemination activities

			Status
ICCP – July 2016 International Conference on Clouds and Precipitations	HAIC/HIWC field projects : ice crystal mass-size relationship in high ice water content cloud conditions	Leroy et al.	Oral
	Mass retrieval for ice crystals from particle images and ice water content measurements: a numerical optimization approach	Coutris et al.	Poster
	Simulations of radar reflectivity factor at 94 GHz : Ice crystal approximation with oblate spheroids	Fontaine et al.	Oral
	Variations of ice microphysical properties in tropical MCSs using cloud in-situ data and corresponding radar reflectivity profiles	Fontaine et al.	Poster
	Improving the retrieval of PSD and LWC from optical spectrometer measurements using a monte-carlo inversion method	Febvre et al.	Poster

High Altitude Ice Crystals (HAIC, 314314)

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