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HAIC-HIWC Science Team Meeting 10/11/2015 - Melbourne

Darwin PSD microphysics results

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Contents

Recall : new MMD computation method

MMD results (update)

15%MD and 85%MD results

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MMD computation method

Previously (Results presented in NYC):

1) Size retrieval → $Deq=\sqrt{4*S/\pi}$ → 2) Particle number SD → $m= \alpha Deq^{\beta}$ → 3) Particle mass SD, MMD, …

α and β from Brown and Francis (1995)

New method:

β(t) deduced from the analysis of the images using results of 3D particle simulations

1) Size retrieval → **D**=Deq, Dmax, Ly, Lx+Ly/2 → 2) Particle number SD → $m= \alpha(t) D^{\beta(t)}$ → 3) Particle mass SD, MMD, …

α(t) deduced from IKP: $TWC(t)=\alpha(t)\sum i \uparrow N(i) D(i)^{\beta(t)}$

MMD computation method

Previously (Results presented in NYC):

1) Size retrieval → $Deq=\sqrt{4*S/\pi}$ → 2) Particle number SD → $m= \alpha D^{\beta}$ → 3) Particle mass SD, MMD, …

α and β from Brown and Francis (1995)

New method: A) sensitivity tests

1) Size retrieval → here: ***D*=Dmax** → 2) Particle number SD → $m= \alpha(t) D^{\beta(t)}$ → 3) Particle mass SD, MMD, …

α and β from Fontaine et al. (2014)

Then keep β constant (=1,2,3) and α(t) deduced from IKP TWC : $TWC(t)=\alpha(t)\sum_i N(i) D(i)^{\beta}$

Main conclusions : MMD values
- do not depend on the α parameter
- are sensitive to the value of β
- when α and β are constant in time, then the MMD is very sensitive to the initial size definition (Deq or Dmax) : MMDeq ≠ MMDmax

MMD computation method

New method: B) developpement (extension of Fontaine et al. 2014 work)

Specifications :

Valid for different diameter definitions : *Deq, Dmax, Dy, Dm=*$Dx+Dy/2$

+

α and β values should reflect the ice shape and density variabilities

β(t) deduced from the analysis of the images using results of 3D particle simulations

1) Size retrieval

D=Deq, Dmax, Dy, or Dm=$Dx+Dy/2$

2) Particle number SD

$m=\alpha(t)D^{\beta(t)}$

3) Particle mass SD, MMD, …

α(t) deduced from IKP: $TWC(t)=\alpha(t)\sum i\uparrow\blacksquare N(i)D(i)\uparrow\beta(t)$

MMD computation method

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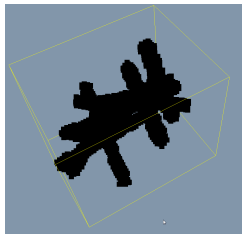
3D particles simulations



β

THEORY

2D particles projections

Surface-size relationship

$S=\gamma D^{\downarrow\uparrow\sigma}$

Perimeter-size relationship

$P=\delta D^{\downarrow\uparrow\tau}$

$\beta=f_{\downarrow D}(\sigma,\tau)$

β(t) deduced from the analysis of the images using results of 3D particle simulations

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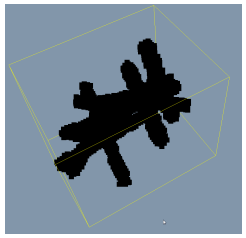

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2D particles projections

Surface-size relationship

$S=\gamma D\downarrow\uparrow\sigma$

Perimeter-size relationship

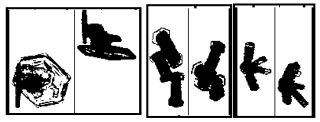
$P=\delta D\downarrow\uparrow\tau$

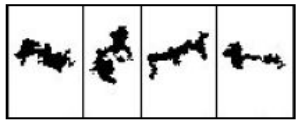
THEORY

$\beta=f\downarrow D\,(\sigma,\tau)$

IN-SITU DATA

2D-S & PIP images





D $S=\gamma D\downarrow\uparrow\sigma$ $N(D)$

$P=\delta D\downarrow\uparrow\tau$

$\beta=f\downarrow D\,(\sigma,\tau)$

1) Size retrieval

D=Deq, Dmax, Dy, or $Dm=Dx+Dy/2$

2) Particle number SD

$m=\alpha(t)D\uparrow\beta(t)$

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α(t) deduced from IKP: $TWC(t)=\alpha(t)\sum i\uparrow\square N(i)D(i)\uparrow\beta(t)$

MMD computation method

New method: B) developpement (extension of Fontaine et al. 2014 work)

Main conclusion :
With the new method, the MMD sensitive to the initial size definition is significantly reduced:

MMDeq ~ MMDmax ~ MMDy ~ MMDm

➔ Ice Crystal Sizes in High Ice Water Content Clouds. Part I : Mass-size relationships derived from particle images and TWC for various crystal diameter definitions and impact on median mass diameter, Leroy et al., Part I, 2015a, manuscript submitted to JAOT.

3- Analysis of HAIC-HIWC 1st field campaign results

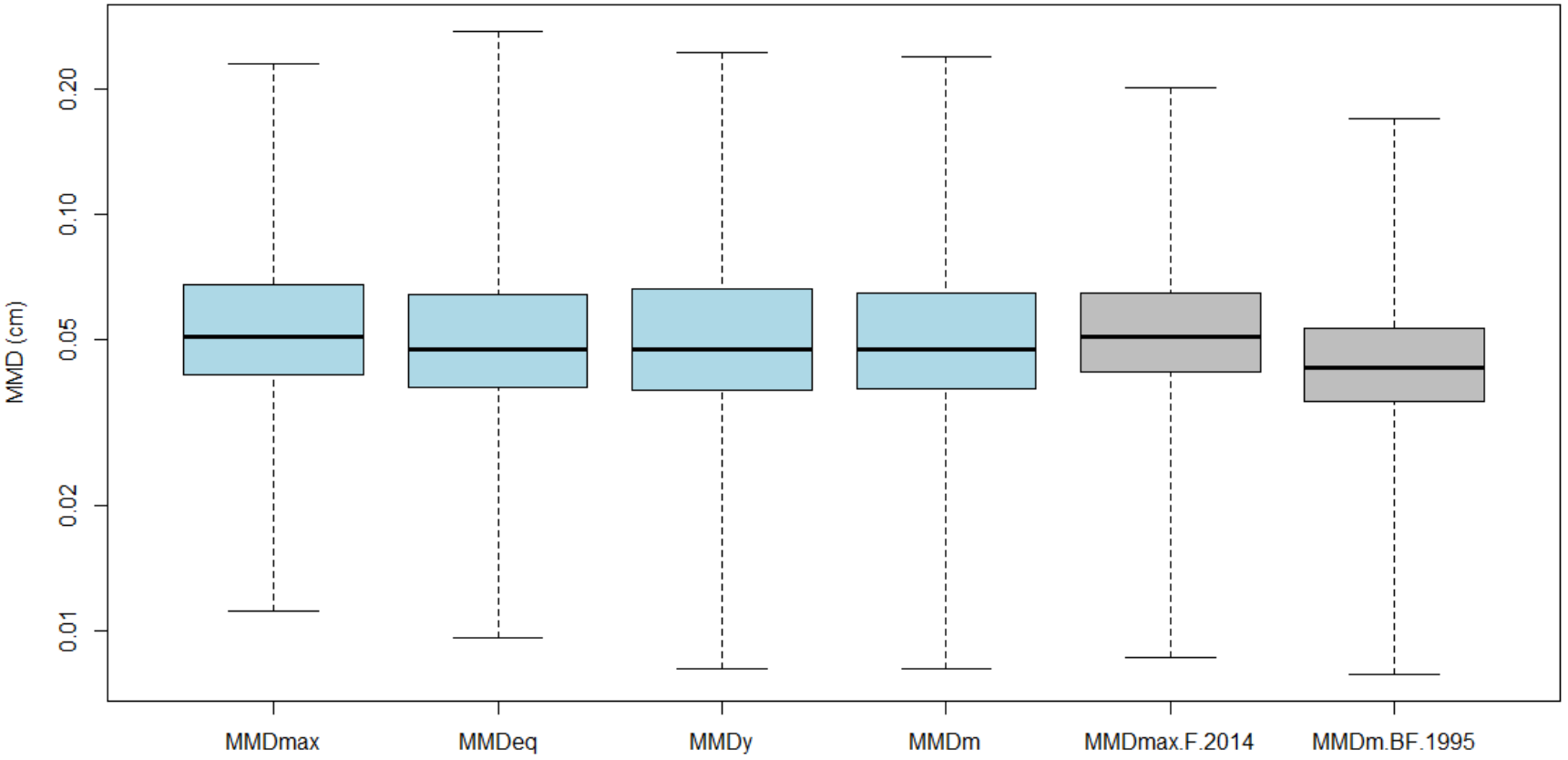
➔ Ice Crystal Sizes in High Ice Water Content Clouds. Part II Median Mass diameters in tropical convection observed within HAIC/HIWC, Leroy et al., Part II, 2015b, to be submitted after Melbourne meeting to JAOT.

MMD results

HAIC Darwin data selection:

- Aircraft is flying on constant level
- IKP TWC is larger than 0.1 g/m3

All flights considered



MMDeq ~ MMDmax ~ MMDy ~ MMDm

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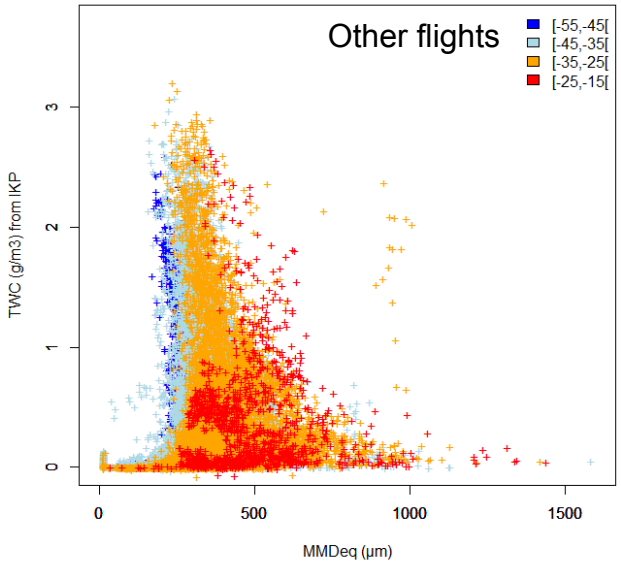
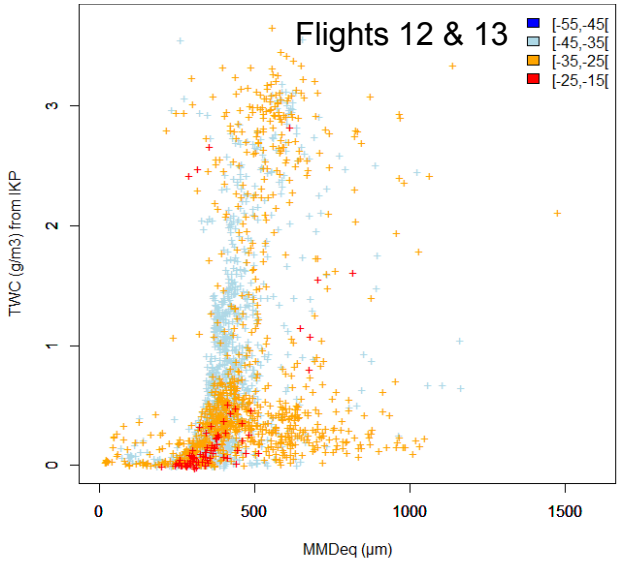
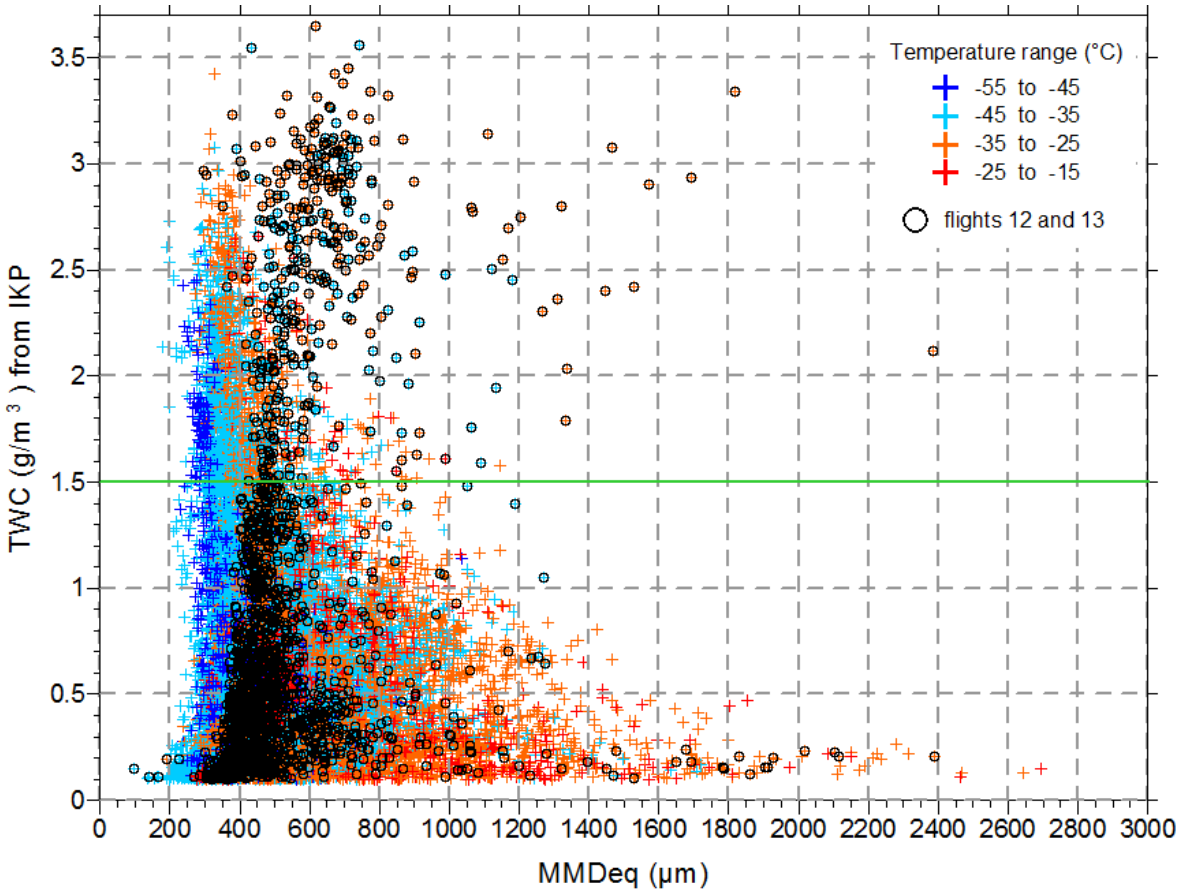
New York results





Updated results



Same trends !
No MMD below 200 µm.

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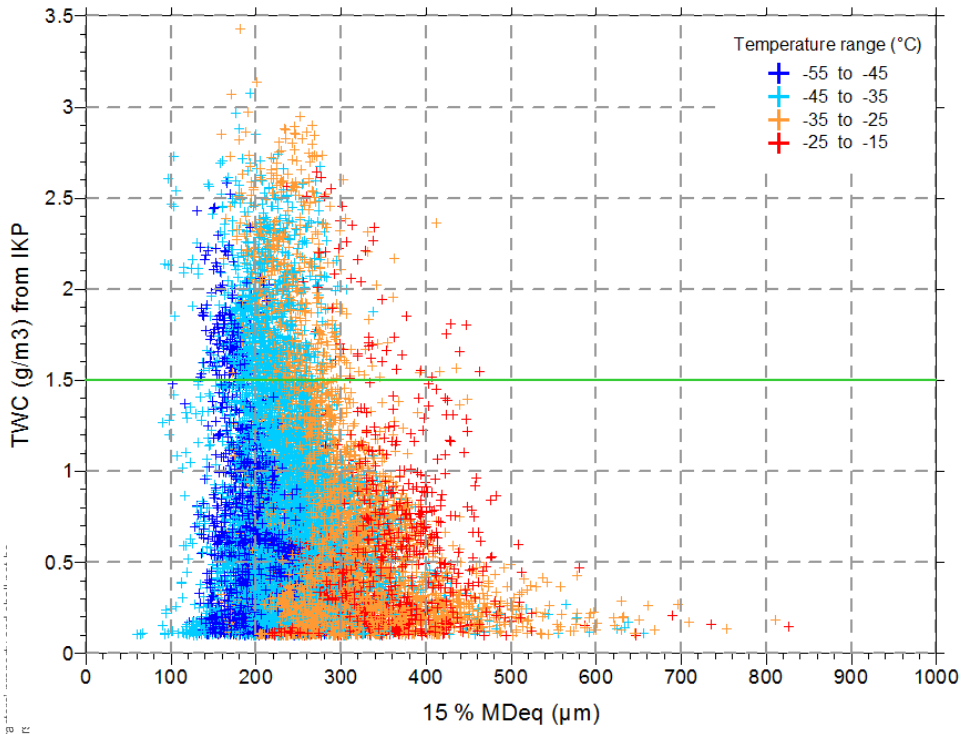
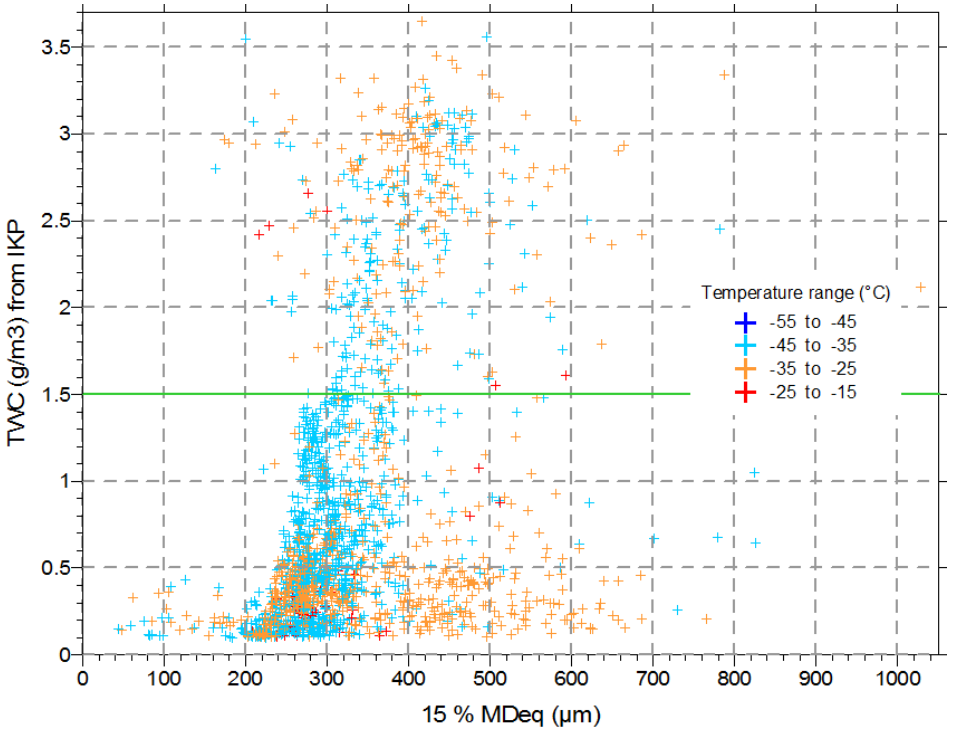
15%MD

Other flights



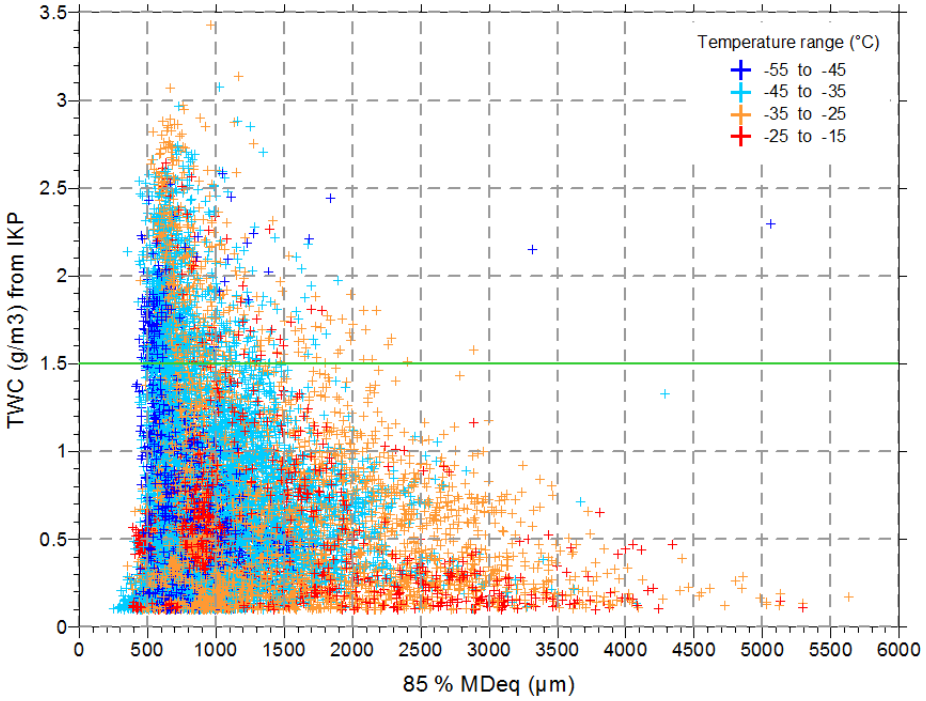
Flights 12 & 13



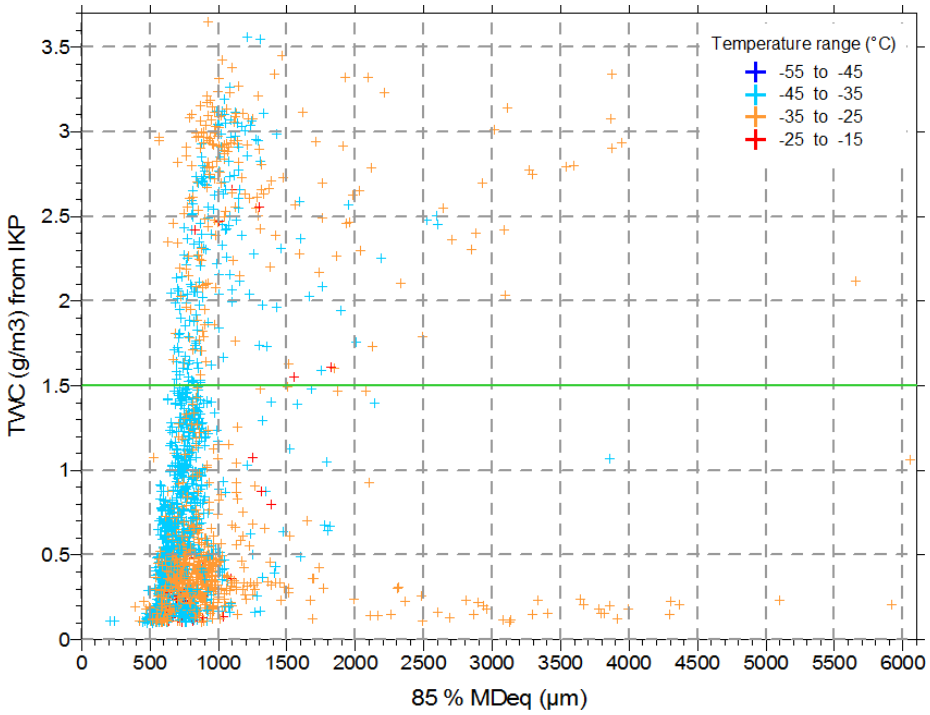
➔ Ice crystals smaller than 100 µm accounts for less than 15% of the mass

85%MD

Other flights

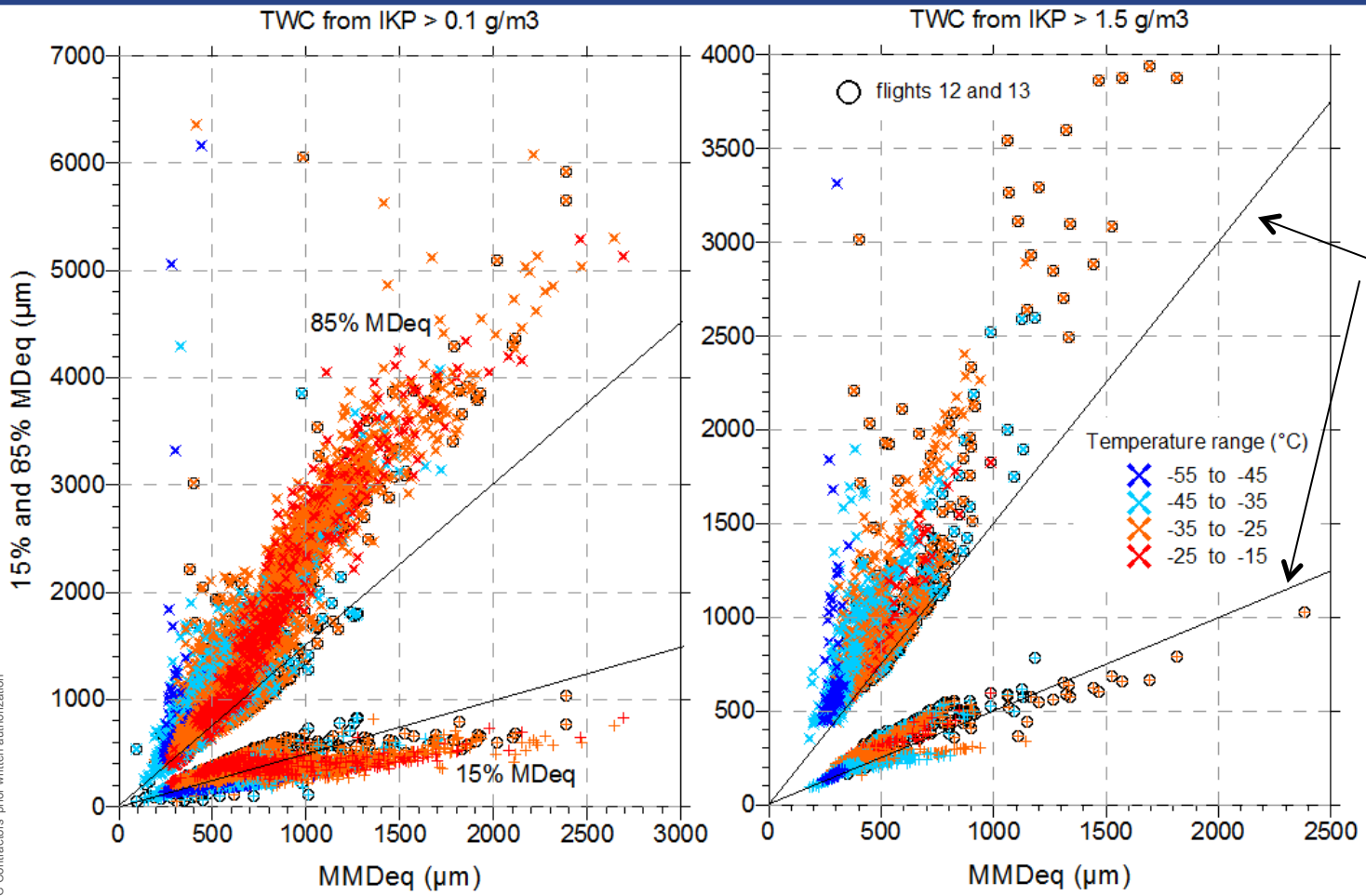


Flights 12 & 13



➔ 500µm id the smallest possible 85%MD values

Estimates of 15% and 85%MD from MMD



Heymsfield (2003) :
15%MD ~ 0.5 MMD
85%MD ~ 1.5 MMD

HAIC dataset (2014)

15%MD ~ 0.5 MMD : good for MMD lower than 1mm, but 15%MD ~ 0.44 MMD should be preferred for larger MMD values

85%MD ~ 2 MMD seems to be a better proxy than 85%MD ~ 1.5 MMD

Conclusions

- ✓ The MMD computation method reduces the MMD sensitivity to the size definition
- ✓ MMD trends presented in NYC remains
- ✓ Ice crystals smaller than 100 µm accounts for less than 15% of the total mass
- ✓ 0.5*MMD is a quite good proxy for 15%MD when MMD are lower than 1mm but overestimates the 15%MD real value for larger MMDs
- ✓ 2*MMD seems to be better estimate of the 85%MD than 1.5*MMD

➔ Ice Crystal Sizes in High Ice Water Content Clouds. Part II Median Mass diameters in tropical convection observed within HAIC/HIWC, Leroy et al, 2015b, in prep.

High Altitude Ice Crystals (HAIC, 314314)

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