Cloud Properties from CALIPSO/CALIOP

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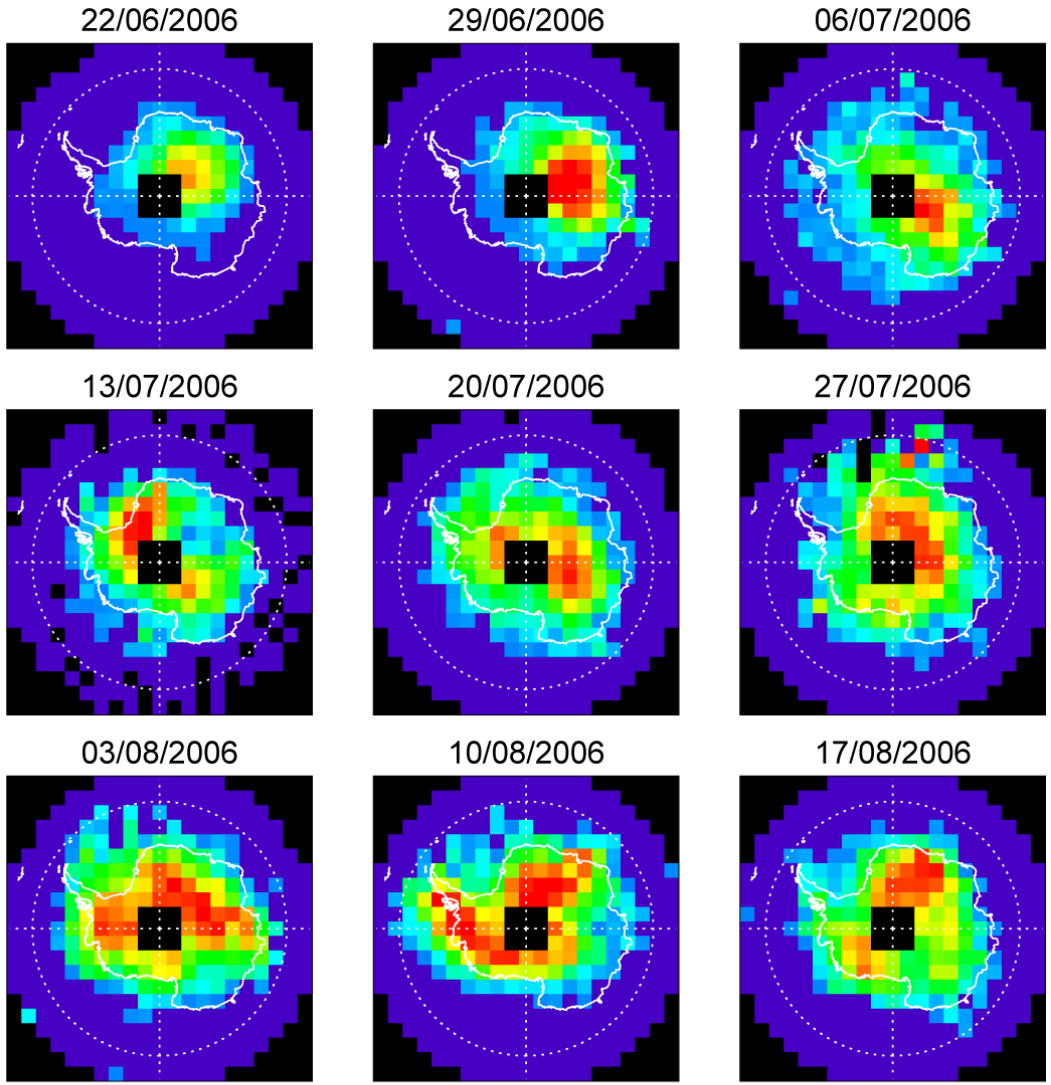
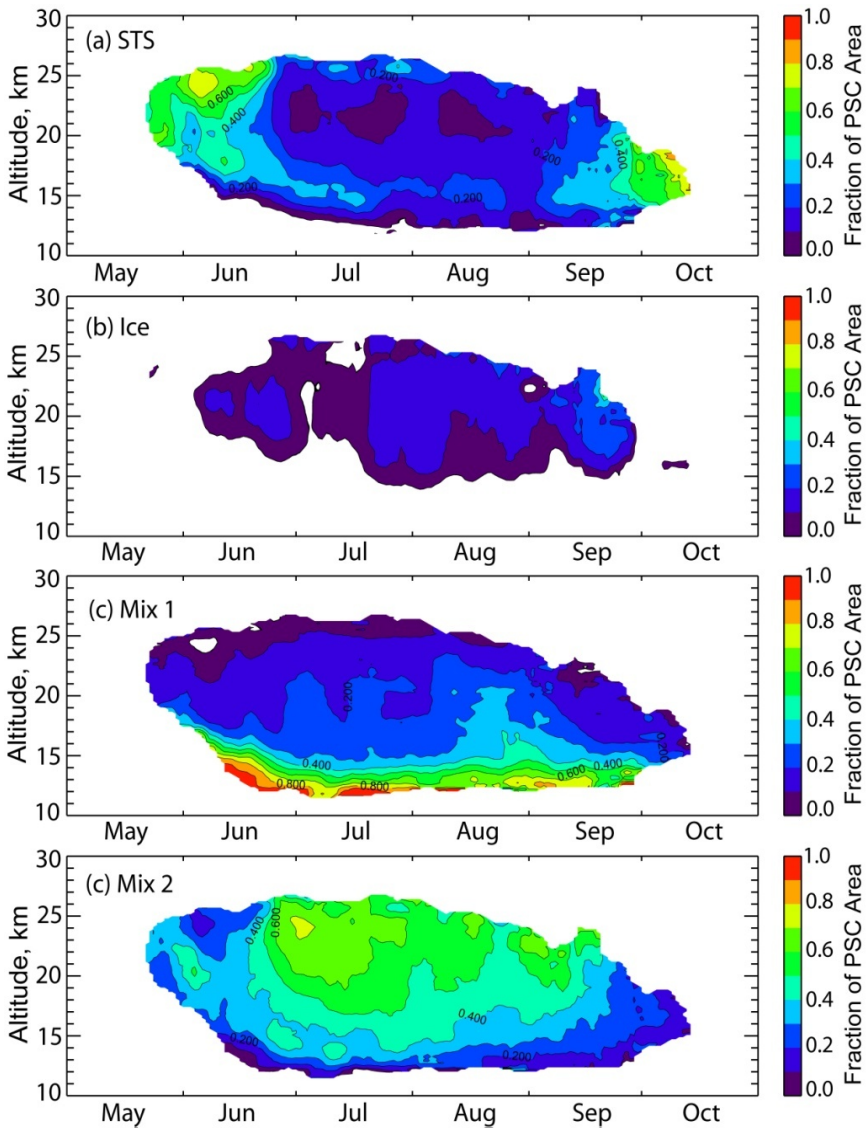
GEWEX CA Workshop June 2010, Berlin

PSC Spatial Distribution

(2006-2008 average)





Courtesy of Mike Pitts

Status of CALIPSO cloud properties

- **Cloud cover, height**
- **Temperature** (CALIOP height + GMAO)
- **Ice/Water phase** (CALIOP depolarization)
- **Optical depth, extinction profile**
  - **'Thin' cirrus only, $\tau < 3 - 5$**
  - **Can be retrieved from CALIOP transmittance**
  - **Or from CALIOP forward retrieval**
- **IWC** (from CALIOP extinction)
- **Emissivity** (CALIOP + IIR)
- **Particle size** (CALIOP + IIR)
  - **Cirrus only**
- **IWC** (from CALIOP+IIR particle size)
- **LWC**

In CA database

Near future

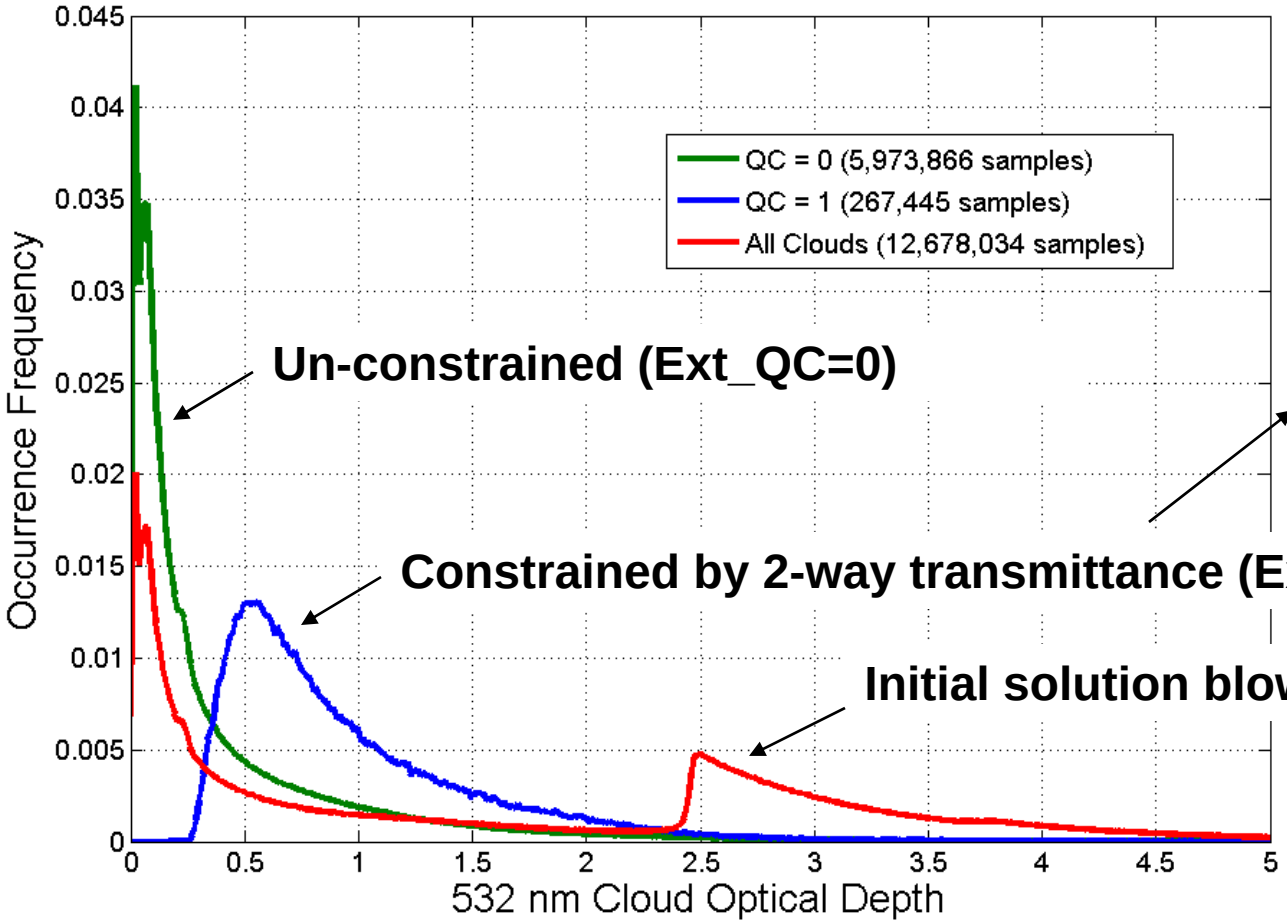
In Version 3 IIR

Never

Cirrus (ice) optical depth product

Two cirrus extinction retrievals are used in production:

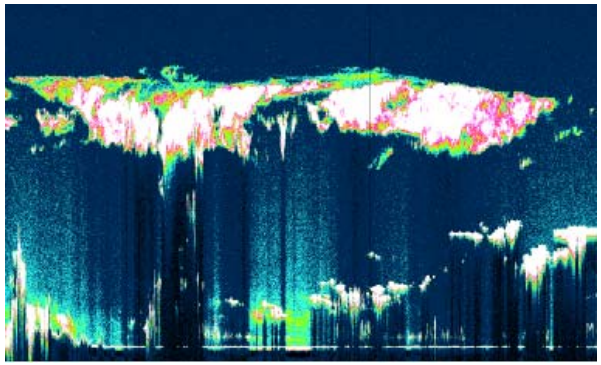
- **Unconstrained (forward retrieval), *a priori* lidar ratio**
- **Constrained, lidar ratio retrieved from transmittance (~10%)**



Un-constrained (Ext_QC=0)

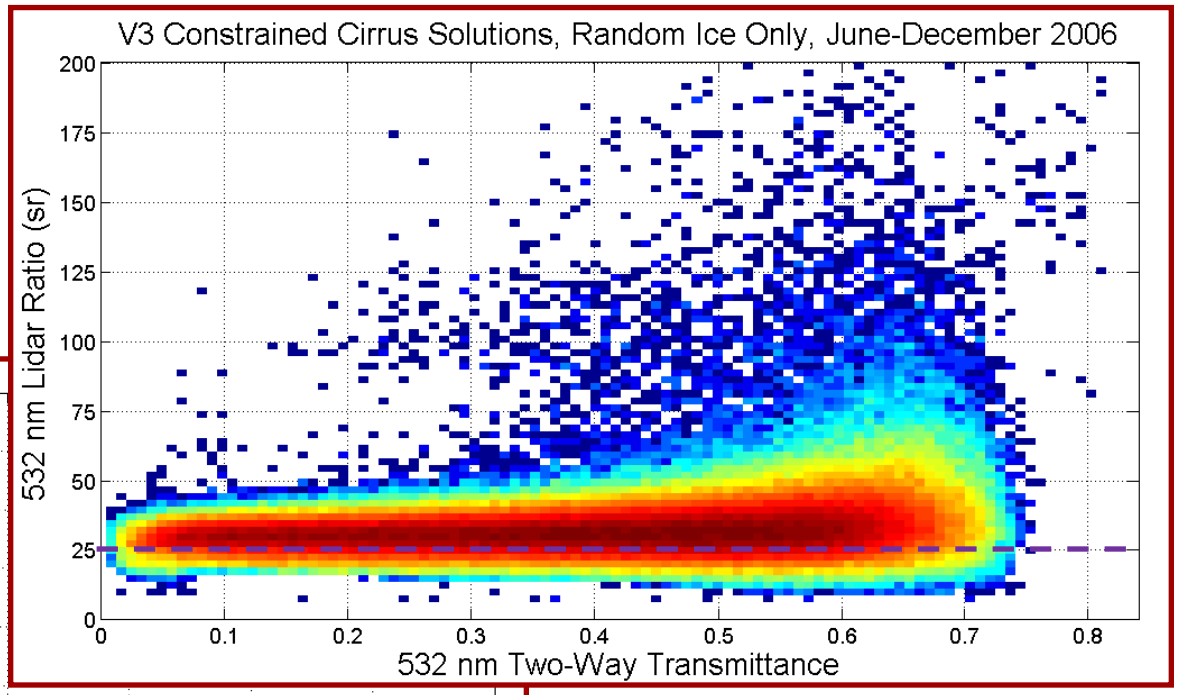
Constrained by 2-way transmittance (Ext_QC=1)

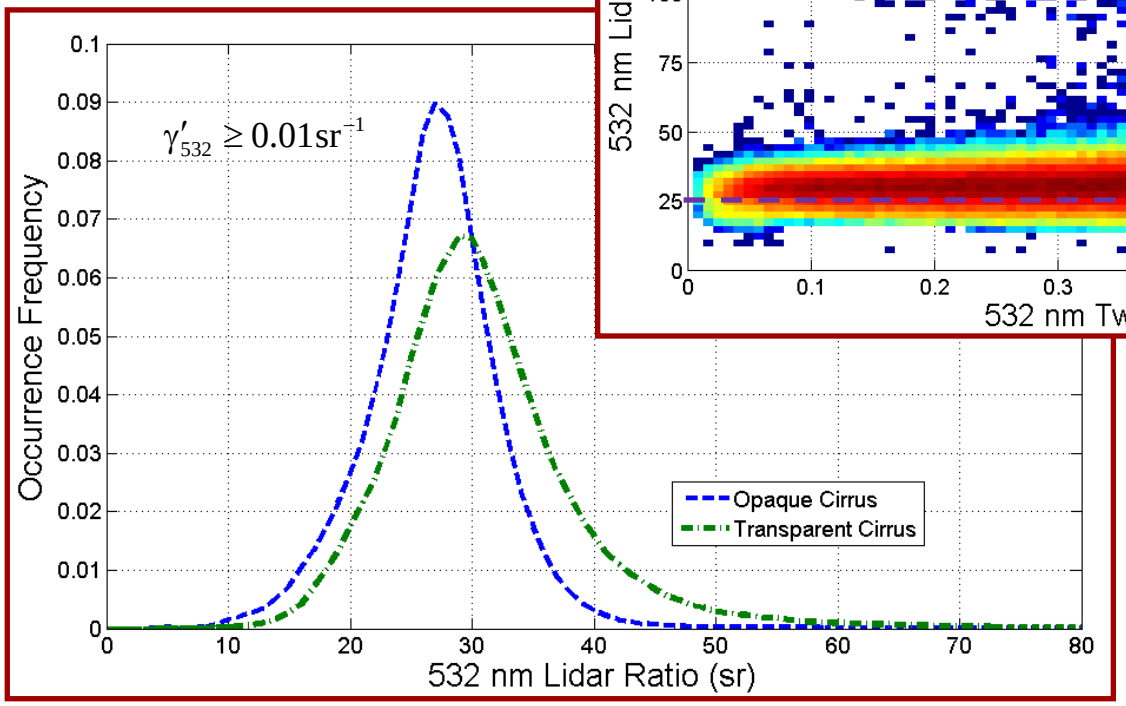
Initial solution blows up



Lidar Ratio Retrievals

From transparent cirrus:
S = 29 ± 6 sr

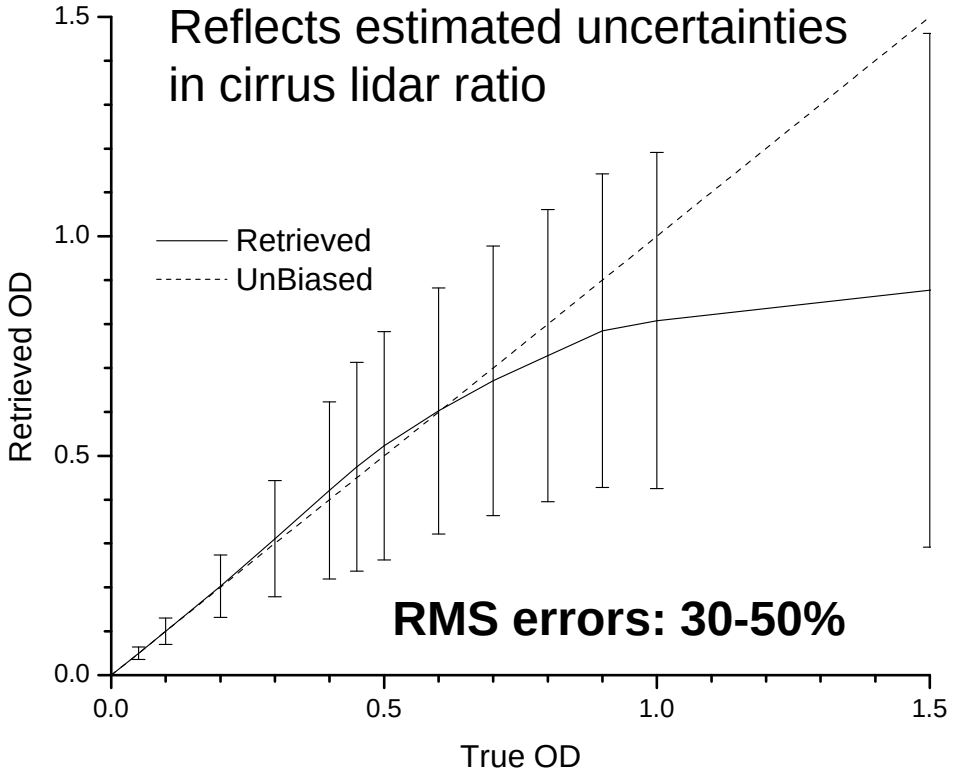




From opaque cirrus:
S = 27 ± 6 sr

Ice Cloud Optical Depth Uncertainties

- **Unconstrained retrievals: 30-50% RMS error**
  - **Significant bias as OD grows larger than 1**
- **Constrained retrievals: ~30% RMS error**
- **Validation underway**

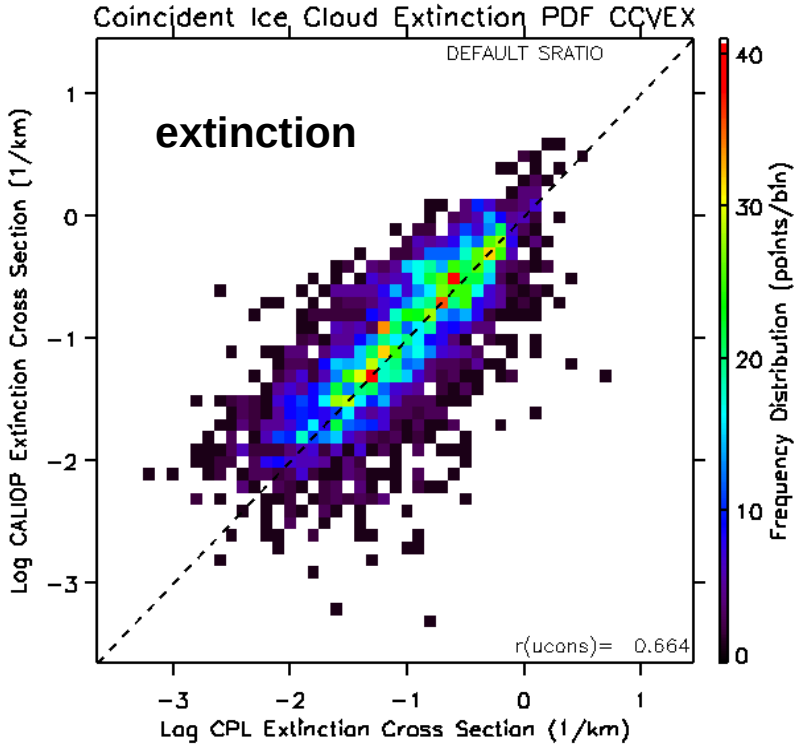


Water cloud OD

- **V2: qualitative at best**
- **V3: may be OK for τ <1,**
  (or maybe τ << 1)
  - not validated yet

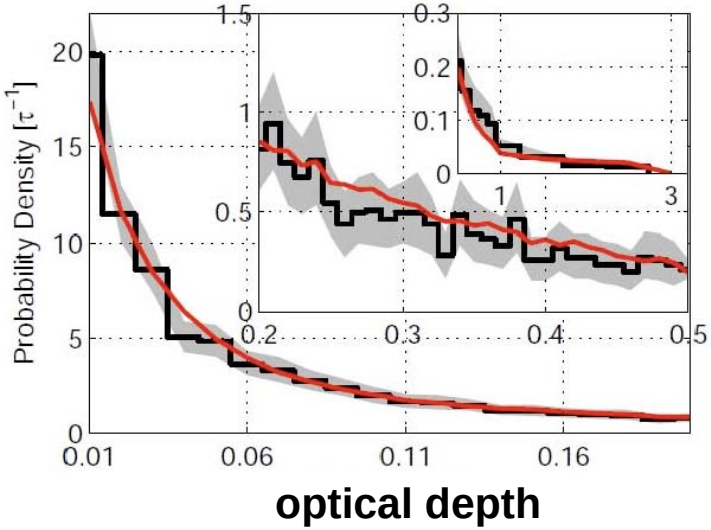
Cirrus Extinction, OD: Validation

- **CALIOP vs. CPL, CCVEX campaign**
- **significant scatter, small mean bias**
- **validation paper underway**



CALIOP vs. Nauru ARM lidar

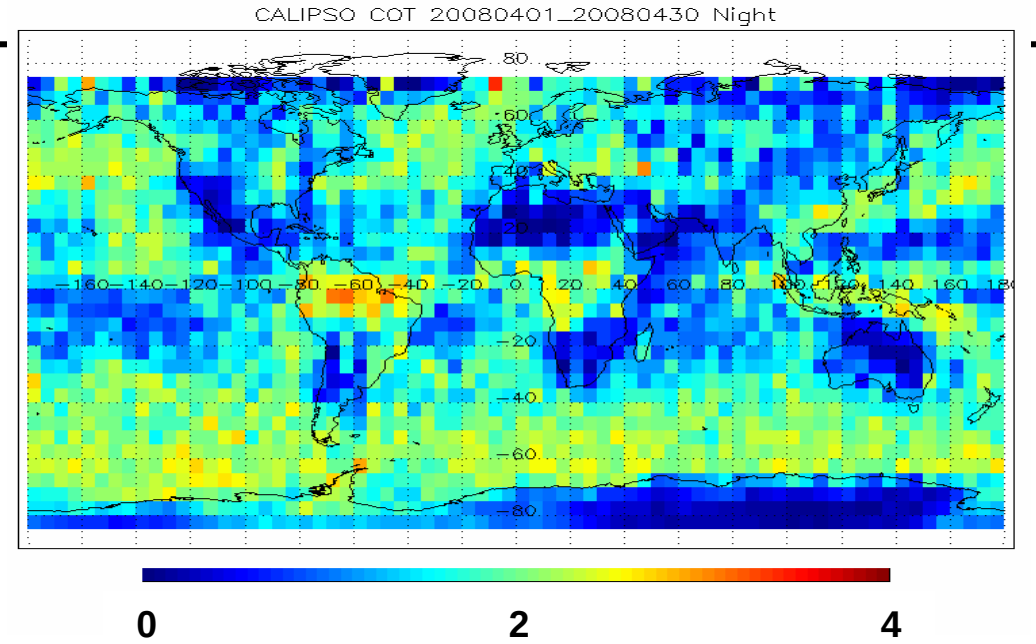
- Mean (standard deviation) cloud optical depth:
  - Ground-based: 0.235 (0.133)
  - CALIPSO: 0.210 (0.134)



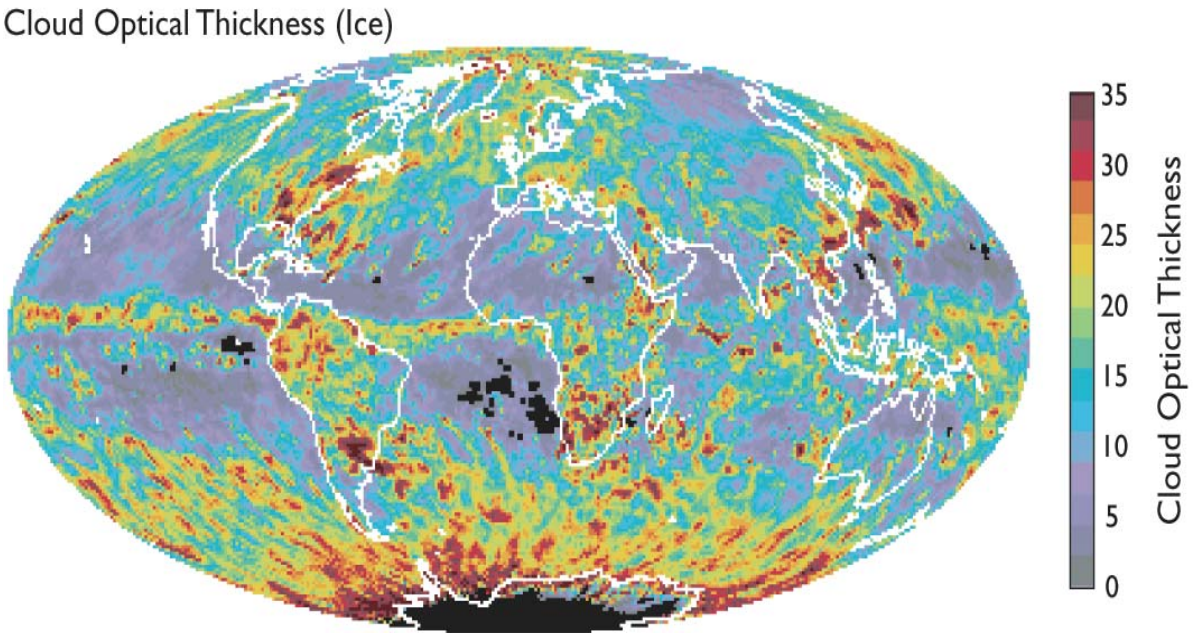
(Thorsen, Fu, and Comstock)

Column Cloud (ice) Optical Thickness

CALIOP, Version 2
April 2008



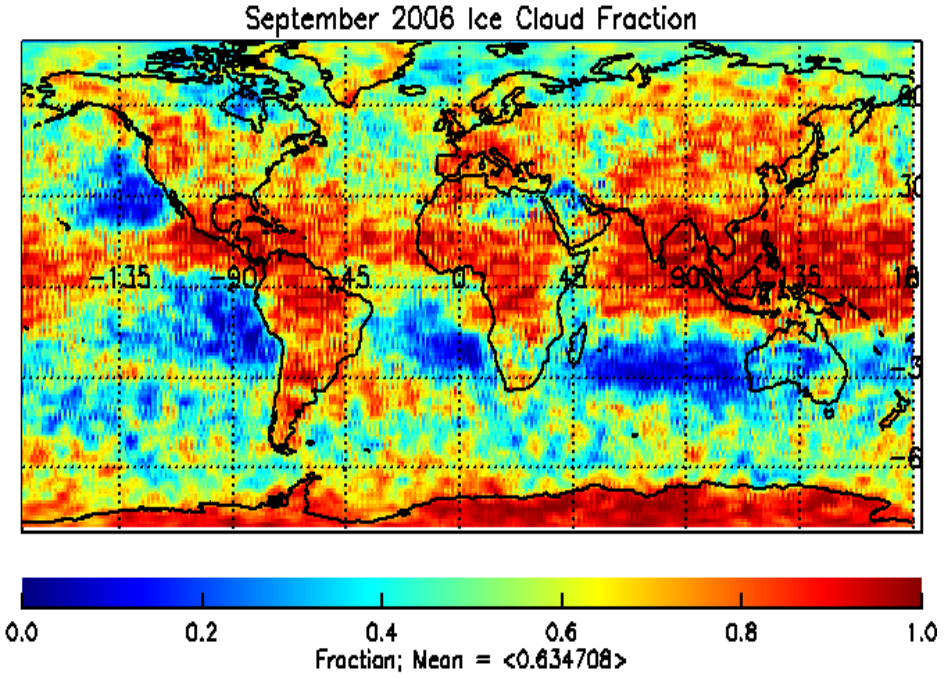
MODIS Aqua, Collect 5
April 2005 (QA mean)



Cloud fraction by thermodynamic phase

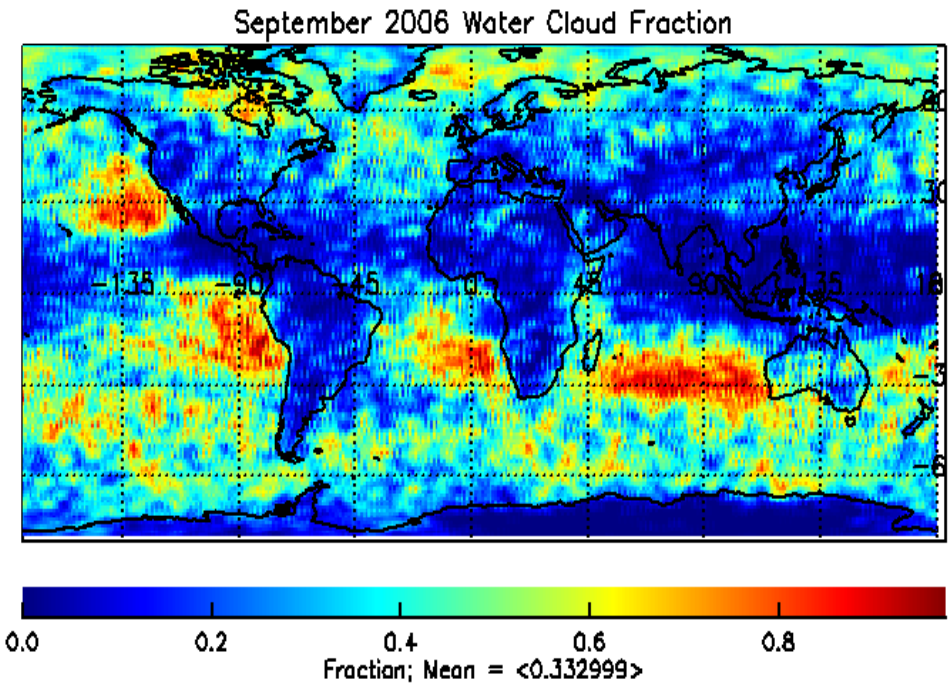
Highest cloud in column (Sept 2006)

Ice Clouds (64%)



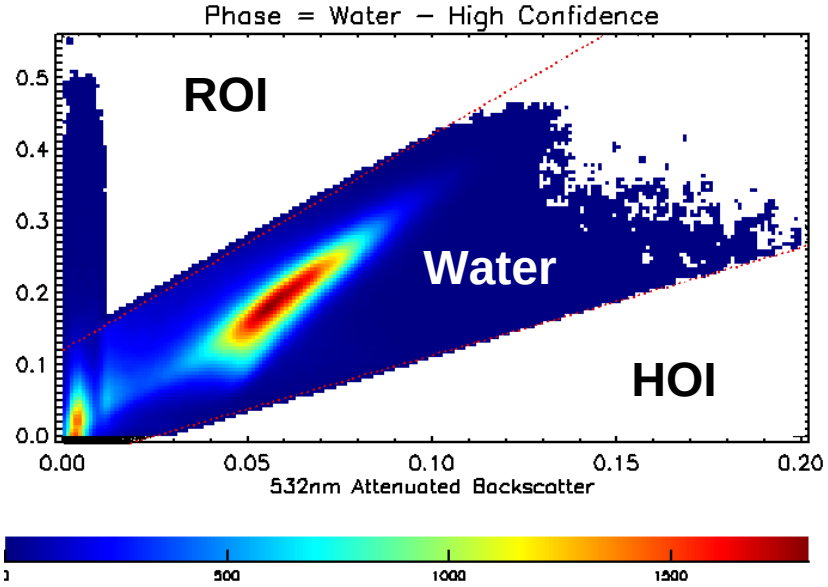
1-deg resn; Nearest neighboring smoothing

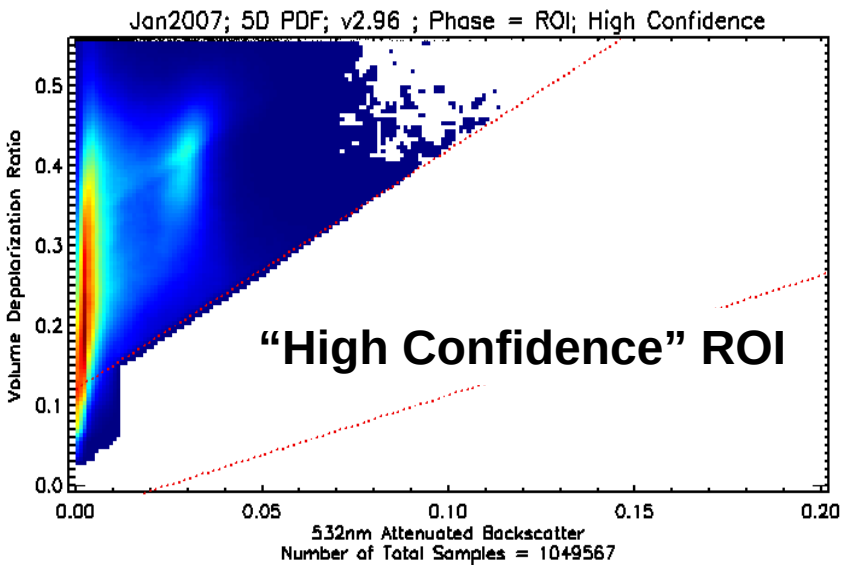
Water Clouds (33%)

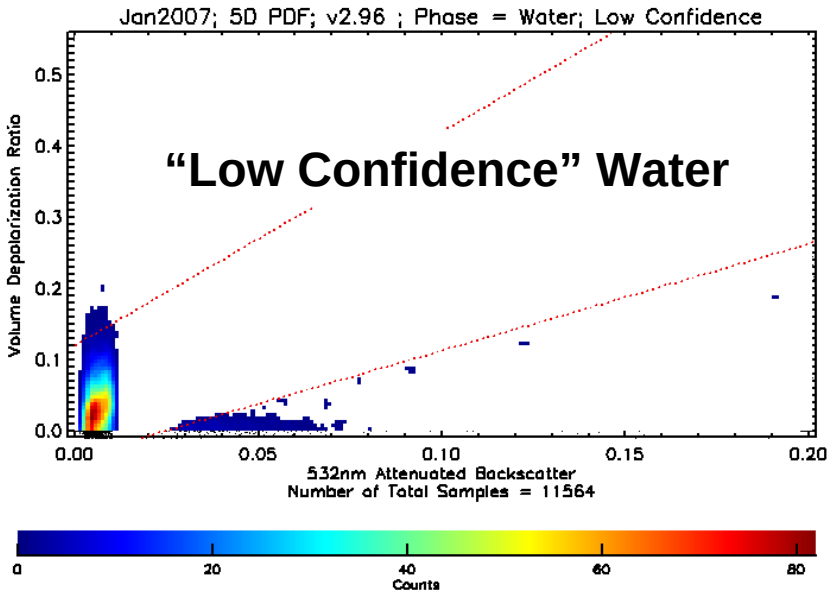


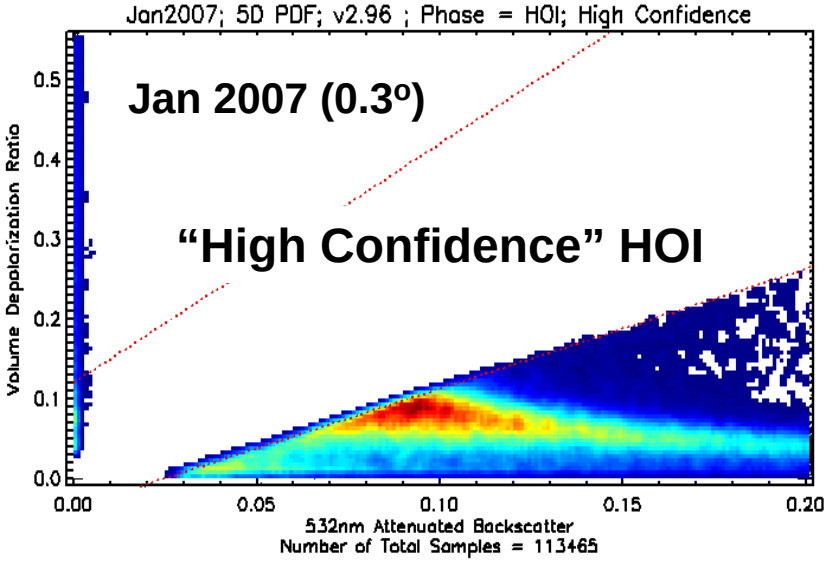
1-deg resn; Nearest neighboring smoothing

Version 3: New Cloud Phase Algorithm





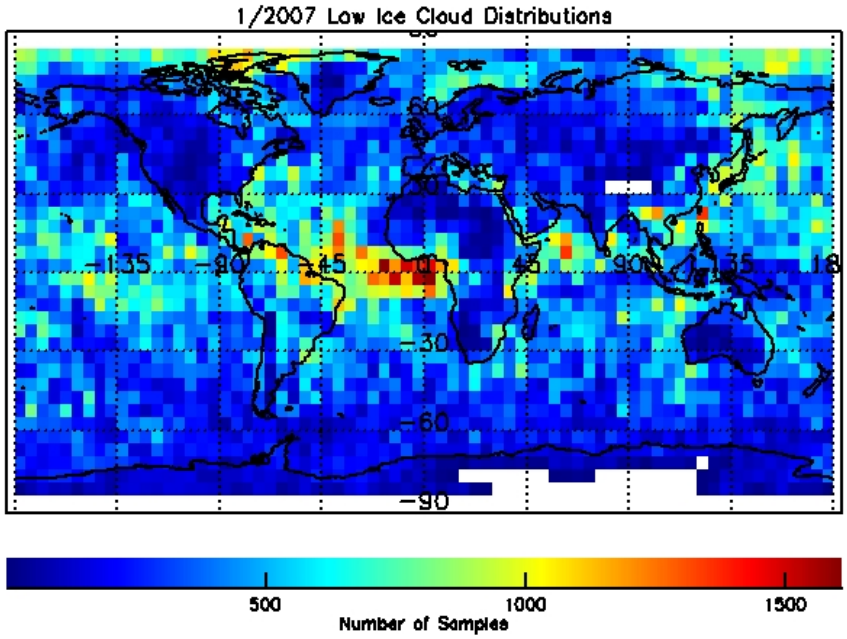




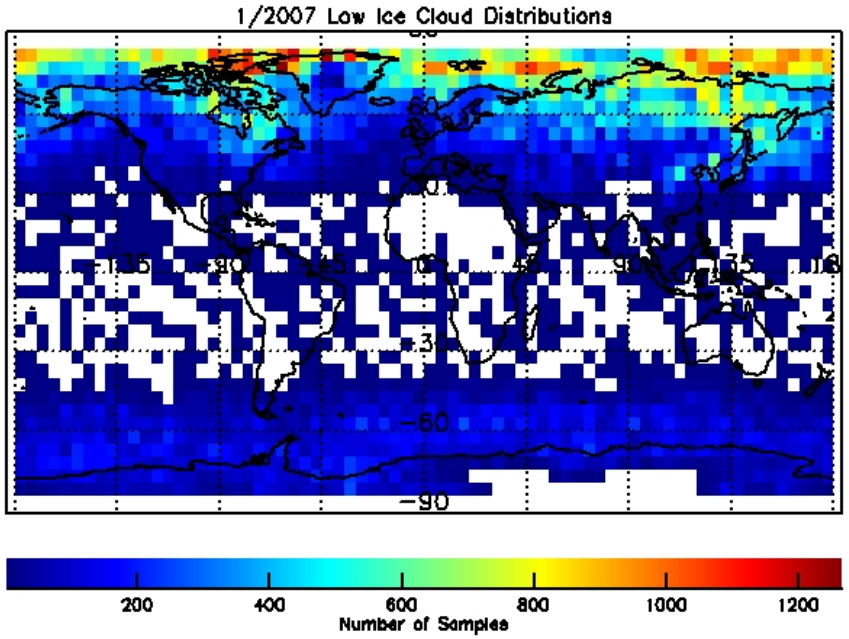
Reduced artifacts in cloud ice-water phase

Oriented ice now properly classified (HOI → water in V2)

Version 2.01

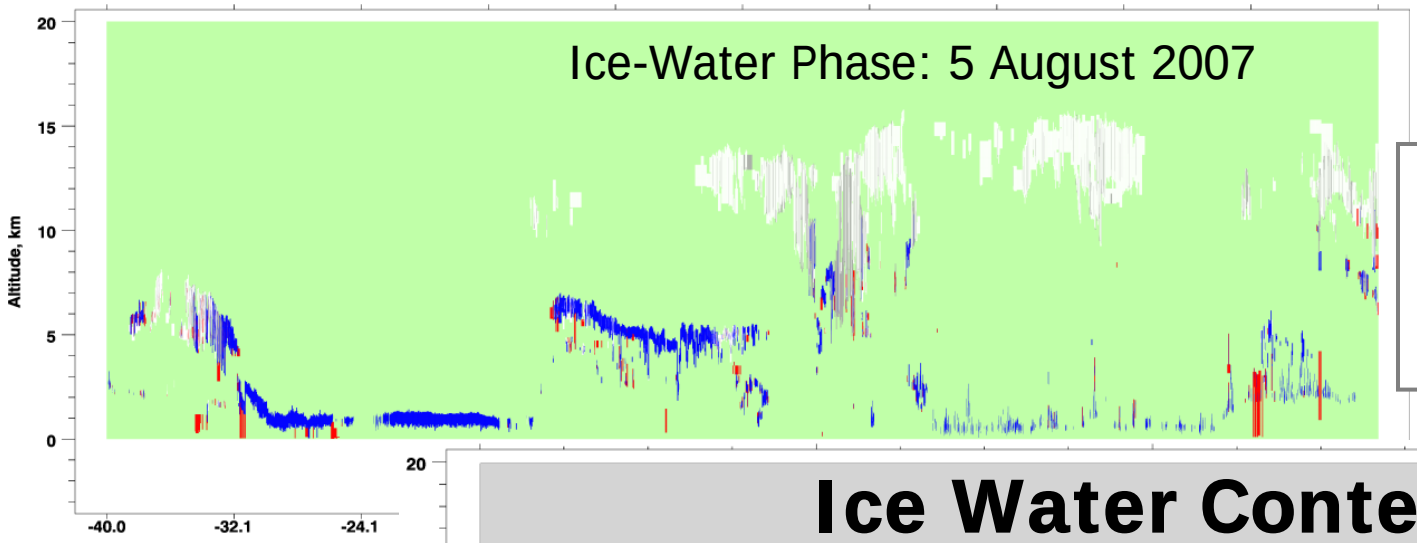


Version 3



Number of 'ice' clouds with tops below 3.25 km

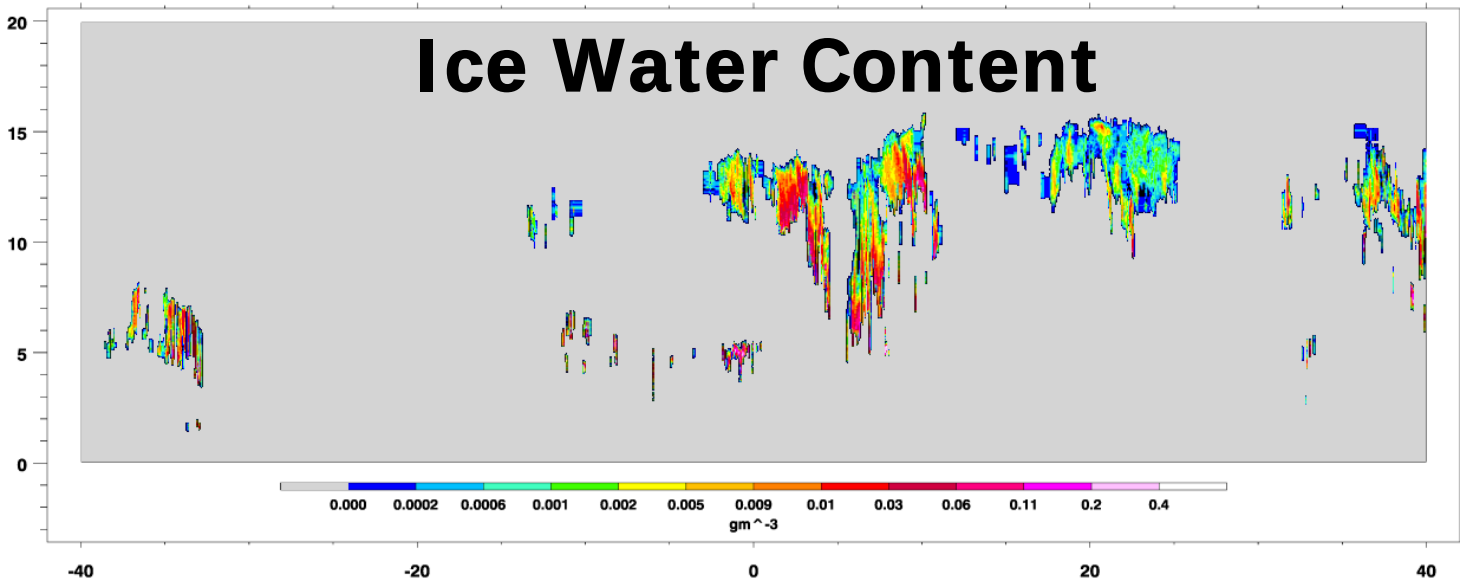
New V3 product: IWC



$$IWC = C_0 \left(\frac{\sigma}{1000} \right)^{C_1}$$

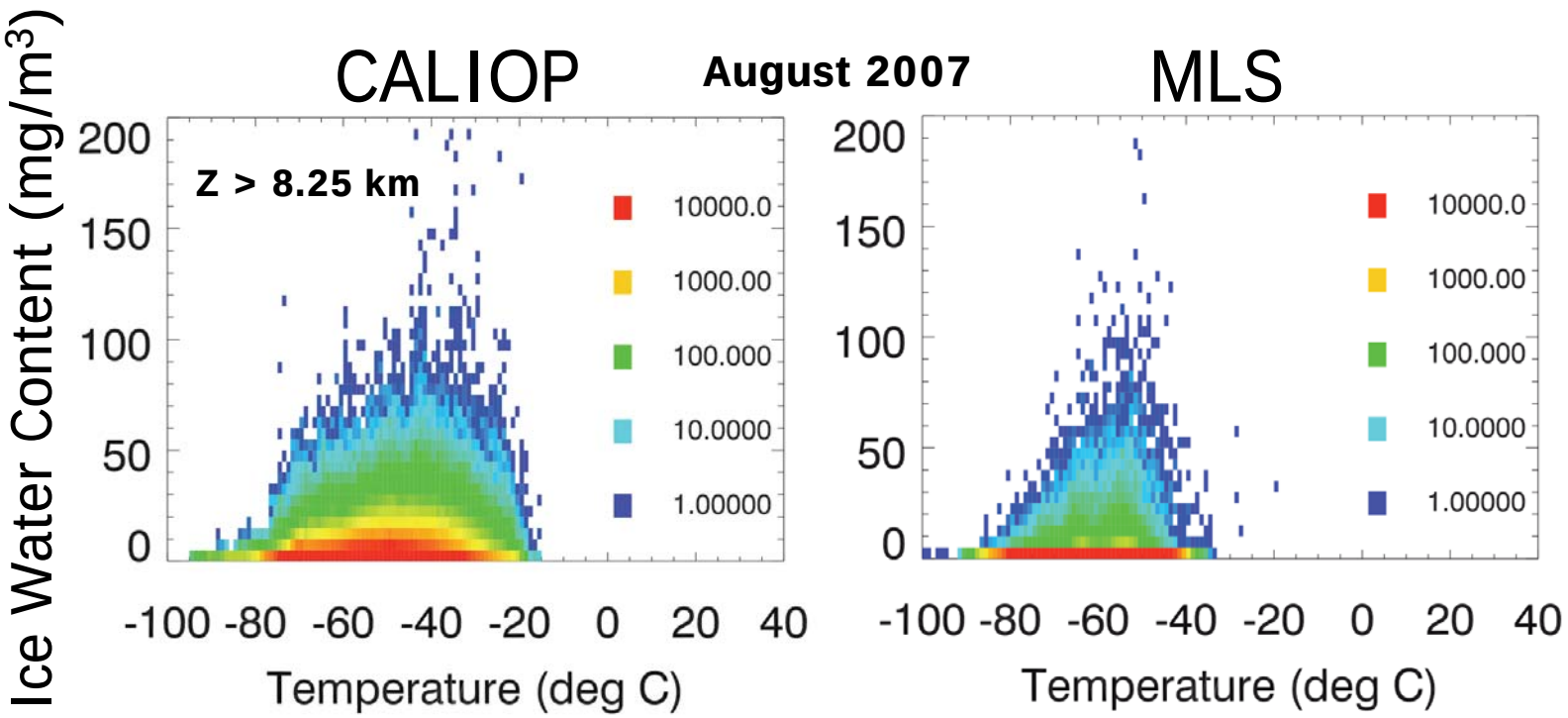
$C_0 = 119\ g/m^3$

$C_1 = 1.22$



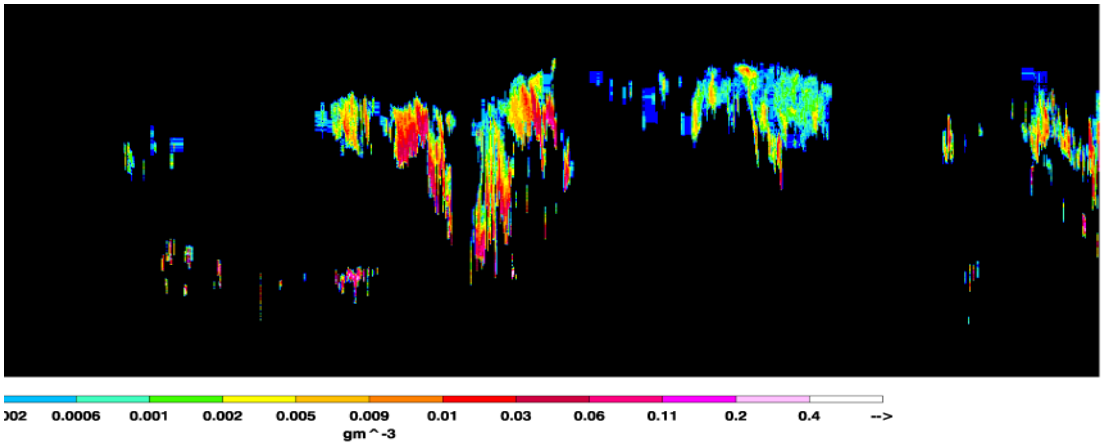
IWC parameterization from Heymsfield et al (2005)

Ice-Water Content Comparison



CALIOP V3.01 Cloud Ice:

- **Compares to MLS**
- **CloudSat comparison underway**



Conclusion

- **Version 3 data is now available:**
  - **Improved cirrus OD, ice/water classification**
  - **New IWC, IWP product**
  - **Many improvements over Version 2 products**
- **Taking another look at extinction-IWC parameterization**
  - **Now have better in situ measurements, better understanding of particle shattering**
  - **Current IWC likely off by a factor of 2**
- **New Level 2 IIR product by end of 2010: D_{eff}, IWC from lidar+IR**