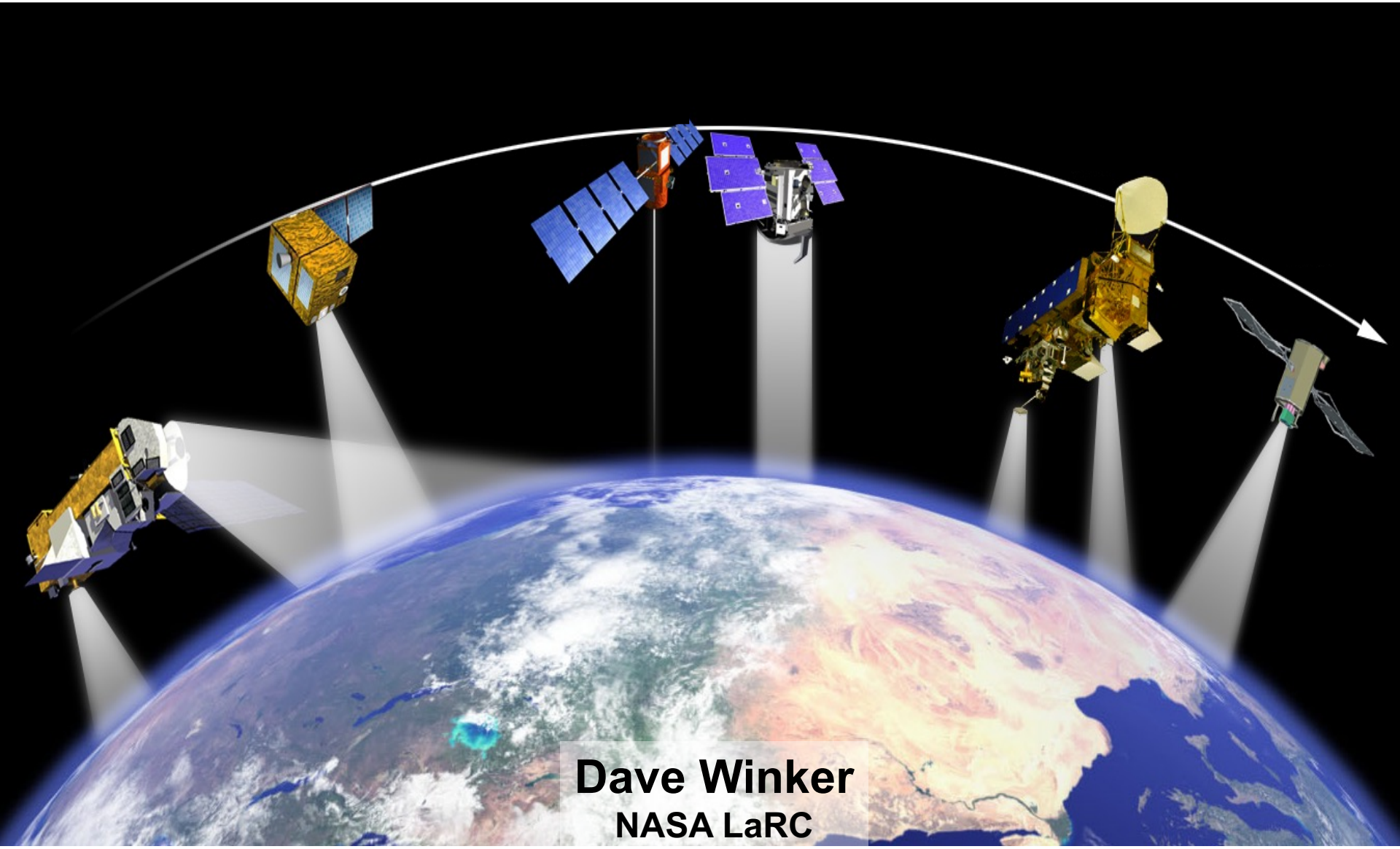
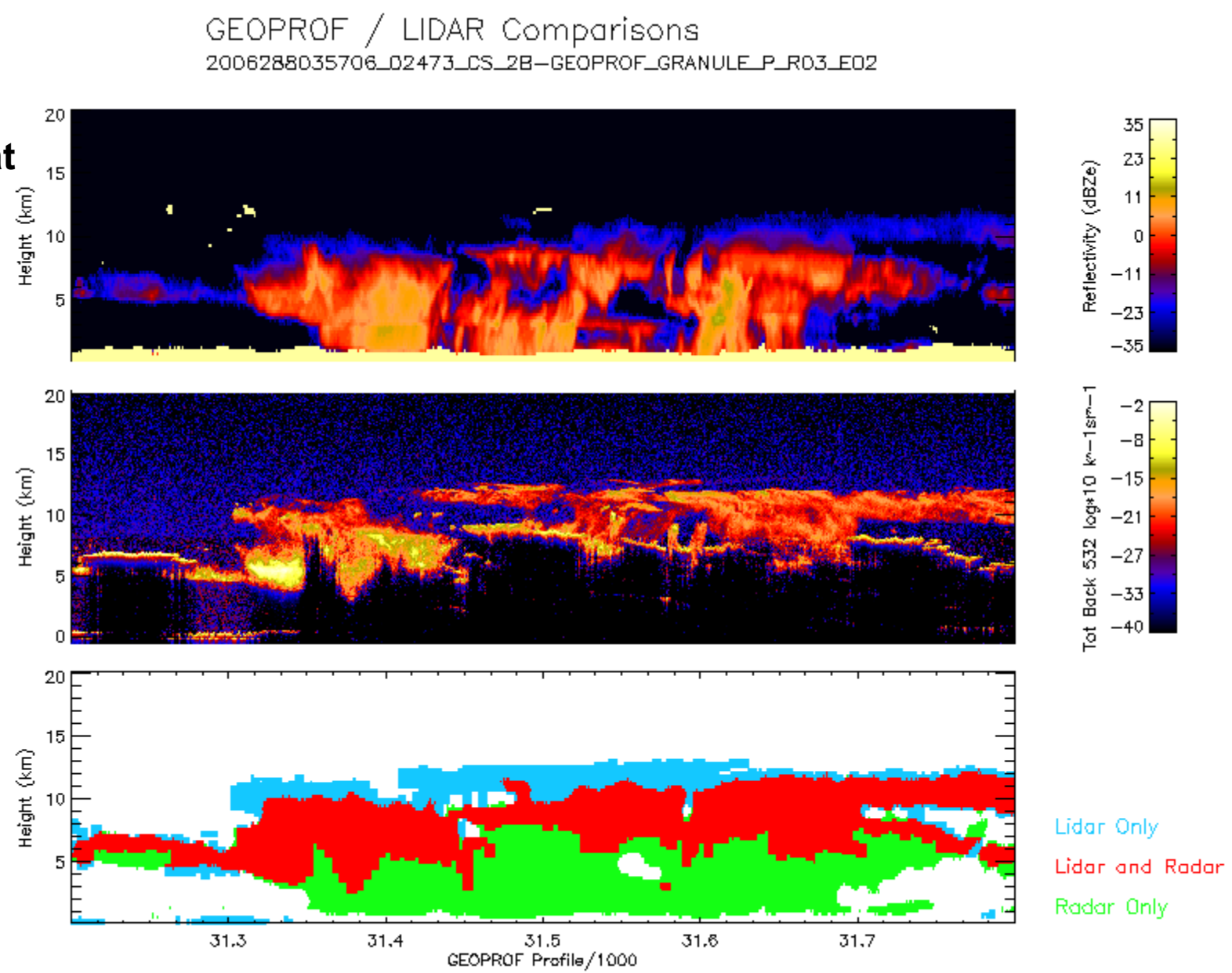
An initial CALIPSO cloud climatology



Dave Winker
NASA LaRC

ISCCP Anniversary, 23-25 July 2008, New York

Merged CALIPSO-CloudSat product now available



CALIPSO vs. GEWEX CA

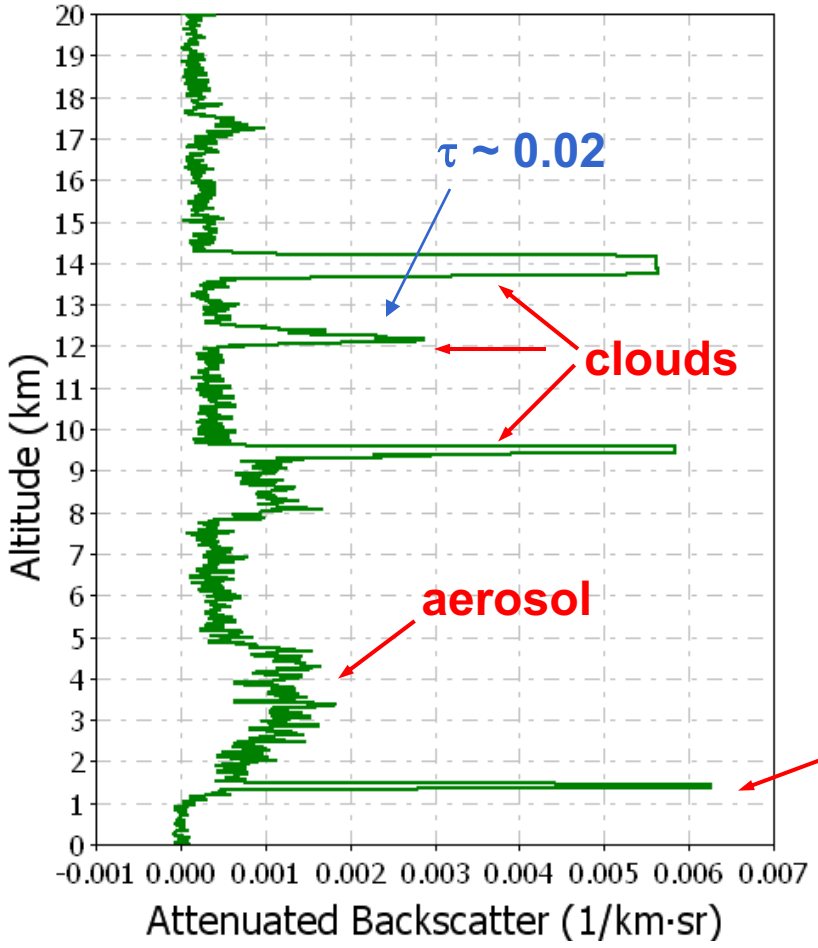
- **Cloud cover, height** - CALIOP
- **Cloud temperature**
  - **Mid-cloud temperature** (from CALIOP height and GMAO)
  - **Brightness temperature** (from CALIOP + IIR)
- **Optical depth, extinction profile**
  - 'Thin' cirrus only, $\tau < 3$ to 5
  - From CALIOP transmittance (good, 4%)
  - From CALIOP retrieval (not as good, 96%)
- **Emissivity** – CALIOP + IIR
- **Ice/Water phase** – CALIOP depolarization
- LWC/IWC – parameterized from CALIOP extinction
- **Particle size**
  - Cirrus only – CALIOP + IIR
  - CloudSat + CALIOP (overlap regions only)

Available now

Available, but Beta

(near) future

Not available



Sampling resolution:

Δz = 30 m

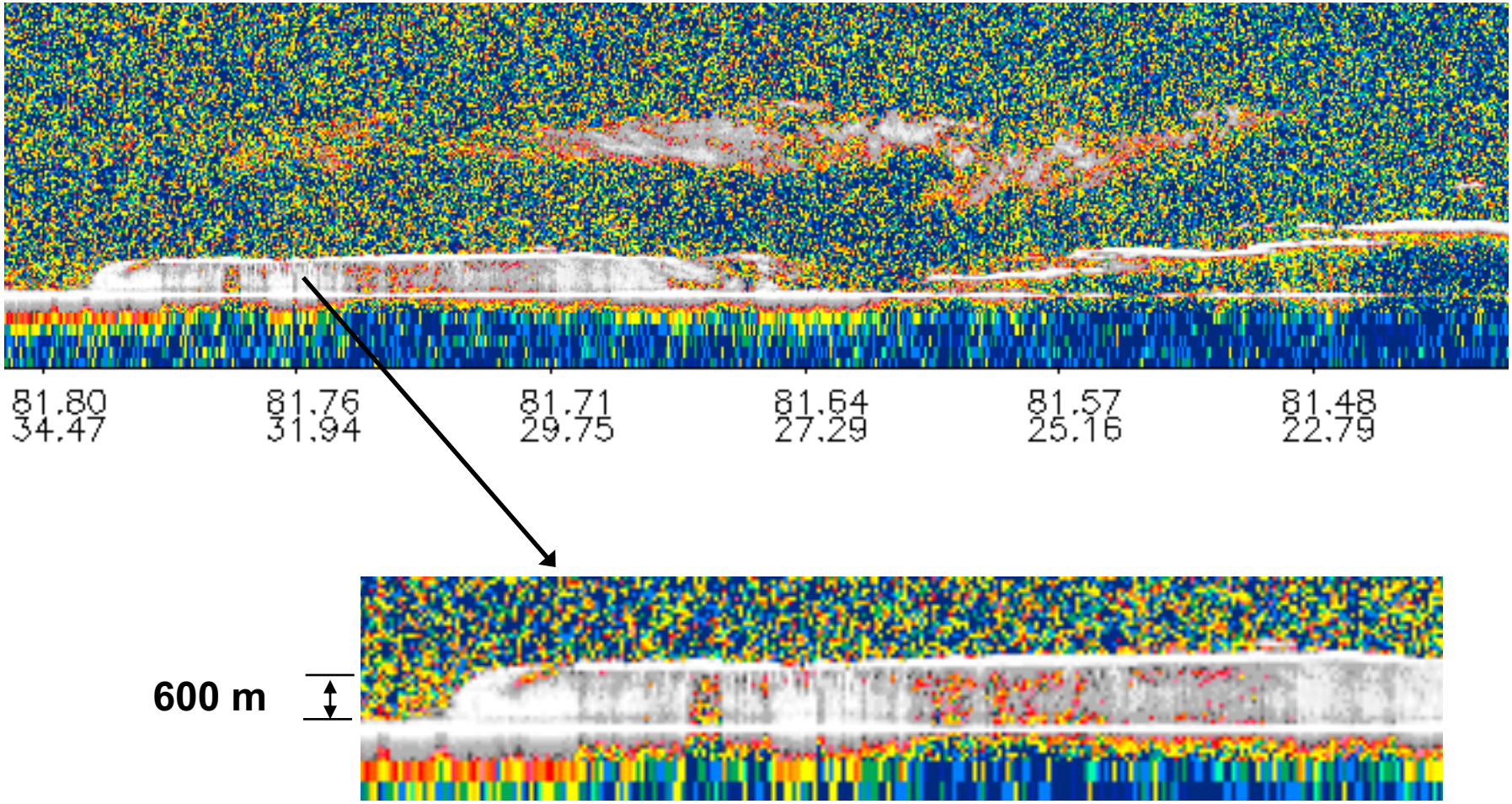
footprint = 70 m dia.

footprint separation = 335 m

Altitude location error << 30 m

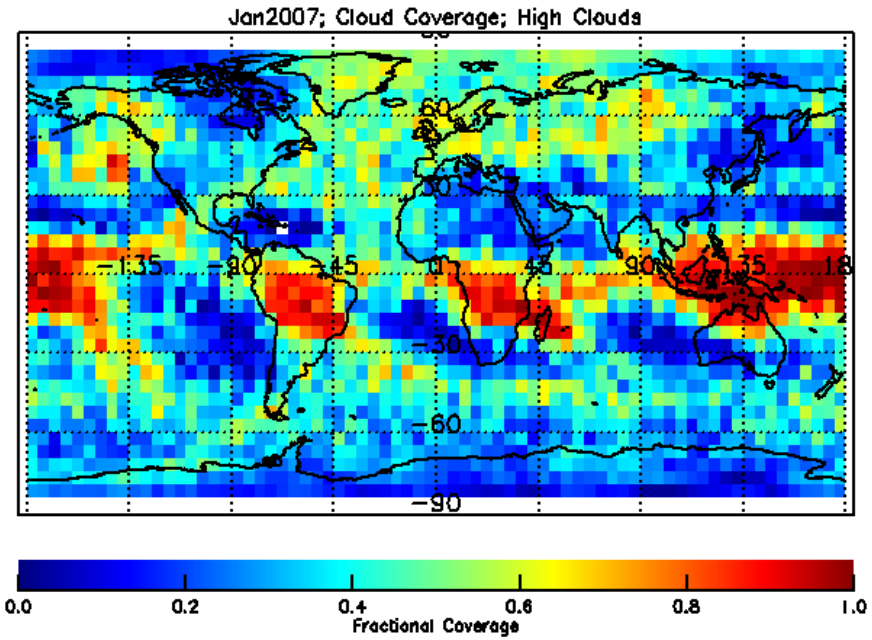
Cloud detection is weakly dependent on calibration

Arctic Stratus, full resolution (30 m, single shots)

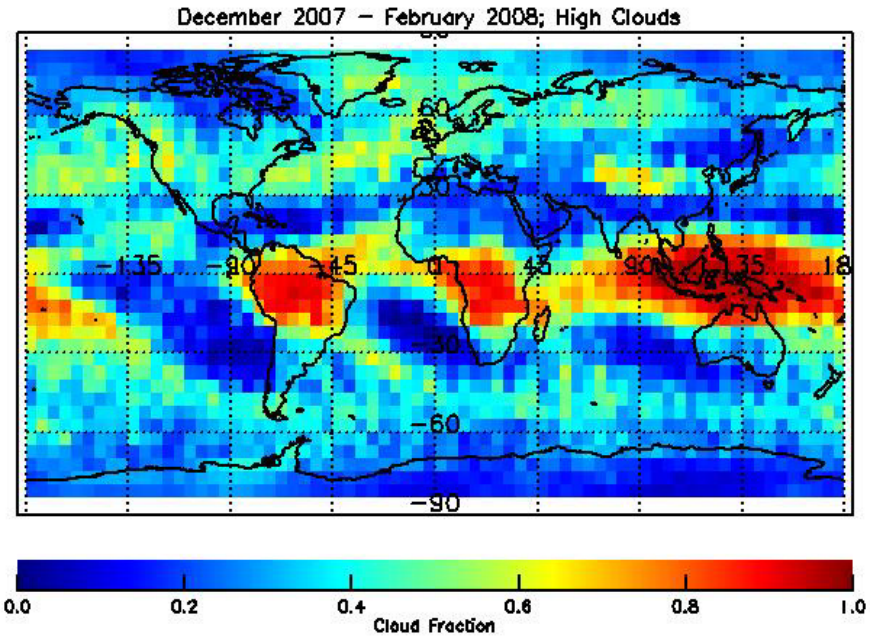


Temporal Averaging (high clouds)

one month



one season



Cloud Fraction Analysis

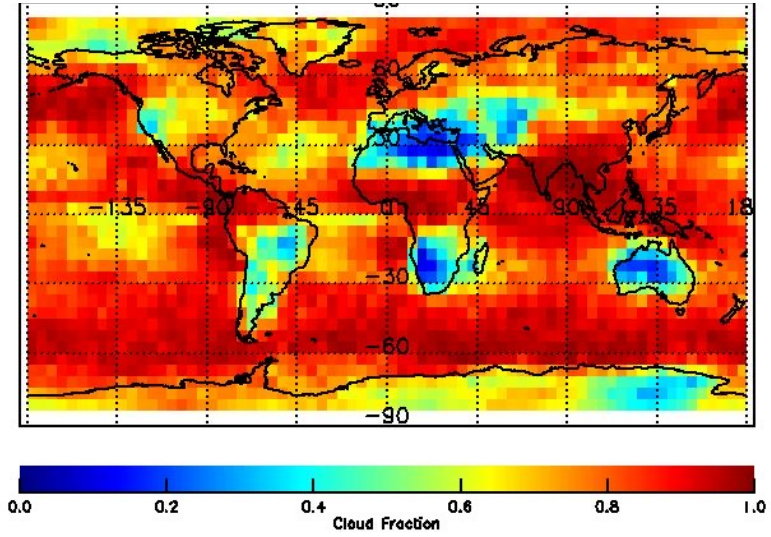
- **Merge clouds in 1/3-km and 5-km products**
  - **1/3-km clouds are cleared from 5-km profiles during processing**
- **Use only layers with CAD score 70-102**
  - **Layers with CAD = < 70 (especially 0-20) tend to be "spurious"**
    - > **Affects cloud fraction at the 1% level**
  - **101 = thin polar cirrus originally classified as aerosol, reclassified based on depolarization**
  - **102 = cloud dominated by horizontally oriented ice crystals**
- **Reclassify "aerosol" over Antarctic plateau as cloud**
  - **Increases Antarctic cloud fraction by ~ 5%**
- **Reject PSCs mistakenly classified as tropospheric cloud**
  - **Ambiguous GMAO tropopause results in misclassifications**

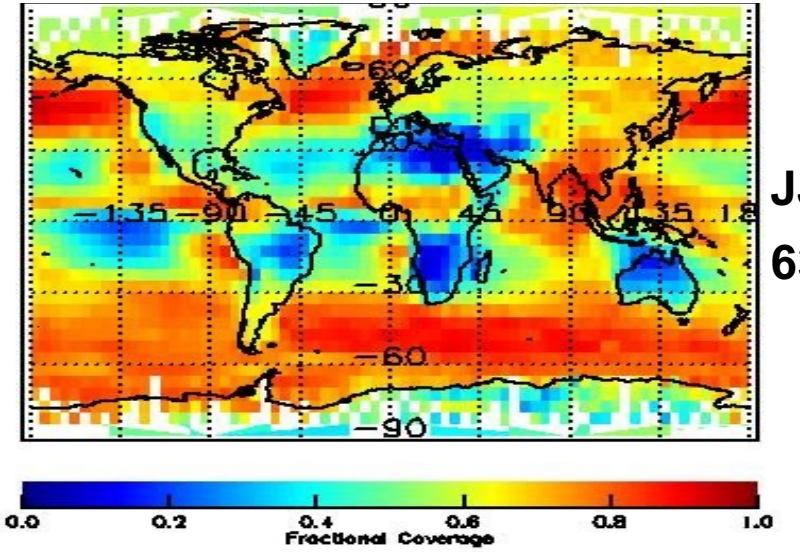
Total Cloud Cover

CALIPSO

ISCCP

JJA
78.8%

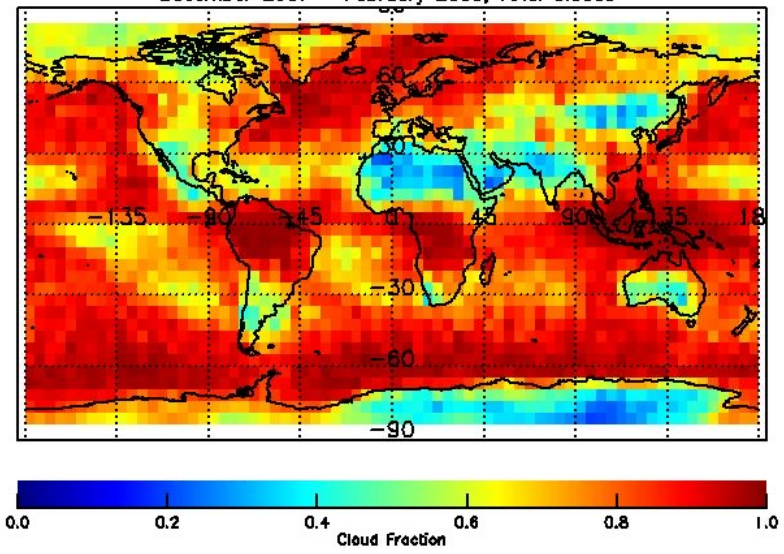


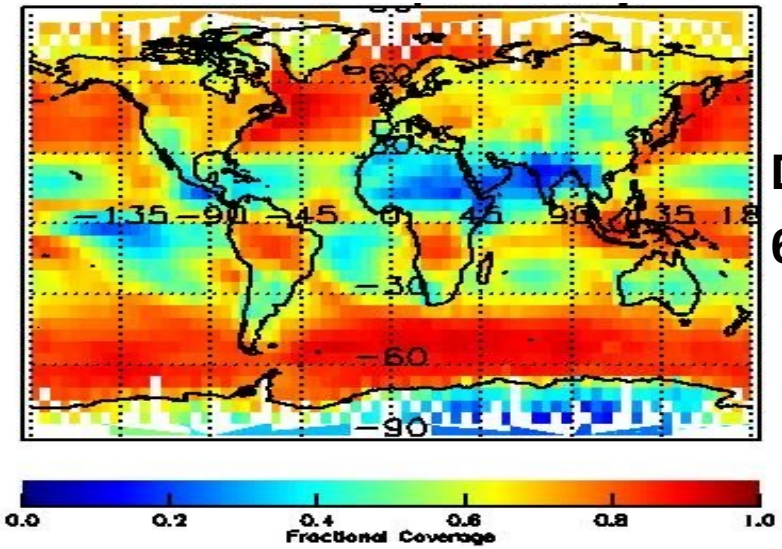


JJA
63.5%

December 2007 – February 2008; Total Clouds

DJF
76.5%

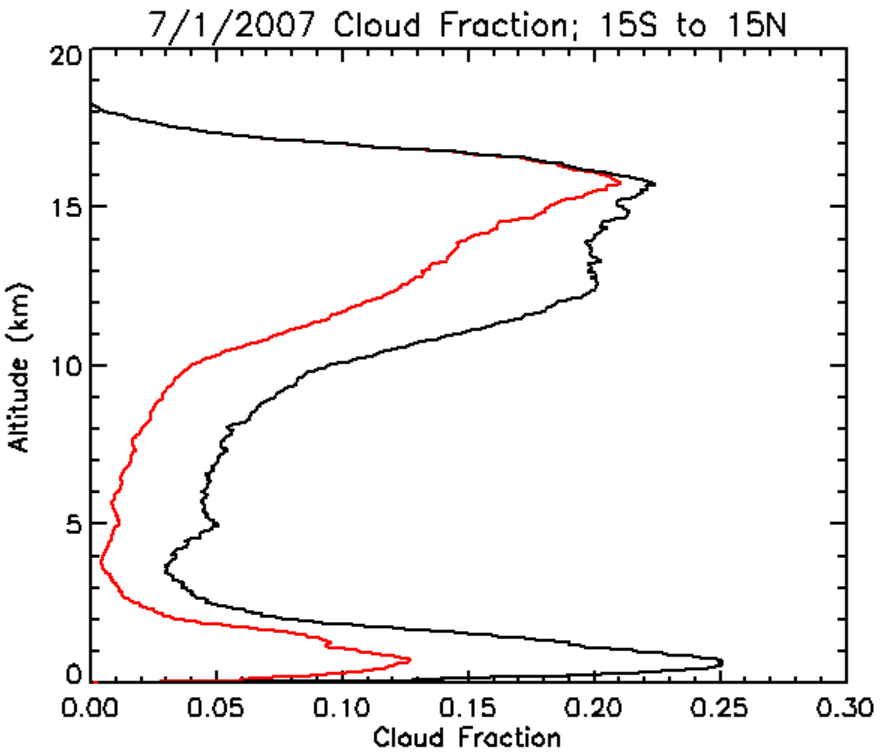




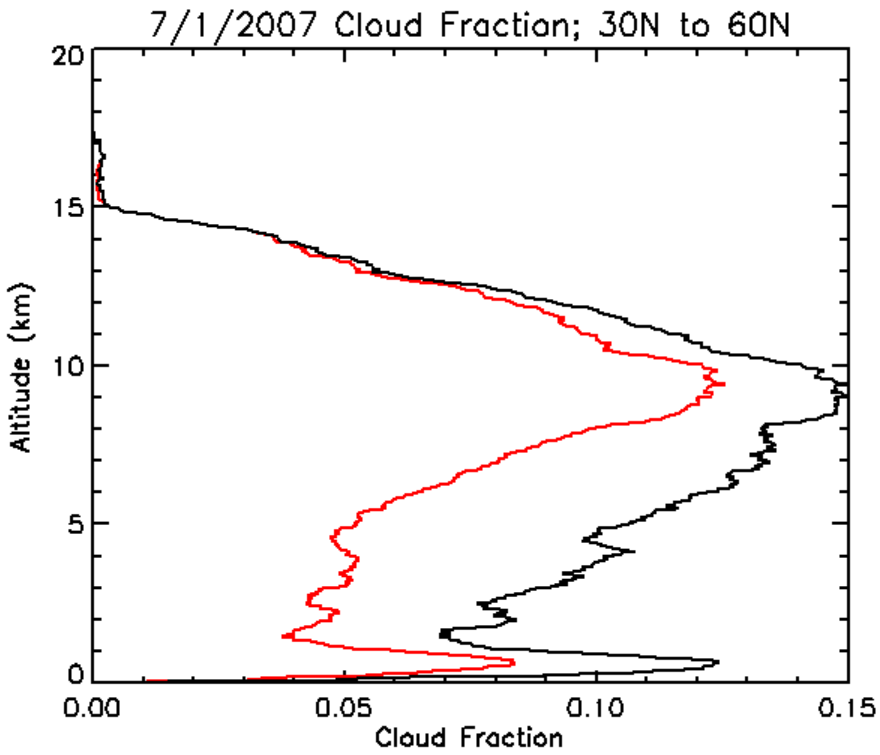
DJF
65.6%

Profile of Cloud Frequency

Tropics



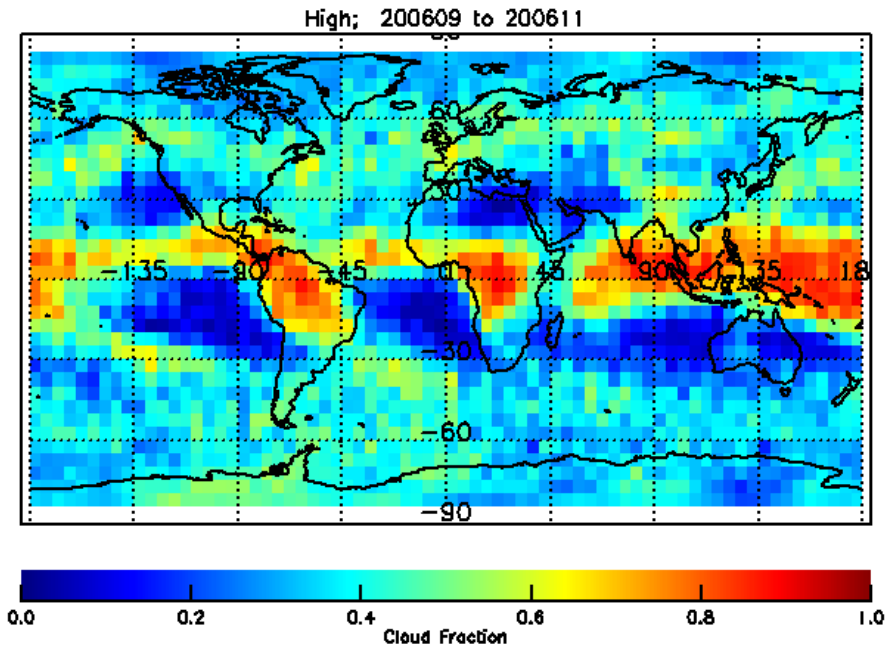
30N - 60N



Black -> All Layers Detected, Red -> Highest layer only

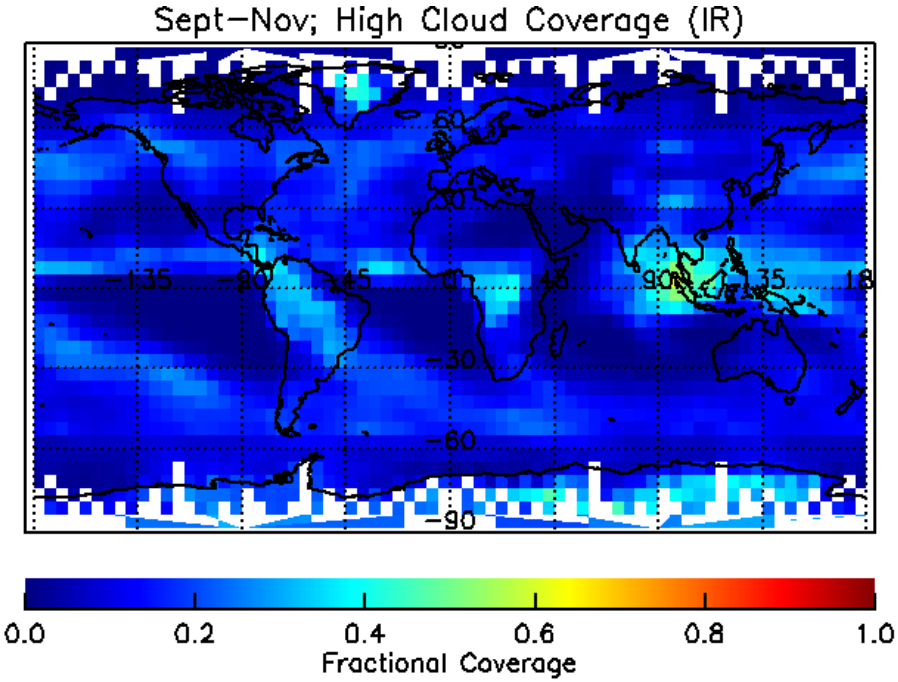
High Clouds - SON

CALIOP (2006)



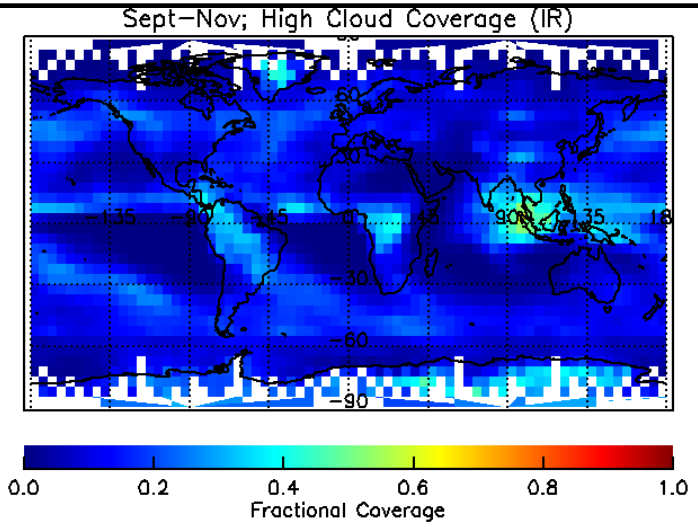
Layer>=6.5km; 2006/09/01 00:41:40 to 2006/12/01 00:13:50

ISCCP (2005)



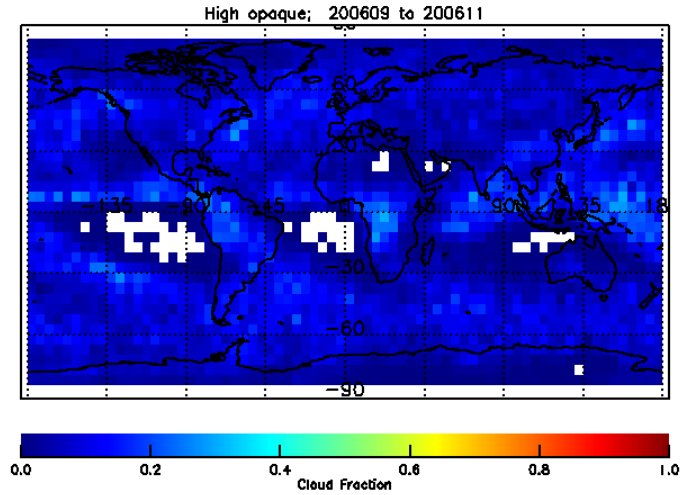
Mean=0.1243

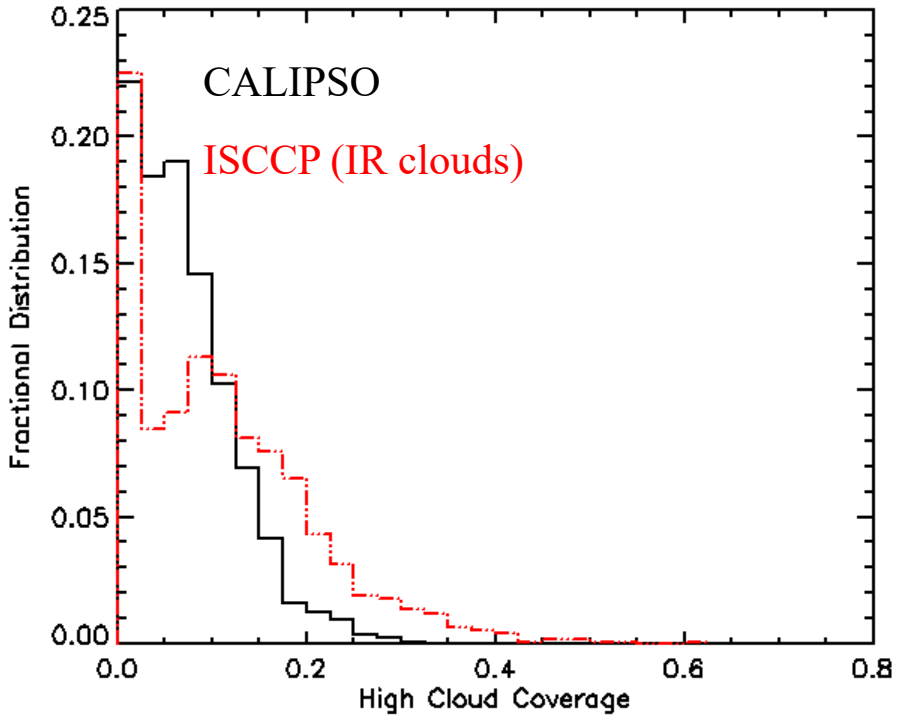
High Opaque Clouds - SON



ISCCP

Mean=0.1243

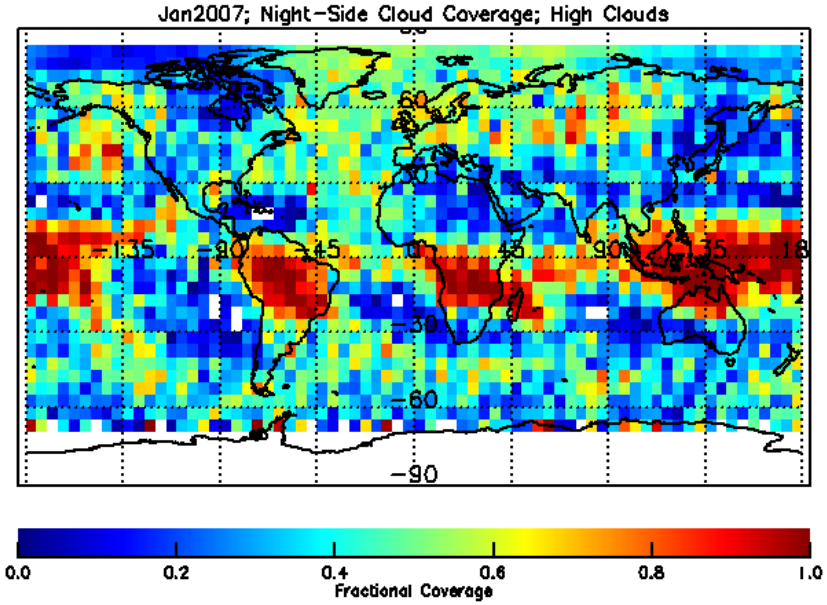




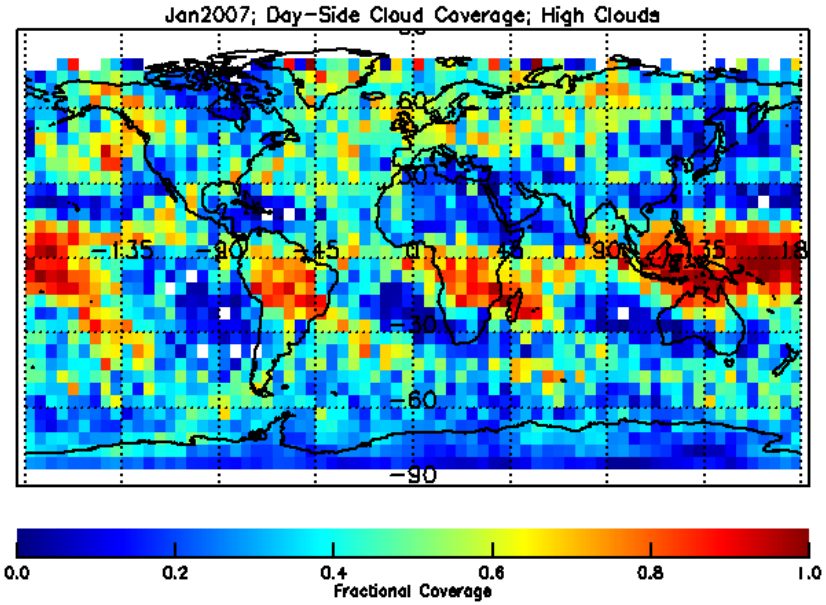
CALIOP

High clouds, diurnal difference – Jan 2007

night



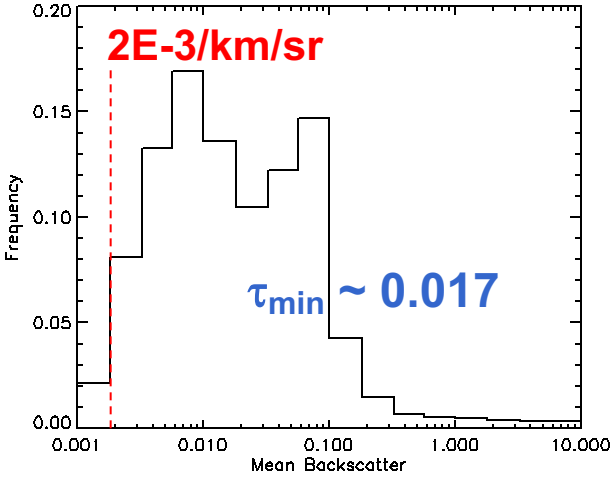
day

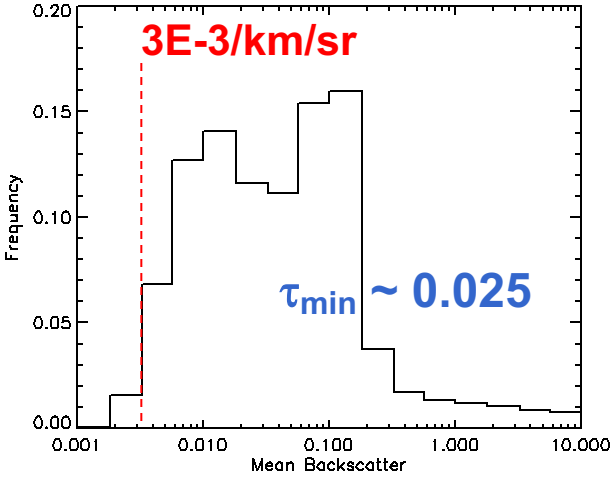


Cloud layer-average backscatter (V2.01)

Night | **Day**

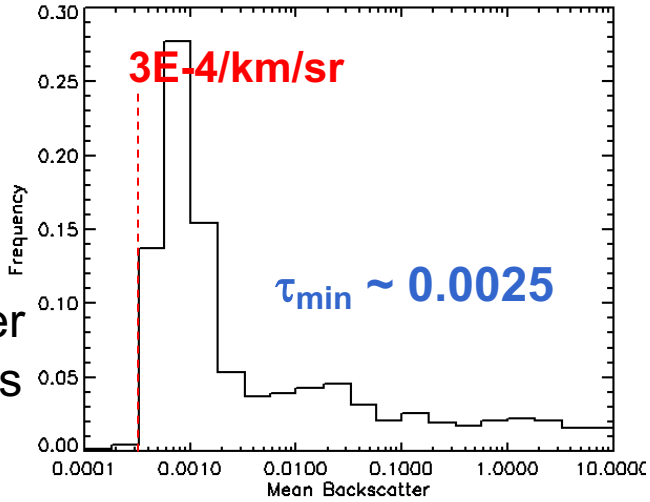
5-km avg

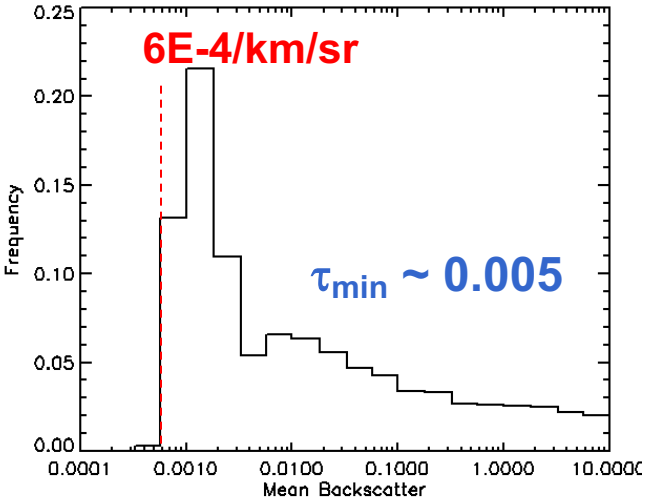




τ_{min} estimated from distribution of layer IAB

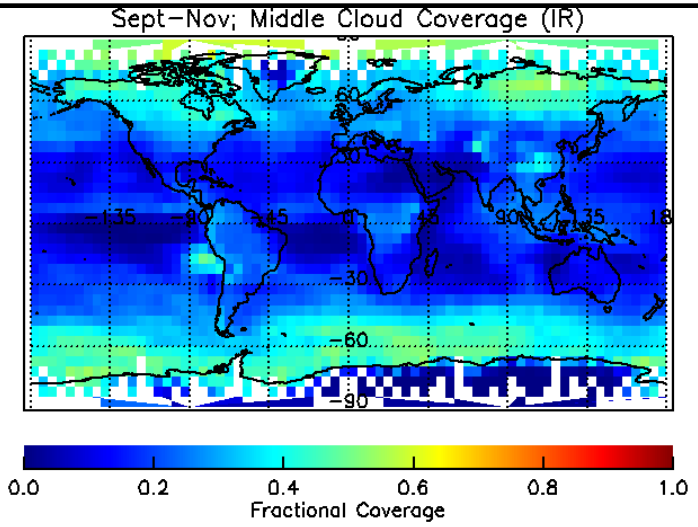
80-km avg



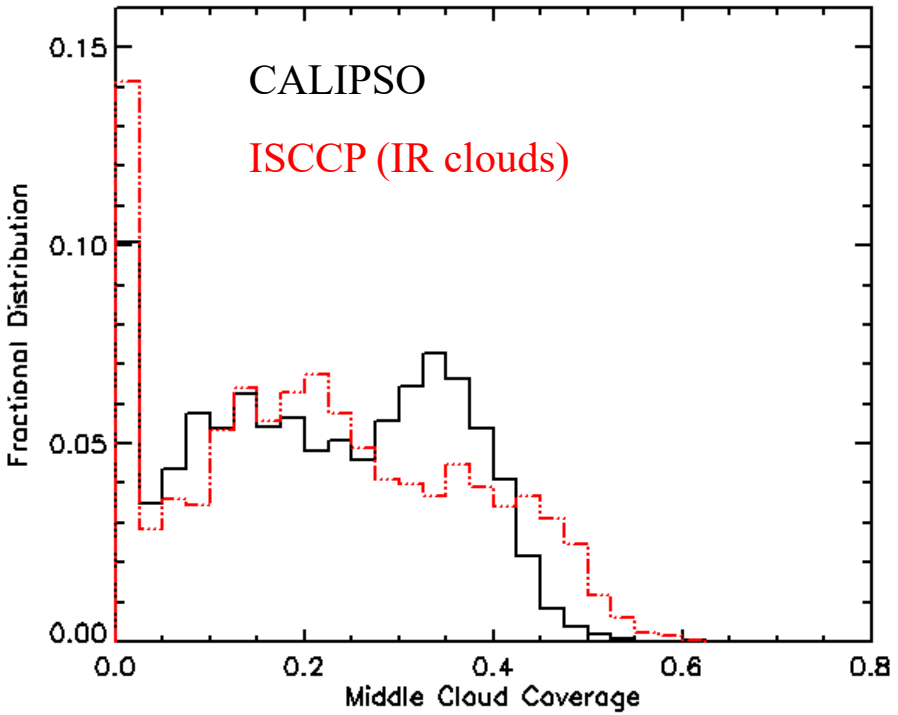


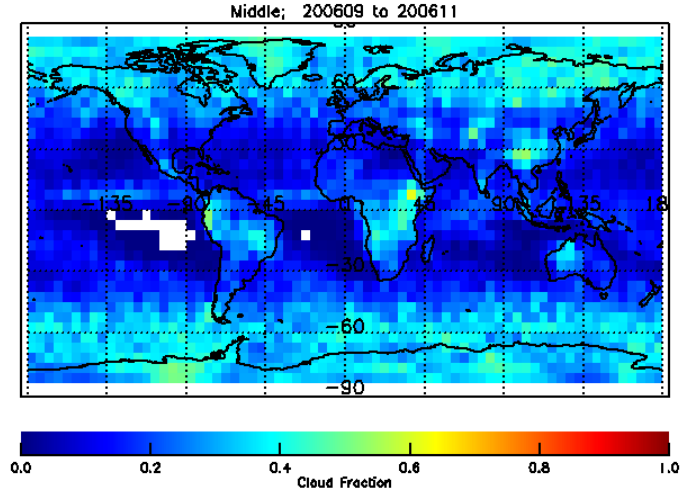
Histograms of layer-average cloud backscatter for 5-km and 80-km layers July 1-7, 2006.

Middle Clouds - SON



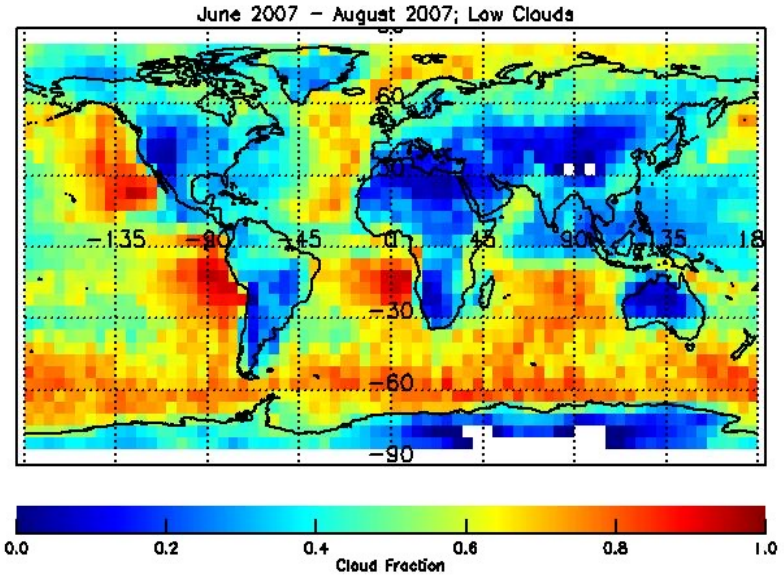
ISCCP (2005)





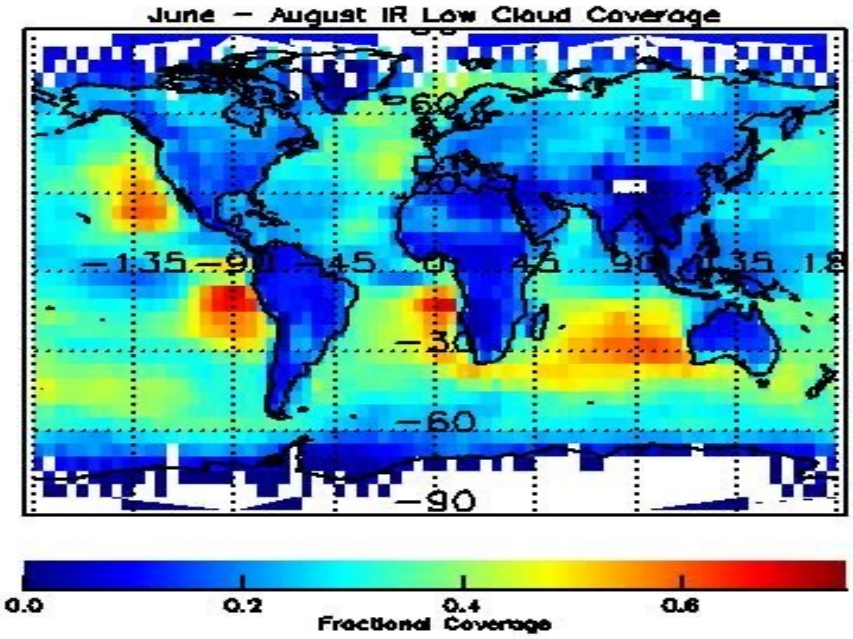
CALIOP (2006)

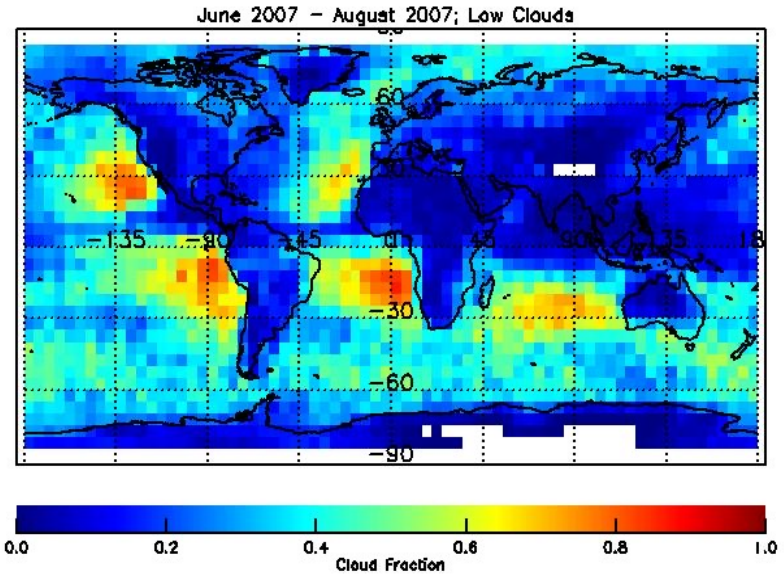
Low Clouds - JJA



CALIPSO: 49.4%

ISCCP: 25.2%

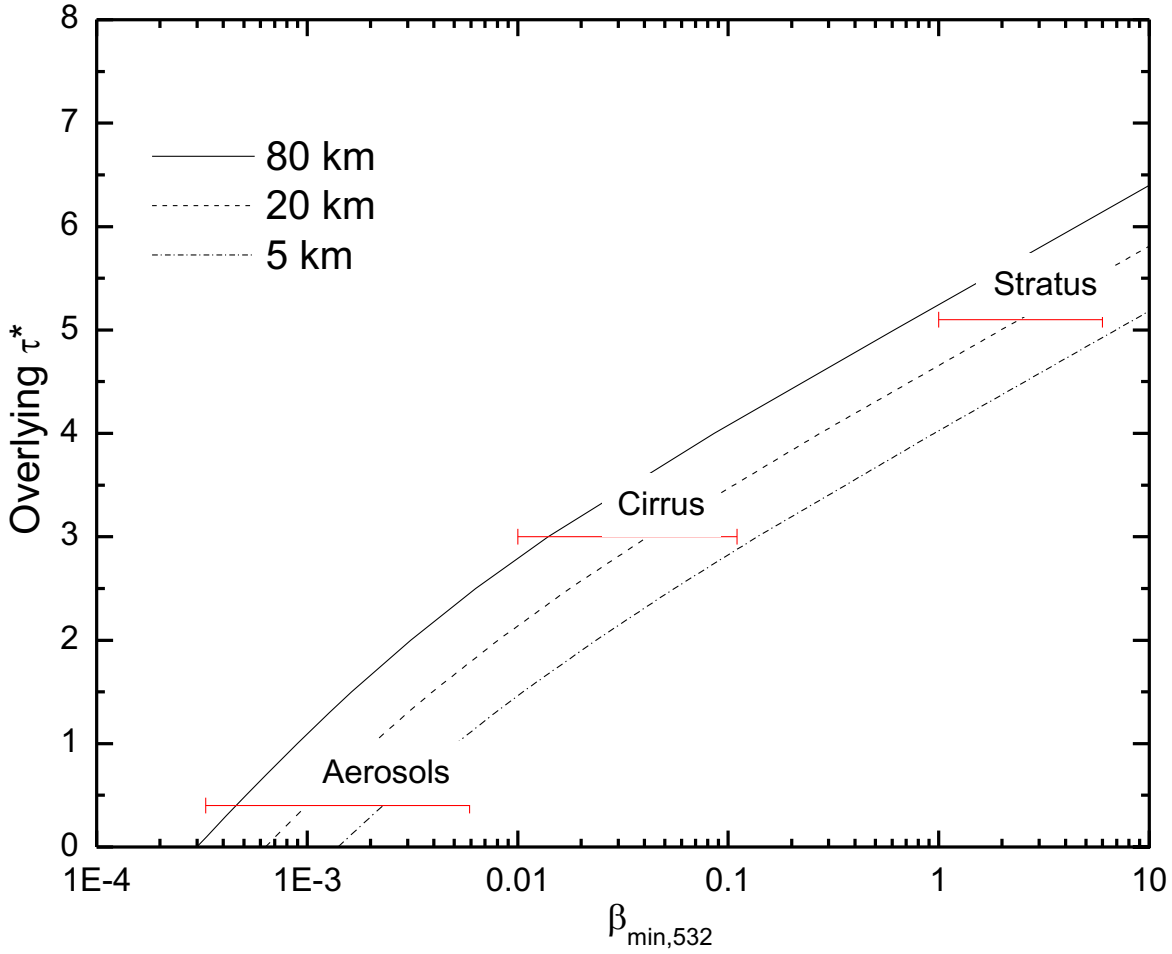




CALIPSO, single-layer low cloud: 27.5%

Sensitivity to layers underneath thin clouds (night)

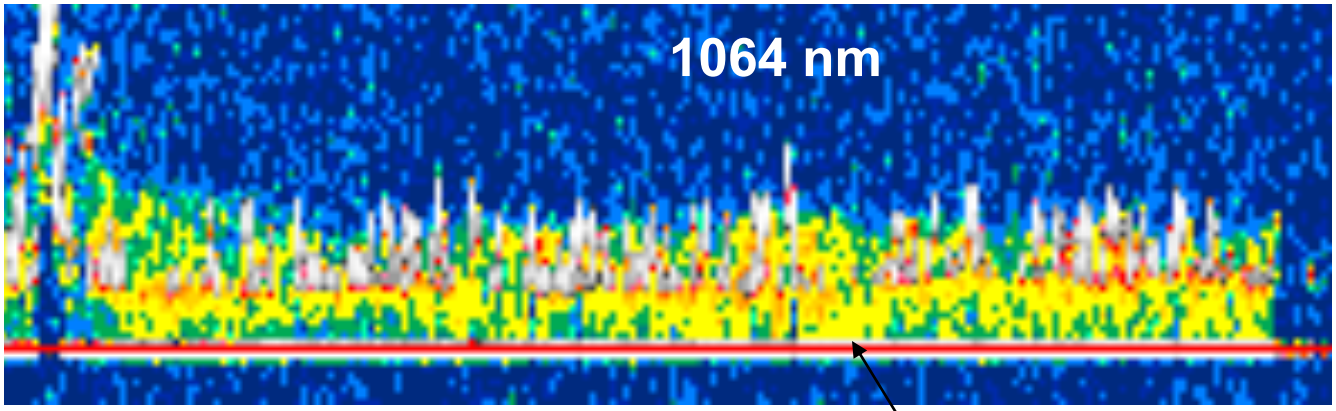
weaker layers disappear as overlying layer becomes optically thicker

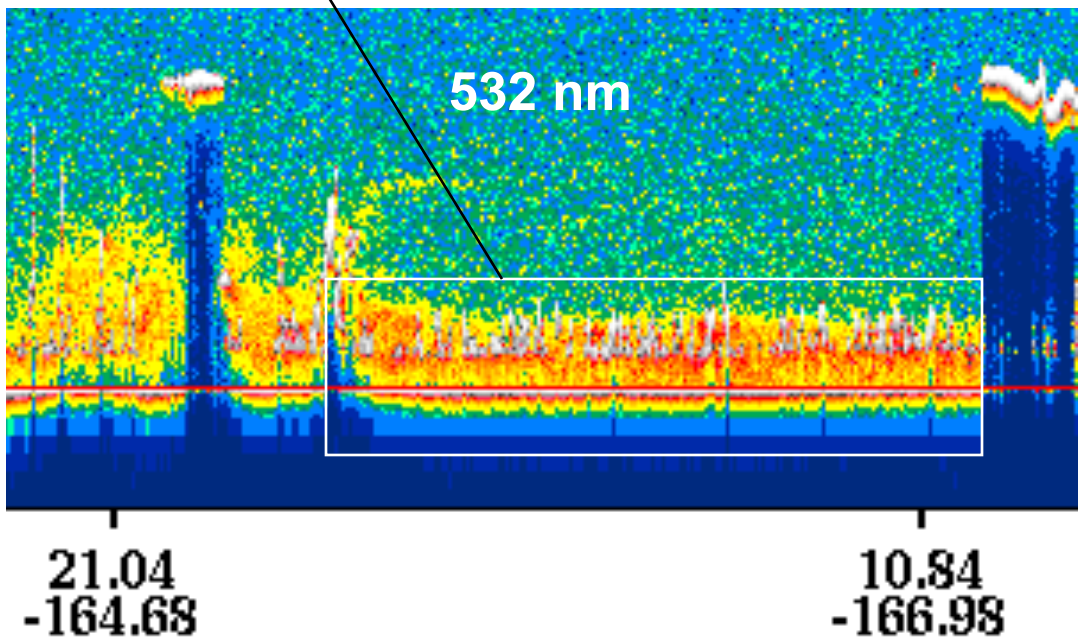


Stratus detectable underneath clouds of optical depth ~ 5

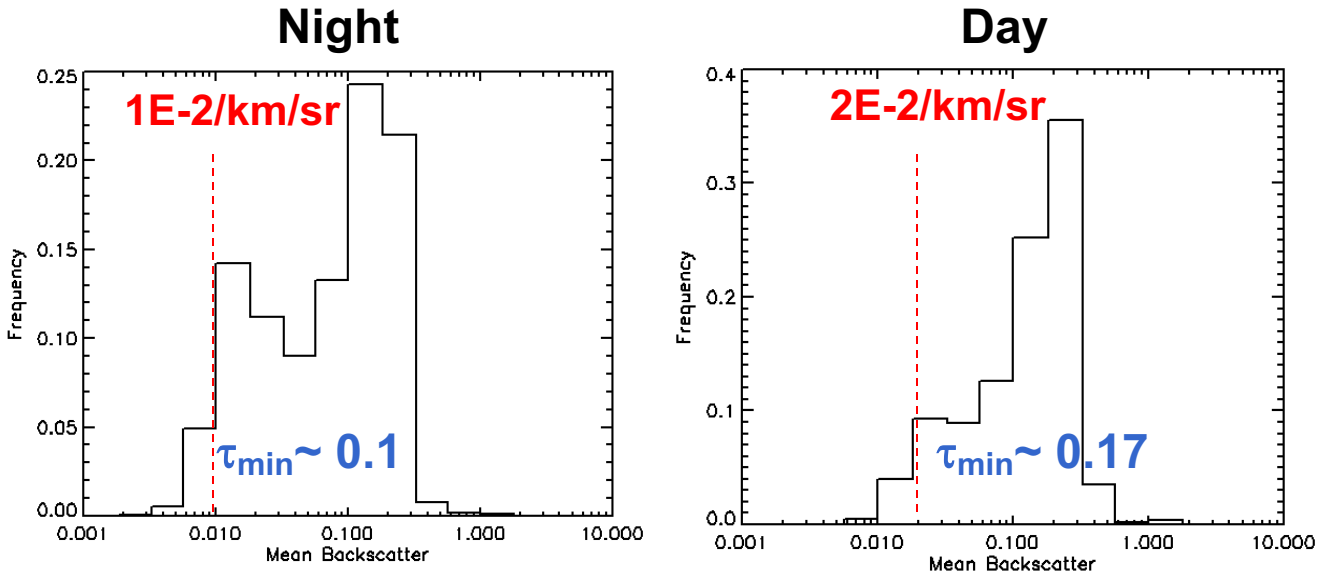
Aerosols detectable underneath clouds of optical depth 1-2

8 July, 1200Z





Cloud layer-average backscatter distributions (V2.01)



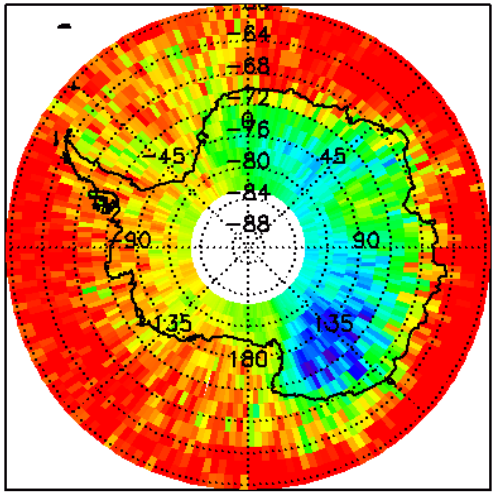
Histograms of layer-average cloud backscatter for **single-shot clouds**, July 1-7, 2006.

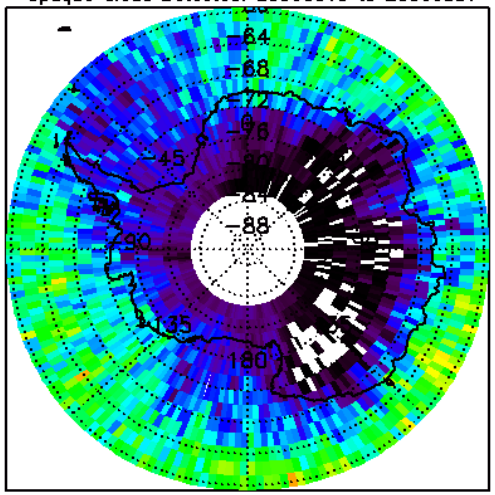
Antarctica

All cloud

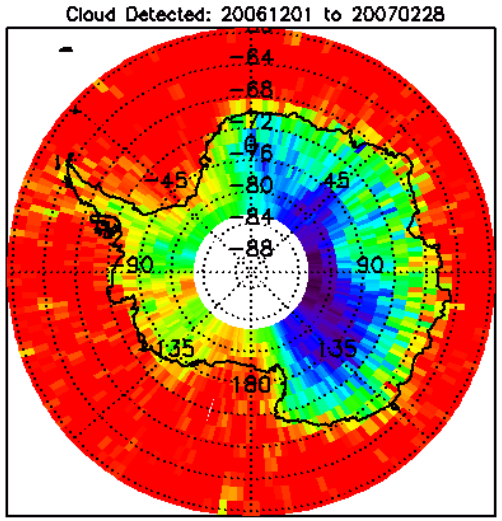
Opaque cloud

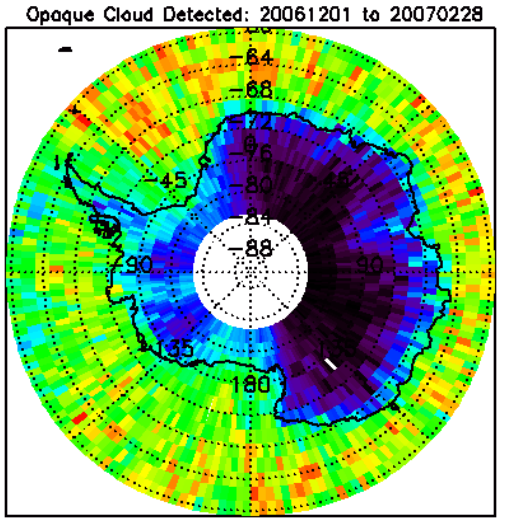
winter (JJA)





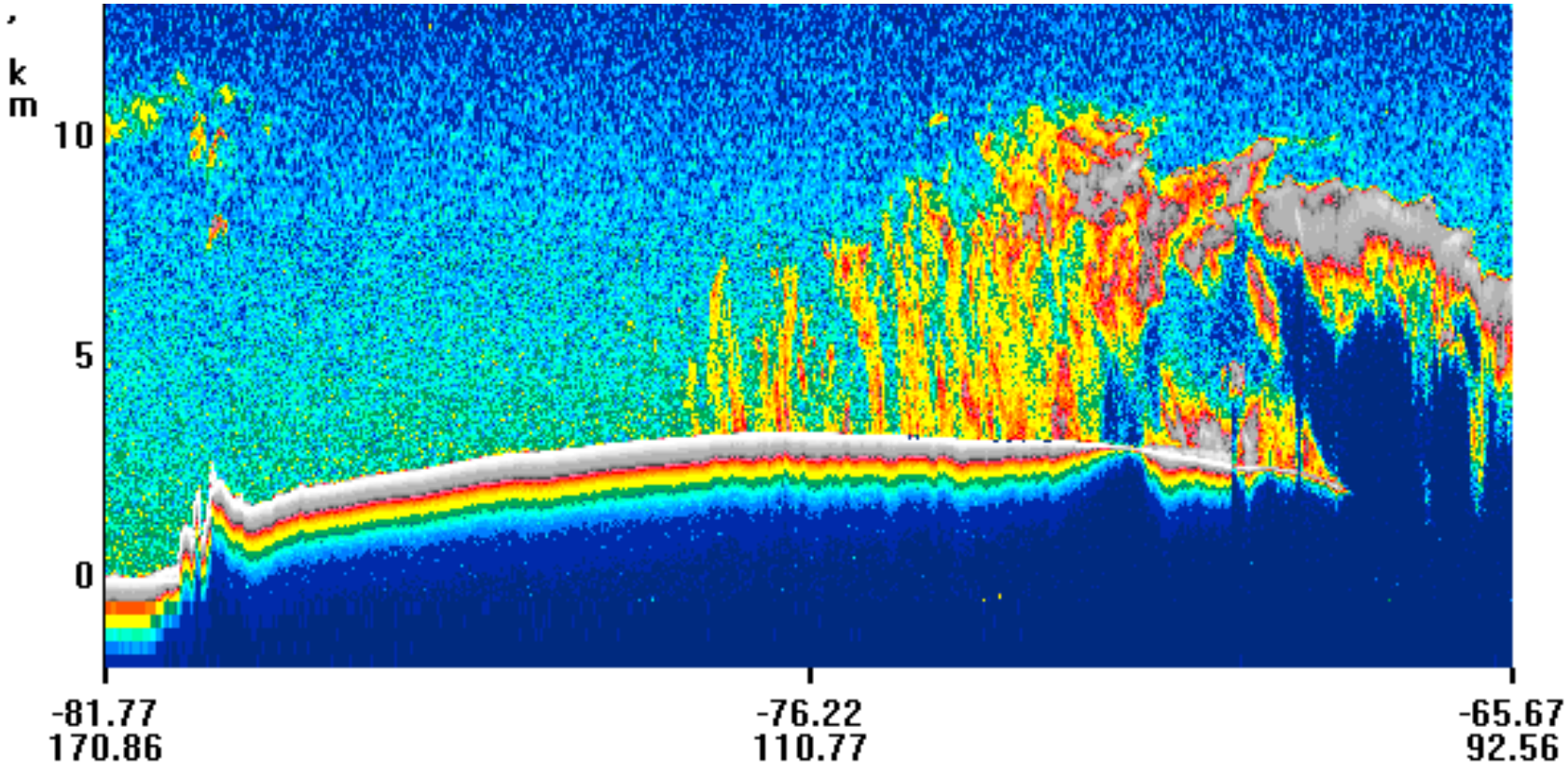
summer (DJF)



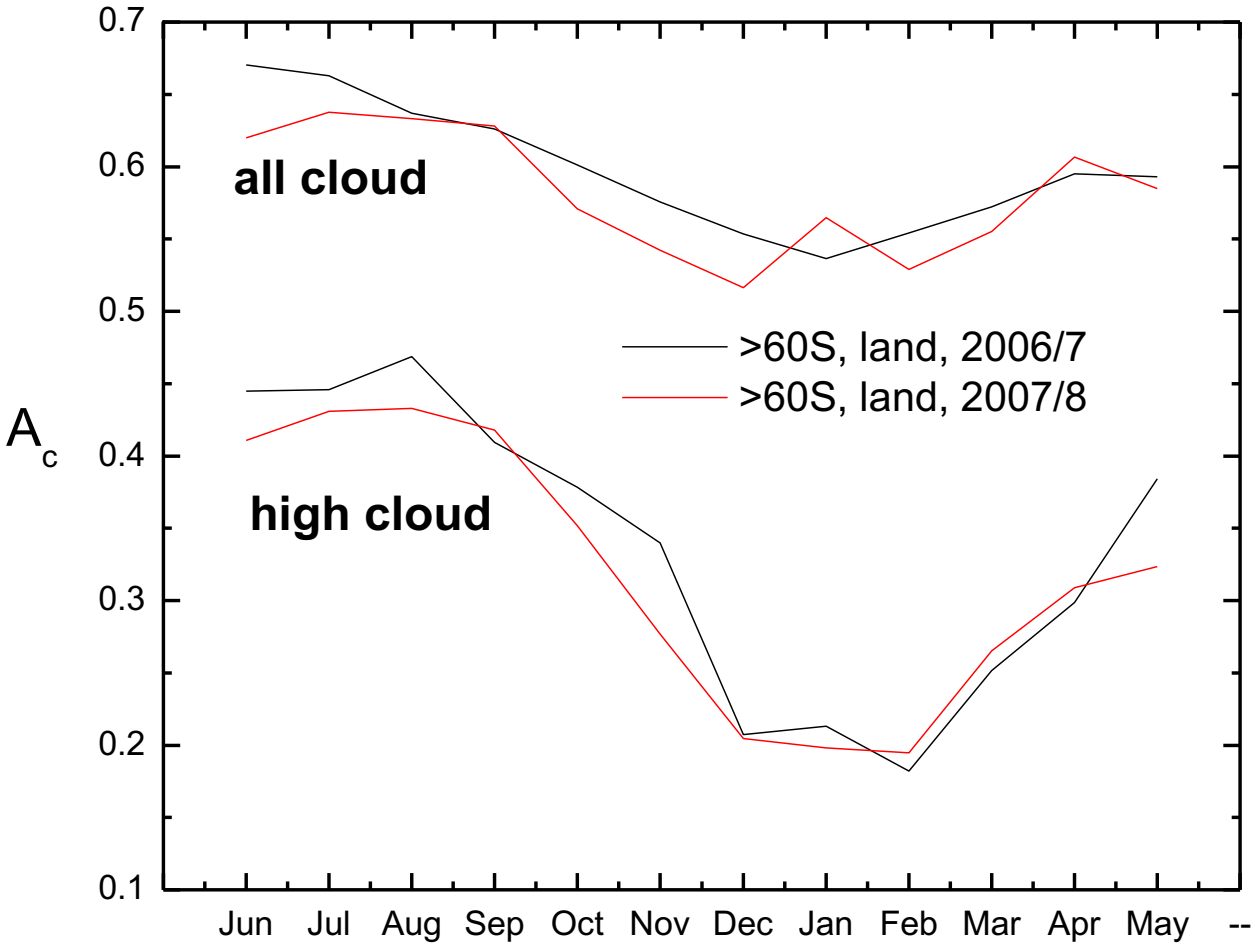


15 June 2006

Antarctic winter

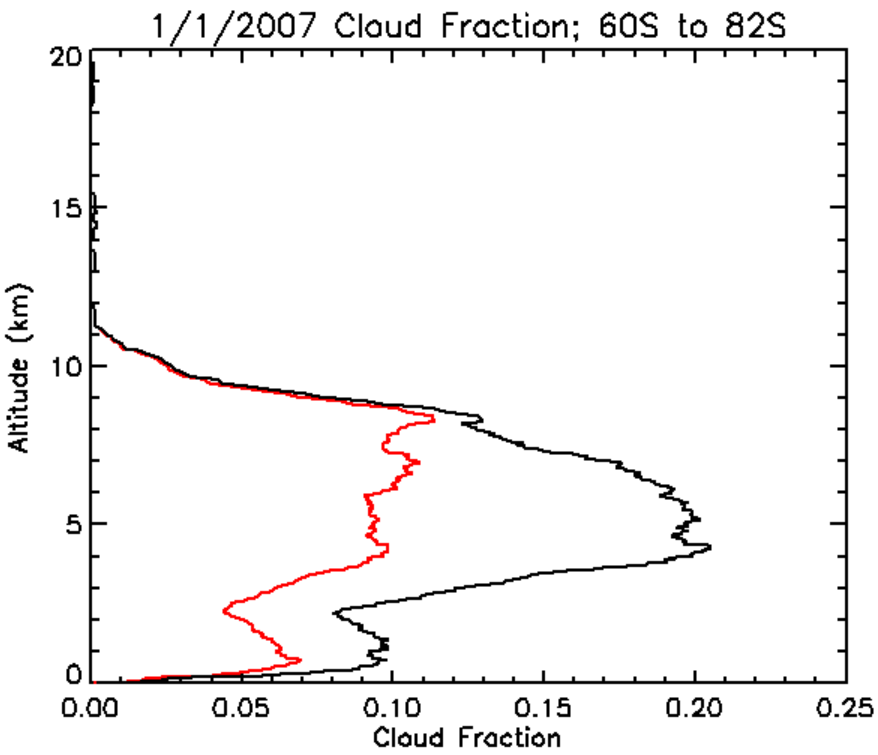


Annual cycle of polar cloud, 60S – 82S land only

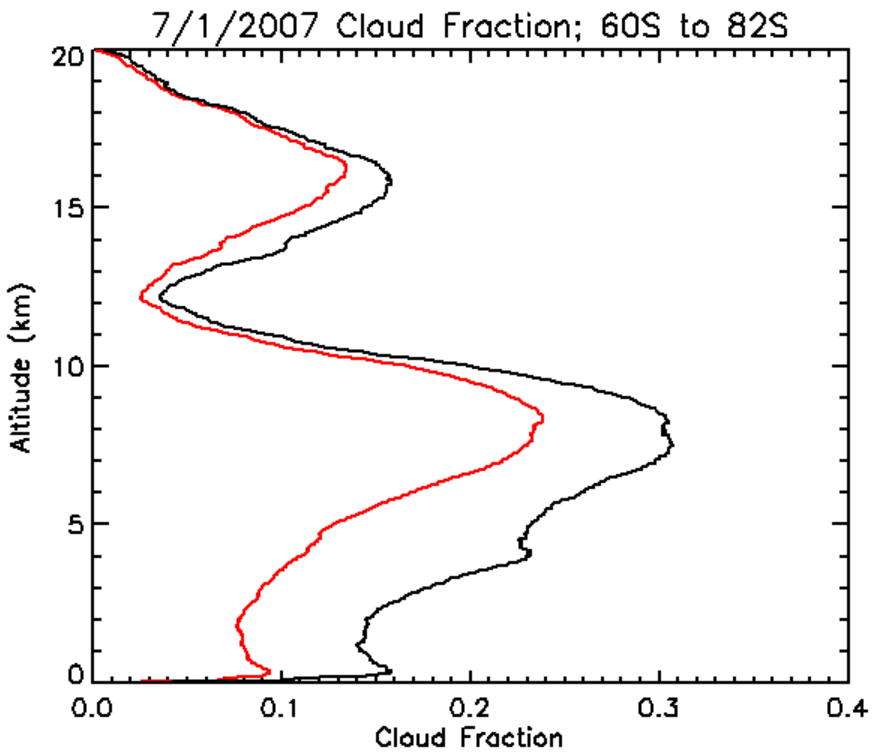


Profile of Cloud Frequency: Antarctica

Summer

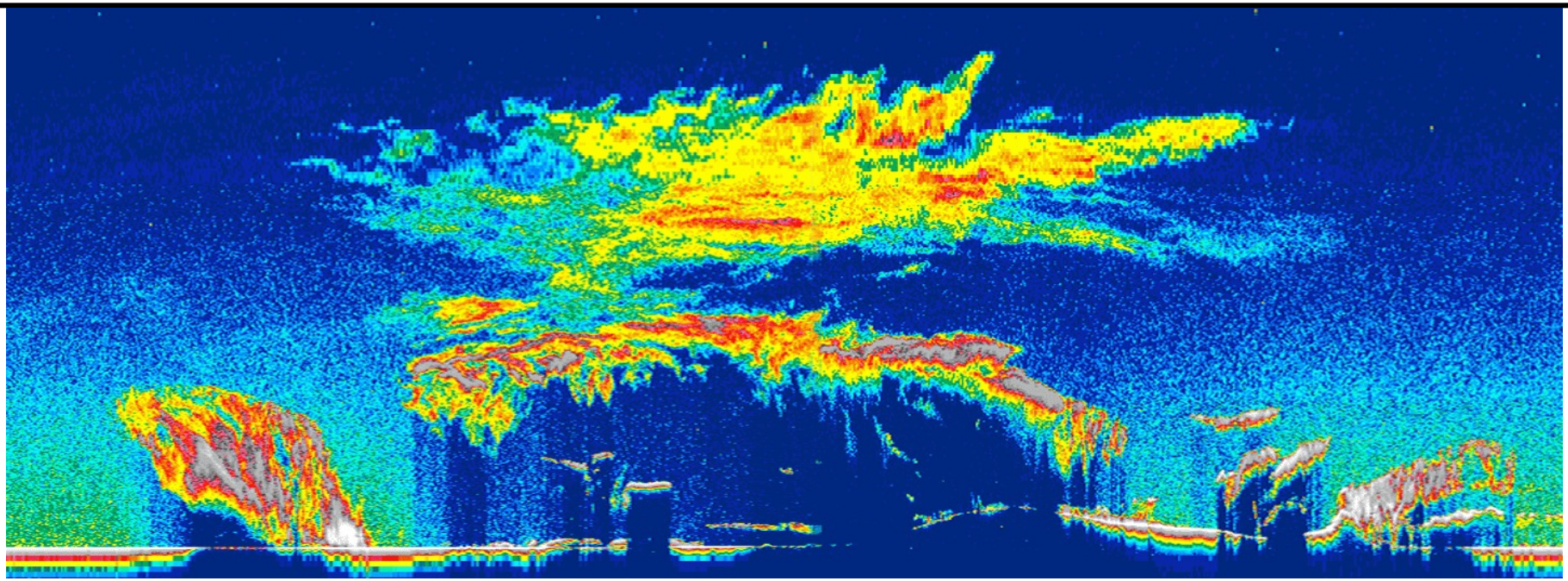


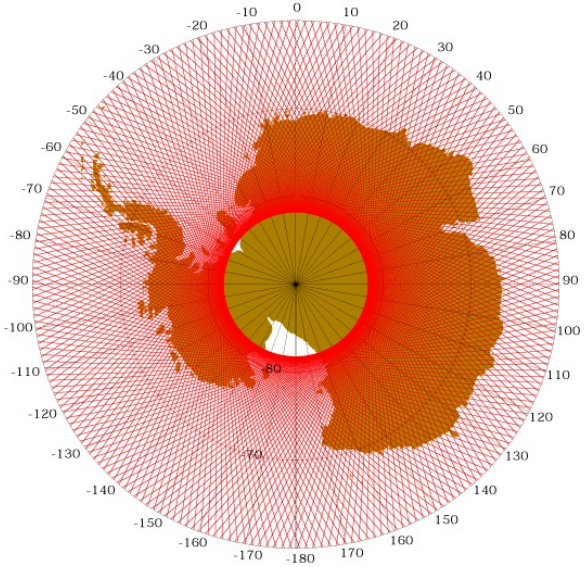
Winter



Black -> All Layers, Red -> Highest layer only

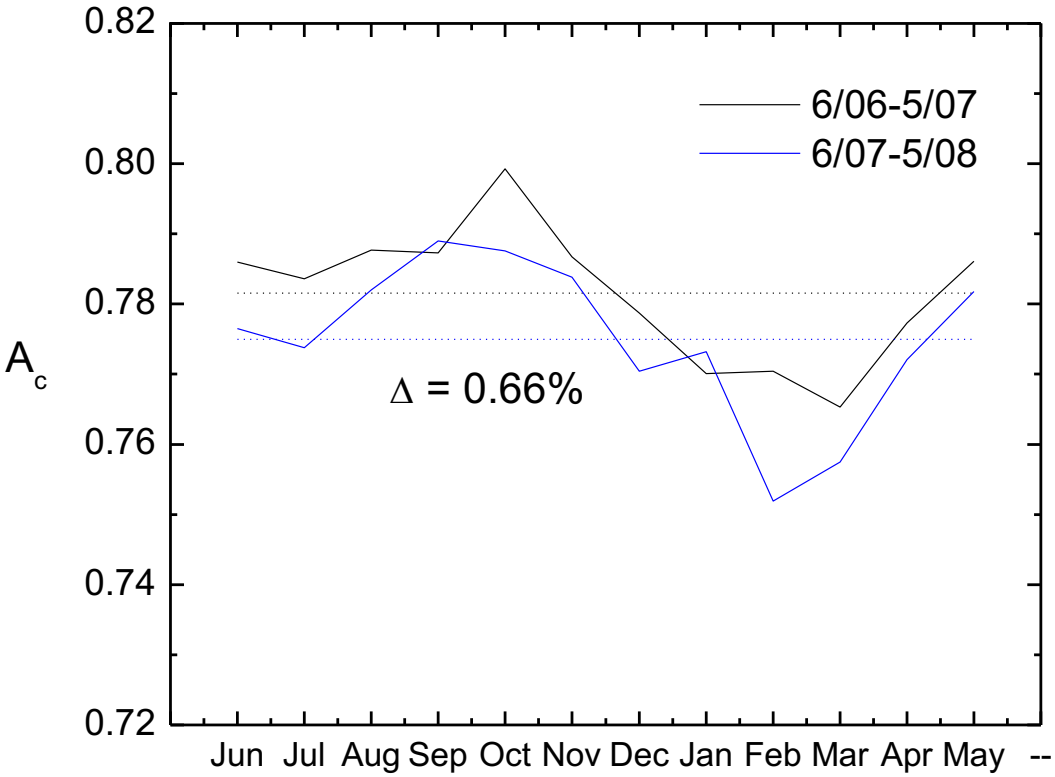
CALIPSO Is Providing A Wealth of Information on Polar Stratospheric Clouds





- **Extensive measurement coverage over polar regions into polar night**

Annual cycle: global total cloud

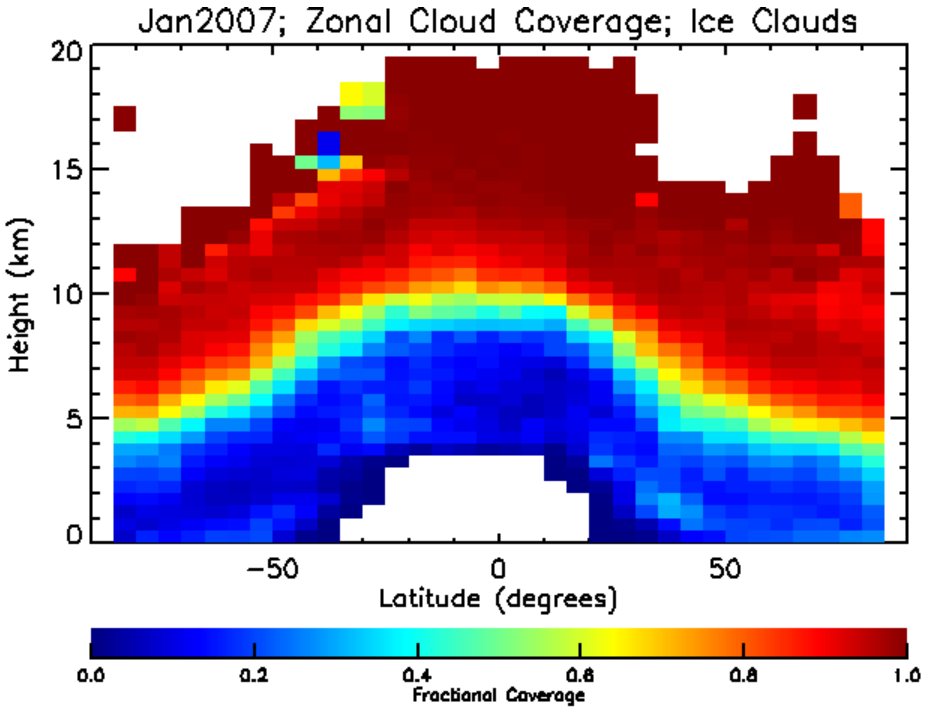


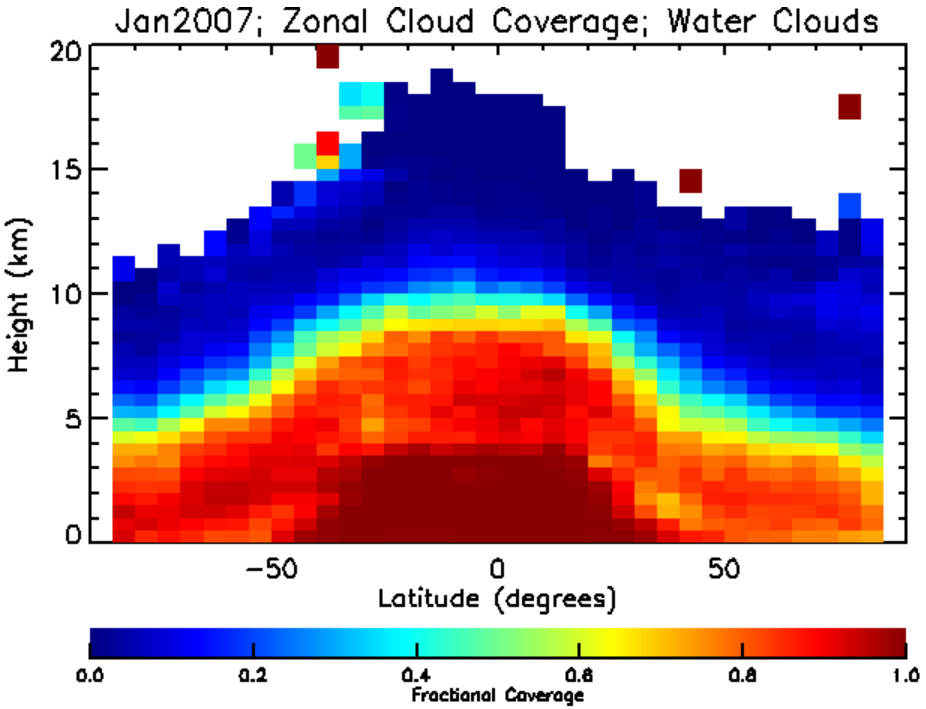
	CALIPSO	ISCCP*	TOVS-B*	HIRS*
Global annual mean (%)	77.8	66	73	75
RMS difference (%)	0.26	2.3	2.4	3.5

* 1987-1995

Zonal fraction of ice and water

Ice/water determination is based on depolarization signature

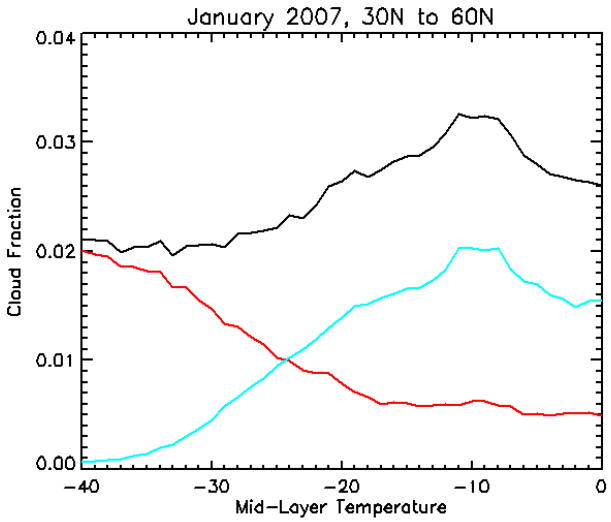


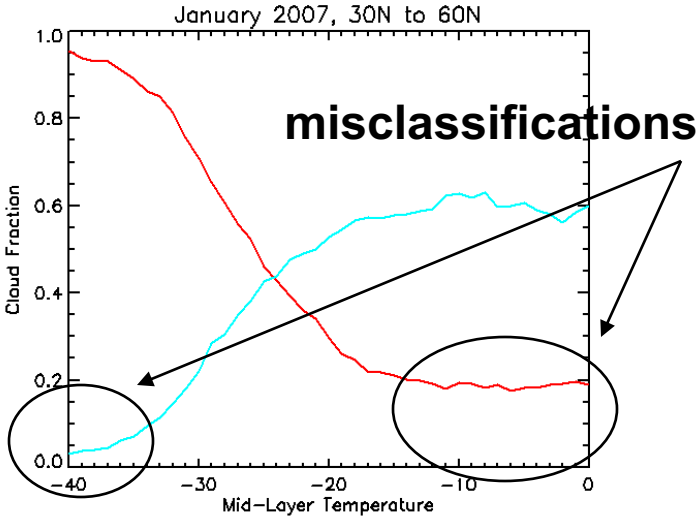


25

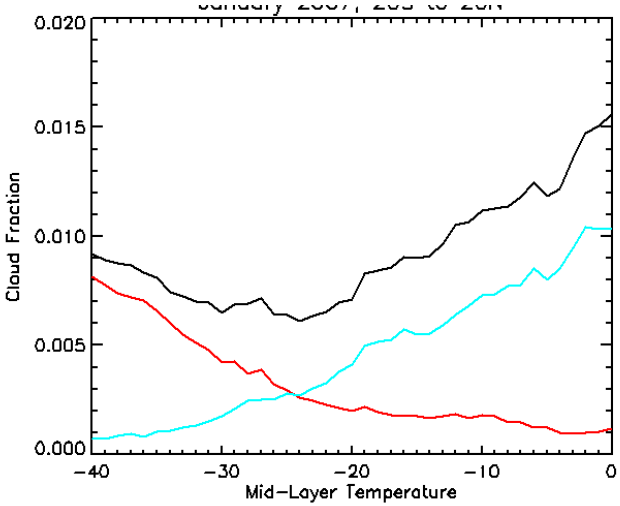
Fraction of Ice and Water Cloud

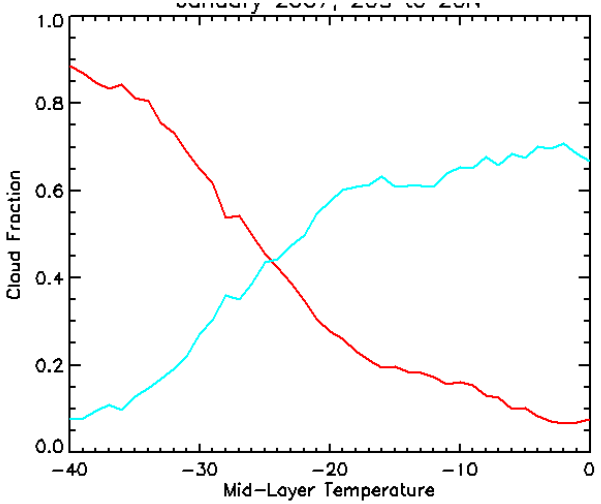
NH mid-latitudes





Tropics





Cloud Fraction = Cloud (all, ice, or water) / # of Samples

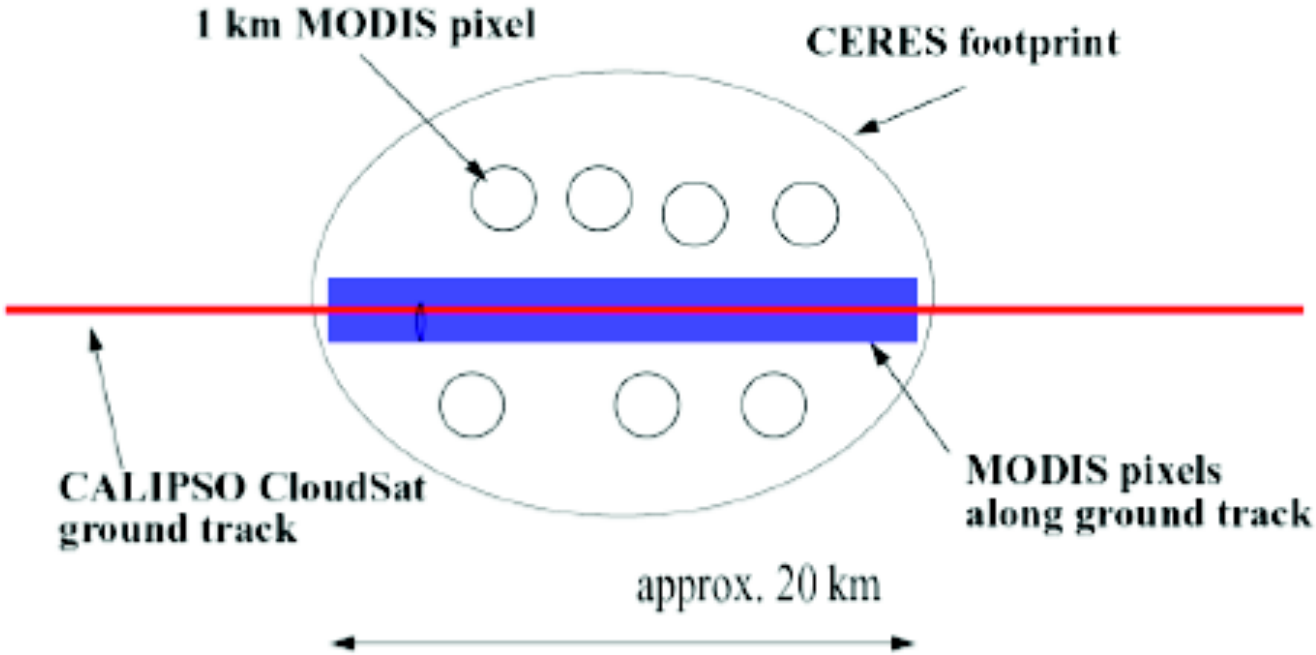
Cloud Fraction = Cloud (ice or water) / Cloud (all)

Cloud, Ice Cloud, Water Cloud

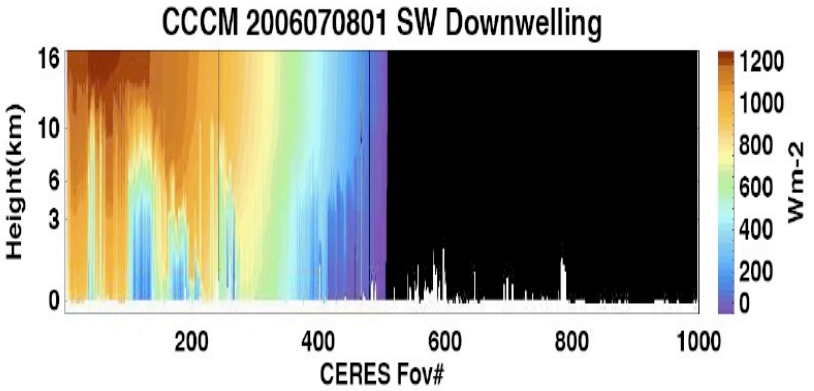
CALIPSO-CERES collaboration

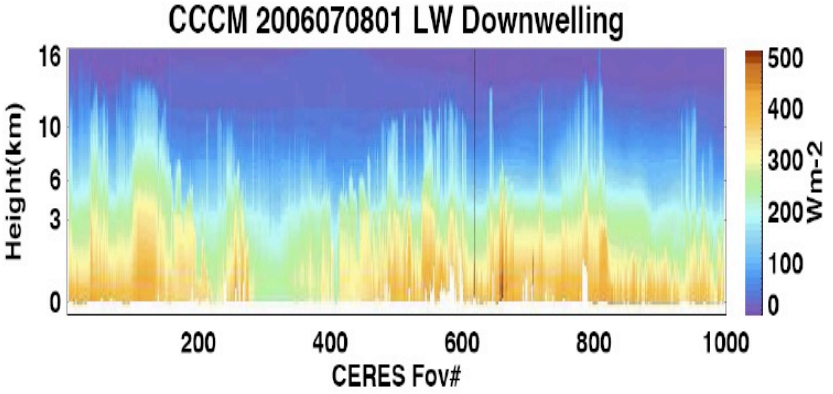
Surface and atmospheric fluxes estimated from:

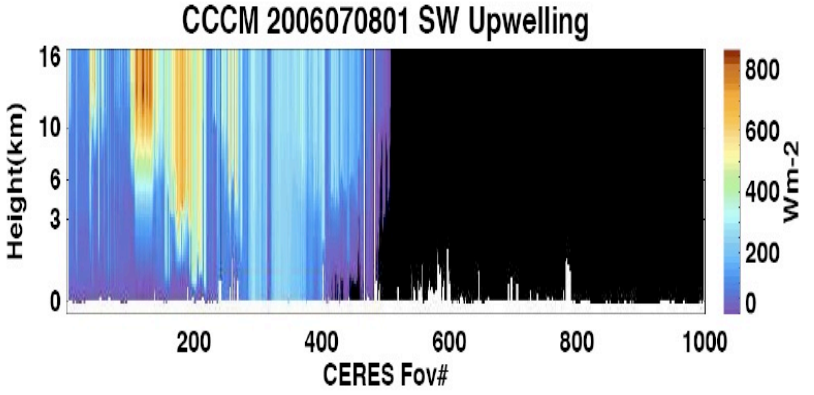
- **Cloud profiles: CALIPSO, CloudSat**
- **Cloud/aerosol properties: CALIPSO, CloudSat, MODIS**
- **TOA radiances: CERES**

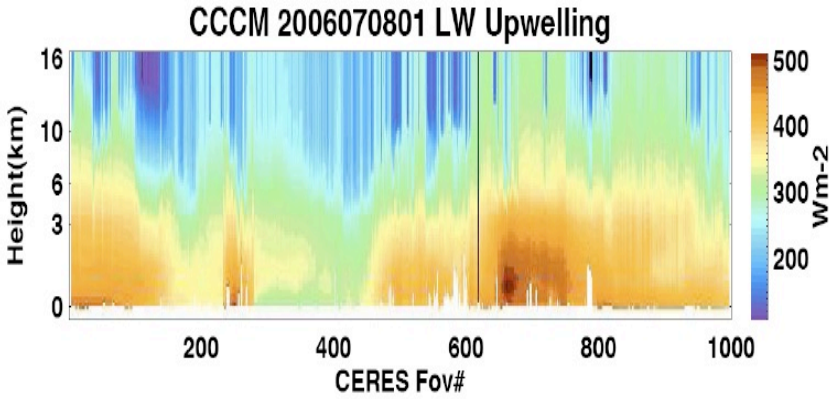


Flux Profiles: first example









Next Steps

- Complete evaluation of cloud statistics for GEWEX assessement
- Development and distribution of Level 3 cloud product
- Improve cirrus optical depth, ice/water classification
  - Cloud fraction as a function of cloud optical depth
  - Cloud fraction by cloud type
- Characterize uncertainties due to sparse spatial sampling
- Climatologies of other cloud properties (τ , ε , etc)
- Coordinate with CALIPSO simulator group at LMD