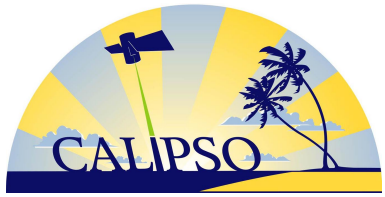


CALIOP Level 3 Ice Cloud Product

Xia Cai¹, David M. Winker², Mark A. Vaughan², Brian Magill¹, Brian J. Getzewich¹, Melody A. Avery², Charles R. Trepte² and Patricia Lucker¹

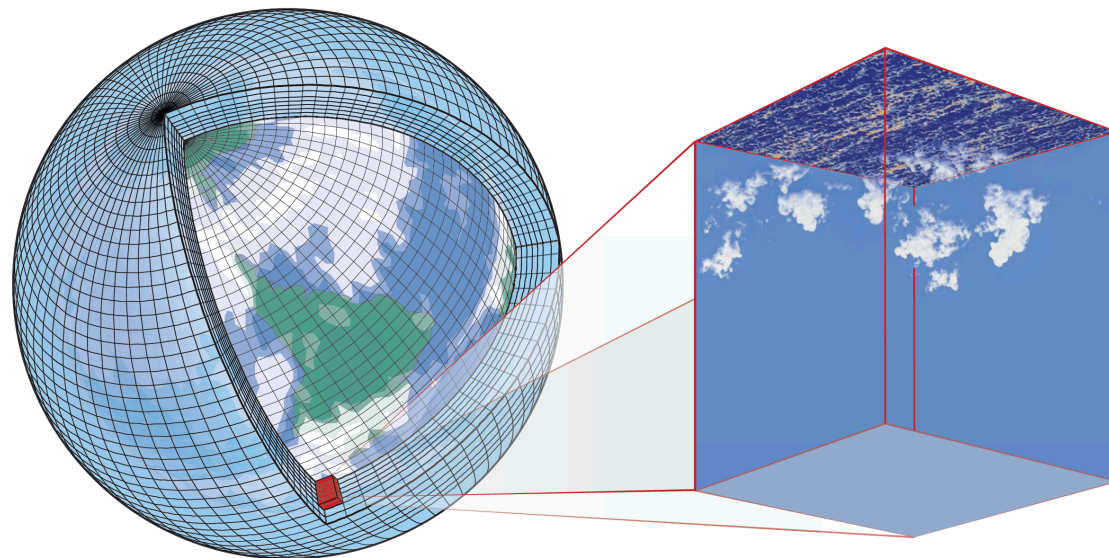
(1) Science Systems and Applications, Inc.,
Hampton, VA, United States

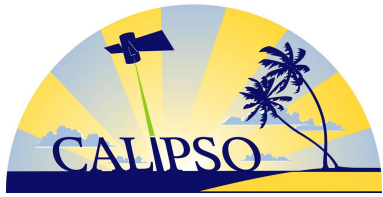
(2) NASA Langley Research Center, Hampton,
VA, United States



Introduction – L3 Ice Cloud Product

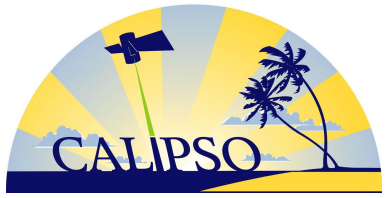
- ❑ The CALIOP level 3 (L3) ice cloud product provides vertically resolved ice cloud extinction coefficients and ice water contents (IWC) as monthly statistics on a uniform 3D grid.
- ❑ One of several planned L3 cloud products. Others:
 - 3D cloud occurrence
 - Optical and microphysical properties
 - Lidar + imaging infrared radiometer (IIR)





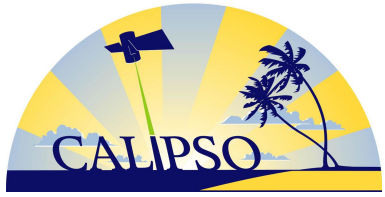
Introduction – What Is New?

- ❑ Specially designed to fully exploit the CALIOP lidar capability and CALIOP L2 products describing cloud boundaries and cloud phase at high spatial resolutions both in horizontal and vertical dimensions.
- ❑ Different L3 cloud products designed for modelers and data scientists.
- ❑ Reports sample numbers instead of averages allowing further aggregation of statistics.



File Contents

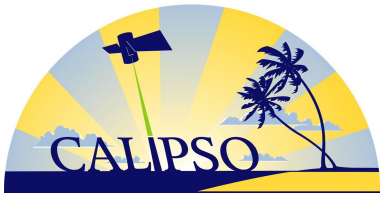
- Based on the latest version 4 level 2 (V4L2) profile product
- Resolution: latitude 2°, longitude 2.5°, altitude 120 m
- Three files each month: day, night, day + night
- Output format: Hierarchical Data Format (HDF) 4
- Parameters include:
 - Extinction coefficient & ice water content histograms/medians
 - Grid information, meteorological data, surface statistics, sample cloud counts



Quality Assurance & Control

- ❑ Quality assurance (QA) filters: random-orientated ice clouds
 - Feature: clouds
 - Feature QA: low, middle, high confidence
 - Phase: random-oriented ice clouds
 - Phase QA: high confidence

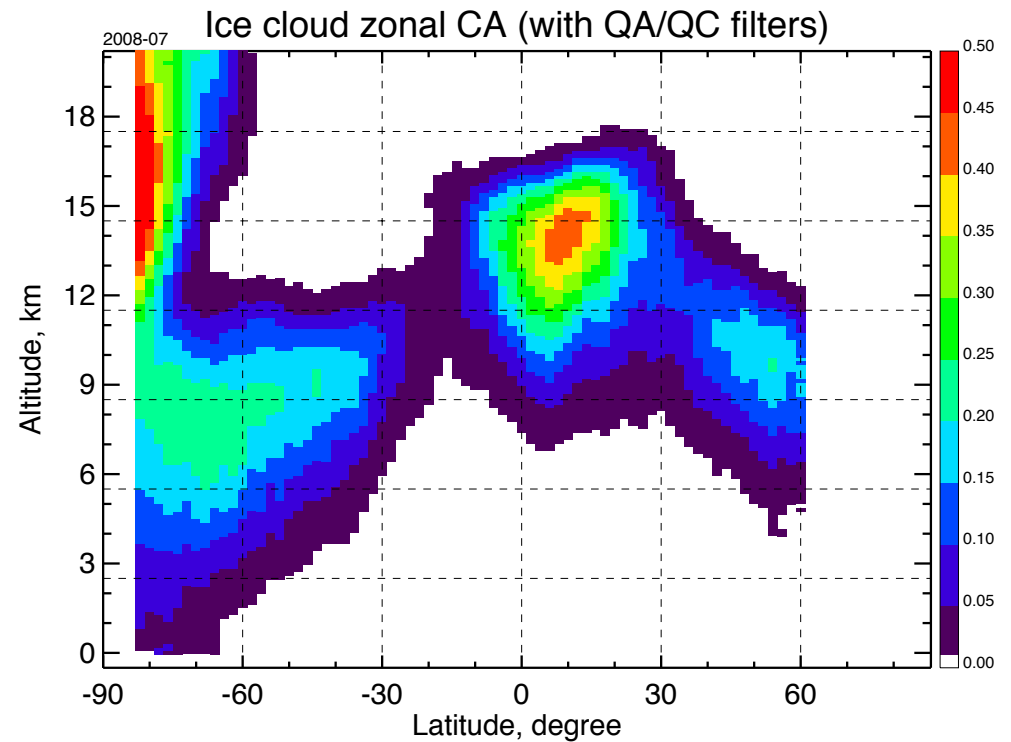
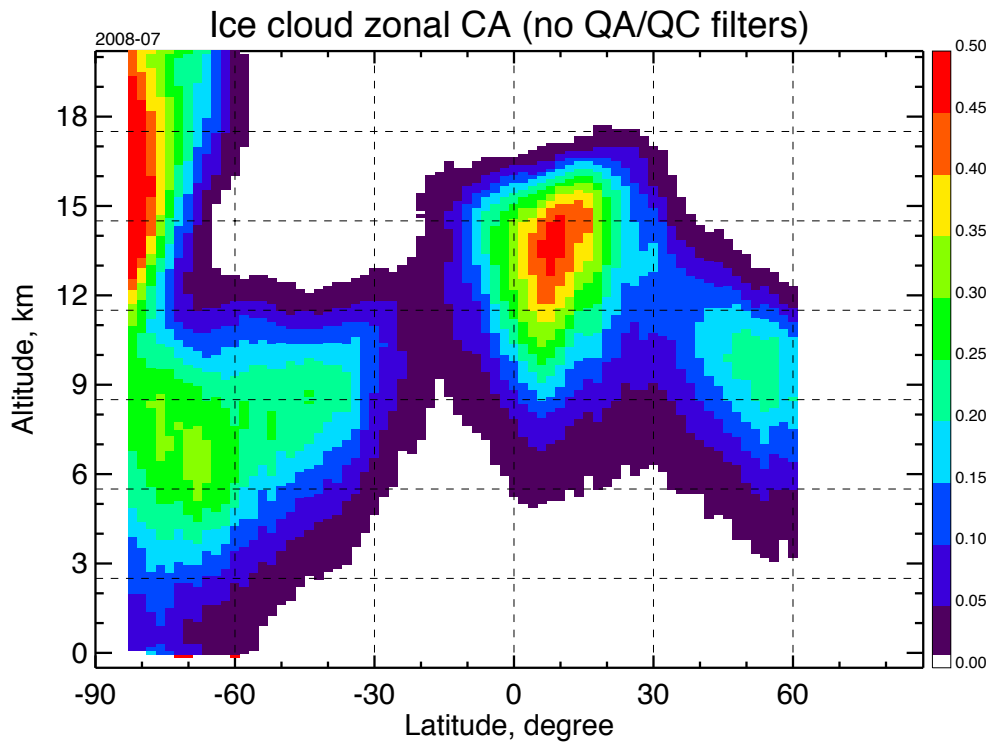
- ❑ Quality control (QC) filters: confident retrievals
 - Confined retrieval
 - Convergent solution
 - Overlying optical depth ≤ 2
 - No “invalid” feature overhead
 - No water clouds overhead



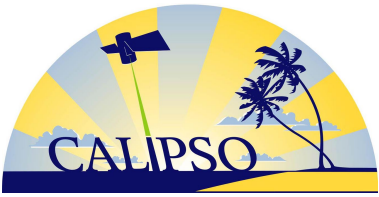
Quality Assurance & Control

No QA/QC filters

With QA/QC filters

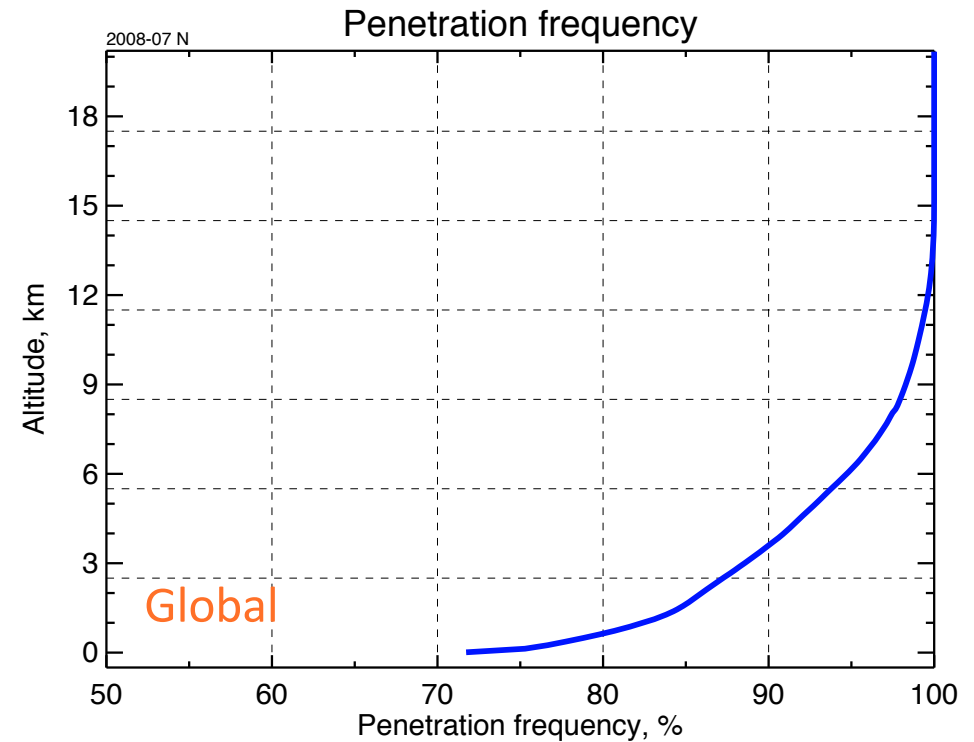
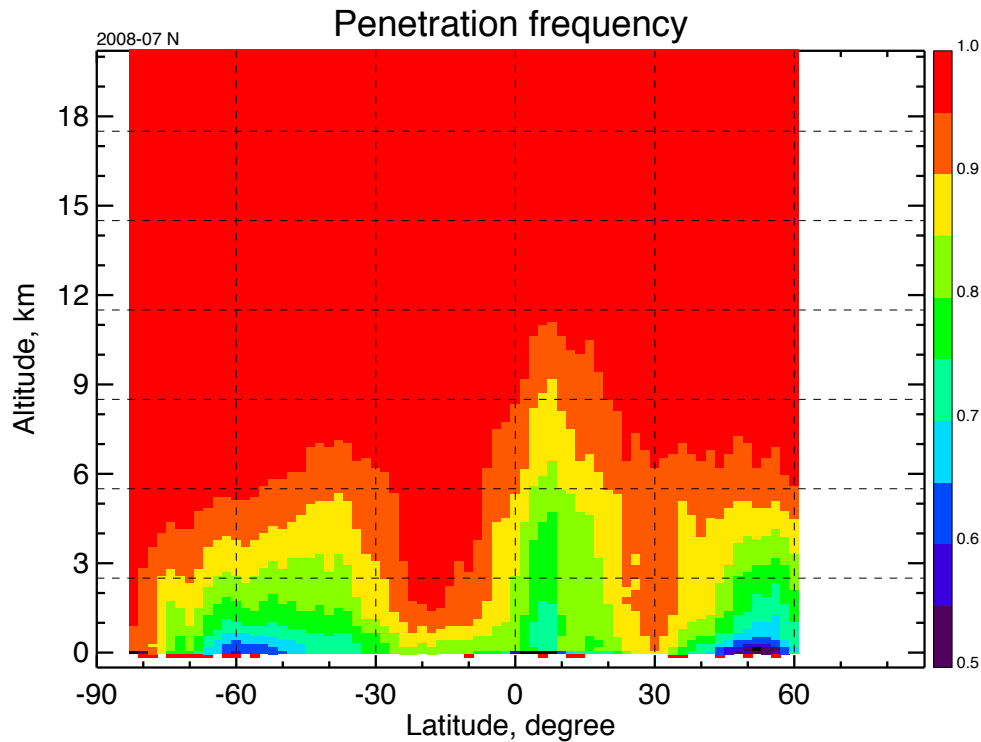


Night, July 2008

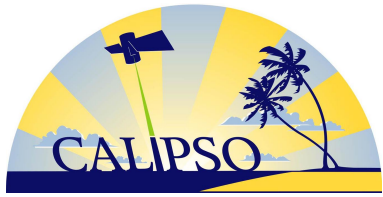


Lidar Attenuation in Opaque Clouds

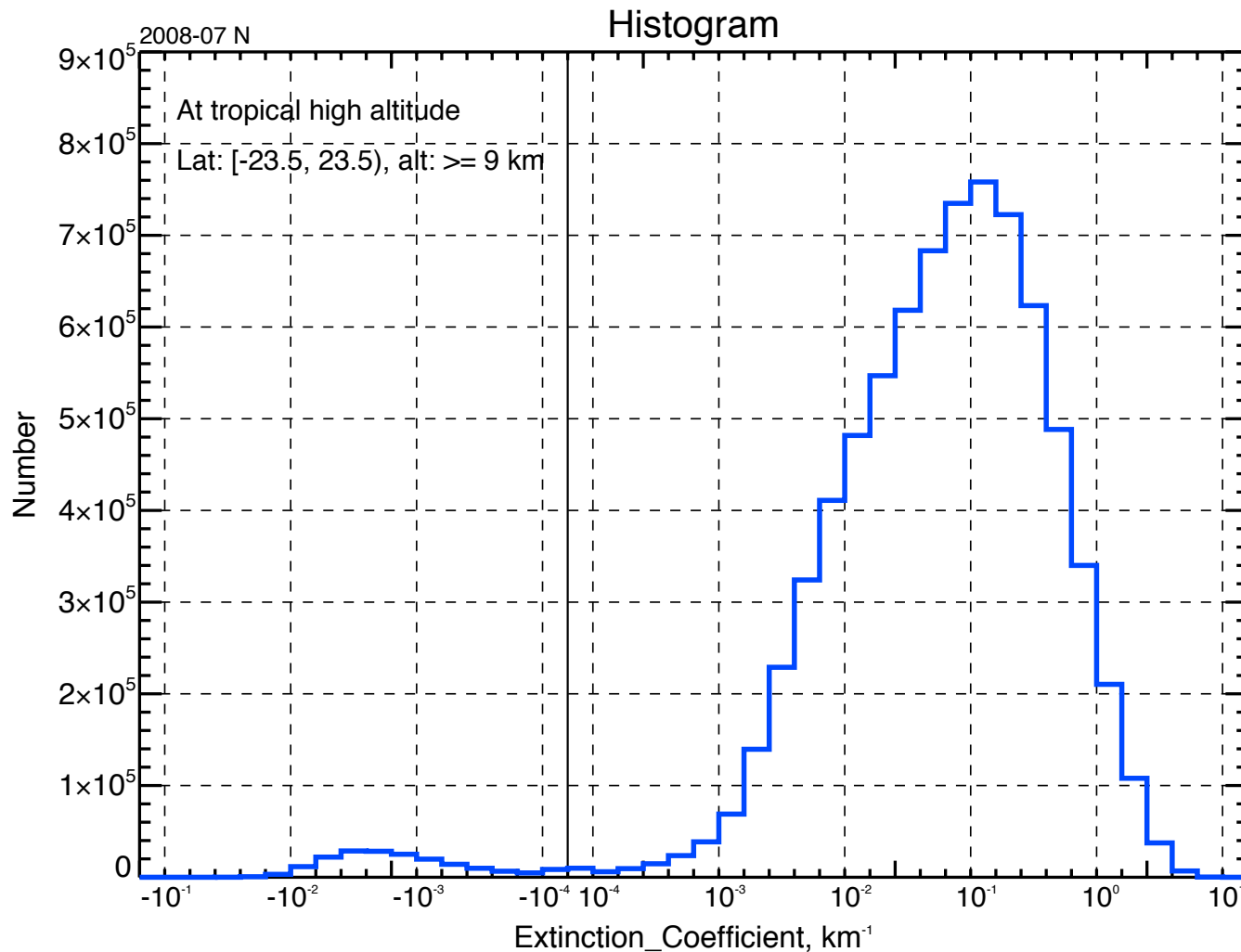
Penetration frequency



Night, July 2008



Initial results – histogram of extinction coefficient

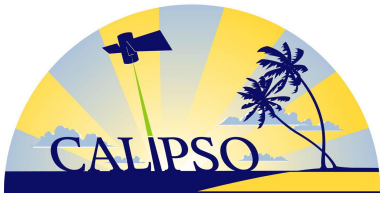


44 bins

Bin 0: $< -10^{-1} \text{ km}^{-1}$; bin 1-43: $-10^{-1} \sim 10^1 \text{ km}^{-1}$; bin 43: $> 10^1 \text{ km}^{-1}$

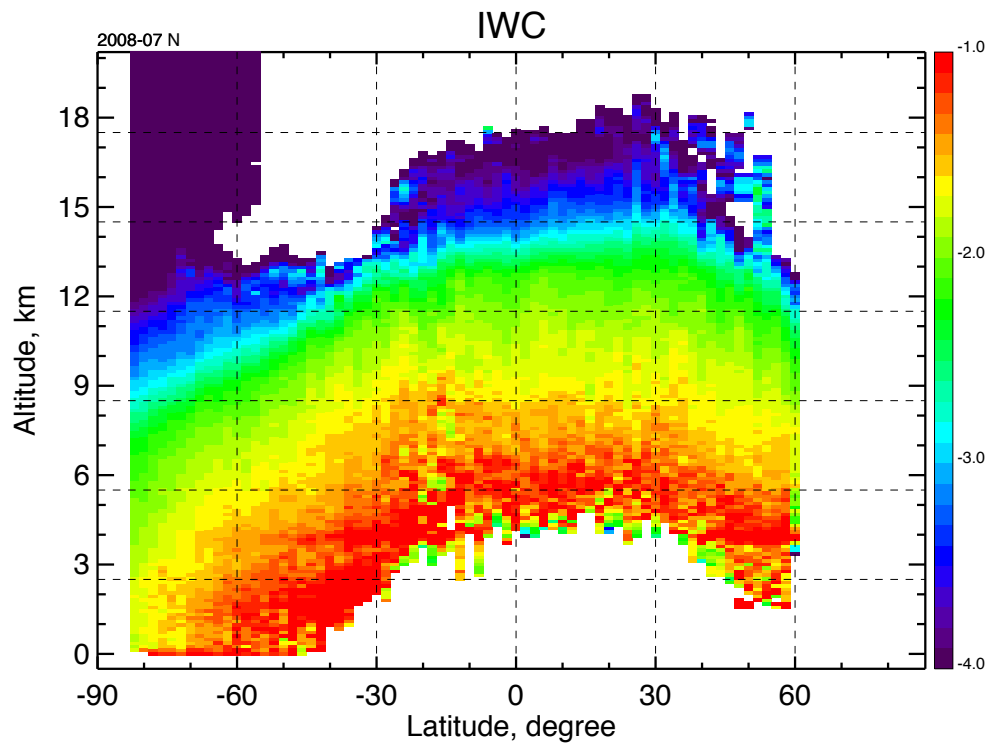
Why histograms?

- Understand the inconsistency when comparing averages from sensors with different sensitivity
- Provide a more comprehensive evaluation of models than averages.



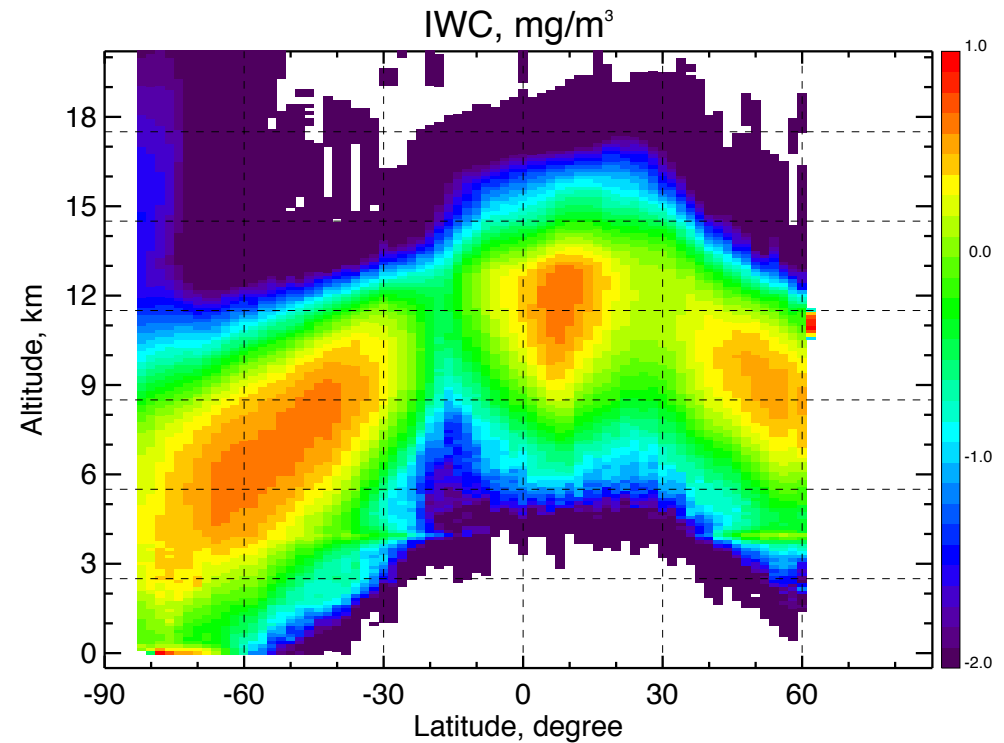
Initial results – Zonal IWC

IWC in ice clouds



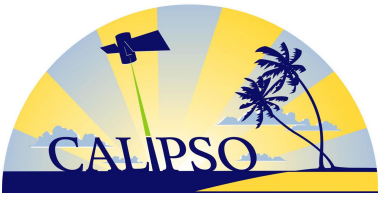
- Mean of median IWC
- Considering ice clouds only

IWC in 3D cell

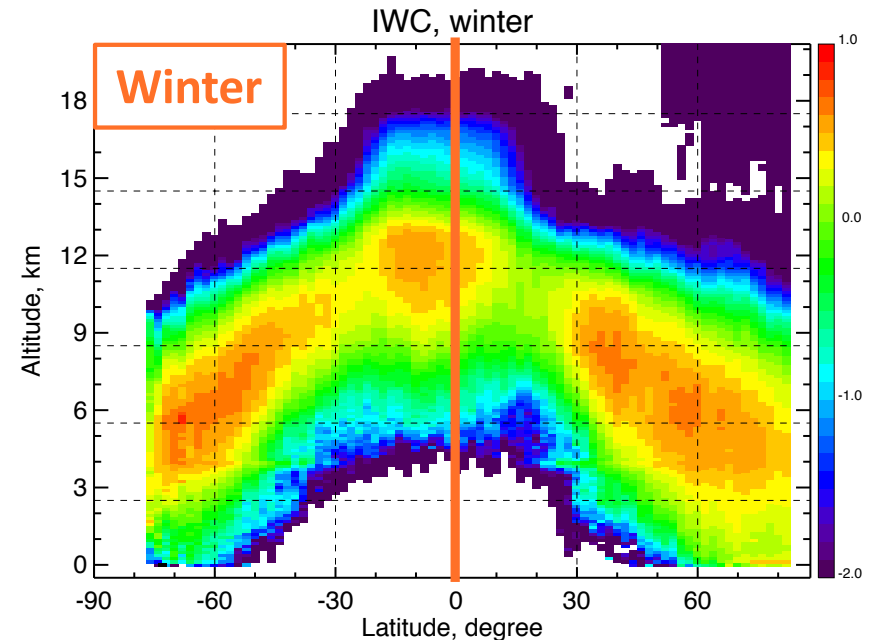
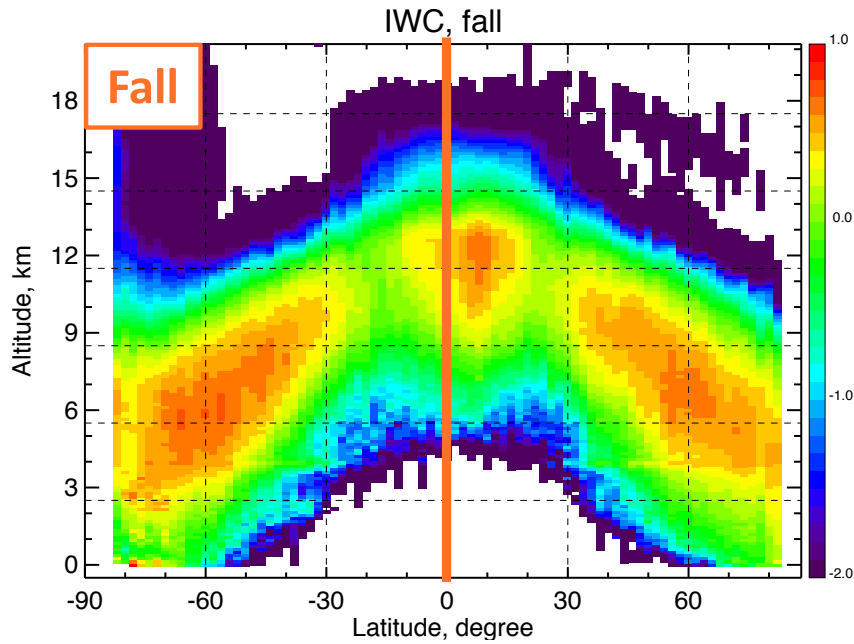
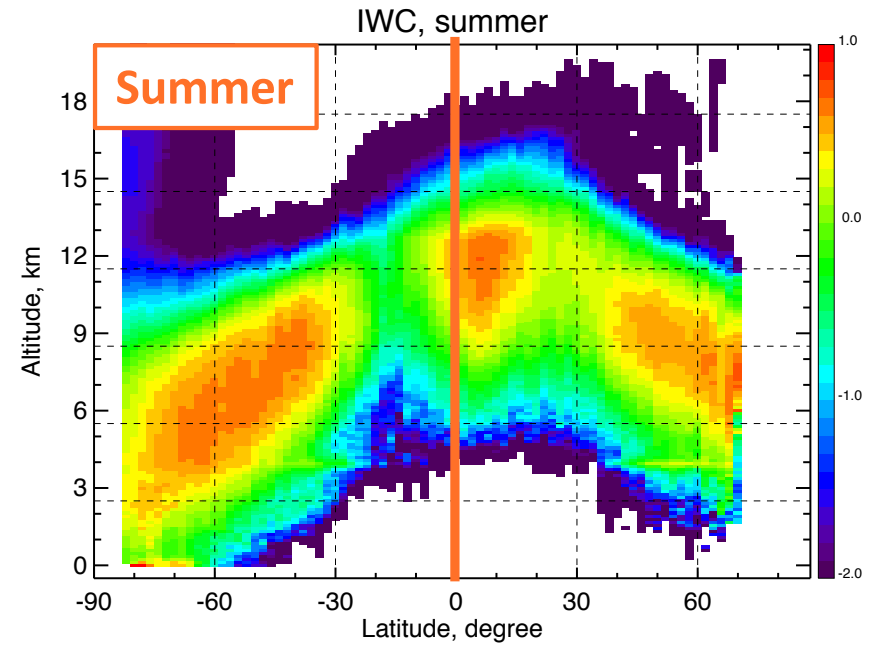
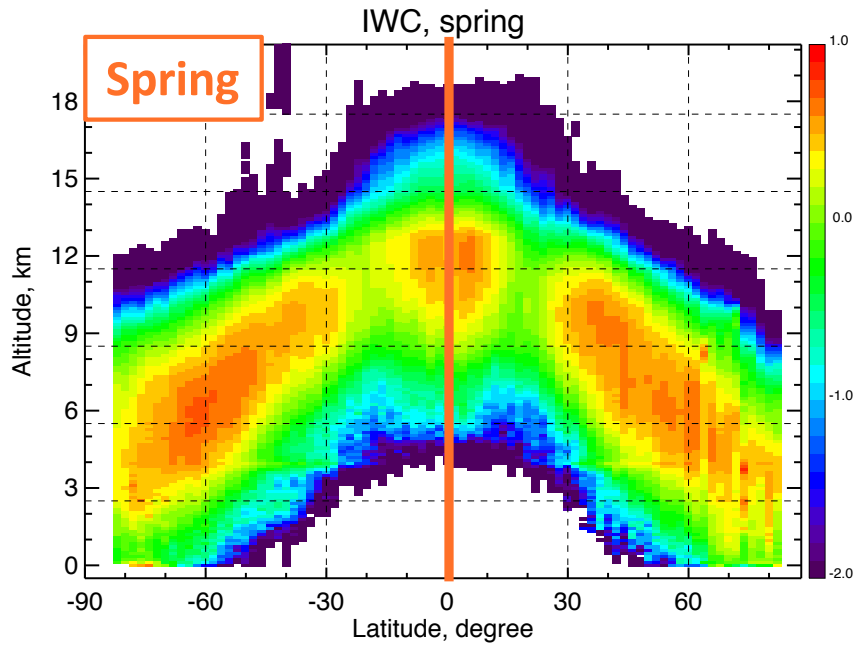


- Mean of mean IWC, excluding outliers
- Considering clouds and cloud free sample

Night, July 2008

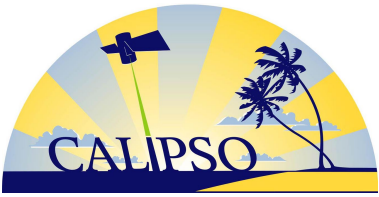


Seasonal Variation – Zonal IWC

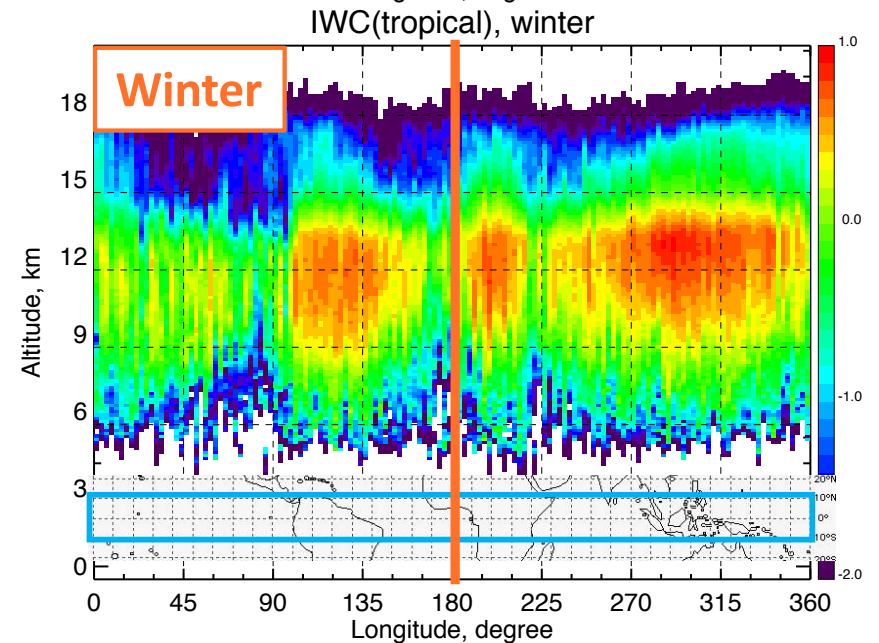
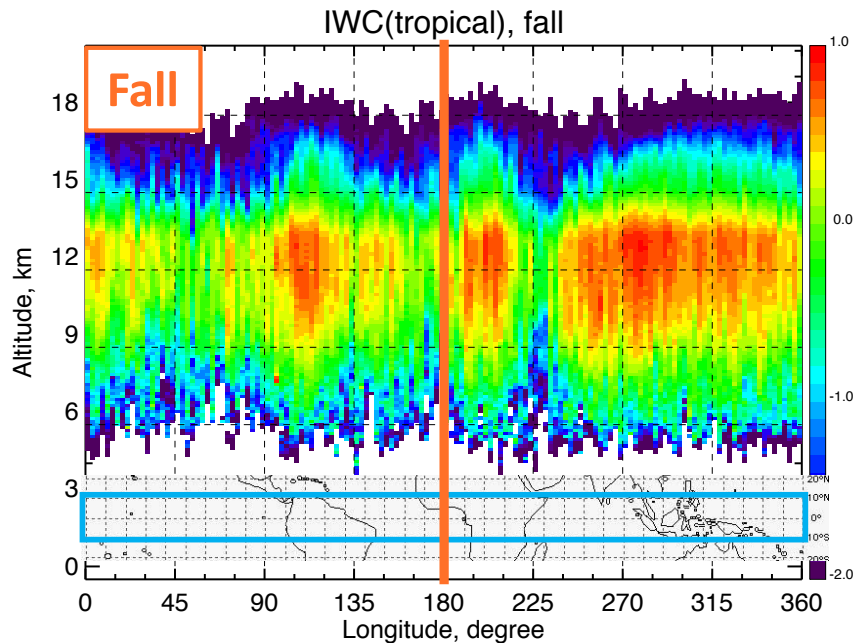
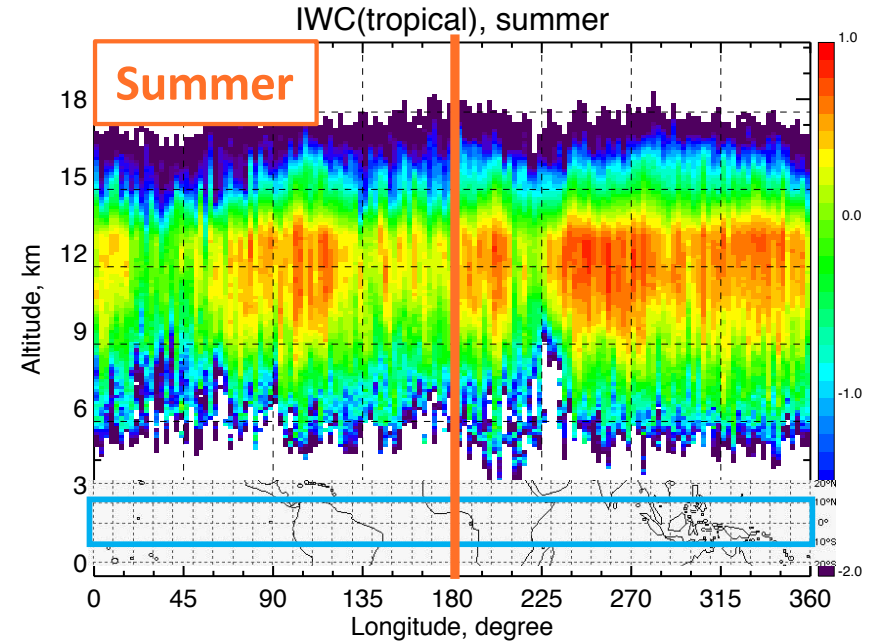
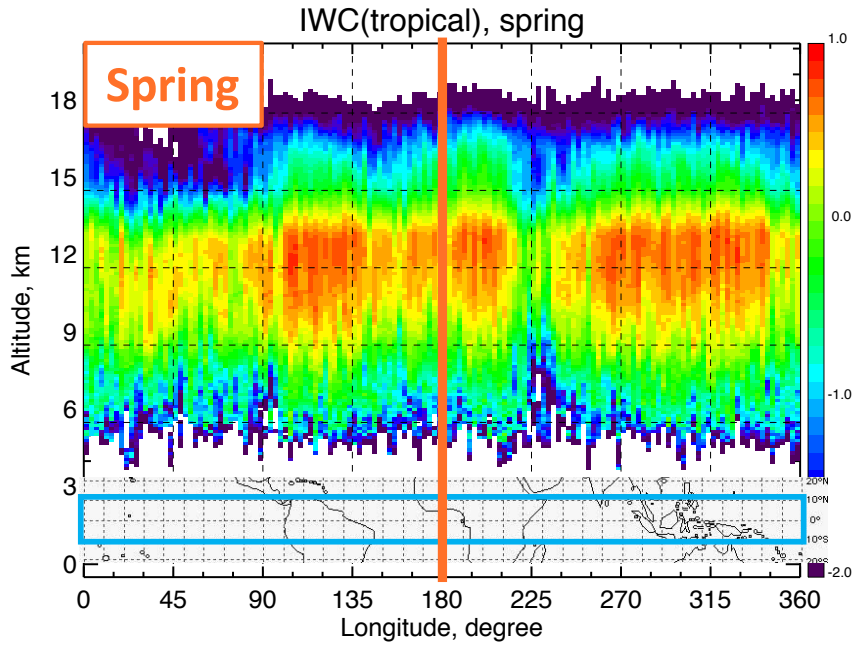


Altitude

Latitude

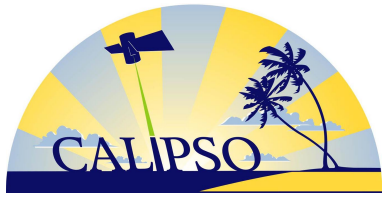


Seasonal Variation – Tropical IWC



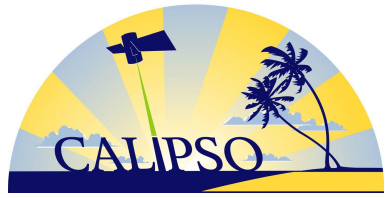
Altitude

Longitude

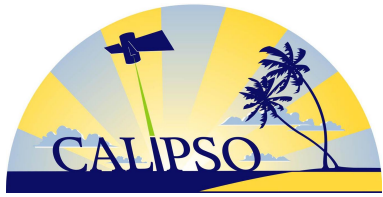


Summary

- ❑ The CALIOP L3 ice cloud product describes ice cloud extinction coefficients and IWC as monthly aggregation in uniform 3D grid.
- ❑ Reports cloud sample numbers instead of averages.
- ❑ The ice cloud extinction coefficients and IWC are described with a full distribution.
- ❑ Other L3 cloud products: 3D cloud occurrence, lidar + IIR, special versions for CALIOP simulator and GEWEX community.

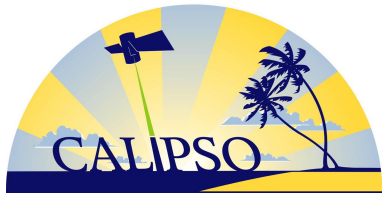


Backup slides



Introduction – An Overview of CALIOP Products

- ❑ L1B:
- ❑ L1.5:
- ❑ L2: profile, layer,, vertical feature mask products
 - Profile products: cloud (05kmCPro), aerosol (05kmAPro)
 - Layer products: cloud (333mCLay, 01kmCLay, 05kmCLay), aerosol (333mALay, 05kmALay), merged layer (05kmMLay)
 - Vertical feature mask product (vfm)
- ❑ L3: aerosol products, **cloud product**, polar stratospheric cloud product



Possible questions audience would ask:

- When will the L3 ice cloud product be available? How about other products?
- Why are the extinction coefficient and IWC negative?
- How would this product compare to the available cloud water content (CWC) from CloudSat level 2B-CWC-RO?
- What is the limitation producing water content product with ice clouds only?
- Why reporting cloud sample counts? Can I use them to estimate the cloud occurrence?
- Why choose this 3D grid resolution? (CloudSat allows users choose from several resolutions.)
- Why can not I access the CALIPSO data website?