Orbit Characteristics and View Angle Effects on the Global Cloud Field

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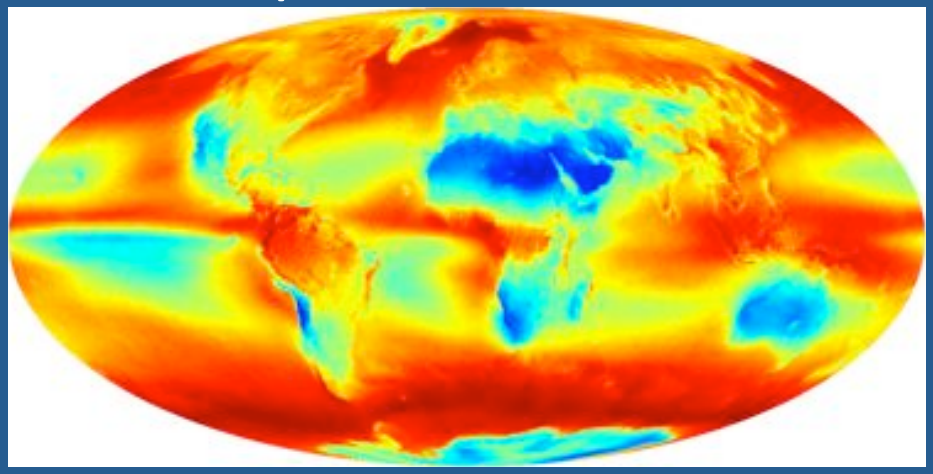
Motivation

- Comparison to other cloud datasets (apples-to-apples)
- Place ‘error bars’ on global mean statistics
- Quantify cloud variability globally

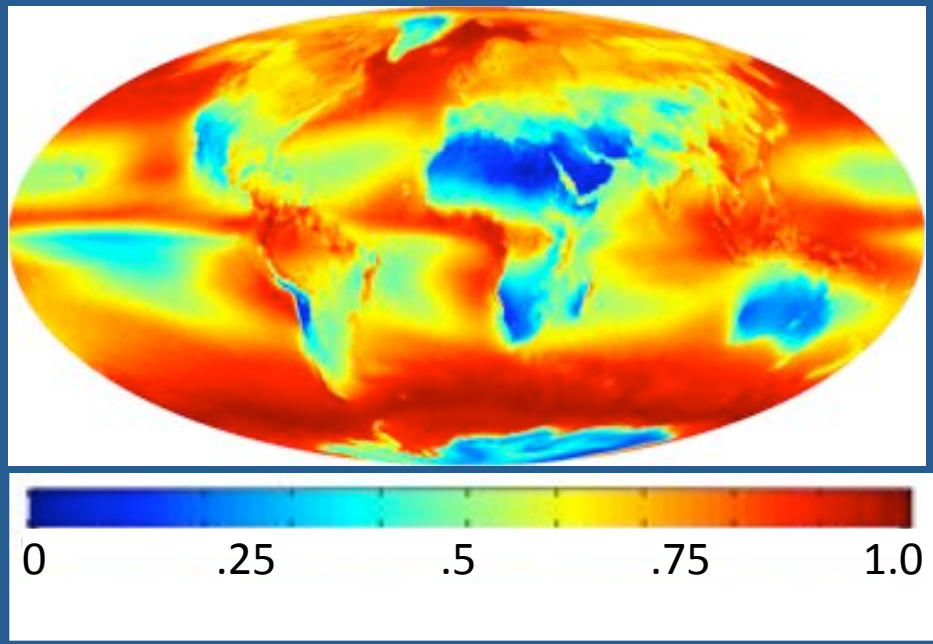
Global Means

- Daytime Cloud Fraction
- Coast lines evident
- Differences where expected: maritime stratocumulus decks, SH land, etc.

Aqua 7 Year Mean

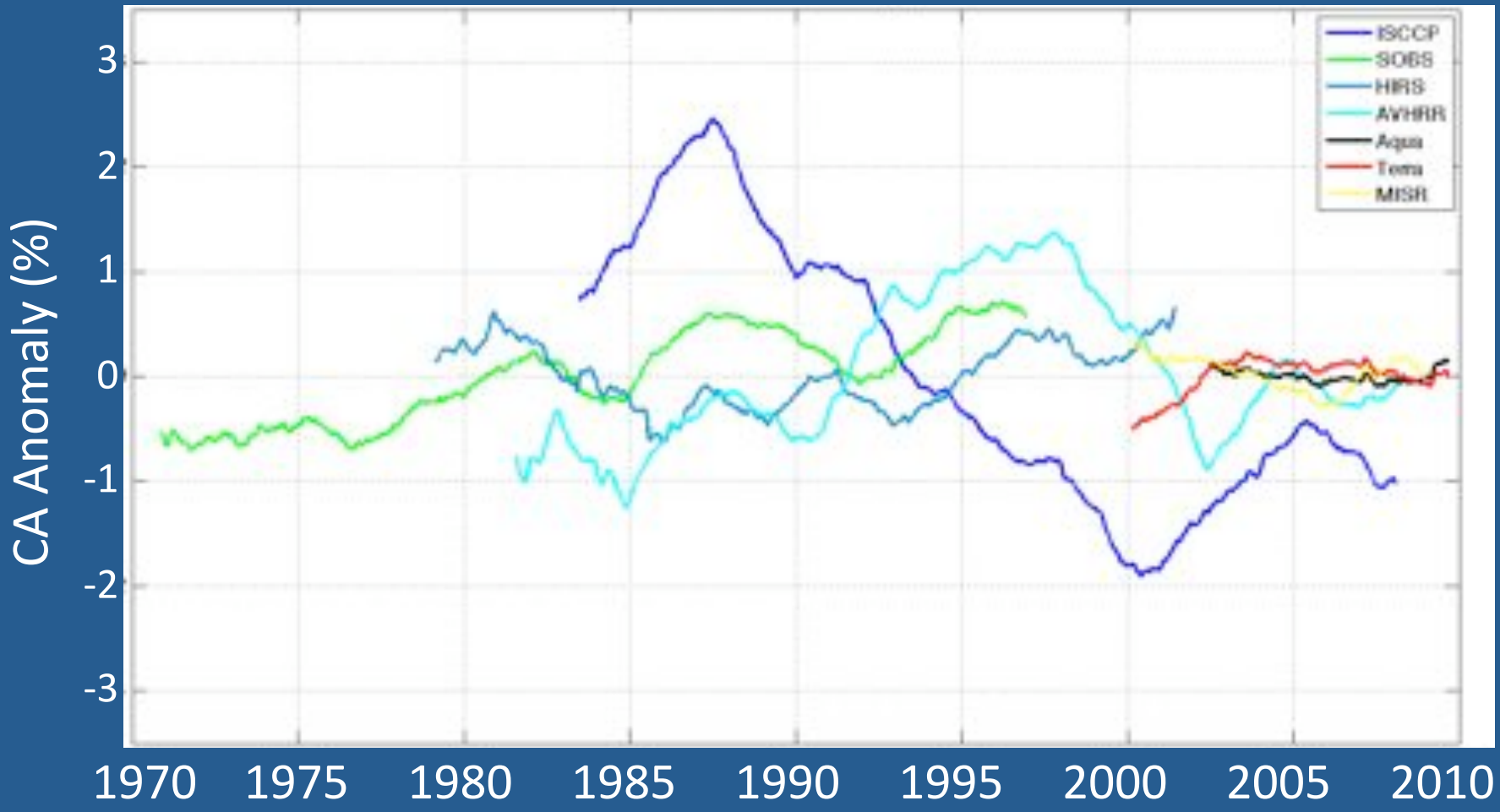


Terra 9 Year Mean



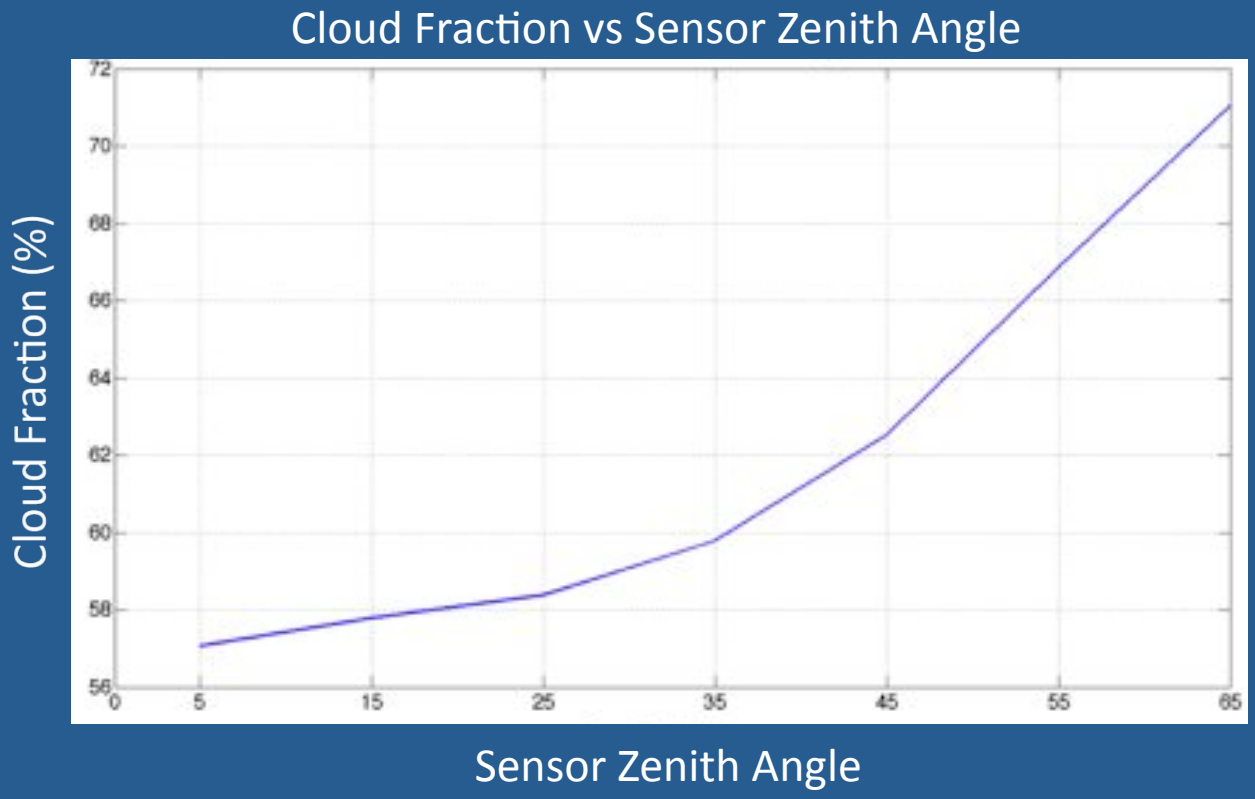
Global Cloud Amount Anomaly

MODIS Cloud Fraction Terra (Red) and Aqua (Black)



Cloud Fraction vs Viewing Angle

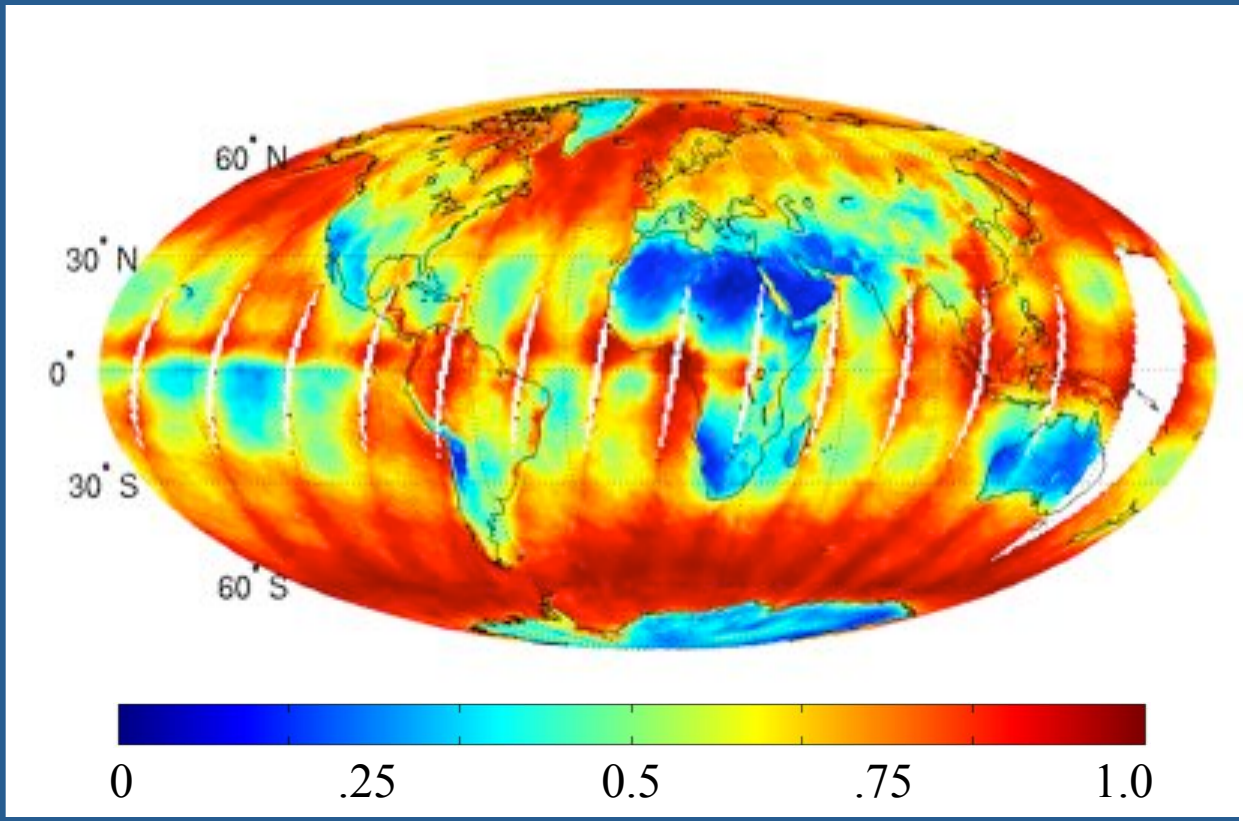
- 7 years of Aqua and Terra
- 16% increase from near nadir to edge of scan
- View angle effect not constant for all cloud types



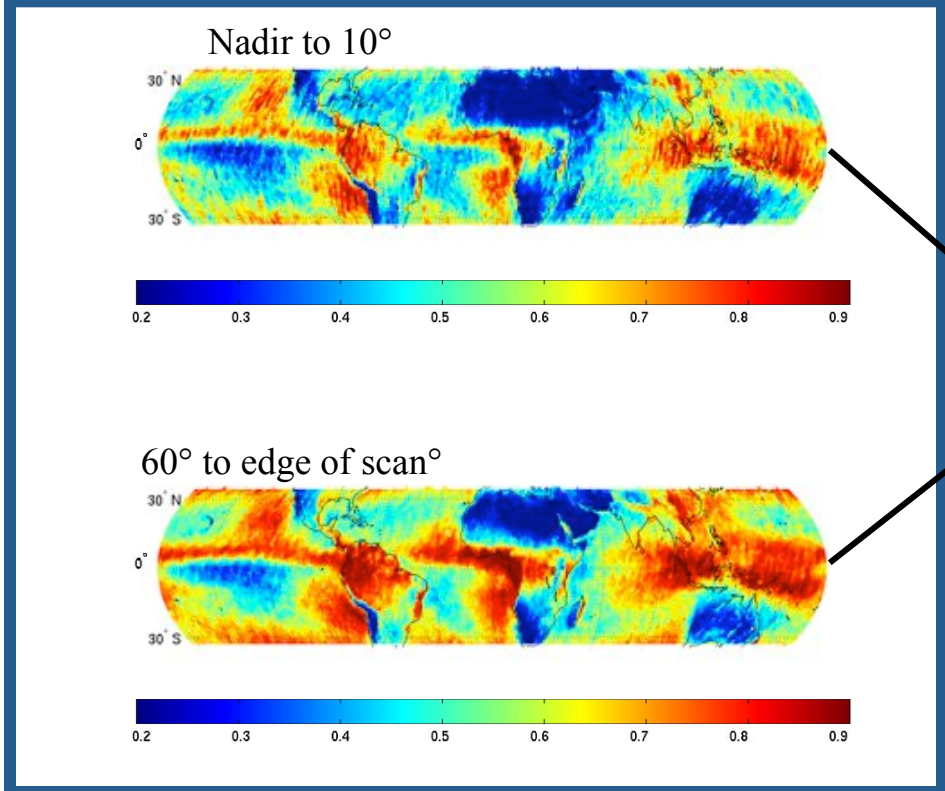
Single Day in the MODIS Orbit

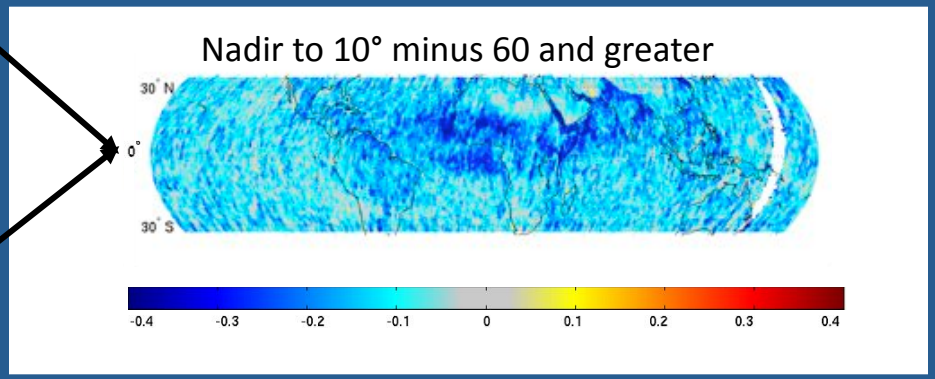
- Geostationary-like view
- 16 day orbit procession
- U-Shape at edges of convection and cloudy regions
- Increase in pixel size with view angle

Terra Daytime Cloud Fraction



Daytime Cloud Fraction Mean





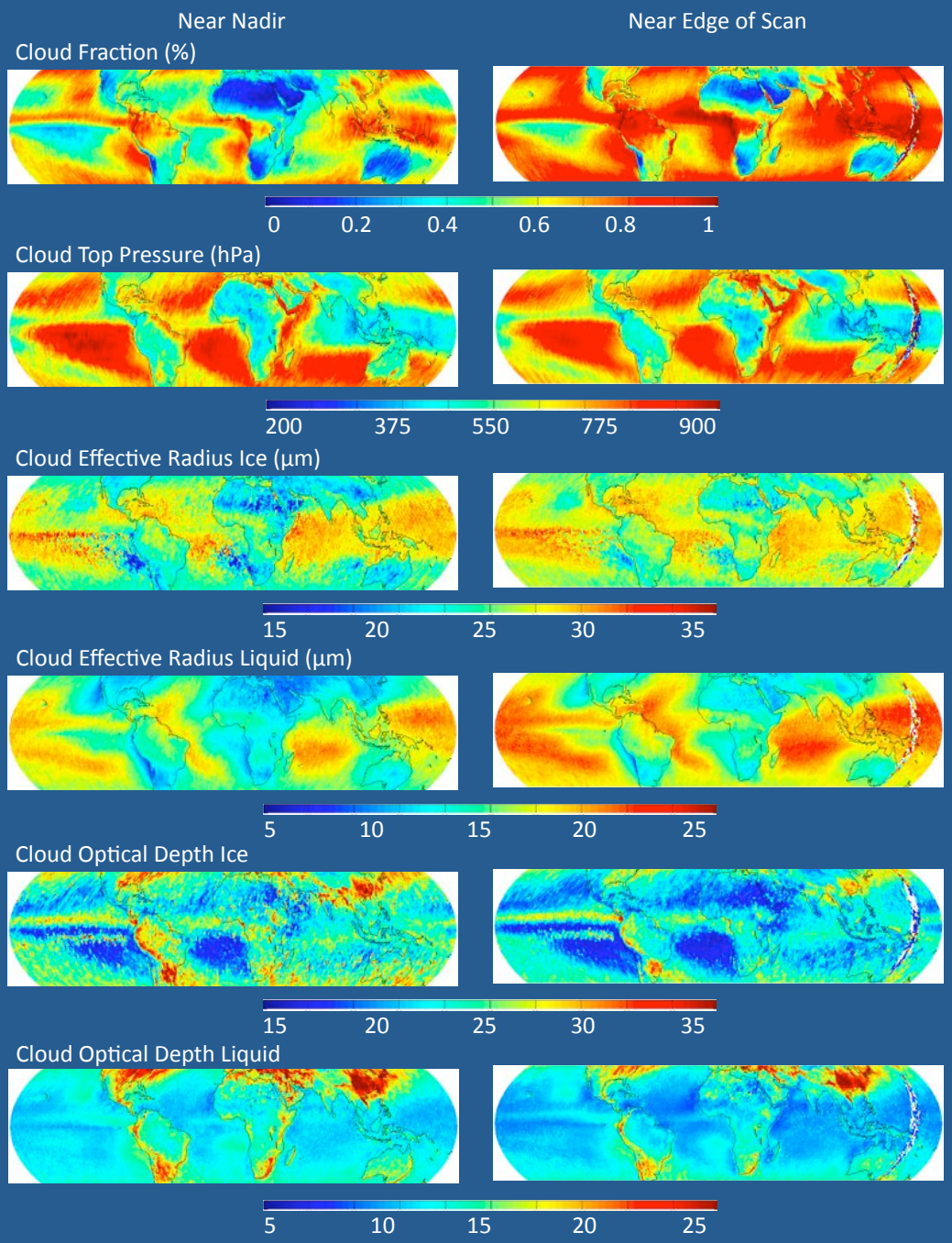
- Differences not uniform
- Largest differences not where thin high clouds exist

Nadir vs Edge of Scan

- Changes are not uniform

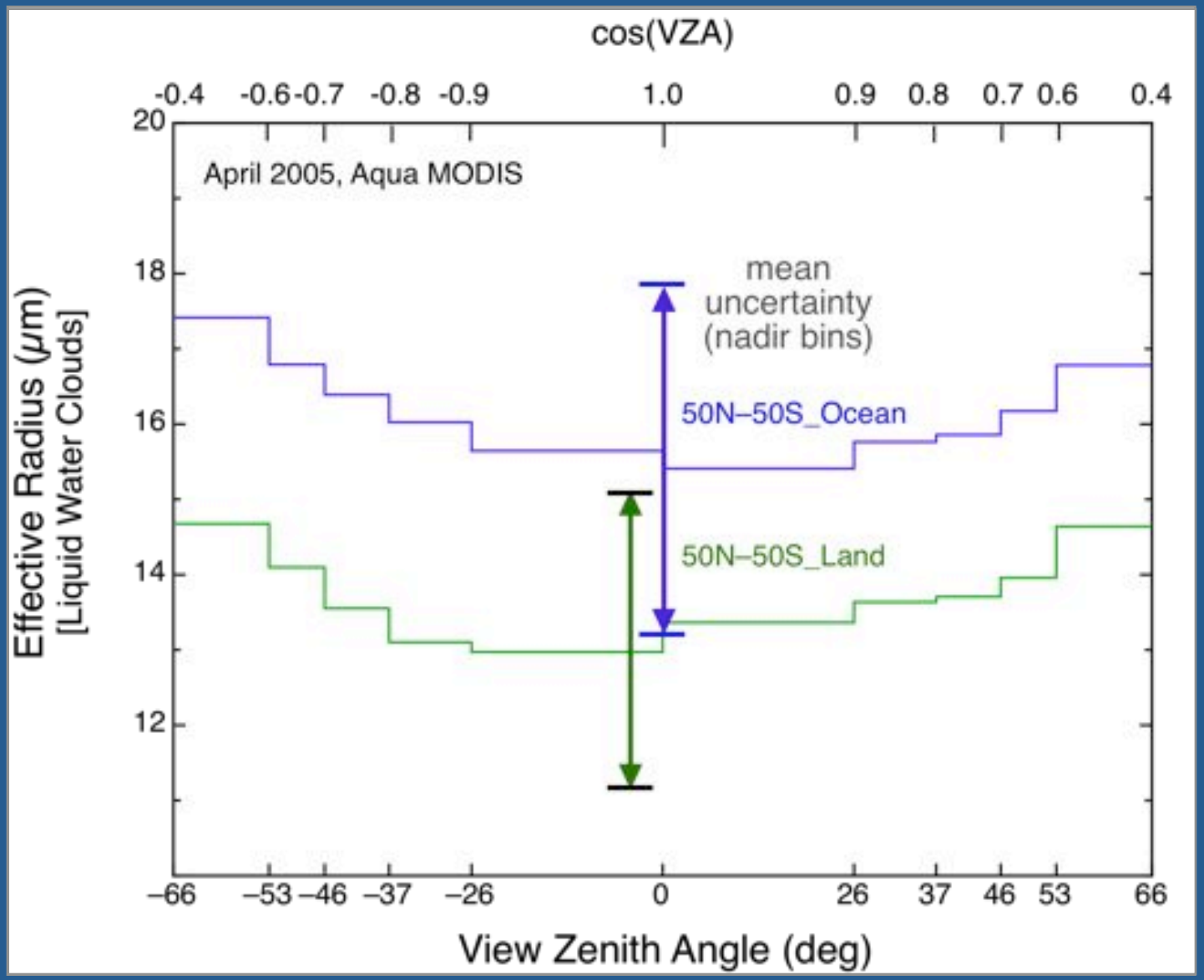
- Largest changes in CF aren't the same as largest changes in optical properties

- Near Nadir ≤10°
- Near Edge of Scan ≥50°

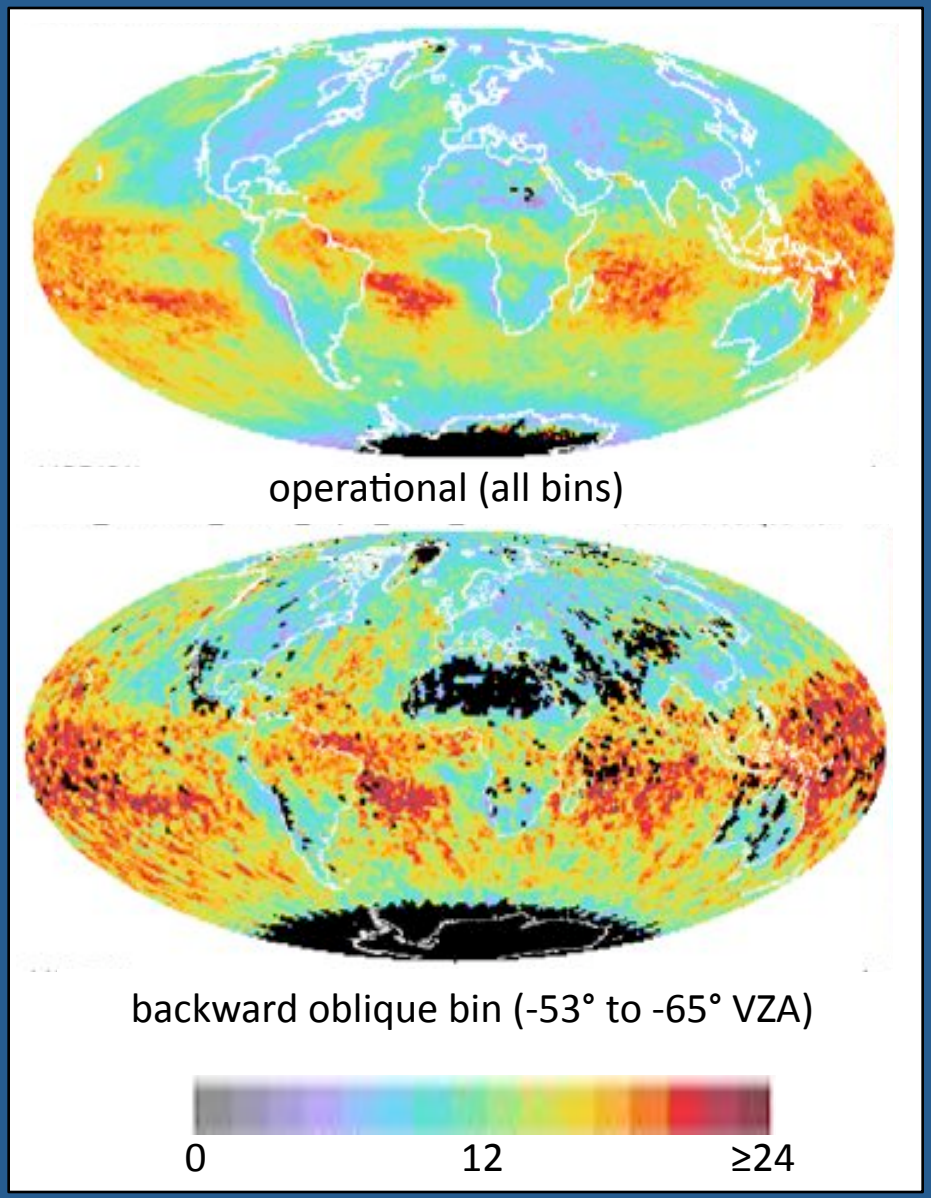


L3 Statistical Uncertainty Study: Zonal Retrieval Statistics vs. VZA

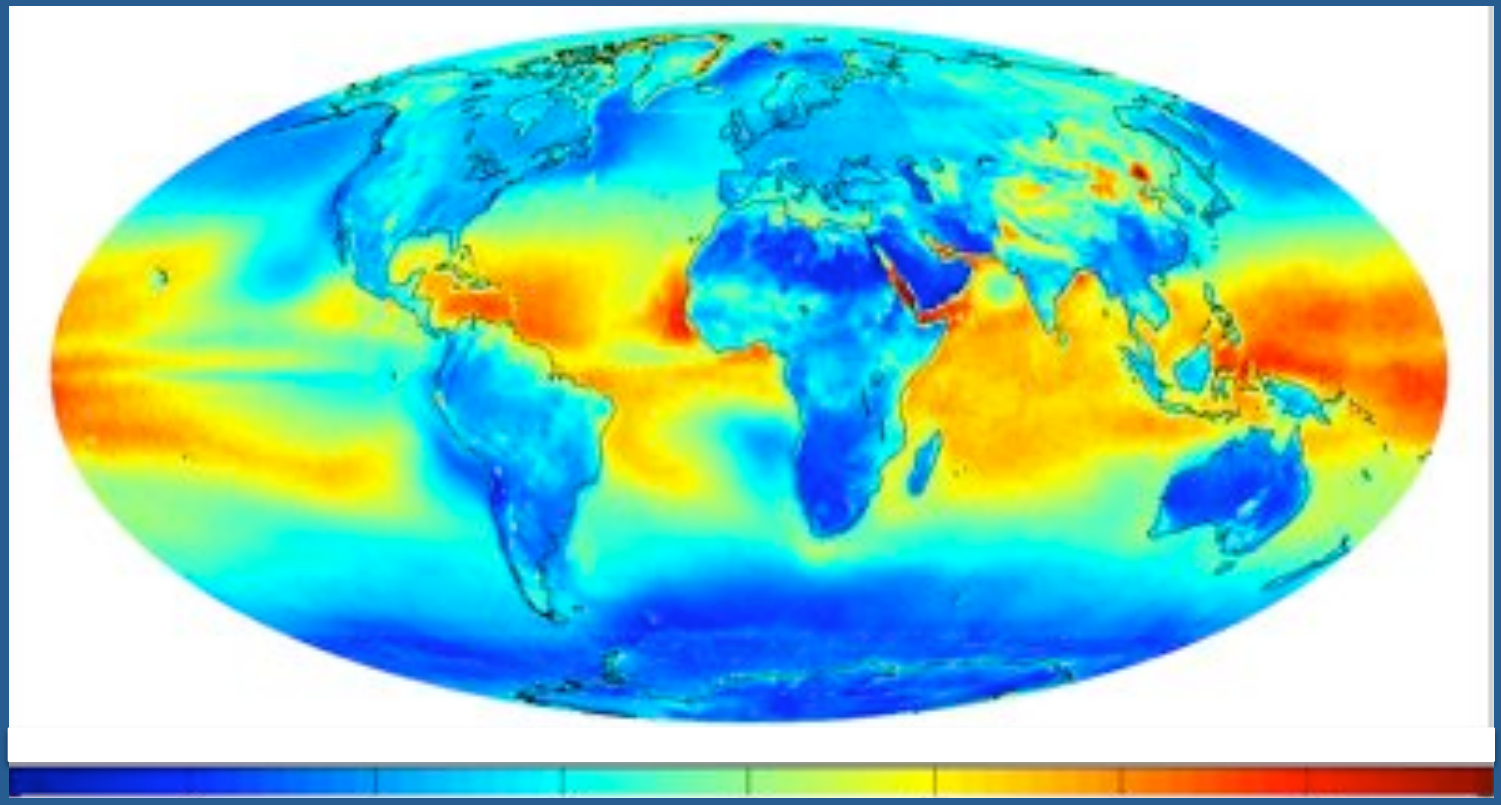
Effective Radius, water clouds



L3 Statistical Uncertainty Study: Global Retrieval Statistics vs. Zenith Angle Effective Radius, water clouds, MODIS Aqua, April 2005

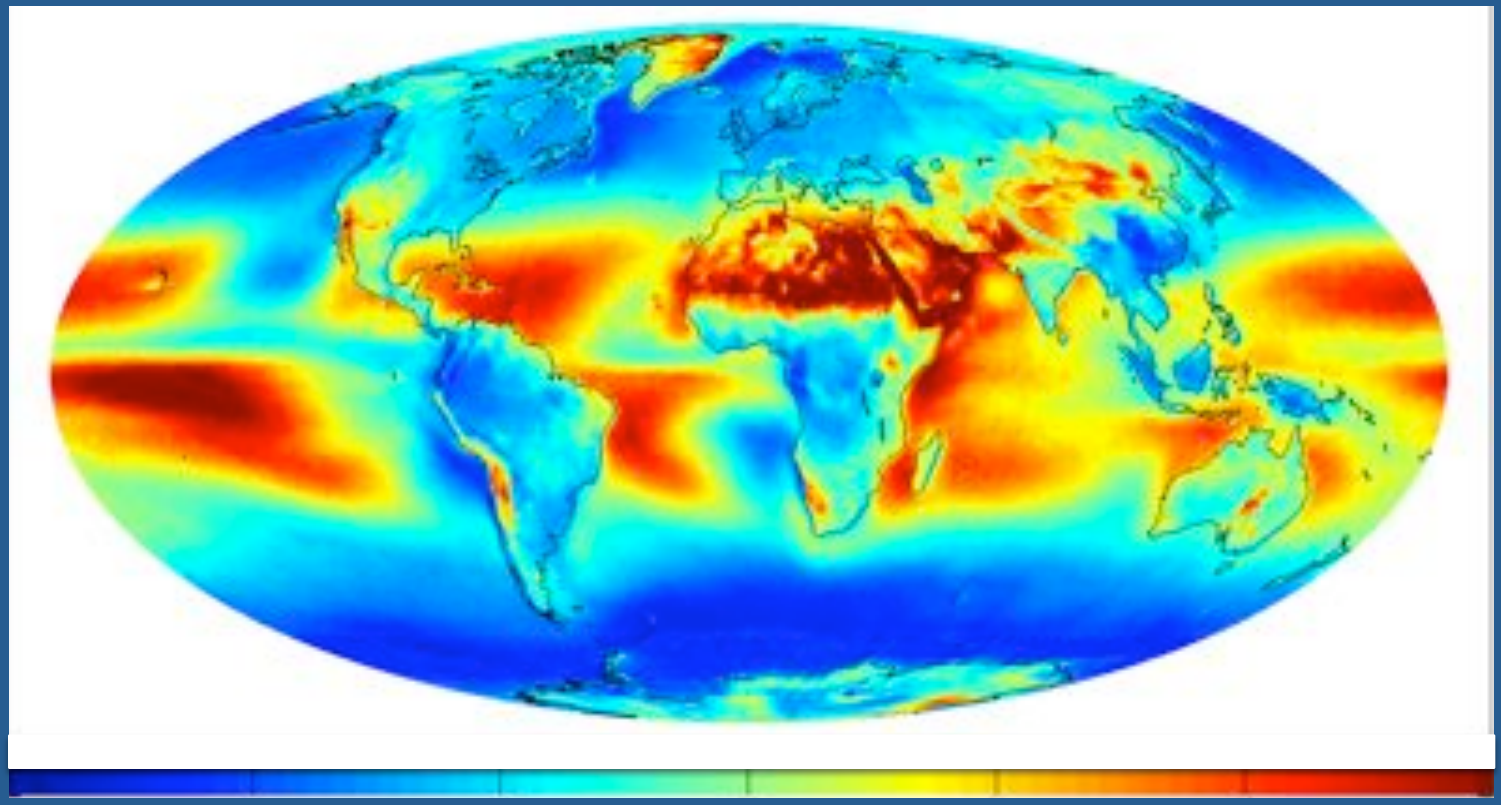


Mean Cloud Fraction Difference (MOD35-MOD06)



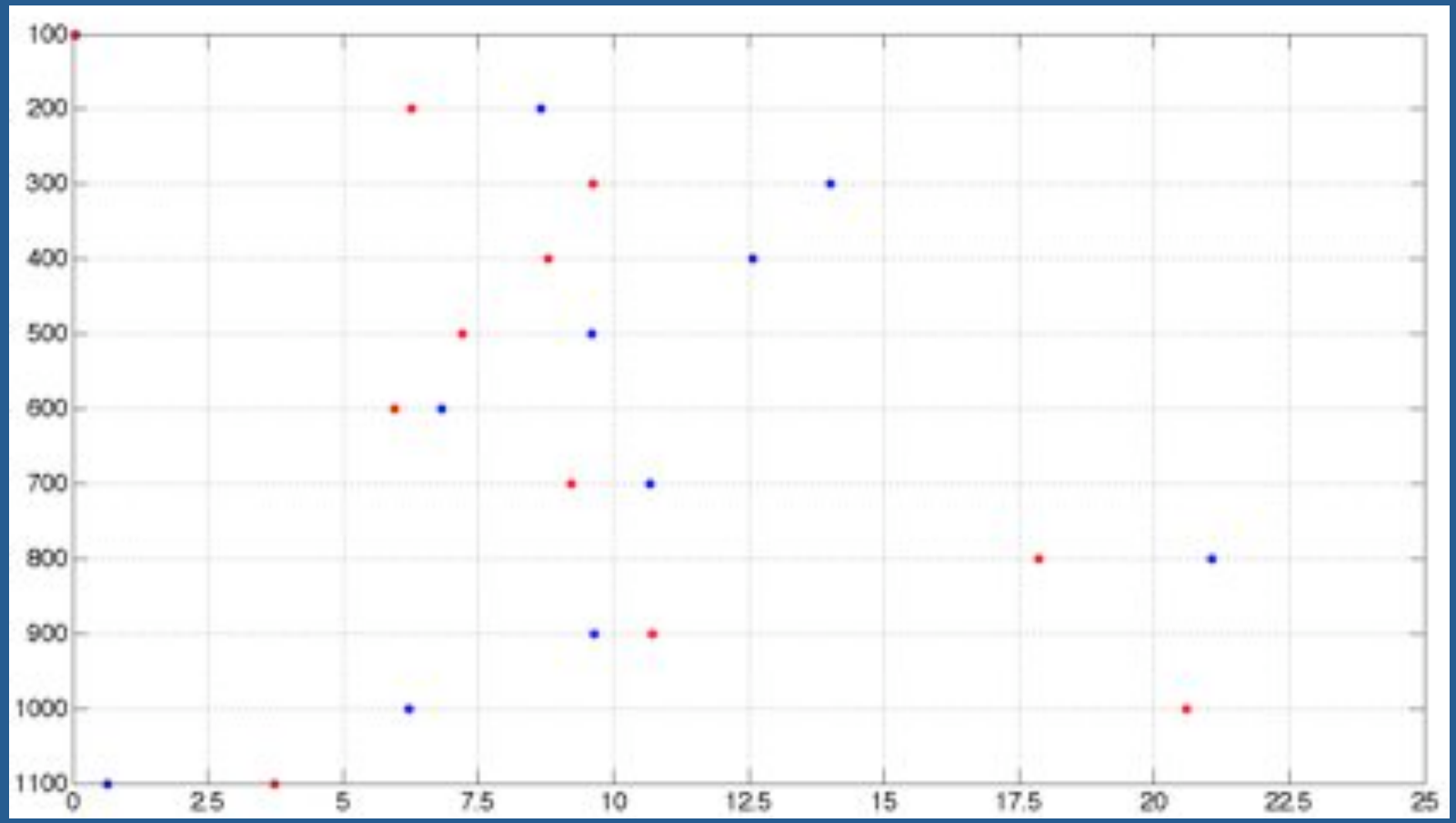
MOD06 cloud fraction is a quality assured subset of MOD35
to retrieve better cloud optical properties

Mean Cloud Fraction Difference in Percent (MOD35-MOD06)/MOD35



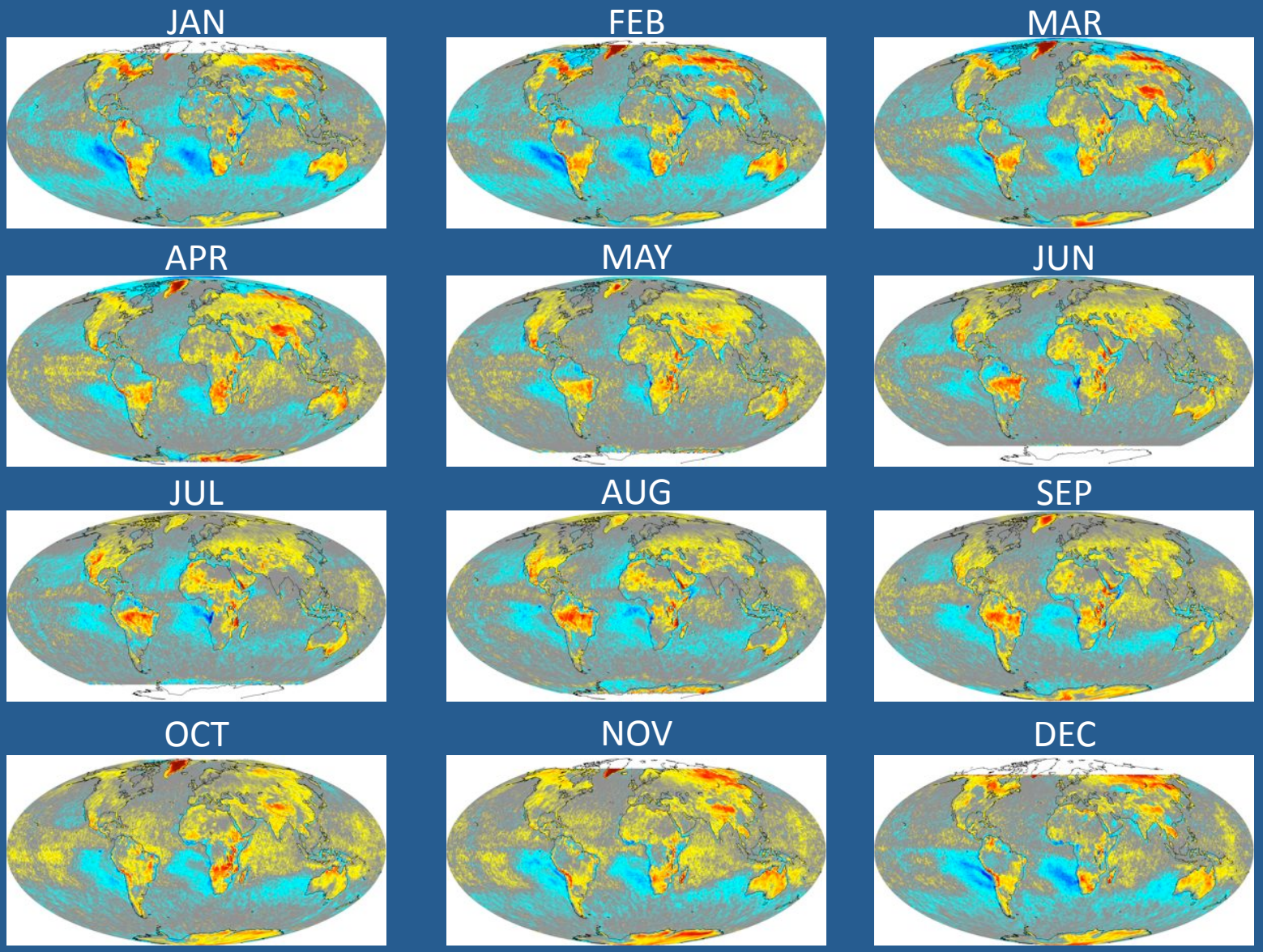
Differences are due to the QA stuff(clear sky restoral and cloud edges, thin clouds, and surfaces influences).

CTP histogram from CTP (red) and CTPvsOD (blue) histogram



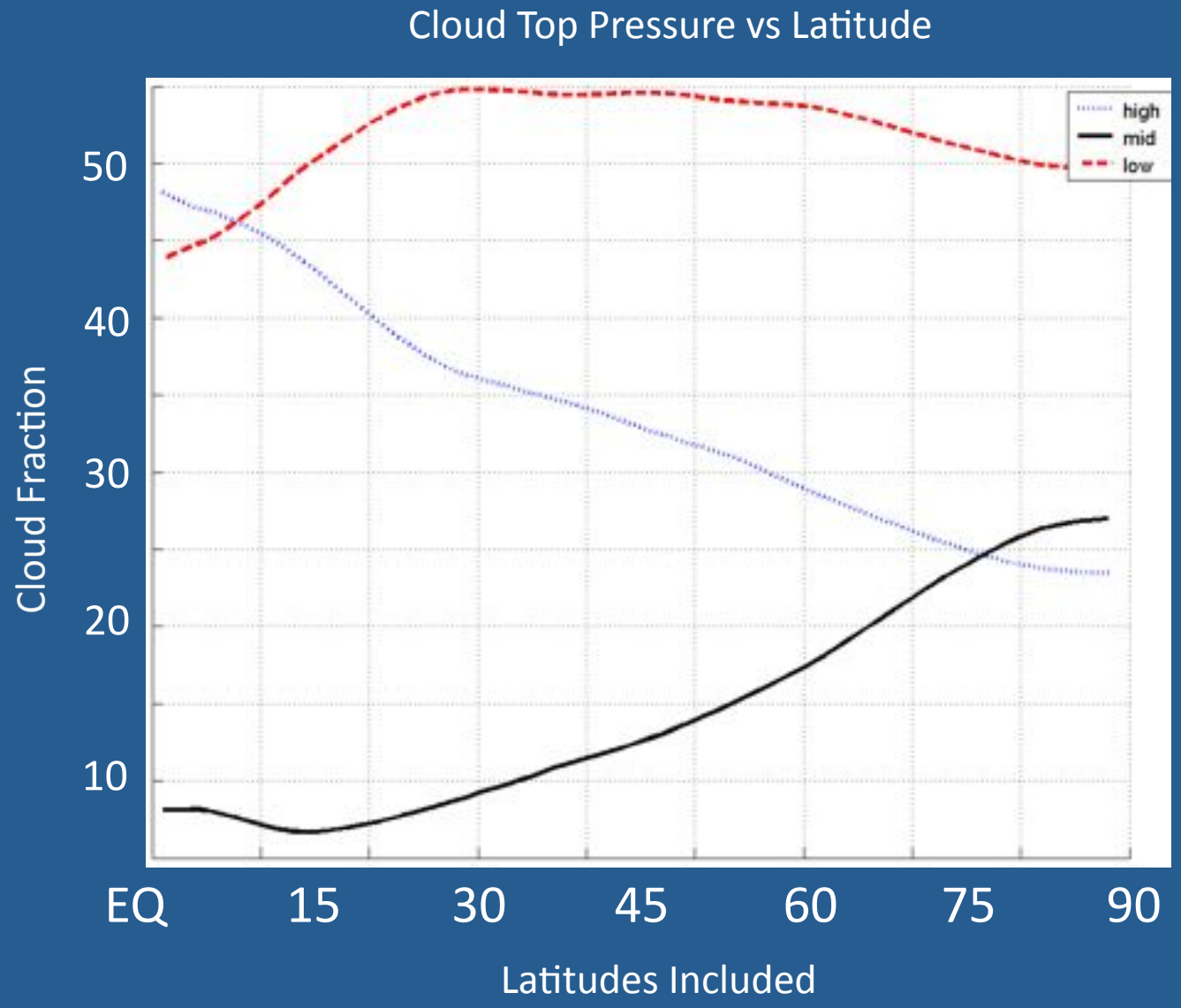
Difference in high and low cloud fraction

Cloud Fraction Day Difference for 7 yrs (Aqua minus Terra)



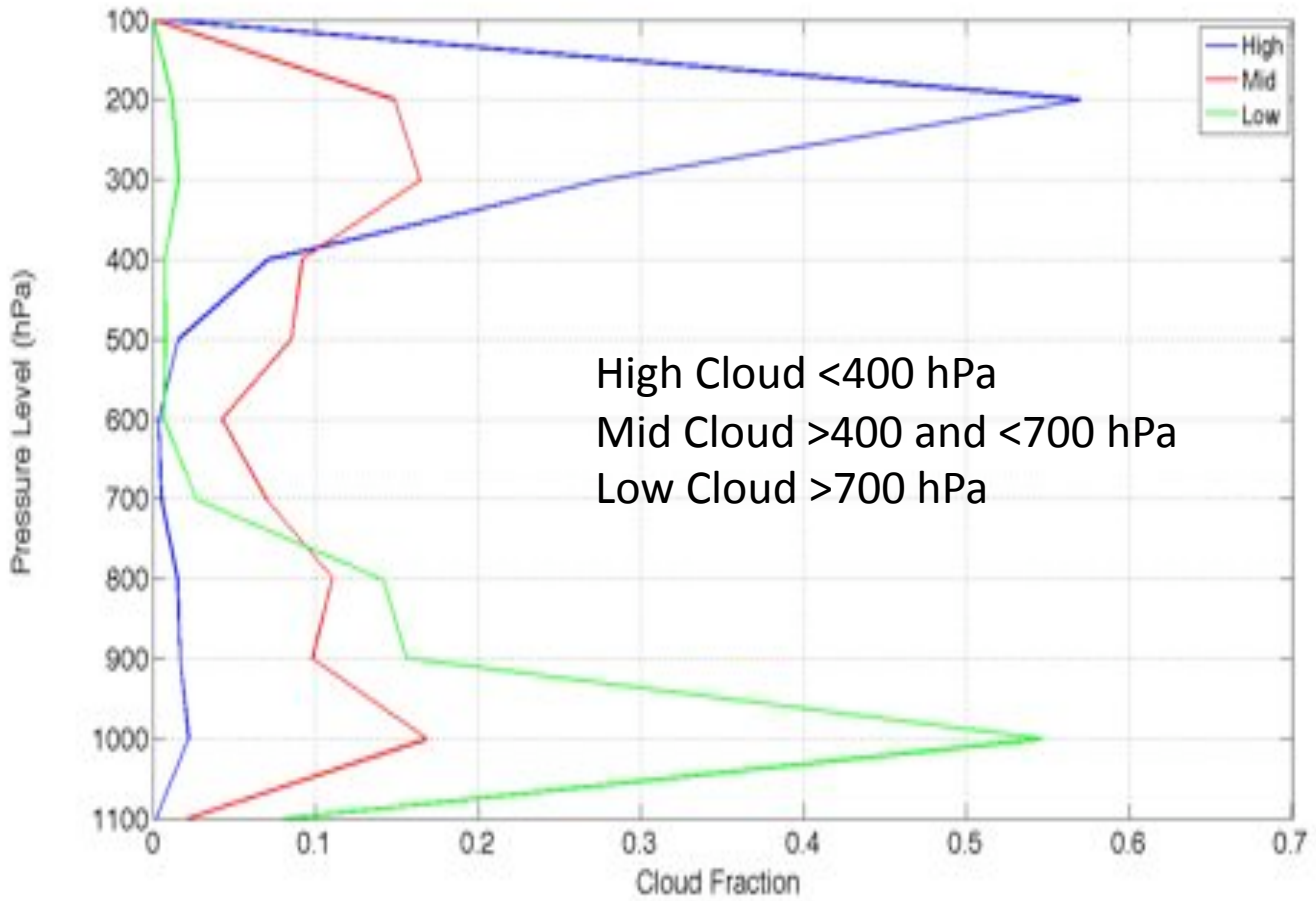
Grid Cell Size and Swath Overlap

Swath overlap causes more cloud to be averaged into the middle cloud bin



Grid Cell Size and Swath Overlap

Cloud Top Pressure Histogram



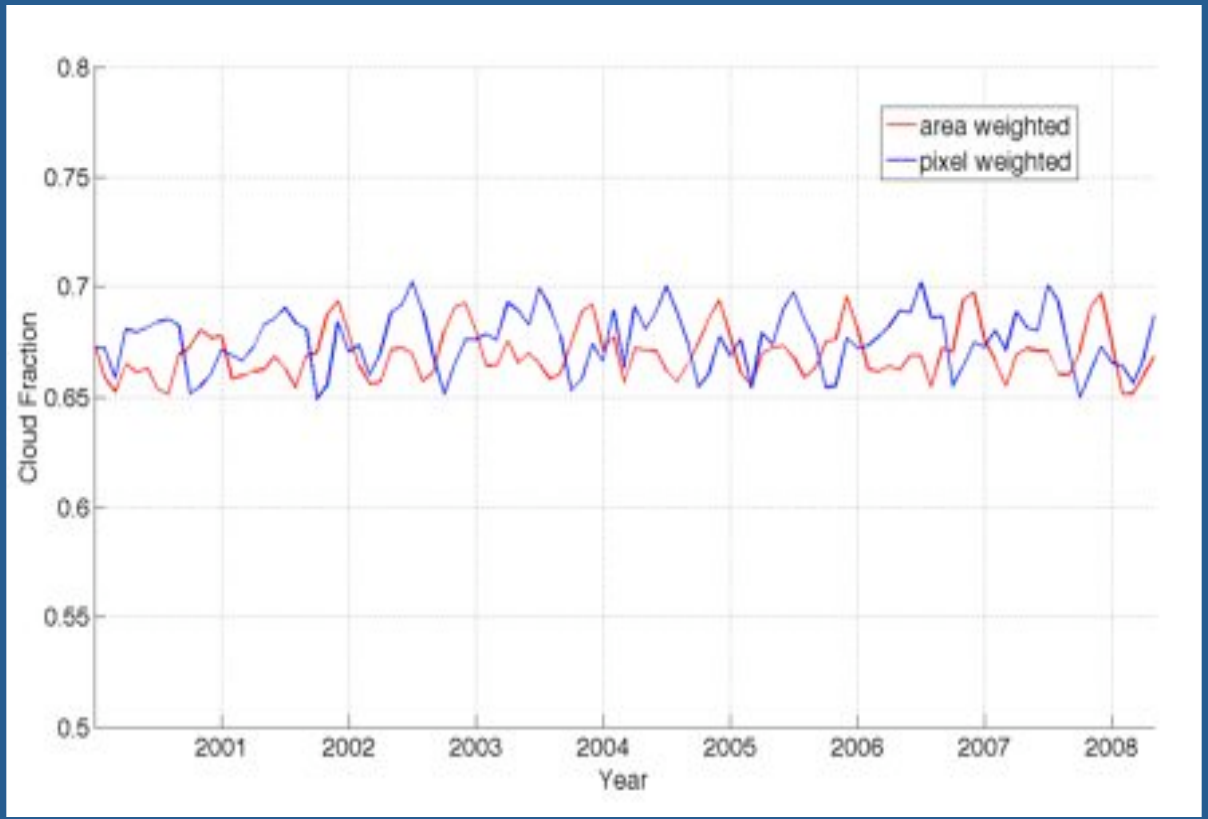
Summary

- Cloud fractions need to characterize the global cloud trend within ±1%
- View angle dependencies are large across swath
  - 16% cloud fraction (>60 locally)
  - 30hPa for cloud top pressure (>200 hPa locally)
  - 2µm for effective radii (10µm locally)
  - 2 for optical depth (20 locally)

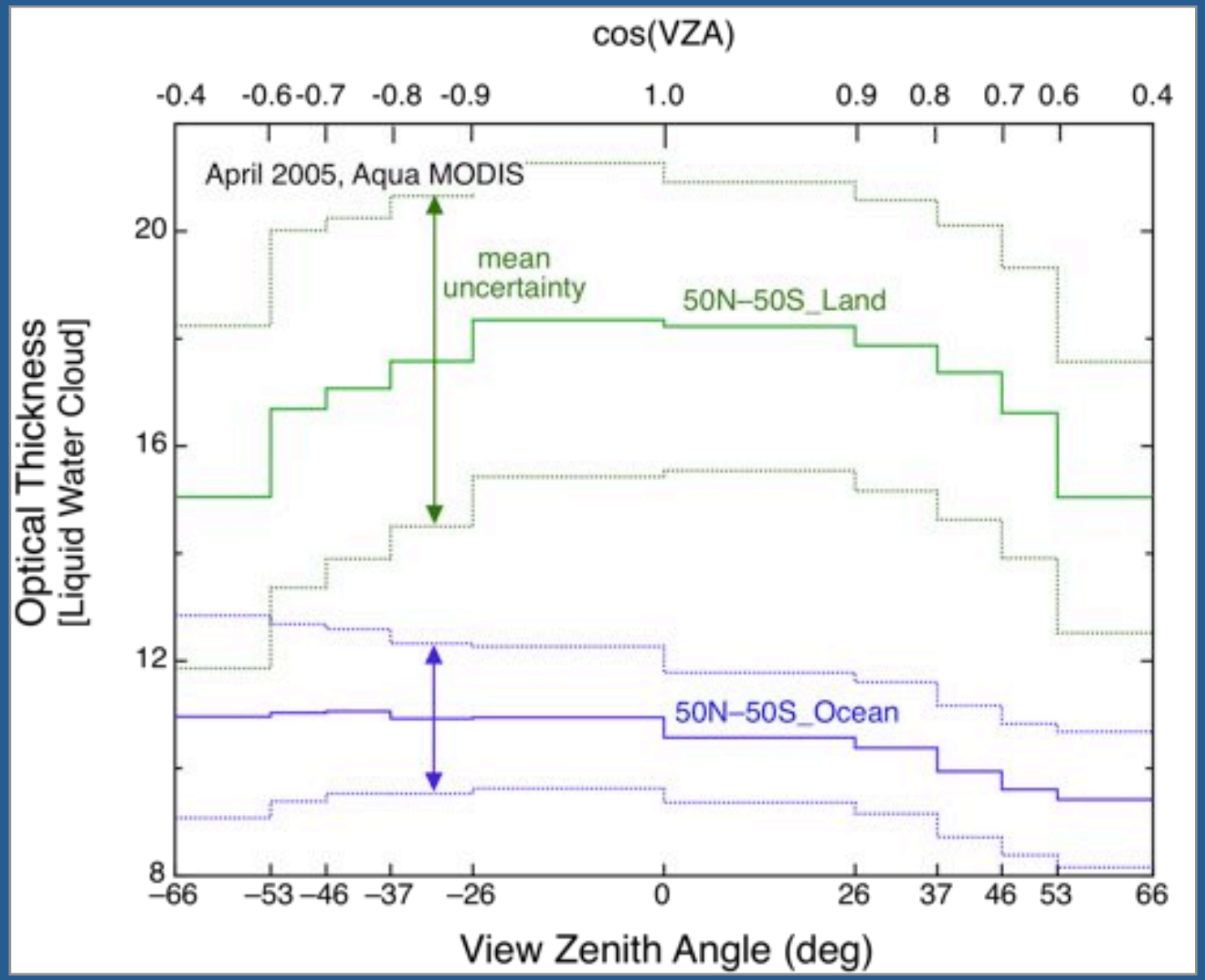
Pixel vs Area Weighting

- Not a uniform offset
- Doesn't change long term mean (.2%)
- Polar regions oscillate opposite mid-latitudes

MODIS Terra Cloud Fraction Area (Red) and Pixel (Blue)



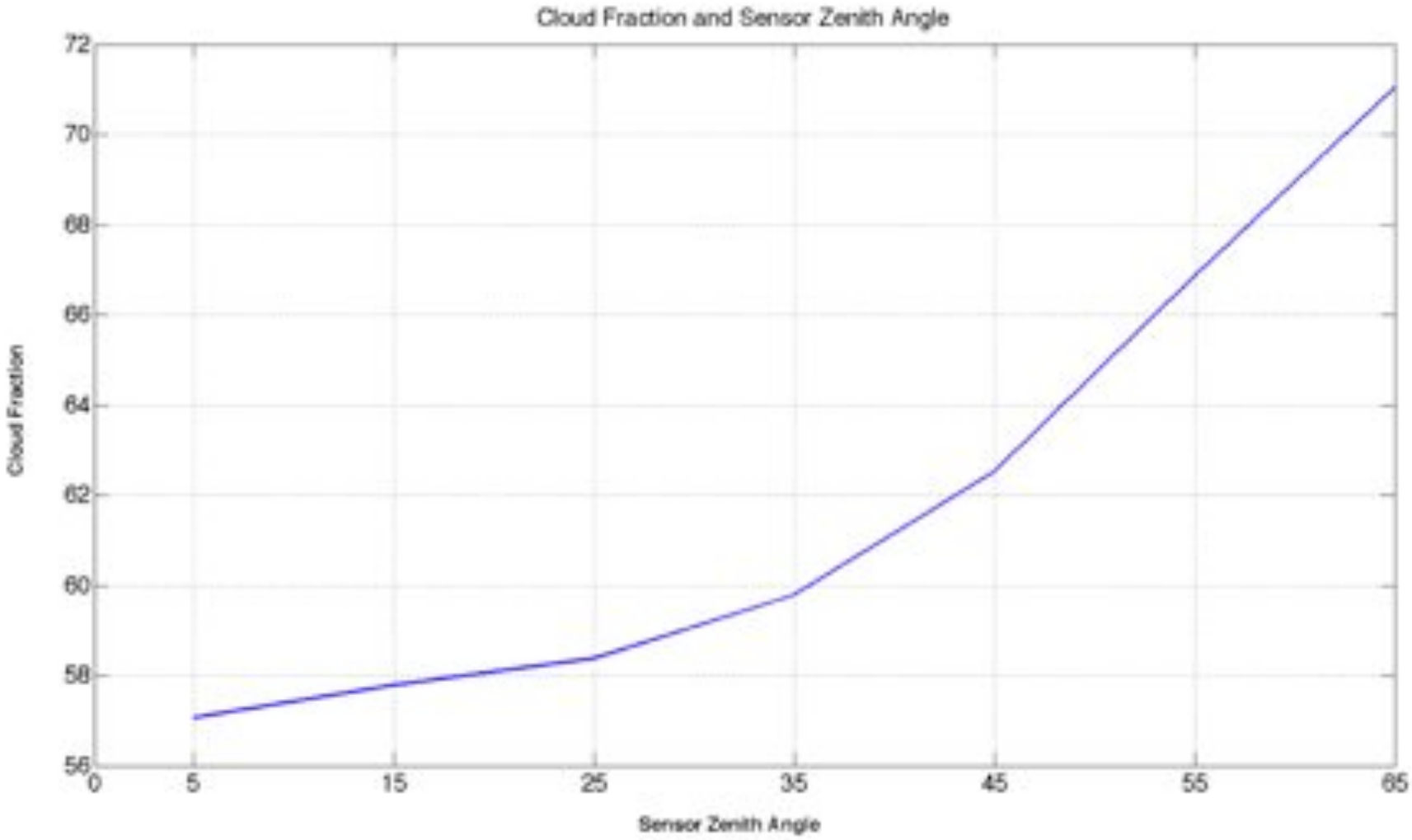
L3 Statistical Uncertainty Study: Zonal Retrieval Statistics vs. VZA
Optical Thickness, water clouds



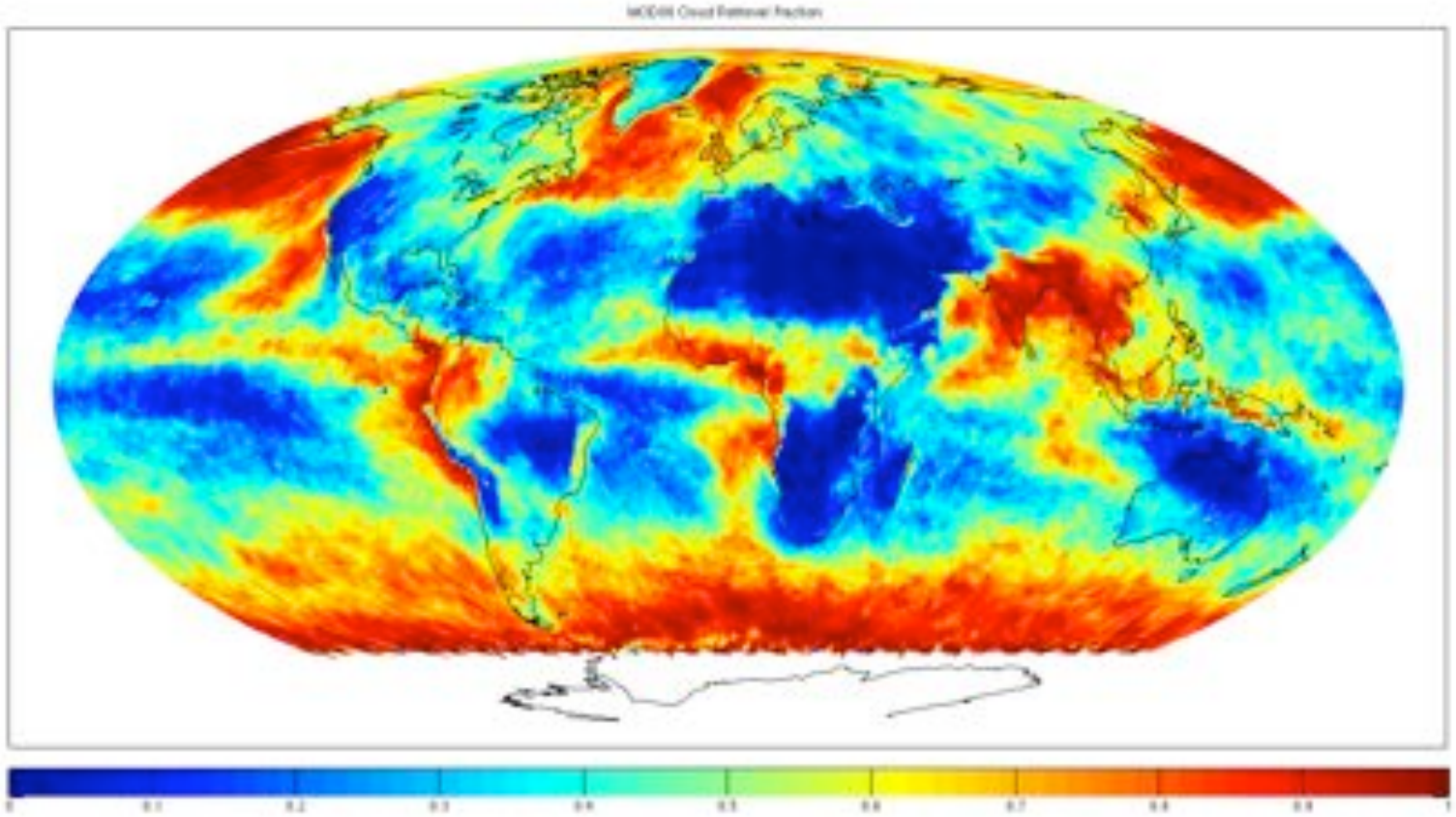
Summary of VZA Results

For water clouds:

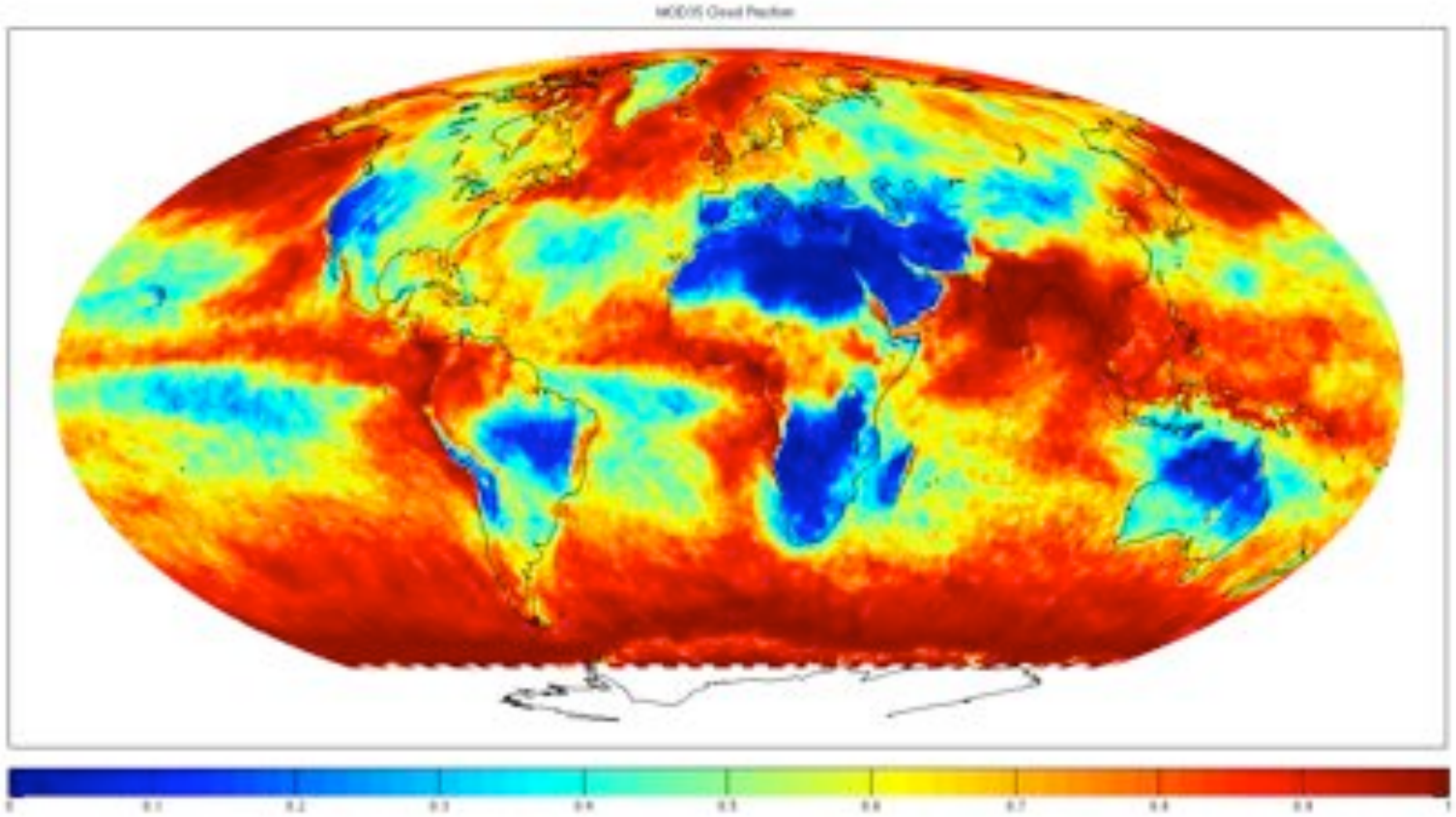
- Zonal mean statistics: at all latitudes (land and/or ocean) VZA dependencies for τ and r_e are within product's mean instantaneous uncertainties
- Optical Thickness zonal means:
  - ocean clouds show some asymmetry (slight indication of shadowing on sun view side of scan?)
  - land clouds symmetric.
- Effective Radius:
  - no obvious shadowing effect (symmetric), both zonal and some regional analysis


Cloud Fraction and Sensor Zenith Angle
Cloud Fraction
72
70
68
66
64
62
60
58
56
0
5
15
25
35
45
55
65
Sensor Zenith Angle

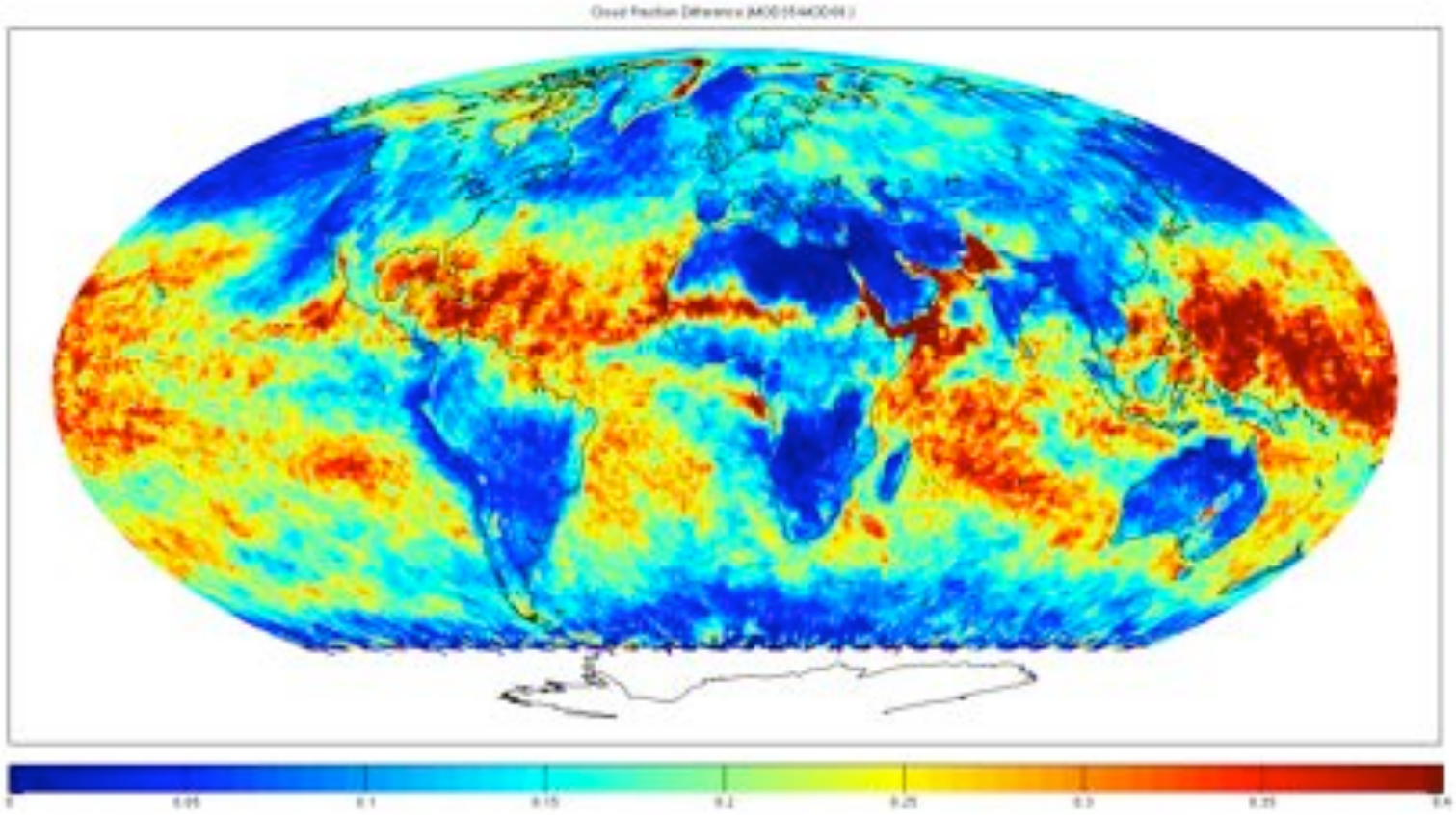
Cloud Retrieval Fraction for one month (MOD06 optical properties cloud fraction)



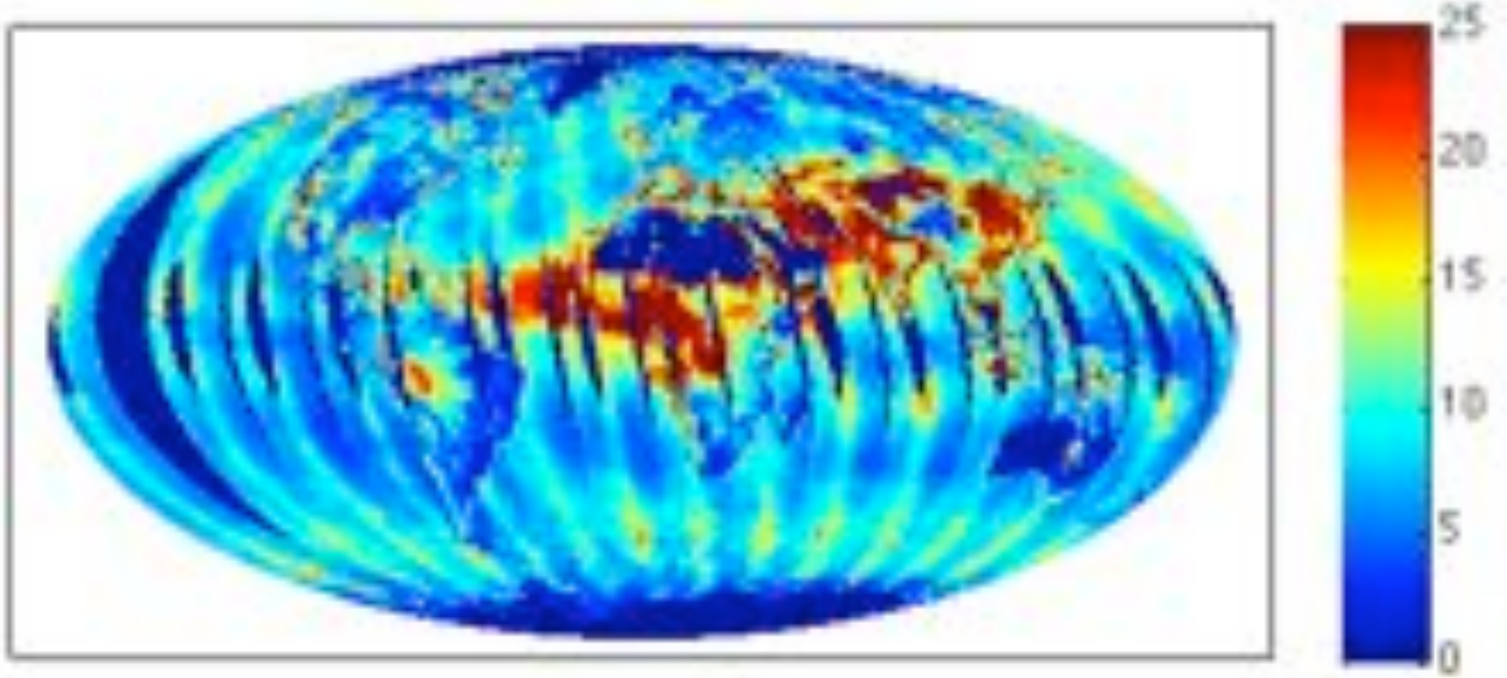
Cloud Fraction for one month (MOD35)



Mean Cloud Fraction Difference for on month (MOD35 minus MOD06)



Mass Concentration for 1 orbit day



Cloud Fraction

- MODIS cloud mask (MOD35, described in Ackerman et. al 1999)

- Up to 19 channels in vis and IR
- 1km to 250m resolution
- For Level-3 statistics there are clear and cloudy pixels

Introduction

- Two types of variability
- Natural:
  - Time and spatial scales
- Artificial:
  - Instrument (Aqua-Terra Differences)
  - Orbit (polar vs geostationary)
  - Algorithm- channels choices

2.1 and 37 differences

- TTD:
- CTPDH vs angle for Aqua 2004
- Find distribution of re and od vs solar angles
- Pdfs from poster
- Make a error bar plot on dataset
- Include figures on angle attribution for two main influence, pixel size and thin clouds at oblique angles

Histograms:

-Make the histograms span the data and not be sparse…base them on the algorithm

-CTT histogram span the domain, the lower end is truncated.

-CF histogram of the 5x5 cloud fraction with 4% resolution.

For the 5x5 Properties:

-Need to know the number of clear, partly cloudy, cloudy, partly cloudy and cloudy not retrieved pixel counts

Moving forward with Level-3:

-We need to decide at what view angle to cut the data off at for L3. All swath or 40 or 20?

-Create single overpass cloud datasets?