MODIS Infrared Cloud Phase and the MODIS Simulator Radiative Transfer Package

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MODIS Science Team Meeting
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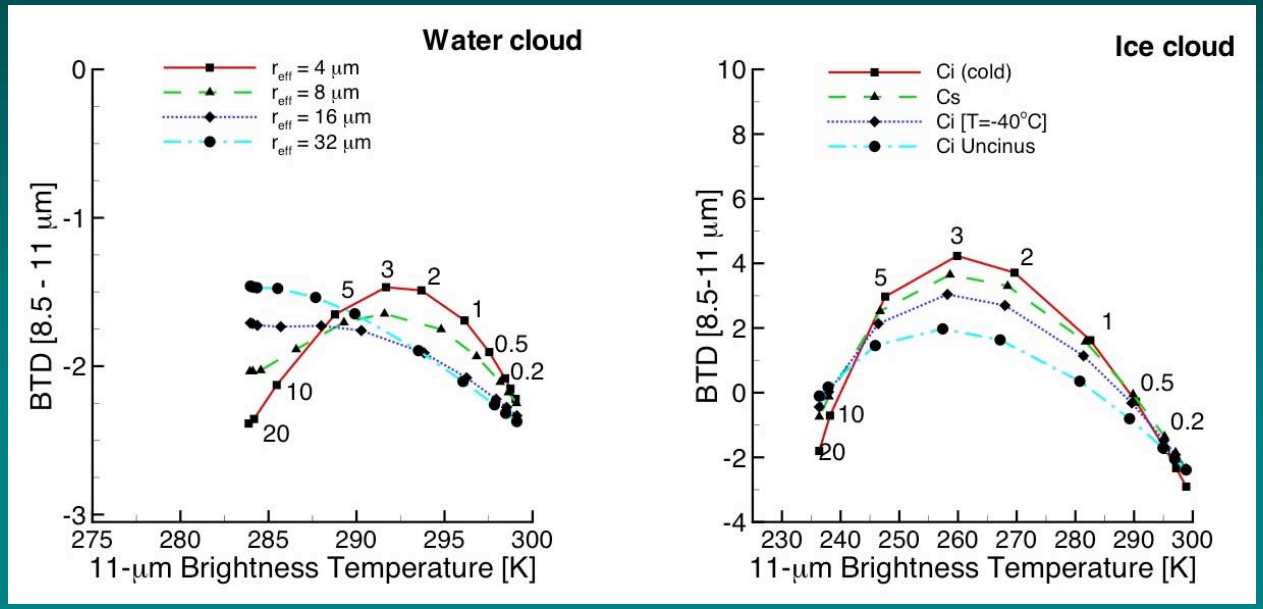
IR-Based Cloud Thermodynamic Phase

Approach through Collection 5



RT calculations form basis of algorithm;

Operational IR algorithm applied to 5x5 averaged data

Validation primarily from field campaigns involving MAS/MODIS & CPL

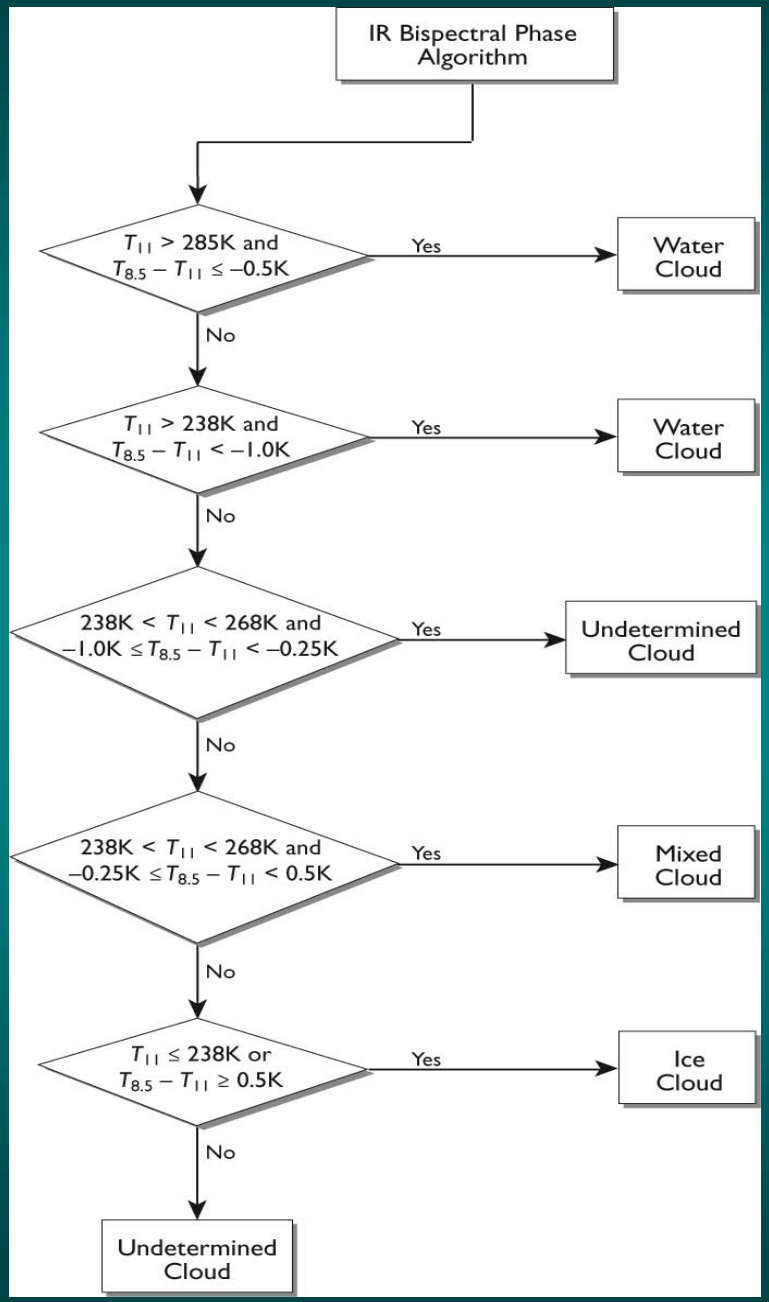
IR-based cloud phase

***Philosophy**: do what can be done well; leave the rest for research*

What has changed?

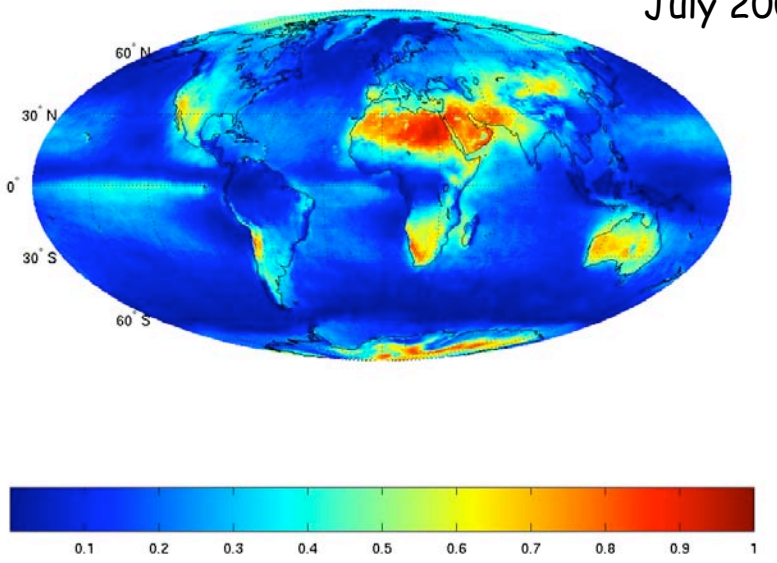
Much more depolarization lidar data from HSRLs, CPL, CALIOP, so potential for validation

Improvements in just about every aspect of RT modeling

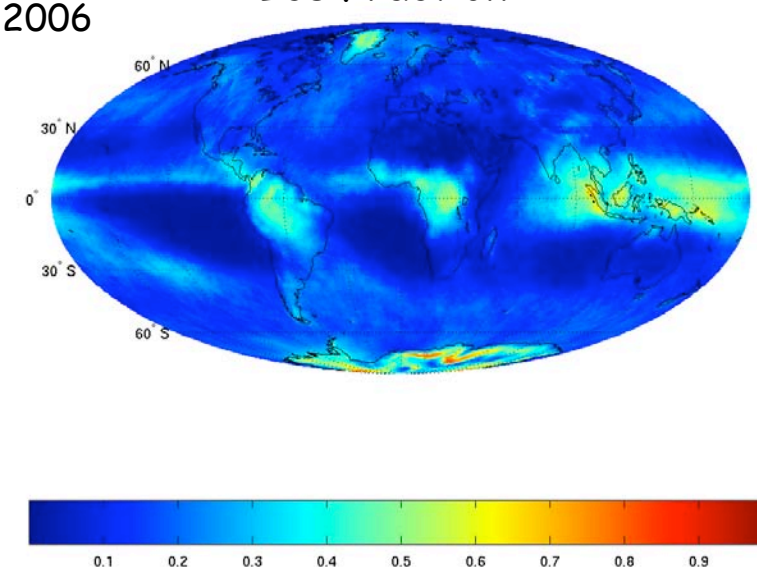


Aqua: 4 years
July 2002 - July 2006

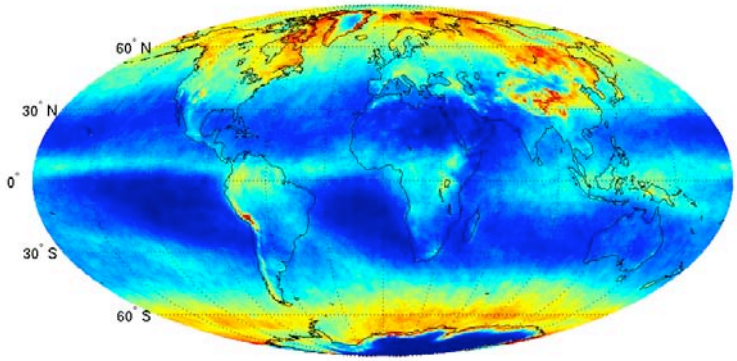
Clear Fraction

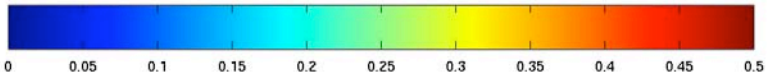


Ice Fraction

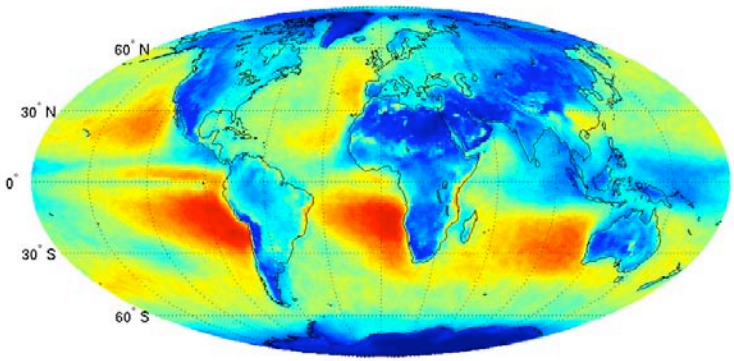


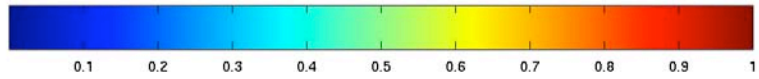
Mixed/Uncertain Fraction





Water Fraction





Rapid product evaluation and improvement

Must be able to recreate the products, using research models/code

Require same inputs as operational products

Given a date and location, need

- RT models
- 101-level atmospheric profiles developed from GDAS (or another source)
- Surface albedo & surface emissivity values
- Satellite viewing angles
- Cloud libraries

The MODIS Simulator Radiative Transfer Package

Work in progress - older code being refurbished

Based on the Discrete Ordinates radiative transfer model

Atmospheric column absorption: correlated-k routines

23 MODIS bands total: 1-7; 17-20; 22; 23; 26-29; 31-36

Water cloud bulk scattering properties: Mie theory

Ice cloud bulk scattering properties: Collection 5 ice models

Phase function expansion: Dfit routine - being updated

CO_2 concentration now an input variable to correlated-k routines

Atmospheric CO_2 has not been constant

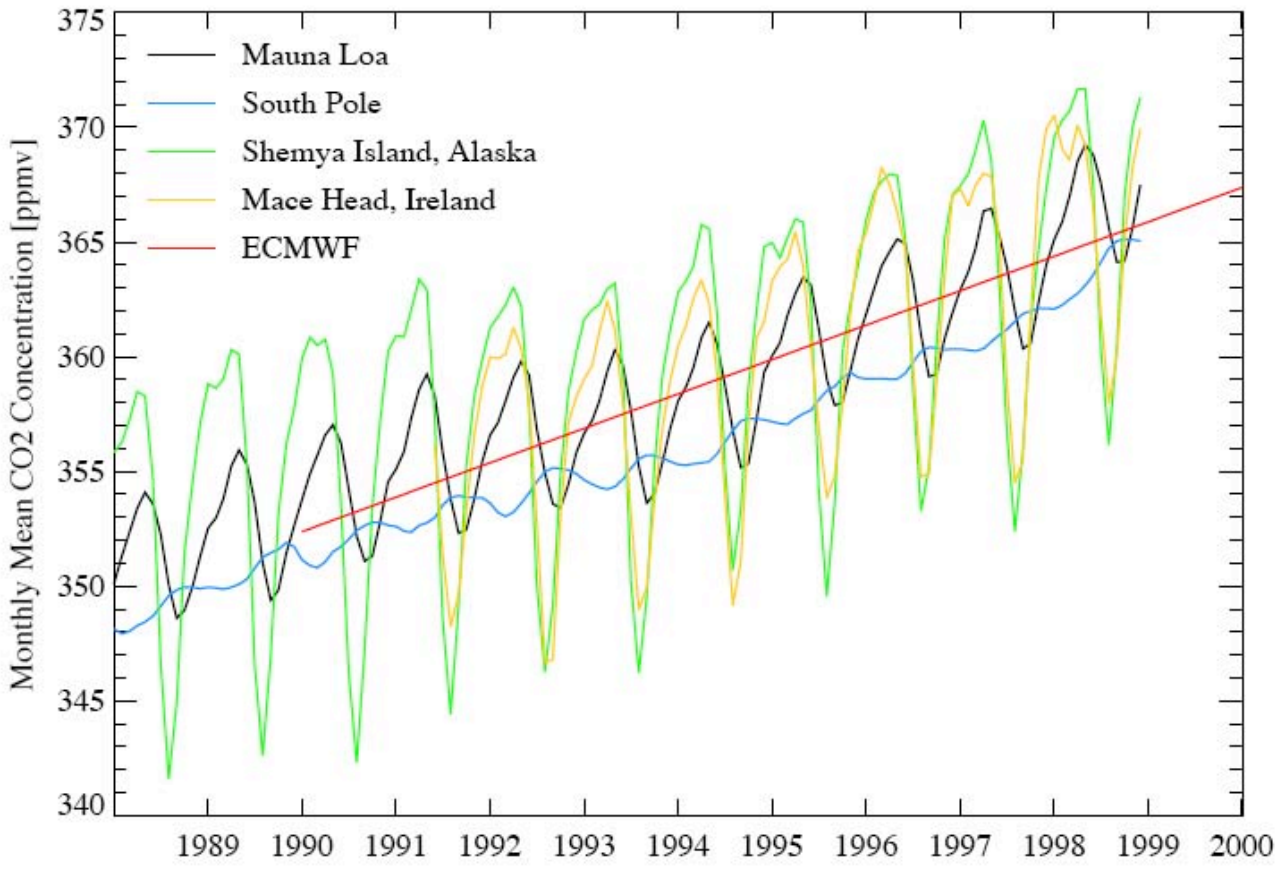


Figure 1. Time series of monthly mean surface CO_2 volume mixing ratios for 4 flask stations. The red line represents the values used by ECMWF.

(From Engelen et al., Geophysical Research Letters, 2001)

Finally have some independent cloud phase data

Goal: Evaluate MODIS cloud thermodynamic phase through intercomparison with depolarization measurements from CALIOP & depolarization lidar data (i.e., HSRL)

Strategy for product improvement:

- *develop protocols for intercomparisons*

- *prioritize problem regions*

- *use new RT package for investigation*

- *test proposed solutions on global data*

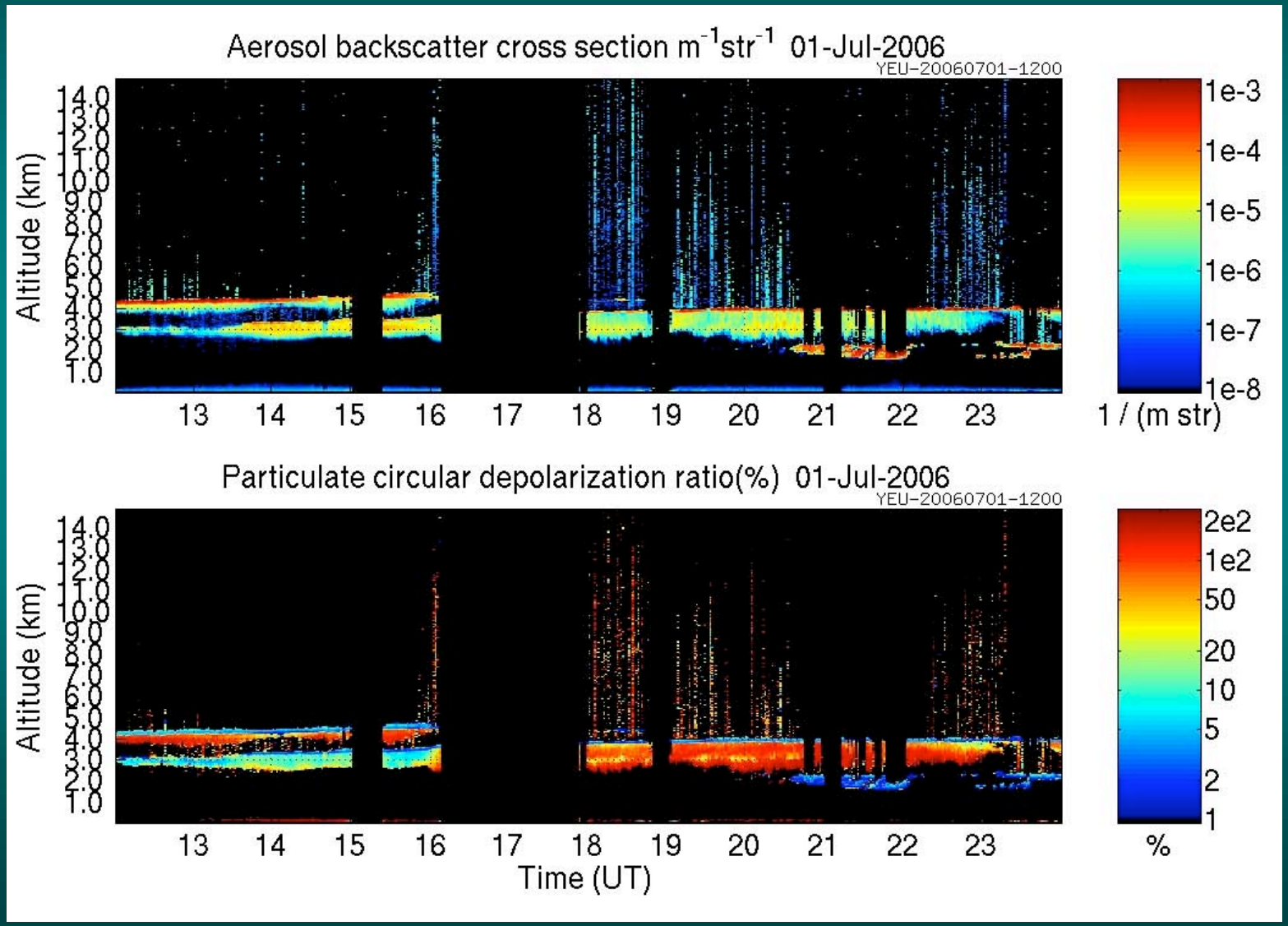
- *focus on efficiency*

- *develop and test solutions*

- *quantify improvement*

Arctic HSRL - Barrow, Alaska

http://lidar.ssec.wisc.edu



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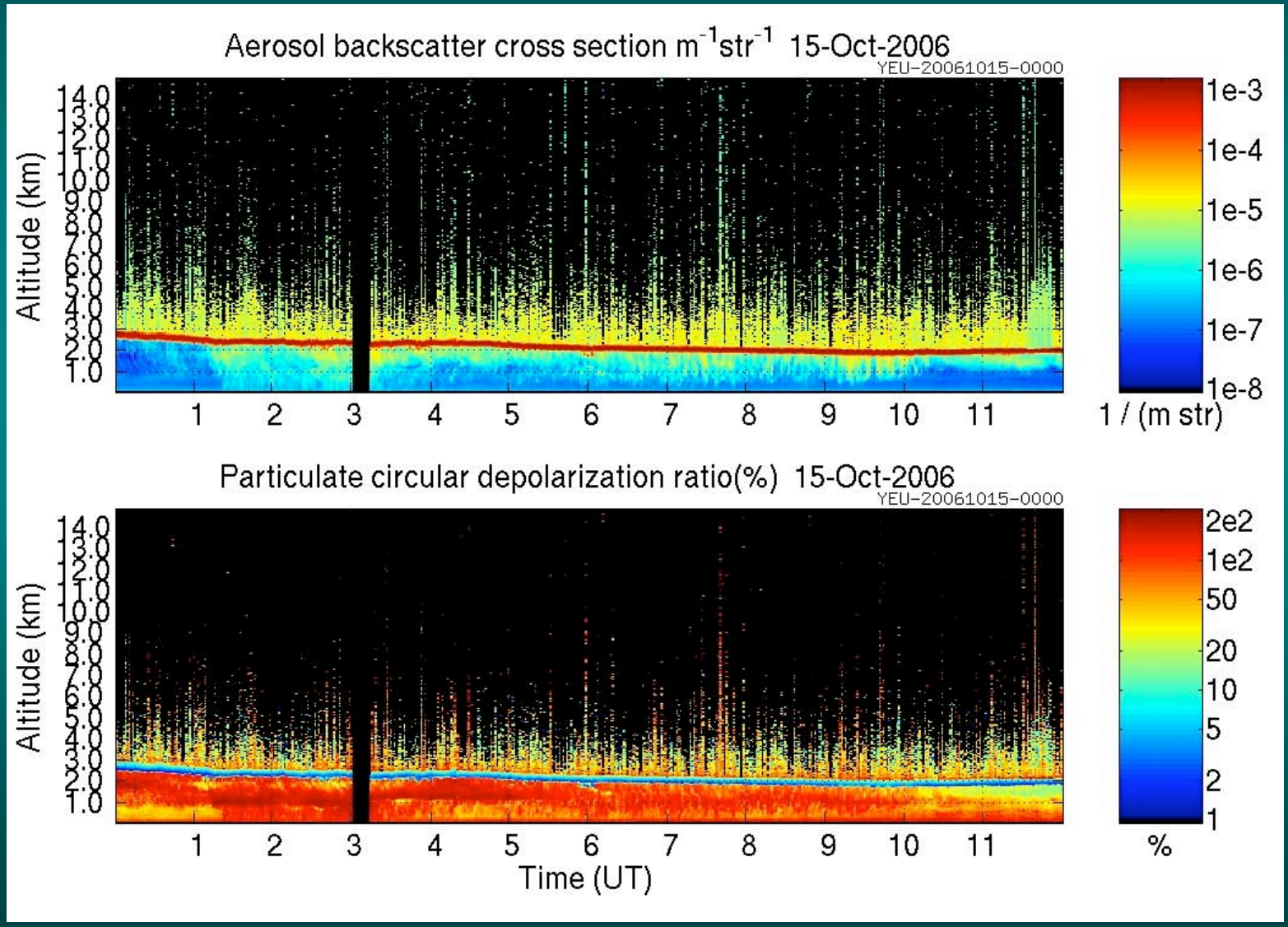

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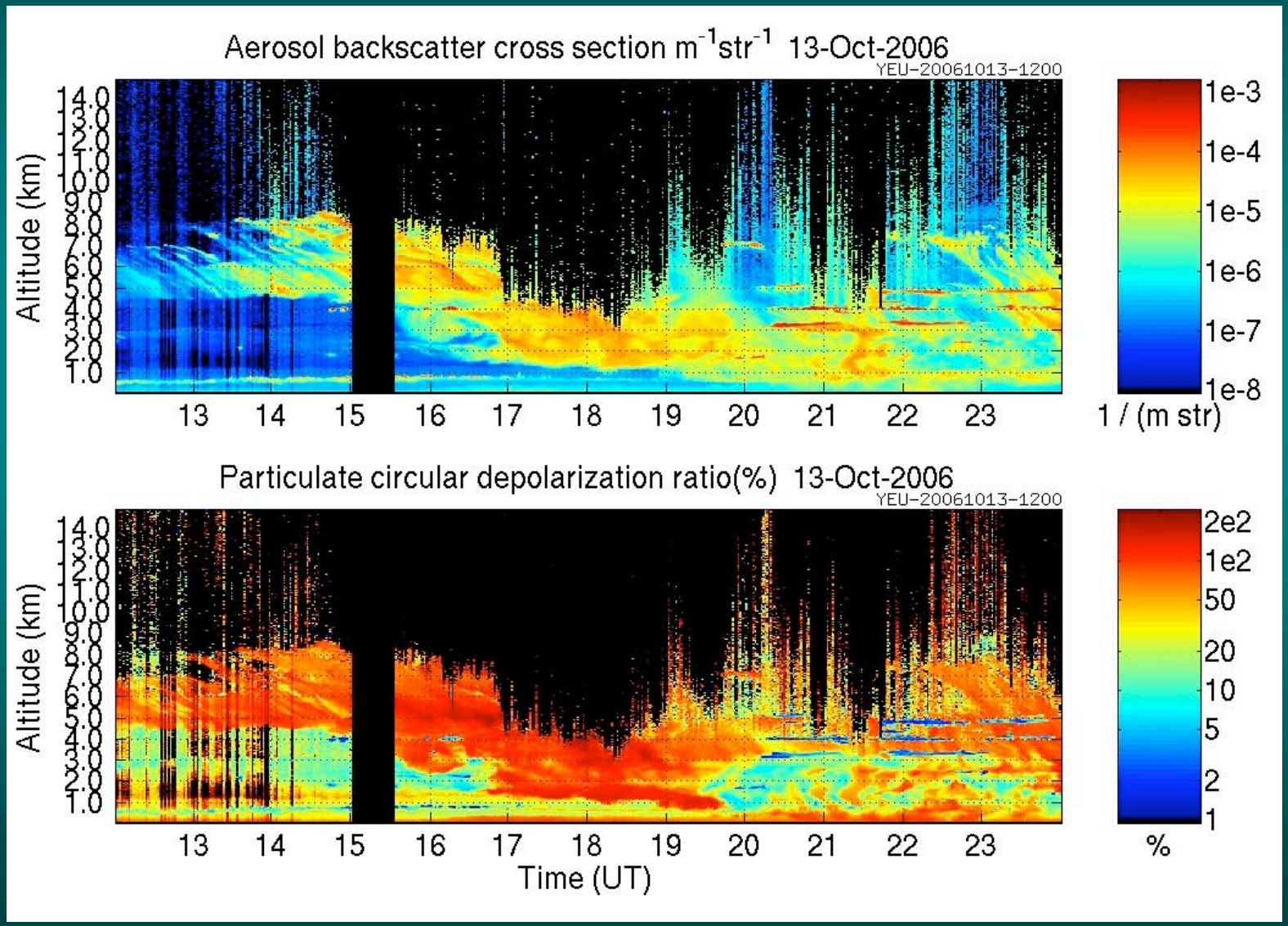


Intercomparing CALIOP and Aqua Data

CALIOP data: about 80 m resolution

MODIS cloud products at both 1 & 5 km

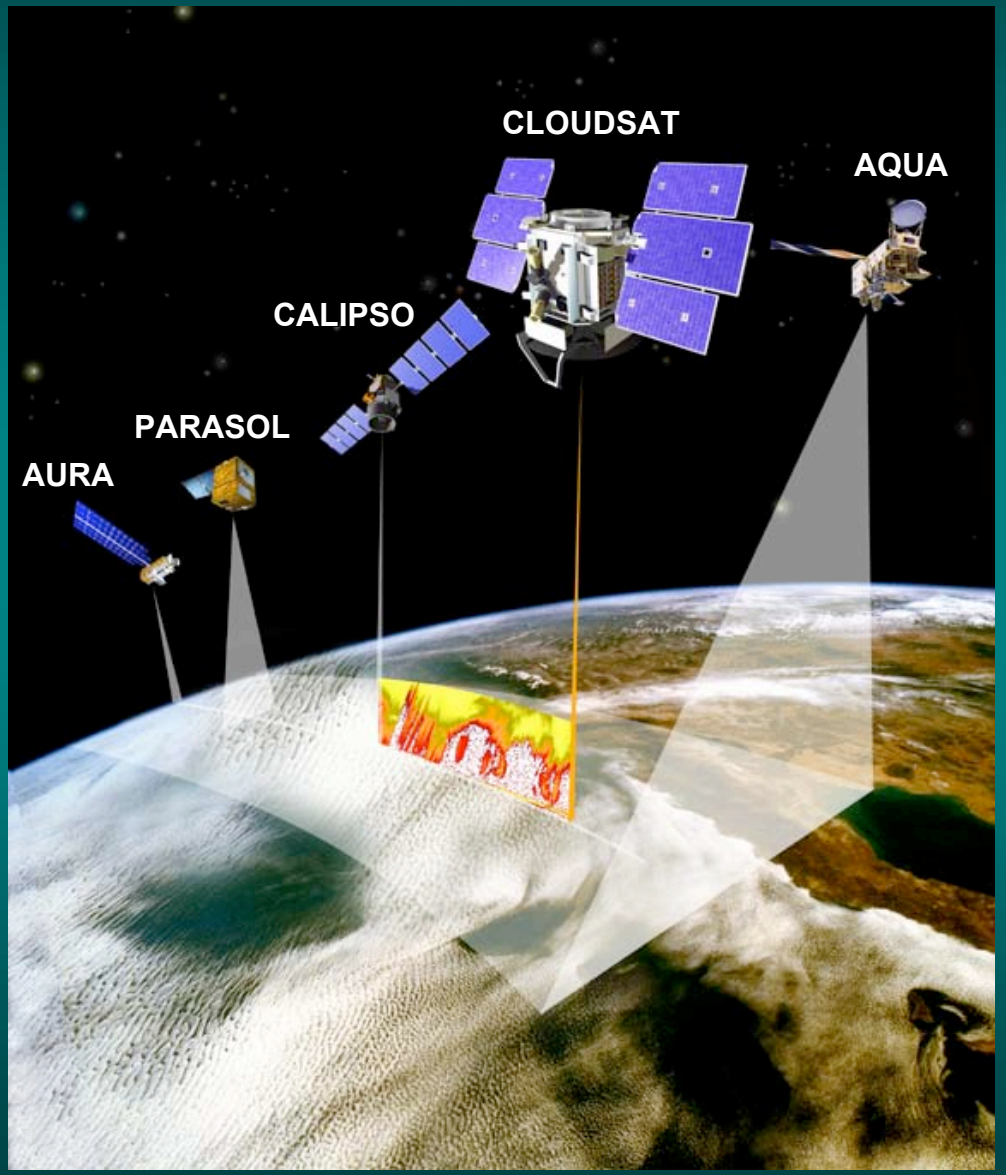
Process goes like this:

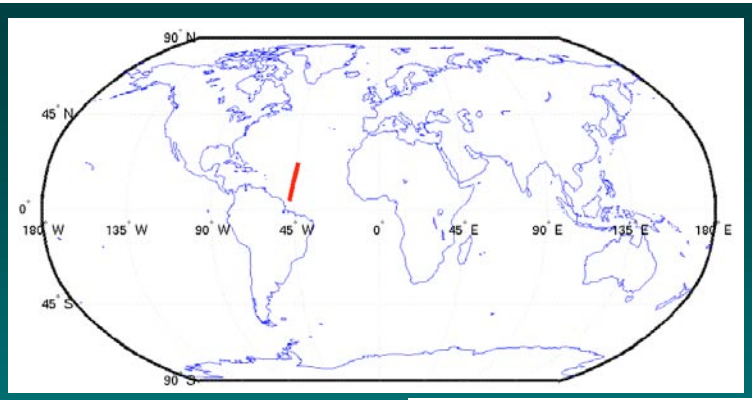
1. *Determine mechanics how to link observations from two different spaceborne platforms (i.e., Aqua and CALIPSO)*

2. *Link viewing geometry to obtain correspondence between observations*

3. *Strip out the appropriate data products (may mean multiple granules)*

4. *Perform intercomparison**

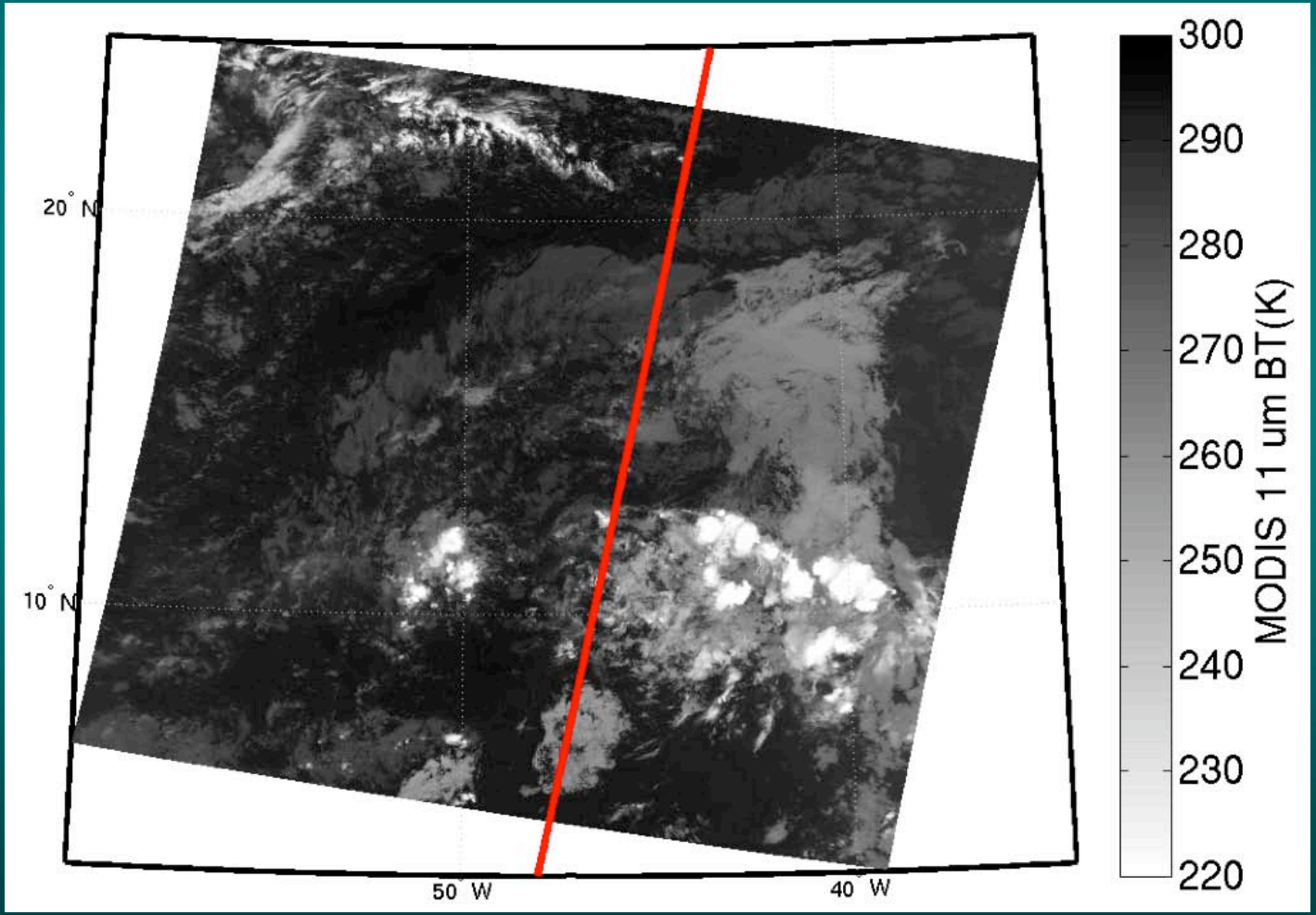


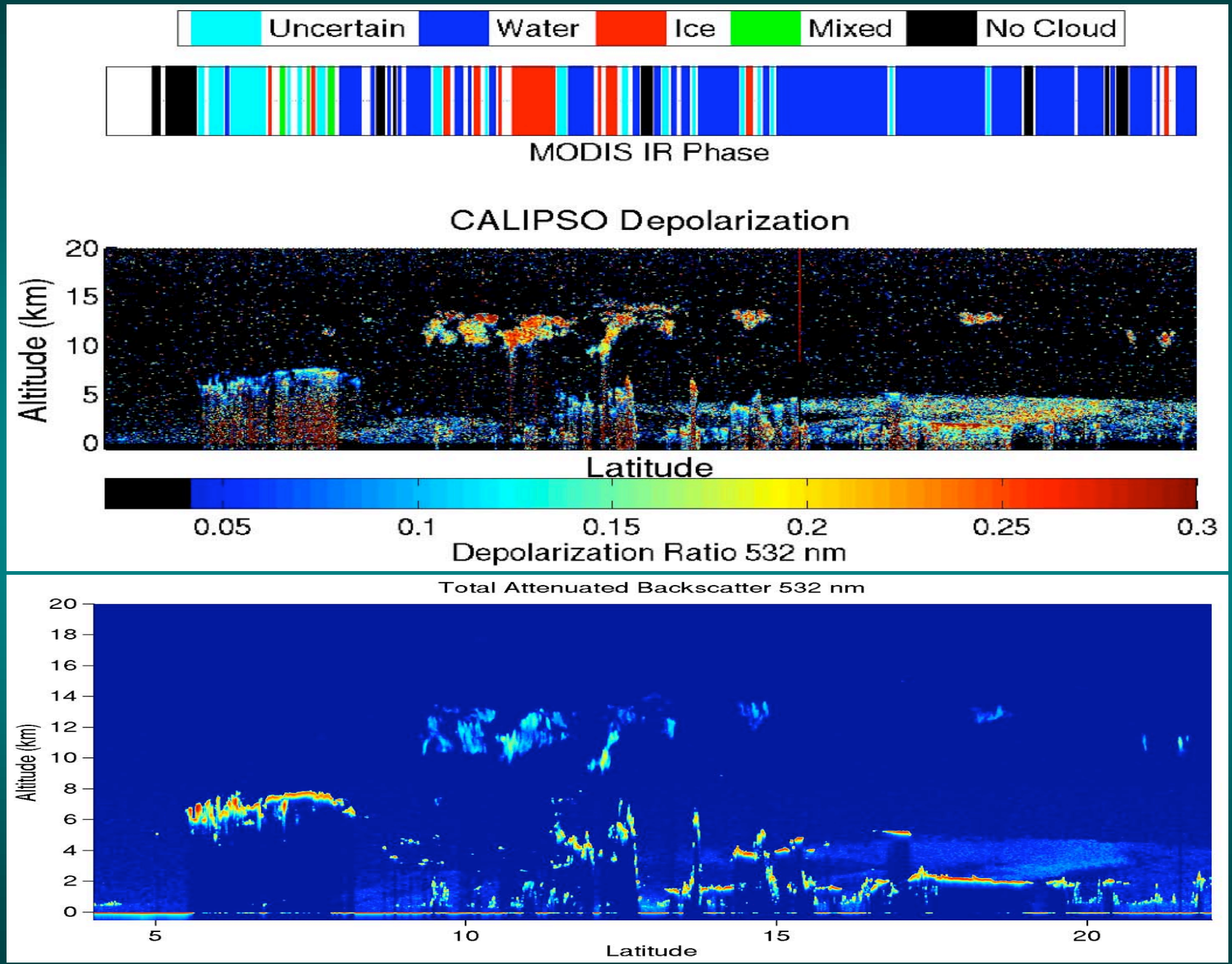


Example of CALIOP-MODIS
June 15, 2006; 0450 UTC
Nighttime

Technique for matching data from different platforms (CALIOP with MODIS) by Fred Nagle and Bob Holz

Will also be used for
CALIOP-AIRS
AIRS-MODIS
Geosynchronous-polar
…




Uncertain
Water
Ice
Mixed
No Cloud
MODIS IR Phase
CALIPSO Depolarization
Altitude (km)
20
15
10
5
0
Latitude
0.05
0.1
0.15
0.2
0.25
0.3
Depolarization Ratio 532 nm
Total Attenuated Backscatter 532 nm
Altitude (km)
20
18
16
14
12
10
8
6
4
2
0
5
10
15
20
Latitude

Summary

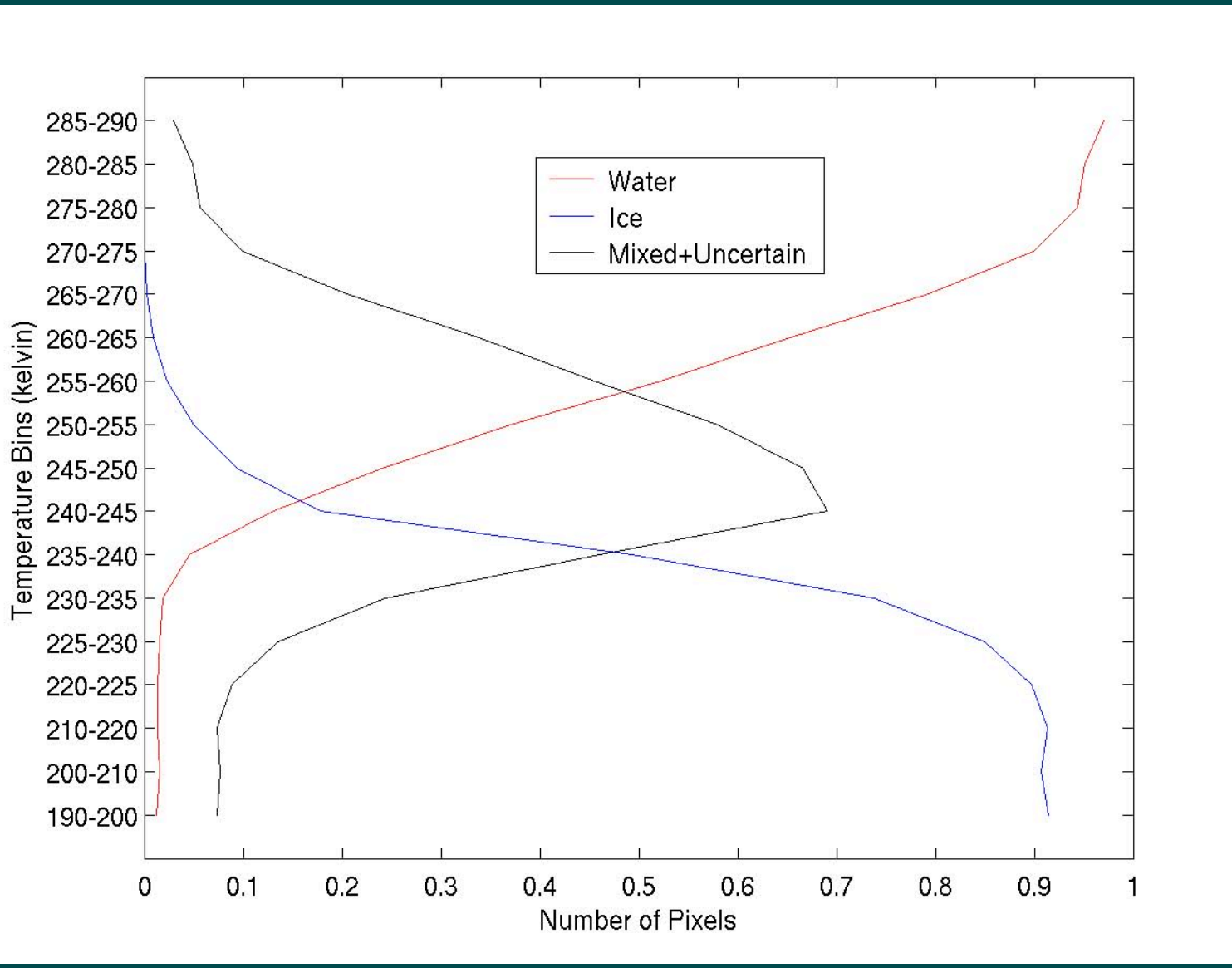
CALIOP provides first comprehensive dataset for independent inference of cloud thermodynamic phase

Code is available to merge MODIS with CALIOP

Developing new MODIS simulator RT package for MODIS atmosphere team

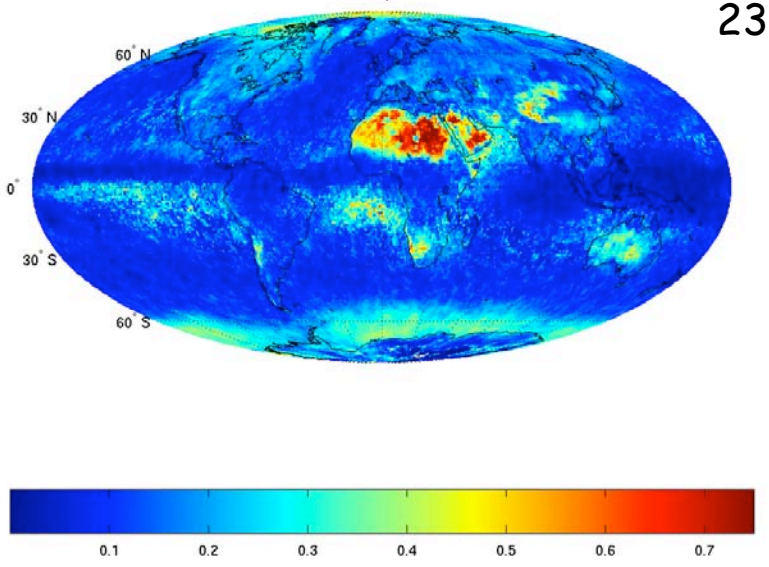
Use PEATE-like environment to evaluate performance using global MODIS and CALIOP data

Approach will reduce time necessary to update MODIS operational code should there be a new collection

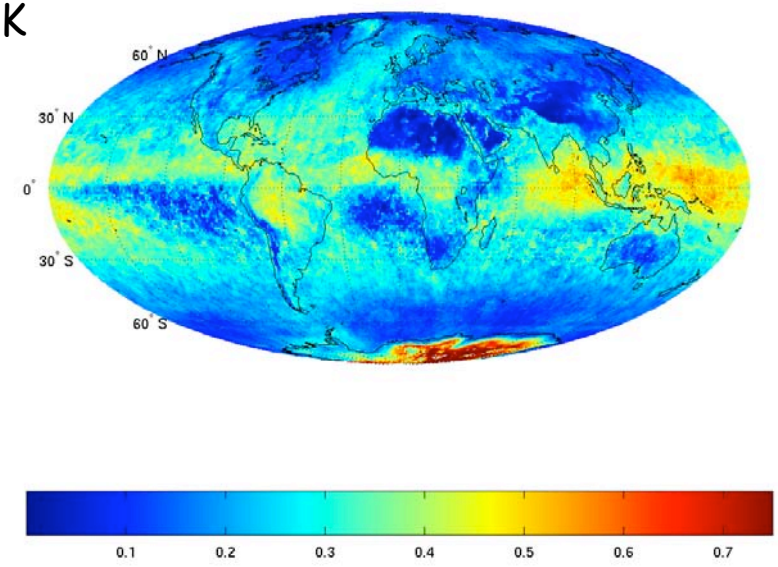

Water
Ice
Mixed+Uncertain
285-290
280-285
275-280
270-275
265-270
260-265
255-260
250-255
245-250
240-245
235-240
230-235
225-230
220-225
210-220
200-210
190-200
Temperature Bins (kelvin)
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Number of Pixels

Cloud-Top Temperature
235 K-255 K

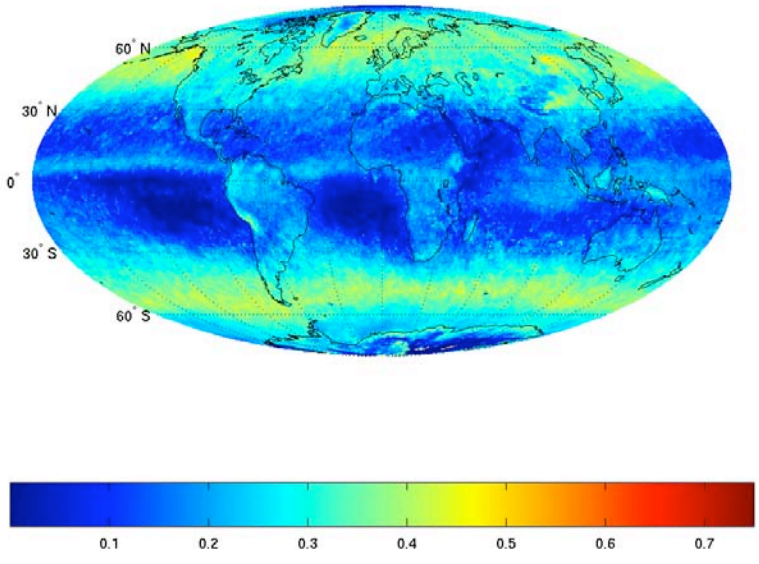
Liquid



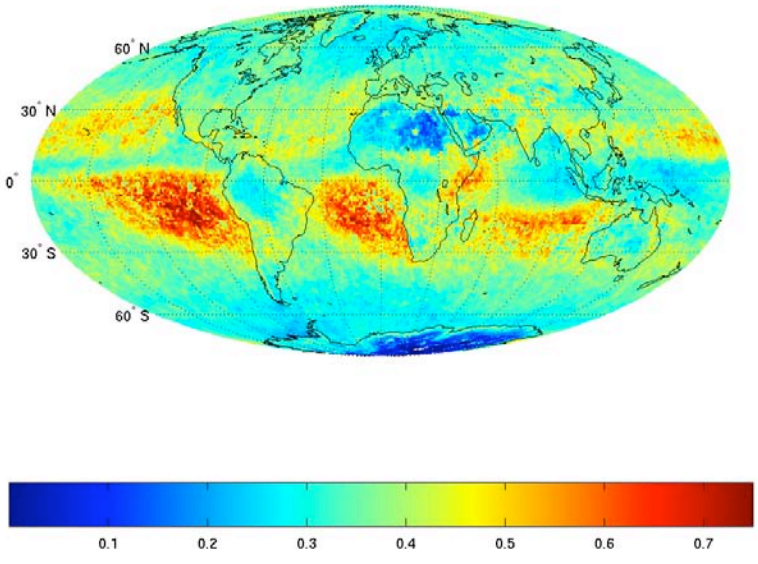
Ice



Mixed Phase

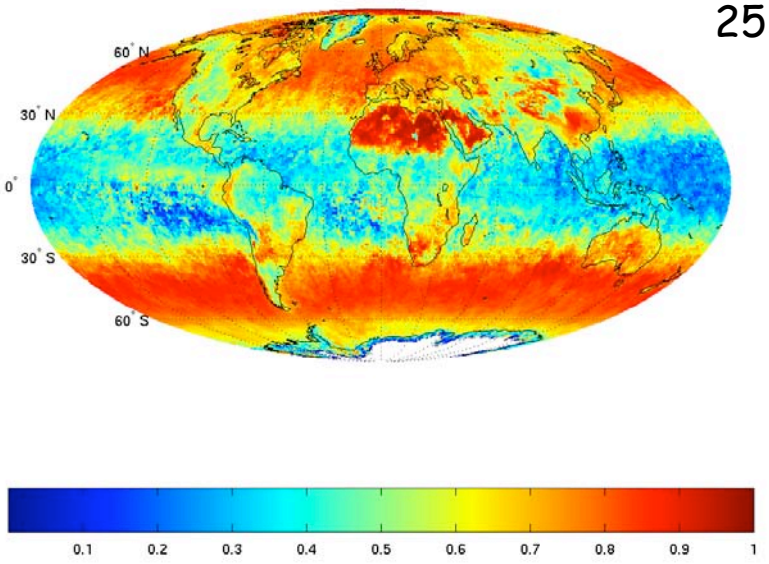


Uncertain

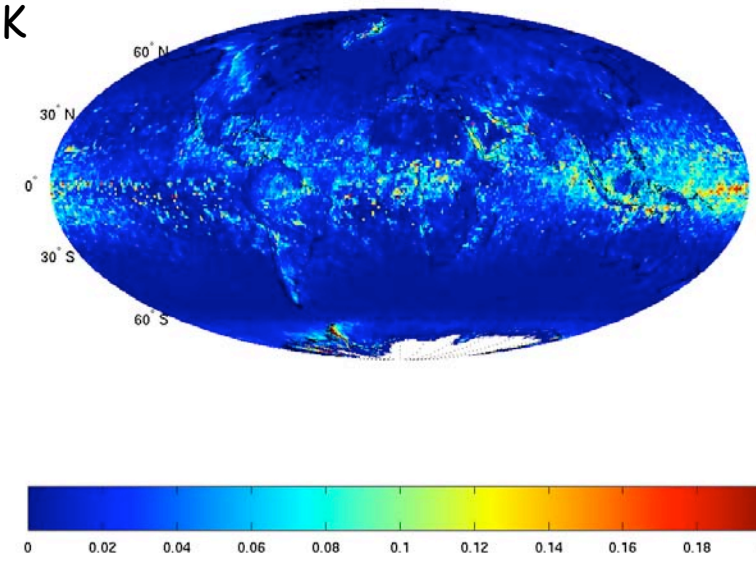


Cloud-Top Temperature
255 K-275 K

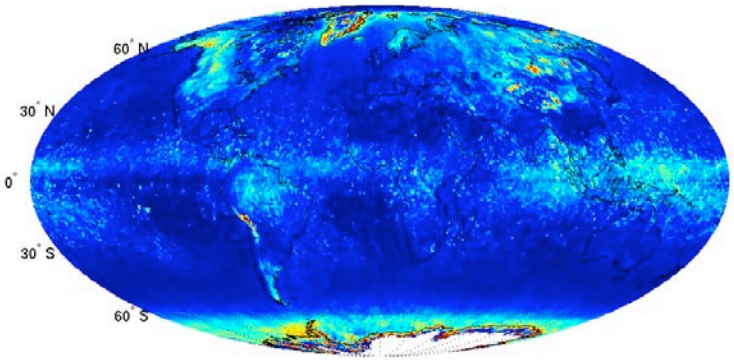
Liquid

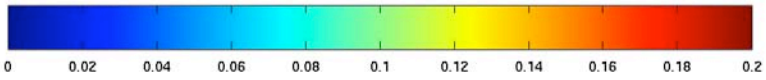


Ice



Mixed Phase





Uncertain