

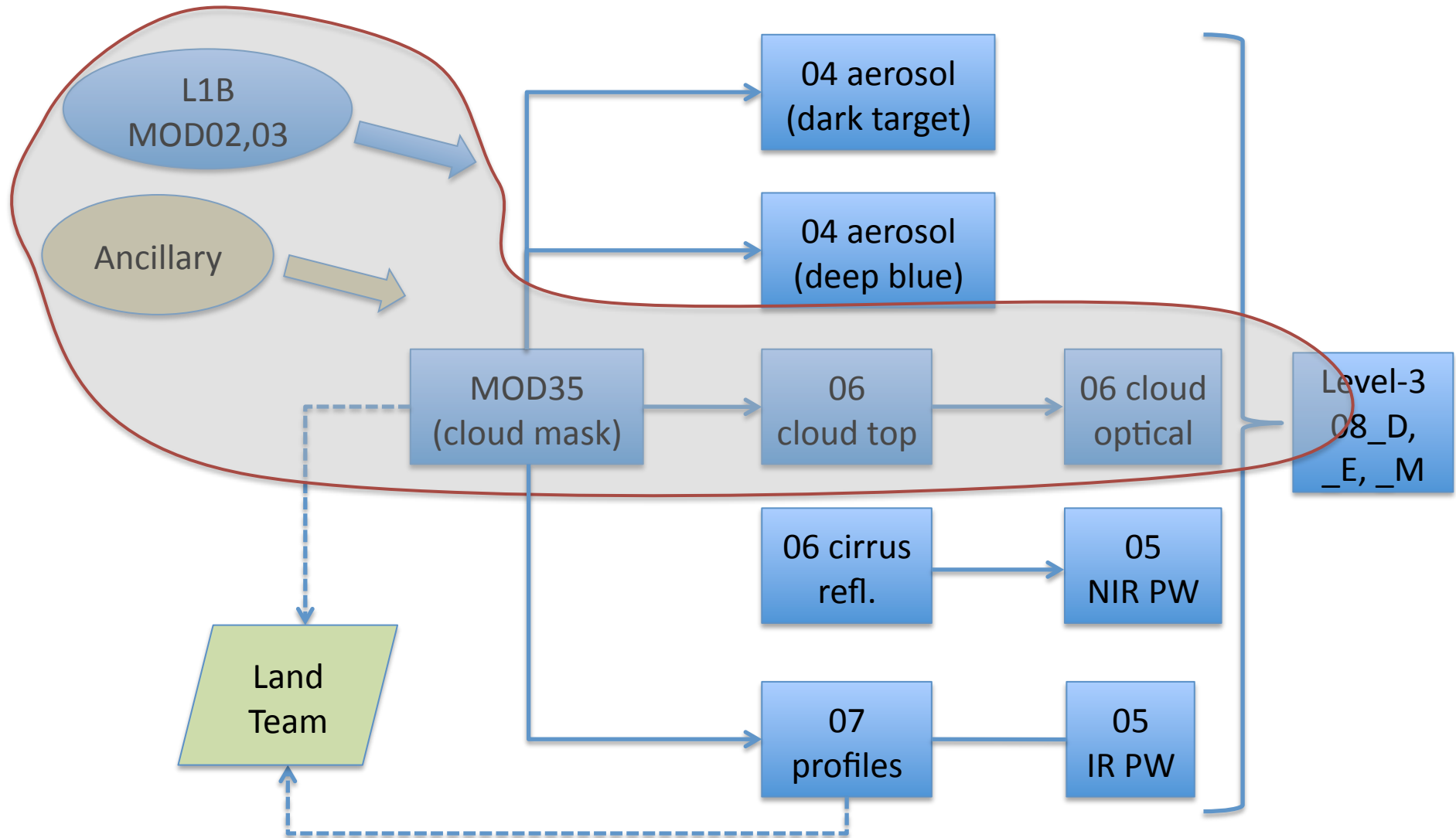
# MODIS Atmosphere Team Summary

S. Platnick and the atmosphere team

## Atmosphere Team Agenda

- Day 1: Collection 6
  - L2 Algorithm Plans/Status
  - L3 Discussion: L3 issues (one size does not fit all!) and alternate approaches
  - Status of “Testing” systems
  - Schedule
- Day 2:
  - Science Talks (6) + 42 Posters
  - VIIRS Updates
    - Aerosol (C. Hsu)
    - Clouds (B. Baum)
    - Cal/Val plan (D. Starr)
    - Discussion on merging atmosphere data records (AVHRR/HIRS, MODIS, VIIRS)

# MODIS Atmosphere Team Algorithm Dependencies

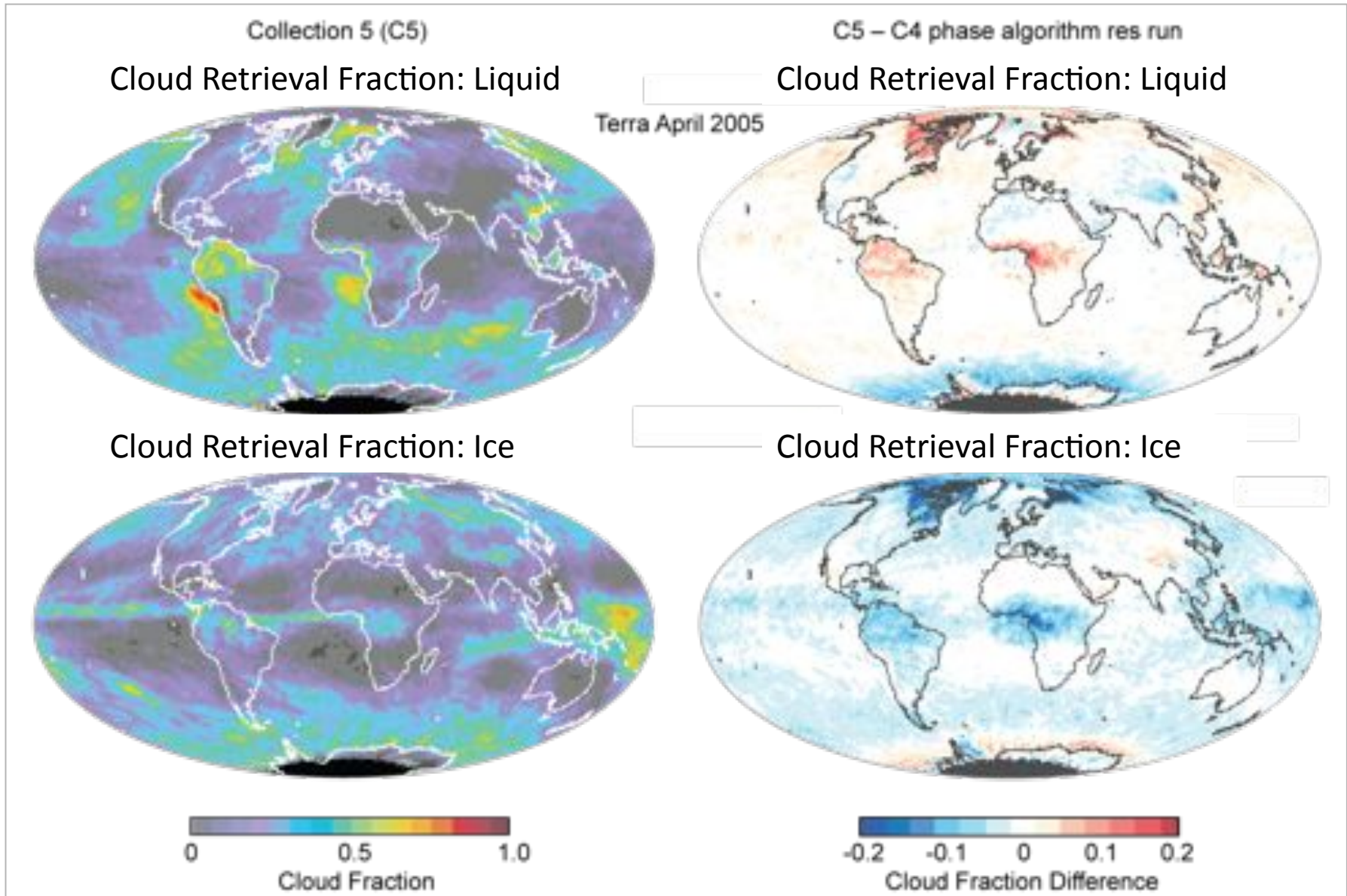


# MODAPS Algorithm “Testing” Strategy

## C5 History

- Approach: Multiple algorithm team deliveries integrated simultaneously or as available into the production system. Individual/isolated algorithm testing relegated to selected L2 granules or selected days as teams could muster on their own, inadequate L3 statistical analysis available.
- Problem:
  - What is useful for testing the end-to-end production environment is not suited for testing/understanding changes in scientific algorithms.
  - Can't isolate and evaluate the impact of individual algorithm changes; difficult to find code bugs; schedule difficult to control (everything thrown into the same pot at once).
  - Backwards testing (i.e., turning off a C5 modification) after the start of C5 not built easily accommodated in a production system.

# Difference in Cloud Retrieval Fraction: C5 minus C5 w/C4 Phase Algorithm (06\_OD)



# MODAPS Algorithm “Testing” Strategy

**C6 Approach** (*thanks to Mike Teague, George Britzolakis, Gang Ye, Bill Ridgway*)

- Philosophy: Algorithm development required a test system, not a production system, i.e., minimize delivery overhead, provide a baseline set of fixed input data files, fast turn-around of several months including L3 files.
- Strategy: Goal of ~3 day turn-around for test deliveries w/2 months.
  - Example: MOD06\_OD scoped 12 primary tests, 3 have been completed.
  - On-line documentation, visualization support (Ridgway)

+ Wisconsin Cloud/Aerosol PEATE

# MODIS Atmosphere Team C6 Schedule

## Goal: Production code ready in January 2011

- **MOD35 (cloud mask) and MOD07 (profiles)**
  - Both part of PGE03. Delivery in mid-March. Available for production (and use in Land and Atmosphere team testing) in early April.
- **MOD06 Optical Properties**
  - First MODAPS test date: 12-29-09
  - Number of primary tests: have scoped 12 primary tests, 3 have been completed.
  - Nominal date of final primary test: 10-31-10 (with assumptions on testing through-put, nominal analysis time, and 50% contingency). Production code ready by end of calendar year.
- **MOD06 Cloud-Top (initial testing at Wisconsin PEATE)**
  - First MODAPS test date: 3-15-10
  - Number of primary tests: 1
  - Nominal date of final primary test: 6-15-10

# MODIS Atmosphere Team C6 Schedule

- **MOD06 Cirrus Reflectance and NIR PW**
  - First MODAPS test date: 8-31-10
  - Number of primary tests: 1
  - Nominal date of final primary test: 10-31-10
- **MOD04 Aerosol (dark target)**
  - First MODAPS test date: 4-15-10
  - Number of primary tests: 4
  - Nominal date of final primary test: 10-31-10
- **MOD04 Aerosol (deep blue)**
  - First MODAPS test date: 9-15-10
  - Number of primary tests: 1
  - Nominal date of final primary test: 10-31-10
- **MOD08 Level-3**
  - First MODAPS test date: TBD
  - Number of primary tests: TBD
  - Nominal date of final primary test: TBD (~2 mos. after final L2 file specs)

# MODIS Atmosphere Team On-line Tracking & Documentation

([modis-atmos.gsfc.nasa.gov/team/](http://modis-atmos.gsfc.nasa.gov/team/), led by B. Ridgway)

## MODIS Atmosphere Team Documents: C6 Schedule

Updated: 01/21/10

[Contacts](#)
[C6 Schedule](#)
[Linux OS Tests](#)
[PC04 Deep Blue Tests](#)
[PC06 OD Tests](#)
[C6 LIB Tests](#)

This table identifies code deliveries and science tests planned in preparation for Collection 6 Terra and Aqua reprocessing. For additional information about test objectives, PGE versions and images, click on the Test Name.

Test Sequence Name	Begin Testing	Number Major Tests Planned	Complete Testing	Status
<a href="#">C5 Mandriva 2008 Test</a>	12-31-09	1	01-31-10	<b>Purpose:</b> Validate all PGE's for operation in Mandriva 2008 MODAPS environment using 32-day Aqua and Terra test sequences. <b>Result:</b> L3 products checked and found to have only nominal differences from the baseline. Cirrus Reflectance was most sensitive. Kathy Strabala still checking CSR products.
<a href="#">C6 LIB Impact Test</a>	01-15-10	1	01-31-10	<b>Purpose:</b> Combine C6 LIB with C5 product PGEs to assess the impact of LIB calibration and geolocation changes on all downstream products. <b>Result:</b> Aqua January 2003 products complete. Reviewing PGE versions. May require new baseline data.
<a href="#">Cloud Mask Test (TBD)</a>	03-15-10	1	03-31-10	PC03 Cloud Mask C6 code delivery by March 15, to include updated Profiles code
<a href="#">Dark Target Aerosol Test (TBD)</a>	04-15-10	4	10-31-10	PC04: first code delivery expected April 15
<a href="#">Deep Blue Aerosol Test (TBD)</a>	09-15-10	1	10-31-10	PC04 code delivery expected Sept 15th
<a href="#">Near-IR Water Vapor (TBD)</a>	08-31-10	1	10-31-10	Code delivery in late August.
<a href="#">Cloud Top Properties (TBD)</a>	03-15-10	1	06-15-10	MOD_PR06CT: first delivery tentatively March 15th
<a href="#">Cirrus Reflectance (TBD)</a>	08-31-10	1	10-31-10	Code delivery in late August.
<a href="#">Cloud Optical Properties</a>	12-15-09	12	10-31-10	MOD_PR06OD: completed 3 of 12 tests of C6 Optical Properties code
<a href="#">Joint ATML2 Product (TBD)</a>	TBD	TBD	TBD	Delivery approximately 60 days after L2 codes/products are finalized.
<a href="#">L3 Products (TBD)</a>	TBD	TBD	TBD	Delivery approximately 30 days after L2 codes/products are finalized.

KEY

Completed	Started	Planned
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## MODIS Atmosphere Team Documents: PGE06 OD Tests

Updated: 01/20/2010

[Contacts](#)
[C6 Schedule](#)
[Linux OS Tests](#)
[PGE04 Deep Blue Tests](#)
[PGE06 OD Tests](#)
[C6 L18 Tests](#)

This table provides links to archived Science Test data (LAADS) and images (TEST ID). The baseline period for these test is April 2005. In each case, test products are produced for one month of Terra and one month of Aqua. All two dimensional (360x180) monthly mean products are displayed along with difference maps with a prior baseline.

TEST	MOD_PR06OD TEST NAME	Version	LAADS	DATE	DESCRIPTION
1.0	Baseline C6 OD Run <a href="#">Reference Document</a> <a href="#">Link to Images</a>	6.0.2	AS222	12-29-09	<b>Purpose:</b> Establish a baseline between C5 and C6. C6 implements part of the CHIMAERA system to replace toolkits. C6 also uses 1-km cloud top properties. Other changes are cosmetic and do not affect retrieved cloud optical products. <b>Result:</b>
2.0	Multi Layer Flag Test <a href="#">Reference Document</a> <a href="#">Link to Images</a>	6.0.4	AS223	01-04-10	<b>Purpose:</b> Test C6 multilayer cloud detection algorithm which includes Pavolonis & Heidinger algorithm. This version is an update to Test 1.0 baseline algorithm. <b>Result:</b>
2.1	Multi Layer Flag Test <a href="#">Reference Document</a> <a href="#">Link to Images</a>	6.0.5	224	01-19-10	<b>Purpose:</b> Re-run of Test 2.0 with modification to Pavolonis & Heidinger algorithm. <b>Result:</b> The Pavolonis-Heidinger algorithm result is not aggregated to Level-3, even though the answer is still present in Level-2 due to a significant number of false-positives produced by that particular test.
3.0	New Look-up Tables <a href="#">Reference Document</a> <a href="#">Link to Images (TBD)</a>	TBD	TBD	TBD	<b>Purpose:</b> Test of new libraries, Lambertian surfaces, C5 water and ice libraries. <b>Result:</b> TBD

### KEY

Completed	Started	Planned
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Atmosphere Collection 6 Planned Updates: [Link to PDF Document](#)

# MODIS Atmosphere Team On-line Tracking & Documentation ([modis-atmos.gsfc.nasa.gov/team/](http://modis-atmos.gsfc.nasa.gov/team/))

## Example Test System Documentation (G. Wind)

### MODAPS Science Test #3 – New lookup tables

**Purpose:** Test the effect of new lookup tables generated using Lambertian surface and collection 5 (C5) phase functions, but at much higher number higher resolution to capture fine features of the phase function better. We've also separated single and multiple scattering with single scattering being retrieval, so MOD06 now uses three forward library files instead of two. The third file is the set of phase functions. We generally cleaned the code u of obsolete subroutines. There are now adaptive re-interpolation thresholds that are based on scattering angle instead of constant 3-degree re-interpol in C5. We also changed the processing direction and chunk size. The code now processes data in along-track direction, 99 lines at a time and there a granule instead of single-scan across-track processing with 203(4) chunks done in C5. The 99 lines at a time processing mode allows us to use more for the clear sky restoral algorithm: 3x3 instead of 5x2 used in C5.

This test includes everything from Science Test #2 plus:

4a.	Add more small $t_c$ in libraries to reduce interpolation errors for thin clouds. <b>Comments &amp; Results:</b> GW-3.3.09: Tested this over two years ago, default behavior for all CHIMAERA codes: tau extended to scaled 0.1. This will be incorporated into the new forward libraries. GW - 6.2.09: New libraries have been delivered to me, integration has started. GW - 7.8.09: received the MAS<TER> libraries, the last part of this task.	X	X	X	X				
4b.	Remove asymptotic algorithm for thick clouds, replacing it with more $t_c$ libraries; no impact on solutions but simplifying algorithm maintenance. <b>Comments &amp; Results:</b> GW-3.3.09: I already tested this and generated difference images for sample granules. The results are a wash as expected. There will be no visible impact when new asymptotic-free libraries are delivered. GW - 6.2.09: New libraries have been delivered to me, integration has started. GW - 7.8.09: received the MAS<TER> libraries, the last part of this task.	X	X	X	X				
5.	Partly cloudy pixels:								
5a.	Better use of 250 m cloud mask (at least over ocean) for QA of MOD06 and CT retrievals. (11/06) <b>Comments &amp; Results:</b> According to Gail Wind, the default for 250 m CSR test is to set all of the CSR to clear and then check to find out what happens with each of these cloud	X	X	X	X	-		-	

# MODIS Atmosphere Team On-line Tracking & Documentation

([modis-atmos.gsfc.nasa.gov/team/](http://modis-atmos.gsfc.nasa.gov/team/))

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Updated: 01/20/2010

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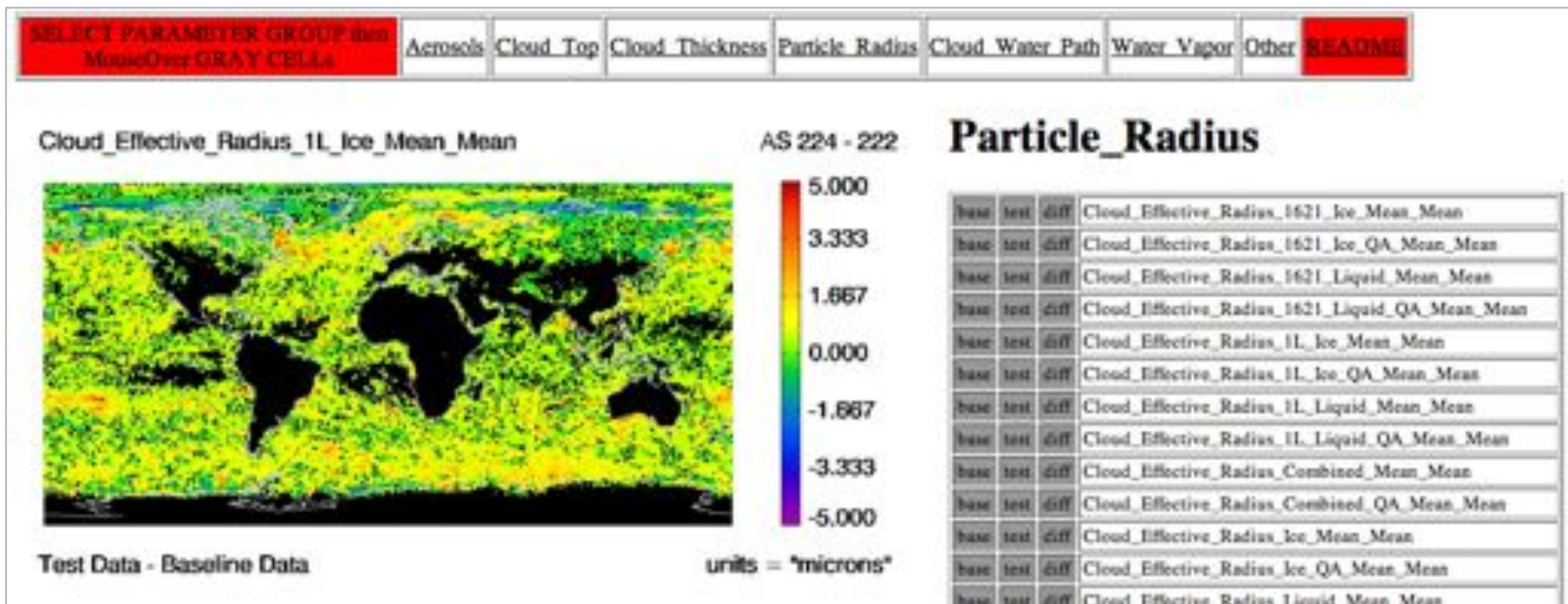
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Atmosphere Collection 6 Planned Updates: [Link to PDF Document](#)

# MODIS Atmosphere Team On-line Tracking & Documentation ([modis-atmos.gsfc.nasa.gov/team/](http://modis-atmos.gsfc.nasa.gov/team/))

## Example Test System Quicklook Imagery (B. Ridgway)



# MODIS Atmosphere Team On-line Tracking C6 Plan ([http://modis-atmos.gsfc.nasa.gov/products\\_C006update.html](http://modis-atmos.gsfc.nasa.gov/products_C006update.html))

The screenshot shows the MODIS Atmosphere website interface. At the top, there is a navigation bar with links for HOME, PRODUCTS, IMAGES, DATA ISSUES, NEWS, and STAFF. Below this, there are sub-links for AEROSOL, H<sub>2</sub>O VAPOR, CLOUD, and PROFILE, and further sub-links for DAILY, EIGHT DAY, and MONTHLY. A sidebar on the left contains a 'PRODUCTS' section with a list of links: OVERVIEW, COLLECTION 6 UPDATE, COLLECTION 51 UPDATE, COLLECTION 5 UPDATE, AVAILABILITY CALENDAR, ACQUISITION, KNOWN PROBLEMS, HDF FILENAMES, and FLOW DIAGRAM. The main content area features a heading 'Collection 006 Update' and a paragraph stating: 'The document below describes 006 changes to all L2 and L3 generation of MODIS data. Collection 006, is expected 2009 or early 2010.' Below this, there is a section titled 'Collection 006 Change Summary' with a bullet point 'Collection 006 Changes'. At the bottom of the main content area, there is a note: 'All Collection 005 Change Summary Portable Document Format (PDF) view these files. If you do not have a download Adobe Acrobat icon to obtain a free copy of Acrobat Reader.'

**Proposed MODIS-Atmosphere Collection 006 Changes**  
Version 22 (1/21/2010)

Status Keyword List: [Not Started], [Investigating], [Coding], [Testing], [Dropped] or [Implemented]. Note: If no status keyword appears after an item, the status was not communicated to the author of this document.

### Aerosol (04\_L2)

**Dark Target Aerosol (04)** [Updated 1/15/2010] Lorraine Remer, Shana Mattoo, Rob Levy, Allen Chu

- Over Land:
  - A) Modify maps for assigning aerosol models over land:

Due to a lack of sensitivity to aerosol absorption, the over-land retrieval must assume aerosol type. For C005, aerosol type was assigned, based on a global map of AERONET aerosol climatology. For C006, these map boundaries will be modified based on AERONET climatology collected since 2005.
  - B) Modify surface reflectance parameterization:

The aerosol retrieval must make assumptions as to surface reflectance boundary conditions. In C005, surface reflectance parameterization was based on small set of collocated MODIS and AERONET, and shown to have dependence on surface type, vegetation condition (NDVI), and scattering angle. For C006, the global parameterization will be modified to correct systematic biases in particular locations.
  - C) Deleted SDSs:

Based on validation studies of C005 products, the following derived aerosol size parameters have little or no quantitative scientific use, and will be deleted from L2 (and L3) processing:

    - Angstrom\_Exponent\_Land
    - Optical\_Depth\_Small\_Land
    - Mean\_Reflectance\_Land\_All
    - Standard\_Deviation\_Reflectance\_Land\_All
    - Path\_Radiance\_Land
    - Error\_Path\_Radiance\_Land
    - Critical\_Reflectance\_Land
    - Error\_Critical\_Reflectance\_Land
    - QualityWeight\_Path\_Radiance\_Land
    - QualityWeight\_Critical\_Reflectance\_Land
  - D) Renamed SDSs:

"Cloud\_Fraction\_Land" becomes "Aerosol\_Cloud\_Fraction\_Land"

# Level-3 Lessons-Learned: One Size Does Not Fit All

- **Issues?**

## Aggregations strategies/choices

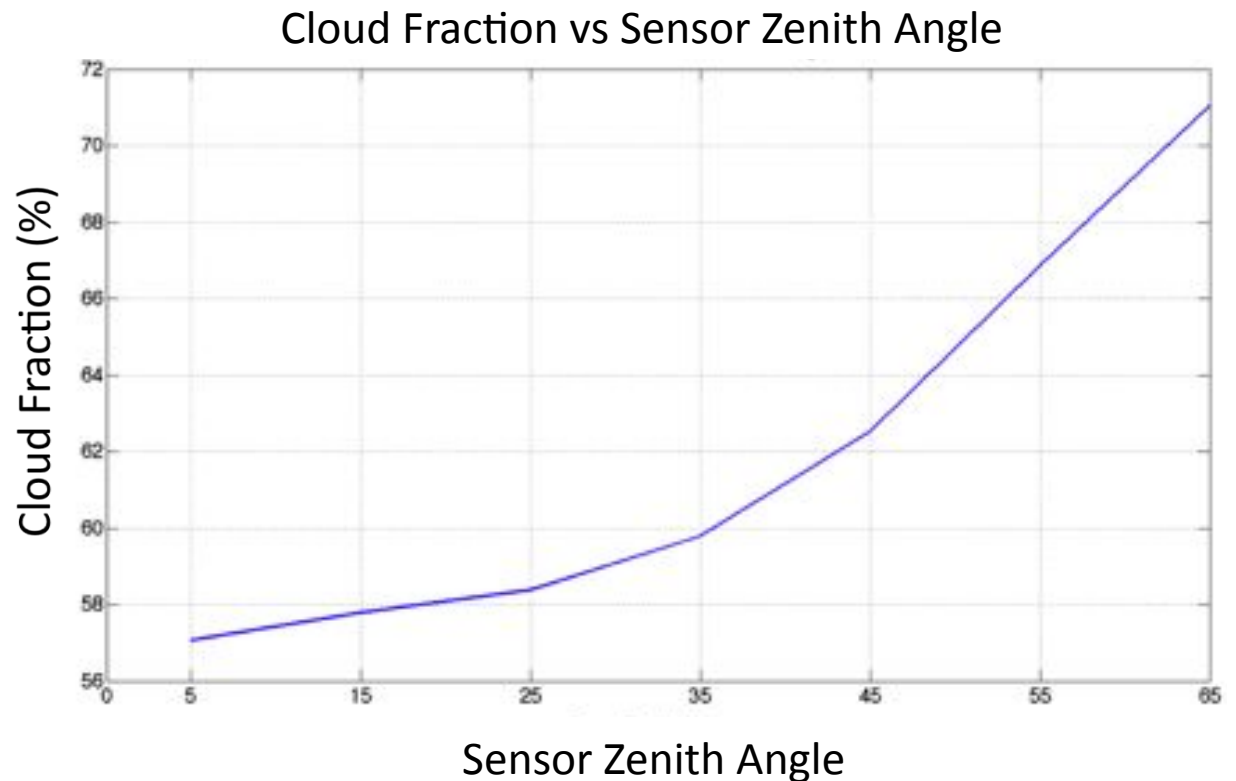
- Daily aggregation: true daily (allow for multiple orbits) or “instantaneous”?
- Definition of day beginning and end? [Greg Leptoukh]
- Grid (equal angle, equal area)
- L2 algorithm choices/QA weightings?
- Acceptable view angle range?
- Multiday aggregation weightings (pixel count)?
- Consistency with heritage gridded data sets?
- Data sets for specific users/uses
  - climate models
  - comparisons with other data sets (e.g., ongoing GEWEX cloud comparison project w/MODIS, ISCCP, AVHRR, HIRS, ...).

# View Angle Dependencies on Cloud Amount Properties

Brent Maddux et al.

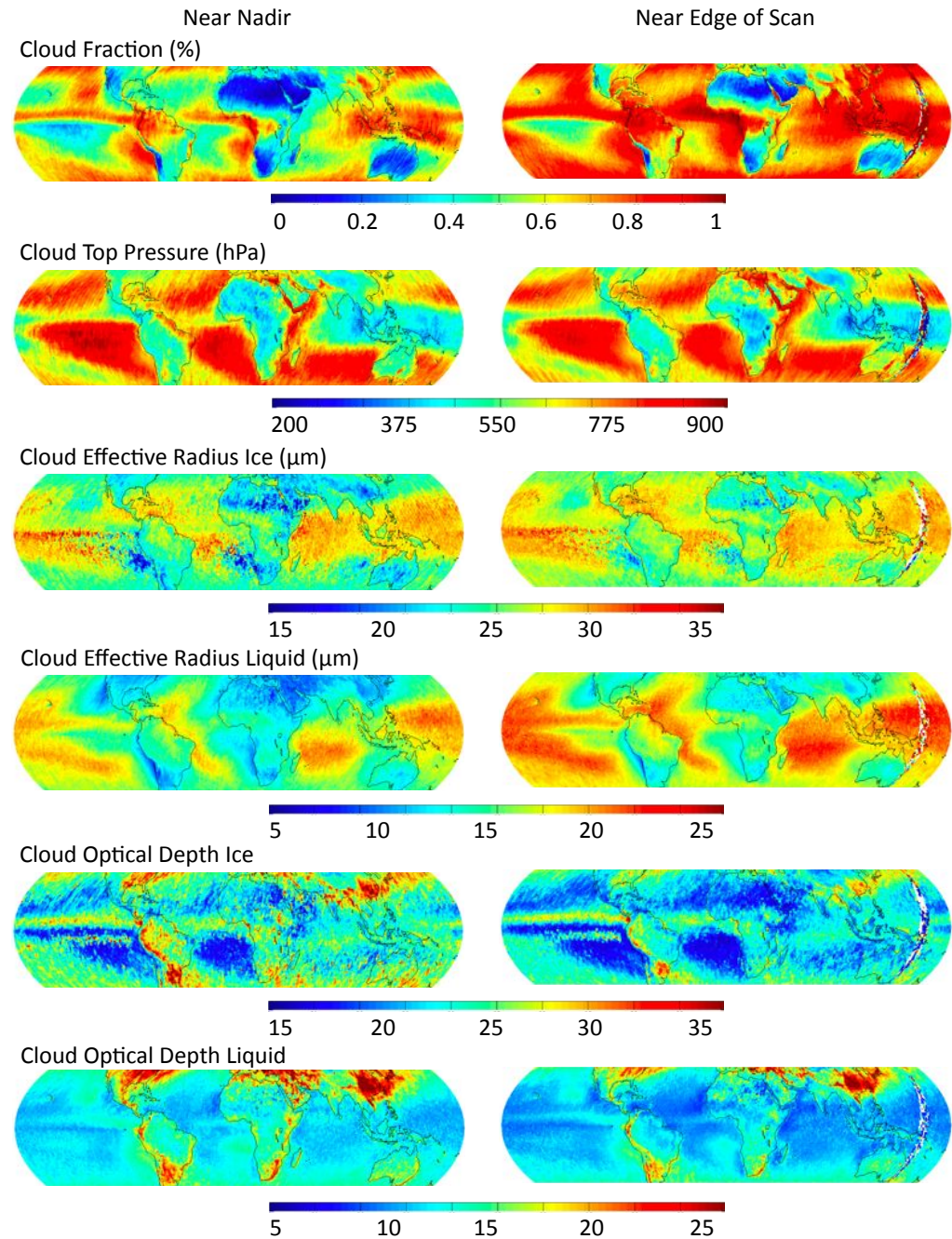
## Cloud Fraction vs View Angle

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



# Cloud Properties: Nadir vs. Edge of Scan (Brent Maddux)

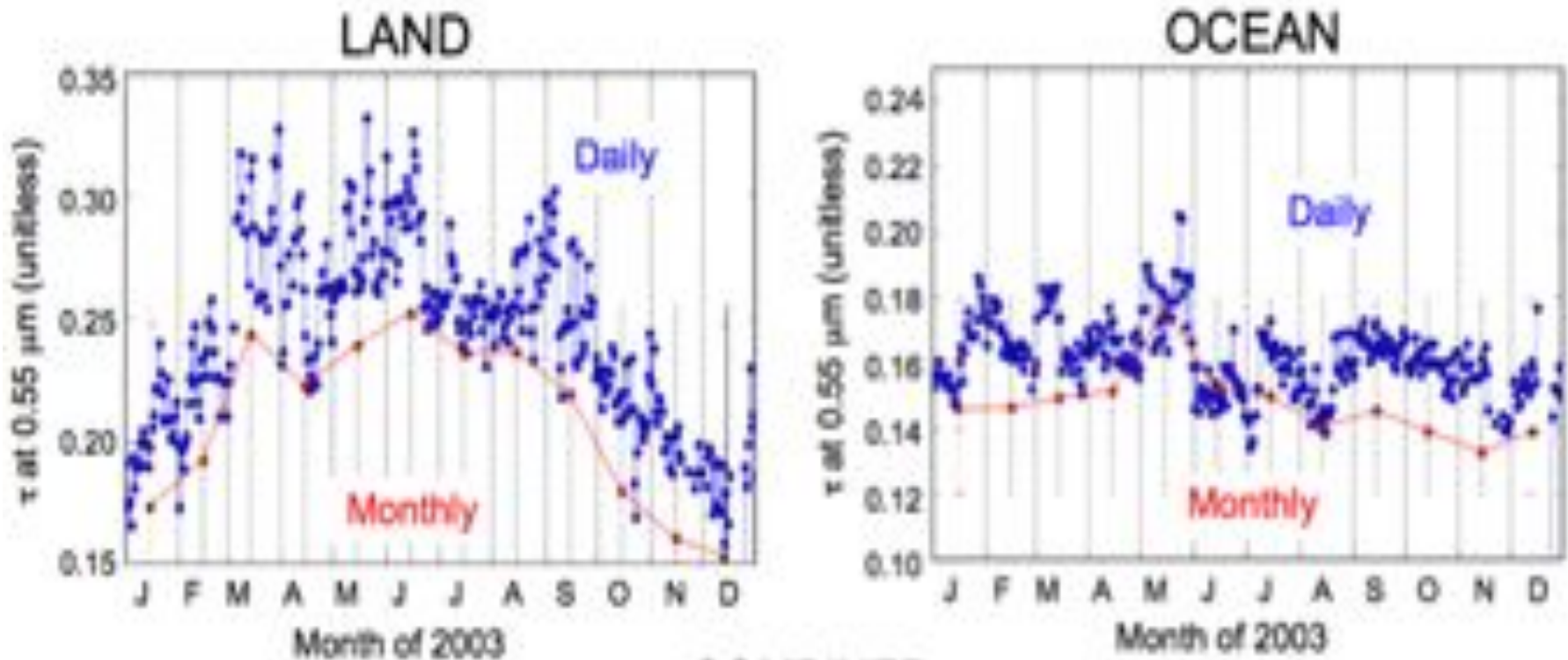
- Changes are not uniform
- Largest changes in CF aren't the same as largest changes in optical properties
- Near Nadir:  $\leq 10^\circ$
- Near Edge of Scan:  $\geq 50^\circ$





## Multiday Aggregation Sensitivity Example

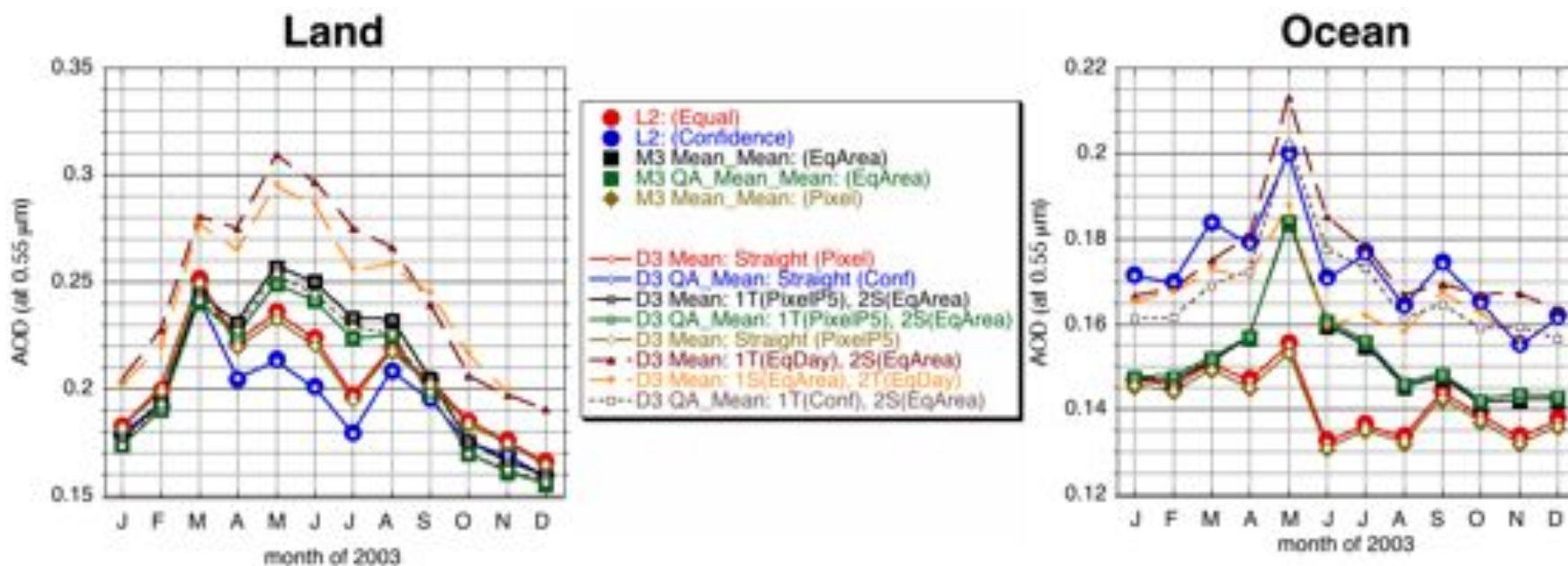
Global Mean AOD from “Giovanni”: MOD08 monthly (M3) vs. Independent calc. from MOD08 daily (D3) (Rob Levy et al.)



- >10% difference in D3 aggregation vs M3!
- Due to pixel-weighting in M3 computation => inherent clear sky bias (that's where retrievals are made)

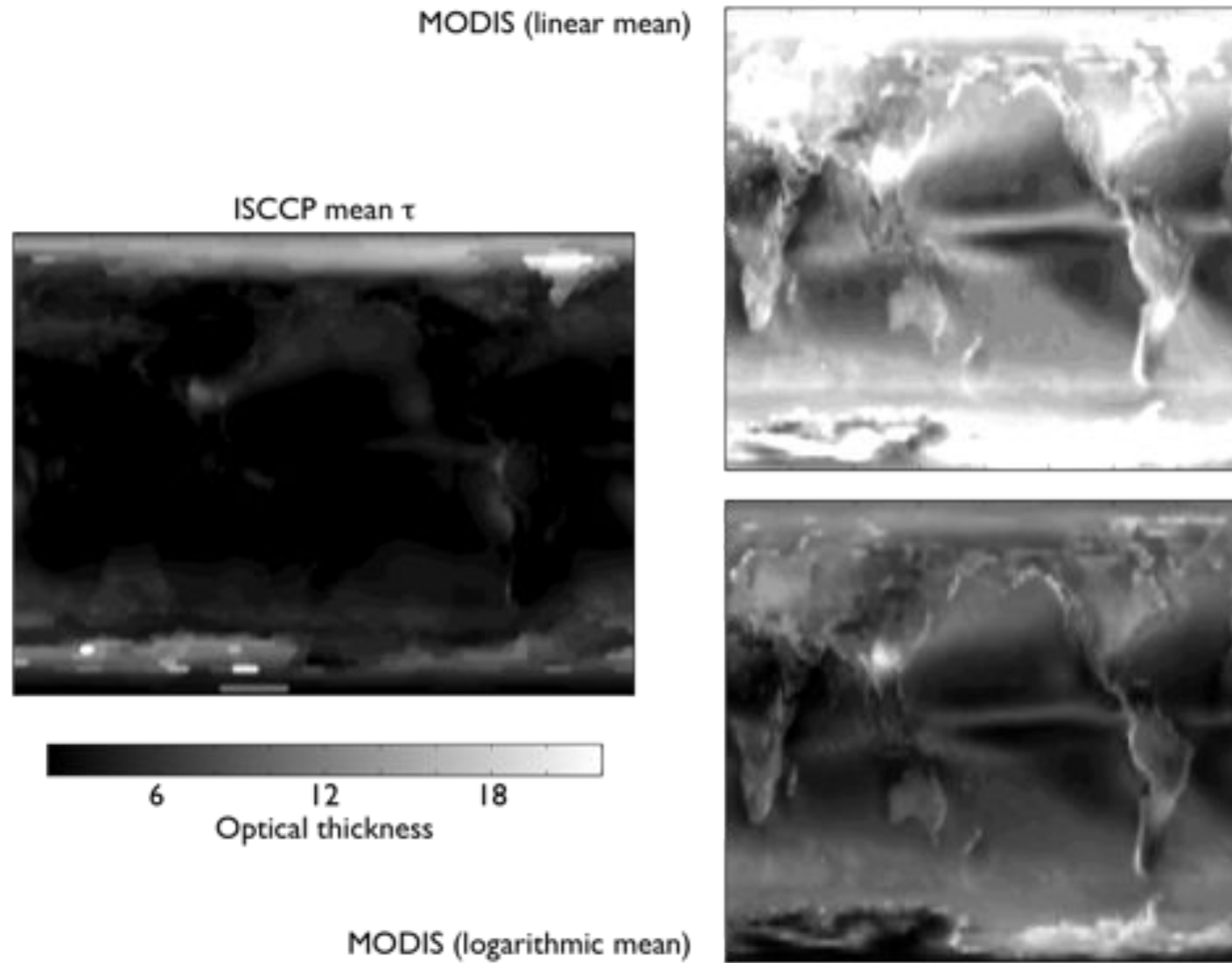
# Multiday Aggregation Sensitivity Example

Other Weightings => Other Results



With “Reasonable” Choices,  
Global means can vary by 40%

# Example ISCCP-MODIS Comparison: Optical Thickness (R. Pincus)



# Flexible Aggregation Approaches

- AVHRR PATMOS-x, Andy Heidinger (NESDIS/UW CIMSS)
  - L2 → L2g (nearest neighbor gridding, e.g., 0.2°)
  - Users can aggregate directly from L2g as they see fit
- MODATML2
  - Selected data sets from all MODIS Atmosphere Team products at 5 and 10 km resolution (1 km data sets sampled to 5 km in a manner consistent with L3 code)
  - Useful for correlative studies, smaller data set for use in multi-month/year studies
  - Can/has served as basis for research L3 aggregations
  - C6 ATML2 plan: update with any needed SDSs/QA with eye towards enabling research L3 aggregations
- Future?
  - Near term: work towards research tools to access MODATML2/L2g
  - Ultimately: data sets and tools with which users can select from a base set of aggregation choices

## Data Sets for Specific Users

### Example: Global Cloud Data Set for GCM Evaluation

(R. Pincus, U. Colorado/CIRES, et al.)

- User issues in comparing model cloud fields with MOD08
  - “Which data sets to use”? (MOD08 has many hundreds of scalar and 1D/2D data sets)
  - “How best to compare data sets with model cloud fields?”
  - “What am I suppose to do with HDF”? Tools developed for netcdf+ metadata conventions are standard in the GCM community; other data sets are being provided as netCDF gridded data for use in model comparisons (ISCCP, CloudSat, CALIPSO, etc.).
- Need to recognize that sometimes you have to go to the user, not expect (force) the user to come to you.
  - giving people the data we want them to use makes it harder for them to misuse the data

## Data Sets for Specific Users

### Example: Global Cloud Data Set for GCM Evaluation, cont.

(R. Pincus, U. Colorado/CIRES, et al.)

- MODIS Cloud Simulator has recently been developed. Similar approach as ISCCP cloud simulator (Klein & Jakob, 1997).
- As model runs, it simulates (in a manner consistent with the MODIS cloud algorithms) a variety of cloud products, AND generates L3-like statistics for comparison with MOD08.
  - cloud fraction, cloud-top pressure, optical thickness, effective particle radius, liquid/ice phase, water path, joint optical thickness/cloud top pressure histogram
- Available as part of COSP: CFMIP (Cloud Feedback Modeling Intercomparison Project) Observational Simulation Package (COSP 1.2) community tool
  - To be used in climate model assessments IPCC 5th Assessment Report (AR5)
  - Thoroughly tested by GFDL, given directly to 3 other groups
  - COSP includes ISCCP, Cloudsat, Calipso, MISR, TRMM, et al.
  - paper for BAMS describing simulator and its interpretation

## Some Summary Points

- We are gaining a reasonably good understanding of algorithms and their uncertainties (A-Train comparisons, AERONET and other ground-based instruments, aircraft/field campaigns, theoretical studies, ...).
- C6 plans are addressing known issues and incorporating recent research results. Plan document and test schedule/results available on-line.
- Level-3 isn't that easy. Need for new approaches and thinking "outside the box".
- Integrating with historic/future data sets won't be easy either.
  - Algorithm continuity through "lowest common denominator" approach, merged data records of varying quality, different approaches for different science questions/communities (similar to L3 issues), ...
- Some things get more difficult with age. Instruments have performed well but in the future will no doubt require careful monitoring of L1B and impact on L2+ algorithms, critical for establishing climatologies and trend analysis.