I. **MODIS Atmosphere Discipline Team**: C6 Status

II. **MODAWG**: MODIS-VIIRS Product Continuity for Cloud Mask, Cloud-Top & Optical Properties Status

S. Platnick et al.

MODIS-VIIRS Science Team Mtg.
Silver Spring, MD
7 June 2016

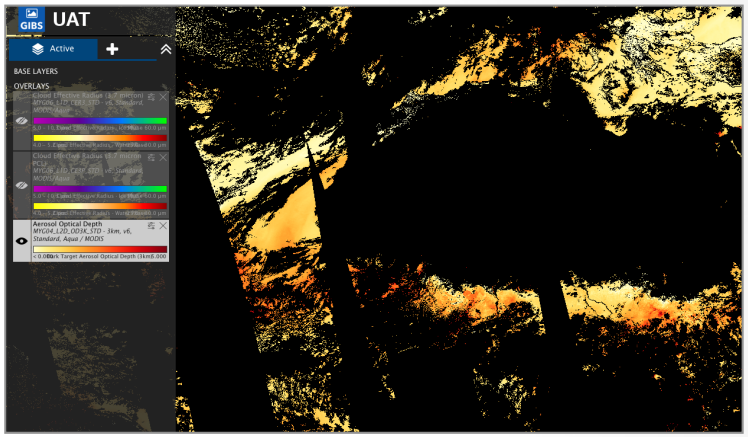
I. **MODIS Atmosphere Discipline Team**: C6 Status

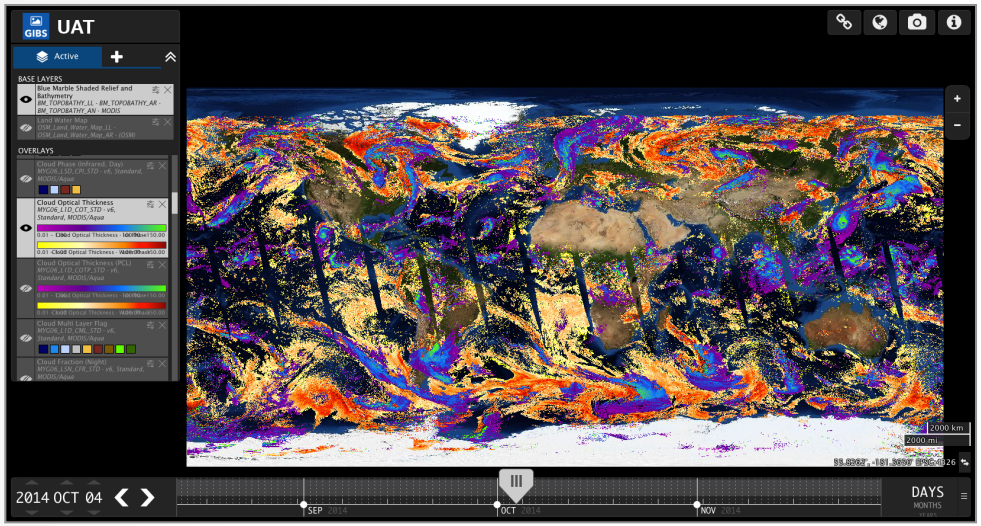
- Collection 6 reprocessing reminder:
  - Release in January 2014 (Aqua L2), April 2015(Aqua L3)
  - May 2015 (Terra L2/L3)
- Browse Imagery
  - GIBS (imminent)
  - L3 Time Series Analysis (new summer 2015)
  - L1B Aggregation: bands 1-7, 26, 20-23, 29-33 (in development)
- Ongoing Data Continuity Challenges
  - Radiometry
  - Safe hold impact
  - NCEP GDAS Continuity
- Next Steps

GIBS Atmosphere C6 Examples

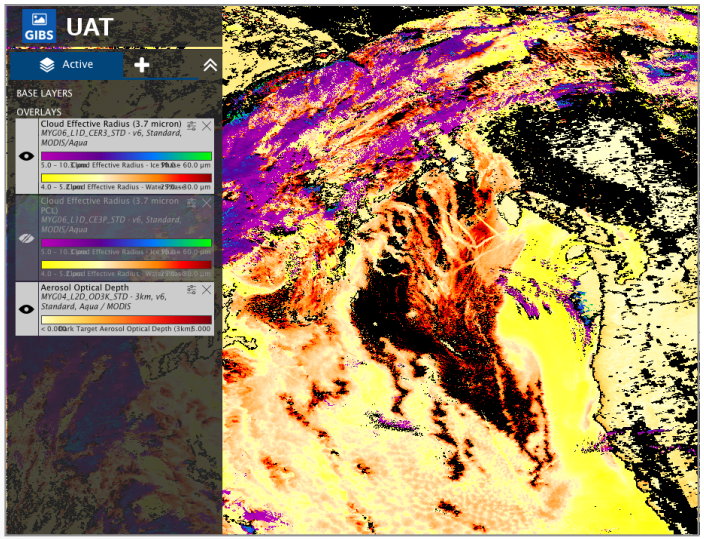
M. Cechini, R. Boller, J. Schmaltz

MOD04: DT 3km

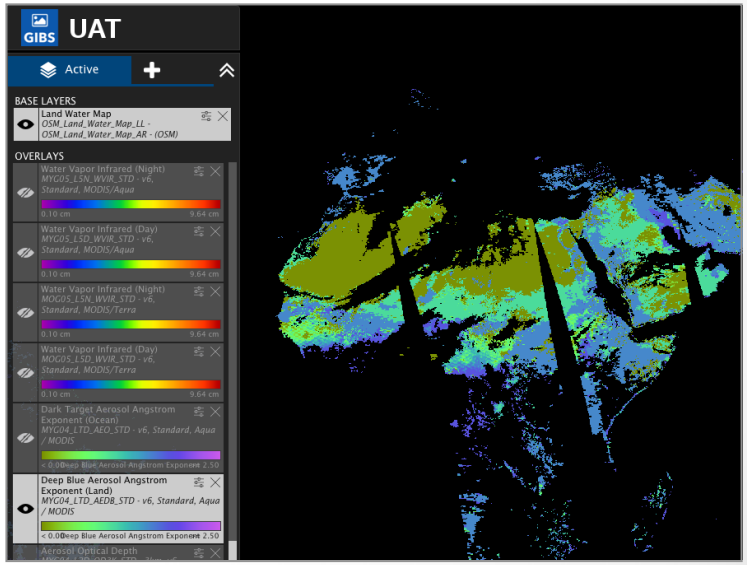




MOD06: COT



MOD06: CER



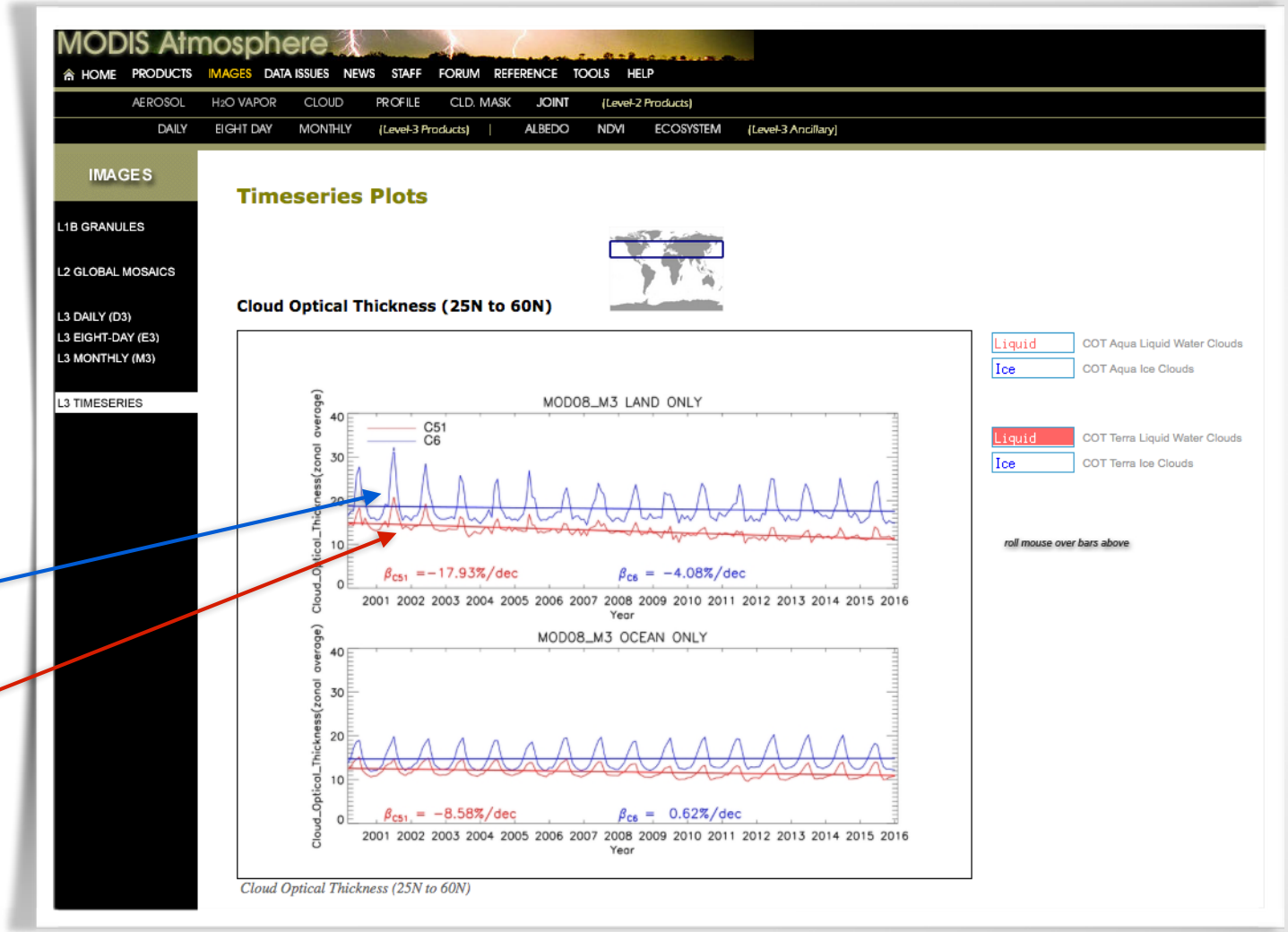
MOD04: DB

L3 Time Series Analysis

S. Manoharan, N. Amarasinghe, S. Platnick

MOD06 25N-60N Zonal Mean Time Series:

Terra Liquid COT
Land (top)
Ocean(bottom)



C6

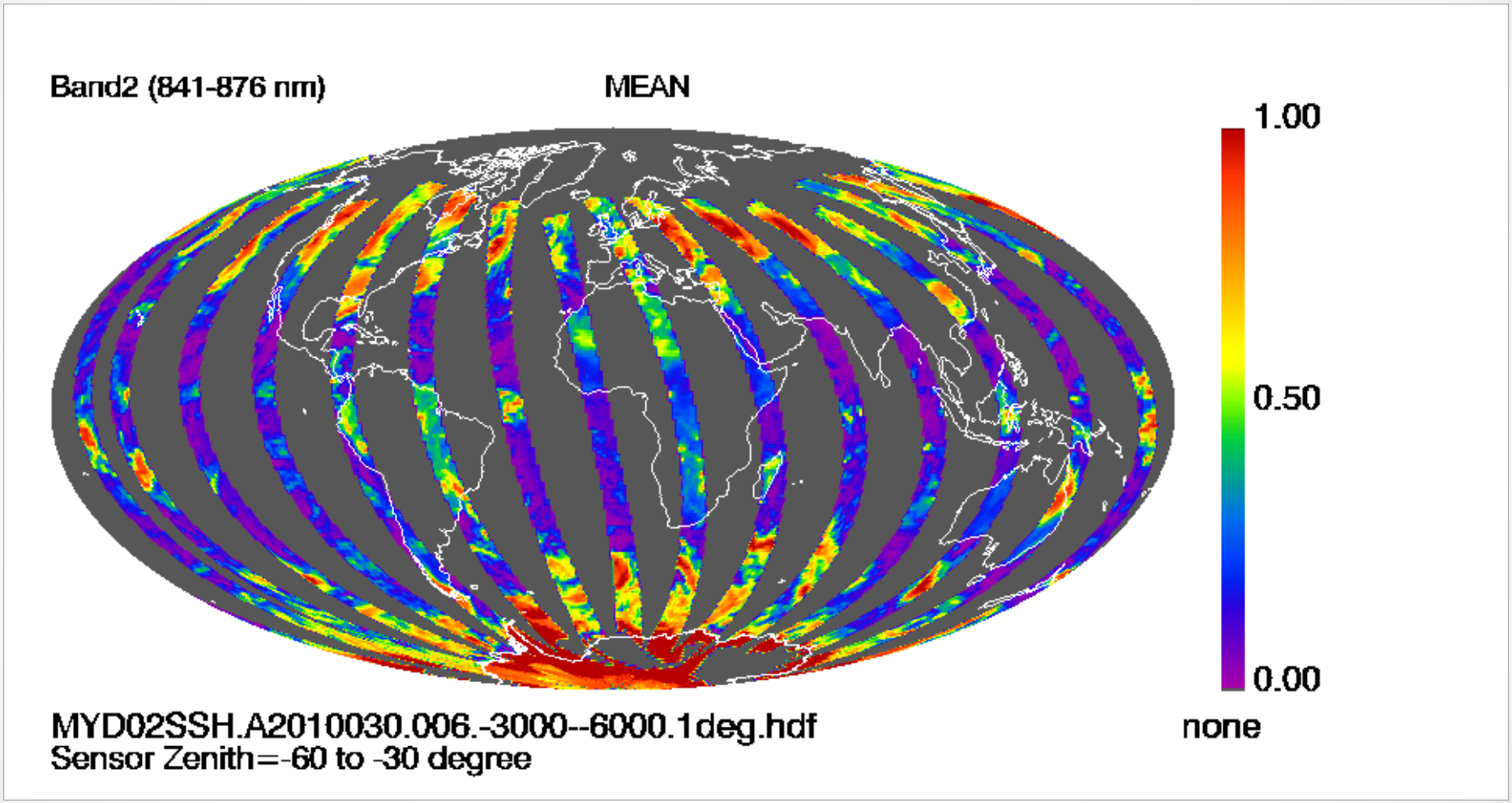
C51

b1 (land) and b2 (ocean) radiometric degradation

http://modis-atmos.gsfc.nasa.gov/IMAGES/08_Timeseries.html

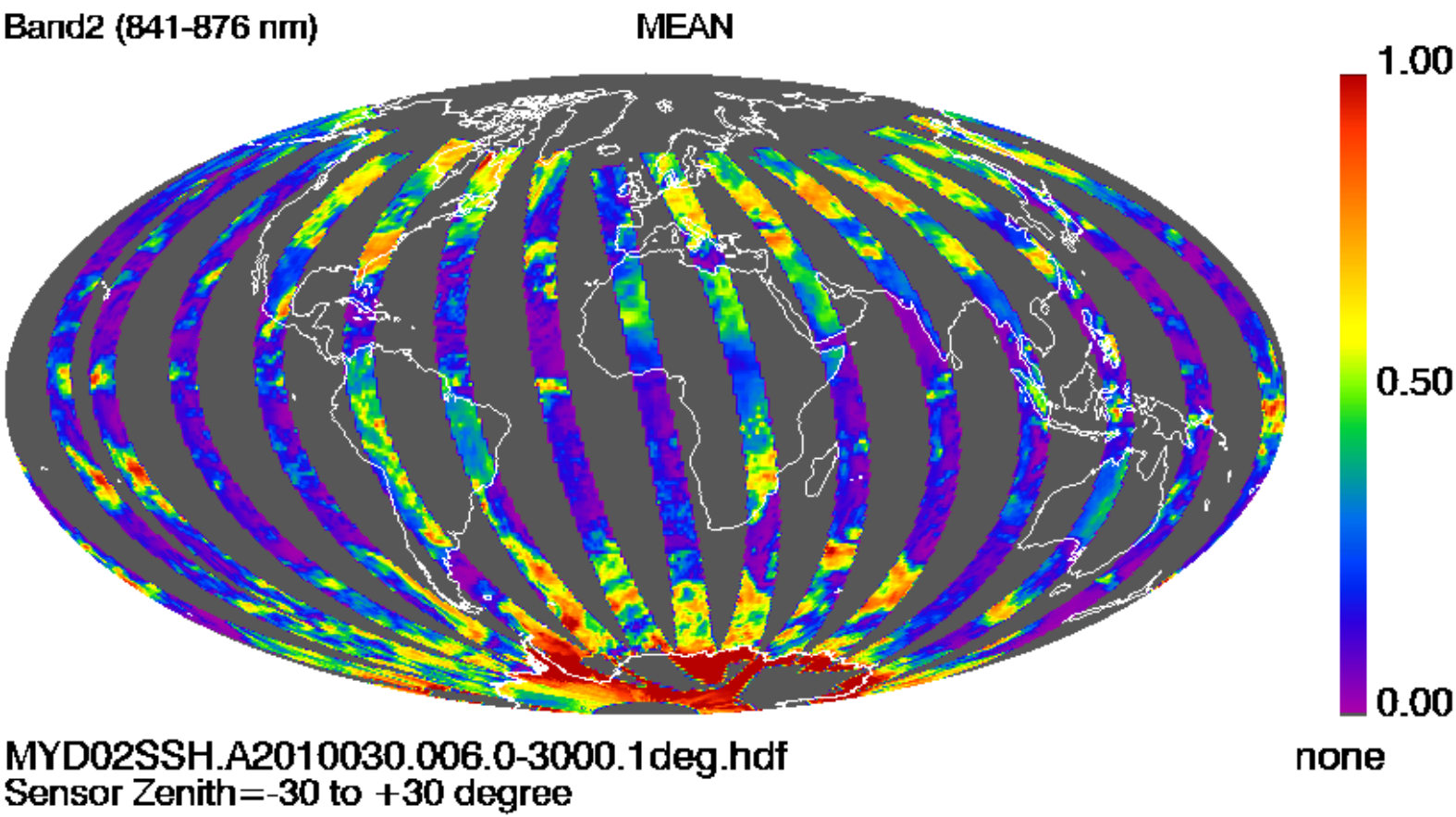
L1B Aggregation

S. Manoharan, S. Platnick, R. Levy



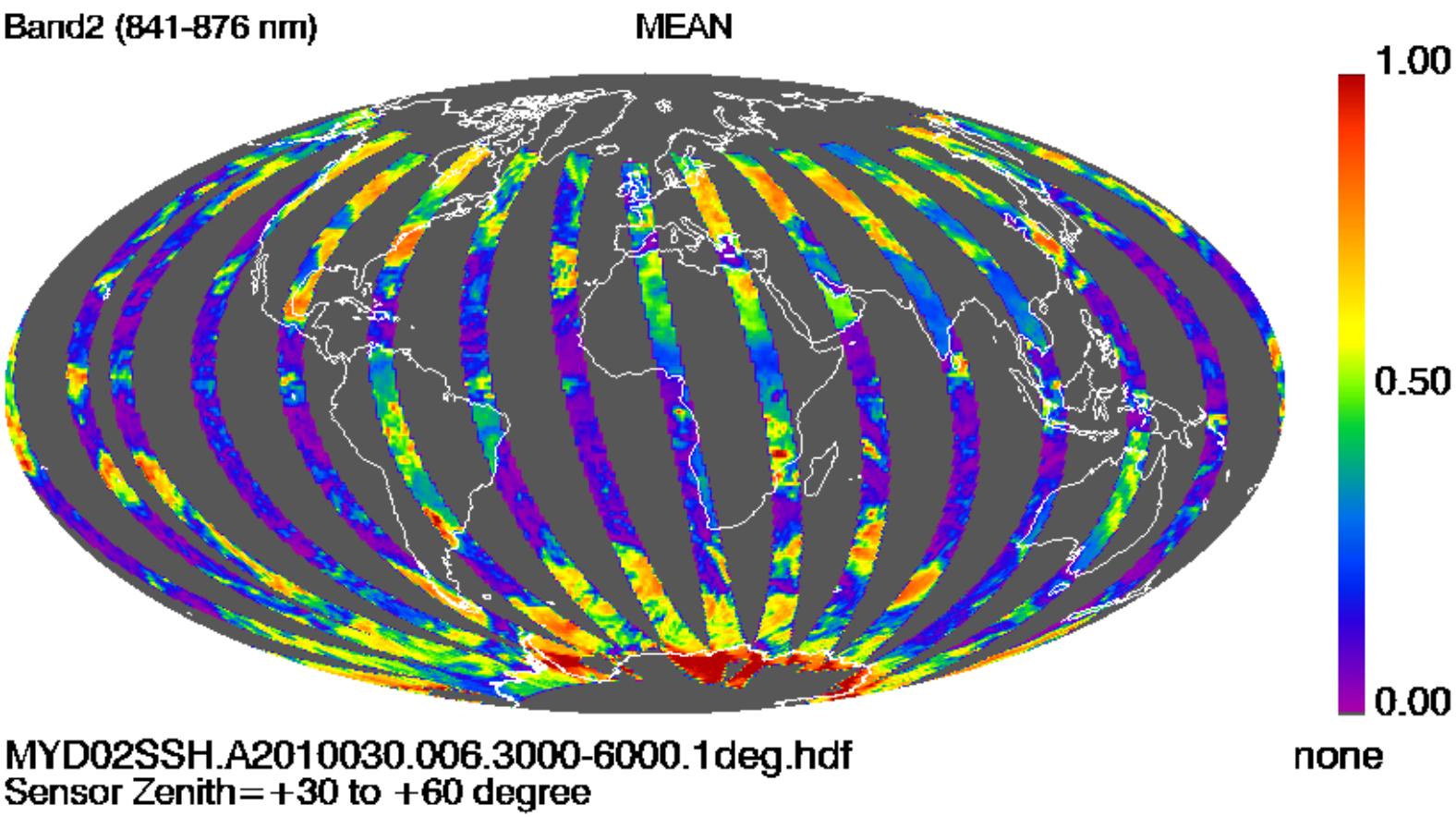
L1B Aggregation

S. Manoharan, S. Platnick, R. Levy



L1B Aggregation

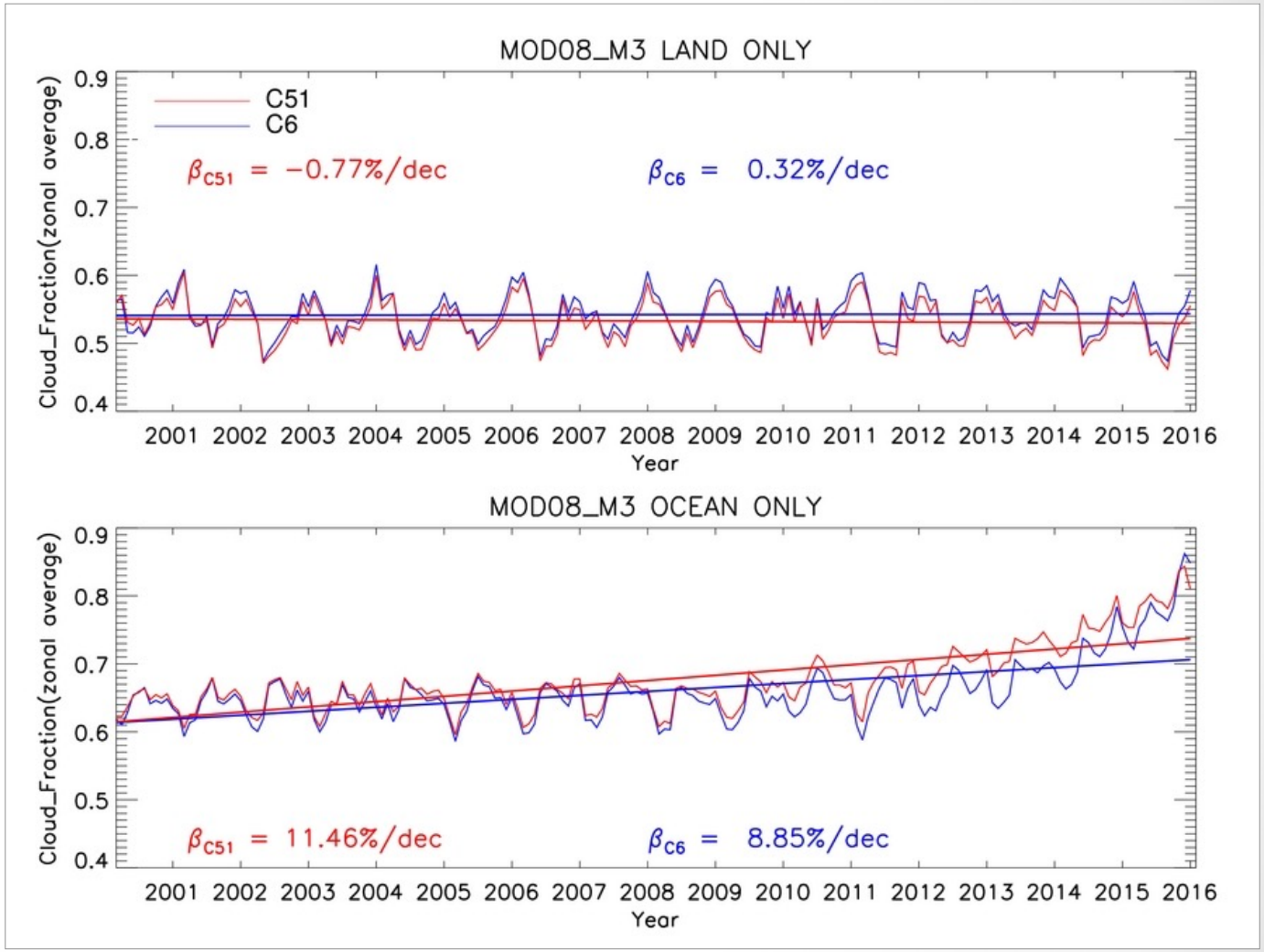
S. Manoharan, S. Platnick, R. Levy



Terra Pre-Safe Hold Radiometry Issue & Impact: B29 "Warming"

MOD35 ±25° Zonal Mean Time Series:

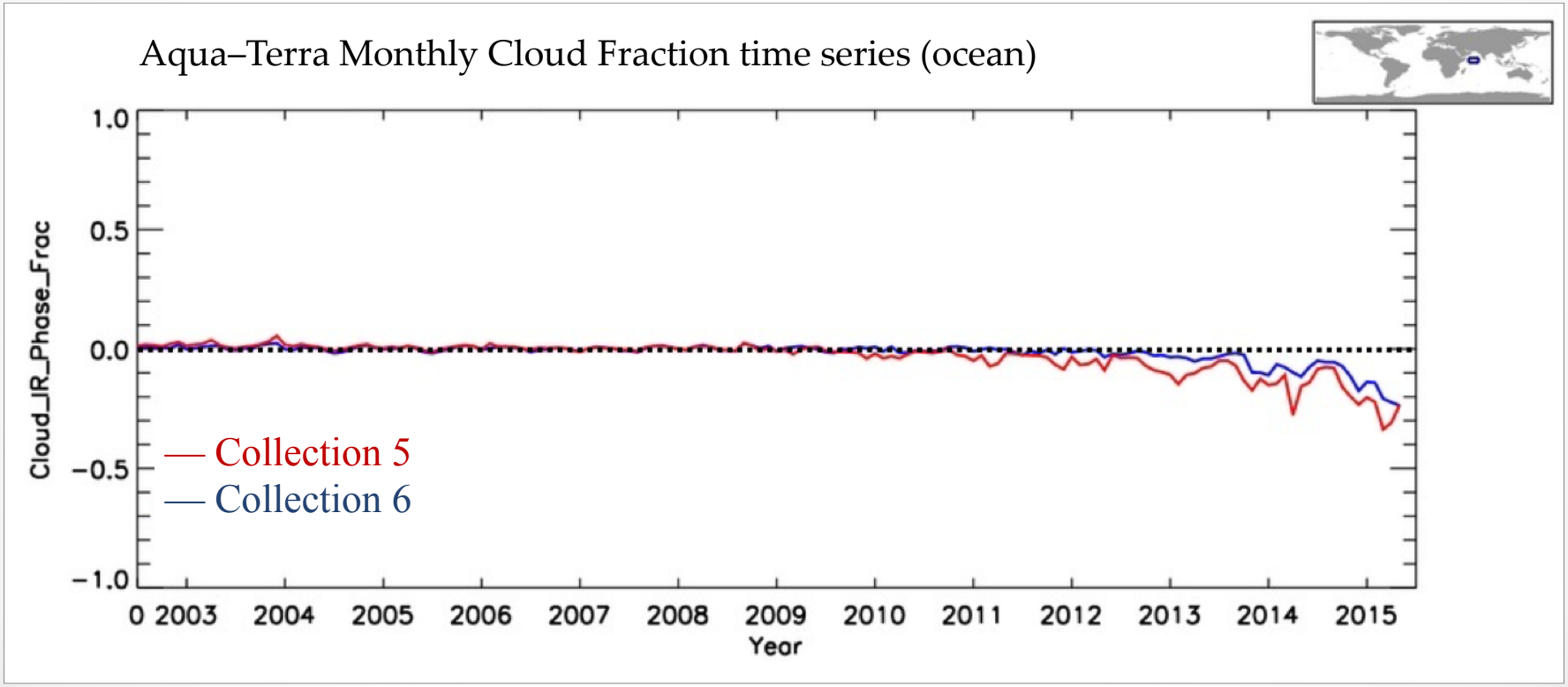
Terra Cloud Mask
Land (top)
Ocean(bottom)
C6
C51



http://modis-atmos.gsfc.nasa.gov/IMAGES/08_Timeseries.html

Terra Pre-Safe Hold Radiometry Issue & Impact: B29 "Warming"

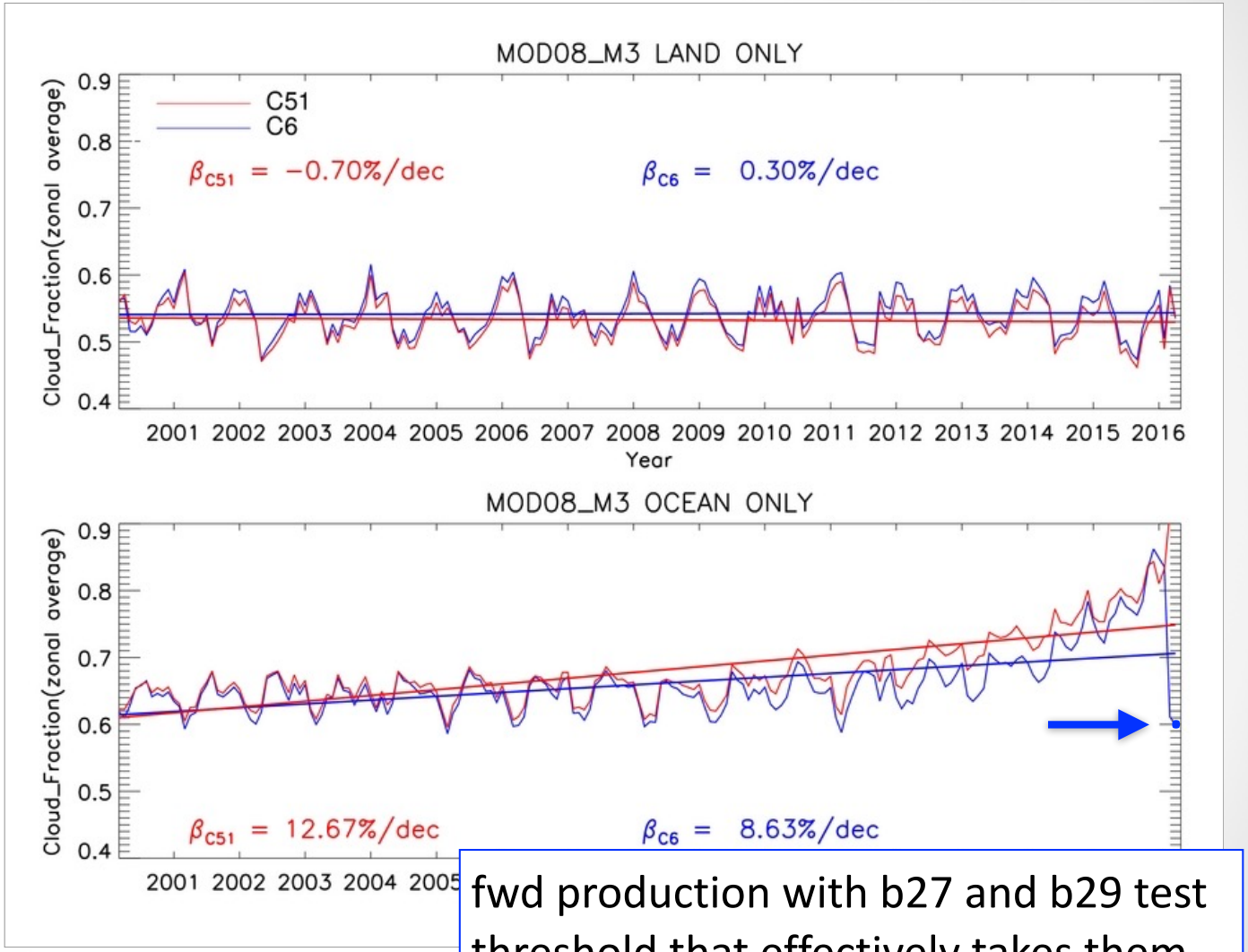
Cause: Cloud mask test over ocean that uses 8.6 μm channel (b29) that's experienced gradual warming over the last ~5 years, apparently related to crosstalk & not captured by on-board calibration systems.



Terra Post-Safe Hold Radiometry Issue & Impact: B29 & B27

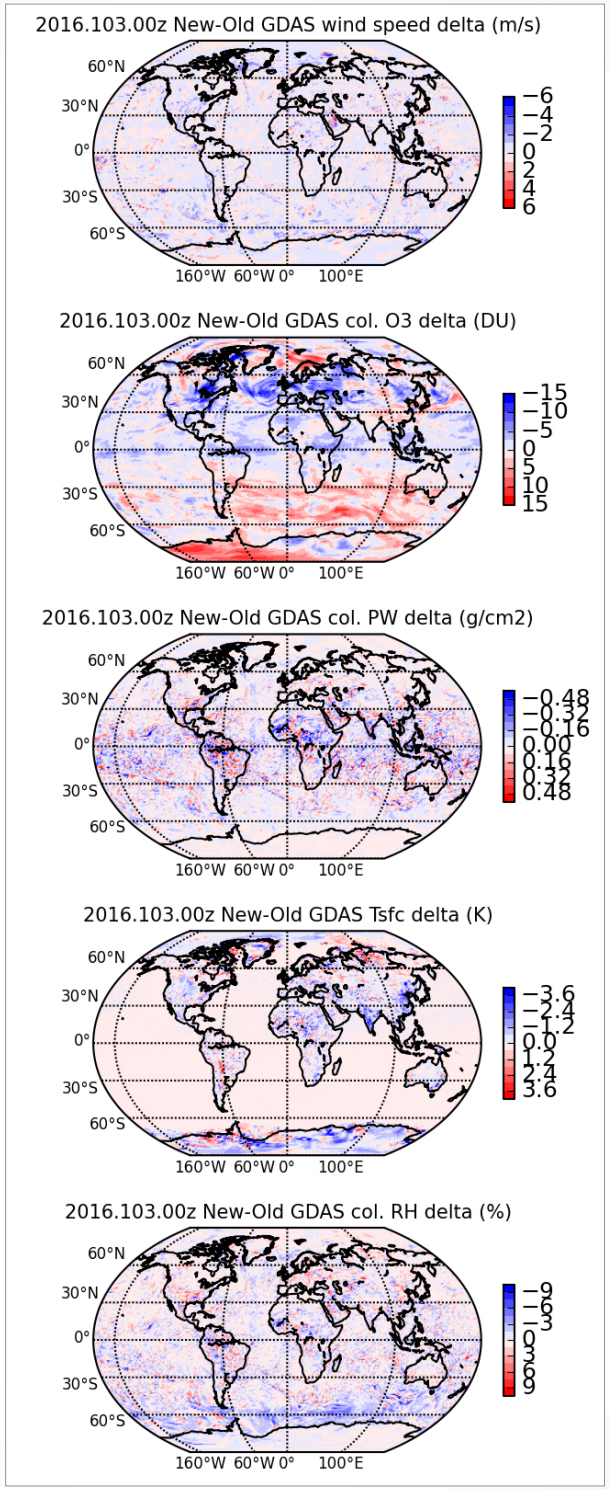
MOD35 ±25° Zonal Mean Time Series:

Terra Cloud Mask
Land (top)
Ocean(bottom)
C6
C51



fwd production with b27 and b29 test threshold that effectively takes them out of the decision making.

NCEP GDAS New – Old example from 2006.103.00z (change put into production in early May 2016)



Sfc. Wind Speed (m/s)

O_3 (DU)

Precip. Water (cm)

T_{sfc} (K)

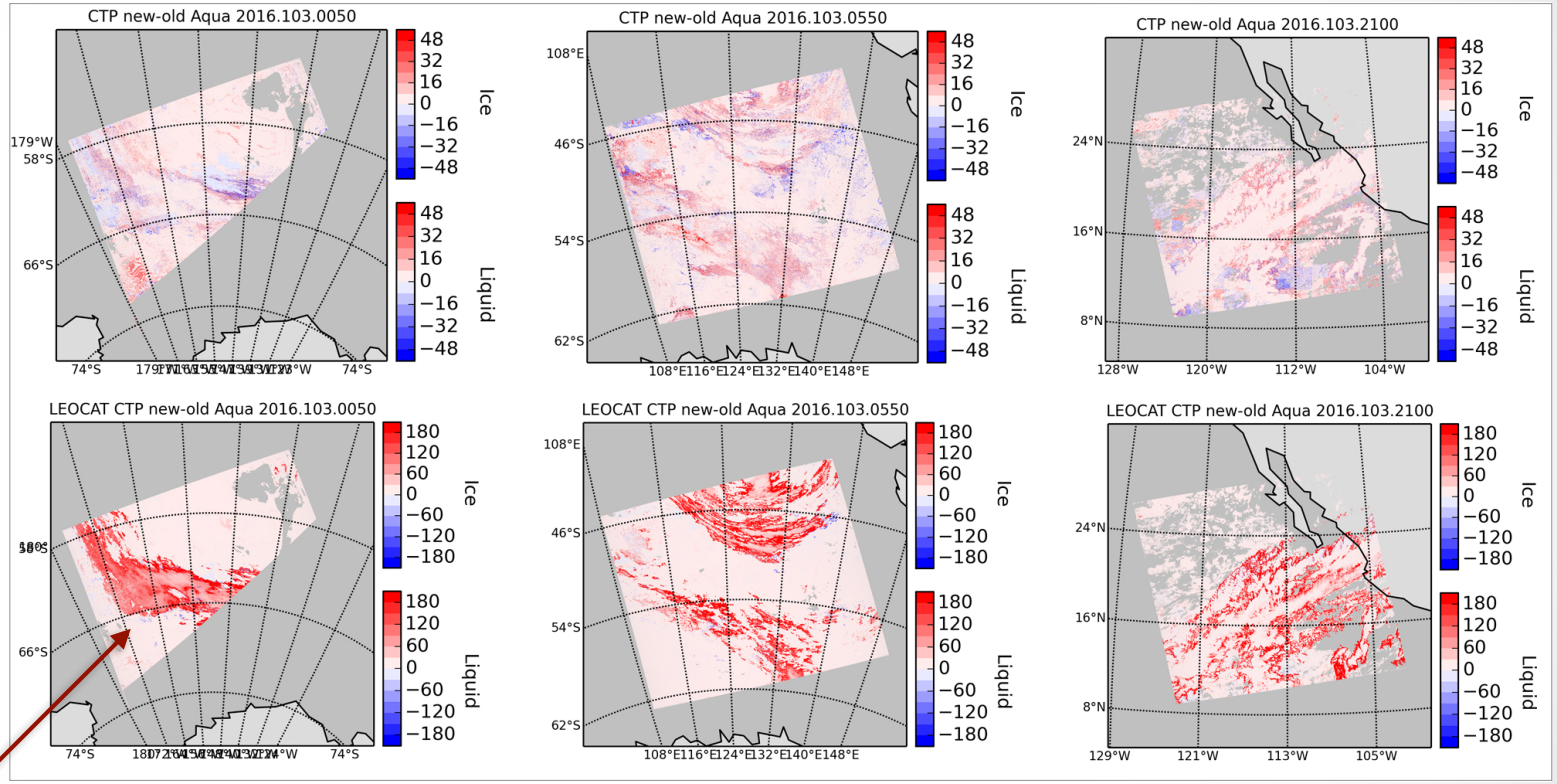
RH col. (%)

NCEP GDAS Change - In Production Starting Early May 2016

1km Cloud-Top Pressure Impact Example (2016.103.0500)

corrected (to be processed)

currently in production

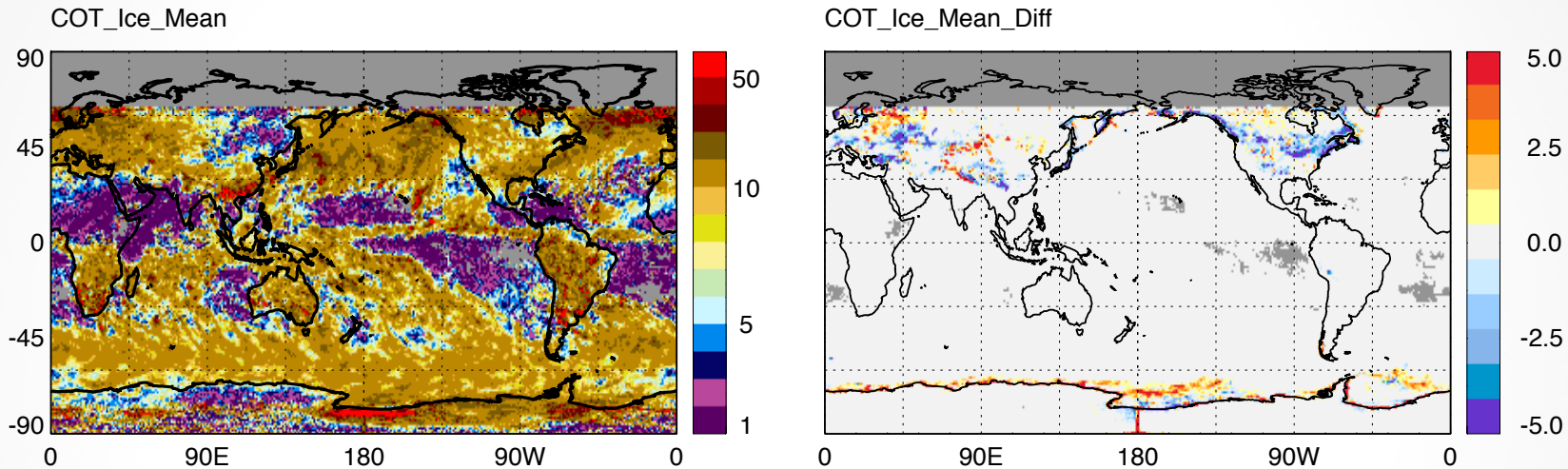


~+180 hPa increase in CTP

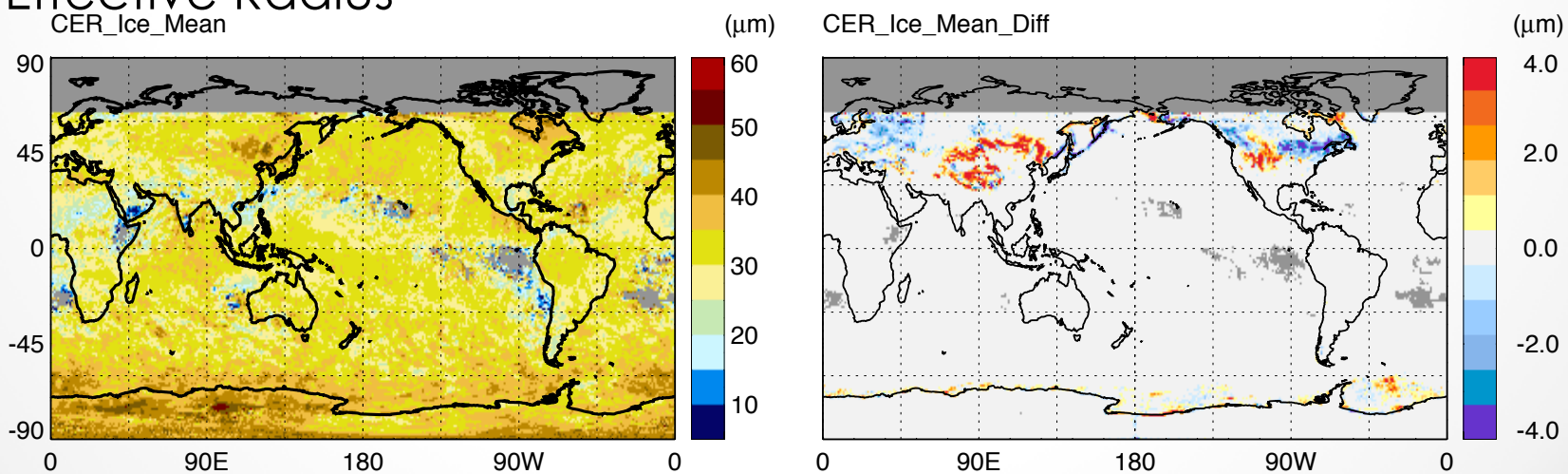
The Path to GOES-5 (FPIT): Snow/Sea Ice Cover vs. NISE/GDAS

Ice Clouds

Cloud Optical Thickness



Cloud Effective Radius



II. **MODAWG**: MODIS-VIIRS Product Continuity for Cloud Mask, Cloud-Top & Optical Properties

GSFC: Steve Platnick, Kerry Meyer, Gala Wind, Nandana Amarasinghe, Ben Marchant, Chenxi Wang, Thomas Fauchez, Tom Arnold

UW/CIMSS: Steve Ackerman, Rich Frey, Bob Holz

NOAA STAR, UW/CIMSS: Andy Heidinger

Atmosphere SIPS: Bob Holz, Steve Dutcher, Liam Gumley, et al.

II. **MODAWG**: MODIS-VIIRS Product Continuity for Cloud Mask, Cloud-Top & Optical Properties

- Spectral Coverage: Main Challenge in Achieving Data Record Continuity with MODIS
- MODIS-VIIRS Cloud Continuity Product Status
- Next Steps

MODIS/VIIRS Spectral Differences

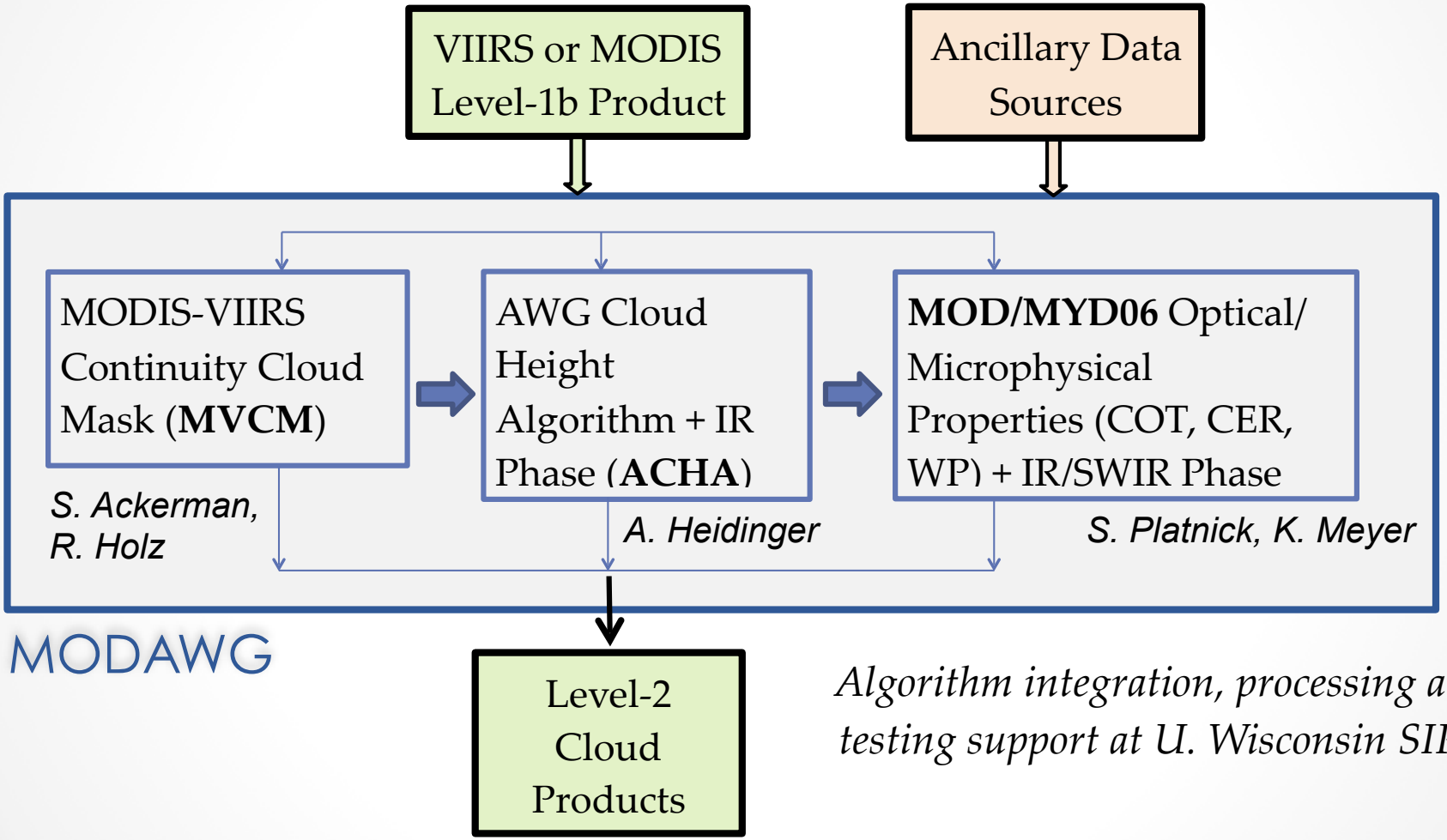
Challenge: Direct cloud data record continuity between the SNPP VIIRS and EOS MODIS imagers is problematic because of the absence or relocation of key spectral channels.

- VIIRS missing CO_2 and H_2O absorption channels present on MODIS (impacts CTP, multilayer detection)
- VIIRS 2.25 μm vs. MODIS 2.13 μm channel (impacts CER)

Approach: Develop common algorithms using common MODIS and VIIRS bands. Alternate algorithm combining VIIRS/CrIS and Aqua MODIS/AIRS to supplement absent VIIRS IR absorption channels under development.

Algorithms/Products: heritage from combined MODIS and GOES-R Algorithm Working Group (AWG) algorithms, i.e., **MODAWG**.

MODAWG Algorithm Process Flow (with PI/Co-Is)

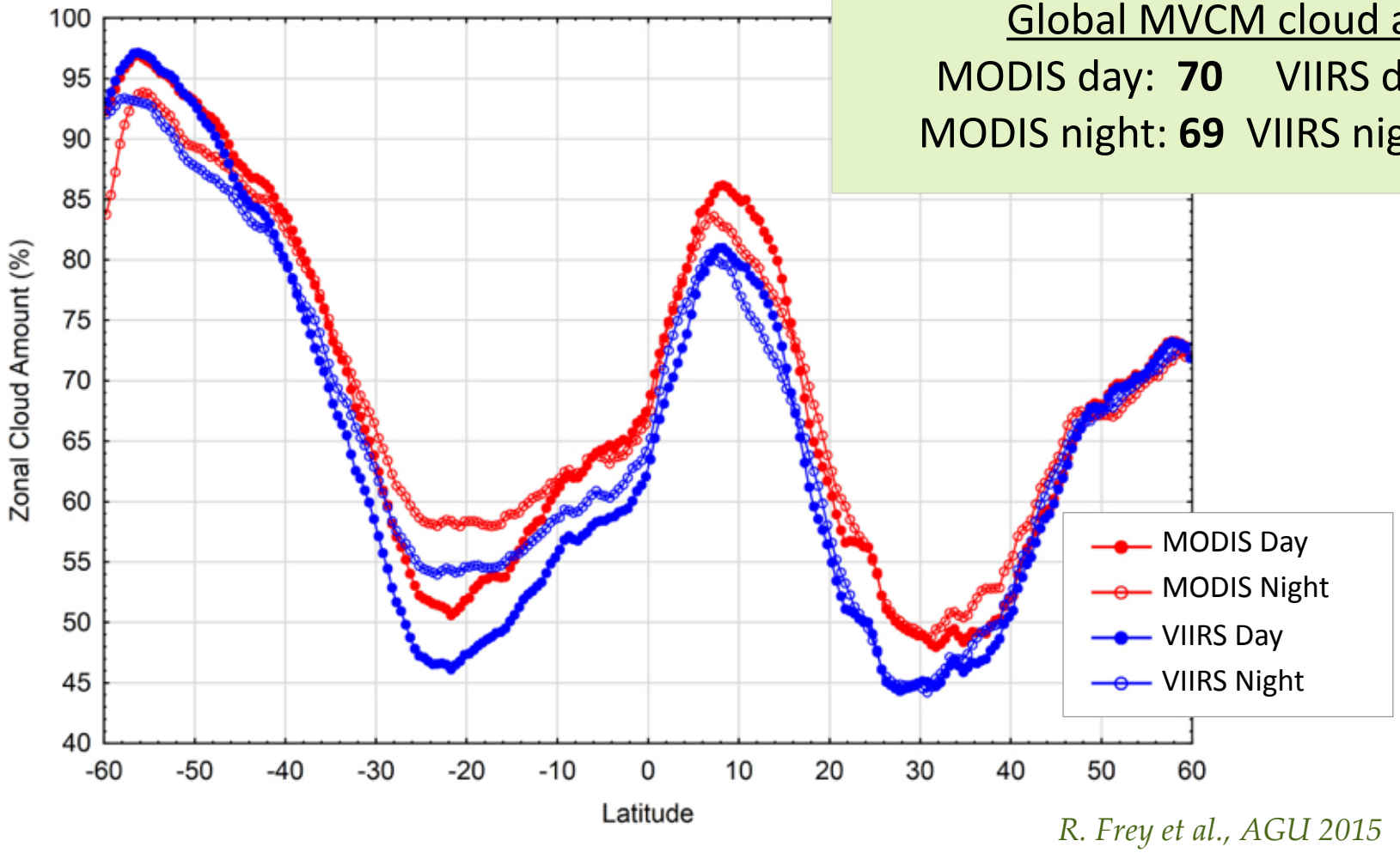


Algorithm integration, processing and testing support at U. Wisconsin SIPS

MODAWG Status

- MODIS-VIIRS Cloud Continuity Product Status
  - Cloud Mask (MVCM): completed v1
  - Cloud Top (ACHA): oceanic lapse rate assumption more similar to MYD06 C6, added multiple microphysical models, improved CrIS data when VIIRS + CrIS data are processed
  - Cloud Optical Thickness (COT), Effective Radius (CER) etc.: new LUTs, updated retrieval phase algorithm

Cloud Mask (MVCM): VIIRS vs. MODIS Zonal Comparisons (Aug. 2014)



Global MVCM cloud amount

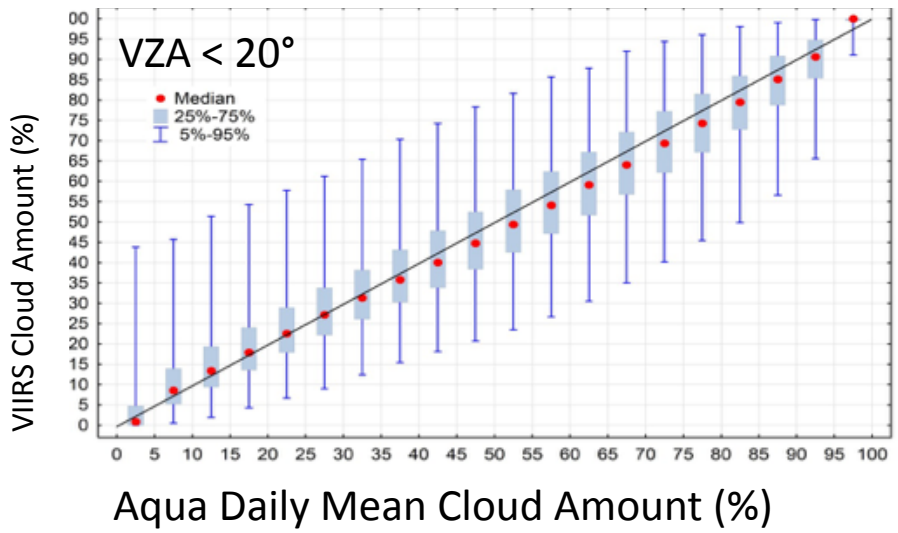
MODIS day: **70** VIIRS day: **66**

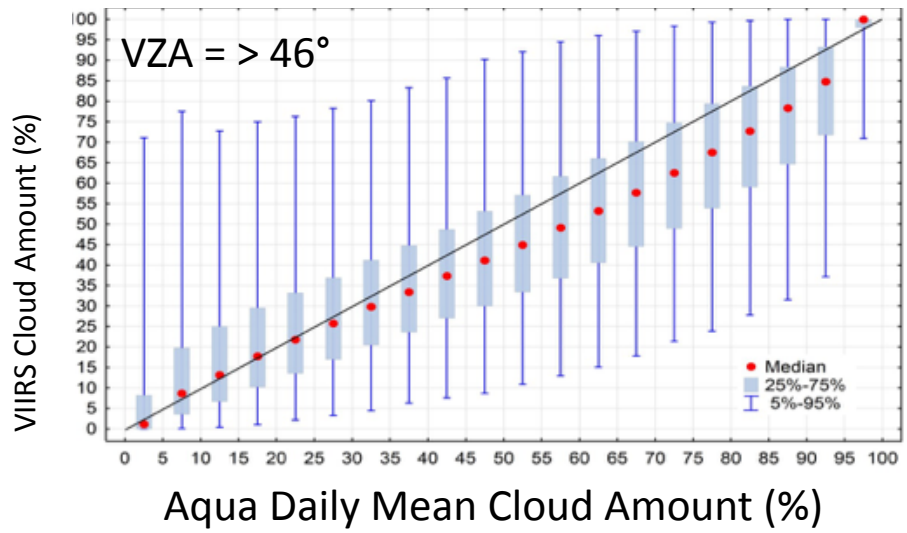
MODIS night: **69** VIIRS night: **68**

R. Frey et al., AGU 2015

Cloud Mask (MVCM): Bias vs. View Zenith Angle

MVCM VIIRS vs. MVCM MODIS Aqua daily regional cloud amounts (0.5° grid, ocean, Jan. 2013)



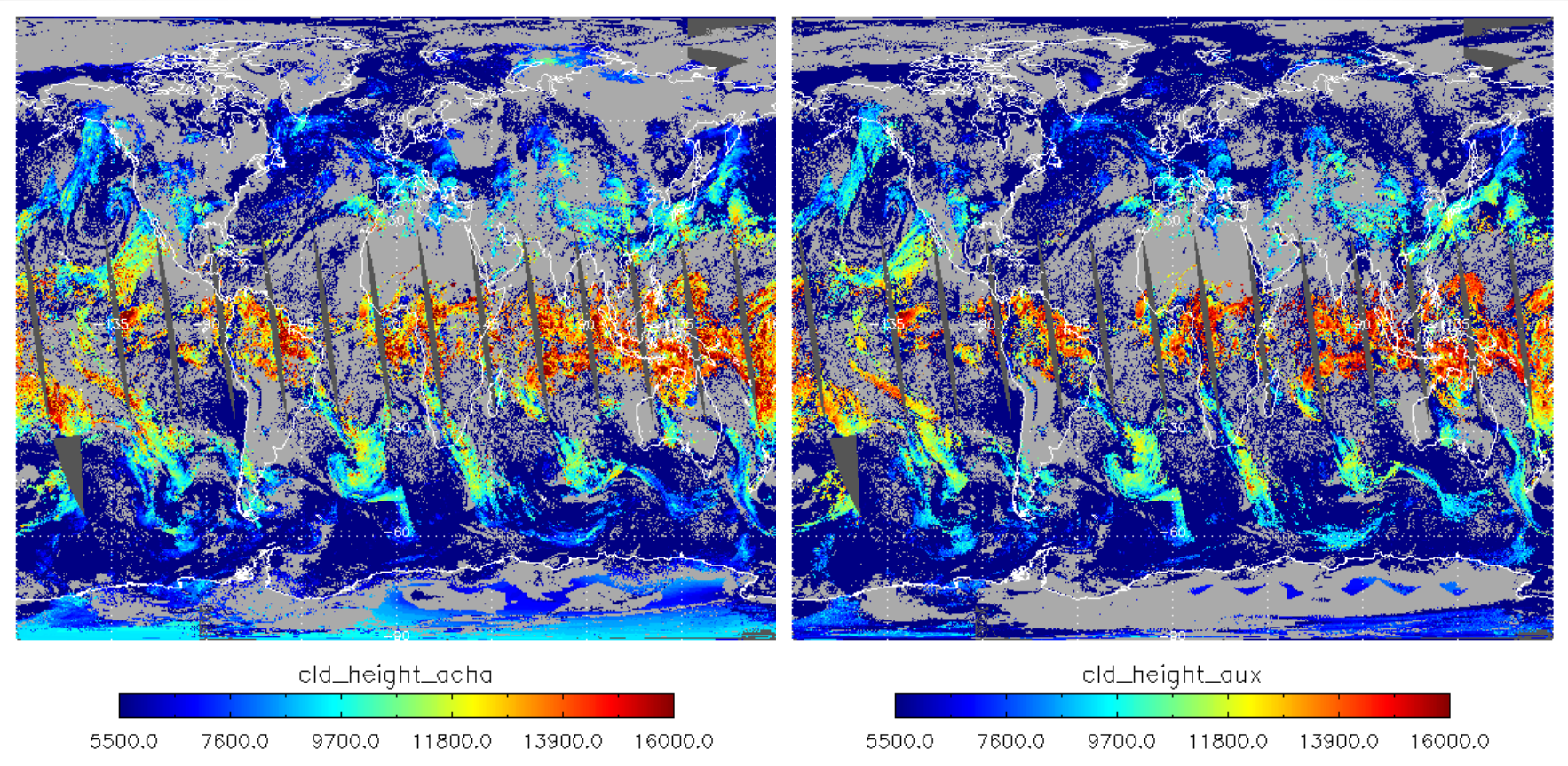


R. Frey et al., AGU 2015

VIIRS cloud amount < MODIS for amounts ~30-95 %. Difference increases with view zenith angle (VZA). => <u>Mainly caused by FOV differences</u>.

Cloud Top (MODAWG ACHA): ACHA MODIS vs. MYD06

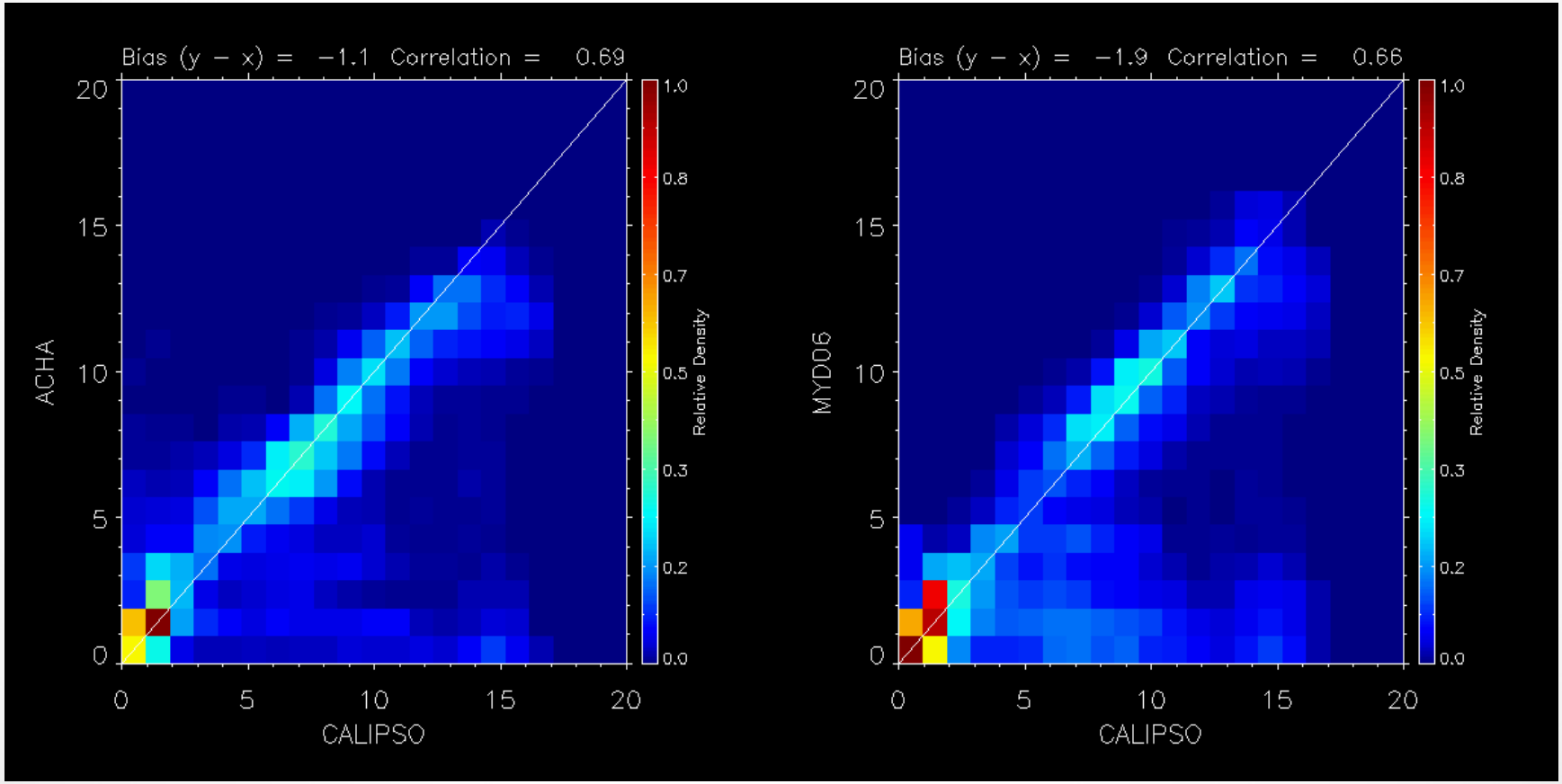
Example of MODAWG/ACHA applied to MODIS (left) and compared to MYD06 C6 (right)
MODAWG/ACHA run using the default VIIRS-only channels (8.5, 11, 12 µm)



March 29, 2013 Ascending Node

Cloud Top (MODAWG ACHA): ACHA MODIS vs. MYD06 & CALIOP

CALIPSO/CALIOP Comparisons to Data on Previous Slide
ACHA bias is smaller and correlation slightly higher

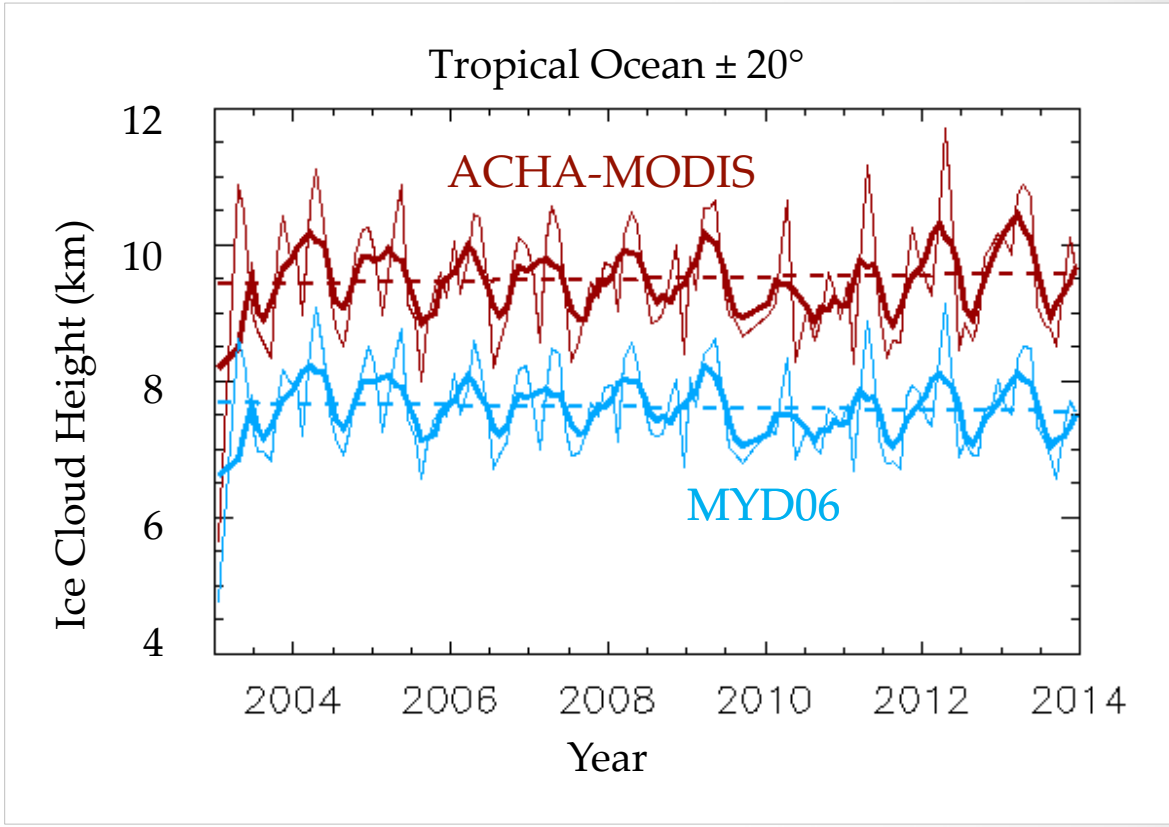


March 29, 2013 Ascending and Descending Nodes

Cloud Top (MODAWG ACHA): ACHA MODIS Ice Cloud Time Series vs. MYD06

Mean Tropical Ocean ice cloud height:

- Despite spectral and algorithm differences, ACHA heights similar to MYD06.
  - Strong annual cycle correlation
  - small/no trends
- ACHA biased high vs. MYD06 as well as CALIOP (not shown).

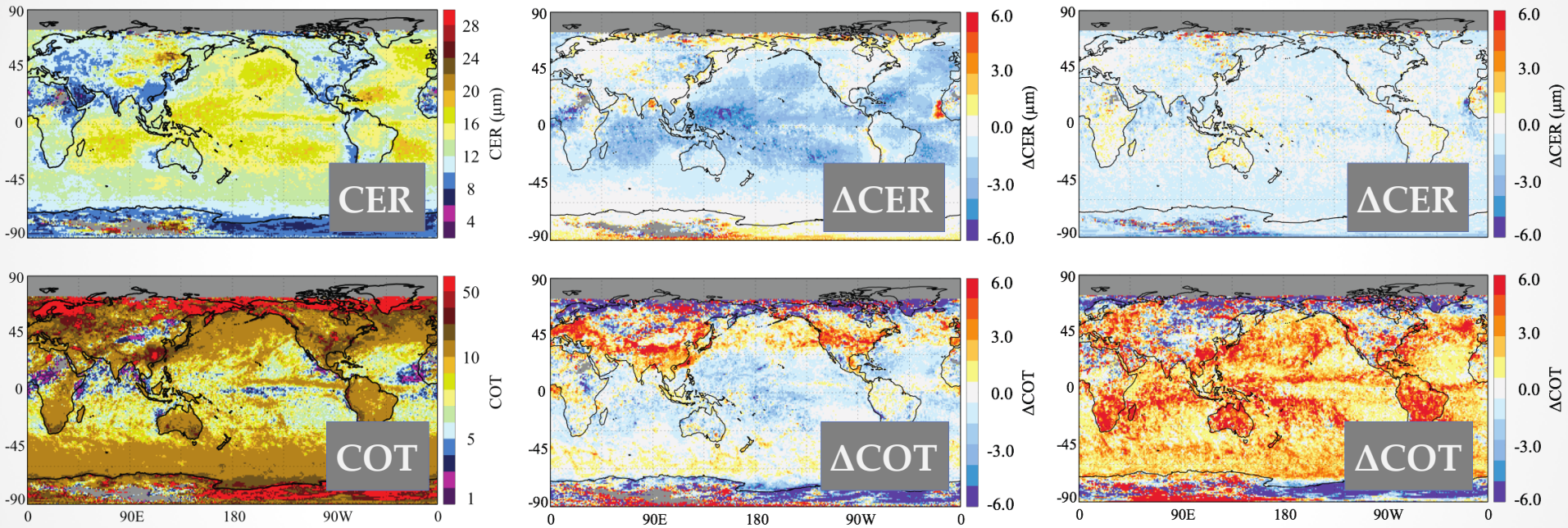


monthly variation *(thin line)*
6-month smoothing *(thick line)*
linear fit *(dashed line)*

Cloud Optical Properties:

Monthly means, Liquid water clouds, 3.7 μm CER & COT retrievals, Feb. 2014

MYD08 (MODIS C6) | **MODIS MODAWG – MYD08** | **VIIRS MODAWG – MODIS MODAWG**



MODIS Operational

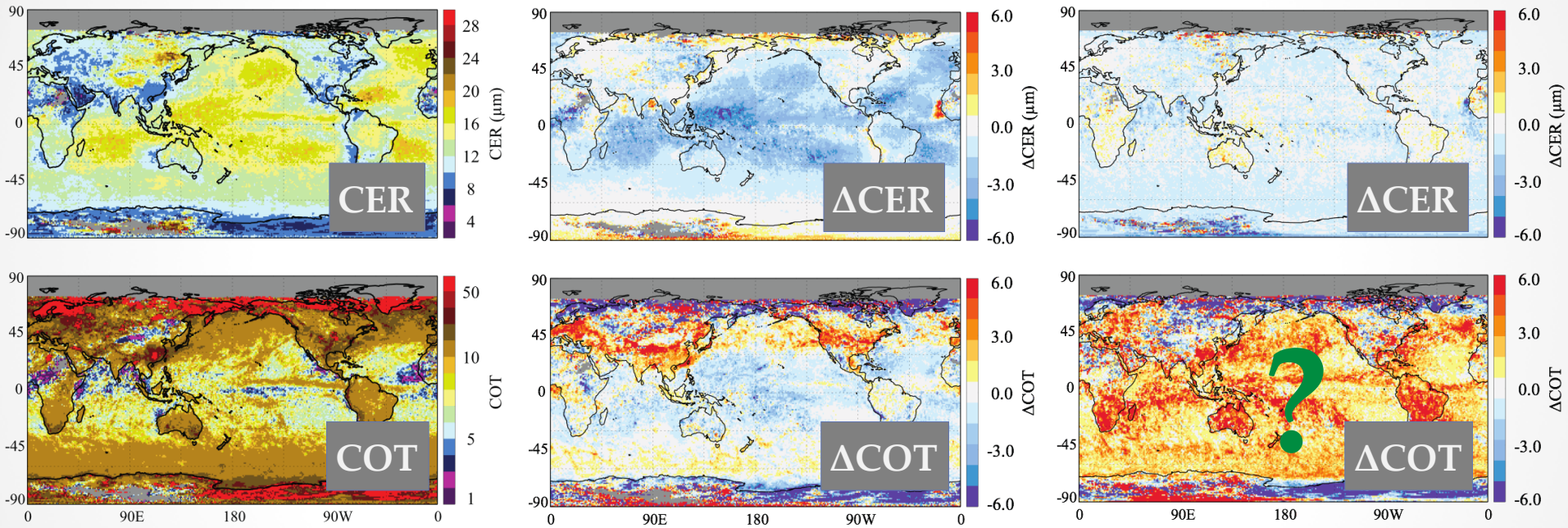
Algorithm evaluation: MODIS Operational vs. MODIS MODAWG

Continuity evaluation: VIIRS MODAWG vs. MODIS MODAWG

Cloud Optical Properties:

Monthly means, Liquid water clouds, 3.7 μm CER & COT retrievals, Feb. 2014

MYD08 (MODIS C6) | **MODIS MODAWG – MYD08** | **VIIRS MODAWG – MODIS MODAWG**



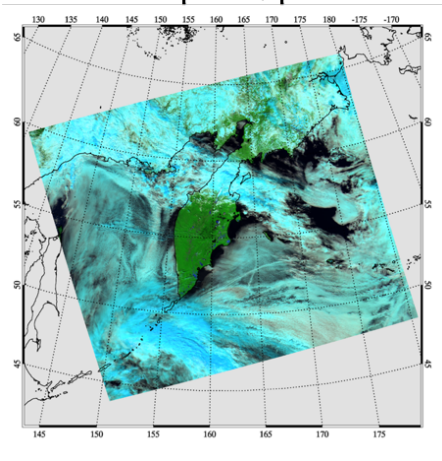
MODIS Operational

Algorithm evaluation: MODIS Operational vs. MODIS MODAWG

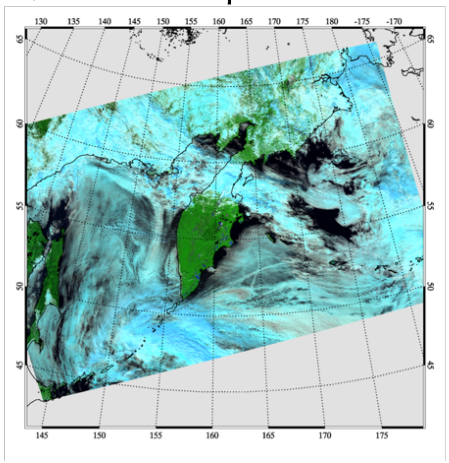
Continuity evaluation: VIIRS MODAWG vs. MODIS MODAWG

Cloud Optical Properties: Granule Example

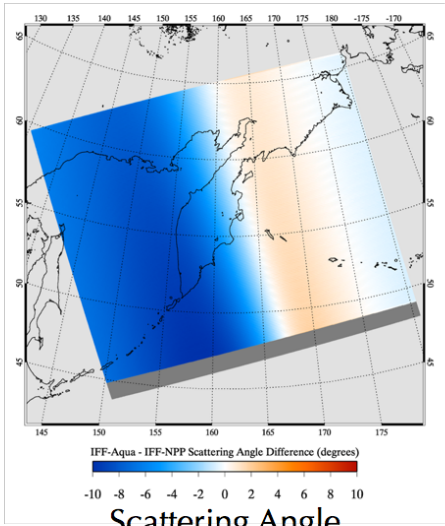
Close overpass (space and time) between Aqua and SNPP near the Kamchatka Peninsula and surrounding waters.



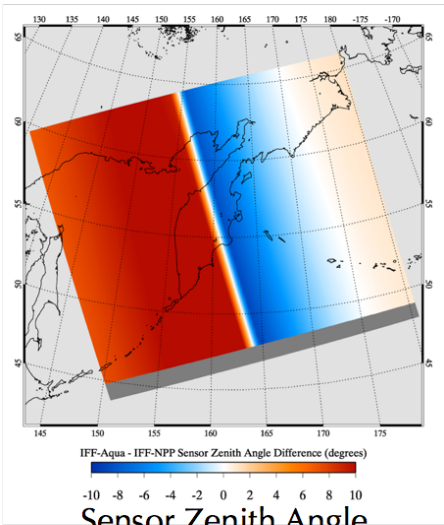
MODIS False Color
(Bands 7, 2, 1)



VIIRS False Color
(M11, M7, M5)



Scattering Angle
Difference

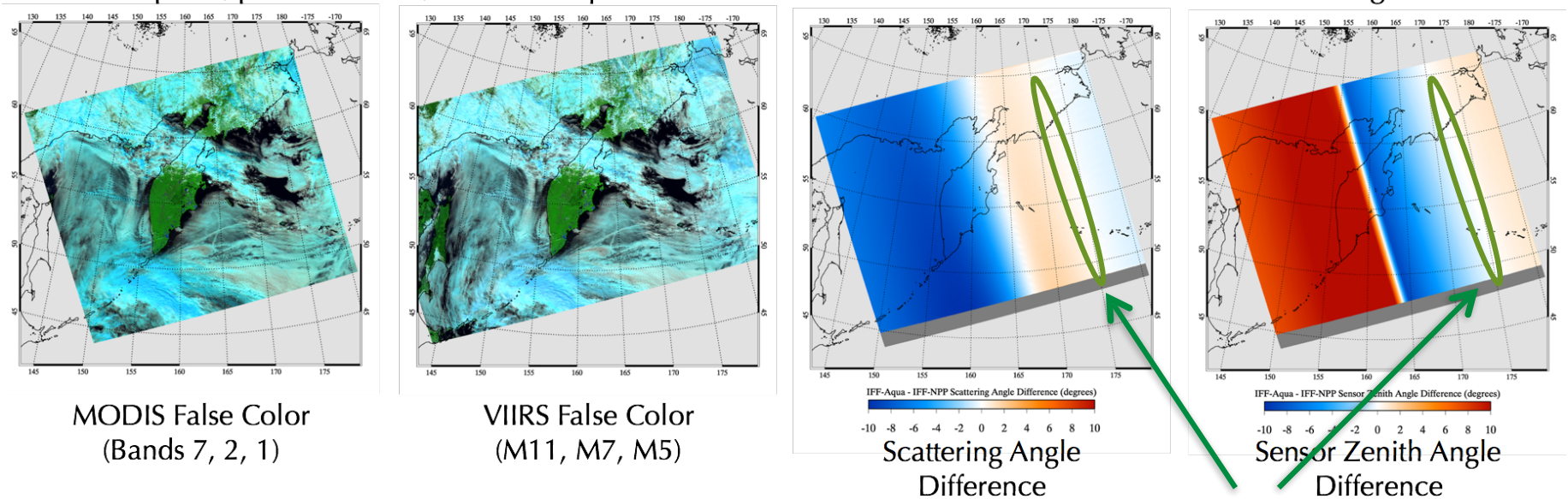


Sensor Zenith Angle
Difference

6 July 2014

Cloud Optical Properties: Granule Example

Close overpass (space and time) between Aqua and SNPP near the Kamchatka Peninsula and surrounding waters.



MODIS False Color (Bands 7, 2, 1)

VIIRS False Color (M11, M7, M5)

Scattering Angle Difference

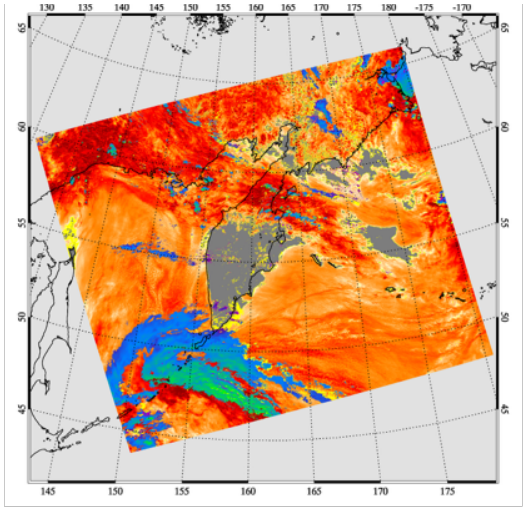
Sensor Zenith Angle Difference

6 July 2014

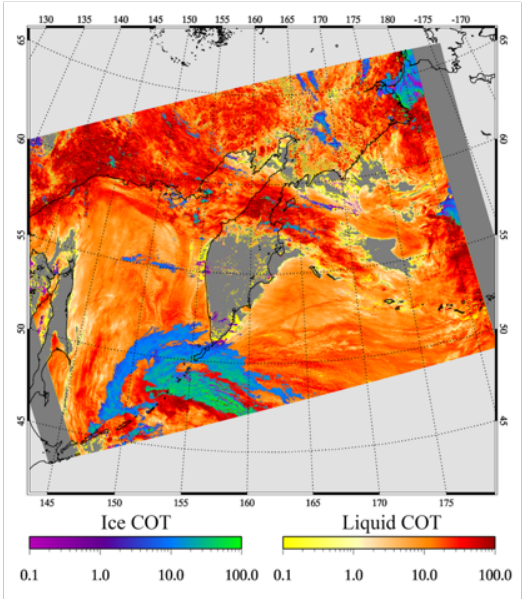
common view zenith & scattering angle

COT MODIS vs. VIIRS: Granule Example

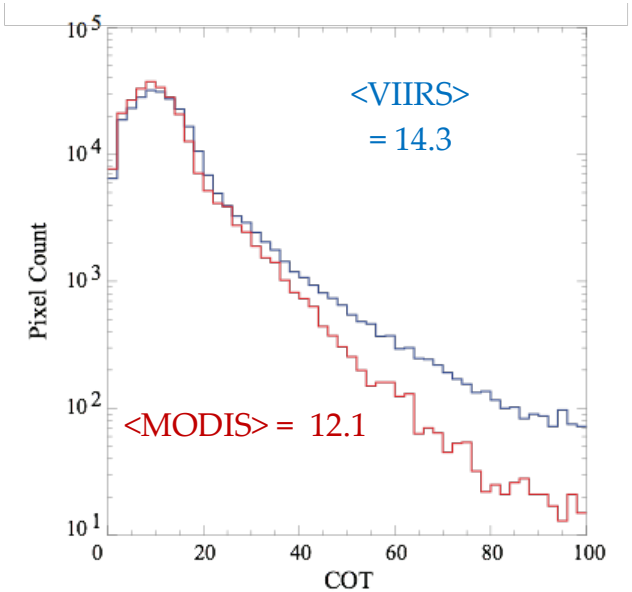
MODIS MODAWG
(liquid & ice)



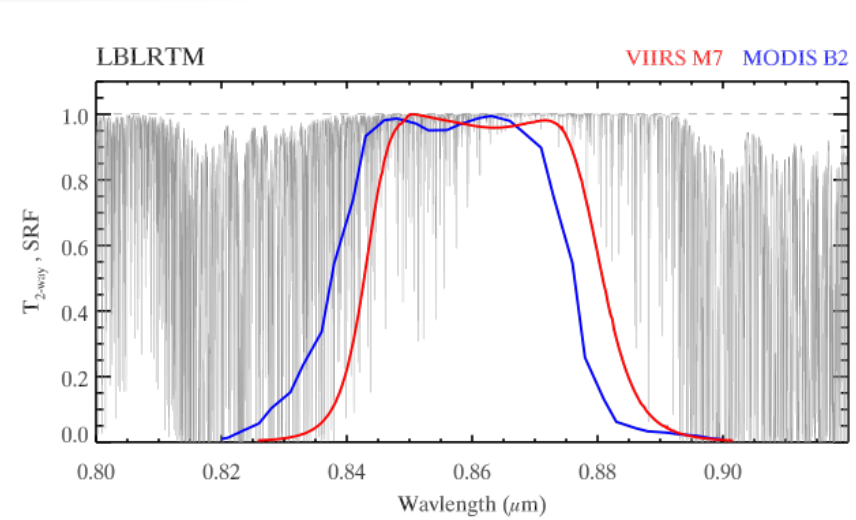
VIIRS MODAWG
(liquid & ice)



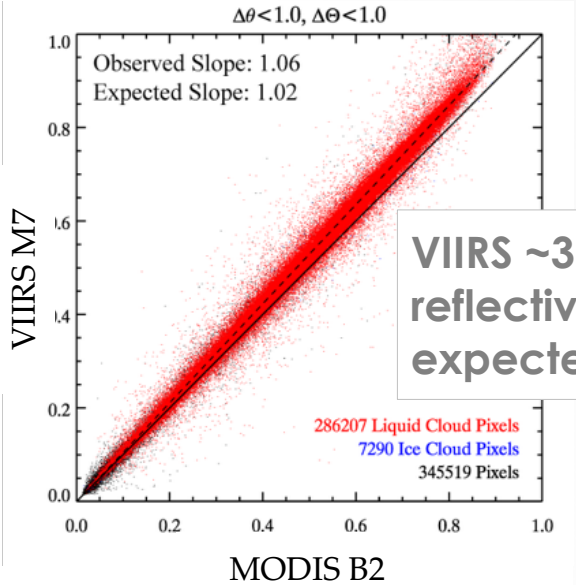
Liquid Retrieval Distributions
(common ±1° view/scattering angle)



Cloud Optical Properties: 0.86 µm Channel Radiometry

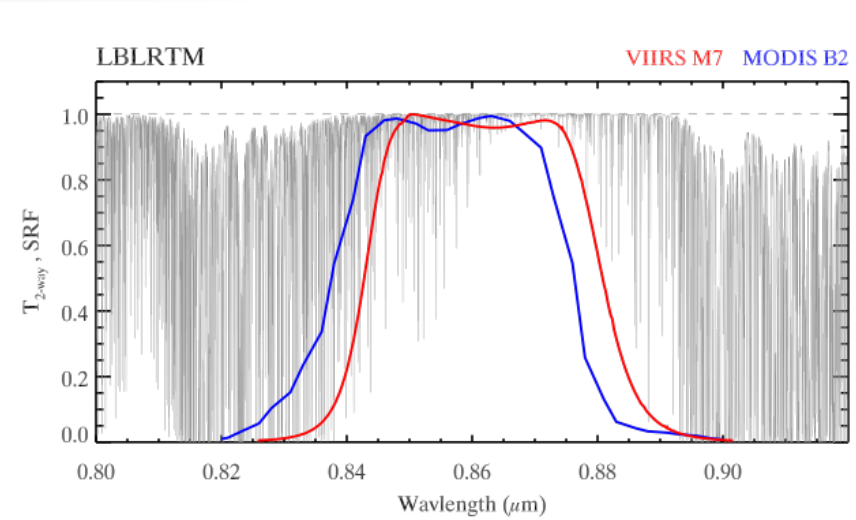


Spectral Response Functions

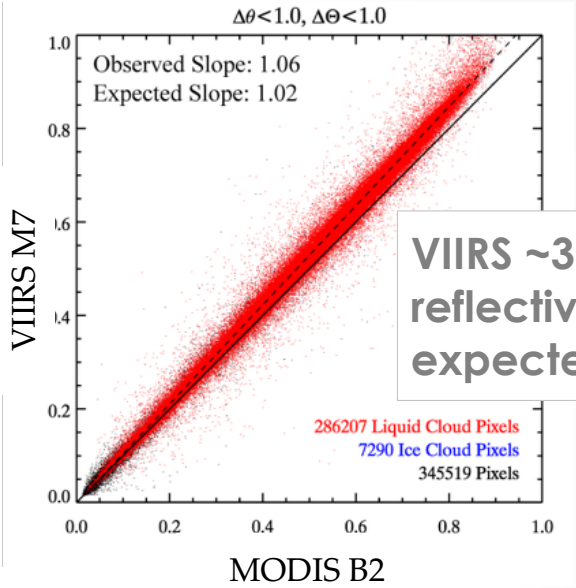


VIIRS ~3-4% more reflective than expected

Cloud Optical Properties: 0.86 µm Channel Radiometry

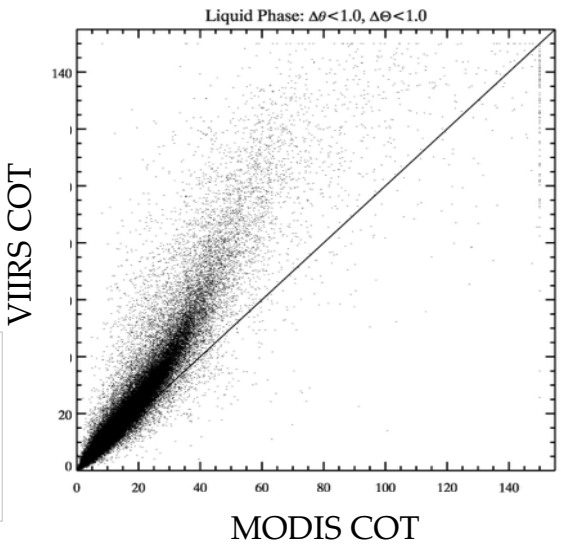


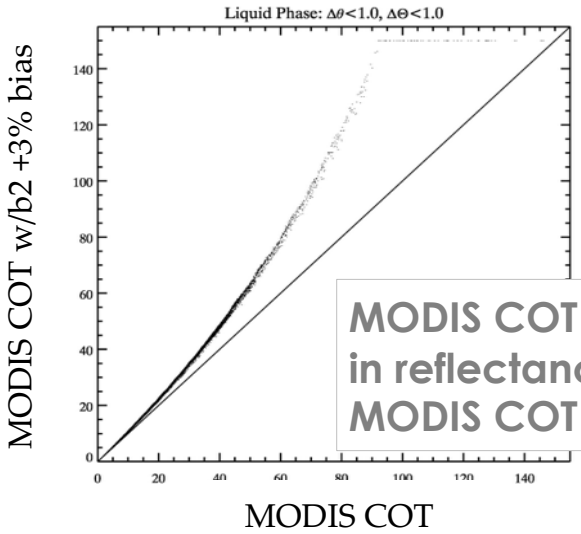
Spectral Response Functions



VIIRS ~3-4% more reflective than expected

Retrieved VIIRS vs MODIS COT



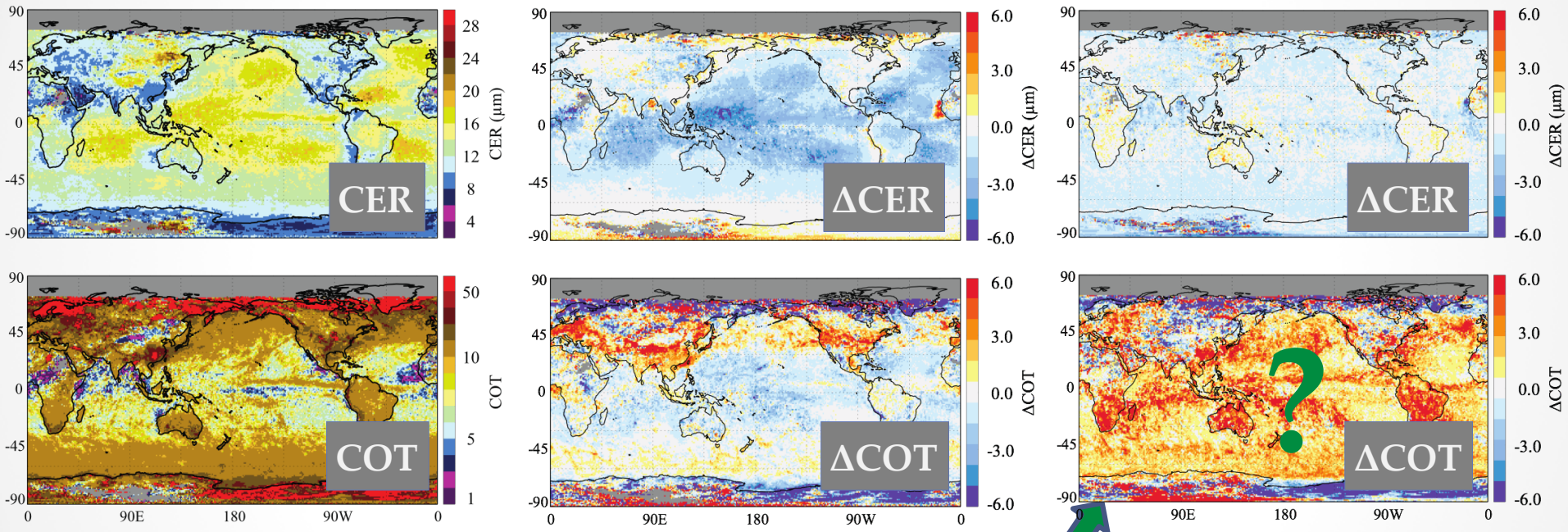


MODIS COT w/3% increase in reflectance vs. baseline MODIS COT

Cloud Optical Properties:

Monthly means, Liquid water clouds, 3.7 μm CER & COT retrievals, Feb. 2014

MYD08 (MODIS C6) | **MODIS MODAWG – MYD08** | **VIIRS MODAWG – MODIS MODAWG**



MODIS Operational

Algorithm evaluation:
MODIS Operational vs.
MODIS MODAWG

Continuity evaluation:
VIIRS MODAWG vs.
MODIS MODAWG

likely inter-cal. bias component

Next Steps …

- Calibration: shortwave channel calibration assessment [cloud mask, optical properties], adjustment and SIPS reprocessing
- Pixel FOV aggregation sensitivity study: approximately aggregate VIIRS to MODIS? [cloud mask]
- Understanding impact of 2 μm window channel placement [optical properties, retrieval phase] and use of other SWIR/MWIR retrievals for continuity.
- Incorporation of CrIS into VIIRS to compensate for missing IR absorption channels (vs. combined AIRS/MODIS algorithm)