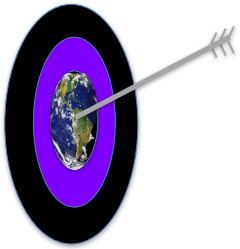
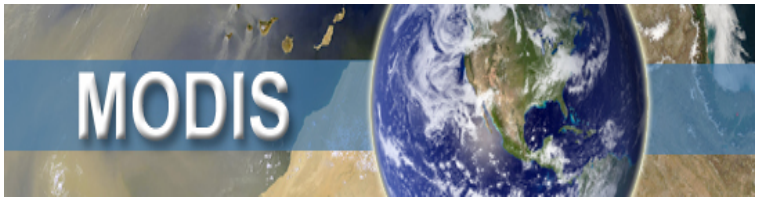
Update on retrieved aerosol products from MODIS, VIIRS and other sensors: Focus on AOD

Richard Kleidman (SSAI/NASA-GSFC), Robert C. Levy (GSFC) and the ”Dark-Target” retrieval team





With contributions from:
Andrew Sayer and Pawan Gupta (USRA/GSFC)

HAQAST

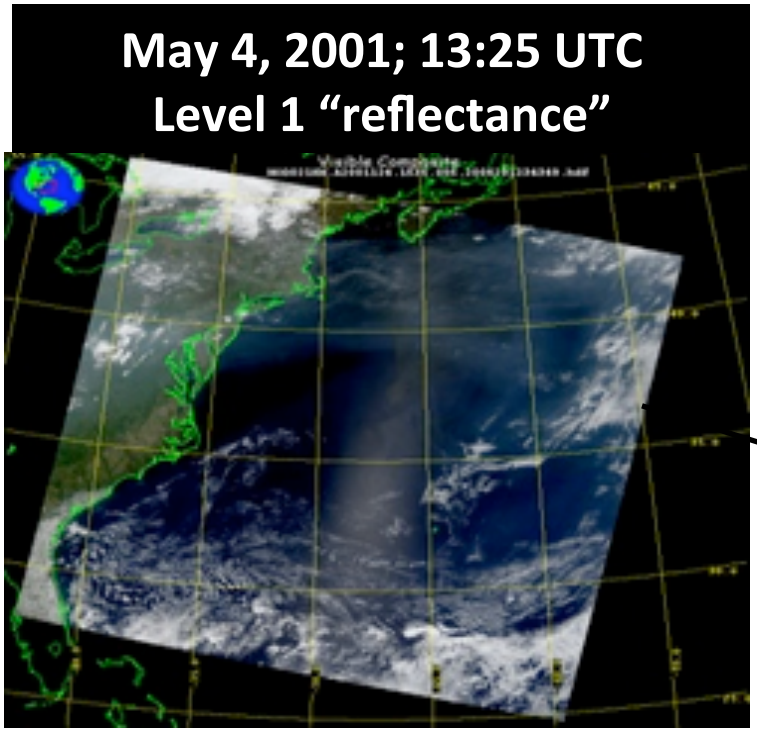
NASA

Current and Near Term Products and Capabilities

- MODIS – Dark Target, Deep Blue, MAIAC
- VIIRS – Dark Target, Deep Blue, NOAA products
- GEO - Dark Target Products
- MISR

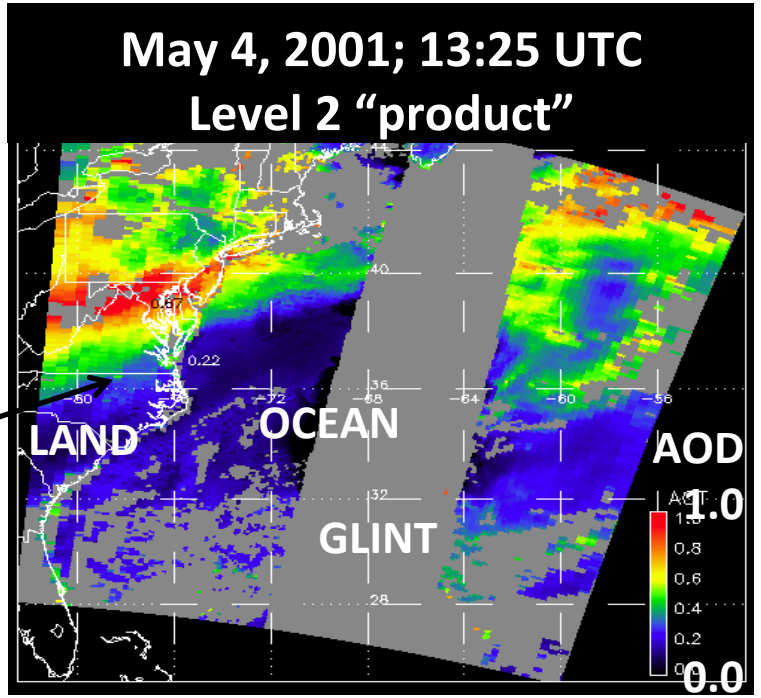
“single-view” aerosol retrieval algorithms (MODIS and VIIRS)

What a sensor observes



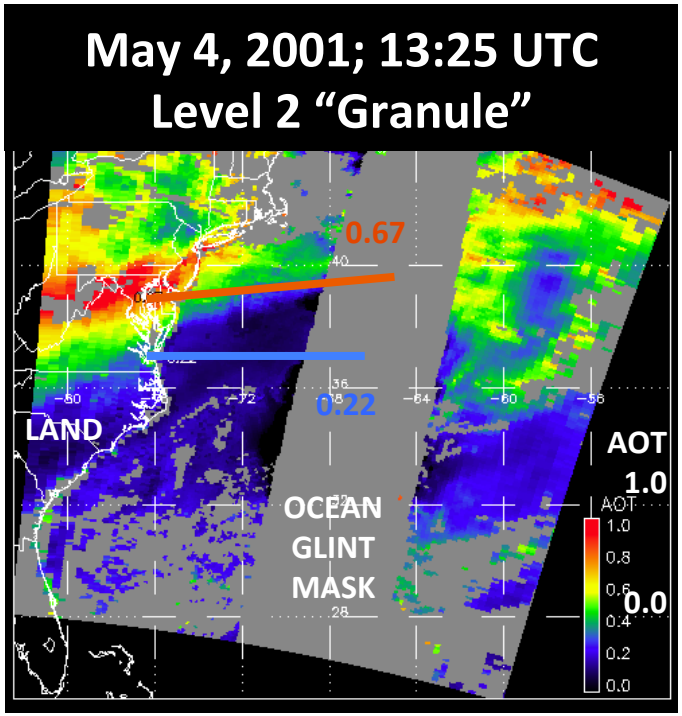
Retrieval Algorithm (e.g. DT or DB)

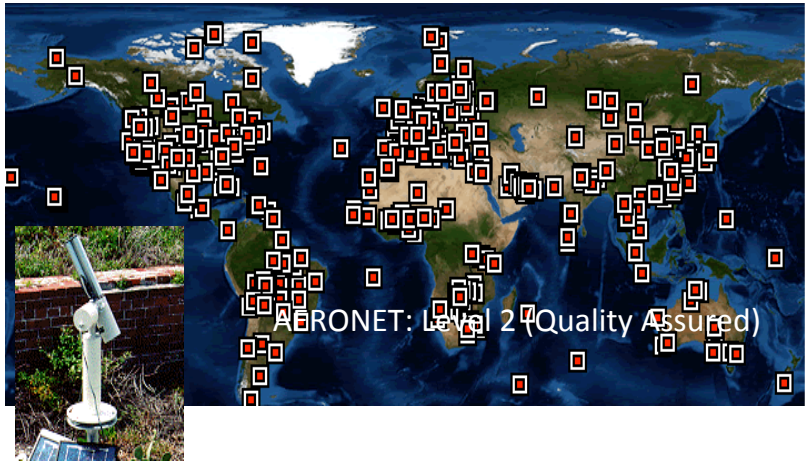
Attributed to aerosol (AOD)



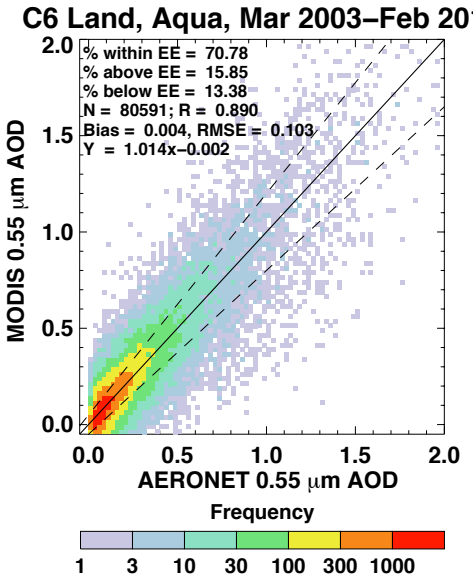
Separate logic over dark land, bright land and ocean
Retrieve: AOD at 0.55 mm, spectral AOD, etc

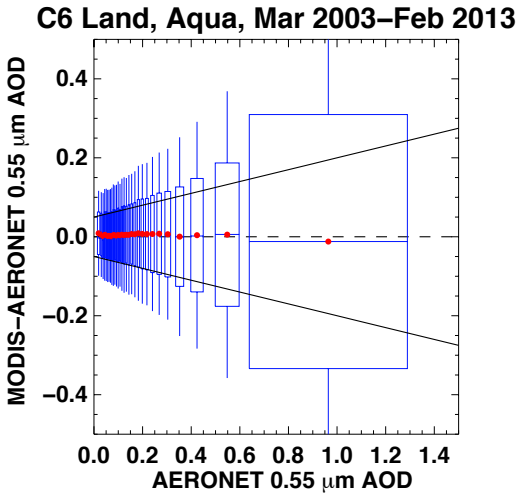
Validation: expected error for MODIS C6 product





- Compare both land and ocean products to AERONET, separately
- Validation: 66% are within "Expected Error" (EE) defined as
  - Land: $\pm(0.15\tau + 0.05)$
  - Ocean: $\pm(0.10\tau + 0.04)$

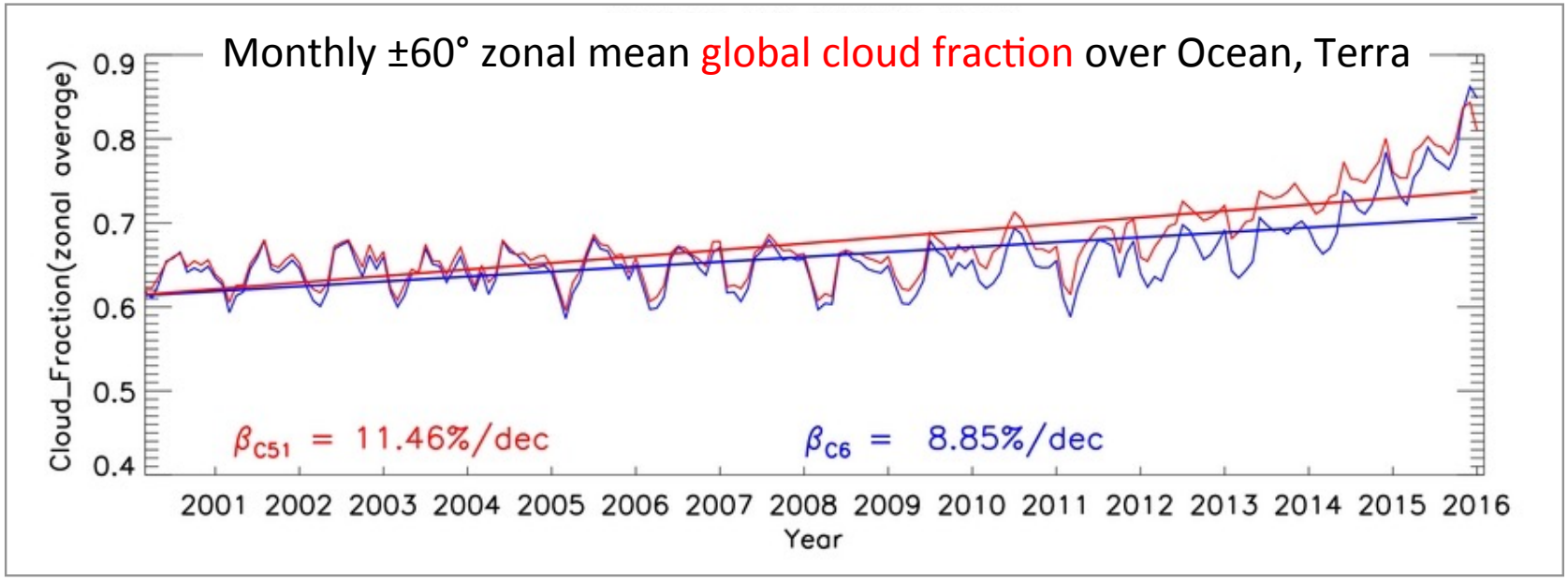




- We are getting close to CDR accuracy requirements!

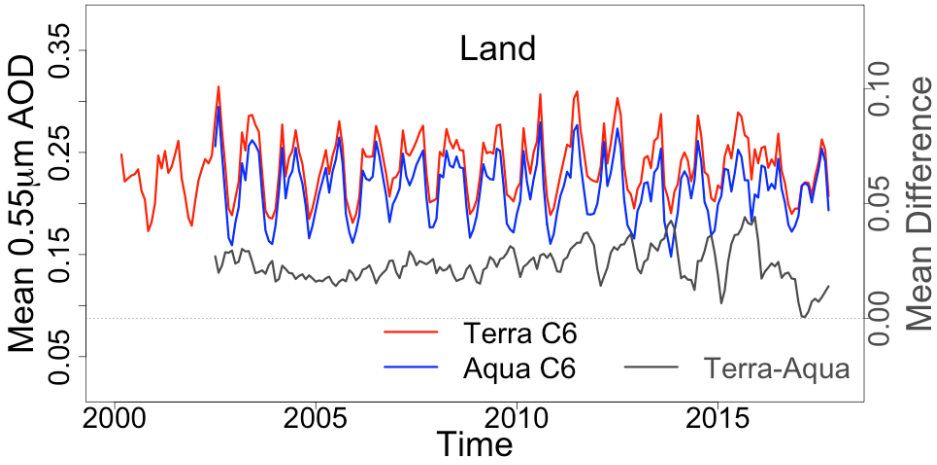
Collection 6.1 (C61)

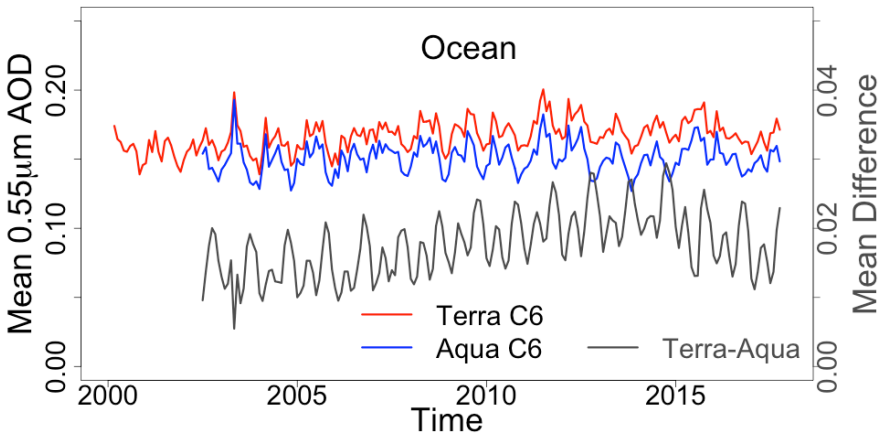
- C6.1: Forward processing began Oct 2017
- Main purpose was to correct “trending” problems in cloud masking (caused by drifting Infrared radiances).



- But C6.1 gave us opportunity to fix other things
  - Terra/Aqua drift
  - Urban bias

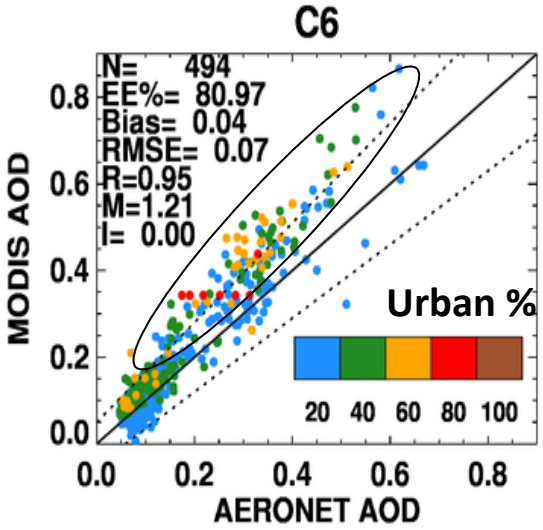
Reduce Terra/Aqua drifting and offset

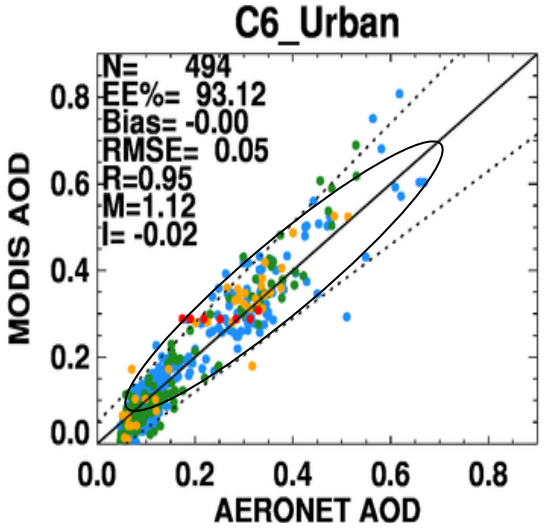




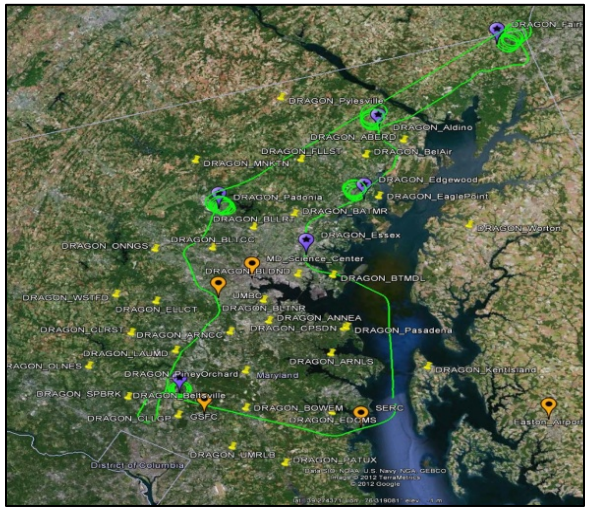
- Terra-Aqua global offset of $\Delta\tau$ = ~0.01-0.02
  - Appears to be bias, but hard to prove and to fix.
- Changing $\Delta\tau$ is likely unphysical
  - C6.1 includes de-trending of MODIS reflectance observations

Urban Retrievals in MODIS 6.1





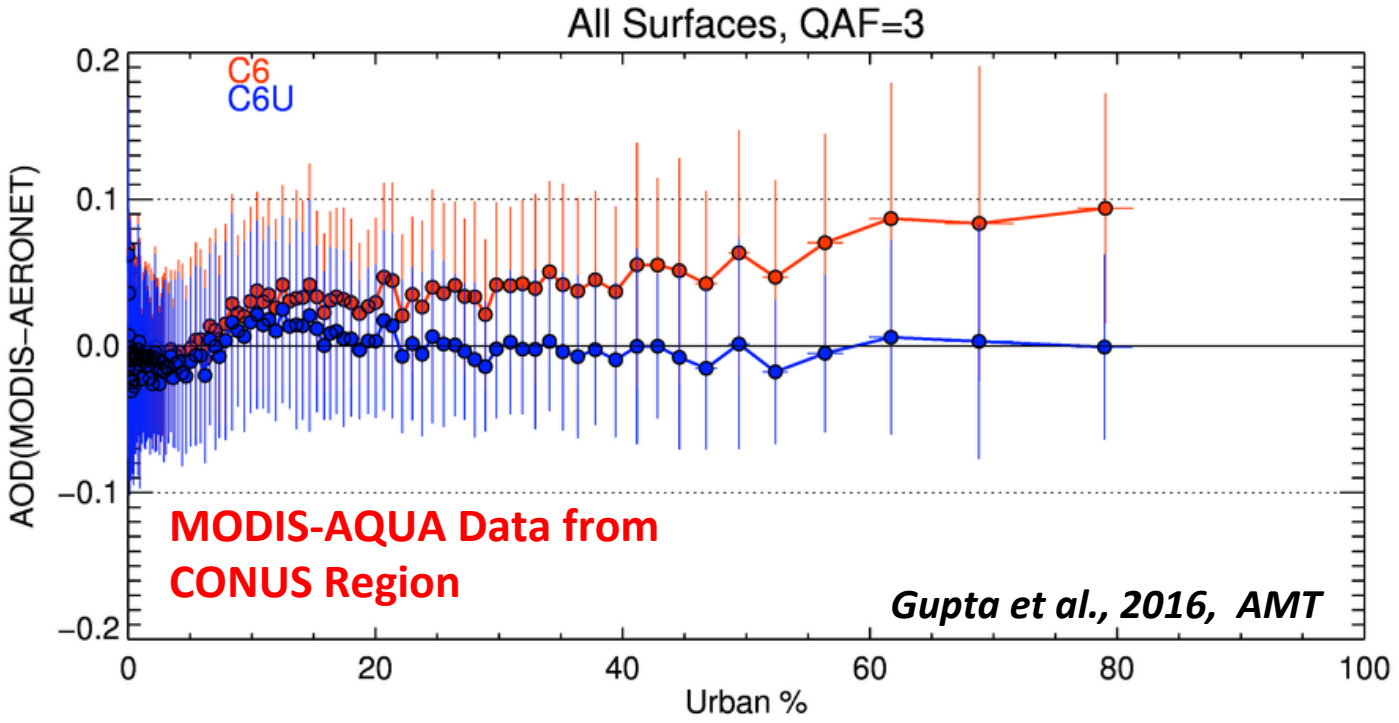
(DISCOVER-AQ, Summer 2011 in Maryland, USA)



Surface reflectance correction as a function of urban %

→**Significant reduction in AOD bias**

Implemented in C6.1

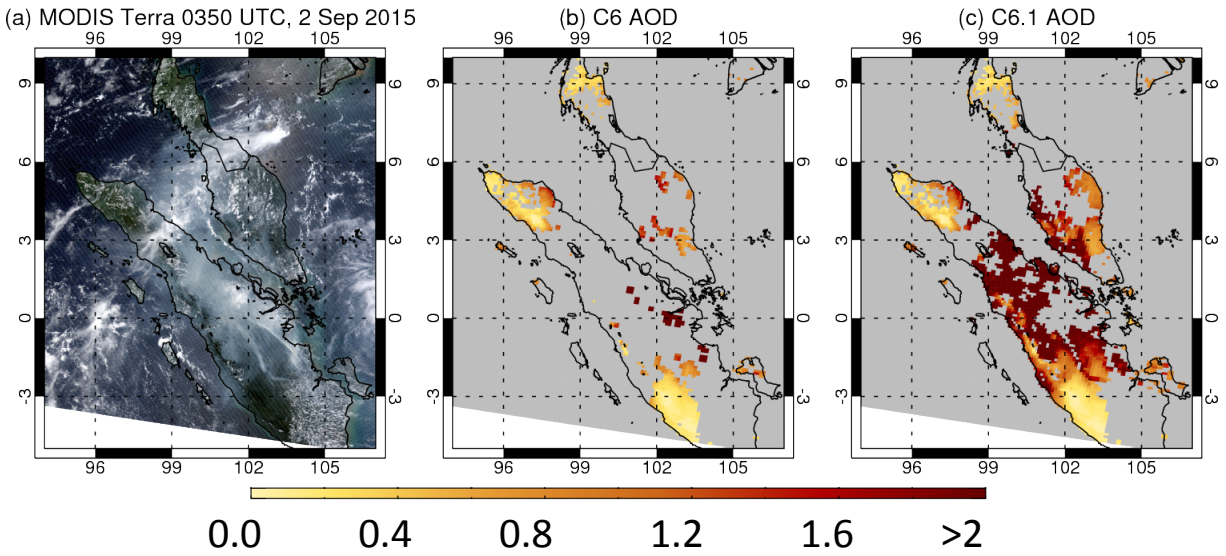


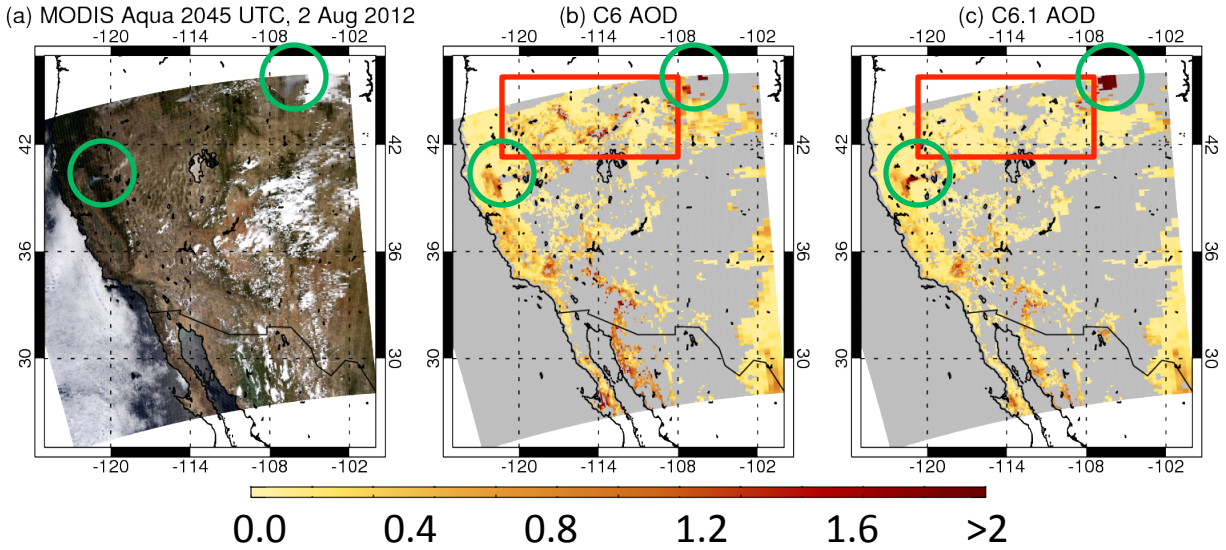
MODIS Collection 6.1 Deep Blue addresses some calibration and regional issues

Better discrimination between **cloud** and large-scale **extreme haze** events

Better **removal of artifacts** in rugged terrain; restoral of **small smoke plumes**

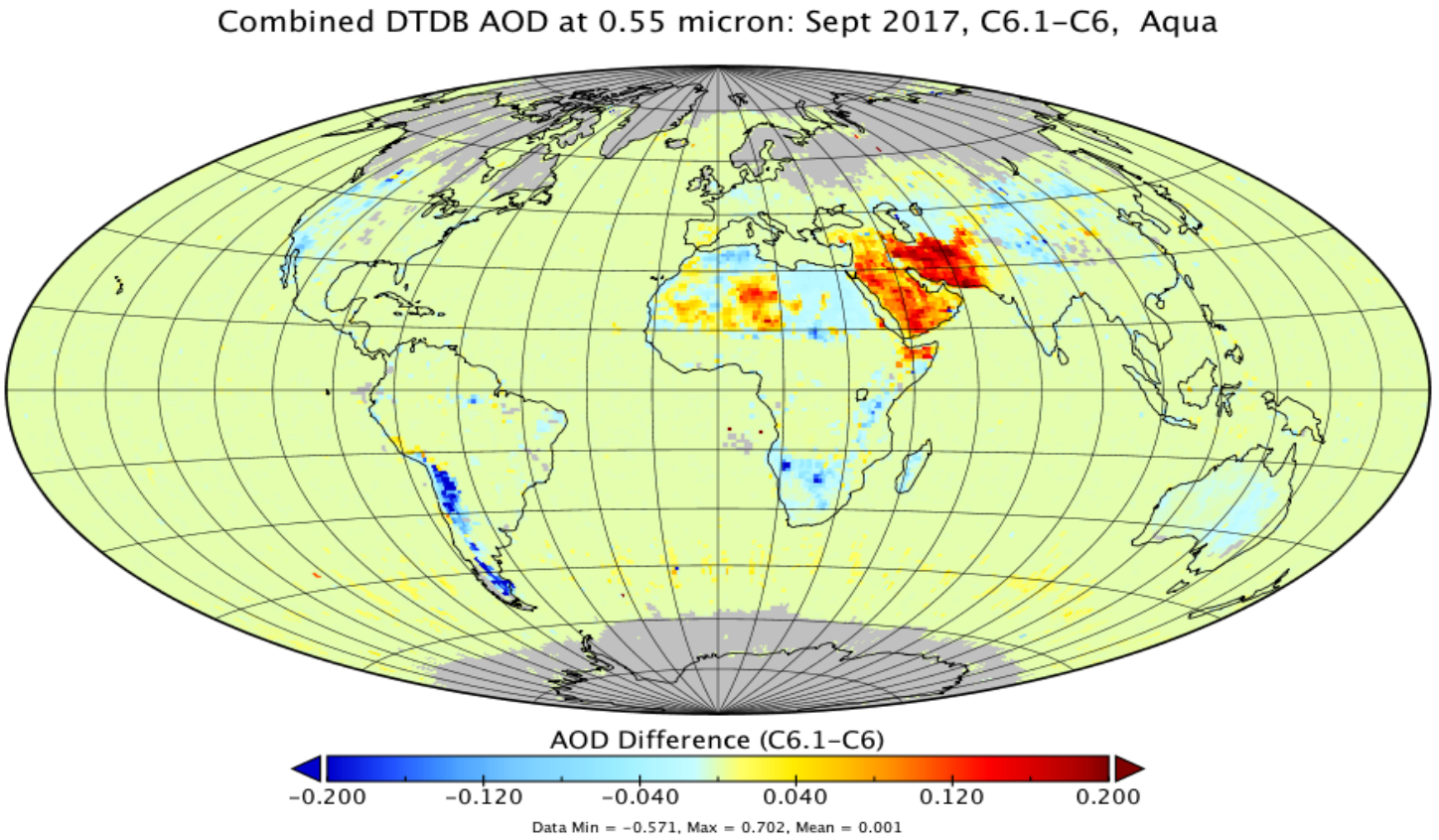
Also updates to sensor **calibration**, retrieval **uncertainty** estimates, and more





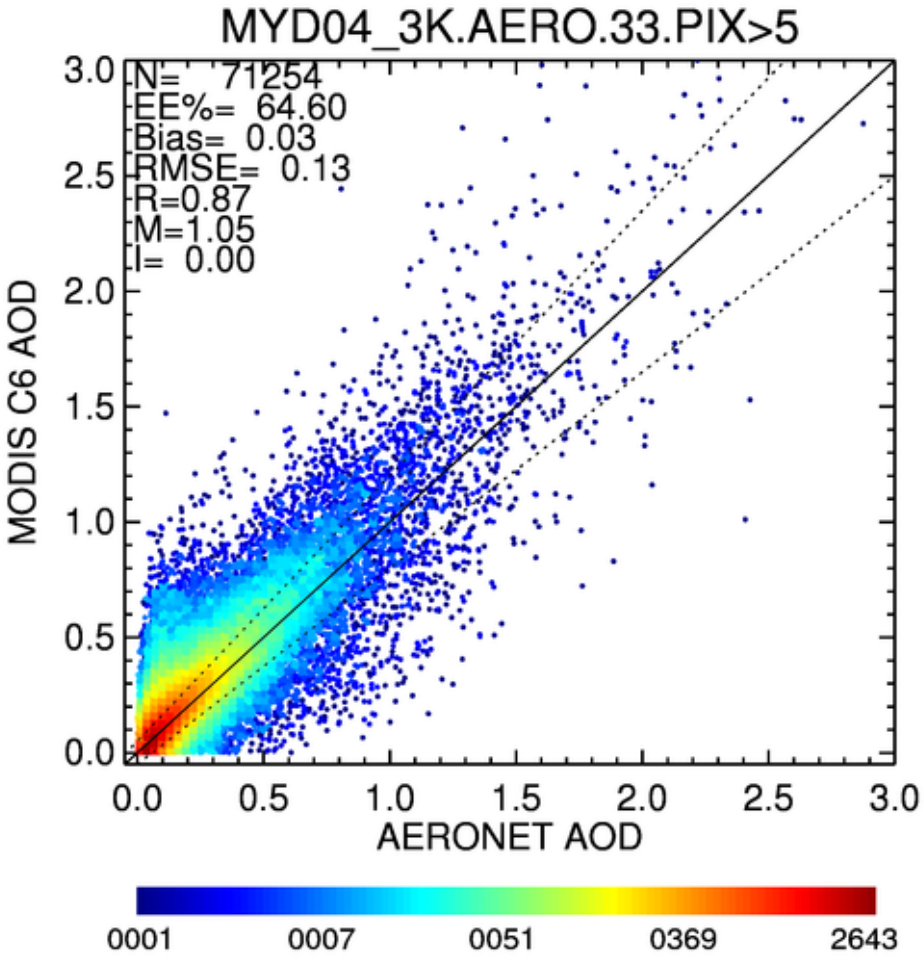
PI: Christina Hsu (christina.hsu@nasa.gov)

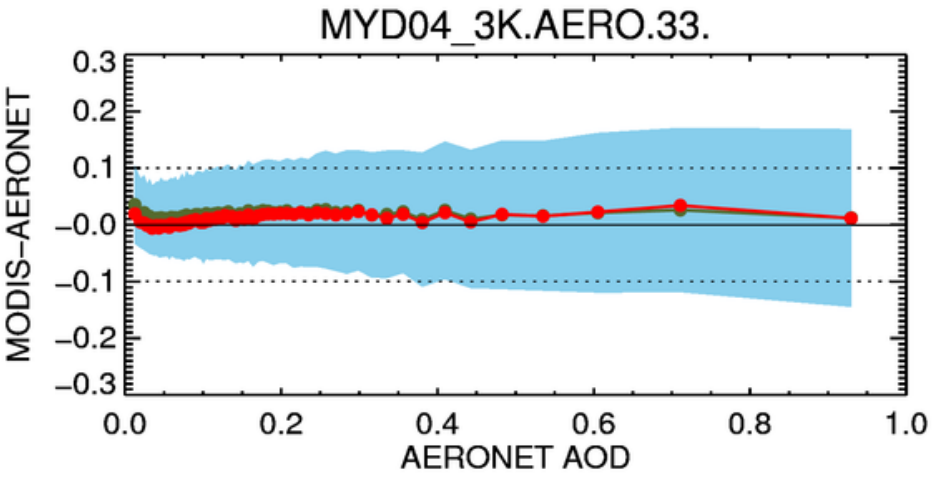
MODIS DT/DB Merged Products (C6.1 compared to C6)



- Additional coverage
- Slightly higher quality
- 10 Km only
- There will be a VIIRS merged product

MODIS Dark Target 3km Product



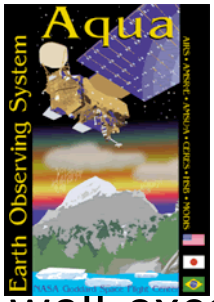


MODIS C6.1 schedule/status

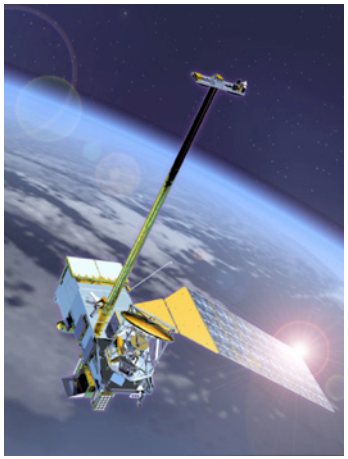
(modis-atmosphere.gsfc.nasa.gov/documentation/collection-61)

- Current: forward-processing mode for both Terra and Aqua -MODIS since Oct 19.
- C6.1 includes:
  - L1B (calibration),
  - upstream Level 2 (cloud mask),
  - L2 – clouds:
  - L2 - aerosols: DT and DB 10-km, and DT 3-km.
  - Level 3 – Aerosols/Clouds/Water Vapor
- Plan for re-processing (starting Oct 19):
  - Terra (2000-2017) complete by mid-Dec 2017
  - Aqua (2002-2017) complete by end of Mar 2018
- Also Near-Real-Time (NRT) processing for LANCE/Worldview applications (including GMAO data assimilation).

Beyond **MODIS**



- Terra (17) and Aqua (almost 15) have both have well-exceeded their planned mission lifetimes.
- With luck, they will last until 2022.
- But for climate, we need to continue the MODIS record, with no “jumps”



VIIRS!

Visible-Infrared Imager Radiometer Suite aboard Suomi-NPP (and future JPSS)

Both DT and DB algorithms are being ported
NOAA operational products available now

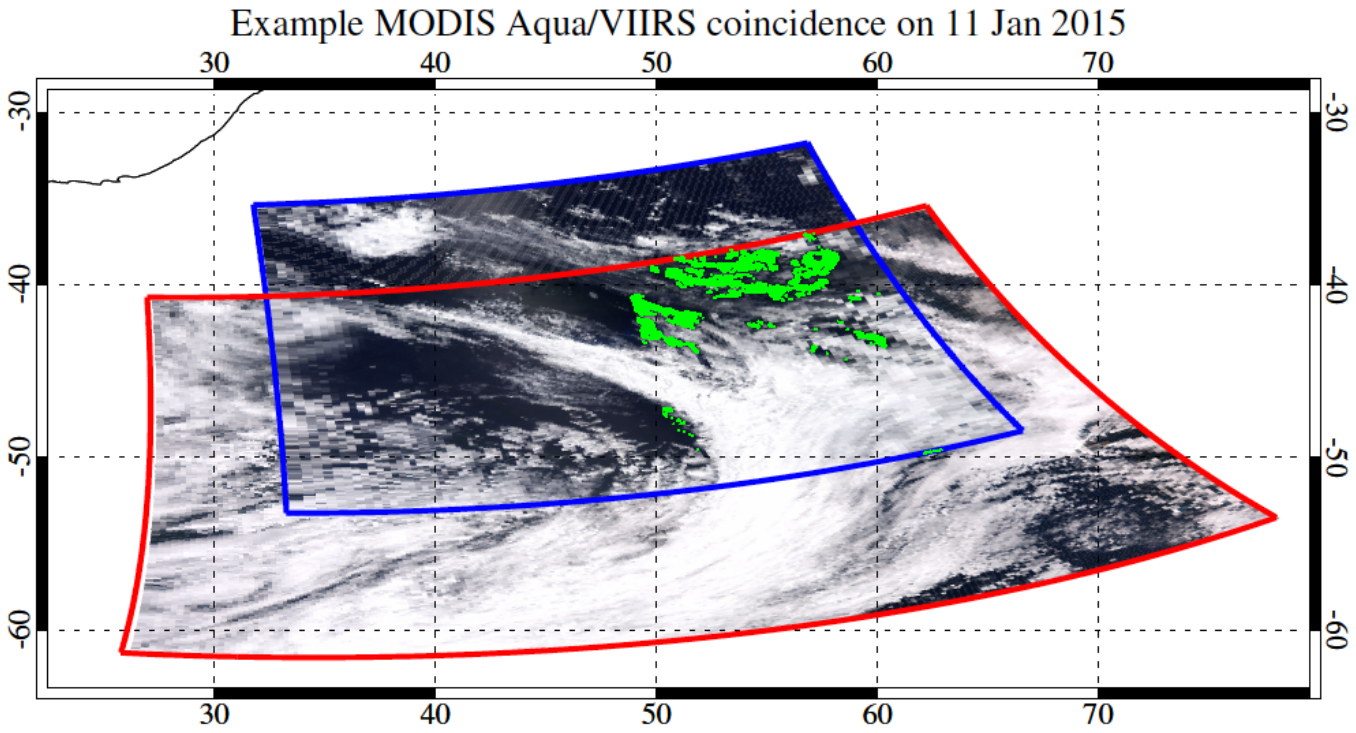


Figure 2. Example MODIS/VIIRS match up for two near-coincident granules (beginning one minute apart). The S-NPP VIIRS granule is outlined in red, and MODIS Aqua in blue. Suitable matched pixels are shown in green.

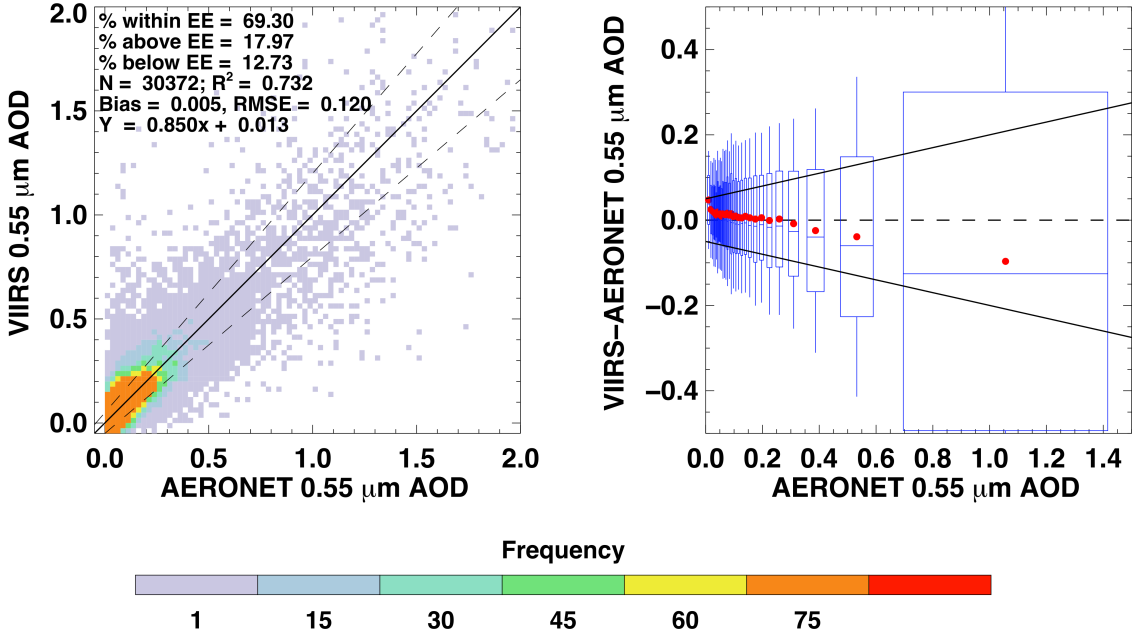
From Sayer et. al. 2015sd

VIIRS vs MODIS: Attributes

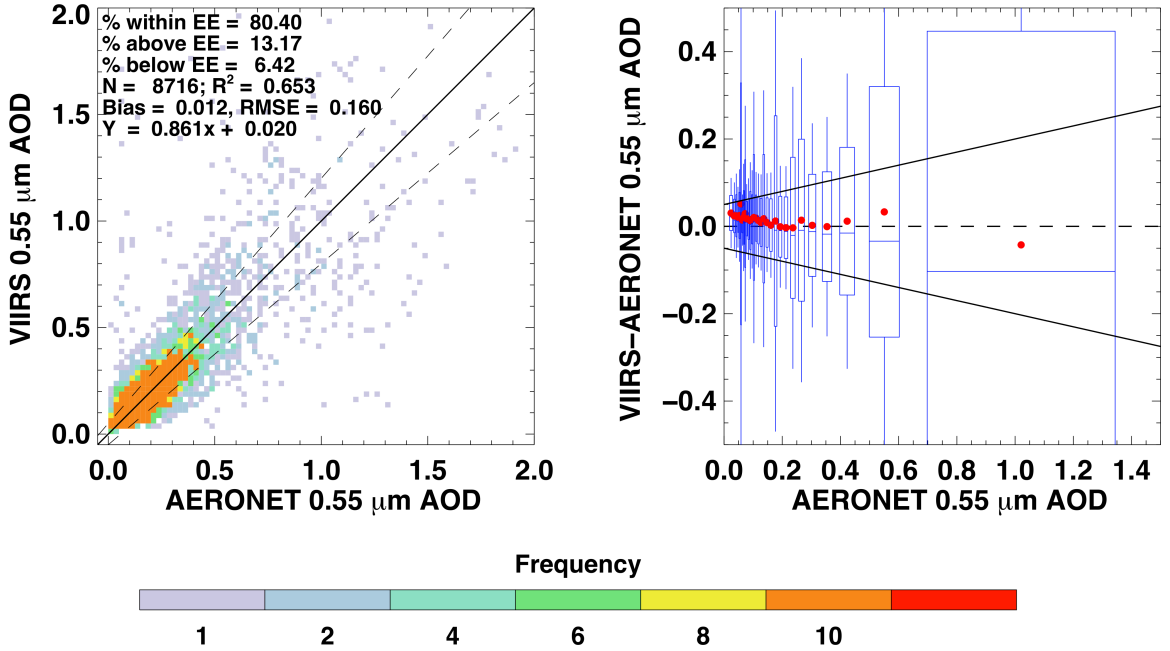
	MODIS	VIIRS - NOAA	VIIRS – NASA
Product Size	10 Km 3 Km (DT only)	1 Km	6 Km
Granule size	5 minute	86 sec	6 minute
Orbit altitude	690 km	824 km	824 km
Equator crossing time	13:30 LT	13:30 LT	13:30 LT
Swath	2330 km	3040 km	3040 km
Pixel nadir	0.5 km	0.75 km	0.75 km
Pixel edge	2 km	1.5 km	1.5 km

NASA VIIRS Dark Target Products

Land



Ocean



VIIRS Deep Blue extends and improves upon our AVHRR, SeaWiFS, and MODIS heritage products

Pixel size **6x6 km^2** at nadir

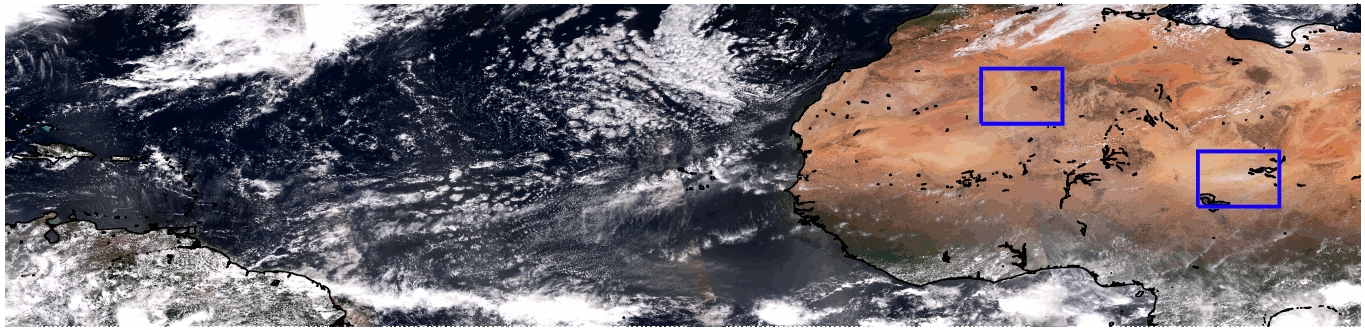
Land and ocean coverage, including deserts

Nonspherical dust aerosol optical models

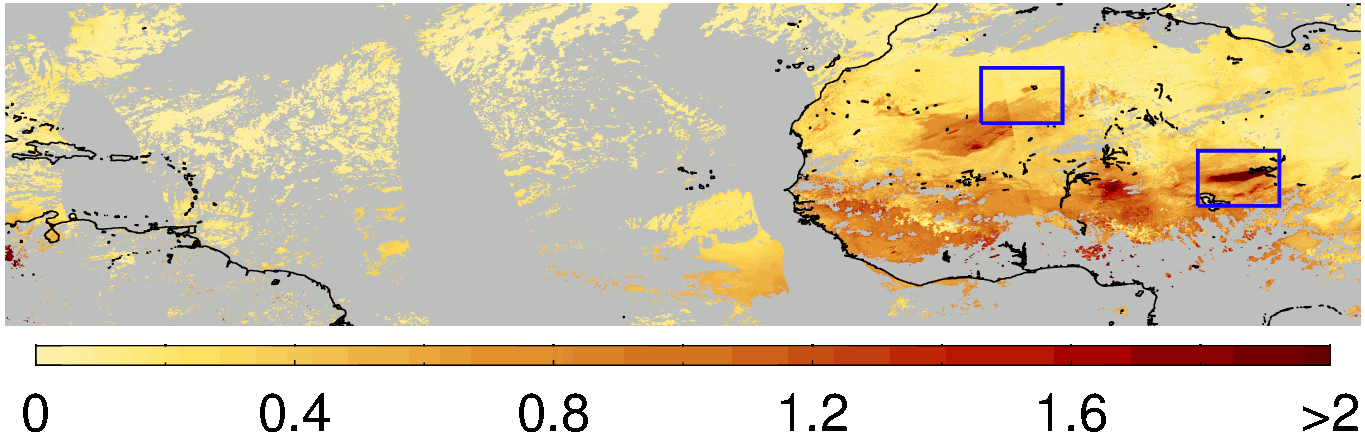
Validation results similar to/better than SeaWiFS, MODIS

Available shortly; demonstration data by request

VIIRS imagery, 20140226



VIIRS Deep Blue aerosol loading (AOD at 550 nm)



Animation showing dust storms in the Bodélé Depression and Algeria

PI: Christina Hsu (christina.hsu@nasa.gov)

MAIAC – MODIS Update

Current Status:

- MAIAC is at MODAPS; C6+ re-processing of MODIS started and should be completed in 4-6 months. A parallel forward processing stream will process the latest MODIS data; expected to become available in 2-4 months. Product name: MCD19.

Products (gridded):

- **Atmosphere**: WV, CM, AOD, aerosol type (background/ smoke/dust), FMF (over water) @1km resolution;
- **Land Surface**: spectral BRDF (RTLS model, naturally gap-filled @ 1km), BRF (surface reflectance) @1km and 500m in bands 1-12, albedo;
- **Detected Snow**: snow grain size, and sub-pixel snow fraction (1km).

MAIAC – MODIS Update

Current Availability:

- MAIAC is available via internal processing on NASA Center for Climate Simulations (NCCS supercomputer) for 2000-2016. Processing is done on a continent basis for the whole globe within 70° latitude except Oceania, Australia and New Zealand (not processed because of lack of space).

Link to Data:

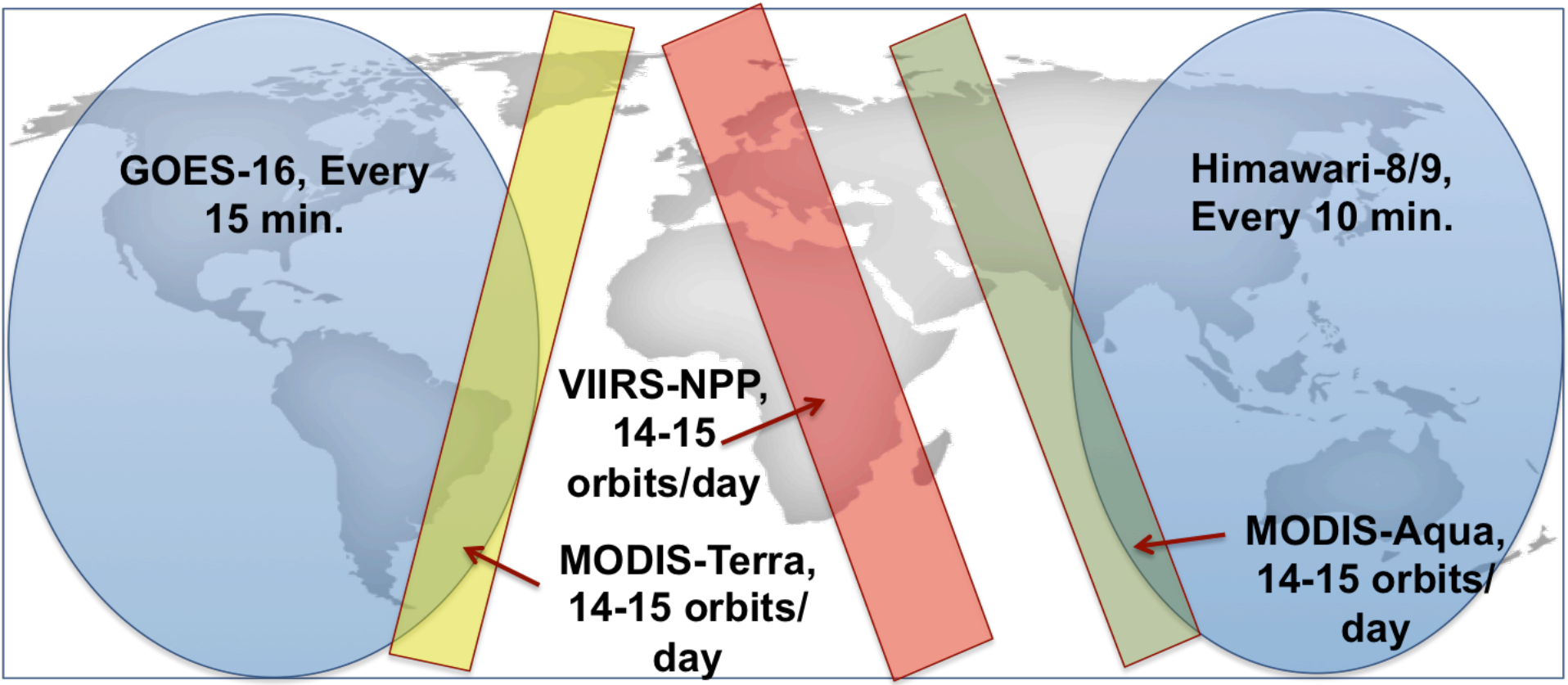
- ftp://maiac@dataportal.nccs.nasa.gov/DataRelease/
- Press 'Enter' if asked for password
- For latest data, use only directories processed in 2017, e.g. NorthAmerica_2000-2016/

  for the North America.
- For questions, please write to Alexei.I.Lyapustin@nasa.gov; Yujie.Wang@nasa.gov

No Matter the Product QA is important!

QA scale and meaning is the same for MODIS and VIIRS DT Products: 0 = low 3 = high

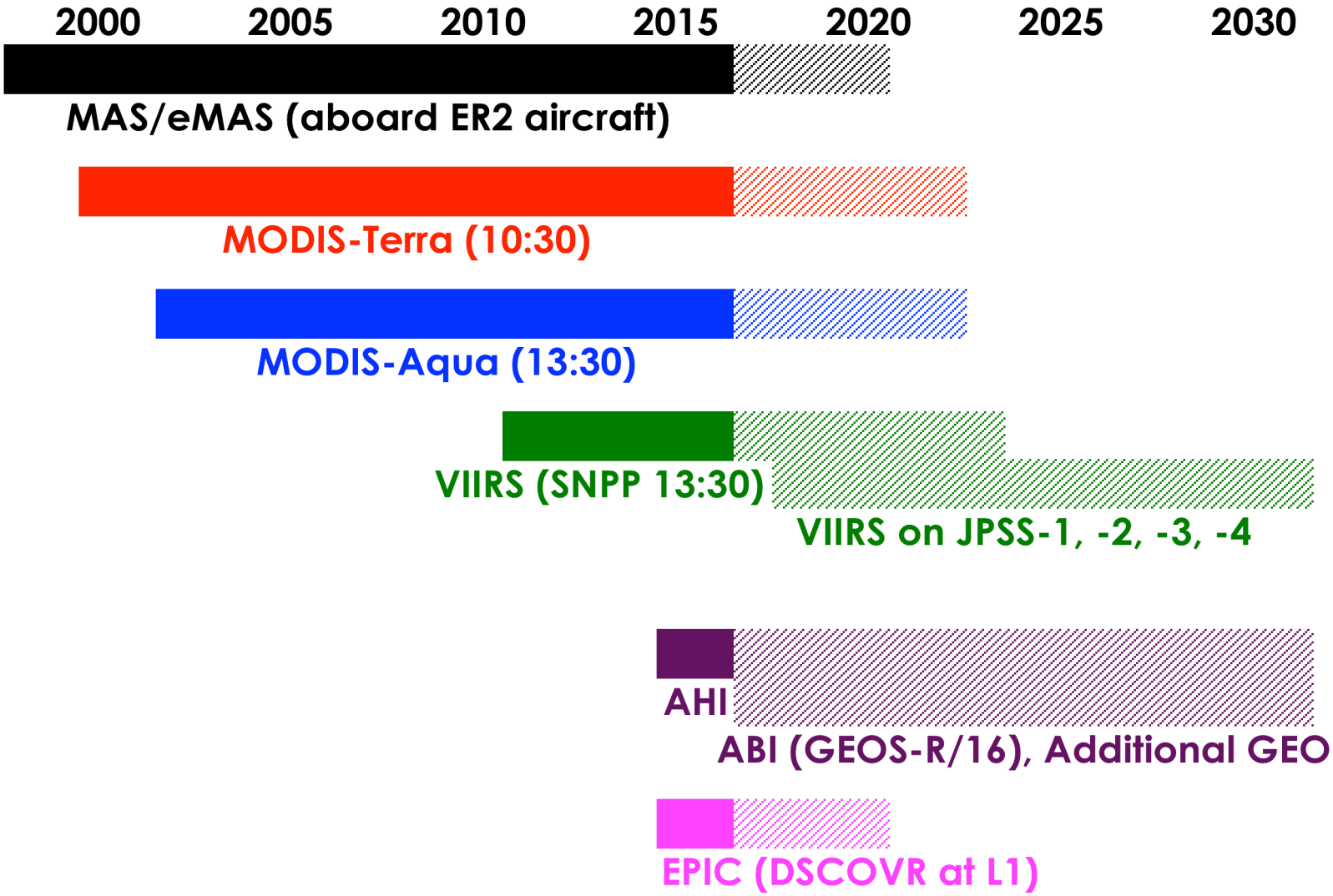
Merge LEO/GEO? Global/Regional?



How many additional sensors do we need to observe climatology (and diurnal cycle and transport) of global aerosol?

Breaking the Temporal Barrier:
15-Day DT retrieval on AHI (May, 2016)

The DT family



With so many products how to do we choose?

- Stay aware of the literature
- Look at product/PI websites
- Talk to the PI's

With so many products how to do I choose?

Although PI's have an interest in seeing people use their own products they will usually tell you . . .

Contacts for Satellite Products

- Dark Target Robert.C.Levy@nasa.gov
- Deep Blue Christina.Hsu@nasa.gov
- MAIAC Alexei.I.Lyapustin@nasa.gov
- NOAA Shobha.Kondragunta@noaa.gov
- MISR Ralph.Kahn@nasa.gov