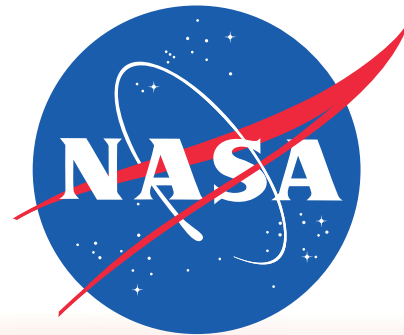
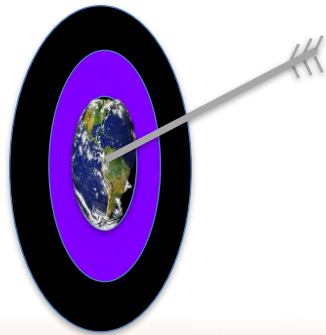


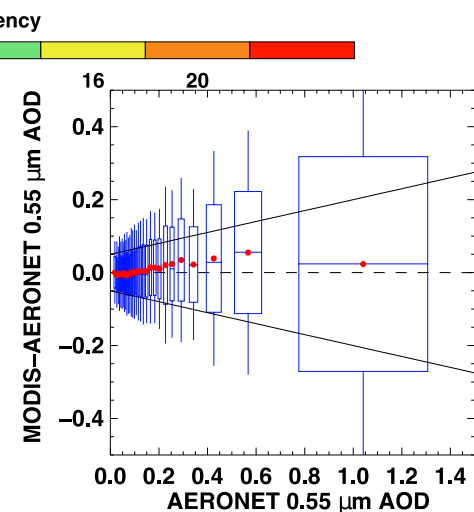
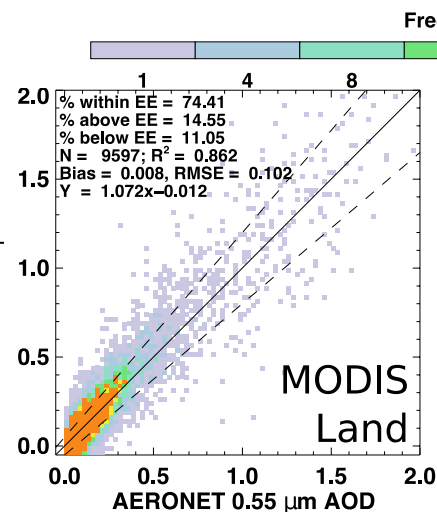
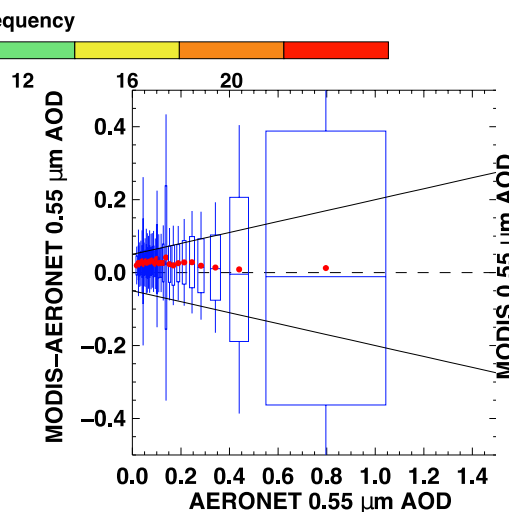
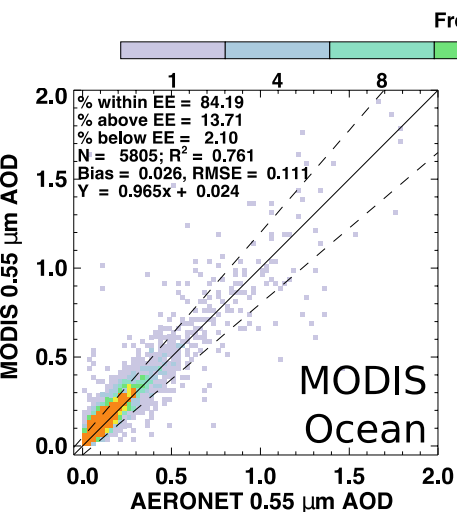
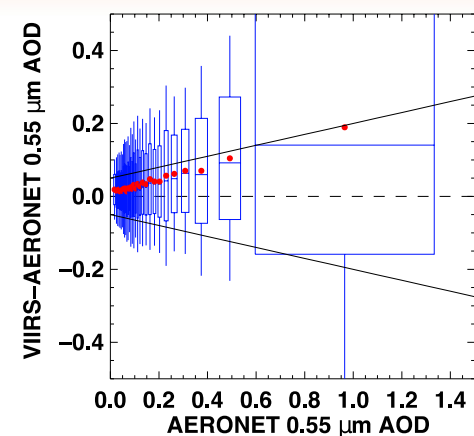
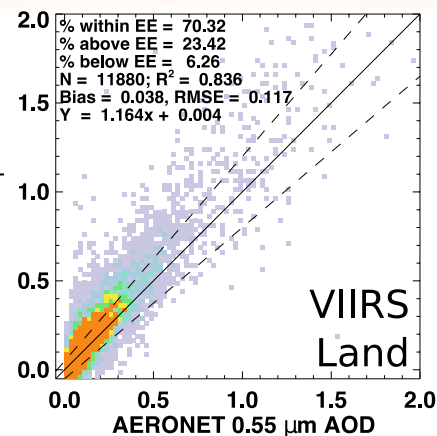
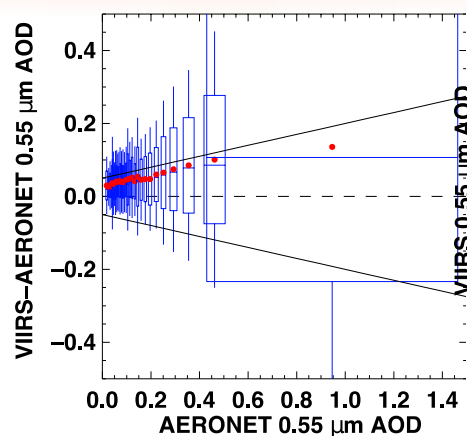
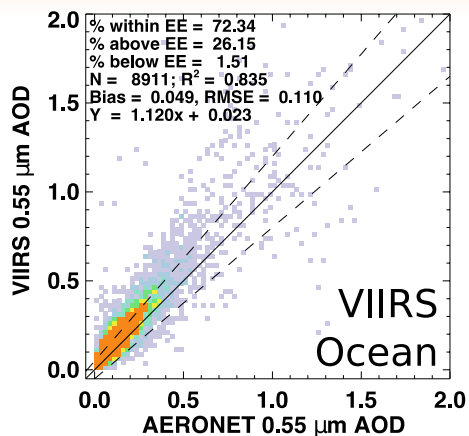
Continuing the Dark Target Aerosol Record from MODIS to VIIRS

Virginia Sawyer, Rob Levy, Shana Mattoo,
Geoff Cureton, Yingxi Shi, Lorraine Remer

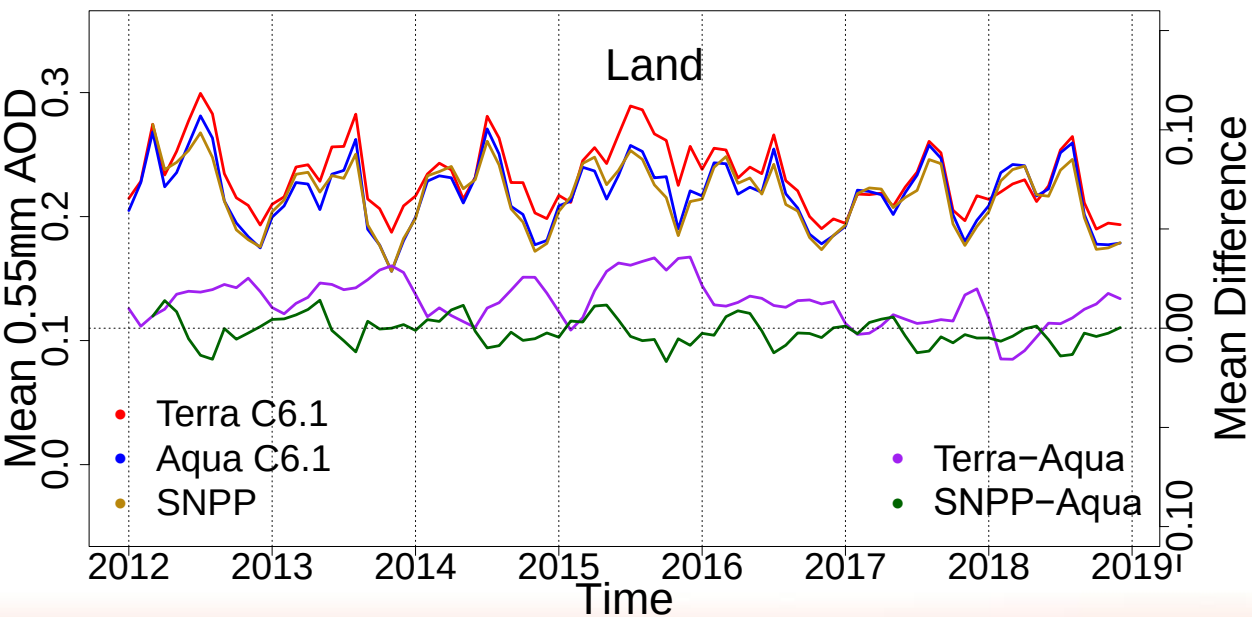
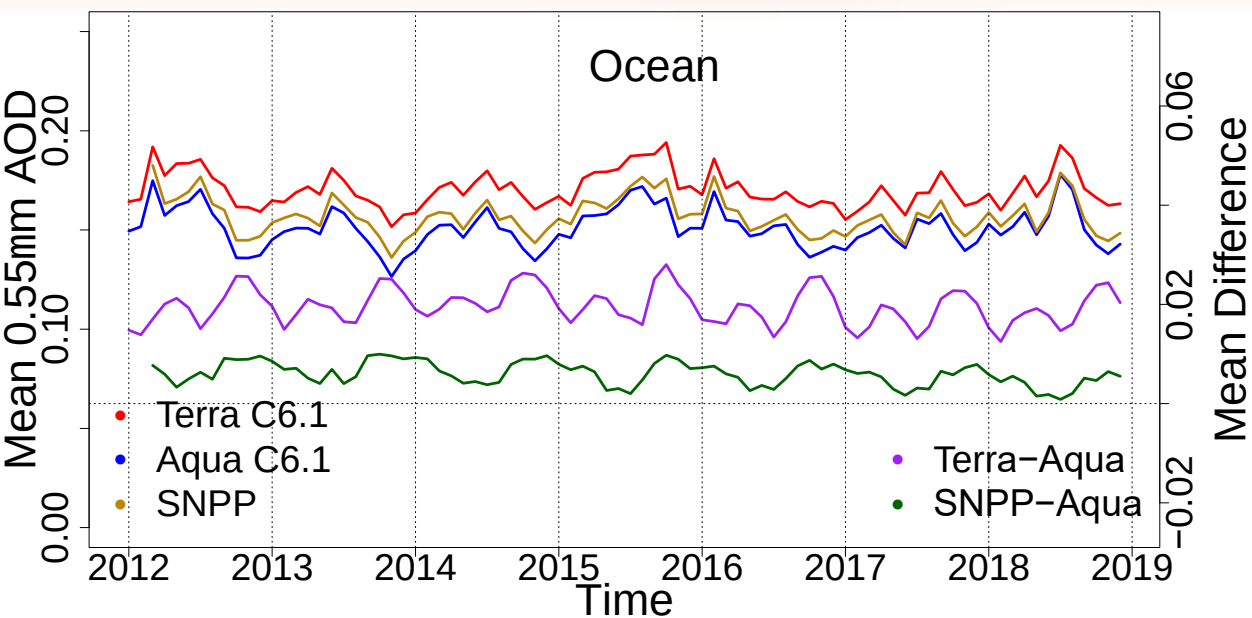


Dark Target AOD as a Climate Record

- The MODIS Dark Target (DT) aerosol record is close to meeting Global Climate Observing System criteria—except for its length
- Differences between MODIS and VIIRS result in AOD offsets, but DT ports to newer instruments allow the record to continue beyond mid-2020s
- Offsets between Terra and Aqua observations are explored in Levy et al. (2018)
- The VIIRS version of the standard DT product, AERDT_L2_VIIRS_SNPP, is currently in the LAADS delivery process
- The performance of AERDT_L2_VIIRS_SNPP is compared to MYD04_L2, since SNPP and Aqua have similar orbits



Collocation with AERONET shows retrieval skill close to MODIS Aqua, with a small overall positive bias



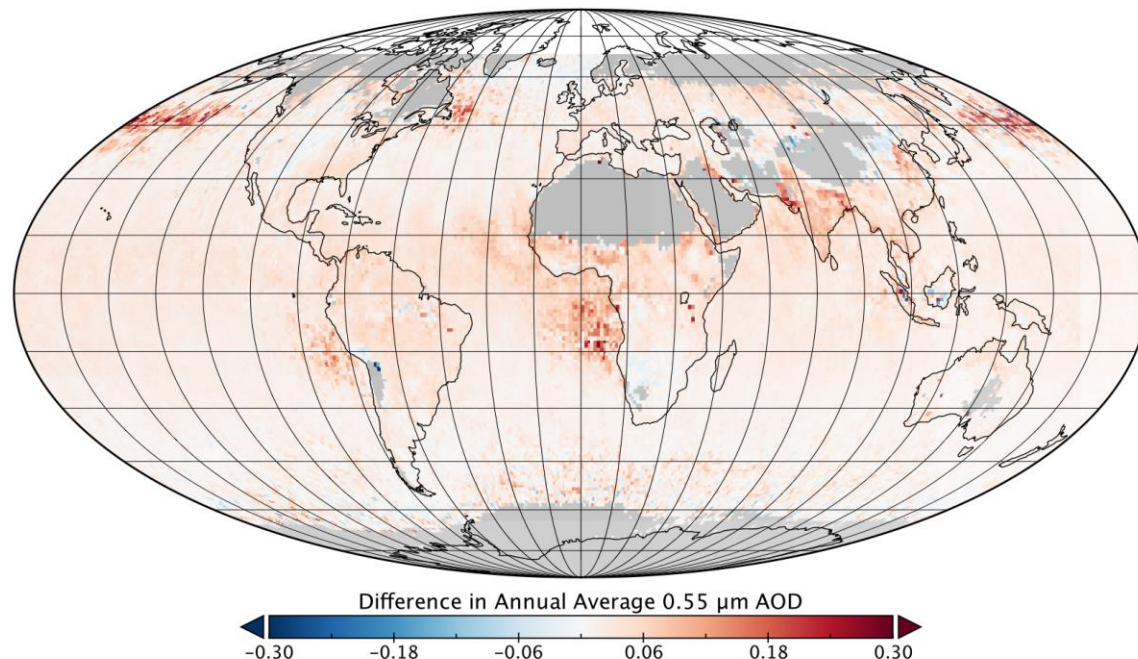
For MODIS C6.1 and operational VIIRS DT, the offset between SNPP and Aqua is smaller than the offset between Terra and Aqua

- No long-term trends
- Average offset over ocean: +0.006
- Over land: -0.002
- Seasonal cycles differ from Terra-Aqua offset

L3-like gridded averages show that VIIRS has a small widespread positive bias, but MODIS-VIIRS offset is not constant over the globe

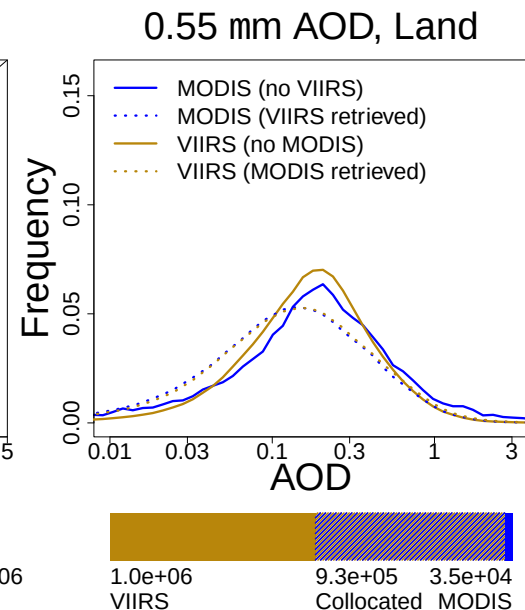
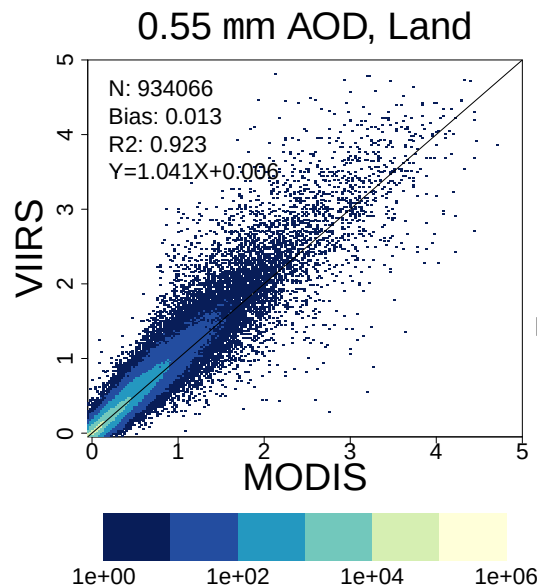
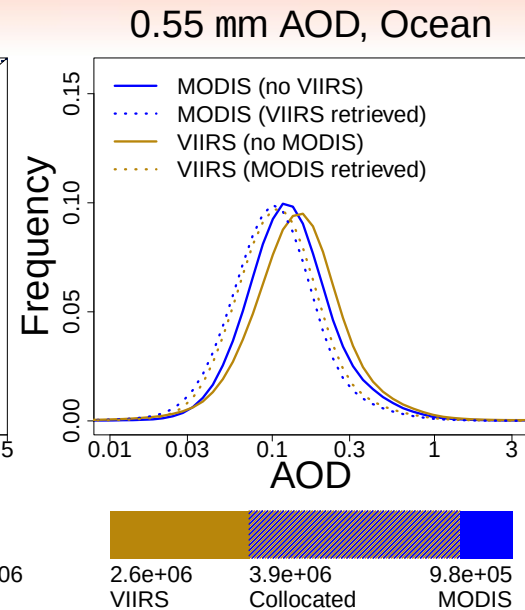
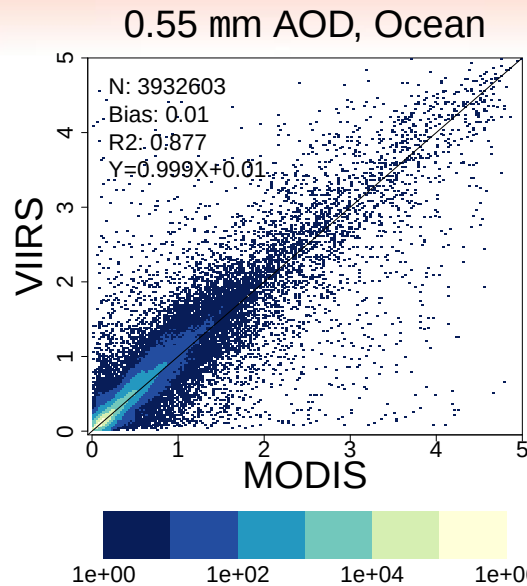
- Regional features change seasonally
- Grid cells are not necessarily collocated in time, as long as minimum threshold for averaging is met
- Ability to retrieve AOD varies by region (cloud cover, surface type)

QA-Filtered Aerosol Optical Depth, VIIRS – MODIS, 2015



Daily average grid cells for all of 2015:

- Collocated grid cells have good agreement and nearly identical AOD distribution
- Roughly half of retrieved grid cells are collocated
- Swath widths make non-collocated grid cells mostly VIIRS
- AOD where only one sensor retrieves skews higher than collocated AOD, but by different amounts for MODIS and VIIRS
- Marginal retrievals (e.g. cloudy areas) account for most bias

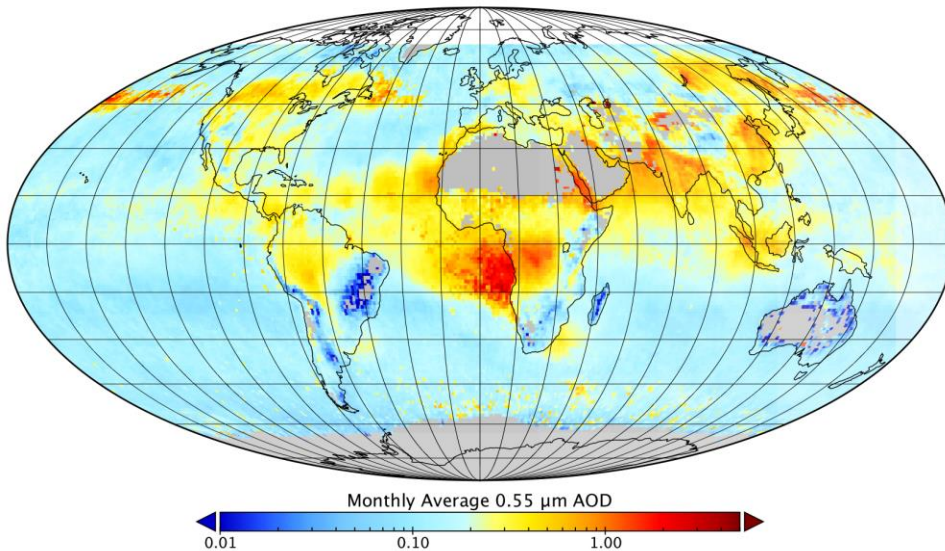


Monthly Average AOD and Seasonal Offsets

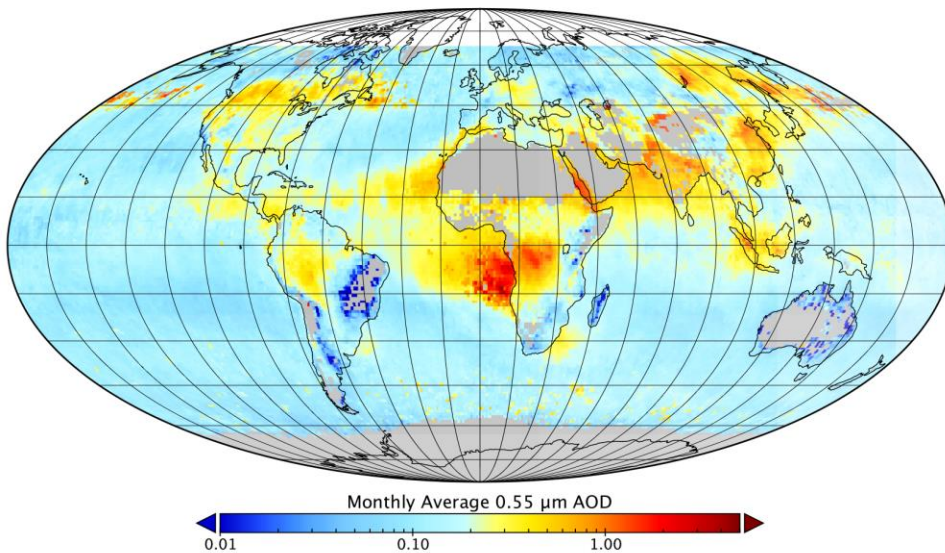
- MODIS-VIIRS offsets vary according to a seasonal cycle, and are subject to storm tracks and regional aerosol events
- Areas with relatively few retrievable pixels have poor collocation for monthly and annual averages, more marginal retrievals, and greater MODIS-VIIRS disagreement
- The seasonal cycle in MODIS-VIIRS AOD offsets over land is most negative in August and most positive in March
- Over ocean, AOD offsets are always positive, but highest in August and lowest in March
- March and August 2015 are compared in detail next

Monthly Average AOD: August 2015

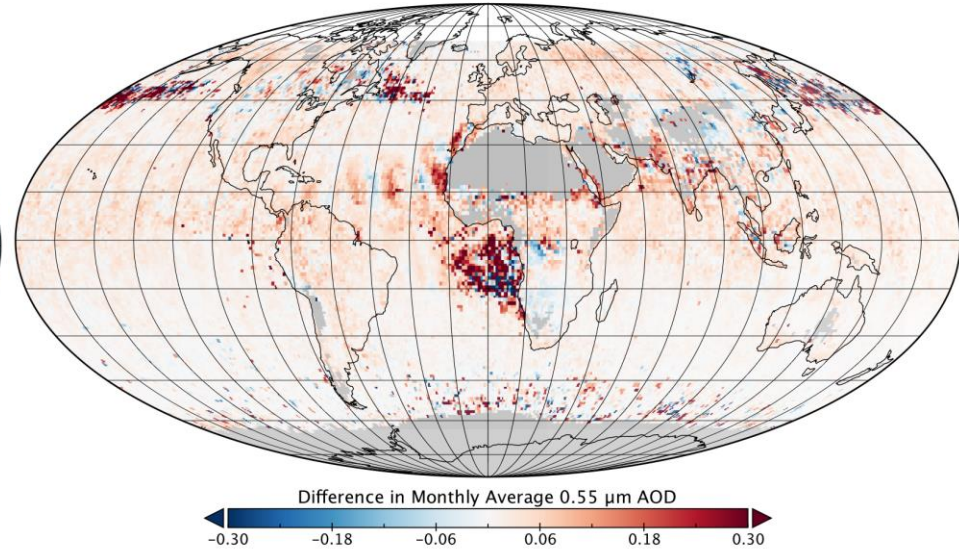
QA-Filtered Aerosol Optical Depth, VIIRS SNPP v1.1, August 2015



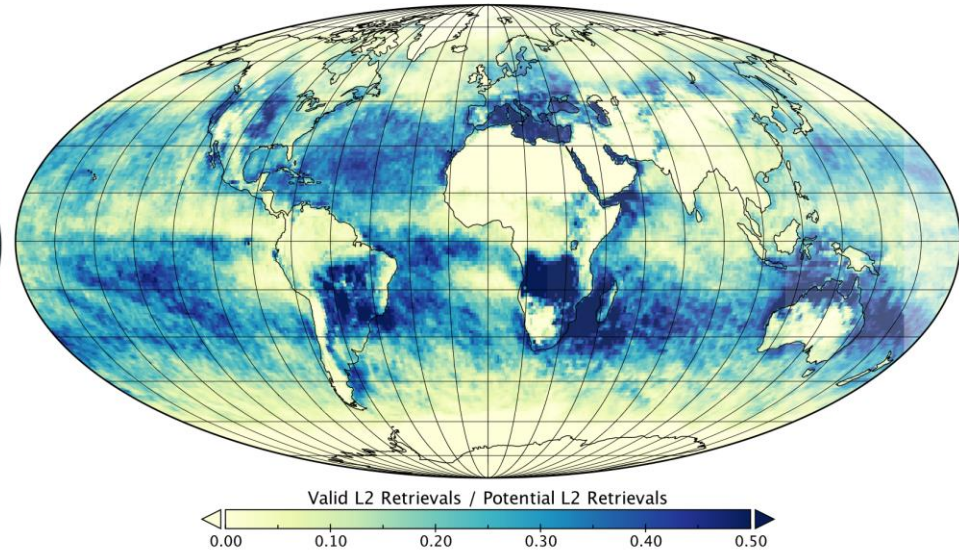
QA-Filtered Aerosol Optical Depth, MODIS Aqua C6.1, August 2015

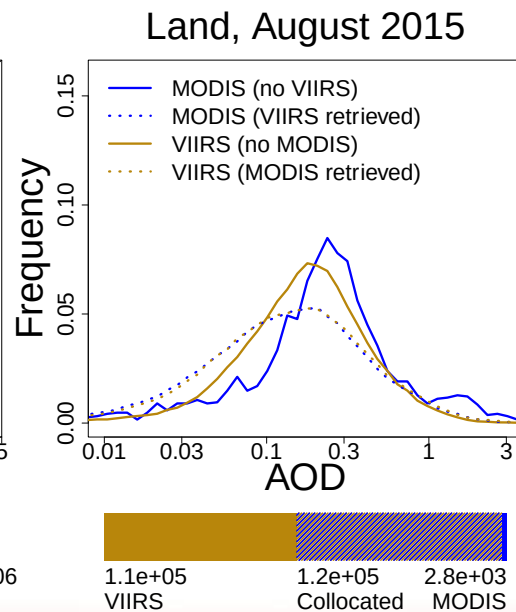
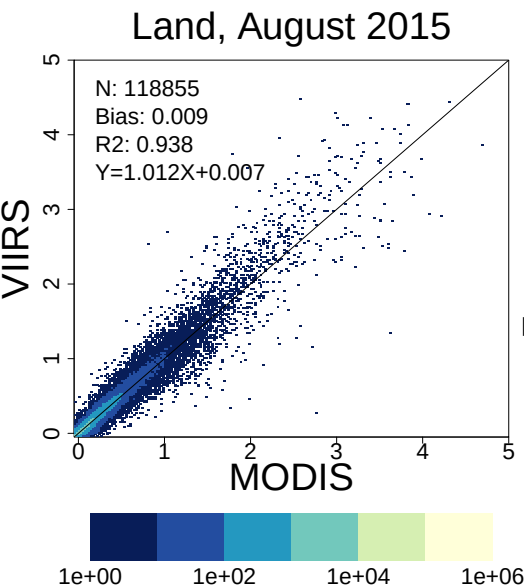
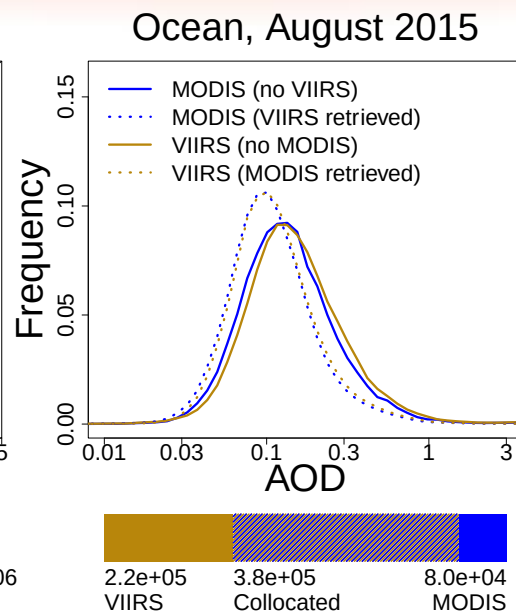
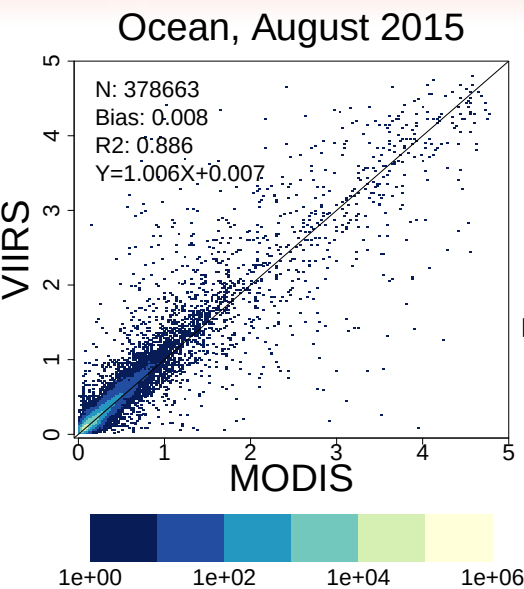


QA-Filtered Aerosol Optical Depth, VIIRS - MODIS, August 2015



Retrievability Fraction of QA-Filtered AOD, VIIRS SNPP v1.1, August 2015

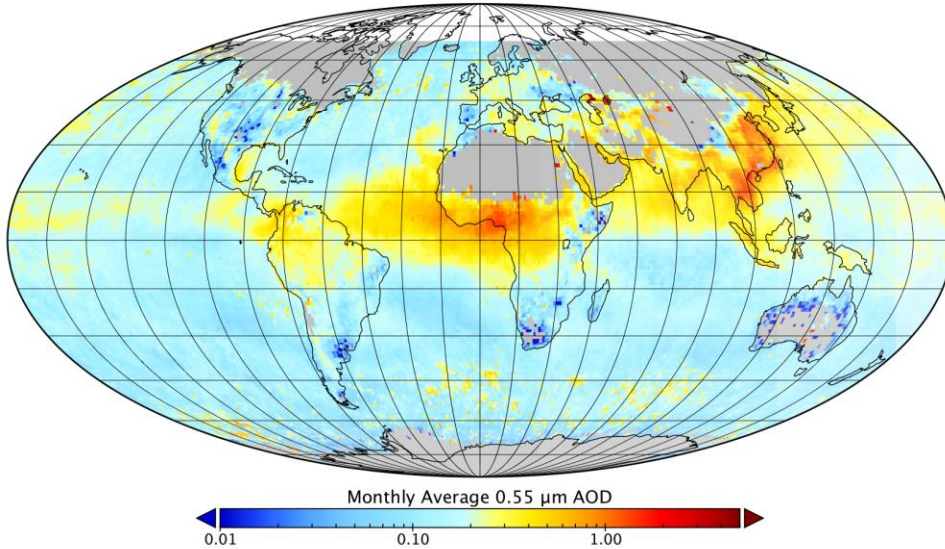




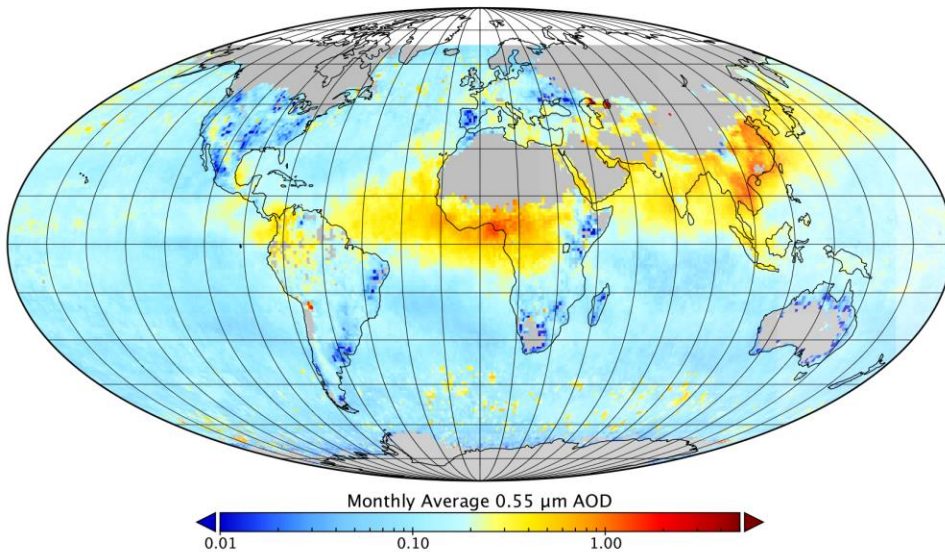
- MODIS and VIIRS capture the same aerosol events over the same parts of the world, but may disagree about magnitude
- Areas of high disagreement tend to have low retrievability, and more non-collocated grid cells
- Non-collocated MODIS skews higher than non-collocated VIIRS over land even though collocated grid cells have the same AOD distribution

Monthly Average AOD: March 2015

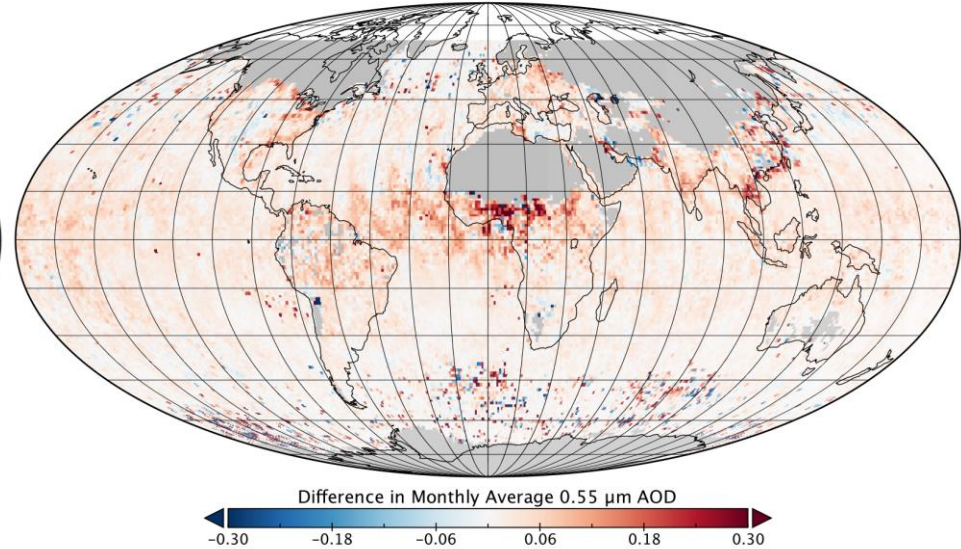
QA-Filtered Aerosol Optical Depth, VIIRS SNPP v1.1, March 2015



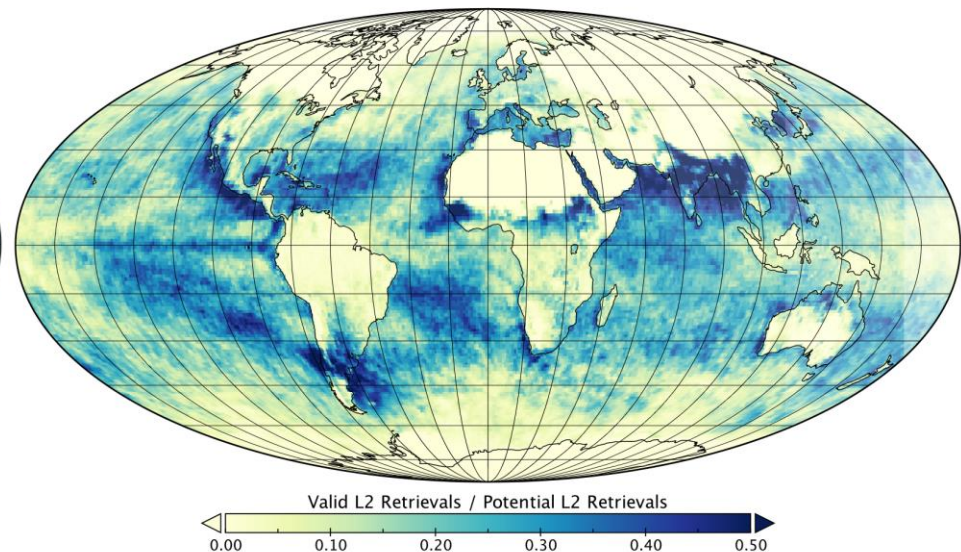
QA-Filtered Aerosol Optical Depth, MODIS Aqua C6.1, March 2015



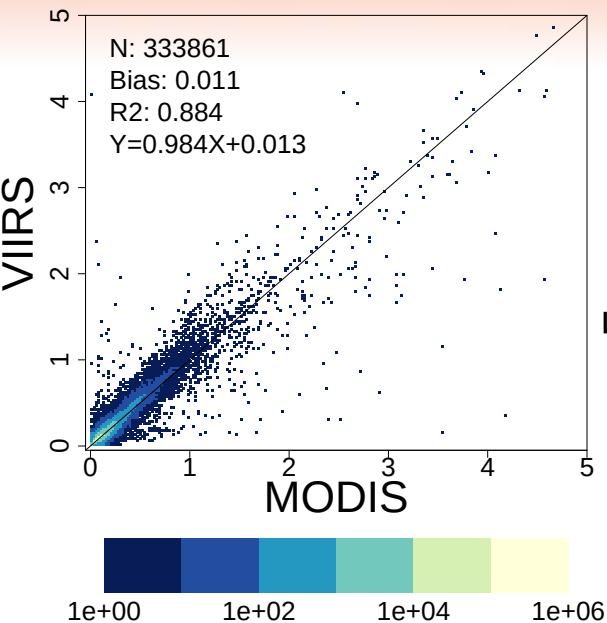
QA-Filtered Aerosol Optical Depth, VIIRS – MODIS, March 2015



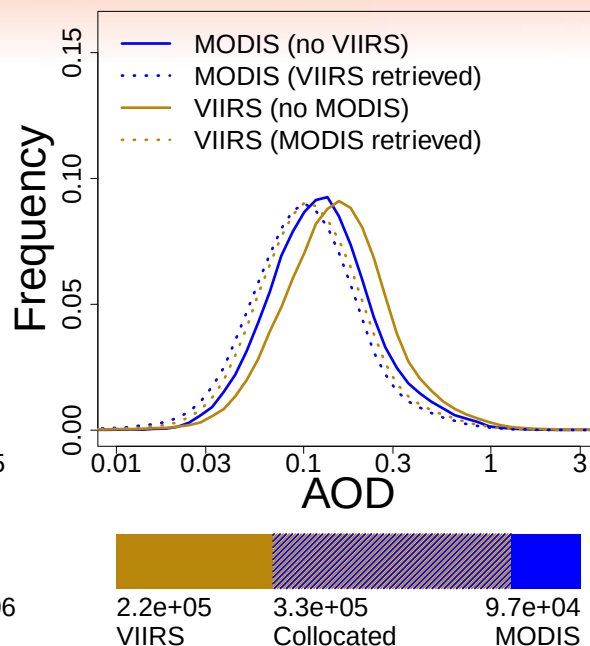
Retrievability Fraction of QA-Filtered AOD, VIIRS SNPP v1.1, March 2015



Ocean, March 2015

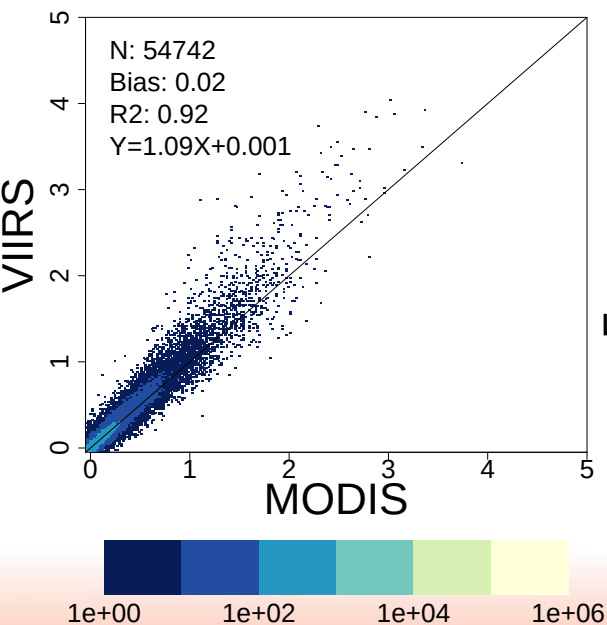


Ocean, March 2015

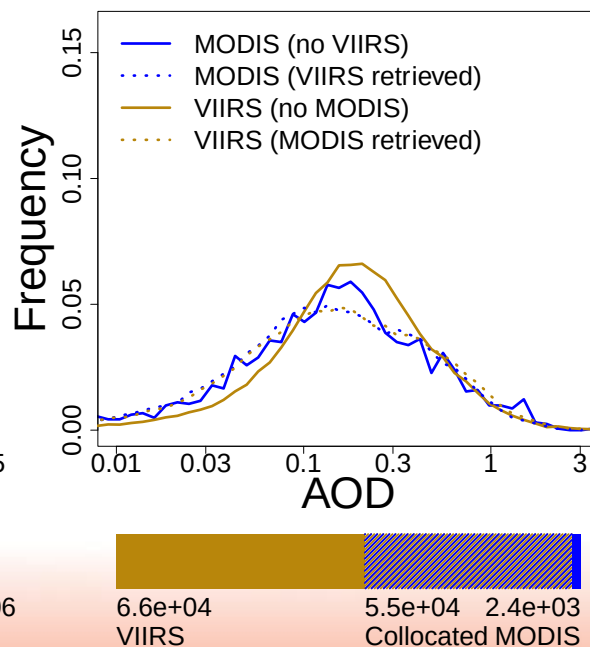


- Overall number of land retrievals is lower in March due to NH snow cover
- Heavy aerosol events seen in August have not begun or are not retrieved

Land, March 2015



Land, March 2015



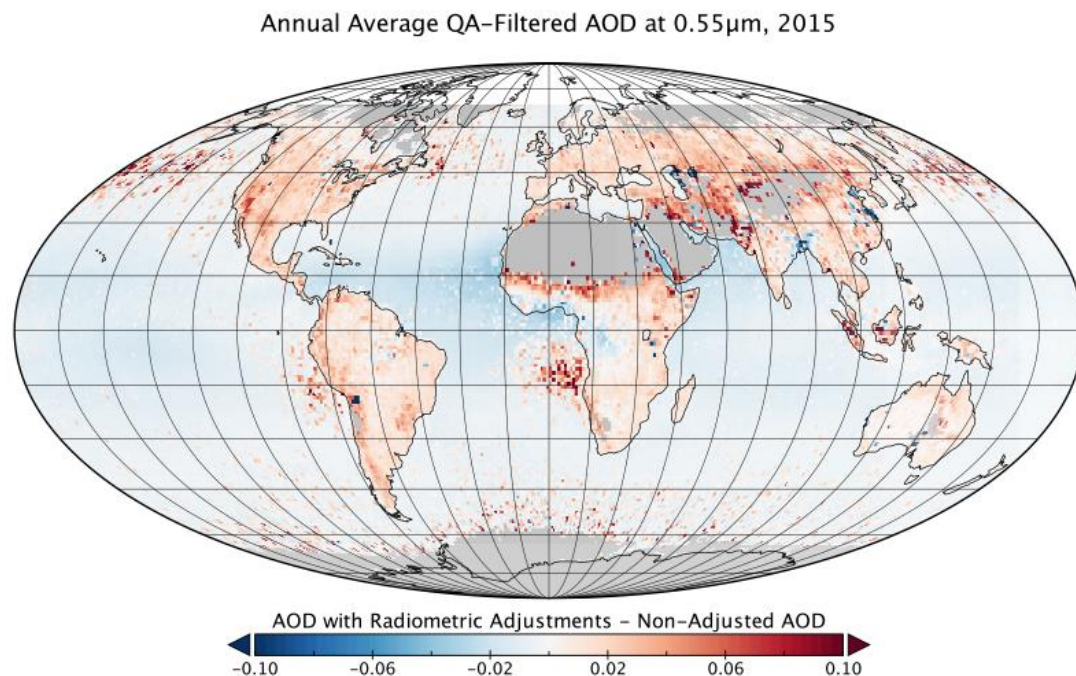
- Ocean AOD distribution closely resembles annual average, with small widespread positive bias

Sayer et al. (2017) calculated radiometric adjustments to be applied to L1b reflectances before L2 retrieval

- Partially compensates for AOD bias vs. Aqua
- Empirically determined: must be recalculated for each sensor reprocessing (either Aqua or SNPP)
- May interact unpredictably with other MODIS-VIIRS continuity products

For now, no adjustment applied to VIIRS DT product.

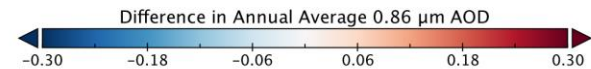
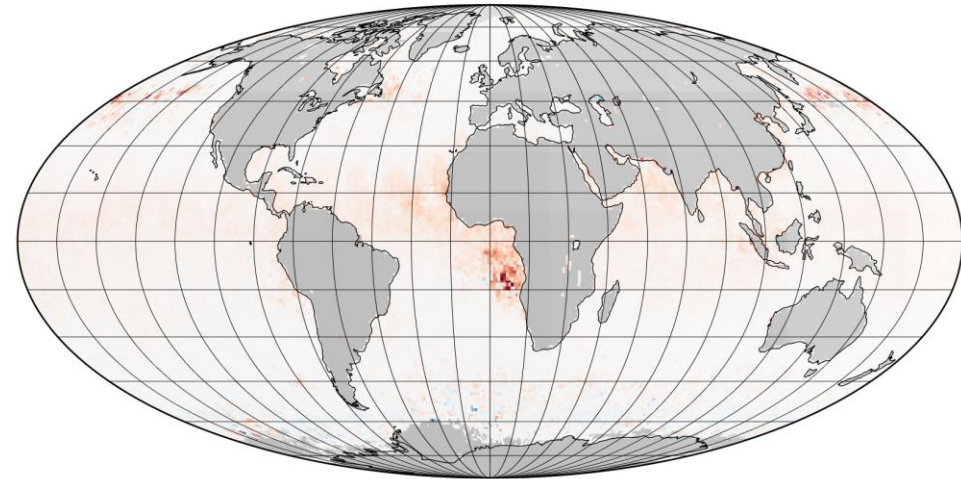
VIIRS Band	(μm)	Factor
M3	0.49	0.990
M4	0.55	0.956
M5	0.67	0.937
M7	0.86	0.962
M8	1.24	1.021
M10	1.60	0.980
M11	2.26	0.933



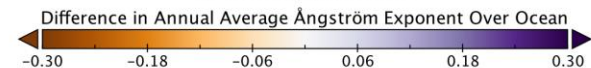
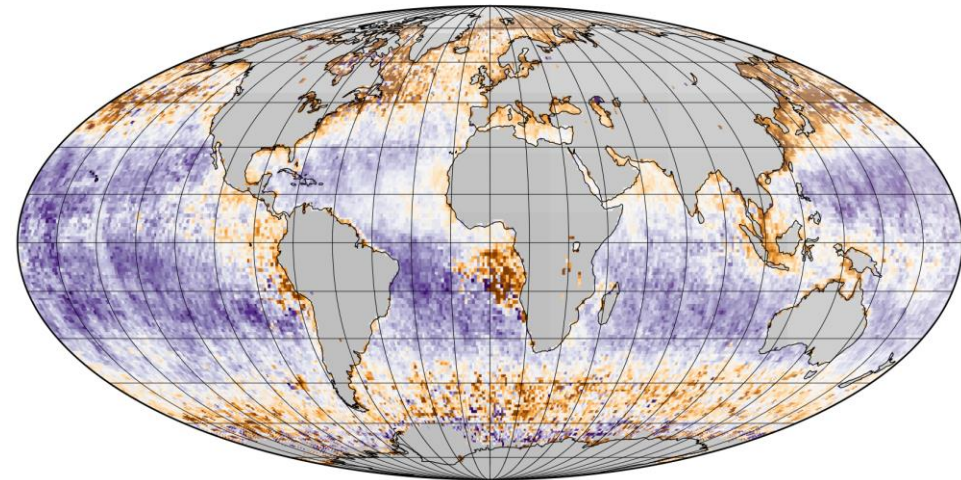
Note: less adjustment is necessary at $0.86\text{ }\mu\text{m}$ than at $0.55\text{ }\mu\text{m}$, because calibration differences between MODIS Aqua and VIIRS SNPP are band-dependent.

- MODIS-VIIRS offset is smaller for AOD at $0.86\text{ }\mu\text{m}$ than for AOD at $0.55\text{ }\mu\text{m}$
- The smaller calibration difference at $0.86\text{ }\mu\text{m}$ magnifies the disagreement in Ångström exponent between MODIS and VIIRS over ocean
- Overall VIIRS Ångström exponent is “smokier” (as opposed to “dustier”) than MODIS

QA-Filtered Aerosol Optical Depth at $0.86\text{ }\mu\text{m}$ Over Ocean, 2015

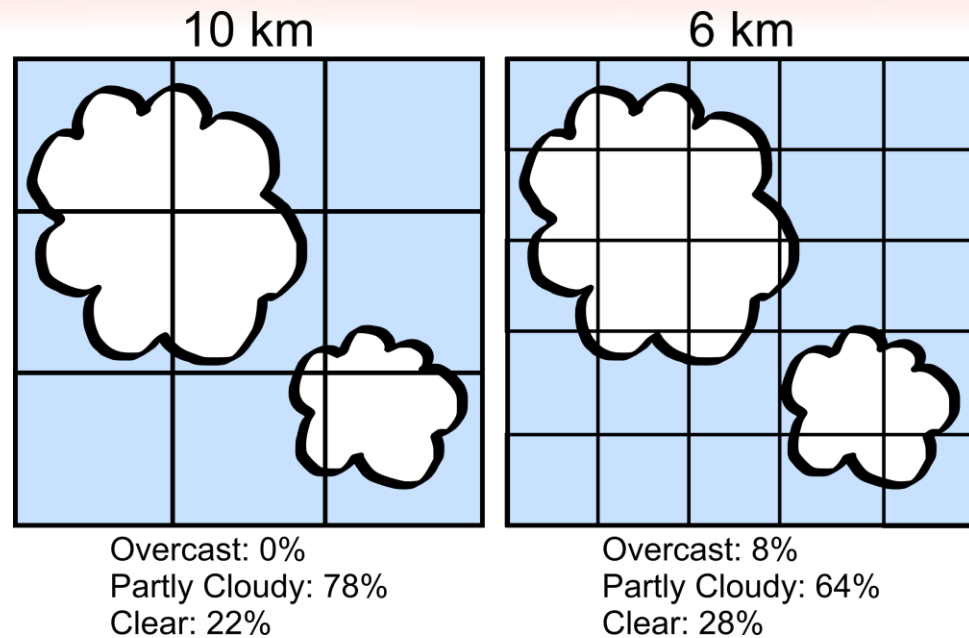


Ångström Exponent, VIIRS - MODIS, 2015

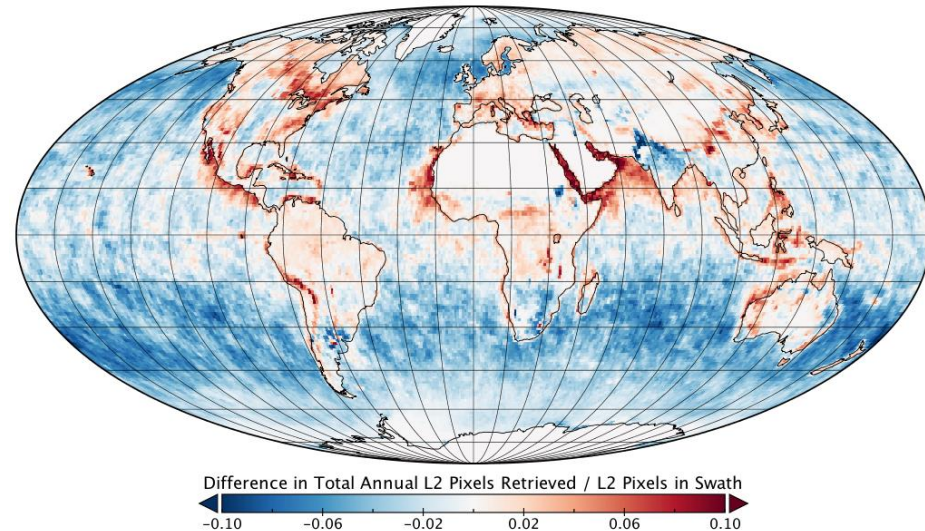


Another cause of disagreement:
resolution vs. sampling

- At L1b, higher resolution = more L2 retrievals (Remer et al. 2012)
- DT uses 0.5 km L1b for MODIS and 0.75 km L1b for VIIRS
- At L2, higher resolution = fewer L2 retrievals (see cartoon)
- L2 DT resolution is 10 km (20×20) for MODIS and 6 km (8×8) for VIIRS
- VIIRS DT samples less of the scene than MODIS



Retrievability Fraction of QA-Filtered AOD, VIIRS – MODIS, 2015



Conclusions and Future Work

- The VIIRS Dark Target aerosol product is ready for operations (and in the LAADS delivery process)
- Agreement with ground truth is comparable to MODIS
- Differences between MODIS and VIIRS have causes that are understood, and are smaller than the differences between MODIS Terra and MODIS Aqua
- NRT and L3 gridded average products are in development
- Planned algorithm updates:
 - Improved retrieval over urban surfaces and coastal sediments
 - High-resolution cloud masking using VIIRS I-bands at 0.375 km
 - Adjusted minimum sampling thresholds
 - Interpolation of main AOD retrieval to 554 nm (MODIS green band)