

Satellite Aerosol Validation

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Satellite Remote Sensing of Dust, Fires, Smoke, and Air Quality, July 10-12, 2018



Objectives

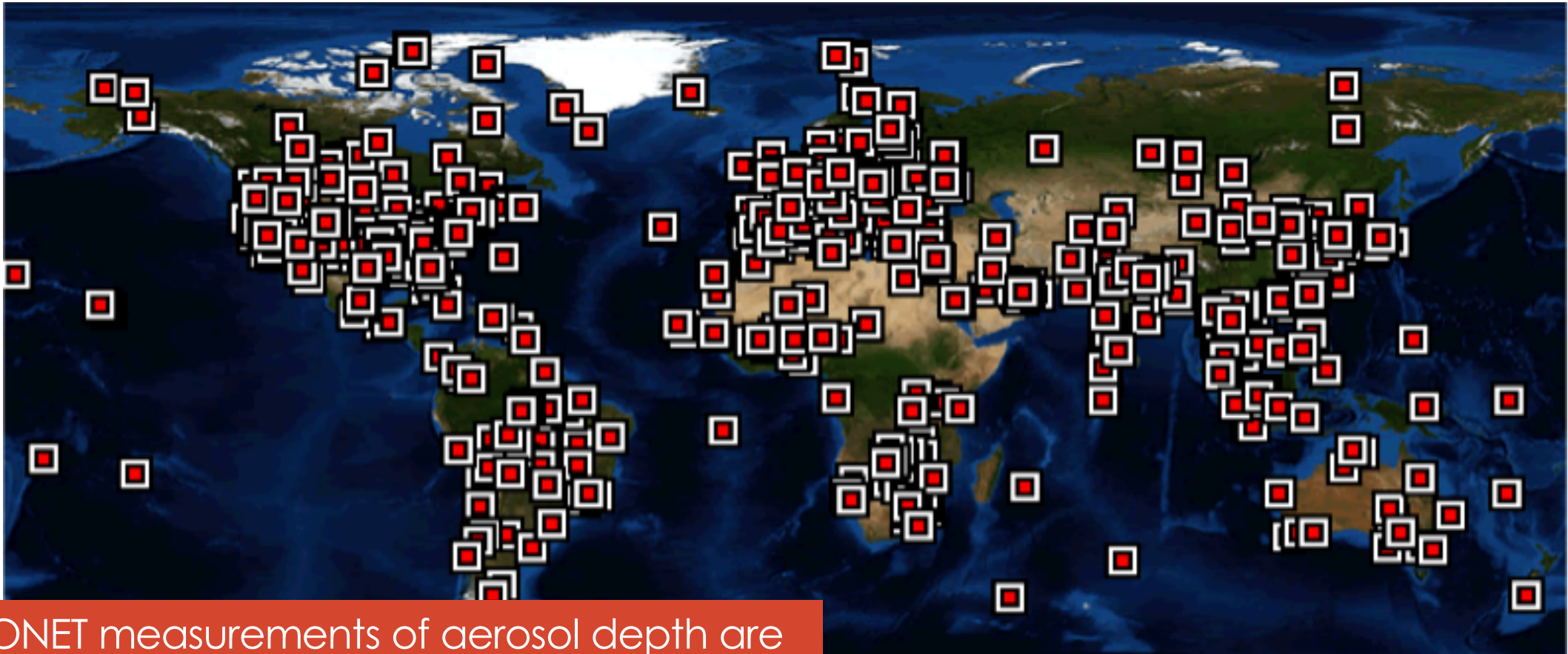
By the end of this presentation, you will learn to:

- Validate satellite-derived aerosol optical depth
- List the uncertainties in the MODIS aerosol product
- Access data and tools for validating satellite aerosol products



AERONET

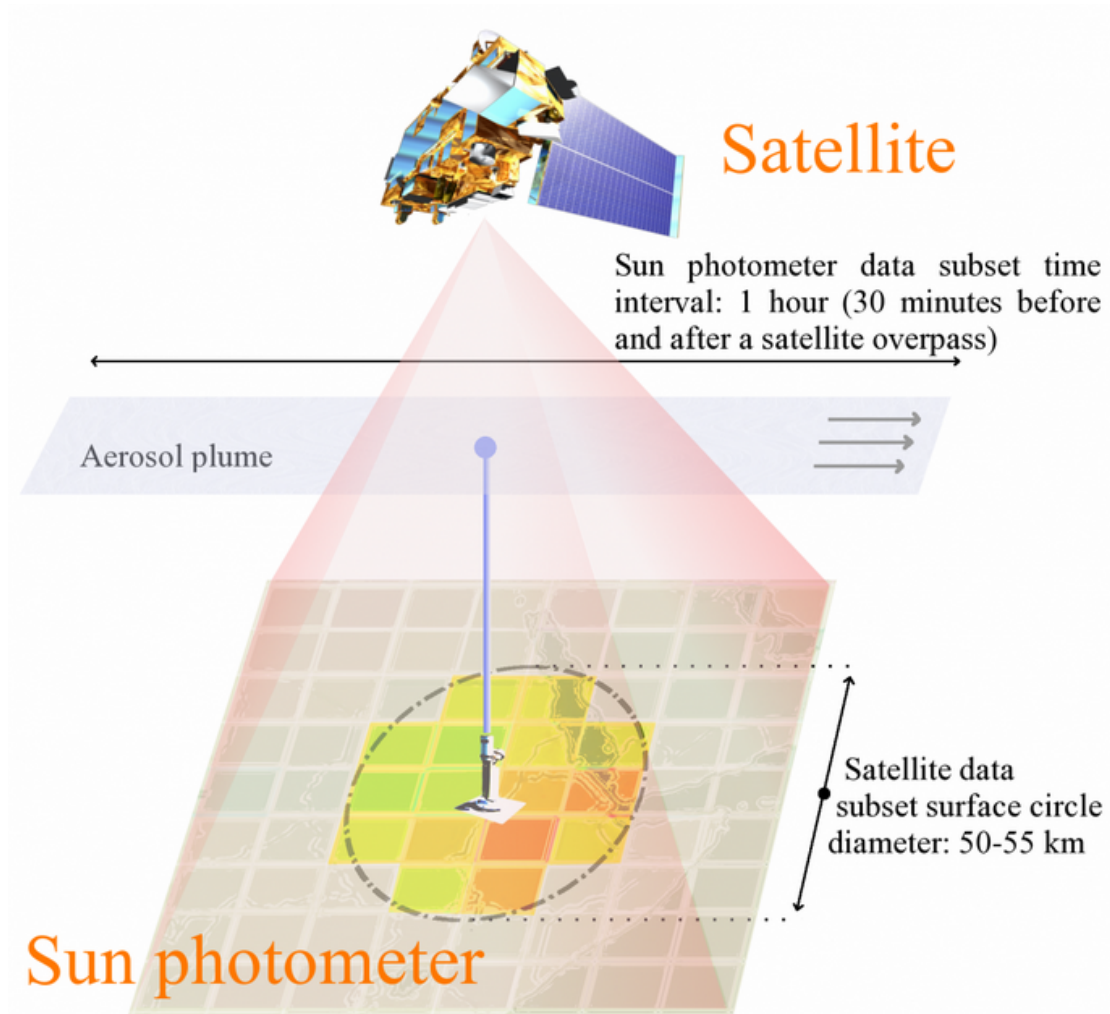
<http://aeronet.gsfc.nasa.gov/>



AERONET measurements of aerosol depth are considered **ground truth** and are used to validate satellite aerosol retrievals

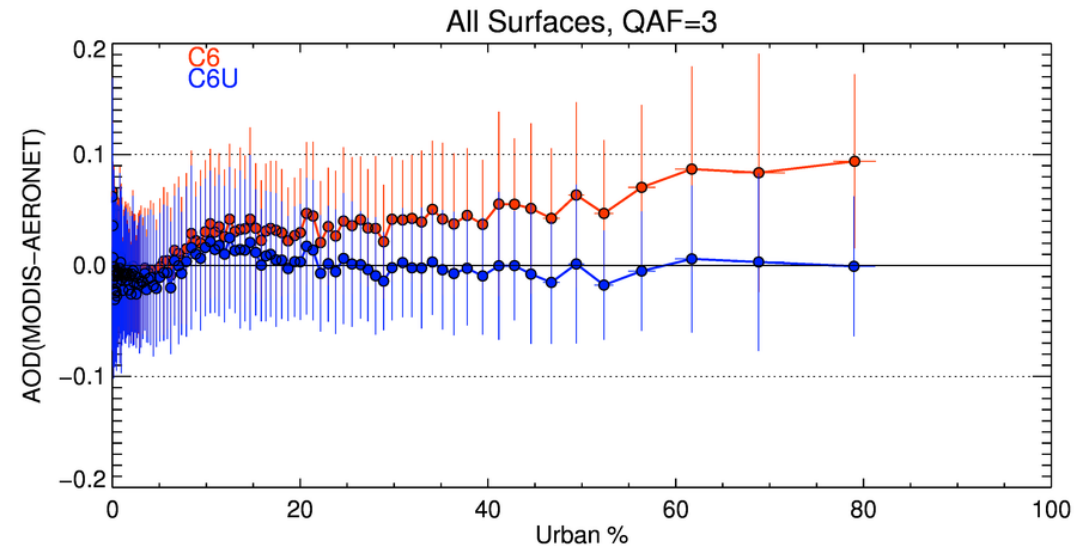
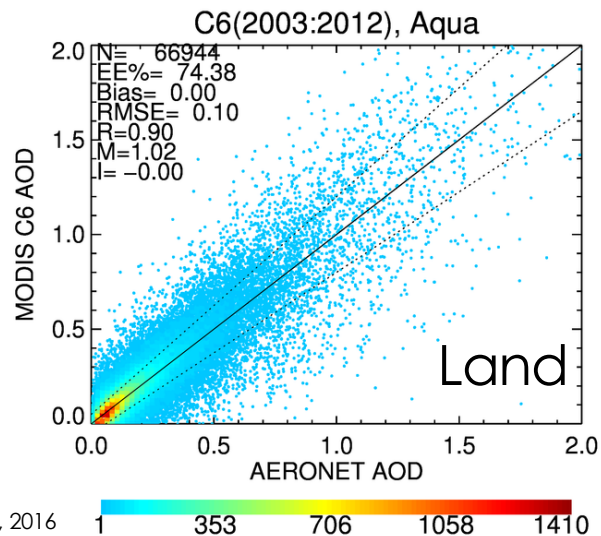
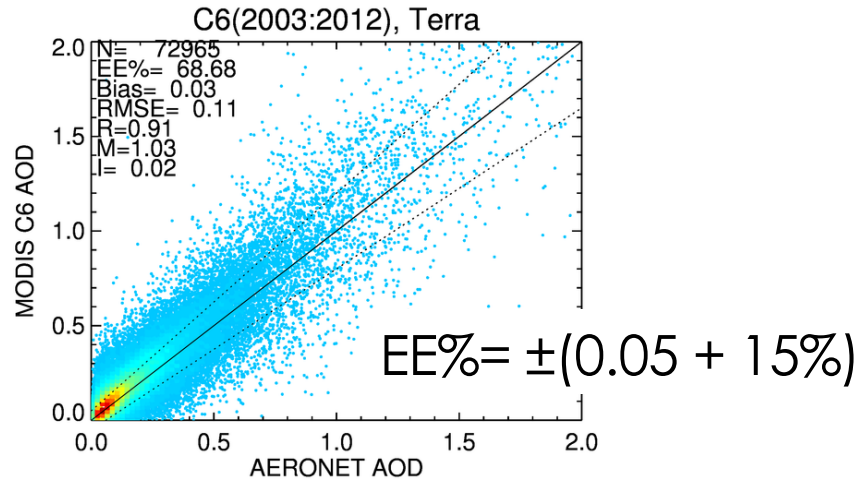


Spatial and Temporal Collocation



Petrenko et al., 2012

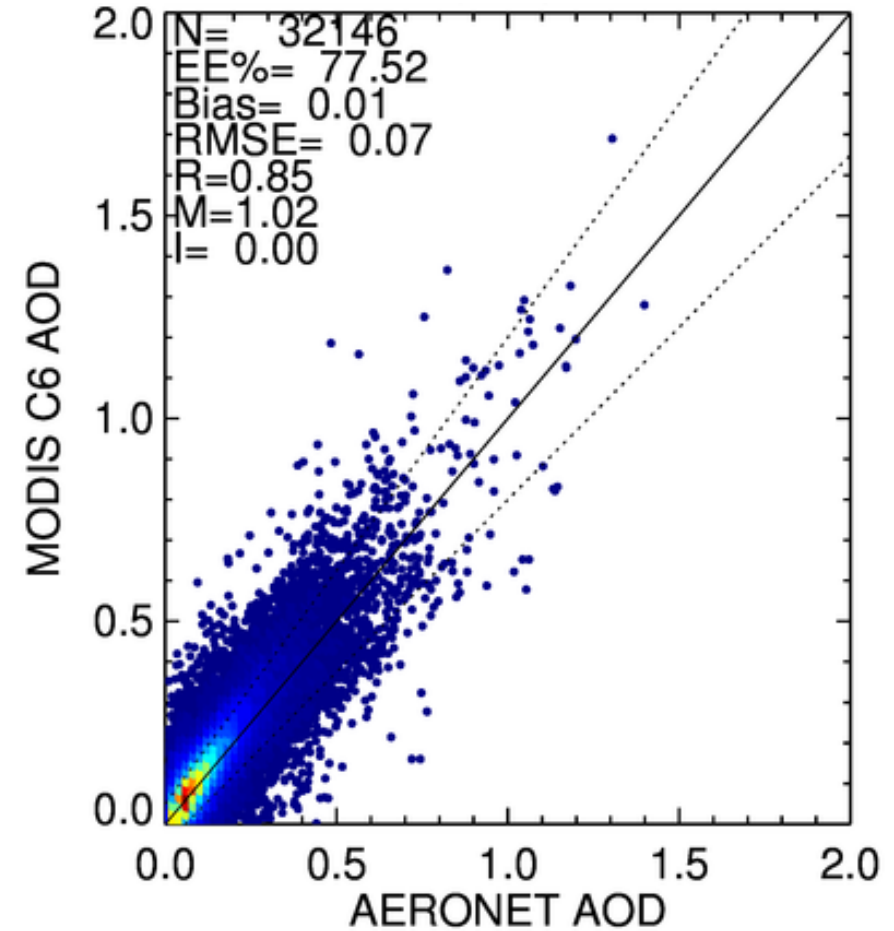
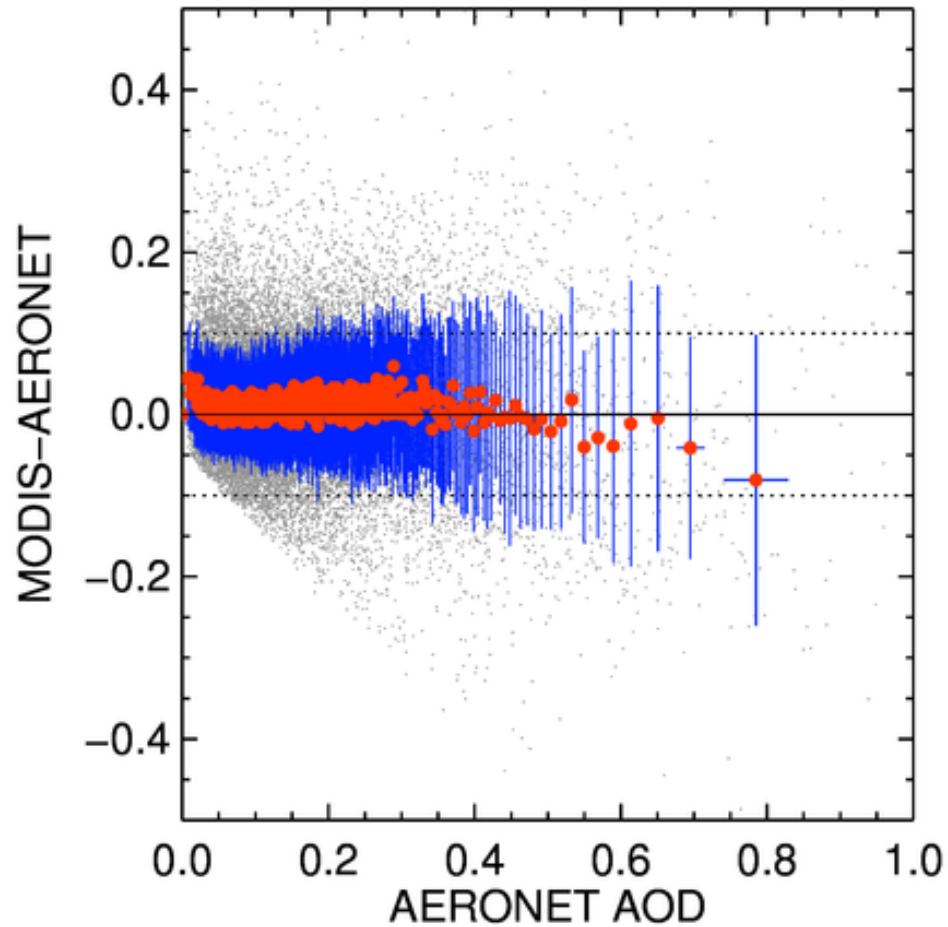
MODIS Dark Target (DT) AOD Validation



Source: Gupta et al., 2016



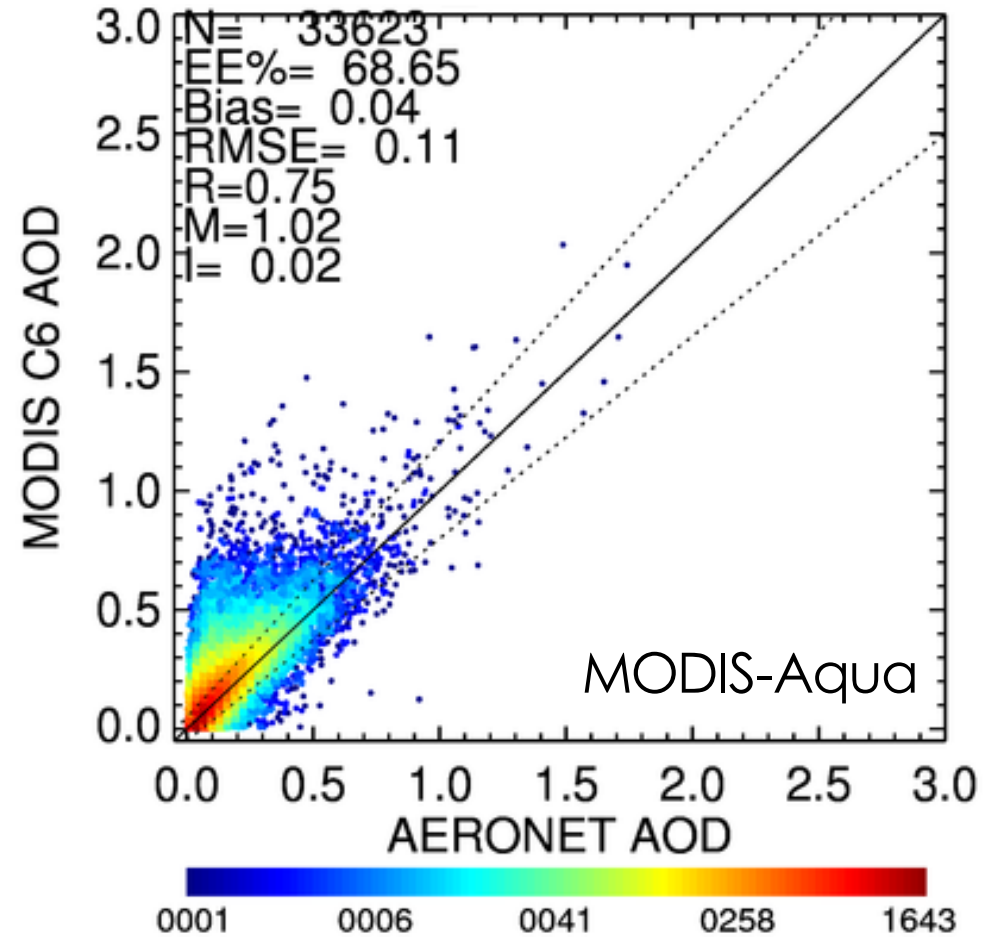
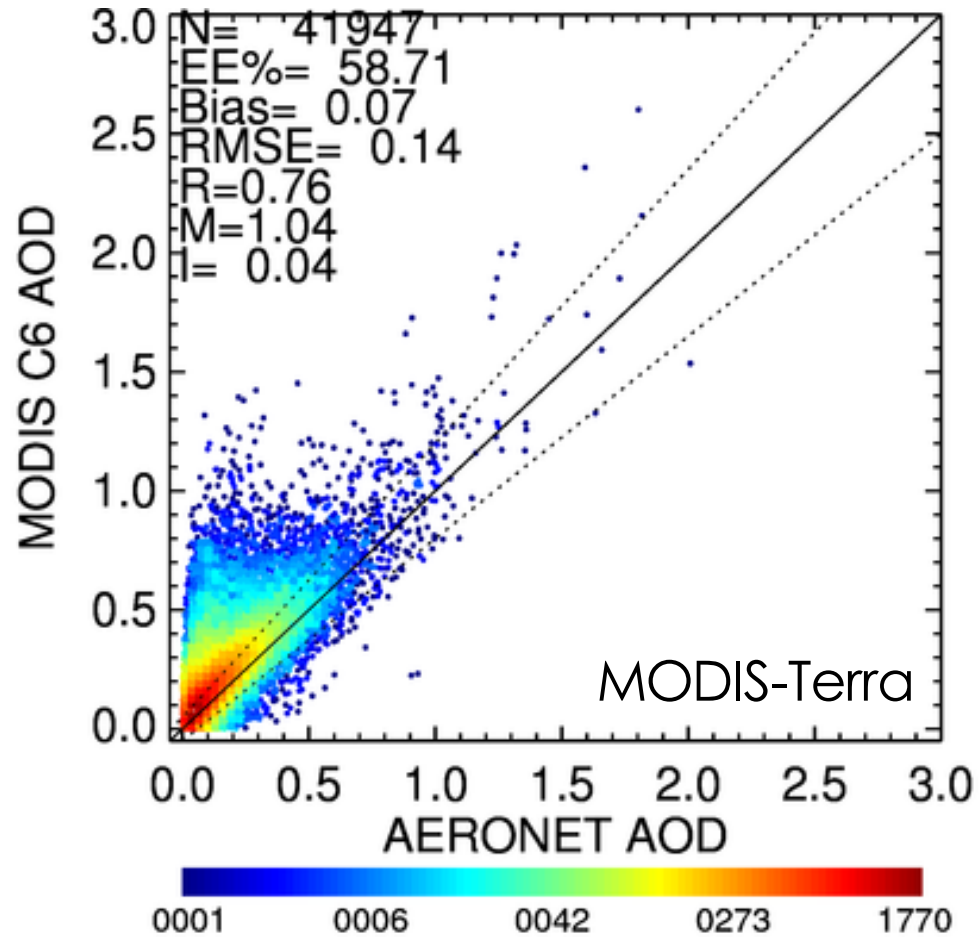
MODIS DT Aerosol Retrieval at 10 km in the U.S.



Source: P. Gupta



MODIS DT Aerosol Retrieval at 3 km in the U.S.



Source: P. Gupta



Dark Target

<http://darktarget.gsfc.nasa.gov/>



The screenshot shows the NASA Dark Target website interface. At the top, there is a navigation bar with the NASA logo, the text "Dark Target MODIS Aerosol Retrieval Algorithm", and a search box. Below the navigation bar are several menu items: ALGORITHM, PRODUCTS, VALIDATION, PLATFORMS, REFERENCE, FAQ, and LINKS. The main content area features a large satellite image of a region in Russia, showing a true color image with fire detections (red dots) in the upper panel and a dark target AOD 10 km product (color-coded map) in the lower panel. Below the images is a caption: "Fires and smoke in Russia captured by Aqua on June 29, 2012. Aqua true color image and fire detections in upper panel, dark target AOD 10 km product in lower panel." Below the caption is a paragraph of text explaining the effect of aerosols on climate modeling and the Dark-Target (DT) aerosol retrieval algorithm. The text states: "The effect of aerosols is one of the greatest sources of uncertainty in climate modeling. Aerosols vary in time in space and can lead to variations in cloud microphysics, which impact cloud radiative properties and climate. The Dark-Target (DT) aerosol retrieval algorithm is applied to multispectral satellite data, and derives aerosol properties including aerosol optical depth (AOD) over land and ocean, and spectral AOD and aerosol size parameters over ocean. Products of the DT retrieval are used to develop global and regional aerosol climatology, to study the interaction of aerosols with clouds, and for air quality assessments and forecasts." Below this paragraph is another paragraph: "There are two separate and distinct 'Dark Target' (DT) algorithms. The first one is used for retrieving aerosol information over ocean (dark in visible and longer wavelengths) and the second one over vegetated/dark-soiled land (dark in the visible). In theory, these algorithms can be applied



MODIS Dark Target AOD Uncertainties

MODIS 10 Km Product

	Collection 5		Collection 6 (Interim Values)	
	Ocean	Land	Ocean	Land
Aqua	+/- (0.03 + 5% of τ)	+/- (0.05 + 15% of τ)	(-0.02 - 10% of τ) (+0.04 + 10% of τ)	+/- (0.05 + 15% of τ)
Terra	+/- (0.03 + 5% of τ)	+/- (0.05 + 15% of τ)	Data not yet available	Data not yet available

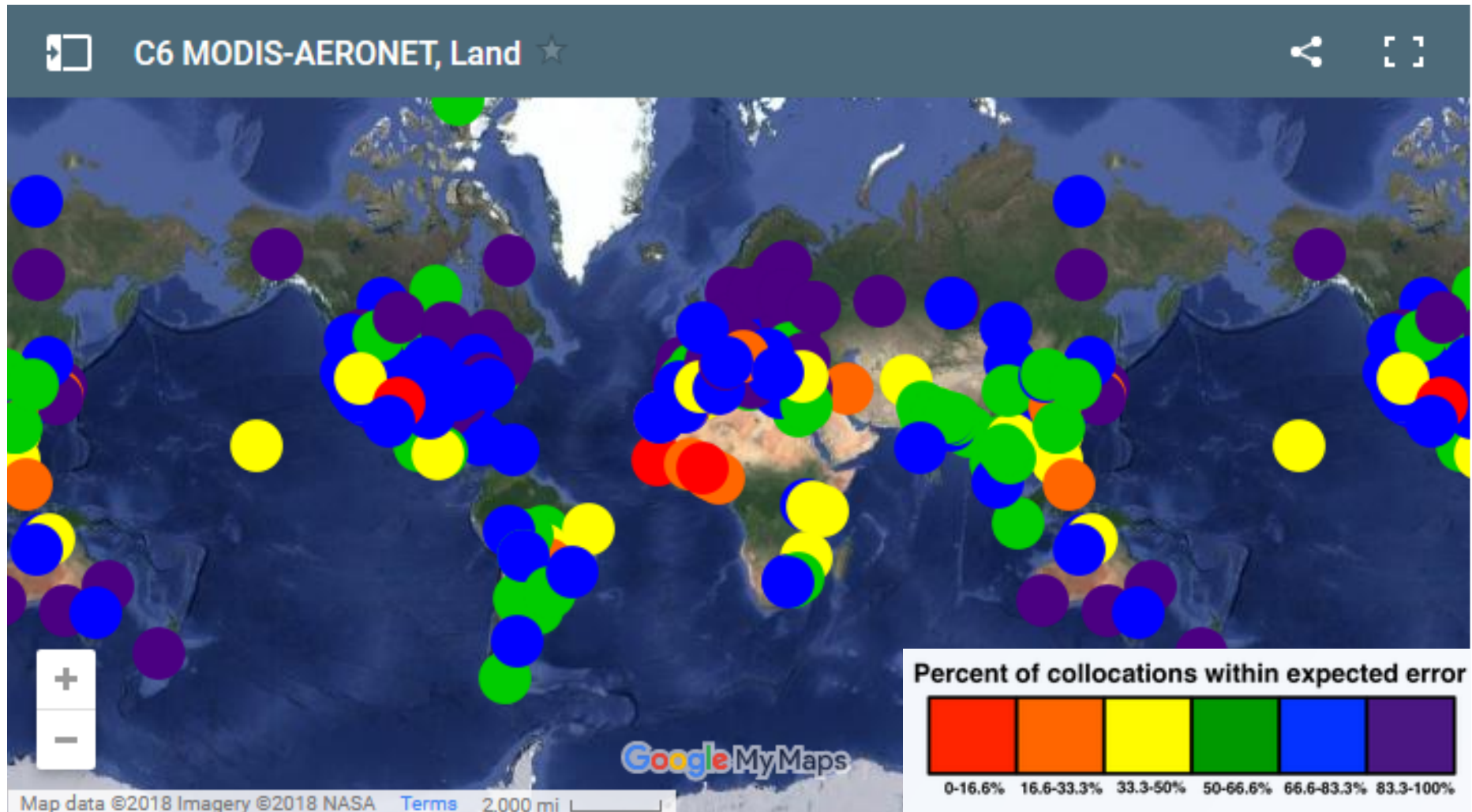
MODIS 3 km Product Uncertainty Values for Collection 6 (Interim Values)

	Ocean	Land
Aqua	+/- (0.04 + 5% of τ)	+/- (0.05 + 20% of τ)
Terra	Data not yet available	Data not yet available

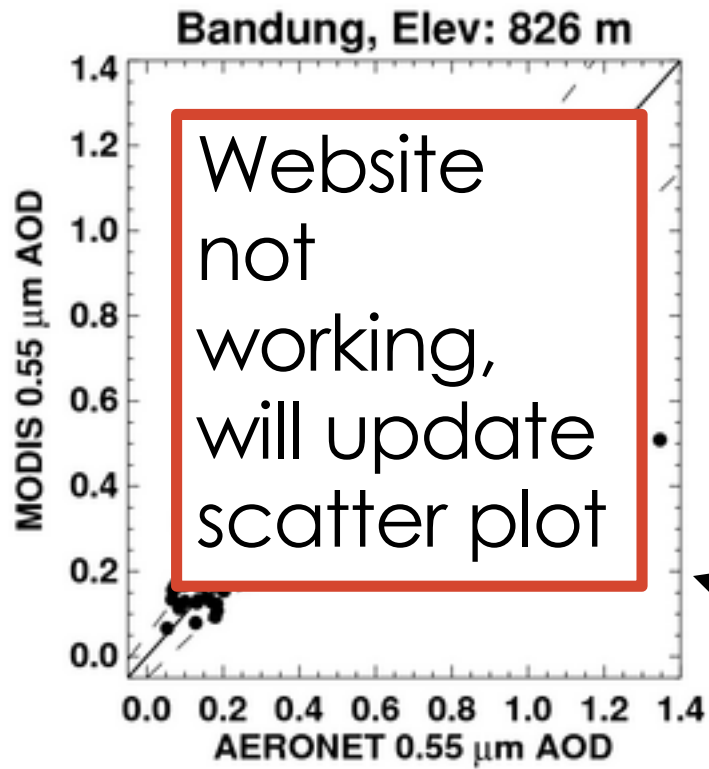


Validation Maps

<http://darktarget.gsfc.nasa.gov/>



Scatter Plot

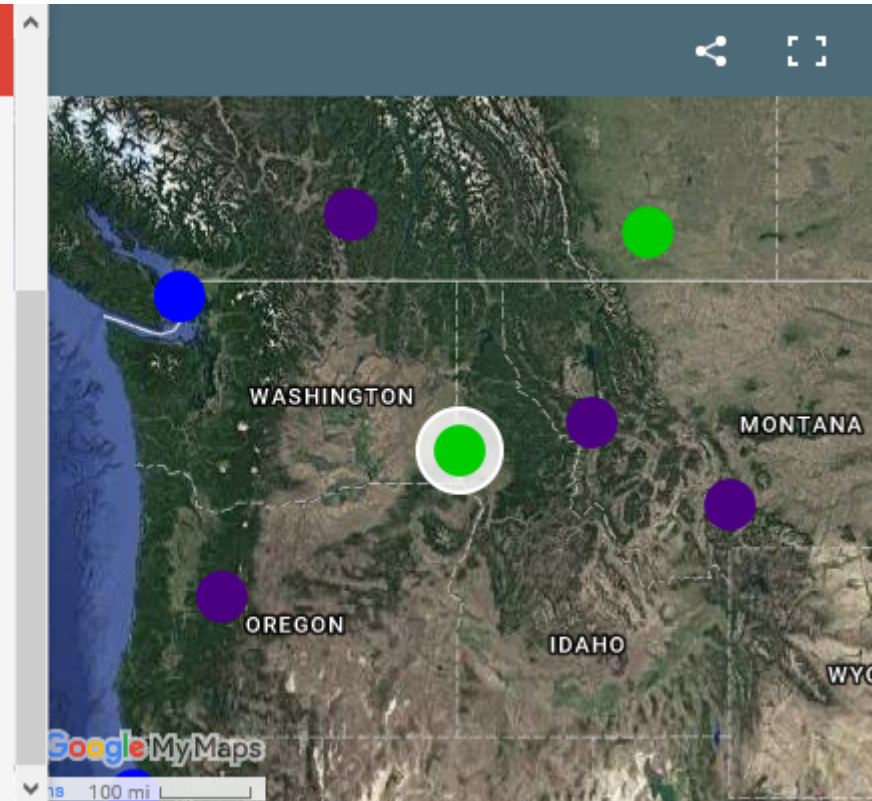


← Rimrock

name
Rimrock

description
Percent within EE = 62.23%
Percent above EE = 34.54%
Percent below EE = 3.23%
N = 744; R = 0.897
Bias = 0.058
RMSE = 0.128
Y = 1.690x - 0.014

``



Deep Blue Product

<http://deepblue.gsfc.nasa.gov>

File Edit View History Bookmarks Tools Help

Validation Maps | Dark Target x modis_aeronet_plot_Bandung x modis_aeronet_plot_Bandung x C6 MODIS-AERONET, Land x Deep Blue | Multi-Sensor Aero x +

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NASA Deep Blue Multi-Sensor Aerosol Project Climate & Radiation Laboratory

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Welcome to the Deep Blue aerosol project webpage

Deep Blue uses measurements made by satellite instruments orbiting the Earth to determine the amount of aerosols in the atmosphere, and the properties of those aerosols. 'Aerosols' is a catch-all term covering particles suspended in the atmosphere, including but not limited to desert dust, smoke, volcanic ash, industrial smog, and sea spray. Improving our understanding of aerosols is important for reasons related to Earth's climate, human health, and ecology, as well as many others.

The Deep Blue algorithms have currently been applied to generate data products from the AVHRR, SeaWiFS, MODIS, and VIIRS spaceborne sensor series.

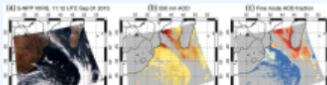
This website is designed to act as a single portal to provide information to both new and experienced data users about our data sets, as well as give an overview of what we do and why we do it to non-specialists. Please use the links across the top of the page to navigate, and feel free to contact us with any questions.

Recent news relating to Deep Blue, such as new data versions or publications, are listed below. You can also [subscribe to our RSS feed](#) for updates.

Current data set status and availability (updated Nov 01 2017)

See also the [Data tab](#):

- AVHRR: Latest version is v001 (demonstration product for selected periods).
- SeaWiFS: Latest version is v004, whole mission (1997-2010).
- MODIS: Latest version is Collection 6.1; available in forward processing mode since Oct 15 2017. Terra (2000 onwards) and Aqua (2002 onwards) reprocessing is ongoing. Near real time (NRT) processing is available on LANCE from Nov 01 2017 onwards.
- VIIRS: Public release expected later in 2017; example data available by request.

 New paper published describing VIIRS ocean aerosol data set



MAPSS

Multi-sensor Aerosol Products Sampling System

- Giovanni instances
- Used to evaluate the quality of satellite retrievals
- MAPSS allows you to compare AERONET data with coincident satellite data
- Quick and effective way to evaluate the quality of the satellite retrieval at particular locations for a range of dates or seasons
- Data from MODIS & MISR
 - Satellite-AERONET Inter-Comparison: <http://aiovanni.asfc.nasa.gov/mapss/>
 - Multi-Sensor Statistics: http://aiovanni.asfc.nasa.gov/mapss_explorer/



MAPSS: Multi-sensor Aerosol Products Sampling System

This user interface is used to obtain selected parameter statistics from the [MAPSS](#) database for a chosen location and time period. Time Series Plot is the available service. Plot output is rendered as a graph and is also available in ASCII format.

Data Selection | Results | **NEW** [Try out the MAPSS Statistical Explorer](#)

Plot Data | Reset | Clear | Send Us Feedback! | Help

Select Station

Click 'Browse' button or type in comma separated names of sta

Select Plot

Satellite Colocated with AERONET

[Time Series](#)

[Scatter Plot](#)

Select Measurements

Click each list below (beginning with the left-most list) to show the set of fully qualified measurements. Select a measurement and then click 'Add'. Repeat for additional measurements.

Basic Advanced

Product	Parameter	Layer
AERONET aerosols L2, ver. 2		
AERONET deconvolution L2, ver. 41		
AERONET inversions L1.5, ver. 2		
AERONET inversions L2, ver. 2		
CALIPSO column and layer aerosols L2, ver. 3		

Time Series Plot: AOD at Rimrock (Lat=46.487 Lon=-116.992 Alt=824m) 01 Jul 2012 to 31 Jul 2012

Scatter Plot: AOD at Rimrock (Lat=46.487 Lon=-116.992 Alt=824m) 01 Jul 2012 to 31 Jul 2012

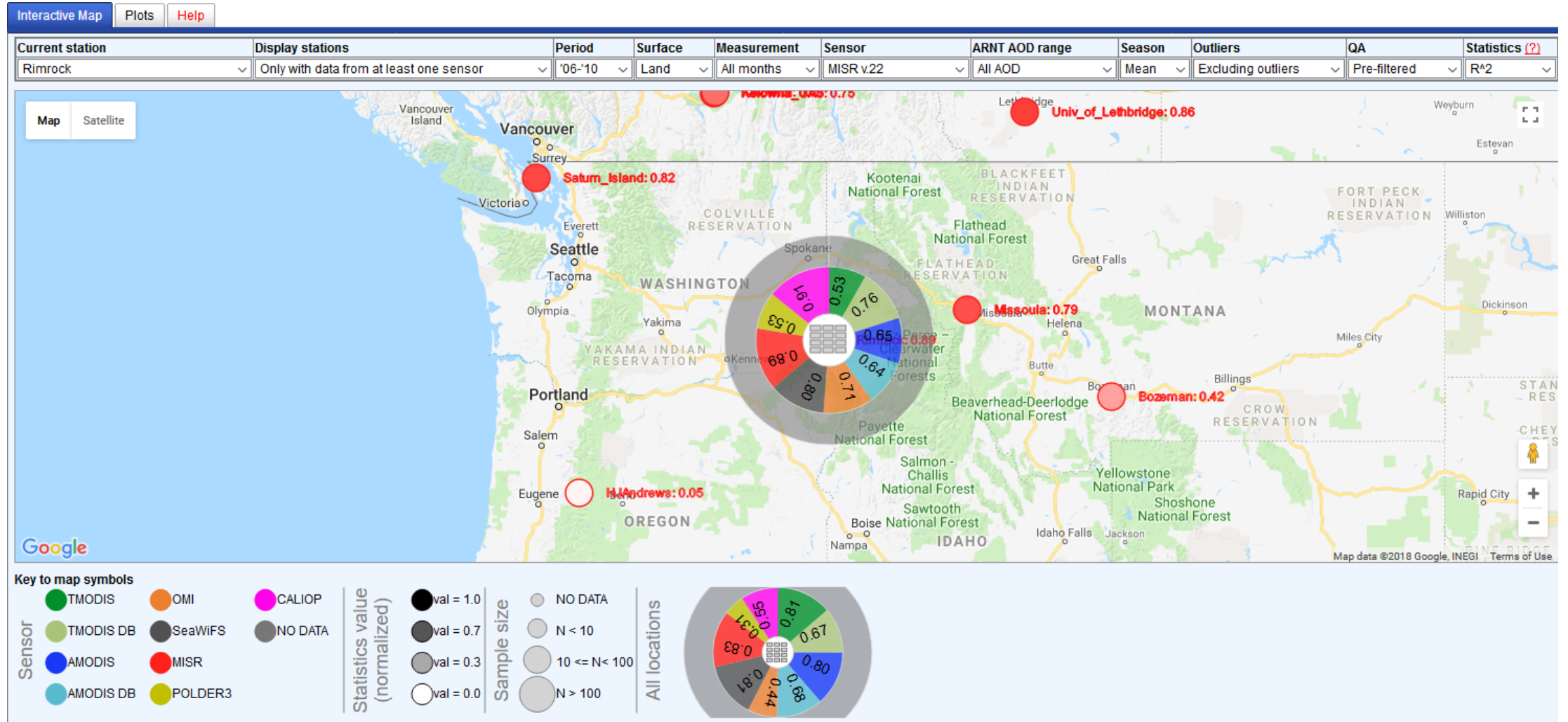
Legend for Scatter Plot:

- MYD04.006 AOD at 550 nm with best QA - land and ocean 550nm Mean, N=19, Fit: $Y=1.10X+0.06$, $R^2=0.65$, RMSE=0.082
- MOD04.006 AOD at 550 nm with best QA - land and ocean 550nm Mean, N=18, Fit: $Y=1.25X+0.06$, $R^2=0.61$, RMSE=0.107
- 1:1 line

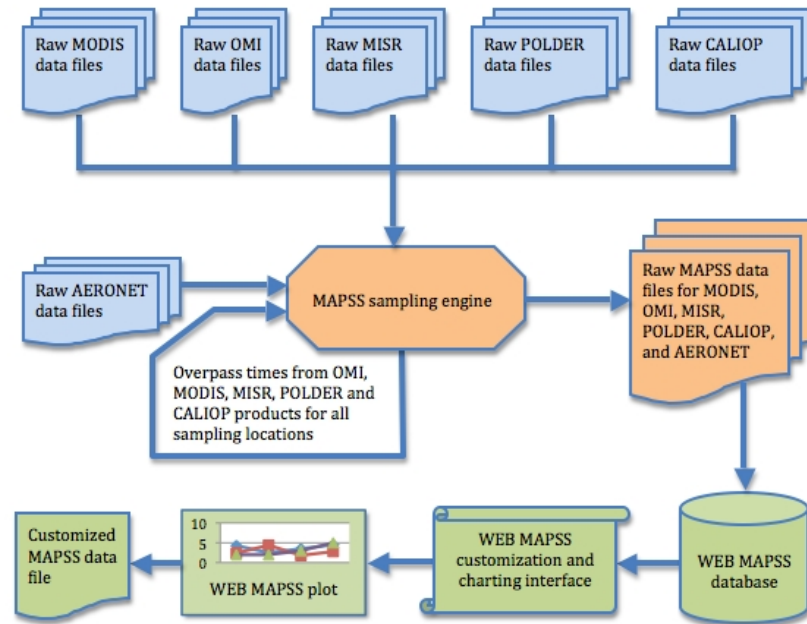


MAPSS Statistical Explorer

http://giovanni.gsfc.nasa.gov/mapss_explorer/



MAPSS – Further Reading



Petrenko, M., and C. M. Ichoku. 2013. "Coherent uncertainty analysis of aerosol measurements from multiple satellite sensors." *Atmos. Chem. Phys.*, 13 (14): 6777-6805 [10.5194/acp-13-6777-2013] [Journal Article/Letter]

Petrenko, M., C. M. Ichoku, and G. Leptoukh. 2012. "Multi-sensor Aerosol Products Sampling System (MAPSS)." *Atmospheric Measurement Techniques*, 5 (5): 913-926 [10.5194/amt-5-913-2012] [Journal Article/Letter]



Published Validation Results

Levy, R. C., Mattoo, S., Munchak, L. A., Remer, L. A., Sayer, A. M., Patadia, F., & Hsu, N. C.. (2013). The Collection 6 MODIS aerosol products over land and ocean.

Atmospheric Measurement Techniques, 6, 2989–3034. doi:10.5194/amt-6-2989-2013

Remer, L. A., Mattoo, S., Levy, R. C., & Munchak, L. A.. (2013). MODIS 3 km aerosol product: algorithm and global perspective. *Atmospheric Measurement Techniques*, 6, 1829–1844. doi:10.5194/amt-6-1829-2013

Sayer, A. M., N.-Y. C. Hsu, C. Bettenhausen, and M.-J. Jeong. 2013. "Validation and uncertainty estimates for MODIS Collection 6 "Deep Blue" aerosol data." *J. Geophys. Res. Atmos.*, 118 (14): 7864-7872 [10.1002/jgrd.50600

Sayer, A. M., L. A. Munchak, N.-Y. C. Hsu, et al. 2014. "MODIS Collection 6 aerosol products: Comparison between Aqua's e-Deep Blue, Dark Target, and "merged" data sets, and usage recommendations." *J. Geophys. Res.-Atmos*, 119 (24): 13,965-13,989 [10.1002.2014JD022453]

