University of Wisconsin SSEC Atmospheric SIPS and AHI/ABI Capabilities

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Overview

- UW NASA Atmospheric SIPS (A-SIPS) VIIRS aerosol processing and data access
- NASA A-SIPS Inter-calibration capabilities and results
- SSEC AHI/ABI data and access
- MURI AHI/ABI geo-stationary littoral aerosol retrieval development

Atmospheric SIPS Web Interface

http://sips.ssec.wisc.edu

Atmosphere SIPS PRODUCTS LINKS CONTACT

NASA VIIRS Atmosphere SIPS

The Atmosphere SIPS, located at the **University of Wisconsin - Madison**, **Space Science and Engineering Center**, processes data from the Suomi NPP satellite to produce VIIRS Level 2 cloud and aerosol products. The products generated by the Atmosphere SIPS are archived and distributed by the **Level 1 and Atmospheric Archive and Distribution System** (LAADS).

This work is being performed for NASA under contract NNG15HZ38C. For more information regarding what a NASA SIPS is, please visit **Science Investigator Led Processing Systems**.

Product Search

The granule search form provides the ability to search for both granule generated locally or ingested from upstream sources in a single uniform interface. Both spatial and temporal search capabilities are provided.

Orbit Tracks

Global and regional orbit track images provided by the **SSEC DataCenter** for many LEO satellites of interest.

Product Search API

A scriptable API that provides all the capabilities of the **Product Search** page intended for ease of use your scripting language of choice. Additionally, the API provides additional flexibility regarding return types and values that my be useful for automatic downloaders.

VIIRS Quicklooks New!

Global granule quicklook browser to help you identify data of interest. Quicklooks are available for both day and night as well as for multiple products including truecolor, falsecolor, IR, visible, and DNB.

Product Availability

Provides an at-a-glance calendar view of the entire data holdings for a particular granule provided by the Atmosphere SIPS.

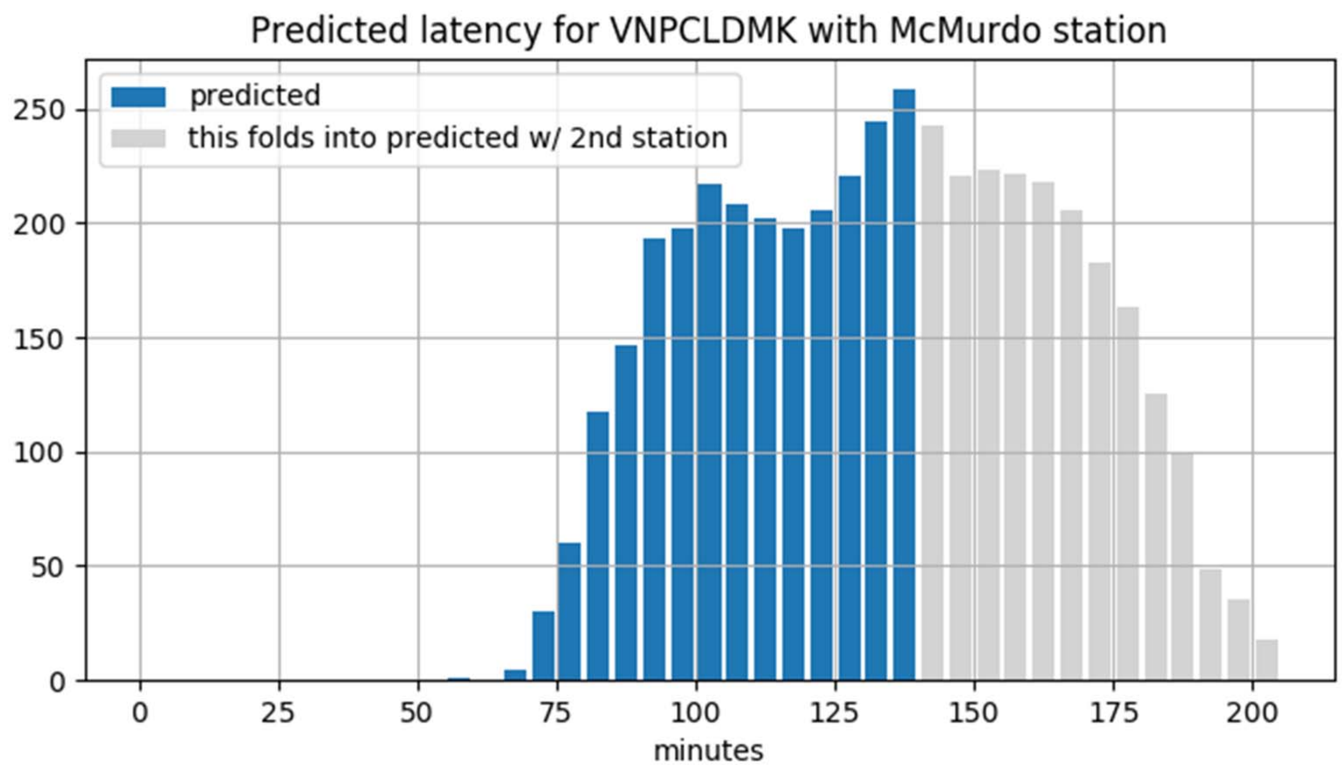
OrbNav

Orbital navigation parameter generation service developed under funding from the NOAA GOES-R program. OrbNav provides both a web form for generating text reports as well as a JSON API that can be queried from your language of choice. If Python is your cup of tea we also provide **OrbNavClient**, a easy to use client library for the API.

NASA Atmospheric SIPS Products

- NASA S-NPP VIIRS Aerosol Products (NETCDF4)
  - Aerosol products in development including:
    - Deep Blue (Christina Hsu and Andrew Sayer)
    - Dark Target (Rob Levy)
- NASA S-NPP Cloud Products (NETCDF4)
  - Beta VIIRS clouds mask based on MODIS currently produced for VIIRS record and in forward stream
  - Cloud products still in development
- NASA VIIRS L1b (NETCDF4) are produced in NRT at the A-SIPS however official L1b products produced by NASA LAADS

A-SIPS Near Real Time Processing

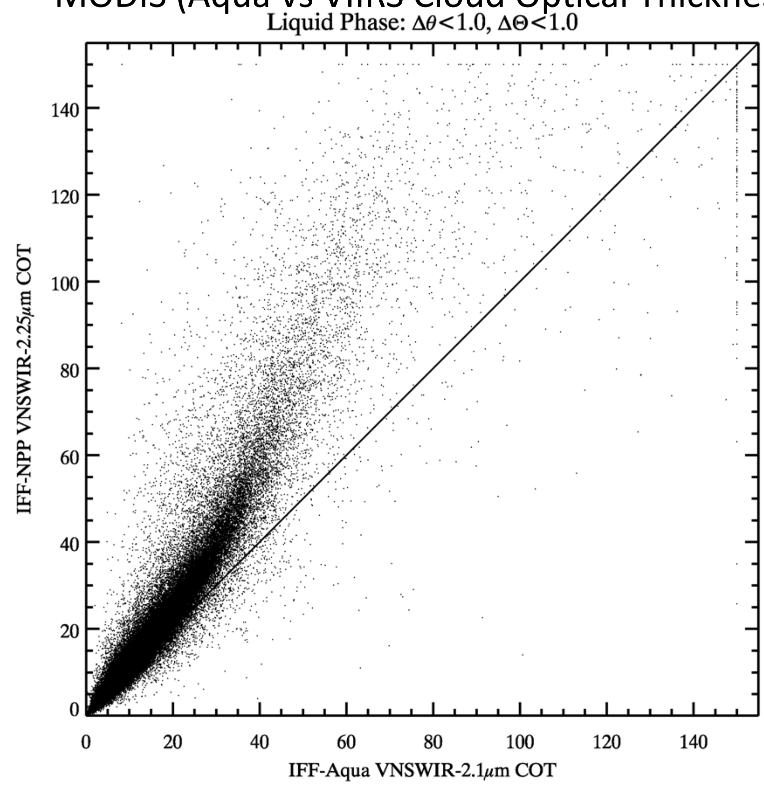


A-SIPS Inter-Calibration Capabilities

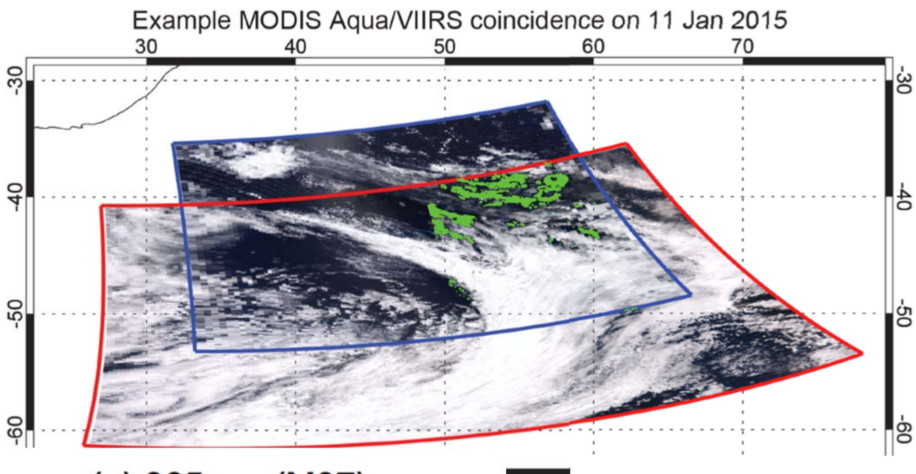
Physical Collocation Support

Master \ Follower	AHI	AVHRR	CALIOP	CLOUDSAT	GOES	MODIS	MTSAT	POLDER	SEVIRI	VIIRS
AHI			✷	✷		✷				✷
AIRS			✷	✷	✷	✷	✷		✷	
AMSR-E				✷		✷				
CLOUDSAT			✷			✷				✷
CrIS	✷		✷				✷		✷	✷
COMS			✷			✷				
GOES			✷			✷				
HIRS		✷	✷							
IASI	✷	✷				✷	✷		✷	
MODIS			✷					✷		✷
MTSAT			✷			✷				
SEVIRI			✷			✷				✷
VIIRS			✷							

MODIS (Aqua vs VIIRS Cloud Optical Thickness



A-SIPS VIIRS/MODIS Inter-Calibration (Sayer et al.)



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www.atmos-meas-tech.net/10/1425/2017/
doi:10.5194/amt-10-1425-2017

Atmospheric Measurement Techniques
Open Access
EGU

Cross-calibration of S-NPP VIIRS moderate-resolution reflective solar bands against MODIS Aqua over dark water scenes

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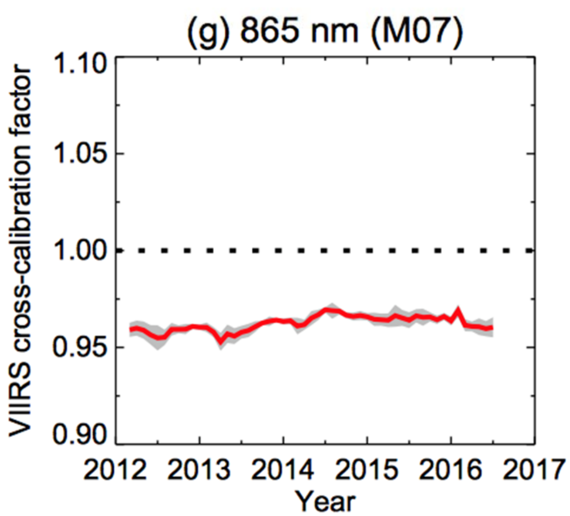
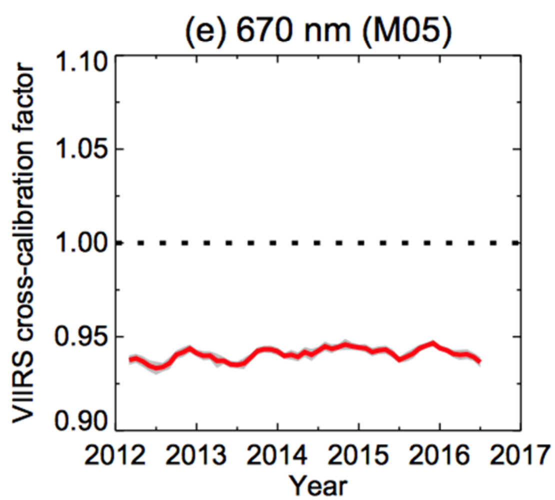
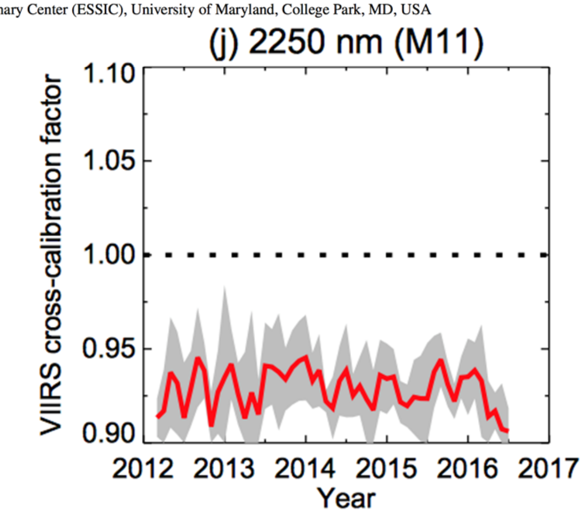






MODIS to VIIRS Continuity Impact (Sayer et al.)

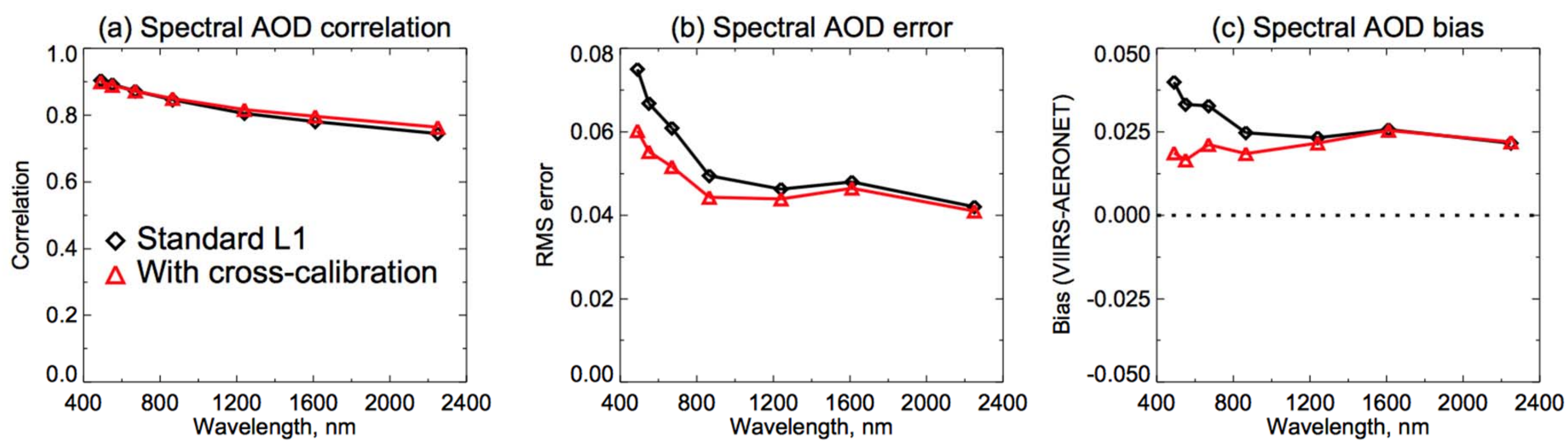
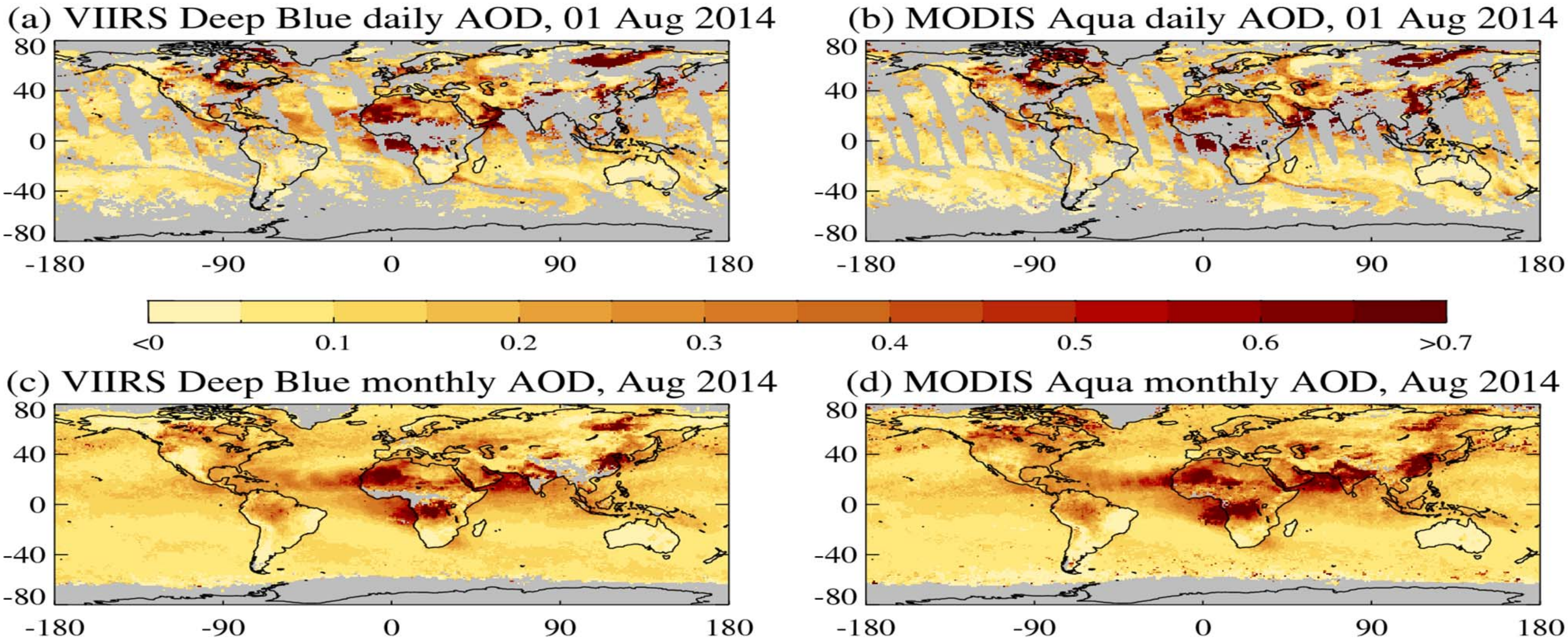


Figure 11. Statistics of SOAR-VIIRS spectral AOD validation against AERONET without (black) and with (red) the gain adjustments derived in the present study. Panels show **(a)** correlation coefficients, **(b)** root-mean-square AOD error, and **(c)** median AOD bias. Statistics are composites for all sites listed in Table 4.

The big picture looks familiar on daily and monthly scales



- Some refinements made since these examples were processed
- Level 3 composites generally have fewer artifacts than MODIS

NASA NRT VIIRS Aerosol Data Access Summary

- The A-SPIS is considered a NASA LANCE Element
- LANCE: https://earthdata.nasa.gov/earth-observation-data/near-real-time
- LANCE VIIRS: https://earthdata.nasa.gov/earth-observation-data/near-real-time/download-nrt-data/viirs-nrt
- The A-SIPS will produce NRT Aerosol products at the A-SIPS
- Granule metadata will be delivered to NASA via their Content Management System (CMS)
- Earthdata Search
  - https://search.earthdata.nasa.gov/search?m=0!0!2!1!0!0%2C2&fst0=Atmosphere&fsm0=Aerosols
- Earthdata APIs
  - https://earthdata.nasa.gov/api
- Access to LANCE NRT products **will require a NASA Earthdata user account**
- https://urs.earthdata.nasa.gov/
- HOWEVER ....
  - On LANCE's own VIIRS page they have direct links to an open FTP server
- TBD if we will provide NRT data in our existing Search Page

UW SSEC Geo-Stationary Capabilities

- Data Center Archives both AHI (Himawari 8) and ABI (GOES-R)
- NRT AHI L1b ingested through NOAA STAR (10 min latency)
- NRT ABI L1b ingested from direct satellite link (1 min latency)
- Data volume is huge (1TB/day). Process aerosol algorithms at the data archive **(ie GEO SIPS?**)
- Running cloud NOAA experimental cloud products (Heindinger) CLAVERx algorithms in near real time for AHI
- UW is developing a littoral zone AHI/ABI aerosol retrieval as part of the Navy funded MURI with Colorado State University

CSU MURI AHI/ABI Littoral Aerosol Development

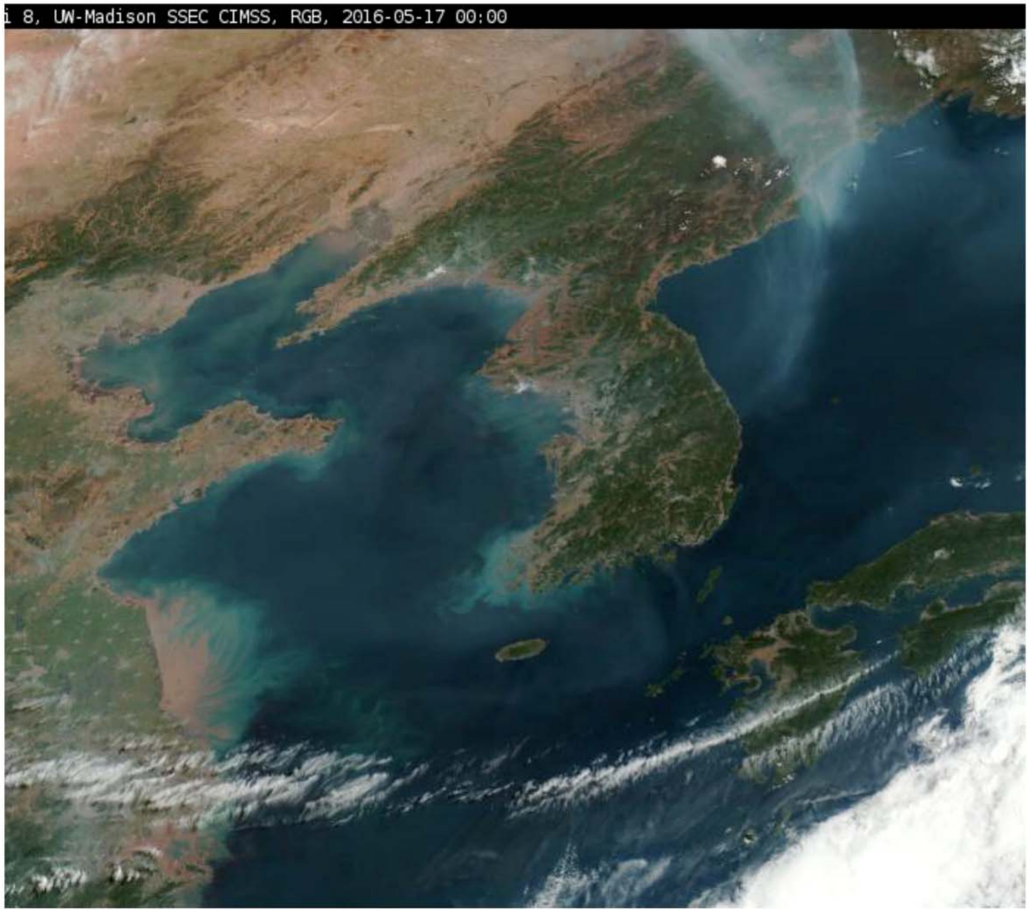
- We are developing three aerosol algorithms for **ocean**, **land** and **littoral zone regions** using the CLAVR-x (NOAA) algorithm framework
- NOAA's operational cloud processing system CLAVR-x (the Clouds from AVHRR Extended) provides well characterized cloud mask, cloud products, glint mask, and ancillary data (NCEP and NWP)
- CLAVR-x supports AHI (and ABI) providing an operational framework to develop the aerosol retrieval
- Andy Heidinger, PI of CLAVR-x, and Andi Walther are funded to support the aerosol effort in supporting the CLAVR-x processing system

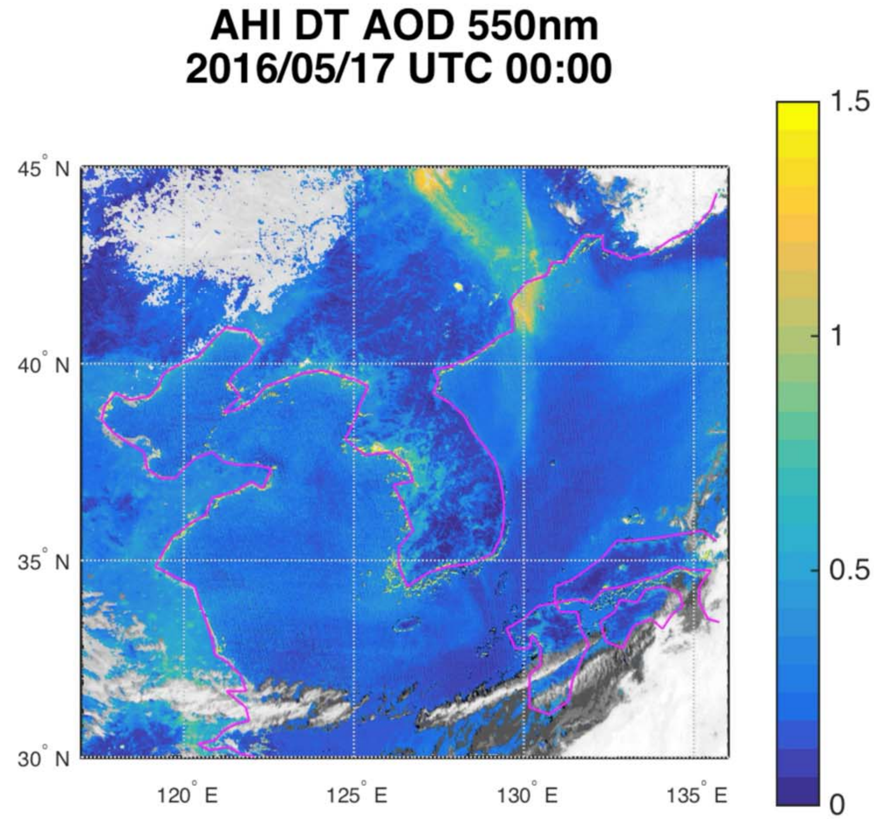
MODIS, VIIRS, AHI and ABI sensors

MODIS, VIIRS,AHI and ABI wavelengths in µm used in aerosol retrieval (Dark Target) algorithm			
MODIS	VIIRS	AHI	ABI
0.47	0.49	0.47	0.47
0.55	0.55	0.51	
0.66	0.64	0.64	0.64
0.86	0.86	0.86	0.86
1.24	1.24		
1.38	1.38		1.38
1.61	1.61	1.61	1.61
2.11	2.25	2.25	2.25

- AHI and ABI are similar Geo-stationary sensors (covering 140E and 105W)
- AHI and ABI wavelengths are slightly different than MODIS or VIIRS but they include similar spectral bands used for Dark Target aerosol retrieval
- We apply the MODIS-like algorithm to AHI over land and ocean aerosol retrieval

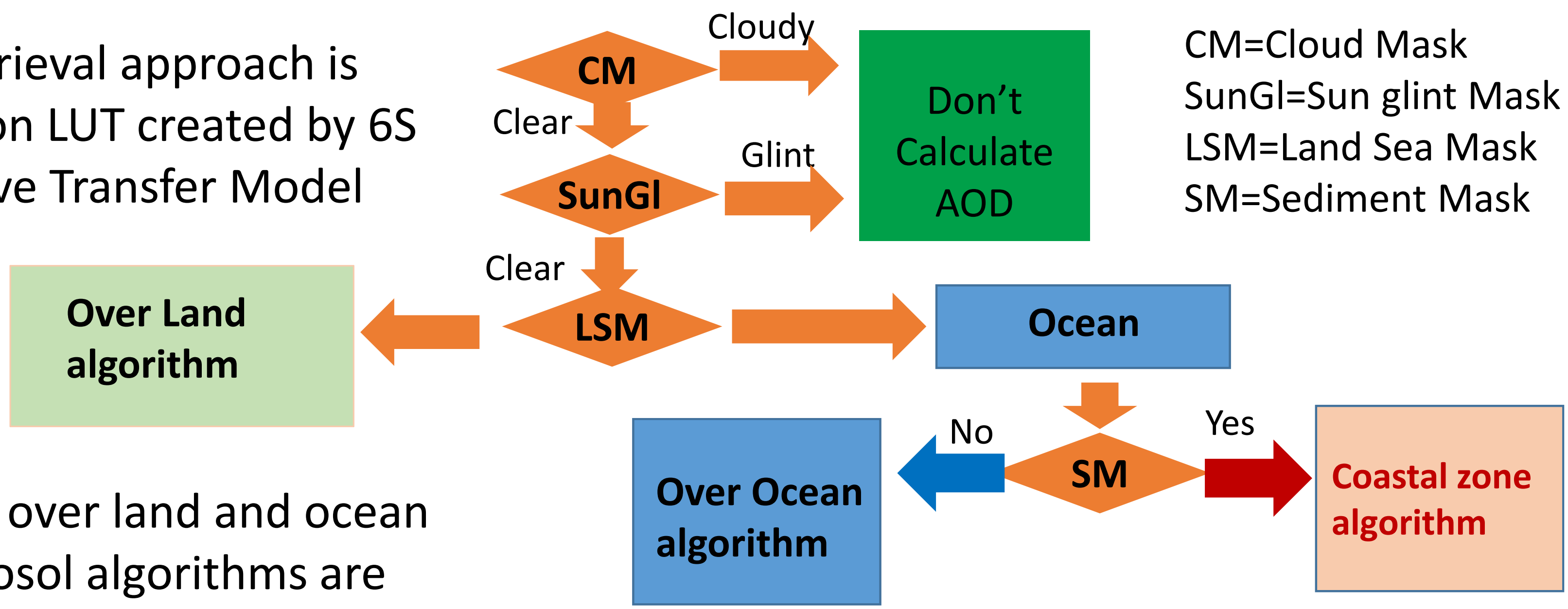
Time-lapse images of 2016-05-17





AHI aerosol algorithm
All procedures applied to individual 2km resolution (at nadir) pixels

- The retrieval approach is based on LUT created by 6S Radiative Transfer Model



- AHI over land and ocean aerosol algorithms are adopted from MODIS DT algorithm

- Current version of coastal zone aerosol retrieval is based on SWIR retrieval assuming surface contribution is negligible in wavelength > 1µm

Ongoing work

- We have implemented a DT (Dark Target) aerosol retrieval for AHI for ocean and land and a version of retrieval for coastal zones
- We are working on integrating the DT algorithm to CLAVR-x processing system to generate both aerosol and cloud products
- Our next step is to develop the littoral aerosol retrieval which requires separating the surface and atmosphere reflectance using the time resolved information in the geo-stationary observations

AHI aerosol algorithm over littoral zone

after cloud Mask, glint mask and sediment mask:

Over turbid water aerosol algorithm

1. Derived ***AODs*** at AHI SWIR with dark surface assumption :
   A. If the present of sediment is low detected by sediment mask, find the exact fit of measured and LUT reflectance at 1.6 µm and the best fit at 1.6 & 2.3µm

   B. If the present of dust is high detected by *DEBRA (CIRA: Dust Enhancement with Background Reduction Algorithm Applicable)*, find the exact fit of measured and LUT reflectance at 2.3 µm and the best fit at 1.6 & 2.3µm

2. Then extrapolate AODs to 0.86µm, and derive surface reflectance from measured reflectance and pre computed LUT
3. Select the *surface reflectance at* 0.86µm from 2 hours or ~ 12 FOVs base on the present of heavy sediment or coarse dust detected to minimize the biases. (*select lowest ρ_B^{surf} or highest ρ_A^{surf} based on stability of reflectance)

		Heavy Dust is detected	
		Yes	No
Heavy Sediments is detected	Yes		?
	No	*?	

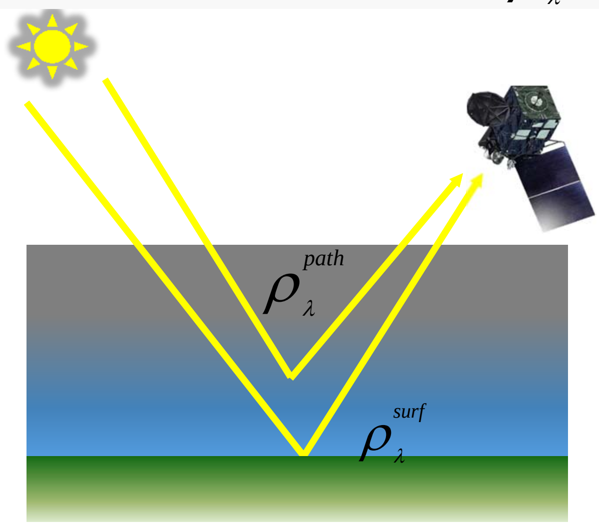
AHI aerosol algorithm over littoral zone

after cloud Mask, glint mask and sediment mask:

4. Generate TOA reflectance using the LUT parameters (i.e., Path reflectance, Transmission up and down, atmospheric spherical albedo) and derived surface reflectance (“bright surface”)

5. Then, process the AOD inversion for all FOVs from measured TOA reflectance and generated TOA reflectance .

$$\rho_\lambda^{TOA}(\tau) = \rho_\lambda^{path}(\tau) + \frac{T_\lambda^{up}(\tau) T_\lambda^{dn}(\tau) \rho_\lambda^{surf}}{1 - \bar{s}(\tau) \rho_\lambda^{surf}}$$



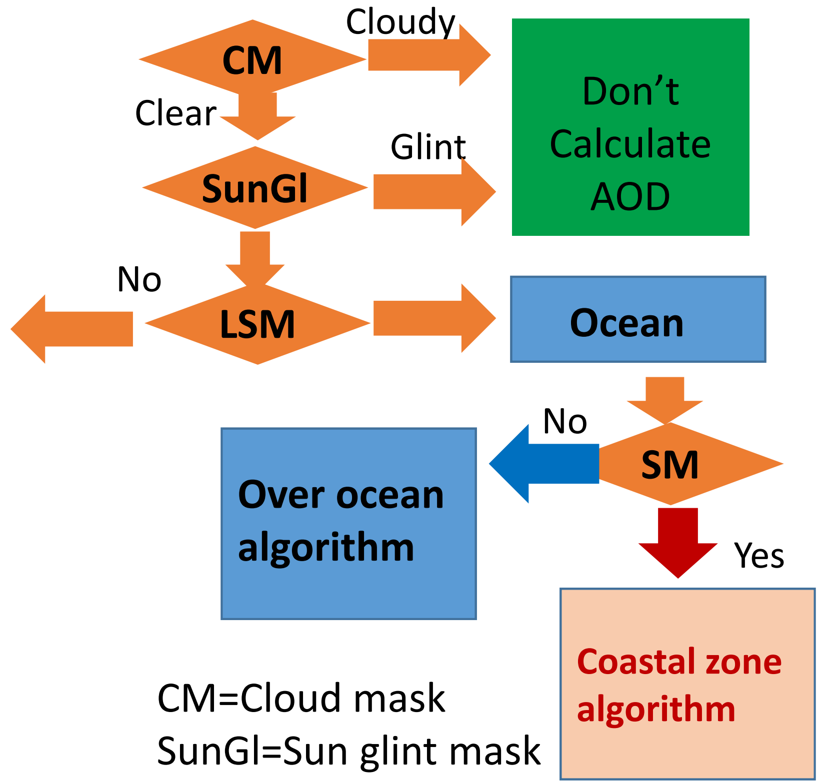
AHI aerosol algorithm over land
All procedures applied to individual 2km resolution (at nadir) pixels

Aerosol algorithm over land

The over land DT aerosol algorithm:

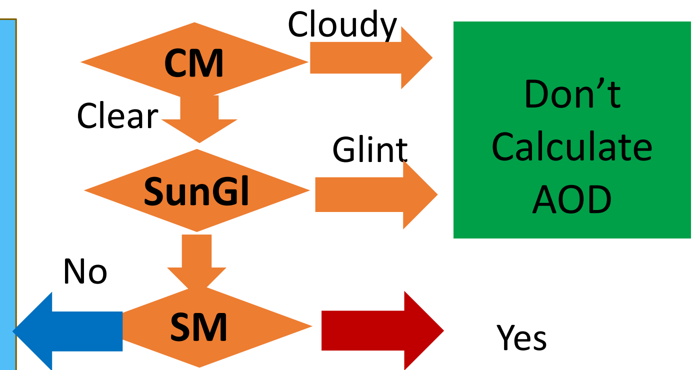
- Based on LUT (computed with 6S RT model) approach; aerosol models are adopted from MODIS.
- Calculate MVI= MVI($\boldsymbol{\rho}_{2.3}$, $\boldsymbol{\rho}_{0.86}$)
- Assume surface reflectance at 0. 47 and 0.64µm
  $\boldsymbol{\rho}^{S}_{0.64}$=f($\boldsymbol{\rho}^{S}_{0.64}$,MVI,Θ) ; $\boldsymbol{\rho}^{S}_{0.47}$=f($\boldsymbol{\rho}^{S}_{0.64}$)
- Select fine aerosol type LUT (function of geography and season) and coarse mode aerosol LUT (Dust).
- Correct LUT for elevation
- Find "Dark Target pixels" that have $0.01 \le \rho^{AHI}_{2.3} \le 0.25$
- Do Inversion : find $\boldsymbol{\tau}_{0.55}$
  $\rho^{AHI}_{0.47} - \rho^{TOA}_{0.47}$=0;
  $\rho^{TOA}_{total}(\tau,\lambda) = \eta\ \rho^{TOA}_{fine}(\tau,\lambda) + (1-\eta)\ \rho^{TOA}_{coarse}(\tau,\lambda)$

exact match at 0.47 and the best fit to 0.64µm



CM=Cloud mask
SunGl=Sun glint mask
LSM=Land Sea Mask
SM=Sediment mask

AHI aerosol algorithm over ocean and coastal zone
All procedures applied to individual 2km resolution (at nadir) pixels



CM=Cloud mask
SunGl=Sun glint mask
SM=Sediment mask

Aerosol algorithm over ocean

The DT aerosol algorithm:

- Based on LUT (computed with 6S RT model) approach
- Microphysical properties of aerosol models are adopted from MODIS
- Surface reflectance assumption is the sum of "dark" underwater, whitecap and sun glint reflection.
- LUT TOA reflectance: the coupling of atmospheric and surface reflection.
- Then, LUT reflectance is compared with AHI measured reflectance; find the exact match at 0.86µm and the best fit to 0.64,1.6 and 2.3µm to retrieve AOD, FMF and aerosol types

Turbid Water – SWIR algorithm

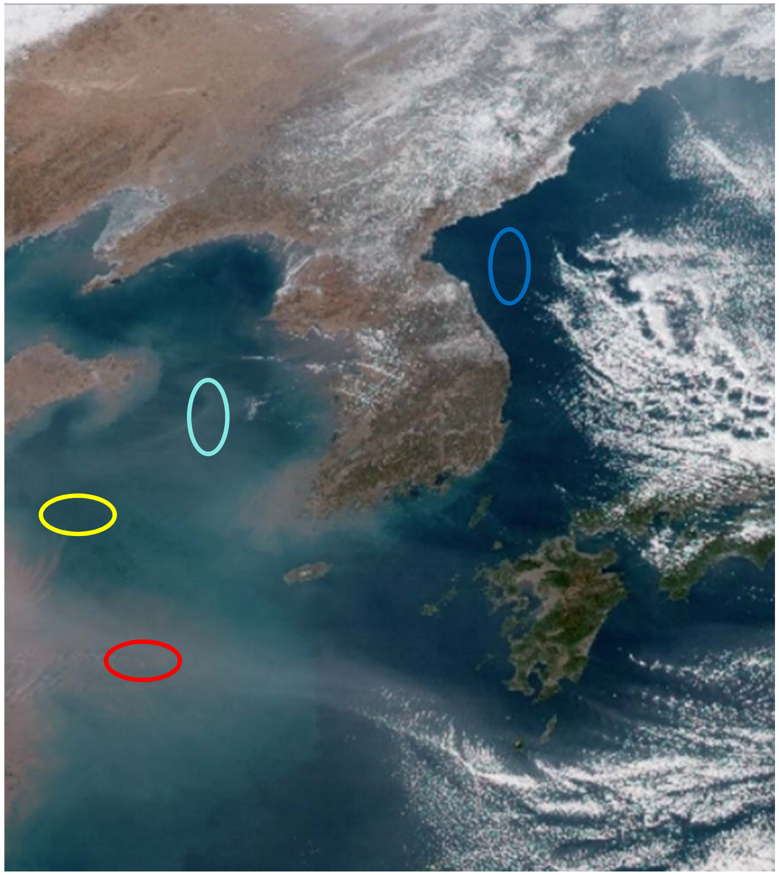
- Surface reflectance in SWIR (>1µm) is negligible (Wang and Shi, 2007)
- Surface can be assumed "dark" at 1.6 and 2.3µm to derive AOD using the LUT.
- Then, find the corresponding AOD at VIS and NIR where surface may be bright.
- Known limitations:

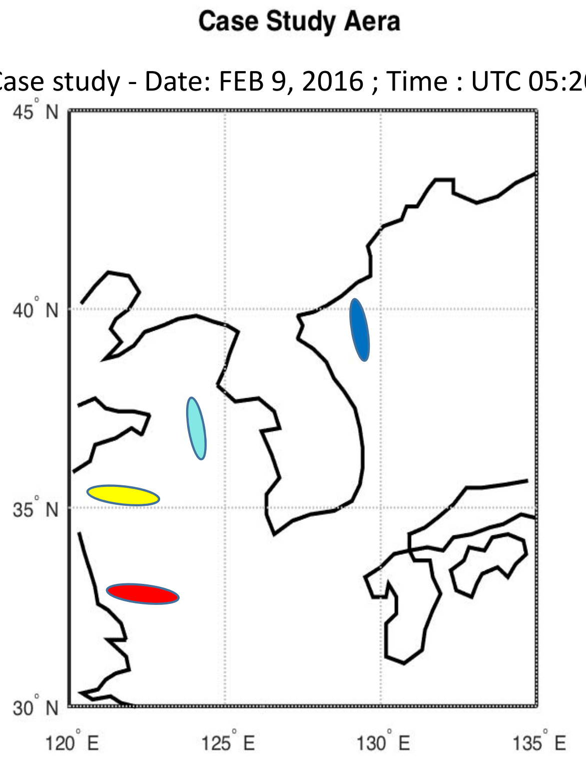
- less sensitive to the presence of fine mode aerosol particle
- highly turbid water background may be not dark

Sediment Mask

MOU1

Training Sediment Mask using known surface



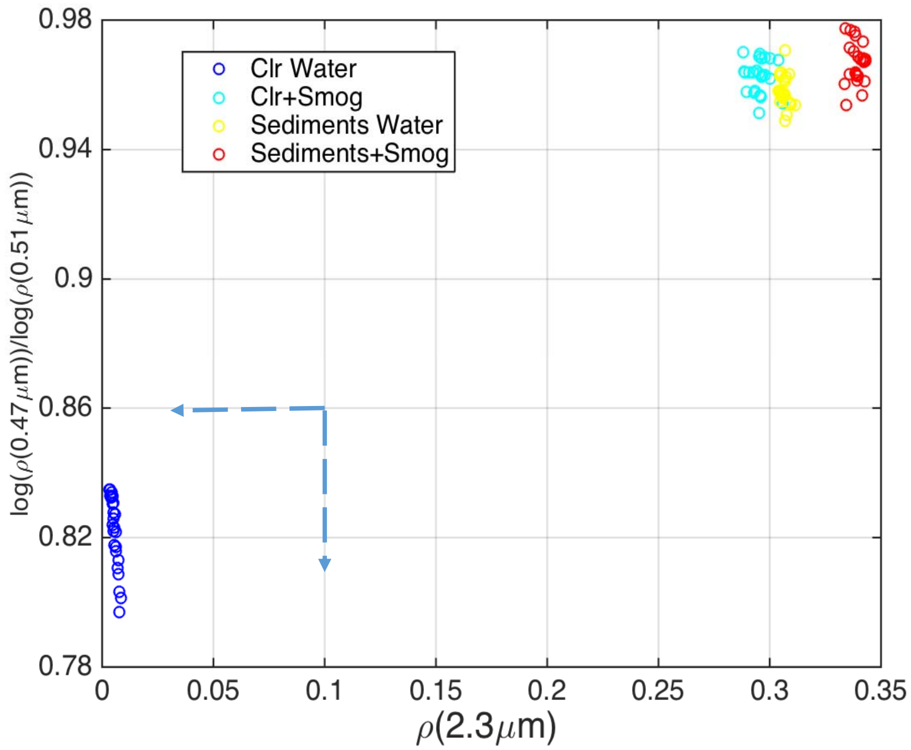


Blue = clear water ; **Cyan** = clear water with smog ;
Yellow = sediment water;
Red = Heavy Sediment water with (heavy) smog

Slide 24

MOU1 Min Oo, 6/13/2017

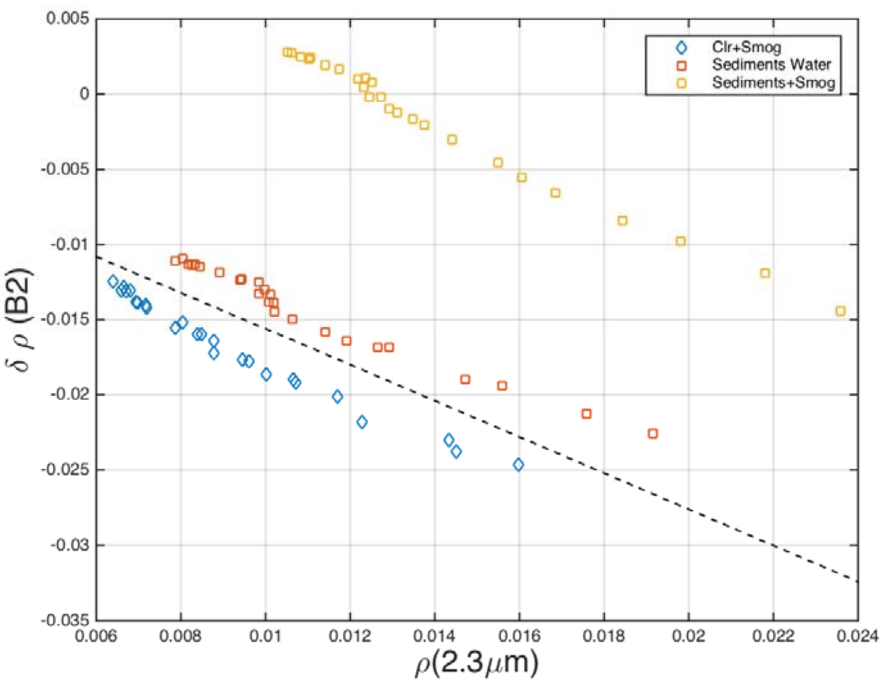
Dark target mask



the filtering threshold of:

1. Band 6 (2.3 µm) apparent reflectance less than 0.1 and
2. the log apparent reflectance ratio of blue B1 (0.47µm) / B2 (0.51µm) less than 0.86 (***Amin and Abdullah 2010***) to define "dark target".

Call back smog + clear water case



- Y-axis : $\boldsymbol{\Delta\rho}_{0.51\mu m}$ is the different between B2 measured reflectance and B2 *reference reflectance* interpolated by B1 and B6 (similar to MODIS & ***Li sediment mask***).
- ***Call back*** (to dark-target polluted aerosol + Clear water case) if $\boldsymbol{\Delta\rho}_{0.51\mu m}$ is threshold line:

$\boldsymbol{\Delta\rho}_{0.51\mu m} = -1.2\ \boldsymbol{\rho}_{2.3\mu m}\ -0.0036$

AHI Sediment Mask Algorithm :