How can the NASA PEATE be a testbed for NRT aerosol products?

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Tsukuba November 6th 2013

Outline

- An overview of the UW Atmospheric PEATE
- Products and data access
- Collocation and validation of aerosol products using CALIOP, MODIS, and VIIRS
- Processing of VIIRS and MODIS products on the PEATE
- Leveraging the PEATE at UW to support NRT processing.

The UW Atmospheric PEATE

- The NASA Atmospheric PEATE is located at UW-Madison
- The PEATE's have been funded by NASA to provide validation and algorithm development support for the NASA NPP science teams.
- The UW Atmospheric PEATE supports VIIRS and CrIS validation (Both SDR and EDR (Aerosol and Cloud)

The UW Atmospheric PEATE

The Atmospheric PEATE is an integrated processing and evaluation system designed to:

1. Process (rapidly) VIIRS (MODIS) cloud products from raw data records and ....

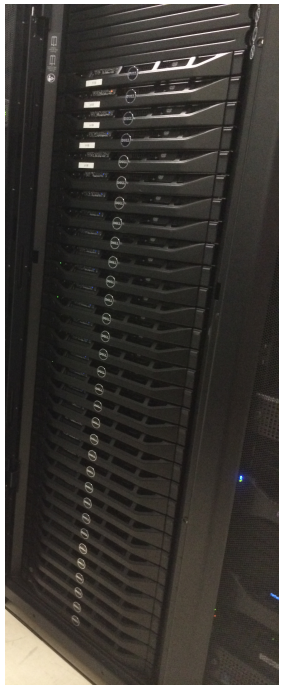
2. Evaluate the cloud/aerosol products by providing **collocated** satellite, aircraft, and ground evaluation observations allowing for quantitative analysis of global cloud/aerosol algorithm performance to .....

3. Support the VIIRS (MODIS) science team in evaluating and improving the VIIRS (MODIS) cloud/aerosol products

The UW Atmospheric PEATE

Compute Infrastructure

Cluster Submit Head Node



500 Compute Cores
In House

6,000 Cores Shared
On Campus

amazon web services™

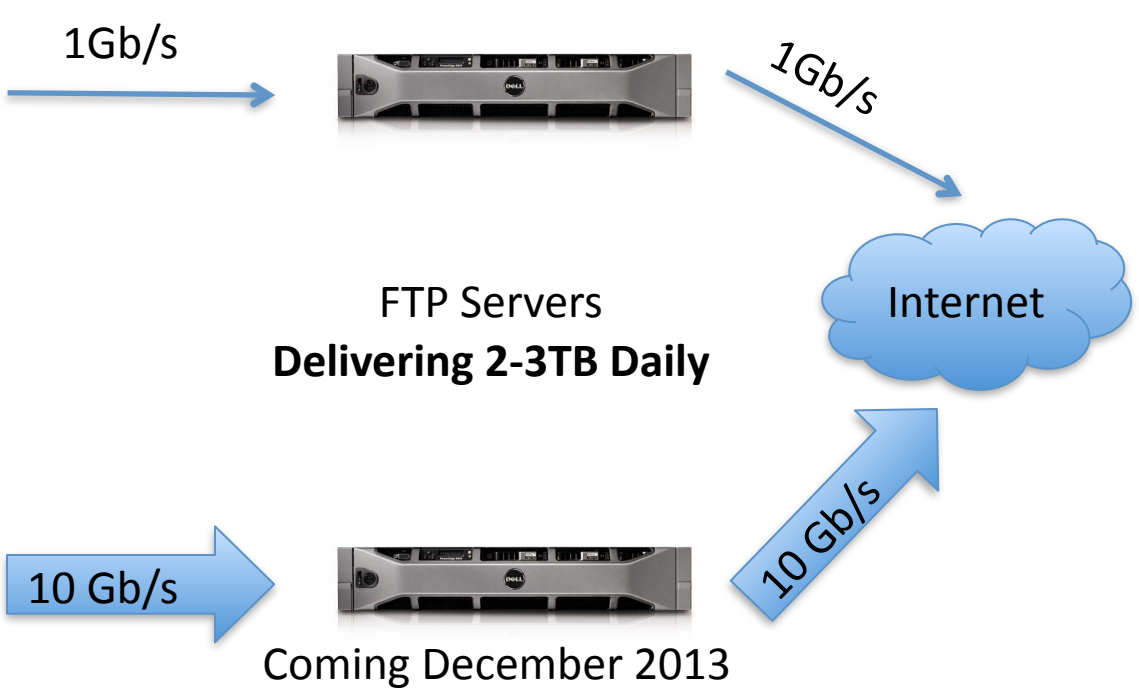
Harnessing Cloud
Resources as Needed

The UW Atmospheric PEATE

Storage and FTP Infrastructure

1.6 PB Gluster Distributed File System

Ingesting ~1TB Daily



The UW Atmospheric PEATE

Processing System

PEATE processing is coordinated by Flo, a system built in house for executing parallel remote sensing workflows. Key features include:

- Forward stream and archival processing
- Geographical and multi-sensor processing via integrated orbital prediction
- An extensible catalog of scientific algorithms; algorithms specify sensor and ancillary input requirements; Flo chains algorithms together as needed to reach output products

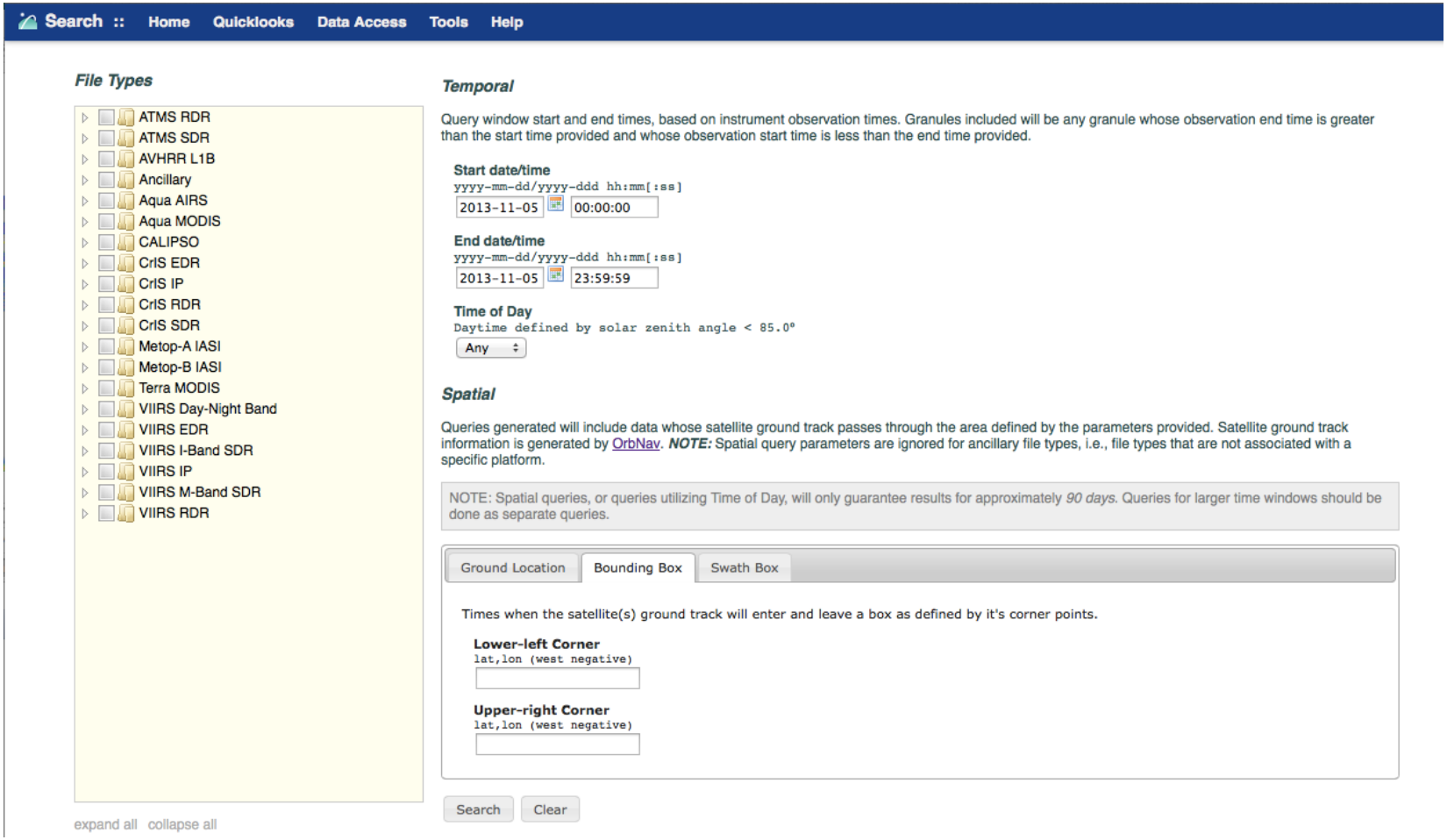
The UW Atmospheric PEATE

Ingested Products

- VIIRS RDR, SDR, and EDR (Clouds and Aerosols)
- MODIS Terra and Aqua L1a, L1b, MYD04 (aerosol), MYD06 (Cloud)
- AVHRR L1B
- ATMS RDR and SDR
- CALIPSO V3 L1b, L2 products (aerosol), and IIR
- CloudSat L1 and L2 products
- CrIS SDR and EDR
- Metop-A (IASI) and Metop-B (IASI)

The UW Atmospheric PEATE

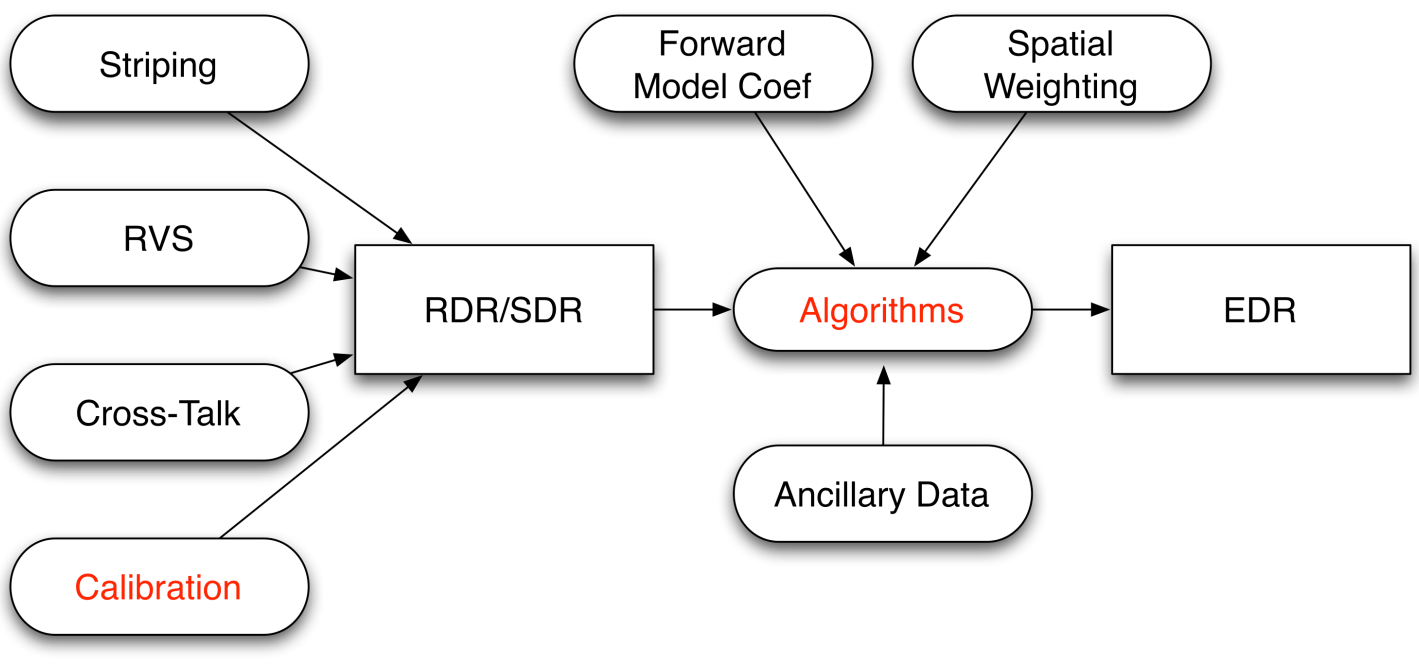
Data Access (peate.ssec.wisc.edu)



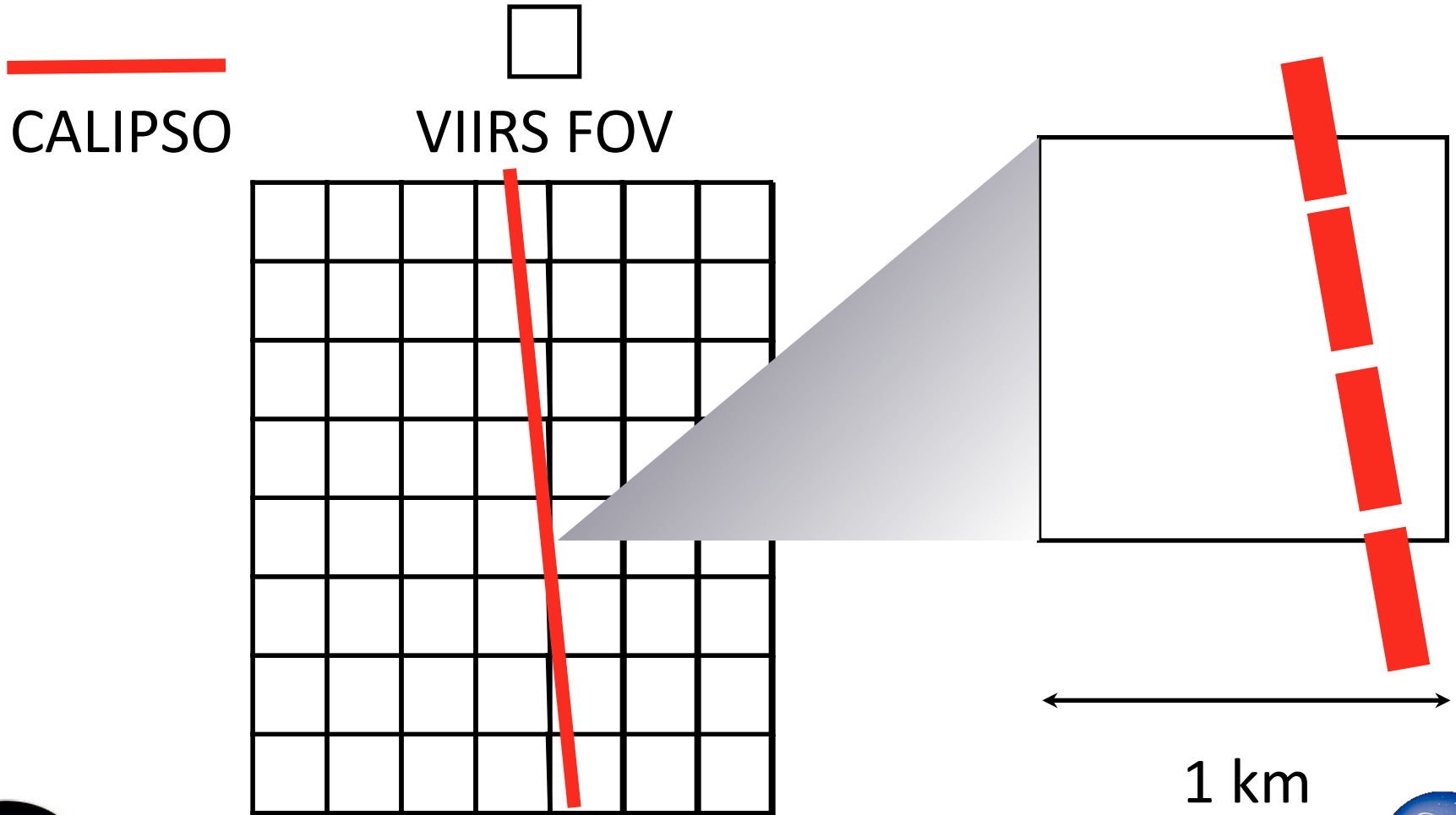
Collocation and Evaluation

EDR Sources of Uncertainty

- Raw measurements (RDR)
- Calibration (SDR)
- Retrieval (EDR)



Collocation and Evaluation



Space Science and Engineering Center
University of Wisconsin-Madison

Collocation and Evaluation

PEATE multi-satellite sensors collocation

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

Collocation and Evaluation

Current available multi-satellite sensors collocated data for Aerosols

	Geo-stationary satellites sensors		Polar-orbiting satellites sensors		
	SEVIRI	***COMS***	***VIIRS***	***CALIOP***	***MODIS (Aqua)***
MODIS (Aqua)	✔✔	✔✔	✔✔	✔✔	
VIIRS				✔	✔✔
CALIOP	✔	✔✔	✔		✔✔

✔ Aerosol Products

✔ Cloud Products

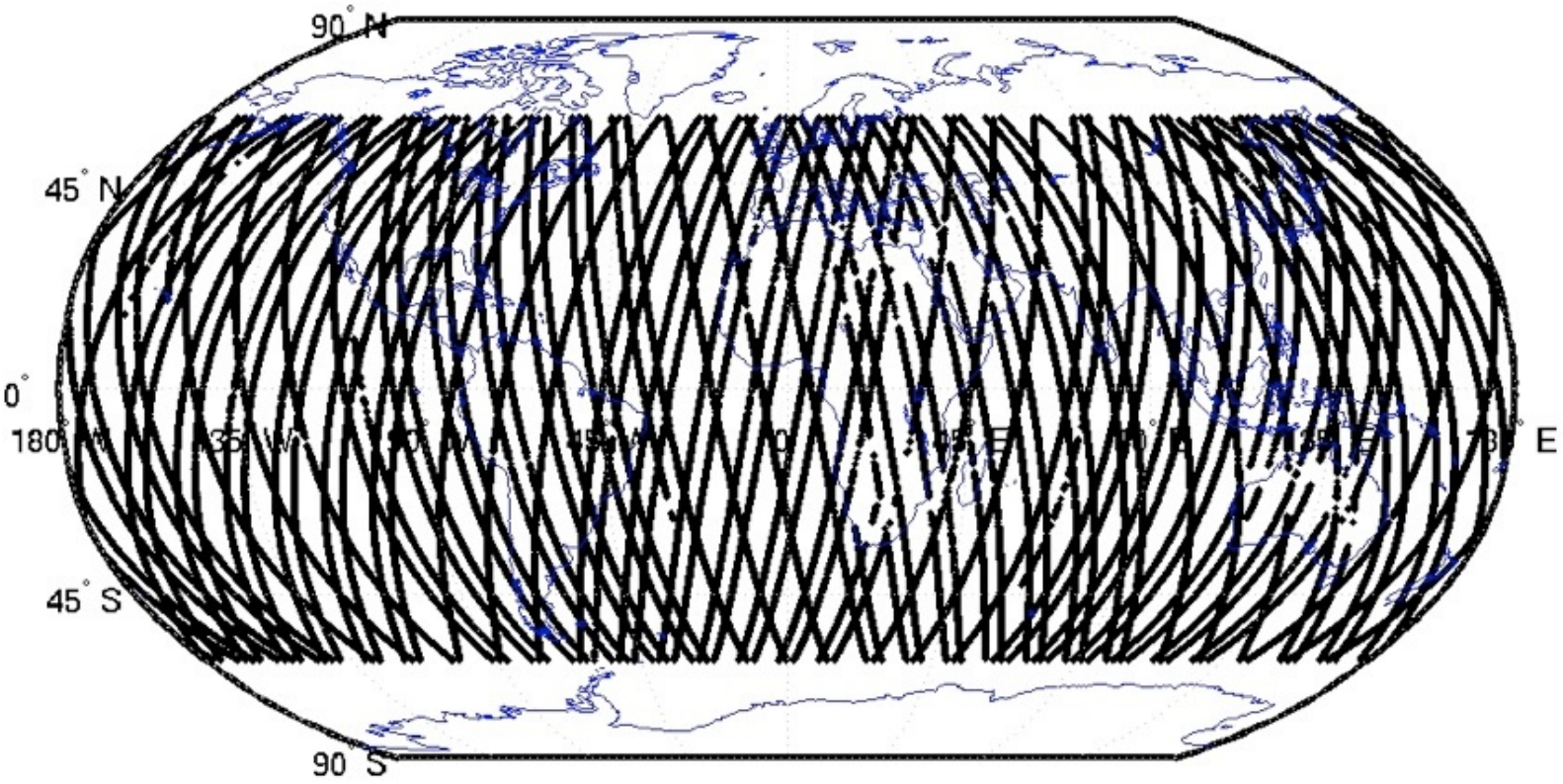
SSEC

NASA

Collocation and Evaluation

Aqua/CALIPSO Intersections with NPP

May 1 - Aug 11 2012Observations within 20 min



Collocation and Evaluation

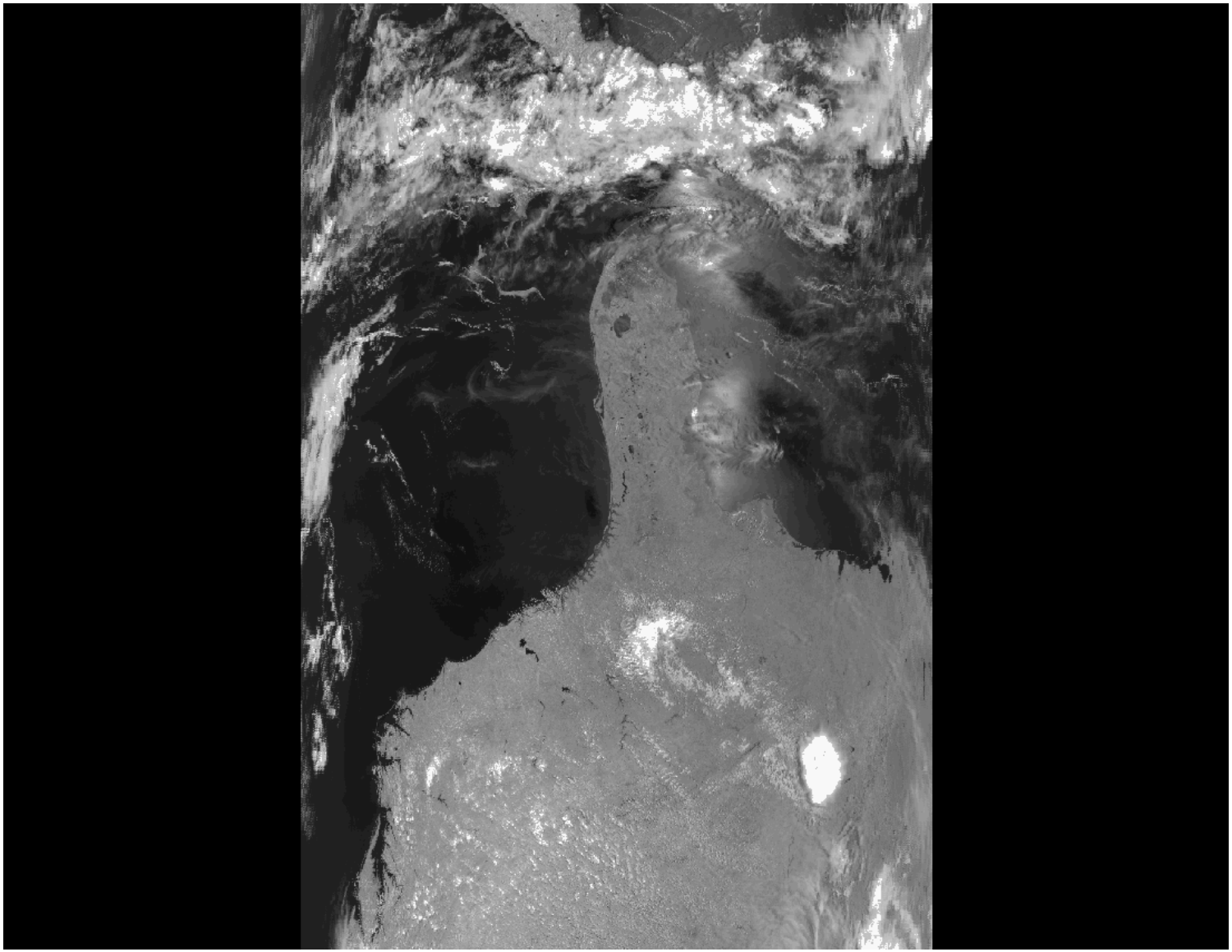
Match Files Generation

```
                                    MODIS_Latitude: [713674x1 double]
                                   MODIS_Longitude: [713674x1 double]
                         MODIS_Cloud_Effective_Radius: [713674x1 double]
                        MODIS_Cloud_Optical_Thickness: [713674x1 double]
                                MODIS_Cloud_Mask_Flag: [713674x1 double]
                                     MODIS_DayOrNight: [713674x1 double]
                                      MODIS_SunGlint: [713674x1 double]
                             MODIS_SnowIceBackground: [713674x1 double]
                                   MODIS_LandWater: [713674x1 double]
                          MODIS_Cloud_Mask_Quality: [713674x1 double]
                              VIIRS_collocated_num: [1x713674 double]
                                    VIIRS_Latitude: [1x713674 double]
                                   VIIRS_Longitude: [1x713674 double]
                                     VIIRS_MidTime: [1x713674 double]
                                  VIIRS_SolarZenith: [1x713674 double]
                                 VIIRS_SolarAzimuth: [1x713674 double]
                               VIIRS_SatelliteZenith: [1x713674 double]
                              VIIRS_SatelliteAzimuth: [1x713674 double]
                                  VIIRS_IVCOP_AvgCOT: [1x713674 double]
                                  VIIRS_IVCOP_StdCOT: [1x713674 double]
                                  VIIRS_IVCOP_AvgEPS: [1x713674 double]
                                  VIIRS_IVCOP_StdEPS: [1x713674 double]
                                  VIIRS_IVCTP_AvgCTH: [1x713674 double]
                                  VIIRS_IVCTP_StdCTH: [1x713674 double]
                                  VIIRS_IVCTP_AvgCTP: [1x713674 double]
                                  VIIRS_IVCTP_StdCTP: [1x713674 double]
                                  VIIRS_IVCTP_AvgCTT: [1x713674 double]
                                  VIIRS_IVCTP_StdCTT: [1x713674 double]
                    VIIRS_IICMO_num_of_Cloud_Mask_Quality: [1x713674x4 double]
VIIRS_IICMO_num_of_Cloud_Detection_Result_and_Confidence: [1x713674x4 double]
                          VIIRS_IICMO_num_of_Day_Night: [1x713674x2 double]
                     VIIRS_IICMO_num_of_SnowIceSurface: [1x713674x2 double]
              VIIRS_IICMO_num_of_Sun_Glint_Detection_Result: [1x713674x4 double]
                   VIIRS_IICMO_num_of_Land_Water_Background: [1x713674x5 double]
                          VIIRS_IICMO_num_of_ShadowDetected: [1x713674x2 double]
                            VIIRS_IICMO_num_of_HeavyAerosol: [1x713674x2 double]
                            VIIRS_IICMO_num_of_FireDetected: [1x713674x2 double]
                      VIIRS_IICMO_num_of_Cirrus_Detection_Solar: [1x713674x2 double]
                        VIIRS_IICMO_num_of_Cirrus_Detection_IR: [1x713674x2 double]
```

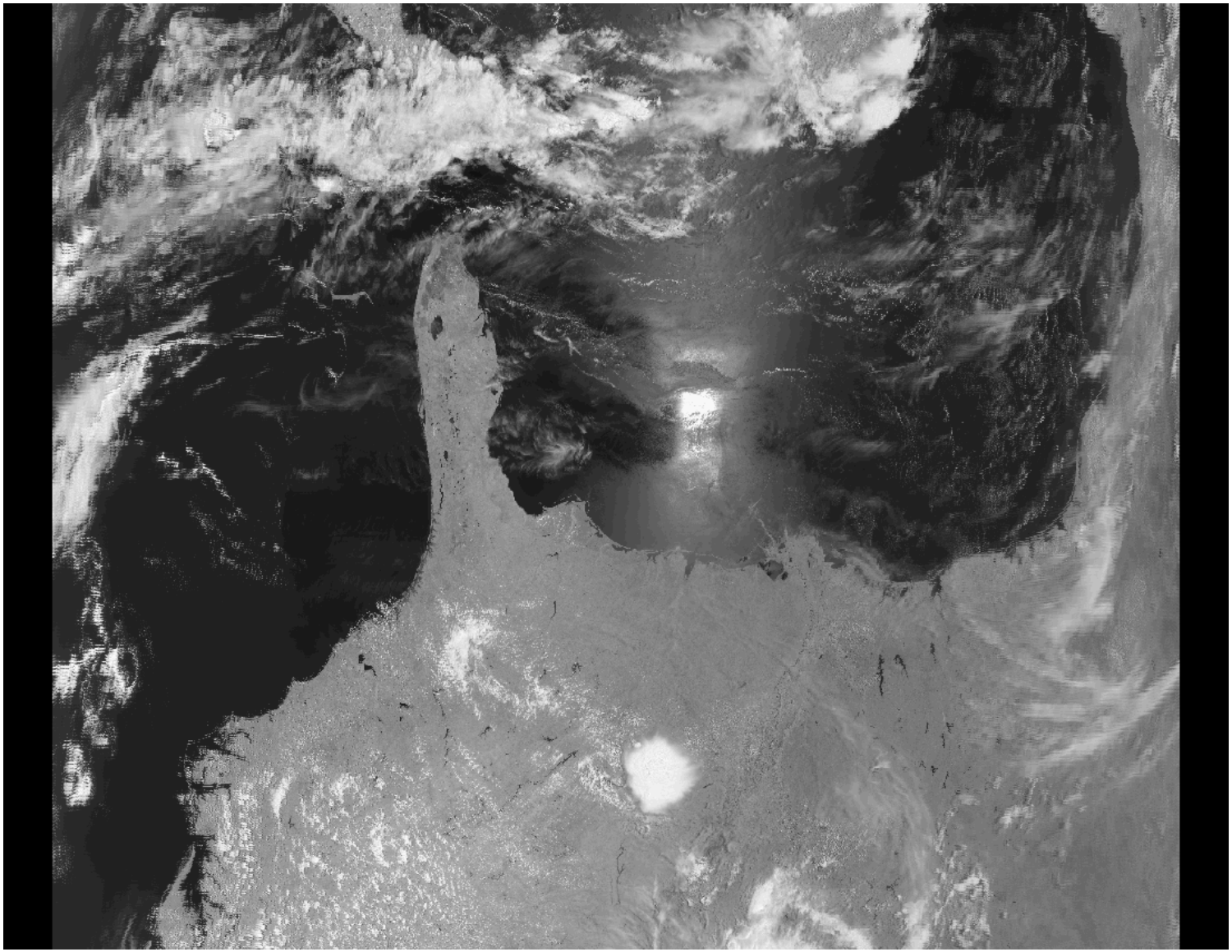
Intermediate File Format IFF

- One file format for both MODIS and VIIRS data
- HDF4 format with all data stored as 32-bit floats
- HDF4 internal compression to save space
- All bands with the same spatial resolution are stored in one file (e.g., all MODIS 1KM bands in one file, all VIIRS M-bands in one file)
- Geolocation data are stored with image data
- Granule size is 5 minutes for MODIS and VIIIRS
- Bowtie deleted VIIRS pixels are restored
- Can include MODIS like CO2 and water vapor channels using collocated CrIS observations

Aqua MODIS 2012/06/03 18:40
0.87 micron (1KM-band 2, 1000 m)

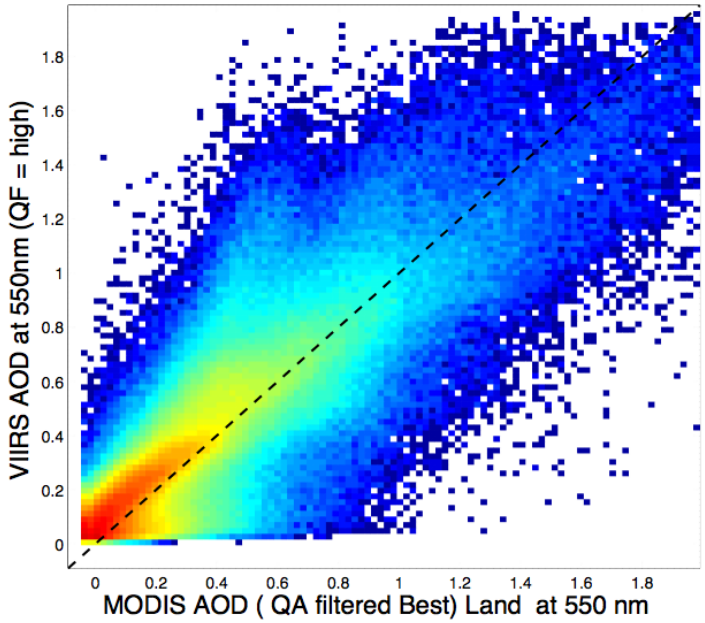


Suomi NPP VIIRS 2012/06/03 18:45
0.87 micron (M-band 7, 750 m)

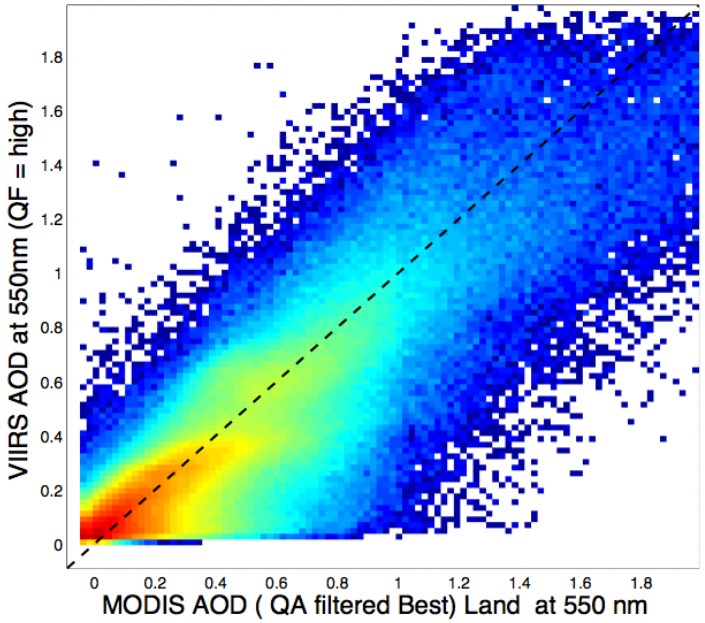


Collocation and Evaluation

MODIS VIIRS (EDR) AOD comparison over Land



May 2, 2012 to Jan 22, 2013
(Before PCT update) 1.4 millions sample

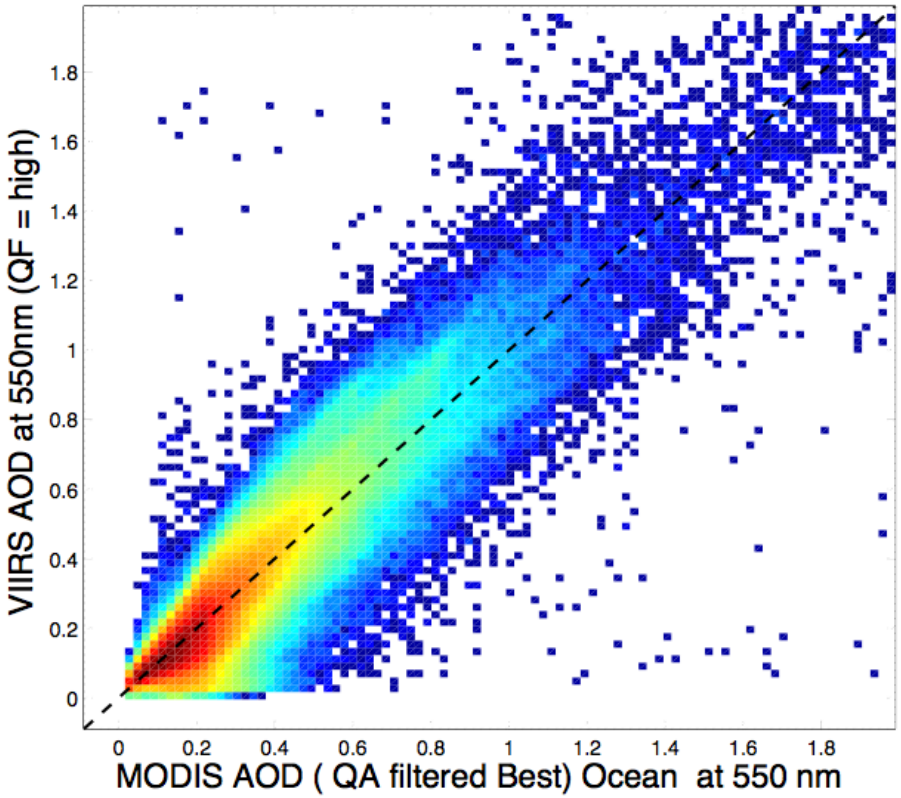


Jan 23, 2013 to Sep 15, 2013
(After PCT update) 1.6 millions sample

PCT: Processing Coefficient Table update [Jackson et al., 2013 at JGR]

Collocation and Evaluation

MODIS VIIRS (EDR) AOD comparison over Ocean

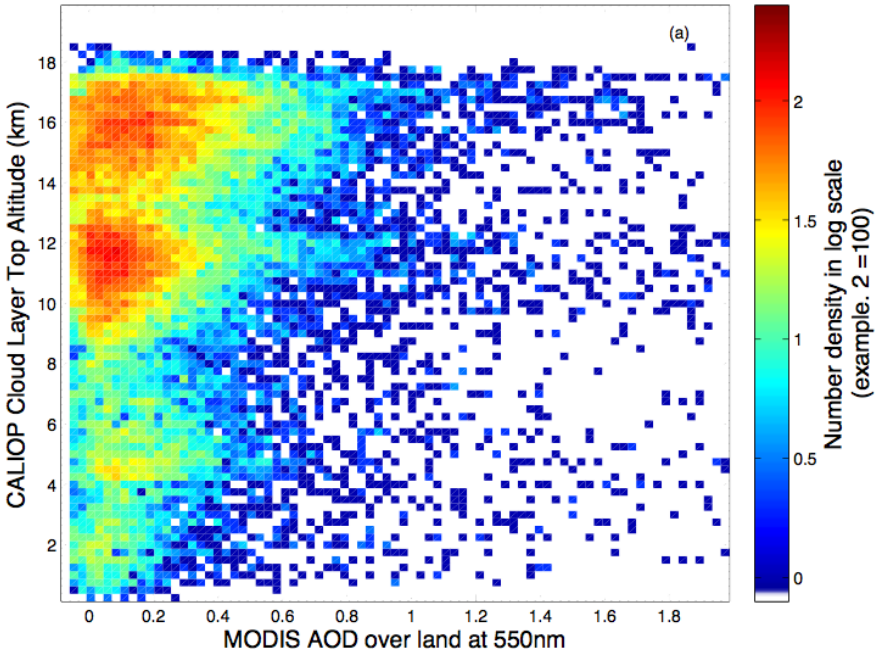


- Time period is:
  - May 2, 2012 to Sep 15, 2013 (excluding the processing error of Oct 15, 2012 to Nov 27, 2012) over ocean) 3.3 millions sample

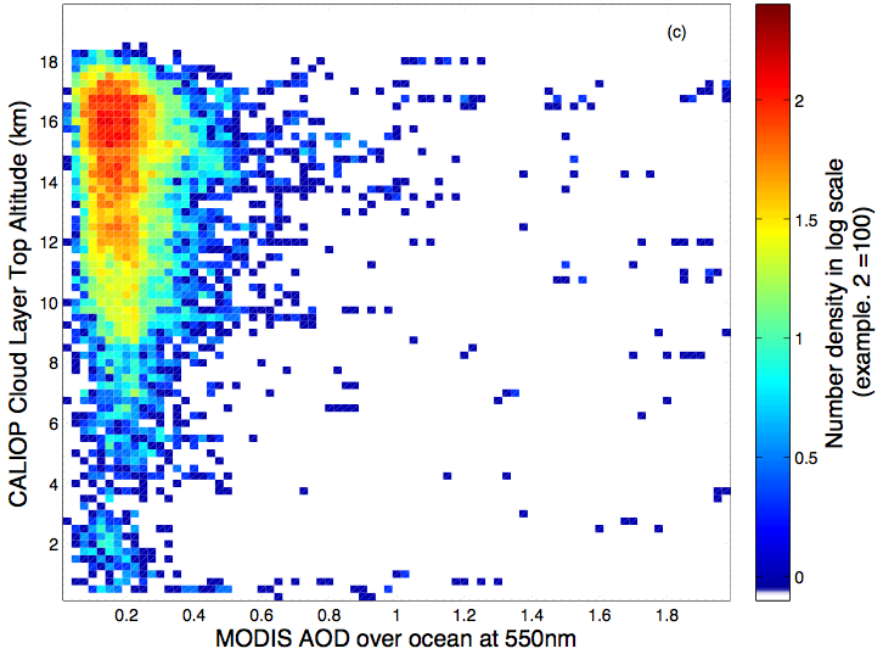
Collocation and Evaluation

Using collocated CALIOP and MODIS to evaluate global cirrus contamination in the MODIS aerosol product

Land



Ocean



SSEC

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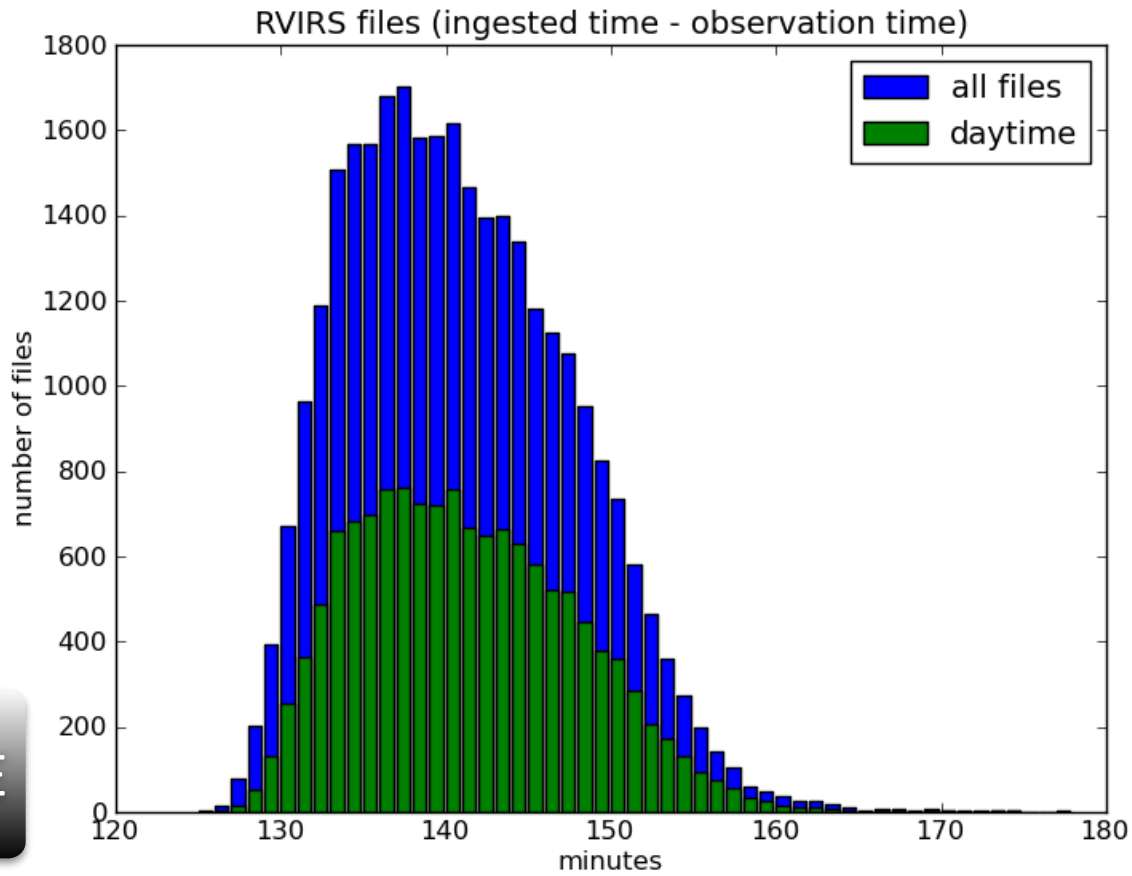
NRT and the PEATE

- 97% of VIIRS RDR files are created at 118 minutes after observation
- PEATE could ingest VIIRS RDR files within 5 minutes after creation on the IDPS
- Process RDR - IP or EDR within 10 min after being ingested

VIIRS RDR 130 minutes (min)

VIIRS RDR Latency Between IDPS and PEATE



NRT and the PEATE

Current PEATE data product generation

Contractor Algorithms

- VIIRS SDR
- VIIRS Cloud Mask
- VIIRS Contractor IDPS AOT V6.5
- CrIS SDR

VIIRS NPP ST Algorithms

- MODIS Deep Blue ported to VIIRS (Christina Hsu)
- MODIS AOT ported to VIIRS (Rob Levy)
- MODIS COP (clouds) ported to VIIRS using Patmos-X Cloud Heights (Steve Platnick)
- MODIS like cloud mask (MYD35) ported to VIIRS (in progress)
- GOOES-R Proxy Cloud Algorithms (Patmos-X) ported to MODIS and VIIRS (Heidinger)

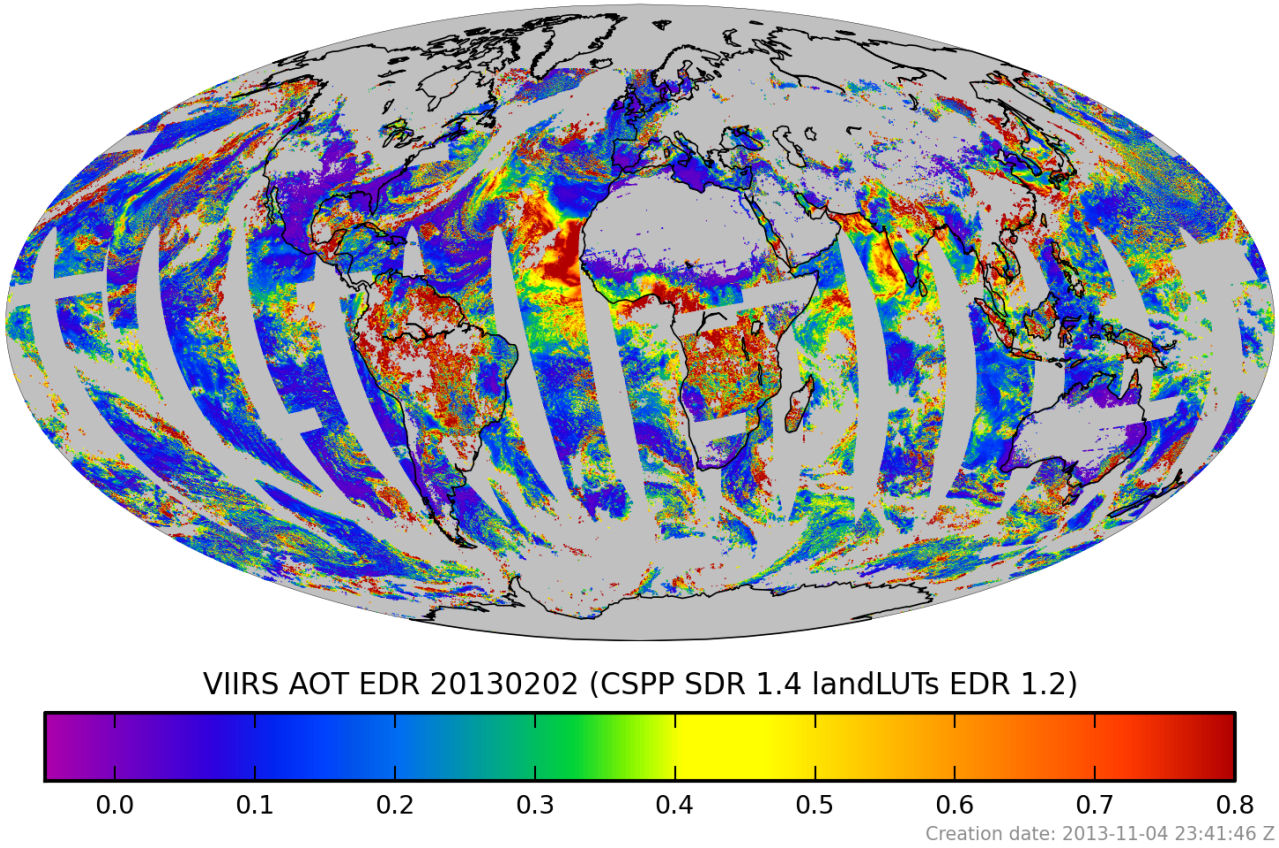
Direct Broadcast (DB) Community Satellite Processing Package

- The CSPP software for NPP is based on the Algorithm Development Library (ADL) developed by Raytheon and the JPSS project *(the same software that runs in IDPS)*.
- SSEC has packaged the ADL software to run from the Linux command line in real-time direct broadcast mode. *We have not changed the underlying processing source code, algorithms, or data formats.*
- The output files from the CSPP NPP SDR processing software *are identical in naming, format, and structure to the corresponding files from IDPS.*
- Ancillary data files are different than IDPS to enable real-time processing.

NRT and the PEATE

VIIRS IDPS compared to the PEATE CSPP AOT

PEATE



Take away messages

- Thanks to the support of NASA, we have developed the UW Atmospheric PEATE which provides a truly new capability to inter-compare and evaluate satellite observations
- Using this new capability we are improving both the NPP and MODIS retrievals of clouds and aerosols
- The PEATE infrastructure is capable of supporting NRT processing and product delivery including NRT multi-satellite collocated products
- Using the PEATE for NRT processing has the advantage of quickly transitioning algorithm improvements into the NRT environment