Identifying a NRT Path to Assimilate Geostationary Aerosol Data

Arlindo da Silva*

arlindo.m.dasilva@nasa.gov

Global Model and Assimilation Office, Code 610.1

LANCE UWG Meeting

4 May 2022

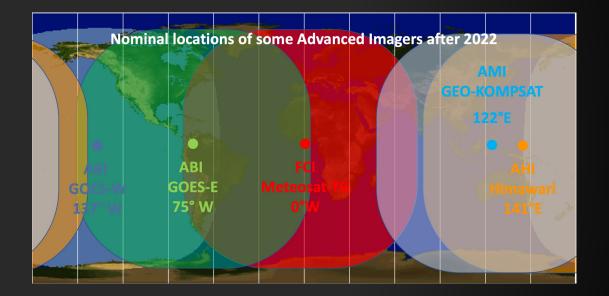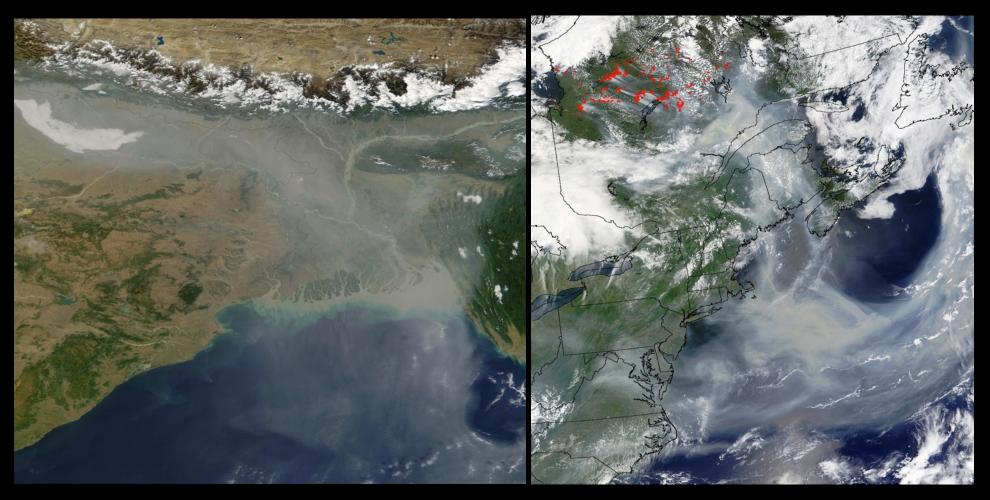** With contributions from Rob Levy and Jeff Reid.*

Outline

- Dark Target aerosol algorithm: MODIS, VIIRS, GEO

- Impact of geostationary data in GEOS Aerosol DA System

- Need for NRT geostationary aerosol data: feedback from US/international community

- Possible path for NRT geostationary aerosol retrievals

Nominal locations of some Advanced Imagers after 2022

AMI
GEO-KOMPSAT
122°E

ABI
GOES-W
137° W

ABI
GOES-E
75° W

FCI
Meteosat-TG
0°W

AHI
Himawari
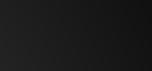141°E

We can see haze and smoke from space

Haze over the Ganges/Bay of Bengal (4 December 2001)

Smoke transported over Eastern Canada/USA (8 July 2002)

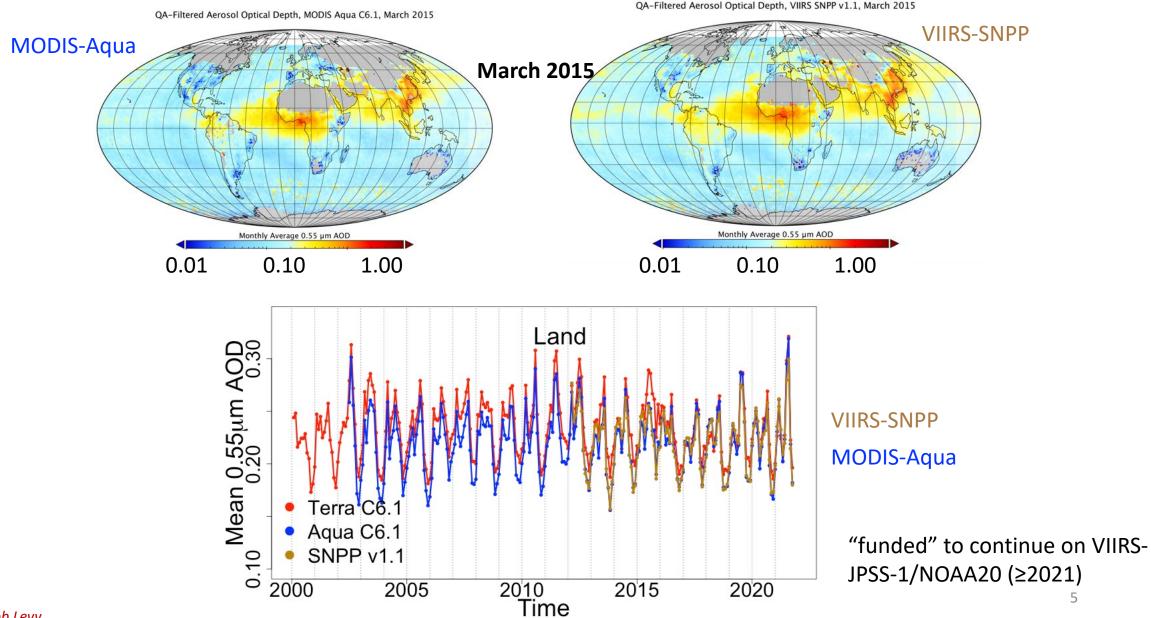http://earthobservatory.nasa.gov/

The Dark Target/Deep Blue Algorithms
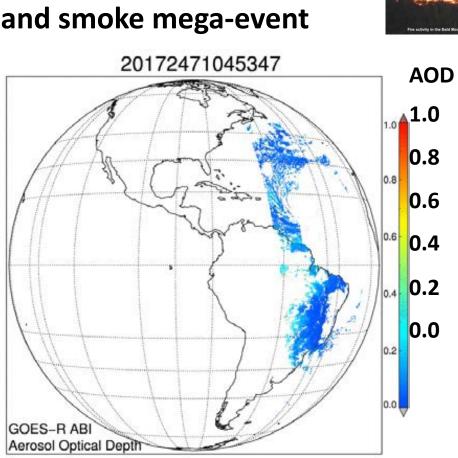
MODIS-heritage Algorithms

MODIS + VIIRS --> Long term climate

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

MODIS-Aqua

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

VIIRS-SNPP

March 2015

Monthly Average 0.55 μm AOD

0.01   0.10   1.00

Monthly Average 0.55 μm AOD

0.01   0.10   1.00

VIIRS-SNPP

MODIS-Aqua

Land

Mean 0.55μm AOD

Terra C6.1
Aqua C6.1
SNPP v1.1

2000   2005   2010   2015   2020

Time

"funded" to continue on VIIRS-JPSS-1/NOAA20 (≥2021)

Expanding to retrieve from GEO-Imager data!

RGB and AOD from ABI for Sep 4, 2017 (animation)
Canada/Washington fires and smoke mega-event

Fire activity in the Bald Mountain area in August, 2017. (Courtesy BC Wildfire Service via Twitter)

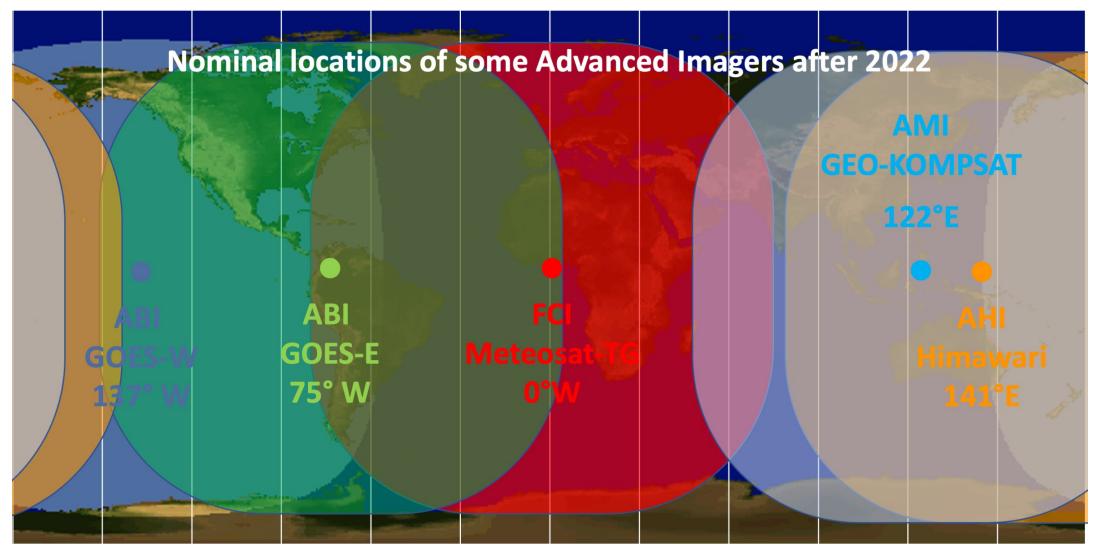20172471045347

GOES–R ABI
Aerosol Optical Depth

AOD

ABI = Advanced Baseline Imager

- Polar Orbiting Satellites: 1-3 observations per day, per sensor, cannot resolve diurnal cycle

- Current Geostationary Satellites: Every 10 min (Full Disk). Can resolve time

6

With options for adding even more sensors!

Nominal locations of some Advanced Imagers after 2022

AMI
GEO-KOMPSAT
122°E

ABI
GOES-W
137° W

ABI
GOES-E
75° W

FCI
Meteosat-TG
0°W

AHI
Himawari
141°E

Status of Dark Target/Deep Blue Aerosol Products
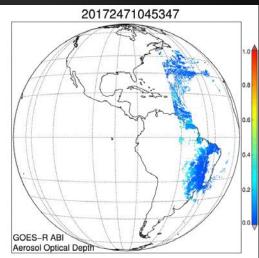
- **MODIS Collection 6.1 ('MxD04_L2' and 'MxD04_3K')**
  - Data (2000-present) available in HDF4 format.
  - Includes Dark-Target / Deep Blue (DT/DB) merge product
  - **Includes 3 km resolution product (MxD04_3K)**

- **VIIRS Version 1.1 Dark-Target ('AERDT_VIIRS_SNPP')**
  - DT Data available in NetCDF4.   Most output parameters same as MODIS
  - Deep Blue already ('AERDB') available since early 2019, and no current merge
  - Funded development for retrievals on NOAA-20 ('AERDT_VIIRS_N20')

- **Geostationary Beta product ('AERDT_ABI_G16', 'AERDT_ABI_G17', 'AERDT_AHI_H08')**
  - Data are being processed 2019-present (and some earlier data).
  - DT Data available in NetCDF4.   Most output parameters same as VIIRS
  - Deep Blue already ('AERDB') in funded development and plans for merge

---

- MODIS + VIIRS Data currently available on LAADS.
  - https://ladsweb.modaps.eosdis.nasa.gov/missions-and-measurements/science-domain/aerosol/
- GEO Beta available by asking Rob Levy! (Open to public on LAADS after 2022)

Dark Target Products in GEOS

- MODIS DT/DeepBlue products are assimilated in GEOS NRT system (thanks, LANCE!) and in the MERRA-2 reanalysis; VIIRS in progress

- DT/Deep Blue products are very convenient for assimilation in GEOS
  - Provides *cloud cleared/gas corrected* reflectances used for the retrieval (at ~10 km product resolution)
  - Product files are in NetCDF/HDF format
  - Variable names similar to MODIS

- Currently testing ABI on GOES-16/17, and AHI on Himawari-8 in 2019 during FIREX-AQ and CAMP²EX airborne campaigns
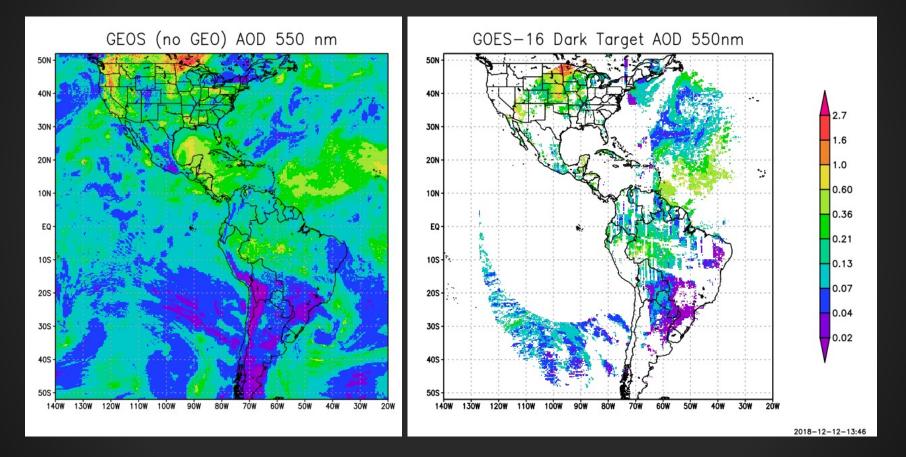
- Observations of diurnal aerosol!

2017247045347

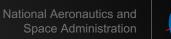GOES–R ABI
Aerosol Optical Depth

The before picture …

GEOS (no GEO) AOD 550 nm

GOES—16 Dark Target AOD 550nm

2018-12-12-13:46

Snapshot on 18Z 10Aug2018

GEOS AOD analysis: the impact of ABI

GEOS (no GEO) AOD 550 nm

GEOS (+GEO) AOD 550 nm

2018-12-12-14:14

Snapshot on 18Z 10Aug2018
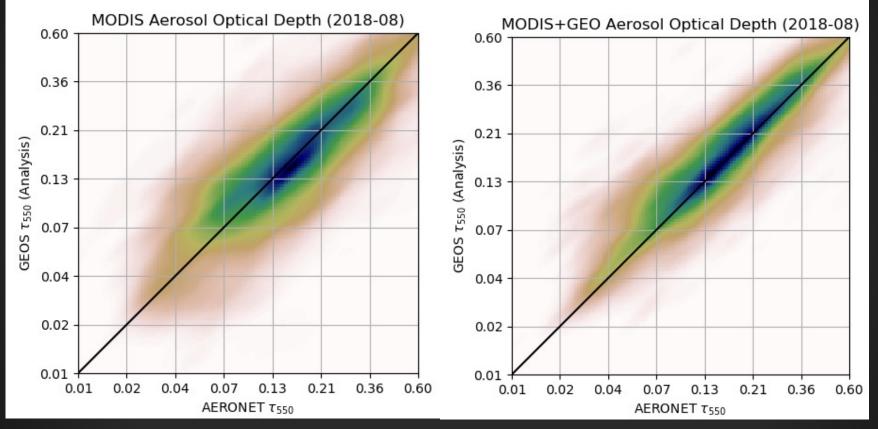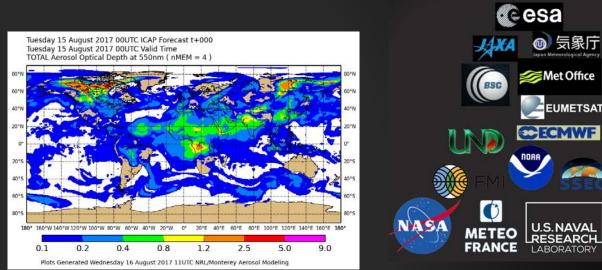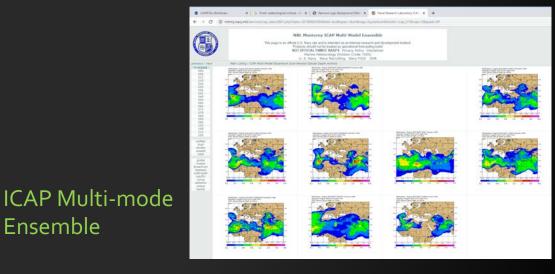
AERONET Verfication

August 2018

ICAP
International Cooperative for Aerosol Prediction

- By now, most major global centers have some form of NRT aerosol prediction

- Originated from a 2010 ad hoc meeting between model & remote sensing developers concerned with the transition from the MODIS to the VIIRS era. Discussions continue until today about all manner of aerosol modeling, remote sensing, and data assimilation problems.

- Given global reciprocity needs, developers agreed to begin collaborative aerosol research on satellite QA/QC, verification, and consensus/multi-model ensemble to diagnosing data requirements.

- ICAP members do not speak for their agencies, but ICAP allows developers to speak as a community to establish best practices and make scientific recommendations

- Model members: BSC, ECMWF, FMI, JMA, GMAO, MeteoFrance, NCEP, NRL, UKMO.

- Remote sensing members: JAXA/JMA, ESA, Eumetsat, NASA, SSEC

Tuesday 15 August 2017 00UTC ICAP Forecast t+000
Tuesday 15 August 2017 00UTC Valid Time
TOTAL Aerosol Optical Depth at 550nm (nMEM = 4)

Plots Generated Wednesday 16 August 2017 11UTC NRL/Monterey Aerosol Modeling

ICAP Multi-mode Ensemble

Feedback from ICAP Members

- **From GMAO and the AOS Project:**

  Geostationary data is a critical portion of the GEOS aerosol observing system. Having this data in NRT will significantly benefit the generation of low latency Level 4 products for the AOS mission that are needed for applications.

  --- Arlindo da Silva/Dalia Kirschbaum

- **From ECMWF:**

  I think it would be amazing to have the geostationary retrievals on LANCE. Total support from our side.

  --- Angela Benedetti

- **From NRL:**

  I think the whole community has been waiting for this for a long time. I think NRL is close to operational implementation-we just needs a dataset.

  --- Jeff Reid

- **From JMA:**

  Aerosol retrievals from geostationary satellites are of great interest, since JMA's aerosol prediction uses JAXA's aerosol retrieval algorithm with Himawari-8.

  --- Taichu Tanaka

Possible Path Forward

- Members of the US and international aerosol prediction community agree about the urgent need to add geostationary data in NRT

- Although other MODIS-heritage aerosol algorithms exist (*e.g.*, Deep Blue, MAIAC), the Dark Target algorithm offers the breadth of sensors and maturity for NRT implementation of geostationary aerosol retrievals
  - Over time, other algorithms could be integrated as well

- The University of Wisconsin/SSEC has access to ABI and AHI data in NRT and have experience deploying the Dark Target algorithm for LEO and GEO sensors.
  - Extension to Meteosat Third Generation, when launched in 2022, will provide much needed GEO-ring global coverage.

- Can LANCE facilitate the implementation of NRT GEO aerosol data?

GMAO
Global Modeling and Assimilation Office
gmao.gsfc.nasa.gov

GODDARD
EARTH SCIENCES