USDA
United States Department of Agriculture

Maintaining Terra and Aqua MODIS Continuity

Fire Geospatial Coordinators Meeting
June 28, 2022

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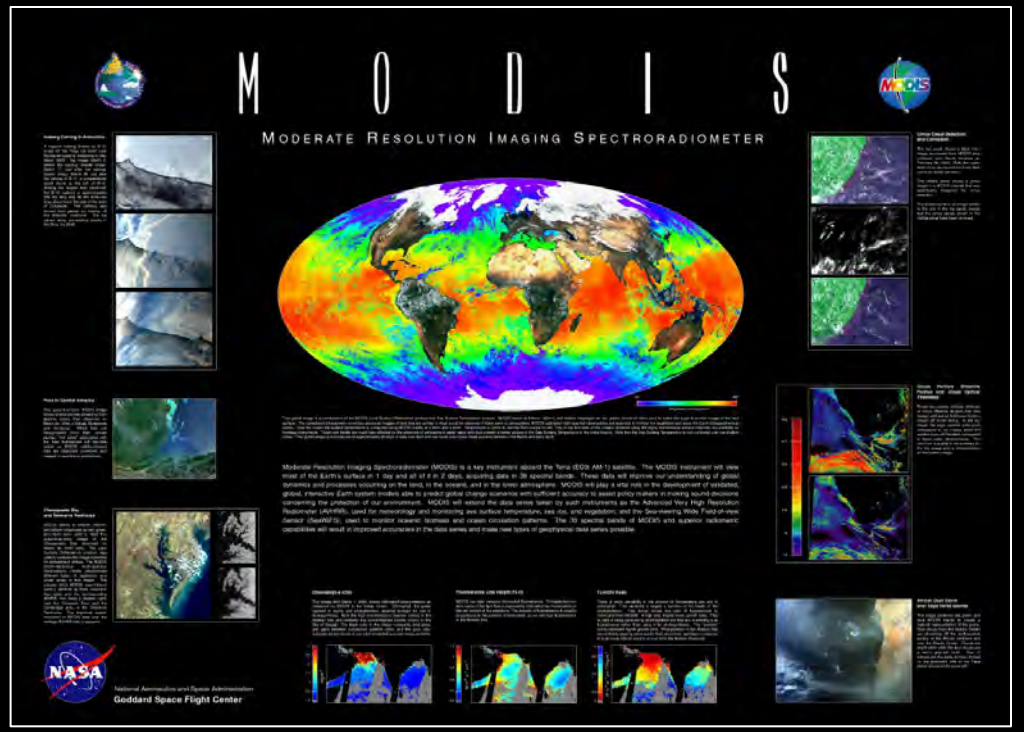
Some content from slides presented at NASA MODIS Land Workshop (April 11, 2022) and other NASA, ESA and EUMETSAT sources

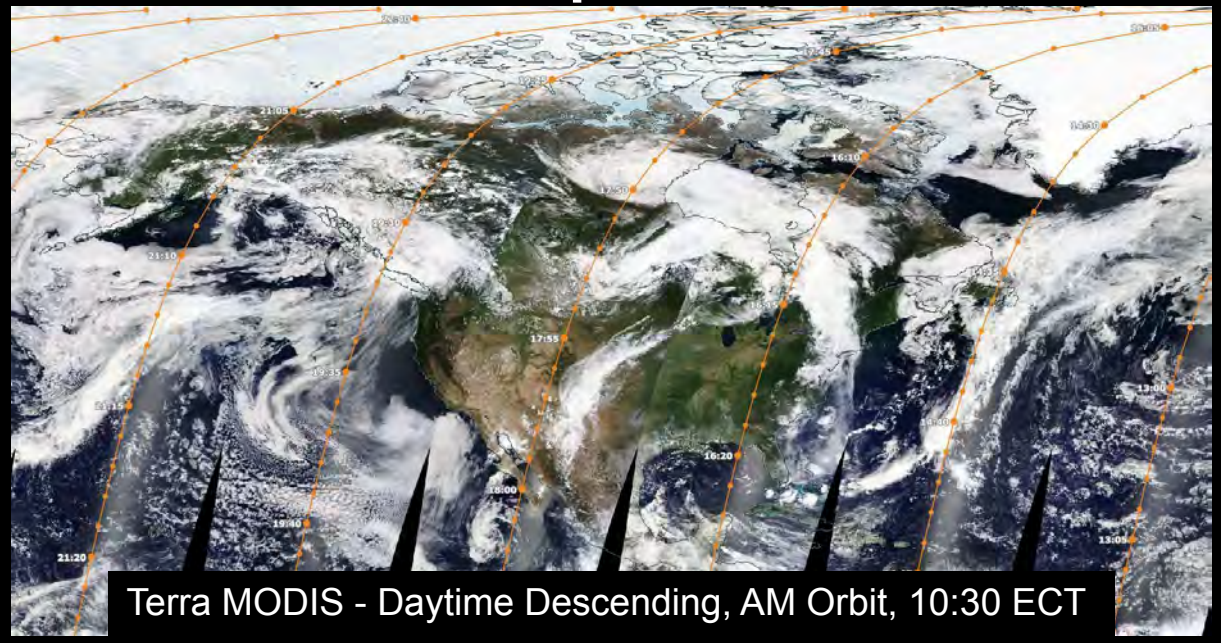
Terra and Aqua Missions - Background

- Launch:
  - Terra - Dec 1999
  - Aqua - May 2002
- Design Life: 6 years
- Multiple instruments onboard both platforms, including MODIS
- MODIS:
  - High temporal, synoptic observations
  - 2,330 km swath
  - 36 bands (VIS / NIR / SWIR / TIR)
  - 29 bands at 1km, 5 bands at 500m and 2 bands at 250m
  - Provides many essential land products, including fire science data
- 15PB of MODIS data in the NASA data archive

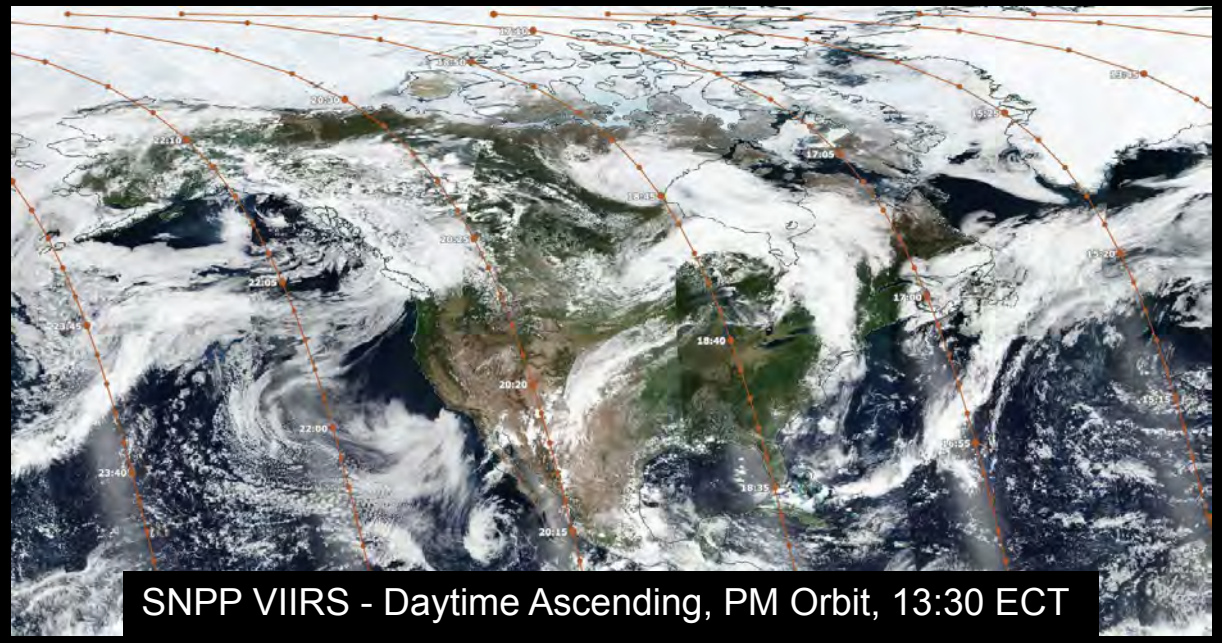


NASA MODIS Press Conference Poster – April 19, 2000

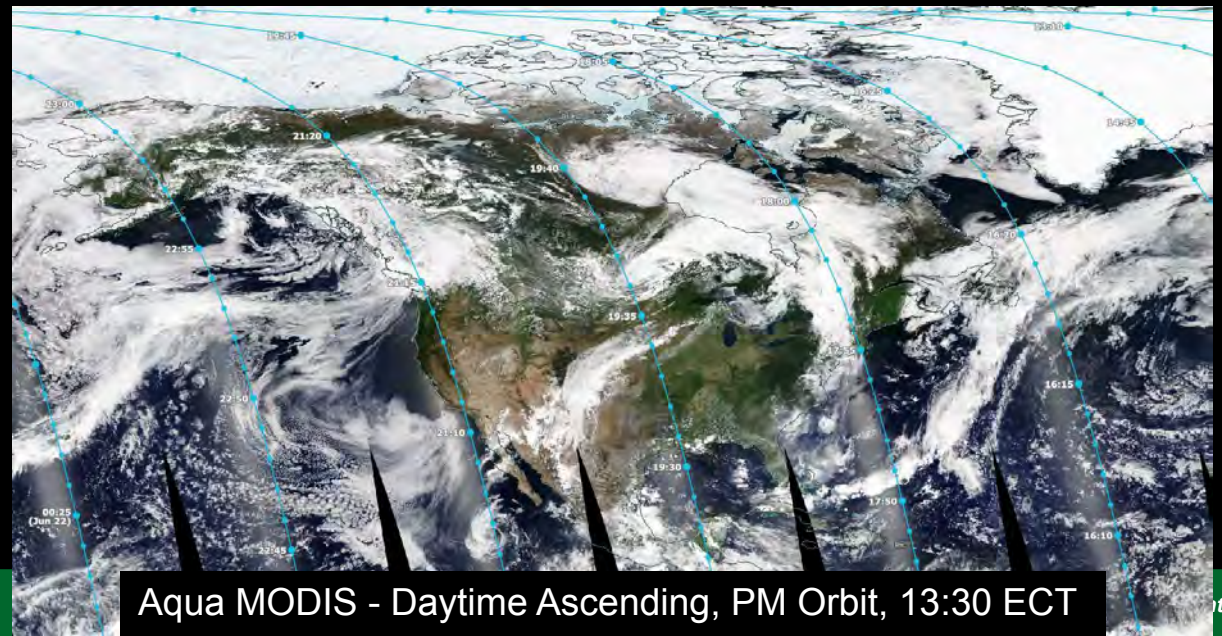
Terra/Aqua MODIS and S-NPP/NOAA-20 VIIRS



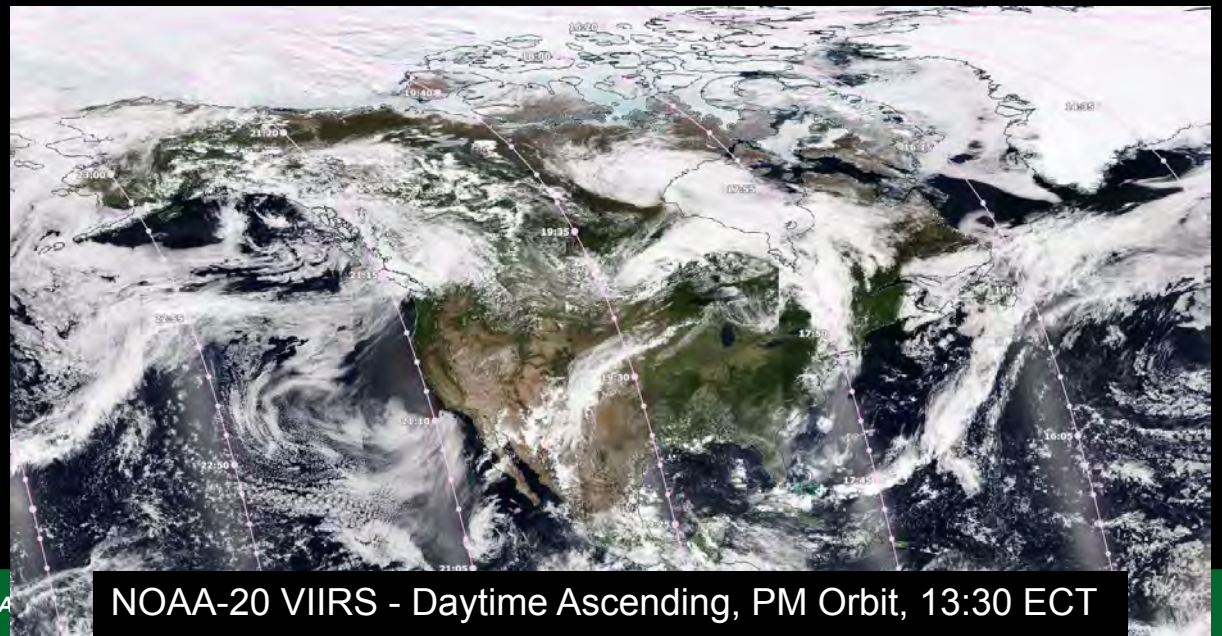
Terra MODIS - Daytime Descending, AM Orbit, 10:30 ECT



SNPP VIIRS - Daytime Ascending, PM Orbit, 13:30 ECT



Aqua MODIS - Daytime Ascending, PM Orbit, 13:30 ECT



NOAA-20 VIIRS - Daytime Ascending, PM Orbit, 13:30 ECT

Terra and Aqua Missions – Current Status

- Still collecting valuable data, but…
  - Both are aging spacecrafts
  - Number of spacecraft anomalies is increasing
  - Increasingly expensive to operate (~$90 million/year)
- Both no longer have necessary fuel to maintain altitude and tight crossing times
- Both are currently exiting their respective constellations and their local-crossing times are drifting earlier (Terra) and later (Aqua) in the day
- End of science data collection/end of mission schedule
  - Terra - December 2023
  - Aqua - August 2023

Observation and Product Continuity

- Aqua MODIS PM observation and product continuity assured through VIIRS
  - S-NPP (2011)
  - NOAA-20 / JPSS-1 (2017)
  - NOAA-21 / JPSS-2 (November 2022)
  - JPSS-3 (2027)
  - JPSS-4 (2032)
- No NASA or NOAA missions to provide AM observation and product continuity for Terra MODIS

Options for Developing MODIS AM Continuity

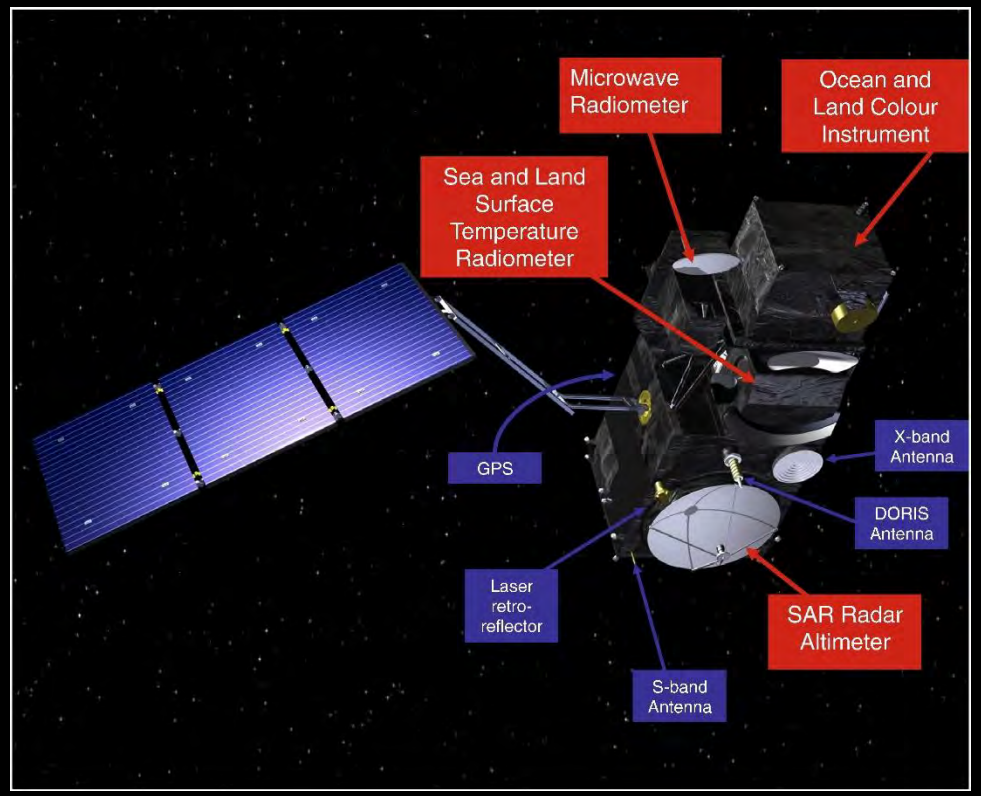
Some initial concepts considered by NASA…

- Move the S-NPP spacecraft from the PM to AM orbit once NOAA-21 is transitioned to operations
  - Determined there is insufficient fuel and time needed to maneuver S-NPP into a 10:30 AM orbit
- Mission Extension Vehicle (MEV) or Robotic Refueling Mission (RRM) for S-NPP
  - Feasibility assessment for either option was not completed

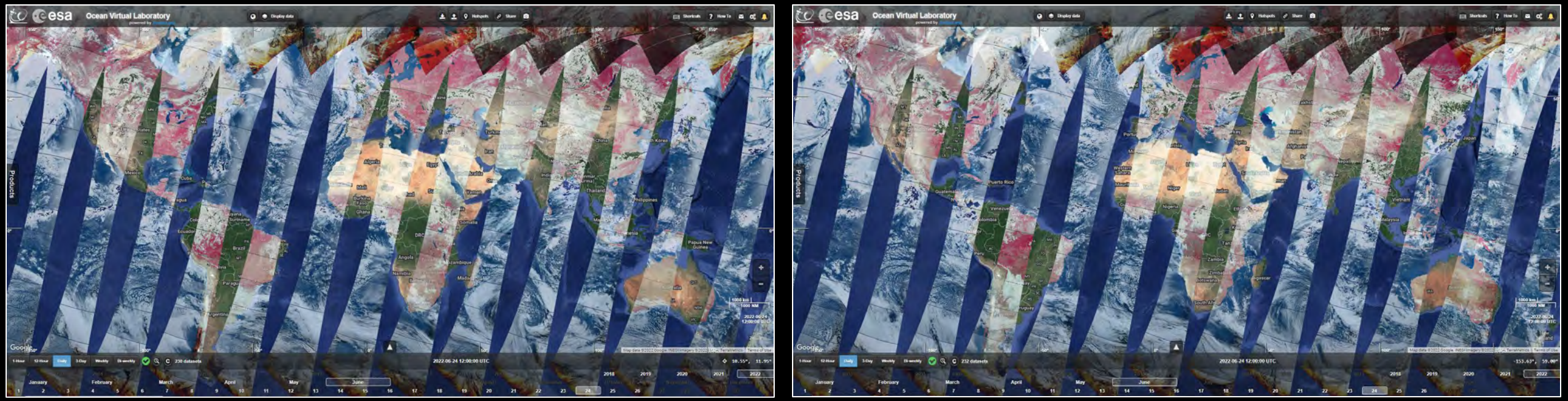
Options for Developing MODIS AM Continuity

1. Sentinel 3 OLCI / SLSTR - European Space Agency (ESA)

- Sentinel 3 mission consists of two identical, concurrently operating platforms
  - Sentinel 3A / 3B
- Ocean and Land Color Instrument (OLCI)
  - 1,270 km swath
  - 21 bands (VIS / NIR) at 300m resolution
- Sea and Land Surface Temperature Radiometer (SLSTR)
  - 1,400 km swath
  - 6 bands (VIS, SWIR) at 500m and 5 bands (MWIR, LWIR) at 1km resolution



SLSTR Daily Coverage Example



Sentinel 3A and 3B SLSTR daytime swath coverage for June 24, 2022

	Constellation configuration	Revisit at equator	Revisit for latitude > 30°
SLSTR dual view (day and night)	One satellite	< 1.8 days	< 1.5 days
	Two satellites	< 0.9 days	< 0.8 days

Global coverage revisit times for SLSTR

Options for Developing MODIS AM Continuity

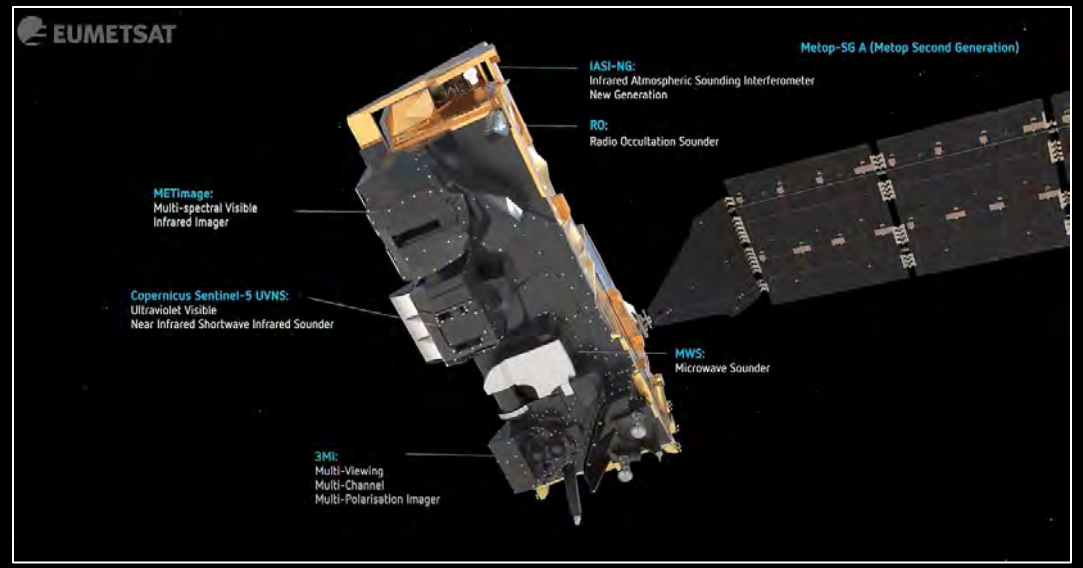
1. Sentinel 3 OLCI / SLSTR - European Space Agency (ESA)

- Sentinel 3 series is planned for operation through 2031 with a 10 am overpass
  - Sentinel 3A (2016)
  - Sentinel 3B (2018)
  - Sentinel 3C (2023)
  - Sentinel 3D (2025)
- NASA GSFC receives a S3 data feed from ESA
- NASA is evaluating “Tier 1” S3 land products (surface reflectance, active fires, land surface temperature)
  - ESA Synergy Surface Reflectance product under-performs compared to MODIS surface reflectance product (Vermote et al.)
  - ESA / EUMETSAT Fire Detection and Fire Radiative Power product evaluation is planned

Options for Developing MODIS AM Continuity

2. MetOp-SG / METimage - EUMETSAT

- METimage, a VIIRS-like instrument
  - 2,670 km swath
  - 20 bands (VIS / NIR / SWIR / TIR) at 500m resolution
  - Temporal resolution / revisit time will be very similar to MODIS and VIIRS
- MetOp-Second Generation mission anticipated to begin in early 2024



Options for Developing MODIS AM Continuity

2. MetOp-SG / METimage - EUMETSAT

- The MetOp-SG series is planned for operation from 2024-2040s with a 9:30 am overpass
  - MetOp SG A1 (2024)
  - MetOp SG A2 (2031)
  - MetOp SG A3 (2038)
- NASA is seeking to establish partnership to access METImage data and conduct instrument calibration after launch
- NASA is seeking to develop and generate ‘Tier-1’ Land Products from METimage test data

Summary of Ongoing / Planned NASA Actions

2022

1. Evaluate Sentinel 3 Fire Detection and Fire Radiative Power product performance compared to Terra MODIS product
2. Complete the preparation of Sentinel 3 ‘Tier-1’ Land Products as an interim solution to data continuity if MODIS Terra data is discontinued
3. Discuss with European partners plans for access, download and storage of METimage Level 1 data

2023

1. Adapt and generate NASA ‘Tier-1’ Land Products from METimage using test data
2. Adapt the Land Products that will require combining VIIRS and METimage data (e.g., Burned Area, Albedo, LAI / FPAR, Snow and Ice) using test data

The Outlook and What Can You Do to Help

- Options exist with Sentinel 3 and MetOp-SG to provide MODIS AM continuity
  - NASA HQ currently supports porting of Sentinel 3 surface reflectance imagery and active fire into heritage MODIS products
  - Support for MODIS-like MetOp-SG products is TBD
  - Stay tuned for more updates
- Community needs to express the value and importance of MODIS AM continuity to NASA
  - Please complete the 2022 Satellite Needs Working Group (SNWG) survey
  - Will help ensure that ongoing Sentinel 3 and planned MetOp-SG efforts continue

https://calval.cr.usgs.gov/apps/snwg

Thanks!

USDA Forest Service Geospatial Technology and Applications Center (GTAC)