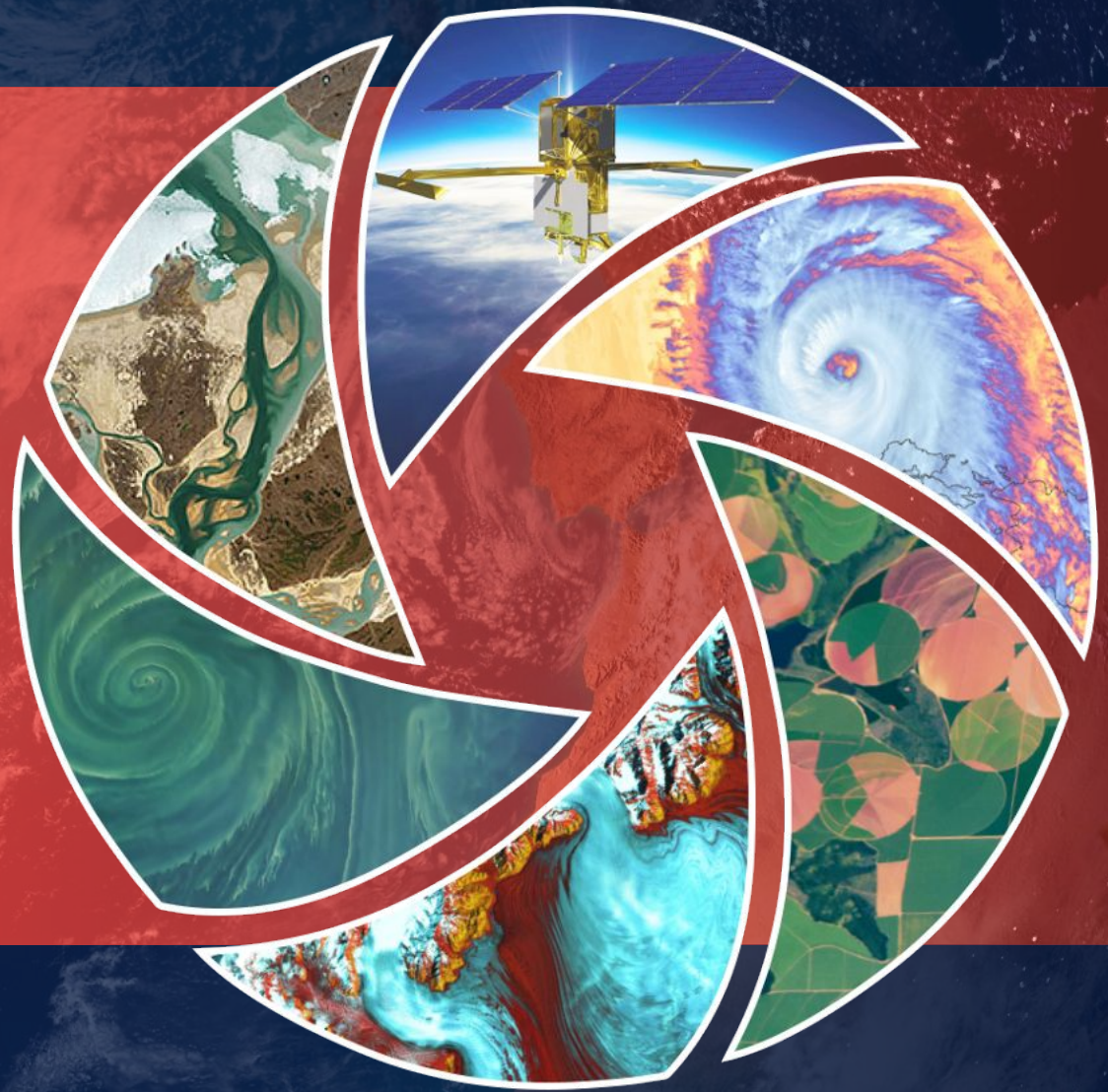
NASA's Land, Atmosphere Near real-time Capability for EOS (LANCE)



Diane Davies, Karen Michael, Jenny Hewson, Dawn Lowe
NASA GSFC

Presentation to ICAP November 9, 2023

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Introduction to LANCE

Land, Atmosphere Near Real-time Capability for Earth Observing Systems (LANCE)

- Goal: to provide near real-time (NRT) data products within 3 hours of observations to meet the timely needs of applications users including disasters.
- Imagery is available within 3-5 hours from GIBS and Worldview.
- LANCE provides a service to enable NRT science and applications and is used by a broad range of operational and applications users, including USDA-FAS, USAID FEWS-NET, USFS, US National Ice Center, NRL, FEMA, NASA SPoRT, Global Forest Watch, Conservation International, GEOGLAM, ECMWF

LANCE supports the following applications Air Quality, Dust storms, Fires, Vegetation changes, floods, ash plumes, drought, smoke plumes, sea ice mapping, and severe storms

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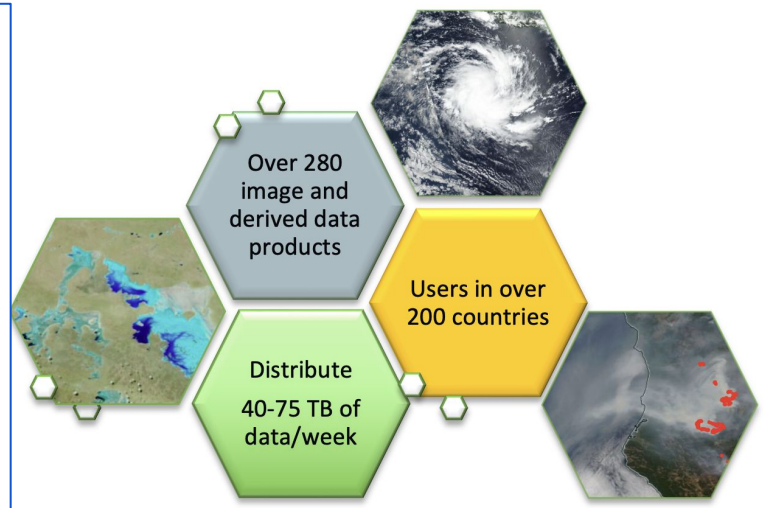
LANCE

- LANCE provides timely data from 12 instruments
- All data with the exception of ICESat-2 and MISR are available within 3 hours of satellite overpass
  - MISR NRT currently unavailable
  - ICESat-2 quick looks - within 3 days (in comparison to an average 45 day latency for the standard dataset

- AIRS - Atmospheric Infrared Sounder
- AMSR2 - Advanced Microwave Scanning Radiometer 2
- LIS ISS - Lightning Imaging Sensor on the International Space Station
- ICESat-2 - Advanced Topographic Altimeter System (ATLAS) on the Ice, Cloud, and land Elevation Satellite
- MISR - Multi-angle Imaging SpectroRadiometer
- MLS - Microwave Limb Sounder
- MODIS - Moderate Resolution Imaging Spectroradiometer
- MOPITT - Measurements of Pollution in the Troposphere
- OMI - Ozone Monitoring Instrument
- OMPS - Ozone Mapping and Profiler Suite
- SMAP - Soil Moisture Active Passive
- VIIRS-Atmosphere - Visible Infrared Imaging Radiometer Suite
- VIIRS-Land - Visible Infrared Imaging Radiometer Suite



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Original Concept of LANCE

1. Leverage existing SIPS and DAACs
2. Leverage the current science teams for algorithms and QA
   - Initially all the NRT products had standard products associated with them
   - Flood Mapping product - first approved without a standard product/associated science team
3. Gather all NRT (3 hr) data under one umbrella
   - Uses “umbrella” set of core requirements – consistency, coordination, collaboration
4. Establish a User Working Group
   - Overall guidance for the evolution of LANCE on behalf of **applications user** communities

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Evolution of LANCE

- No longer just EOS instruments
- Exceptions to the NRT latency requirement (ICESat-2)
  - added in 2022
- FIRMS: Additional Active Fire data
  - Ultra/Real-time MODIS and VIIRS via DB stations (US and S. Canada)
  - Geostationary (GOES, SEVIRI, Himawari)
  - Landsat (US/Canada)
- Further changes expected with Terra, Aqua, Aura end of life

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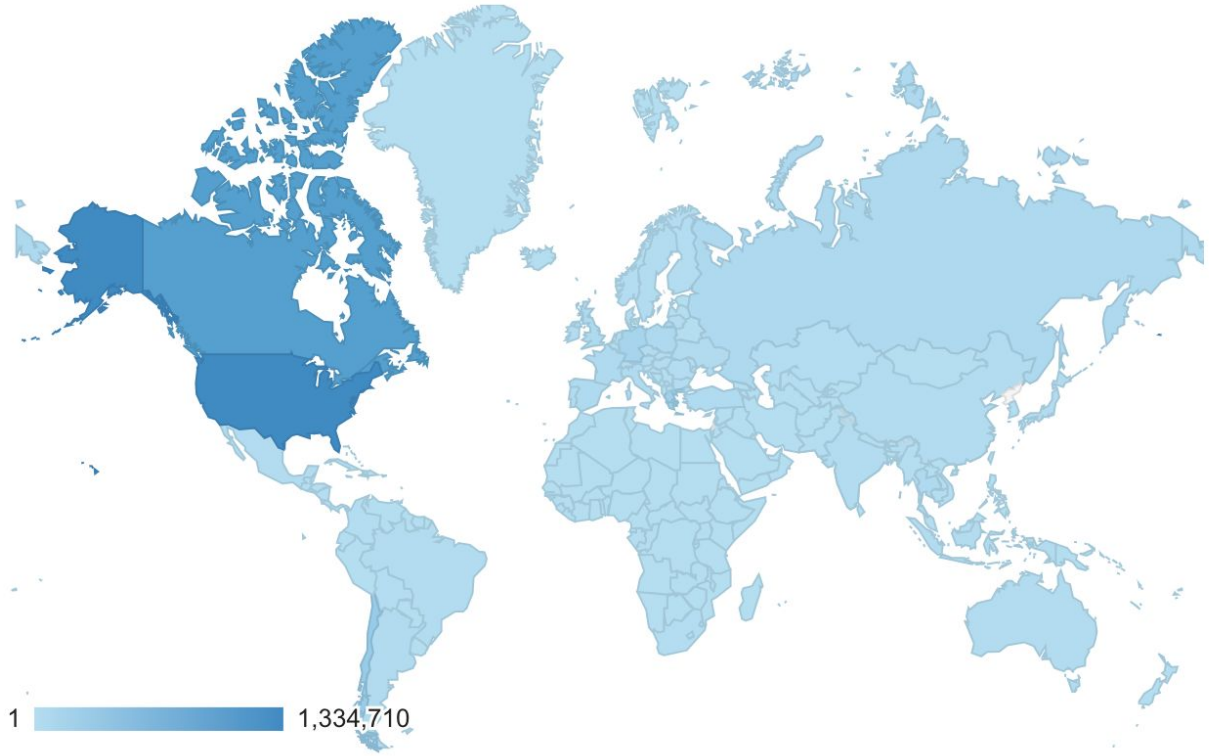
LANCE Metrics



20 Oct 2022 - 26 Oct 2023

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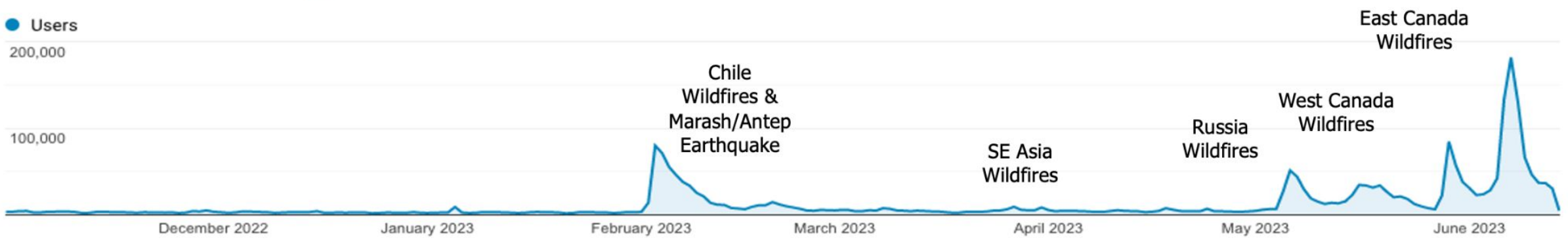

LANCE Updates

Decommissioning of Terra, Aqua, Aura

October 2022: Orbital Drift Workshop
June 2023: Senior Review
Over 200 users replied to an RFI saying

- AIRS - Atmospheric Infrared Sounder
- AMSR2 - Advanced Microwave Scanning Radiometer 2
- LIS ISS - Lightning Imaging Sensor on the International Space Station
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- VIIRS-Land - Visible Infrared Imaging Radiometer Suite

- VIIRS data is available in LANCE for continuity with MODIS (PM)
- OMPS data is available in LANCE for continuity with OMI
- ATMS and CrIS data: available in NRT to a limited customer base from NOAA; would there be value in obtaining permission to re-distribute the NOAA products through LANCE?
- Sentinel 3: some potential for continuity with MODIS (AM); LANCE pilot study underway (Fire product from EUMETSAT for FIRMS; Corrected Reflectance and Land Surface Reflectance for Worldview).

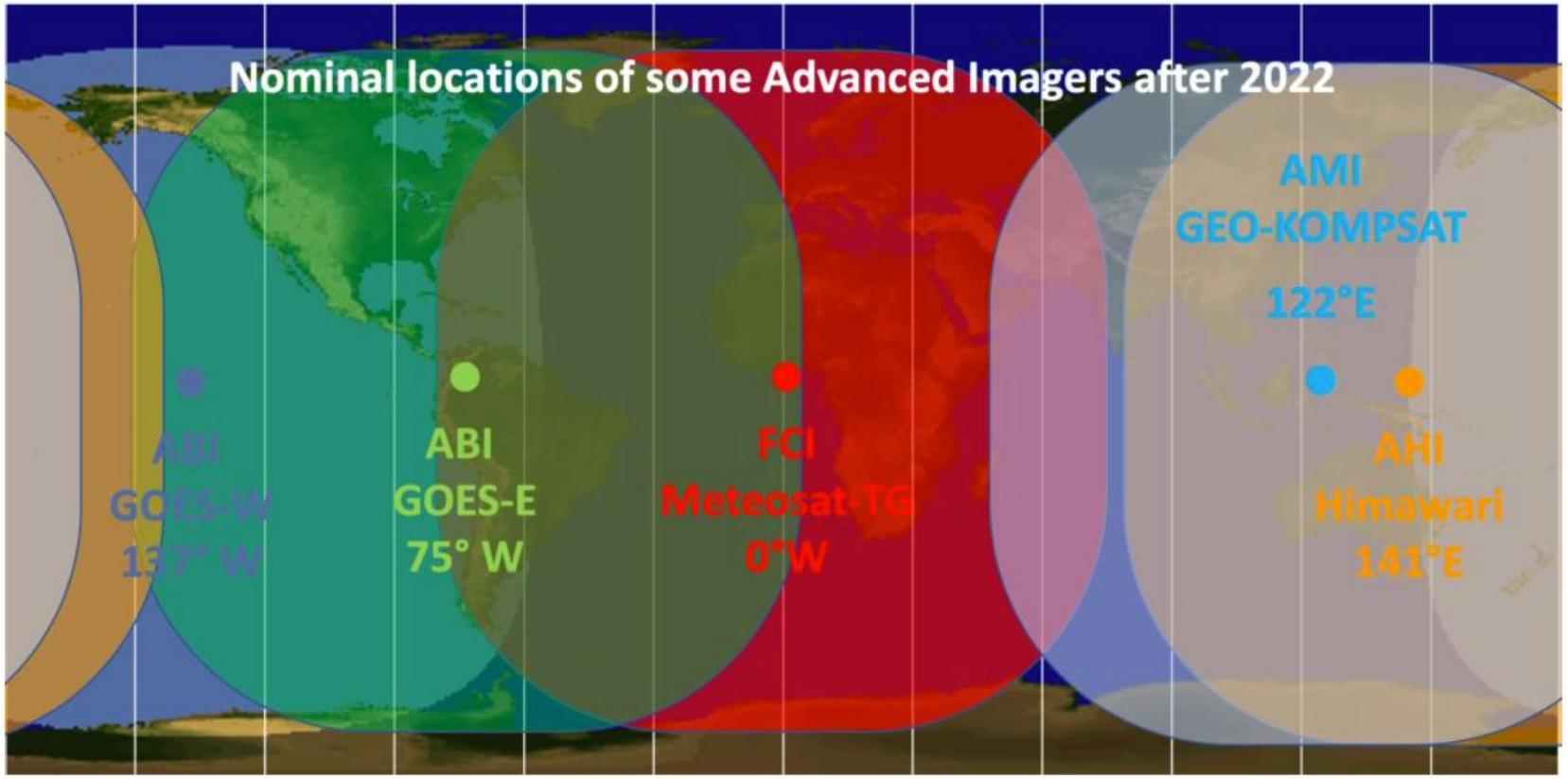
Potential LANCE Products

- TEMPO nominally operational SNWG stakeholder engagement meeting is to be scheduled for November
- AMSR3 is expected to launch between April 2024 and March 2025. JAXA has agreed to provide NRT data to NASA, and a technical approach and budget have been presented to NASA HQ.
- New products may come from the SNWG
- NASA's Earth System Observatory (ESO) missions
- TROPICS - waiting for update from Jess

Update on LANCE Enhancement Request

Near Real Time Geostationary Aerosol Data

Put forward by
Arlindo da Silva (NASA)
Jeffrey Reid (NRL)



Nominal location of some advanced geostationary imagers after 2022

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Sentinel-3 Pilot Study - Background

- MODIS Terra (AM Platform) is a mainstay of land science and applications.
- VIIRS instruments are all PM overpass – no US morning overpass. NOAA uses MetOp AVHRR and will use MetOp-SG MetImage.
- At the 2018 MODIS VIIRS Science Team meeting - the Land Discipline recommended that NASA evaluate Sentinel 3 series (first launched 2016) as a replacement for MODIS Terra
- NASA HQ agreed to fund a pilot study.
    - SNWG agencies (USDA, NASA, USFS) had made strong requests for AM continuity (Agriculture and Fire Monitoring)
    - We received several international inputs on the need for AM continuity for fire monitoring.
    - Use of MODIS Terra data is more extensive than many realize
- The NASA TAA Data Continuity Workshop Land Discipline breakout (May 23) – confirmed the need to evaluate S3 and start to consider METimage data from MetOp-SG.

Objective of the Sentinel-3 (S3) Pilot Study

To study and demonstrate feasibility of Sentinel-3 data towards ensuring continuity of Earth System Data Records (ESDRs) from Terra-AM MODIS. Four main goals of this project are:

1. Evaluate Sentinel 3A (S3A) and 3B (S3B) **NRT Fire Products,** and extract and import the active fire data into the FIRMS database for display and distribution in LANCE FIRMS and Worldview
2. Generate S3A and S3B NRT L2 **Corrected Reflectance (CR) Product** and generate Terra-AM MODIS heritage CR imagery from S3 CR for distribution and display on LANCE and GIBS/Worldview.
3. Prototype Sentinel 3 standard product for **Land Surface Reflectance (LSR)** at SIPS.
4. Support, as appropriate, program-wide engagement with CEOS WGCV on ESA/NASA Bilateral Activities.

Summary of SLSTR Active-Fire Findings

- Each SLSTR (S3A + S3B) reports ~3× as many fire pixels as Terra MODIS
- Higher sensitivity, especially at night
    - Constrained pixel growth + wavelength
- Higher false alarm rate, especially along cloud edges
    - MWIR/LWIR misregistration + wavelength
    - Some surplus fire pixels appear to be regridding artifacts
- Significant differences in distribution of fire radiative power (FRP)
    - FRP-based fire emissions models will require adjustment

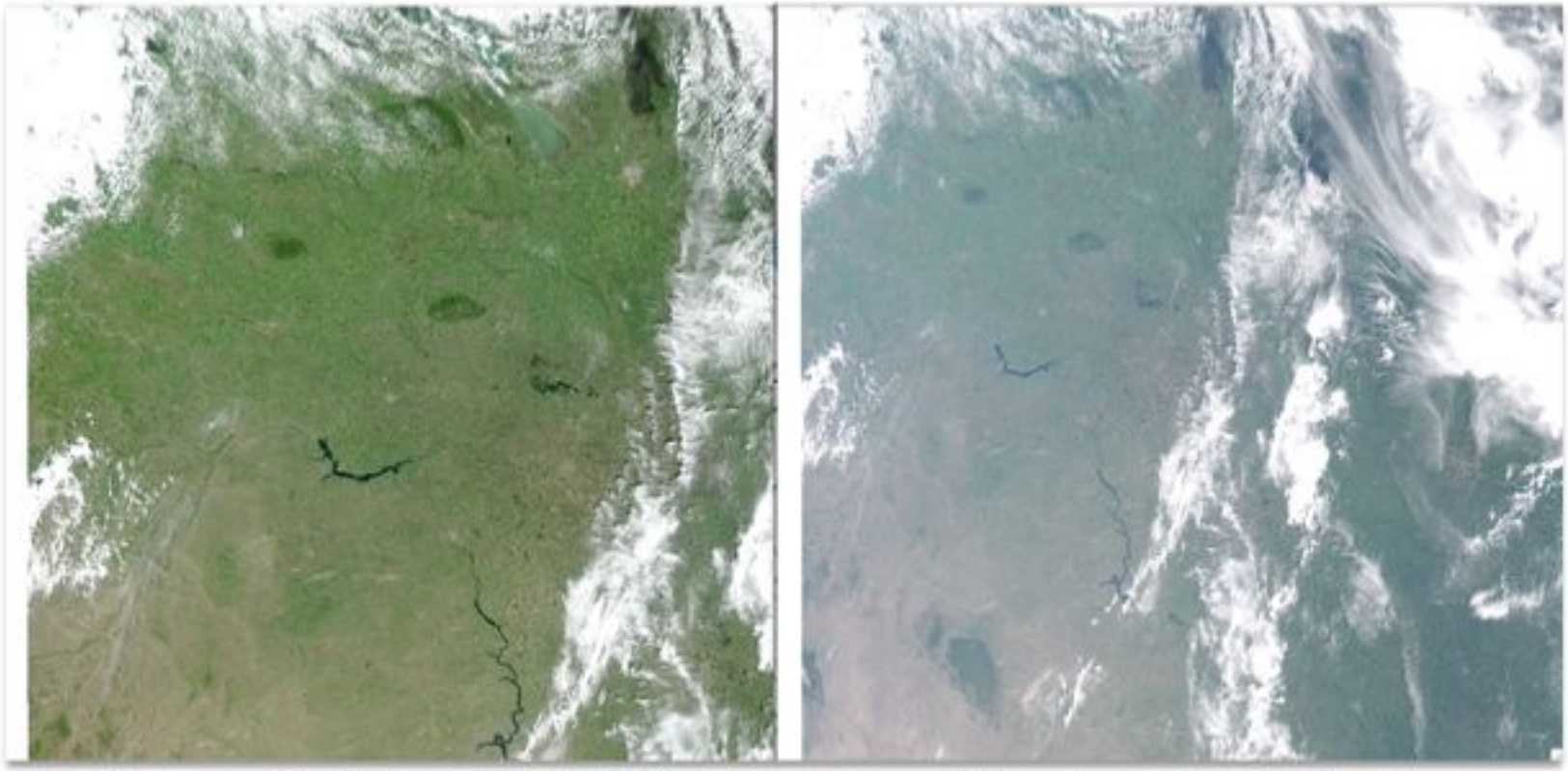
NASA (Louis Gilglio) working with EUMETSAT (Julien Chimot) partners to provide feedback on the FRP product to enable it to be used in FIRMS as a replacement for Terra MODIS

Sentinel 3 Corrected/Surface Reflectance (CREFL/SREFL) Update

Two PGE's, CREFL-O ((OLCI), CREFL-S (SLSTR) (L1 inputs netcdf)

- CREFL-O (300m bands R, G, B, NIR), completed
- CREFL-S (500m bands R, G, NIR, SWIR1 (1.6mic), SWIR2 (2.1mic)

Delivered (April/May2023)



Corrected reflectance's (OLCI) RGB

Top of the atmosphere reflectance's (OLCI) RGB

Sentinel 3 Surface Reflectance (SSREFL) development is progressing (LaSRC code adaptation)

OLCI-SSREFL delivery expected by the end of October 2023

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Eric Vermote NASA/GSFC

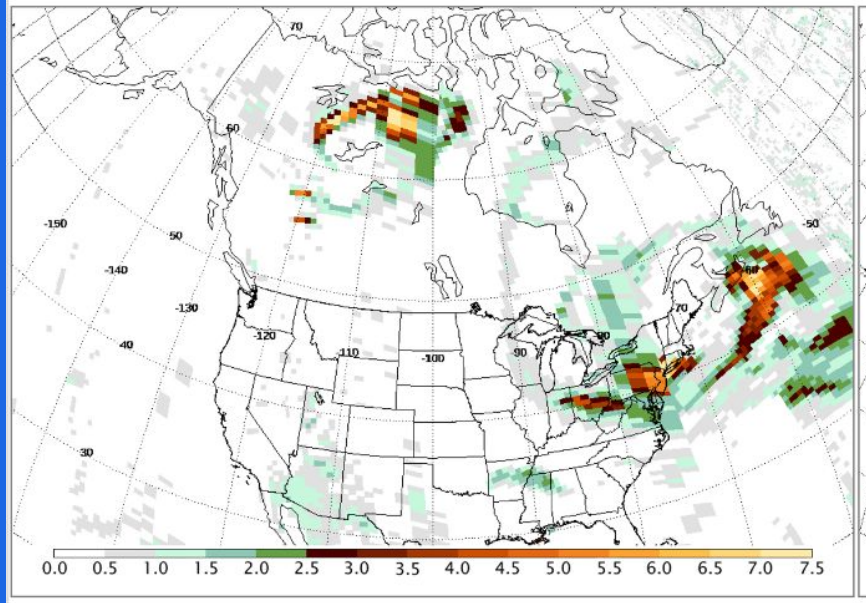
LANCE Aerosol Index

- Work to extend aerosol index availability through LANCE is currently underway
  - Aura OMI is nearing the end of its lifetime, plus the row anomaly prevents full global coverage
  - S-NPP OMPS could be decommissioned as early as next year due to limited fuel remaining
- Code to generate the AI product from the NOAA 20 and NOAA 21 OMPS sensors has been developed and tested
  - These products will utilize the heritage definition of the AI
    - Will make them compatible with the product from heritage TOMS sensors and with the current TROPOMI sensor
    - Will make comparisons between current and historical events easier, particularly for communities like the pyroCb group
- Plan to have both NOAA 20 and NOAA 21 products available by early next year
  - Current S-NPP OMPS product uses a different formulation for the AI, will be reverted back to the heritage form at this time

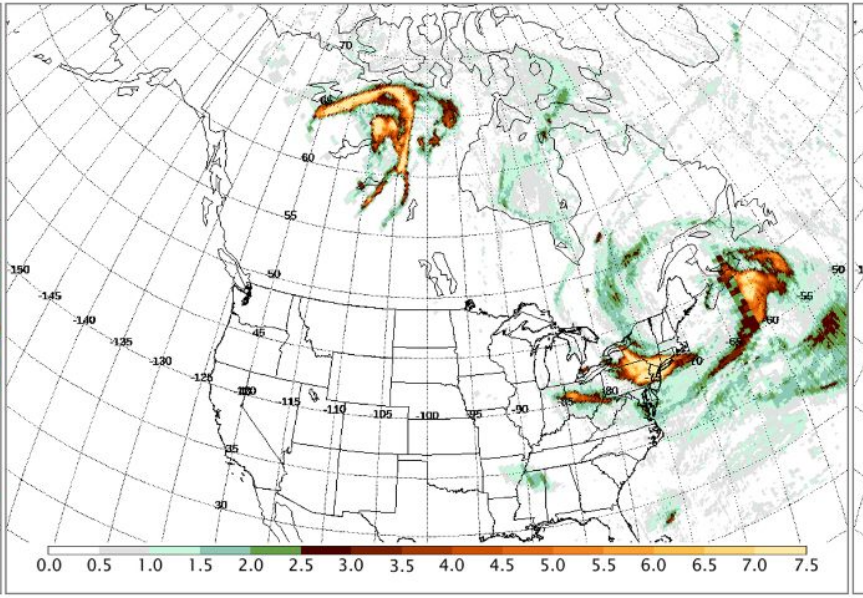
Slide Courtesy of Colin Seftor, NASA GSFC

OMPS AI for 7 June 2023 showing increased resolution from S-NPP to N20 to N21

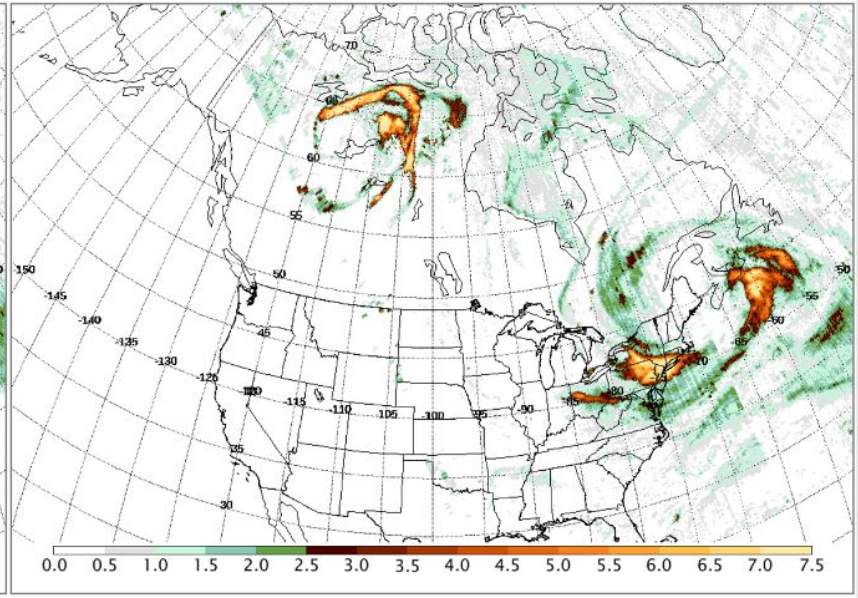
S-NPP

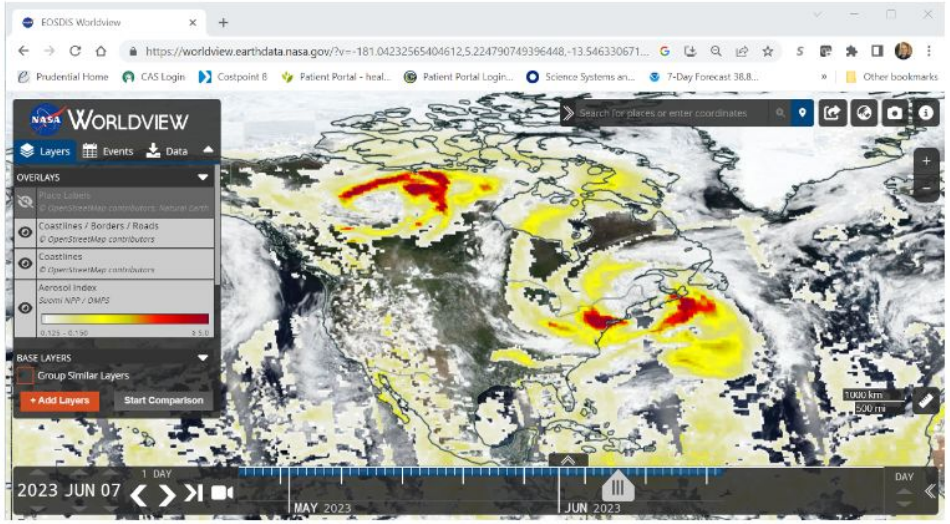


N20



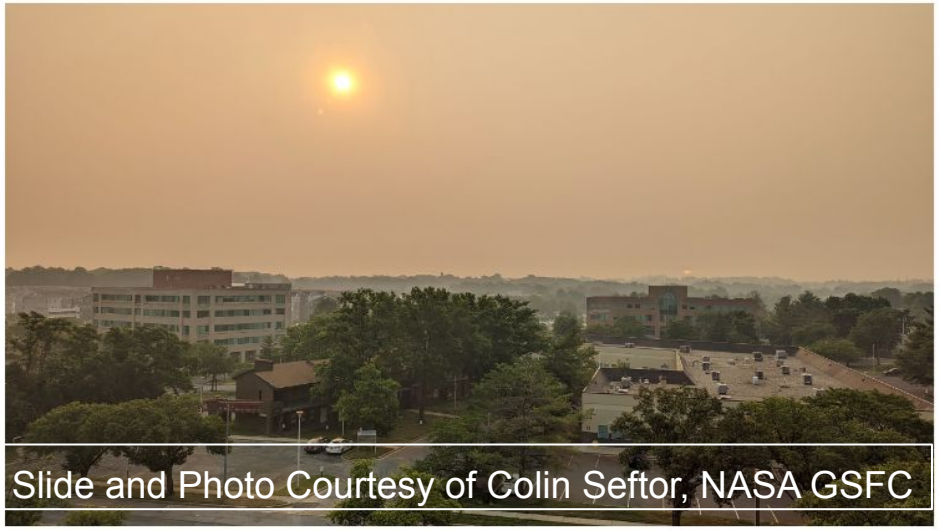
N21





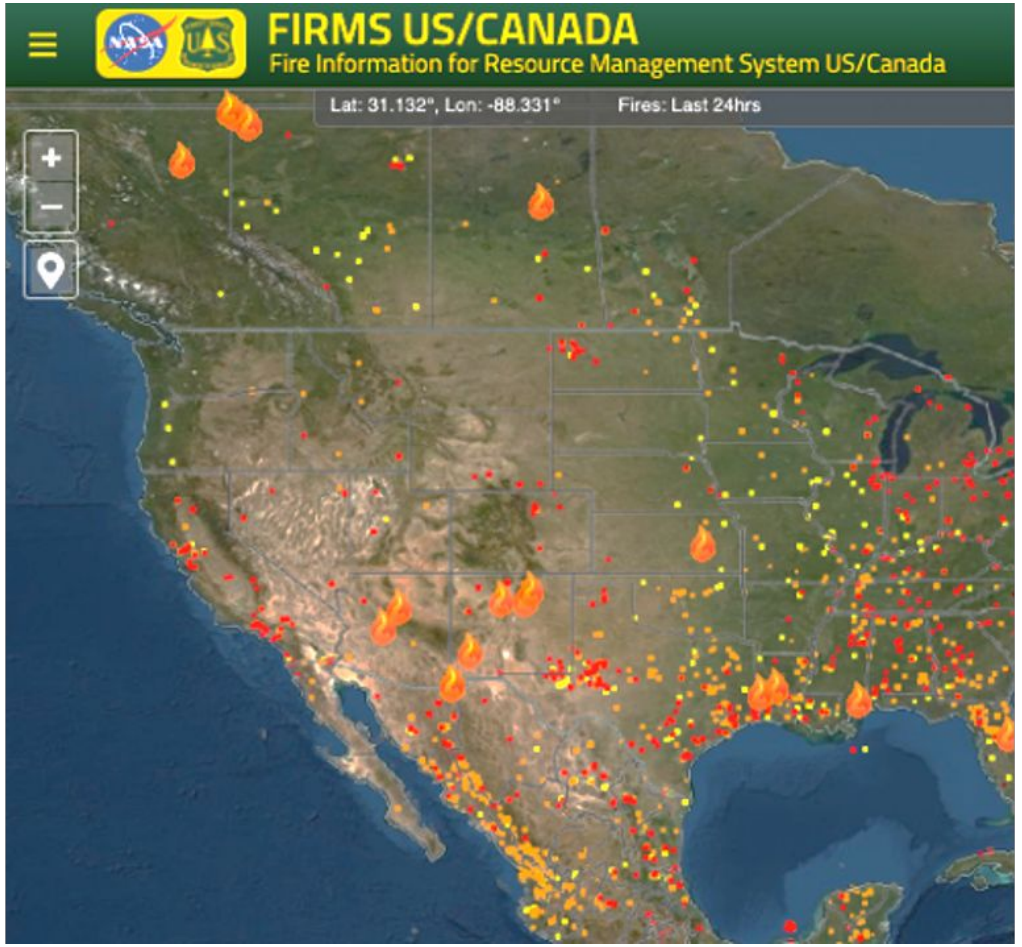
LANCE S-NPP OMPS AI in Worldview on the left

Photo from Greenbelt, MD at ~7 AM EDT on the right



Slide and Photo Courtesy of Colin Seftor, NASA GSFC

NASA FIRMS
Fire Information for Resource Management System



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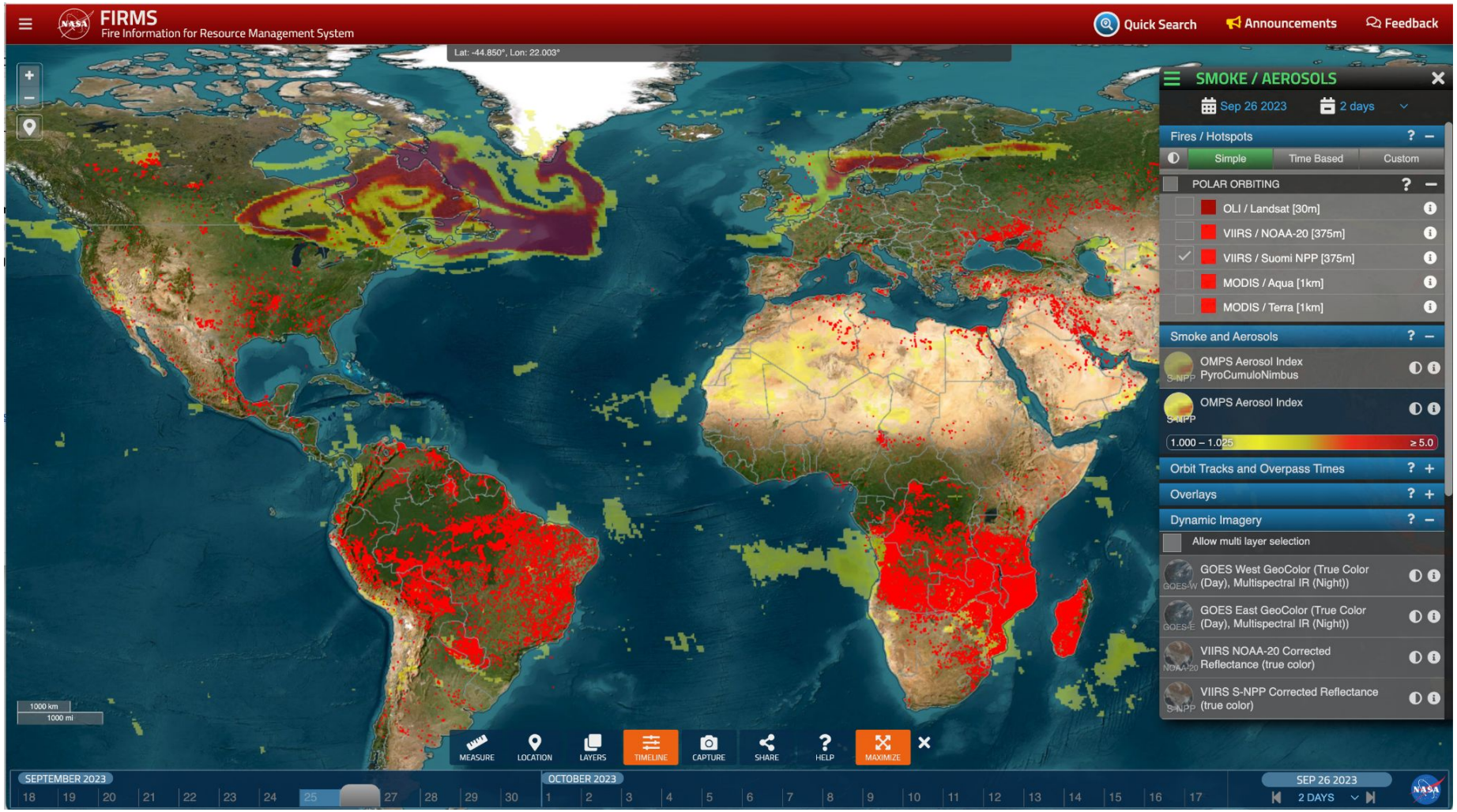
FIRMS US/Canada was launched in 2021 through partnership between NASA and the USDA Forest Service. FIRMS enables timely access to global satellite imagery and active fire detections from multiple satellites.

Update FIRMS UI



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Satellite Active Fire Detection Data Used in FIRMS

Active Fire and Thermal Anomalies Data				
Sensor (Platform)	**Source**	**Spatial Resolution**	**Temporal Resolution**	**Latency[4] (Coverage)**
ABI (GOES-16 & 18)	NOAA	2km sub-satellite[1]	Sub-hourly	RT - ~20-30 mins (Americas)
ABI (GOES-16 & 18)	KCL/IPMA	2km sub-satellite[1]	Sub-hourly	RT - ~20-30 mins (Americas)
SEVIRI (Meteosat 9 & 11)	EUMETSAT/LSA SAF	3km sub-satellite[1]	Sub-hourly	RT - ~30 mins (Europe-Africa-India)
AHI (Himawari-8)	KCL/IPMA	2km sub-satellite[1]	Sub-hourly	RT - ~30 mins (Australia-Asia)
MODIS (Terra/Aqua)	NASA LANCE	1km sub-satellite[1]	Twice daily[2]	NRT - <3 hours (Global)
VIIRS (Suomi NPP/NOAA-20)	NASA LANCE	375m sub-satellite[1]	Twice daily[2]	NRT - <3 hours (Global)
MODIS (Terra/Aqua)	SSEC Univ of Wisconsin	1km sub-satellite[1]	Twice daily[2]	RT - <30 mins (US-Canada)
VIIRS (Suomi NPP/NOAA-20)	SSEC Univ of Wisconsin	375m sub-satellite[1]	Twice daily[2]	RT - <30 mins (US-Canada)
MODIS (Terra/Aqua)	SSEC Univ of Wisconsin	1km sub-satellite[1]	Twice daily[2]	URT - <1 mins (US-Canada)
VIIRS (Suomi NPP/NOAA-20)	SSEC Univ of Wisconsin	375m sub-satellite[1]	Twice daily[2]	URT - <1 mins (US-Canada)
OLI (Landsat 8 & 9)	USGS EROS	30m	8 days[3]	RT - <30 mins (US-Canada)

[1] The pixel size systematically grows from sub-satellite towards the edge of the disk/swath.

[2] Thermal data are collected for daytime and nighttime observations ~ 12 hours apart.

[3] L8 and L9 orbit cycles each have 16-day orbit cycles and their orbits are 8 days out of phase. This does not include potential nighttime observations.

[4] Latency refers to the estimated time from satellite observation to availability in FIRMS. Near Real-Time (NRT), Real-Time (RT) & Ultra-Real-Time (URT).

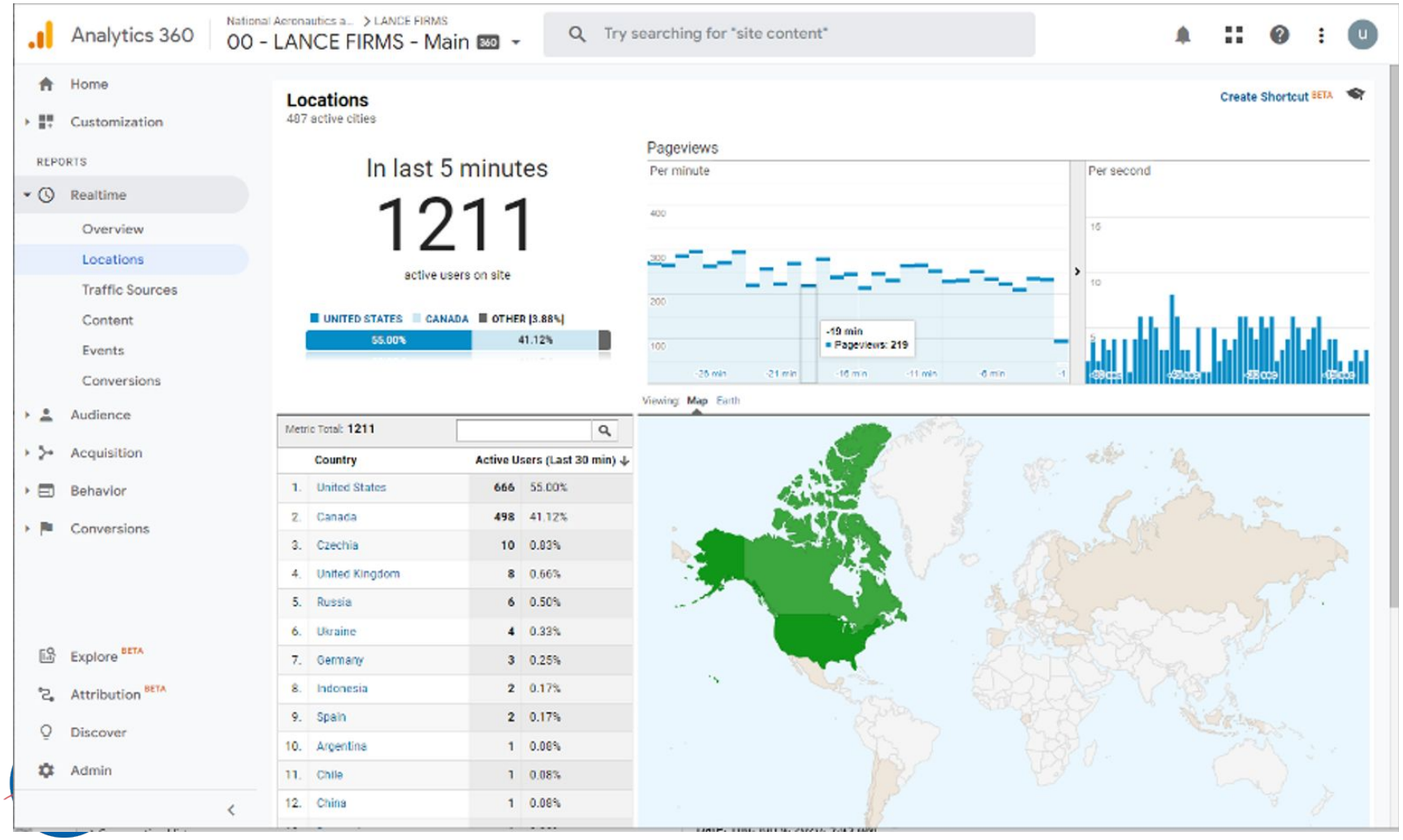
Thank you

earthdata.nasa.gov/lance

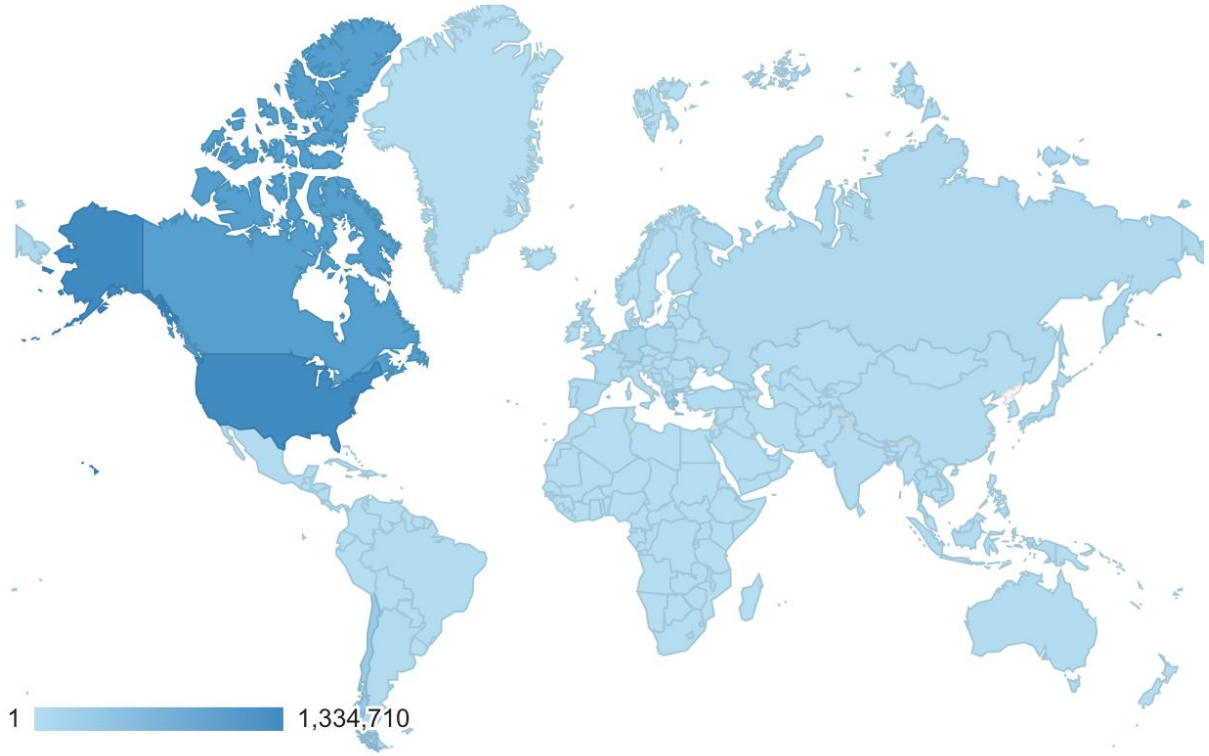
questions: diane.k.davies@nasa.gov

Back-up Charts

Snapshot of use:
Captured June 5th 10.30 AM ET



LANCE Metrics



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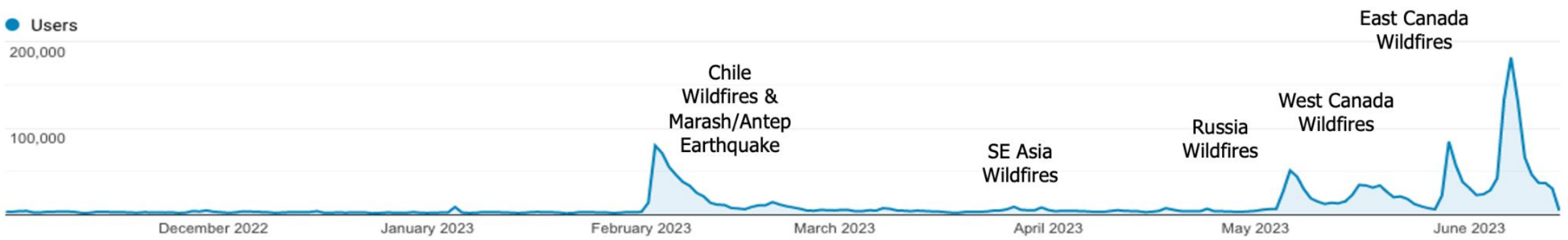
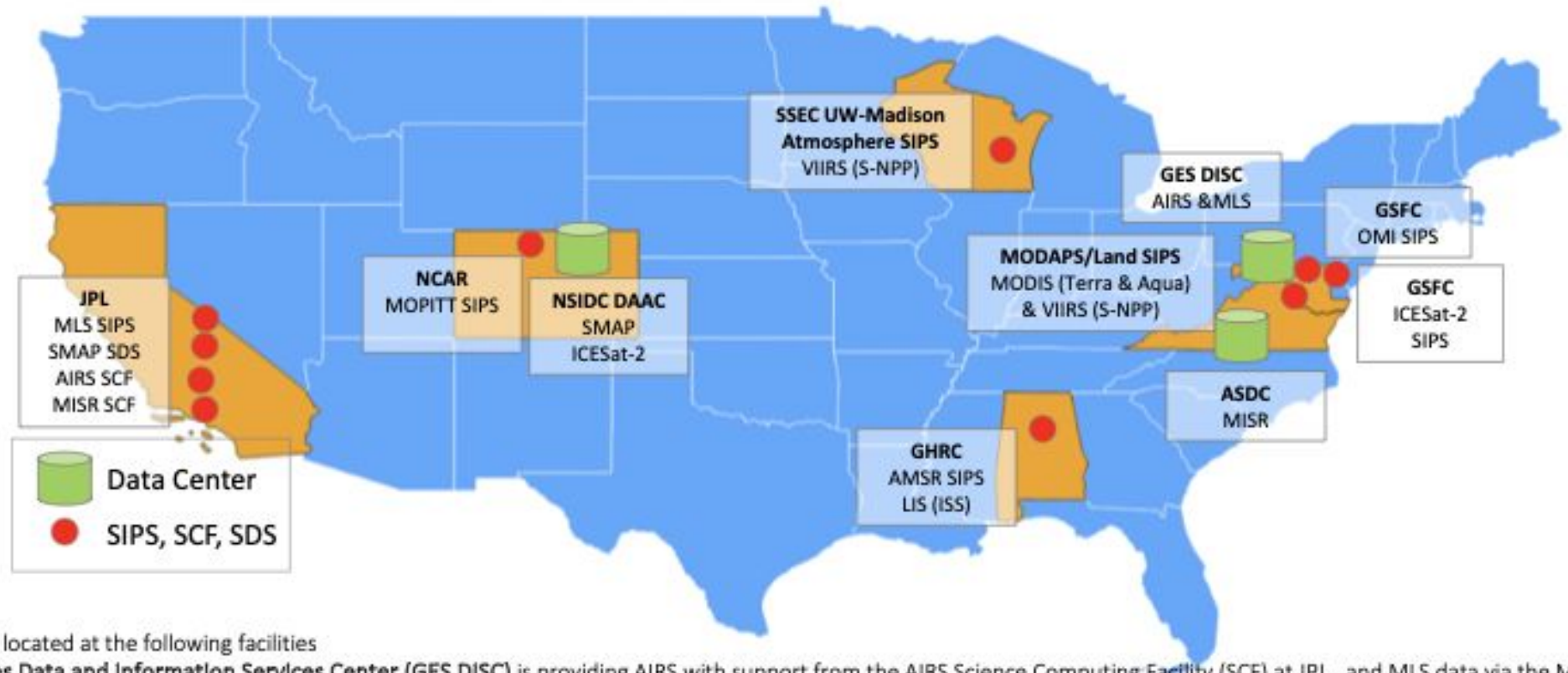


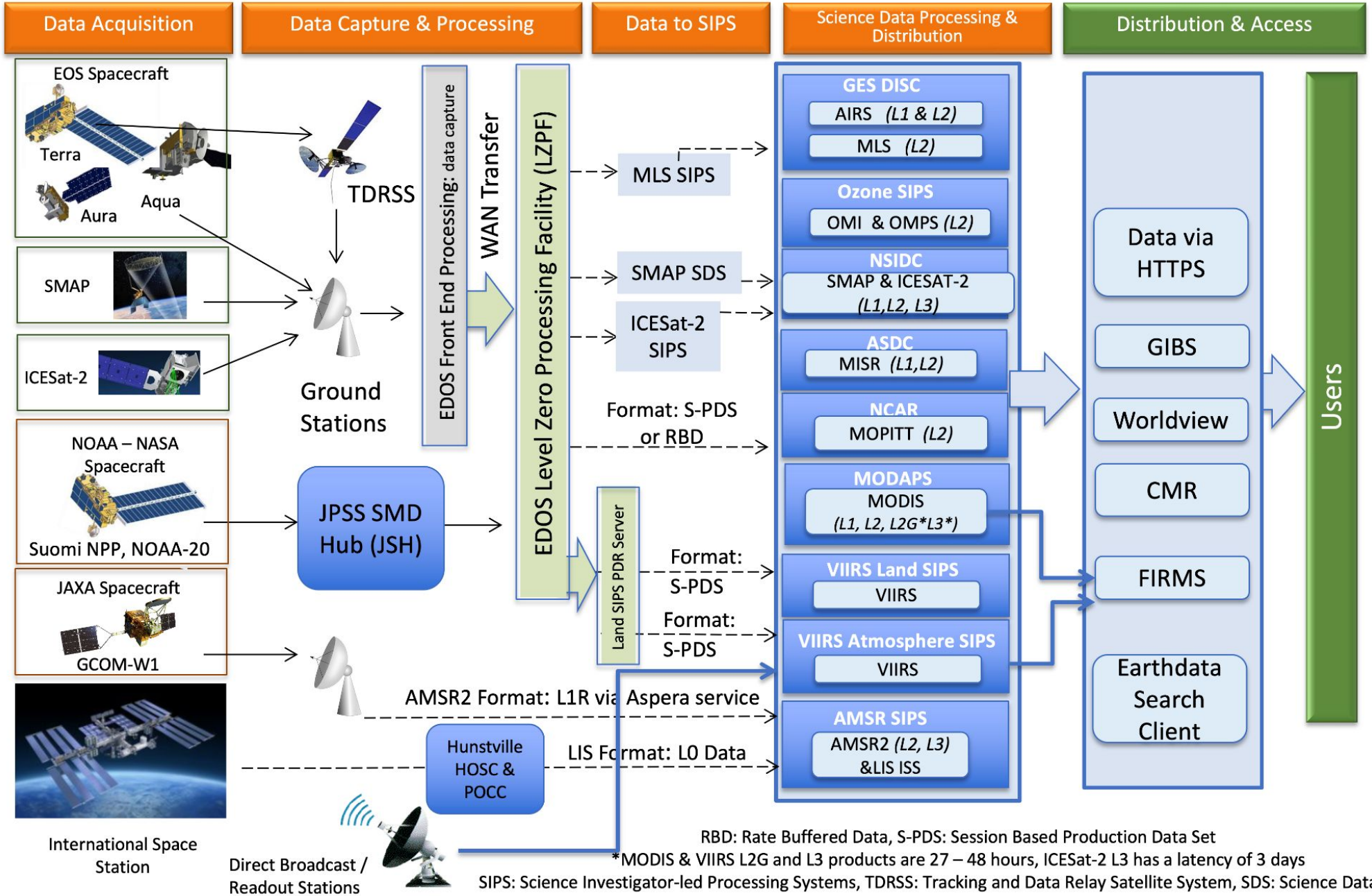
Current LANCE Facilities



The LANCE elements are located at the following facilities

- **GSFC Earth Sciences Data and Information Services Center (GES DISC)** is providing AIRS with support from the AIRS Science Computing Facility (SCF) at JPL , and MLS data via the MLS SIPS at JPL
- **Atmospheric Science Data Center (ASDC)** is providing MISR data with support from the MISR SCF at JPL
- **AMSR Science Investigator-led Processing System (SIPS)** is providing AMSR2 and LIS data
- **MODIS Adaptive Processing System (MODAPS) and Land SIPS** are providing MODIS and VIIRS Land data
- **OMI Science Investigator-led Processing System (SIPS)** is providing OMI and OMPS data
- **MOPITT SIPS (National Center for Atmospheric Research (NCAR))** is providing MOPITT data
- **Atmosphere SIPS (Space Science and Engineering Center (SSEC) University of Wisconsin)** is providing VIIRS Atmosphere data
- **The Jet Propulsion Lab (JPL) Science Data System (SDS) is providing SMAP data for distribution by the National Snow and Ice Data Center (NSIDC)**
- **The Ice, Cloud and land Elevation Satellite-2 SIPS is providing the ICESat-2 data for distribution by the National Snow and Ice Data Center (NSIDC)**

LANCE Architecture



RBD: Rate Buffered Data, S-PDS: Session Based Production Data Set

*MODIS & VIIRS L2G and L3 products are 27 – 48 hours, ICESat-2 L3 has a latency of 3 days

SIPS: Science Investigator-led Processing Systems, TDRSS: Tracking and Data Relay Satellite System, SDS: Science Data System

LANCE in a Nutshell