Minutes of the Land, Atmosphere Near real-time Capability for EOS (LANCE)
User Working Group (UWG)

21-22 June 2023
Pyle Center, University of Wisconsin, Madison

Date: 28 August 2023

Summary

The Land Atmosphere Near Real-time (NRT) Capability for EOS (LANCE) held its biannual User Working Group (UWG) meeting in person at the Pyle Center, University of Wisconsin-Madison on 21-22 June 2023. The meeting was well attended, with approximately **55** participants over two days. There was good discussion on multiple topics.

Upcoming new product releases include: Visible Infrared Imaging Radiometer Suite (VIIRS) 375m Land Surface Temperature (from SNPP and NOAA-20) and the Deep Blue Aerosol from VIIRS NOAA-20, which are expected be released in the summer with the Dark Target Aerosol product expected in the Fall of 2023. Plans to release NRT data from the **T**ime-**R**esolved **O**bservations of **P**recipitation structure and storm **I**ntensity with a **C**onstellation of **S**mallsats (TROPICS) was discussed, as was the desire to have this data distributed through LANCE.

There were several presentations from NASA HQ including Katherine Saad, Christina Moats-Xavier, and David Green. During the meeting the LANCE UWG chair, Miguel Román solicited input on LANCE's Strengths, Weaknesses, Opportunities, Threats (SWOT) for future planning and for the future evolution of LANCE following Terra, Aqua and Aura deorbiting. The Fire Information for Resource Management System (FIRMS) US/Canada highlighted the use of geostationary data for tracking the progress of fires throughout the day as well as presenting the need for a NRT VIIRS burned area product. Terra, Aqua, and Aura deorbiting activities were also discussed as well as their impacts to LANCE and the NRT community. The status of the Sentinel 3 Pilot underway was presented as it has the potential to provide some continuity products for the Terra MODIS morning orbit. The pilot includes evaluating and testing a Sentinel 3 fire product produced by EUMETSAT and updating the existing MODIS algorithms for Corrected Reflectance and Land Surface Reflectance to process the Sentinel 3 data in order to produce baseline imagery for Worldview. Worldview updates and a demo were presented as well as a Worldview adaptation from SSEC. The status of both NASA/LANCE and NOAA/SSEC Flood mapping were also presented.

Pending enhancement proposals presented at the last LANCE UWG include an NRT Aerosol Index product for NOAA-20 and NOAA-21 and a request for NRT Geostationary Aerosol Data are still pending. The meeting concluded with a tour of the Space Science and Engineering Center (SSEC) Near Realtime facility and rooftop antennas.

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1. LANCE UWG Members and Attendees

Nine members of the Land, Atmosphere Near real-time Capability for EOS (LANCE) User Working Group (UWG) were in attendance (Table 1): seven in person and three online. There were additional attendees representing the Near real-time (NRT) user community, representatives of the individual LANCE elements, NASA Headquarters (HQ), and NASA's Earth Science Data and Information System (ESDIS) (see Appendix 1).

Name	Affiliation
Miguel Román (Chair)	Leidos
Robert Brakenridge*	University of Colorado, Boulder - Dartmouth Flood Observatory
Mike Budde*	US Geological Survey (USGS)
Josh Cossuth**	Naval Research Laboratory (NRL), Monterey/Washington, D.C.
Patrick Duran	NASA Marshall Space Flight Center - Short Term Prediction Research and Transition Center (SPoRT)
Vanessa Escobar*	NOAA
Mike Fromm**	Naval Research Laboratory (NRL), Washington, D.C.
Maggi Glasscoe	University of Alabama in Huntsville (UAH)/NASA Marshall Space Flight Center
Sean Helfrich**	NOAA/NESDIS/OSPO
Steve Miller*	Colorado State University, Cooperative Institute for Research in the Atmosphere (CIRA)
Brad Quayle	US Forest Service (USFS)
Arlindo da Silva	NASA Goddard Space Flight Center
Lori Schultz	NASA Marshall Space Flight Center
Fred Stolle*	World Resources Institute (WRI)
Mark Trice	Maryland Department of Natural Resources (MD DNR)

*Table 1: LANCE UWG Members: No asterisk indicates UWG Members that attended the UWG in person, ** denotes UWG members that attended remotely and, * denotes UWG members that were unable to attend.*

LANCE UWG Day 1: 21 June 2023

2. Introduction

Karen Michael, LANCE Project Manager

Karen began with the LANCE Organization Chart (Appendix 2), which included the LANCE Management Team, the ESDIS Project LANCE contributors, the NASA Headquarters (HQ) Chief Science Data Office (CSDO) and Earth Science Data Systems (ESDS) Program Management Team, and the NASA HQ Applied Sciences Division's LANCE Program oversight team, as well as the twelve LANCE elements. She then displayed the Earth Science fleet of satellites. Missions currently contributing near-real-time (NRT) data or expedited data to LANCE include Terra, Aqua, Aura, SNPP, JPSS-1 (NOAA-20), Landsat-8 and 9, SMAP, and ICESAT-2. Future LANCE

missions include JPSS-2 (NOAA-21), TEMPO[1] and TROPICS[2], and potentially the Earth System Observatory (ESO) missions.

Karen provided updates on LANCE. Continuity with the Terra, Aqua, and Aura instrument data remains a primary concern. With the decommissioning of these missions in the not-too-distant future, NRT data from AIRS, MISR, MLS, MODIS, MOPITT, and OMI will no longer be available. The JPSS satellites will provide some continuity: VIIRS data will provide continuity for MODIS (PM), OMPS data is available for continuity with OMI, and ATMS and CrIS NRT data will be available from NOAA to provide continuity with AIRS. The lack of continuity with the MODIS (AM) instrument poses serious issues, particularly for FIRMS and Worldview and other Land and Atmosphere NRT data users. A pilot project is underway to assess the feasibility of using Copernicus Sentinel-3 for active fire products, Corrected Reflectance, and Land Surface Reflectance.

Karen also briefed the UWG on the status of the MISR standard and NRT data processing streams. With the loss of ground track predictability resulting from the Terra orbit lowering maneuver, all MISR NRT production has been suspended. The JPL science team and ASDC DAAC have been working on new methods for geo-registration but have encountered many issues. They are currently focused on the standard science products but have observed that the new processing algorithms are much more computationally intensive, and do not currently meet the LANCE 3-hour latency requirement. Performance concerns will be addressed once standard production resumes.

Karen concluded with an update on other potential LANCE products, including:

- TROPICS – a Pathfinder was launched in June 2021 – a NOAA-funded Pathfinder demonstration reduced latency from 12 hours to 1-2 hours. The Office of Naval Research (ONR) is funding operations of the pathfinder. Four Cubseats were launched in May 2023.
- TEMPO – launched in April 2023: NRT products have been requested via the Satellite Needs Working Group (SNWG) and will be generated by NOAA. Availability through LANCE has not been determined.
- 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.
- It is expected that some new NRT products may come out of the SNWG. The ICESat-2 reduced latency freeboard and ice thickness products resulted from an SNWG request.
- ESO missions (AOS[3] and SBG[4]) are addressing needs for low latency products during Phase-A. With the Near Space Network's in-progress procurement of commercial

[1] Tropospheric Emissions: Monitoring of Pollution Observations

[2] Time-Resolved Observations of Precipitation structure and storm Intensity with a Constellations of Smallsats

[3] Atmosphere Observing System

[4] Surface Biology and Geology

ground stations support, it is anticipated that data latency can be reduced for these missions.

3. HQ Updates & Perspectives

Katherine Saad, NASA HQ ESDS

Katherine opened with a review of the role of the UWG in providing inputs and recommendations to NASA, and the scope of the ESDS program. She touched on the Terra/Aqua/Aura Continuity workshops and the status of the ESO missions in formulation. Katherine emphasized that NASA's Earth science data holdings will increase dramatically in volume and complexity over the coming decade, driving the need for new infrastructure leveraged across all missions.

Katherine then turned to the NASA goal of Open Science, making research products and processes available and accessible to all, while maintaining security and privacy, and fostering collaborations, reproducibility, and equity. NASA is committed to FAIR principles: making data Findable, Accessible, Interoperable, and Reusable, and lowering barriers to the use of NASA data. The White House "2023: A Year of Open Science" is a multi-agency initiative to spark change and inspire open science. Katherine emphasized that a big part of achieving Open Science involves moving to the Cloud for data and computation. She summarized the recommendations from the ESO Mission Processing Study conducted in 2022:

- Use a common service-based processing architecture across ESO missions
- Deploy a multi-mission organization to provide a set of common managed services to reduce duplication of effort (on top of the SMD core services)
- Leverage industry-based protocols and specifications

Science processing and archival of future missions will be in the Earthdata Cloud. Heritage data sets are being migrated to the Cloud now. The top 75 most downloaded data sets have already been migrated to the Earthdata Cloud and as of spring 2023, 2560+ collections and 33+ Petabytes of data are in Earthdata Cloud.

The Visualization, Exploration, and Data Analysis (VEDA) platform will provide a template for future capabilities. VEDA enables in-Cloud exploration and analysis, reducing the need to download large datasets. It also enables researchers without access to high-end computing resources, making the system more equitable, and useable by non-science users, e.g., decision-makers. ESDS Program elements will continue to be stewards of NASA's vast Earth science data, but will also advocate, communicate, and facilitate open-source science.

Katherine highlighted two NASA initiatives intended to promote and facilitate Open Science in the Earthdata Cloud. The NASA Openscapes movement is a multi-year activity, working with the DAACs to create learning resources, workflows, and skills. The Transform to Open Science (TOPS) is a 5-year program to accelerate the adoption of Open science. It is intended to provide researchers with core open science skills. Strategic goals include doubling the participation of

historically excluded groups across NASA science, supporting 20,000 researchers to earn NASA's Open Science badge, and enabling major scientific discoveries through open science principles. NASA Research Opportunities in Space and Earth (ROSES-22 and 23) include solicitations focused on Open Science. Katherine summarized with 3 take-home points:

- Upcoming missions pose big data challenges
- Science in the cloud is a priority for NASA
- NASA is committed to Open-Source Science to accelerate scientific discovery, broaden and diversify the user community, and increase transparency and reproducibility,

Katherine's presentation was followed by a discussion of an issue raised by UWG Member Arlindo da Silva. NASA's Earthdata Cloud resides in AWS West, whereas NOAA's data is in AWS East. There are egress costs for moving data between East and West, which could pose issues when researchers want to work with data from both agencies. Katherine acknowledged this issue being addressed by both the Open Source Science Initiative and the SMD Core Services program.

4. LANCE Metrics, Impacts, Outreach

Diane Davies/LANCE Operations Manager and Jenny Hewson/Outreach & Implementation Manager

Diane began with the LANCE-wide Latency metrics from the EOSDIS Metrics System (EMS), showing that for the most part LANCE Elements provide Level 0, 1, and 2 products well within the 3-hour requirement, with occasional short-lived delays caused by calibrations or system failures. Next Diane presented metrics for Weekly LANCE unique registered users accessing data via Earthdata log-in, which have continued to increase significantly over the past 5+ years. Metrics from EMS also show an increasing trend for data volume and number of files distributed. Metrics for data distributed by instrument show that the vast majority (74%) of products downloaded are from MODIS-Terra and Aqua. Metrics for the past year also show increased downloads of Fire, Snow, Corrected Reflectance, and Geolocation products. There has been an uptick in VIIRS data distribution, which is positive, as eventually Aqua MODIS users will be dependent on VIIRS. Diane then presented metrics from Google Analytics, showing access to LANCE websites (including FIRMS but excluding Worldview). Canada and the U.S. have had the highest number of users overall, but this tends to change depending on locations of disasters like wildfires, floods, and earthquakes. Diane highlighted examples of Worldview and FIRMS being used by media outlets reporting on disasters. The number of wildfires over the past year have driven up the number of users accessing FIRMS. On June 5, during one 5minute period there were 1,211 users on FIRMS, which is a record for FIRMS, but the system performance was robust. In mid-June the FIRMS website was the top NASA website visited.

Diane then reported on a Committee on Earth Observing Satellites (CEOS) study, led by several Canadian agencies, evaluating uptake of Earth Observation data in the context of Fire Management. Comparisons were made regarding utilization of popular online platforms,

between January 2021 – January 2023, including FIRMS, the European Forest Fire Information System (EFFIS) and the Global Wildfire Information System (GWIS). FIRMS had significantly more users than other platforms.

Jenny's presentation highlighted the many organizations, and their purposes, using LANCE resources. LANCE users can generally be categorized as *direct users*, who access and use the data for their own purposes, and *brokers*, who add value and serve the data to targeted end users. She provided examples of government agencies, NGOs and other organizations, including private sector, that utilize LANCE data, broken out by thematic groups. Jenny then presented examples of *how* the data is being used. NASA's Global Modeling and Assimilation Office (GMAO) uses 12 products from LANCE in their models, including Aerosols, Albedo, BRDF, fire and thermal anomalies data. The Copernicus Atmosphere Monitoring System (CAMS) Fire Assimilation System assimilates Fire Radiative Power (FRP) observations from LANCE, and the CAMS Global Aerosol System includes assimilation of Aerosol Optical Depth (AOD) from the MODIS sensors. The Cooperative Institute for Research in the Atmosphere (CIRA) is using Worldview to locate Milky Seas – massive swaths of glowing ocean, thought to be caused by huge bacterial blooms in the near-surface waters.

Jenny continued with several examples of LANCE users focused on monitoring and responding to disasters. A couple of examples Jenny presented included:

- A report from the UN Satellite Centre (UNOSAT) used NASA's Black Marble NRT nighttime lights products to identify areas heavily impacted by the February 2023 earthquake in Türkiye and Syria and used the time-series data from the nighttime lights to monitor power recovery.
- Thailand incorporates FIRMS data into the dashboards and maps used by their Geo-Informatics and Space Technology Development Agency to plan for daily fire suppression activities, and guide fixed-wing drones to check high priority areas and support fire control activities.

Jenny concluded with several examples of LANCE team outreach. Presentations/posters on LANCE were given at the October 2022 ICAP Conference, the December 2022 AGU meeting, The January 2023 AMS meeting, and the May 2023 International Wildfire Conference. LANCE is active on social media, with the highest Impressions and Engagement rate occurring with disaster-related tweets.

5. Terra/Aqua MODIS Fire Product Continuity Sentinel-3 Pilot Study Update

Louis Giglio, University of Maryland

Louis presented the status of a pilot study to provide continuity with the MODIS Active Fire Product as well as the MODIS Land Surface Reflectance and Corrected Reflectance products when Terra and Aqua are decommissioned. The study focuses on the European Union's Sentinel-3 Sea and Land Surface Temperature Radiometer (SLSTR) and Ocean and Land Color

Instrument (OLCI) sensors to provide continuity with Terra-MODIS. Louis presented a chart that showed the differences between the MODIS, VIIRS, and SLSTR sensors. The primary differences between MODIS and SLSTR are:

- MODIS has unconstrained pixel growth; SLSTR has an asymmetric conical scan which constrains pixel growth to maintain uniformity.
- MODIS has a 2300 km swath; SLSTR has a 1420 km swath, so observations from 2 Sentinel 3 satellites (A and B) will be needed to get global coverage.
- MODIS has a specially selected mid-infrared channel specifically set for fire observation (3.96 um); SLSTR is 3.74 um– not as optimal for fire detection, as more reflected sunlight contaminates the signal.
- MODIS has matched low/high gain MWIR; SLSTR has mismatched low/high gain MWIR, which means to get a full dynamic range of fires, have to move across two different focal planes.

EUMETSAT produces the Sentinel-3 NRT Fire products, whereas ESA produces the science-quality (Non-Time-Critical) Fire products. This study focuses on the NRT Fire product for continuity in FIRMS.

Louis summarized the study's SLSTR Active Fire Product findings to date:

- Sentinel-3 NRT and NTC Fire products are two distinct processing branches – they were not required to be consistent or aligned.
- The NRT product actually contains four different active-fire products made with four different detection algorithms – results vary across the four products. Two are strictly night-time, so only the other 2 algorithms are being considered for Terra continuity.
- Globally, each SLSTR product reports ~ 3 times as many fire pixels as Terra. This is due to higher sensitivity, especially at night (constrained pixel growth & wavelength), and a higher false alarm rate, due to slight mismatch in the mid-wave and long-wave channels. Louis presented several map images showing the significant differences in detected fires between the different NRT algorithms.
- There are very significant differences in distribution of Fire Radiative Power (FRP), primarily due to the constrained pixels and higher sensitivity at night-time. (Per Louis, this is just a tuning issue.)
- There are assorted practical (but mostly manageable) product issues:
    - Cumbersome product format (zip files)
    - NRT product is 60 times larger than the MODIS swath product
    - All of the production software is proprietary
    - Do not yet have a detailed description of the NRT detection algorithms
    - Unorthodox "shared" product layers contain the outputs of separate detection algorithms – was difficult to sort out
    - Different Fire Product Formats between MODIS (HDF-2 files containing 5 minute swath) and SLSTR (Zip file containing 3 minutes of swath data) – will need to insulate users from these differences.

Commented [JH1]: I thought SLSTR was 3-minute swaths (we can check with Louis)

- The SLSTR NRT Active Fire product is not widely used, but is being updated by EUMETSAT. The FIRMS team has been working with EUMETSAT, and reporting problems detected, and recommendations. It's expected that the product will remain in a state of flux at least for the near-term, and understanding changes will be complicated by not having access to the algorithms.

Louis then gave a summary of the findings to date with Corrected Reflectance and Surface Reflectance. Transitioning to Sentinel 3 appears to be much more straightforward for these products. The pilot study is producing a SLSTR Corrected Reflectance product and an Ocean and Land Color Instrument (OLCI) Corrected Reflectance 300-meter product. The pilot study also produces a SLSTR Surface Reflectance product with 250-meter and 500-meter spatial resolution, and an OLCI Surface Reflectance Product. Eric Vermote has been leading these, and has delivered code for the Corrected Reflectance product, which is undergoing testing. Louis noted that the Corrected Reflectance product will be NRT, and the Surface Reflectance will be a prototype for a standard product; they could be used to provide continuity from the equivalent Corrected Reflectance and Surface Reflectance products from MODIS Terra.

Arlindo da Silva asked whether a Fire Mask is available from Sentinel-3. Louis responded not directly, they have to reconstruct a mask going into multiple layers – no direct analog to the MODIS Fire Mask. Arlindo also asked if there were any plans to use a MODIS heritage algorithm to produce products from Sentinel-3. Louis said there has been some discussion, but it would be considerably more labor-intensive and costly and would depend on NASA HQ support. One of the challenges is some of the quirks of the detector.

6. Senior Review Panel and Update from Terra/Aqua/Aura Continuity Meeting

Miguel Román, Senior Director & Chief Scientist, Leidos Civil Group, and UWG Chairperson

Miguel arrived fresh from the Terra and Aqua Senior Review Panel sessions, held that morning, and provided insight into some of the discussions. The Aqua Panel had a lot of questions regarding continuity, but the Terra Panel had many questions about Near Real-Time, including how budget cuts would affect the NRT system. Algorithm maintenance covers standard as well as NRT products. Recommendations from the Senior Review Panel influence the budget for that. Guidance from NASA HQ was to cut the budget by 50%. There were also concerns raised about the impact of the outcome of the Senior Review on MODIS Collection 7.

Miguel then presented results of the Terra/Aqua/Aura Continuity Workshop; He began by describing events that preceded the workshop. In October 2022, there was a "Orbital Drift Workshop" for which the main purpose was to decide if Terra/Aqua/Aura would be invited to the June 2023 Senior Review. Over 200 users replied to an RFI, saying that new science and applications *would be* possible in spite of, and because of, the orbital drift. A report was prepared to capture the responses to the RFI, which resulted in Terra/Aqua/Aura being invited

to participate in the 2023 Senior Review, but with direction to cut the budget by 50%, and no over-guide request allowed.

The goals of the Continuity Workshop were to identify needs, issues, and gaps, and suggest possible solutions. The discussion emphasized the importance of Terra data for a large number of Land applications, especially vegetation monitoring. Users need more help in understanding VIIRS capabilities relative to MODIS. Extending Terra operations would allow time to develop and evaluate alternative data sources.

Miguel presented the Categories for Data Products that could substitute for Terra/Aqua/Aura (provided by David Considine at NASA HQ). In the interest of time, Miguel showed the results of the analysis of the 19 RFI responses related to the Land Product Suite:

6.1. An alternative data product is available for a scientific or applied purpose and is an adequate replacement for a T/A/A data product. (4)
6.2. An alternative data product exists and is an adequate replacement for a T/A/A data product but is unavailable to the NASA user community for some potentially solvable reason(s). (2)
6.3. An alternative data product exists but the data product is inadequate. The inadequacy could be due to instrument limitations, insufficient geographic or temporal sampling, or inadequate retrievals. (8)
6.4. An alternative data product could possibly be produced from alternative observations, but such a data product is not currently being produced. (1)
6.5. An alternative data product does not exist without new suborbital or orbital measurements. (1)

The Land Suite team added one more factor: Afternoon Orbit Continuity vs. Morning Orbit Continuity. The result was that there is a fair amount of continuity based on VIIRS for the Afternoon Orbit. All products fell into Categories 3, 4, or 5 for the Morning Orbit, indicating much greater discontinuity. Recommendations from the Land Suite Team were:

1. Continue the current VIIRS Land “continuity” product development with Version 2 reprocessing and when appropriate, move these products into maintenance mode. Start the generation of the currently missing VIIRS Land Products, through the ROSES peer review process.
2. Build on and extend the Sentinel-3 Pilot study with processing at the Land SIPS to generate NASA Sentinel-3 Terra Continuity Science production for Tier 1 products (L1, SR, Fire). Start an S3 Pilot project for Level 2 products (VI, LST, Snow, Sea Ice) and Level 3 products (BRDF, LAI/FPAR).
3. Initiate discussions with EUMETSAT and NOAA on access to NRT METimage VII data. This would create an opportunity to explore a joint initiative and cooperation with NOAA on converged METimage AM Land products.

Miguel acknowledged the need for attention to more than Land products - there is a need for focus on cross-discipline continuity, and it must address both polar and geosynchronous

sources, and morning and afternoon needs. Miguel also stressed continued engagement with Applied Science users, and the SNWG.

David Green, NASA HQ asked about participation of the commercial sector in achieving continuity. Miguel said ESA has invited industry to the table, via the Copernicus Contributing Missions program, and he believes NASA should also move in this direction.

7. Passive Microwave Observations from a Constellation of Smallsats: An overview of NASA's TROPICS Mission

Patrick Duran, NASA Marshall Space Flight Center (MSFC)

Patrick introduced the TROPICS mission, a constellation of four 3U Cubesats containing microwave radiometers with 12 channels (91 - 205 GHz). The constellation was specifically designed to provide high temporal resolution over the tropics and subtropics, with a 60 minute median revisit rate. The primary products TROPICS will provide are Brightness Temperature, Vertical Profiles of temperature and Humidity, Total Precipitable Water, Rain Rate, and Tropical Cyclone Intensity Estimates. Four Cubesats were successfully launched in May 2023, and are undergoing commissioning. Performance has been nominal. TROPICS promises to significantly improve the current constellation of passive microwave radiometers, which are almost exclusively in polar orbit. The lower inclination (30 degrees) of the TROPICS Cubesats allows the mission to increase observations. The revisit rate maximizes near ~15-30 degrees latitude, where most tropical cyclones form and intensify. Patrick presented the data frequencies and resolutions that allow TROPICS to provide Cloud Ice imagery at 91GHZ (similar to other satellites), Temperature Profiles, Humidity Profiles and Cloud Ice Imagery at 204.8 GHz. This is a new channel for Microwave Radiometers that provides higher resolution, and shows promise for improved observations of important structures for analysis of tropical cyclone intensity. Unfortunately, TROPICS does not carry the lower frequency channels (such as 37 GHz) that are important for hurricane applications; that would require a much larger antenna than can be accommodated by a Cubesat.

Patrick then turned to the TROPICS Pathfinder, launched in June 2021. It has the same components as the Cubesats, but was launched into a polar orbit for cost reasons (ride share), and has enabled the TROPICS team to gain experience with the mission operations and ground links and test the algorithms. Patrick presented examples of cyclone imagery from the TROPICS Pathfinder, contrasted with imagery from ATMS. TROPICS is better able to resolve the eye and eyewall of the storm, the inner and outer rain bands, the upper level atmosphere cirrus cloud band, and is able to see the formation of a secondary eyewall in the eyewall replacement cycle. As reported at the previous LANCE UWG meeting, NOAA funded an experiment to demonstrate low-latency operations that was very successful. The current latency of the Pathfinder is ~45 minutes. Additional funding was also received from ONR and latency was decreased by bringing on additional ground station links. This has demonstrated that low latency mode will be very manageable for the constellation.

Patrick then presented examples of other Level 2 TROPICS data products from the pathfinder. The Annual Precipitation product compares well with NOAA-19 and other Sounders. There are two Tropical Cyclone Intensity products. The Hurricane Intensity and Structure Algorithm from CIRA at Colorado State University uses input from TROPICS and other Sounder instruments to produce Tropical Cycle intensity and structure from microwave temperature profiles. The Tropical Cyclone Intensity Estimation (TCIE) Algorithm was developed at the University of Wisconsin Cooperative Institute for Meteorological Satellite Studies (CIMSS). Early validation of the TCIE technique using TROPICS Pathfinder data shows promise in characterizing Tropical Cyclone intensity.

NRT data from the TROPICS pathfinder is currently being provided to Hurricane forecasting centers. The data is in the decision support system at the Joint Typhoon Warning Center (JTWC), and close to being incorporated in the decision support systems at the National Hurricane Center (NHC) (AWIPS2).

Patrick concluded his presentation by reporting that in April 2023 a very successful Joint Cyclone Global Navigation Satellite System (CYGNSS) -TROPICS Applications Workshop was held that identified synergies between the two missions in the areas of soil moisture, precipitation, and inundation; tropical cyclone and tropical rainfall; and data assimilation.

8. TROPICS Products in LANCE Future Plans

Jessica Braun, University of Wisconsin Space Science and Engineering Center

Jessica Braun reported on preliminary plans to add Level-1 TROPICS NRT products to LANCE. She showed an example of TROPICS Pathfinder imagery in the University of Wisconsin-Madison internal version of Worldview, which is being used for development and testing. Eventual public distribution will be done via GIBS/Worldview. Having the Worldview test environment will facilitate working with the TROPICS Science Team to improve/update desired color tables for each channel. Level-2 products may be added in the future, depending on funding. In response to a question from Karen Michael, Jessica said NOAA will be providing funding to add contacts with additional KSAT ground stations to provide NRT data from the constellation.

9. Introduction to CYGNSS and NRT Use

Darren McKague, University of Michigan

The original Cyclone Global Navigation Satellite System (CYGNSS) mission objective was to measure ocean surface wind speed in all precipitating conditions with sufficient frequency to resolve tropical cyclone rapid intensification. Eight smallsats were launched in December 2016, of which seven are still operating. The satellites are in low Earth orbit at 35 degrees inclination. Each carries a modified GPS receiver for bistatic radar measurement of GPS signals scattered by surface. The satellites don't measure spatial dimensions, they measure the GPS time delay,

which is affected by the surface roughness, and doppler frequency shift. The mean revisit time is 3.4 hours. The science scope has been expanded to include Standard Land products. The mission is currently in extended Phase E. All standard products (Ocean Winds, Mean Square Slope, Soil Moisture, and soon a Water Mask) are available from the PO.DAAC.

Darren presented an example of the CYGNSS Global Wind Speed Product. There is also a CYGNSS Level 3 Merged Wind Speed product that combines two products in a Storm Center gridded format. Darren presented a time lapse example of the Level 3 merged product over 4 days in September 2021 during Hurricane Sam.

Darren then discussed the expanded scope of CYGNSS with a Daily Soil Moisture Product and a 6-hour product. The algorithm was trained using SMAP data. Retrieval uncertainty has been validated at an overall 5% by volume, by comparisons with the NASA SMAP global network of surface probes.

CYGNSS can also provide high resolution land imaging from coherent specular scattering. Darren presented examples of images of the same section of the Amazon River to highlight CYGNSS' capability to map land and water basins. He contrasted the resolution from the SMAP passive microwave (30km), the SMAP Active Radar (3 km), and CYGNSS (better than 3 km). A caveat is that the CYGNSS image was created by averaging over a period of time to get the focal coverage. Tradeoffs can be made between higher image resolution or temporal resolution.

Darren's last example of CYGNSS remote sensing capability was Inundation Assessment. He contrasted the resolution of the CYGNSS inundation product with PALSAR-2 and the Surface Water Microwave Product Series (SWAMPS). In both cases there was high correlation, low bias.

Darren wrapped up with a summary of their investigation into the feasibility of producing near-real-time products, which was partially motivated by the Joint Applications workshop conducted with TROPICS in April 2023. Although the official latency requirement for CYGNSS was 6 days, and the program's budget was sized for that, they achieved a median latency of 2 days. The CYGNSS team is developing a low latency version of their Level 3 Merged Winds product for use in Tropical Cyclone prediction. They have merged Level 2 and 3 CYGNSS wind together with NHC and JTWC storm track data to merge Fully Developed Seas (FDS) winds and Young Seas Limited Fetch (YSLF) into a storm-centered gridded product. An analysis was conducted to understand the tall poles in the data acquisition and processing chain. They broke the timeline down into steps. The primary bottleneck is the time from acquisition at the ground station to delivery to the Science Operations Center (SOC). The best-case estimate of total time from Collection to Upload is 2:01 (H:M). Median estimate is 3:22, and typical worst-case estimate is 5:29. With additional ground stations, this could be reduced. Currently for all storms category 3 or higher, the CYGNSS team is already performing additional operations to move more data faster. They have demonstrated they can achieve 2-6 hour latency with the existing infrastructure on a case-by-case basis, and with additional infrastructure could reduce latency further.

Miguel noted that most of the TROPICS and CYGNSS efforts seem to be directed to Federal agencies, and asked if there are plans to reach out to other organizations. Darren said yes, that was part of the discussion at the Joint Applications workshop, in particular support to various NGOs. He also said he expects future Global Navigation Satellite Systems (GNSS) missions will be from the private sector, as there is interest in this type of data from Power companies, etc.

10. Overview and Update from Satellite Needs Working Group (SNWG)

Pontus Olofsson, NASA/MSFC

The SNWG is a U.S. Agencies initiative that includes NASA, NOAA, USGS, and others. The goal is to understand the Earth observation needs of Civilian Federal agencies, and implement solutions that address those needs via existing satellite assets, which may be operated by NASA, NOAA, USGS, commercial providers, and international partners. The SNWG Management Office is part of the Interagency Implementation and Advanced Concepts Team (IMPACT) at MSFC and is responsible for the assessment of the needs. The SNWG operates on 2 year cycles, beginning in 2016. Implementation is typically 5 years. The 10 steps in the cycle are depicted in the figure below:

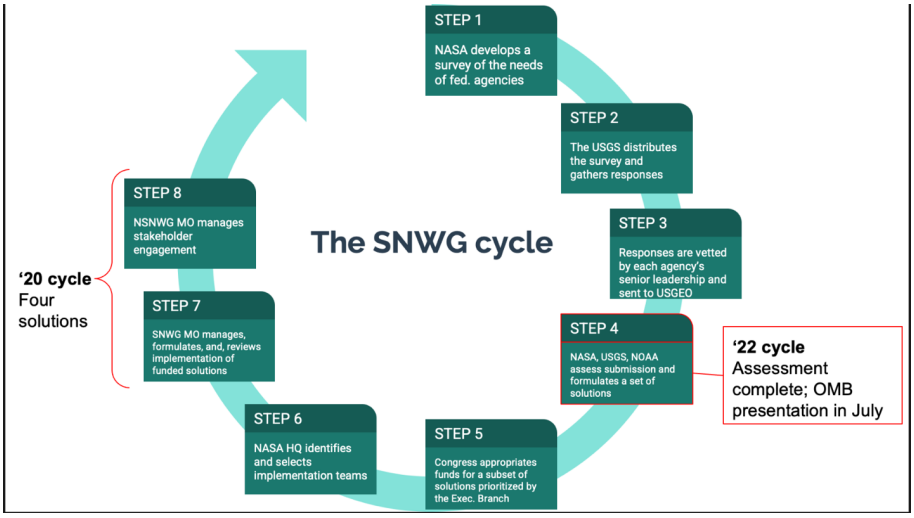

Figure X. The SNWG Cycle taken from the presentation by Pontus Olofsson, NASA MSFC

The 2022 cycle is reaching the end, and 2024 will begin soon. Typically, 3 to 6 solutions will be selected for implementation. Pontus highlighted some of the solutions from the cycles:

2016 Cycle:

- Harmonized Landsat Sentinel-2 (HLS) Surface Reflectance products

- Catalog of Archived Suborbital Earth Science Investigations (CASEI)

2018 Cycle:

- ICE-Sat-2 Quicklook products
- Observational Products for End-Users from Remote Sensing Analysis (OPERA) which includes three products:
    - A near global Surface Water Extent product suite
    - A near global Surface Disturbance product suite
    - A North America Displacement product suite

2020 Cycle:

- TEMPO NRT products
- HLS-derived vegetation indices
- Expansion of Pandora Air Quality Network and air quality forecasts
- Merged atmospheric sounder/GNSS planetary boundary layer product

Pontus shared some of the challenges of the SNWG effort, including how to hand-off maintenance/support at the end of the ~5-year development cycle, and in the case of NRT products, ensuring quality/fitness of use. In response to a question from Karen regarding how cost is estimated and presented to OMB prior to selecting an implementation team, Pontus explained that the SNWG Management Office has a process for estimating solution costs, but improving that process is part of the final (lessons learned) step in the cycle. Karen asked how the TEMPO NRT products could be brought into LANCE, as NOAA is generating them. Pontus replied that a broader discussion will be needed that includes NASA HQ and NOAA. He also acknowledged that with so many NRT requests coming into the SNWG, LANCE involvement in the process needs to be addressed.

11. Comments from NASA HQ

11.1. Christina Moats-Xavier, Program Manager for Mission Engagement, Applied Sciences Program, NASA HQ and Acting Director of Private Sector Engagement, NASA HQ

Christina provided a definition of Earth Science Applications: refers to uses of Earth science data, models, and information products to inform organizations' decisions and actions on management, policy and business activities. The mission of Applied Sciences is to enable people and organizations to make decisions to benefit the economy, health, quality of life, and environment. The goal is to expand the use of Earth science data outside of science researchers. The current program areas are: Agriculture, Disasters, Ecological Conservation, Health & Air Quality, Water Resources, Capacity Building, Mission Engagement, Climate & Resilience, Energy, and Wildland Fires. Christina listed her priorities:

a) Creation of an ESD Handbook that will address the roles of Program Executives, Program Scientists, Program Application Leads, Data Systems Representatives, and Resource Analysts, and how the HQ team members interact in high-priority activities in the mission lifecycle;

b) Applications role and approach to Announcement of Opportunity requirements development, evaluation criteria, and participation in Evaluation Panels;
c) Updating the Directive for Project Applications Programs and developing an Implementation Guide.
d) Cross Mission Focus
e) Communications across NASA missions, NASA users, and NASA working groups
f) Private Sector Engagement

Christina raised a question of when/where the LANCE team should be engaged in mission lifecycle activities. She is open to discussion and thinks this should be addressed in the ESD Handbook. Christina is placing high priority on ensuring that all directed and competed programs have clear Applications requirements. For competed missions, she is ensuring that there are specific Applications criteria as part of the evaluation process. The intent is to elevate Applications, consistent with the Earth Science to Action initiative, and expand the user base. Compliance with the Directive for Project Applications Programs requires that at the start of a mission an Applications Community Assessment Report be generated that identifies the members of that community, and an Applications Project Plan be drafted.

Christina is a strong advocate for Cross Mission communication and collaboration. She applauded the Cross Mission initiatives of TROPICS and CYGNSS. She wants to encourage NASA personnel to be thinking about how we can work across missions, be more inclusive, and integrate data to serve new users. This won't happen by default. Christina has put out offers for funding to initiatives that involve cross-cooperation between at least two missions. Three initiatives have been funded so far. The ESO missions are an example of Cross-mission cooperation: four missions with one purpose – they have to work together collectively to achieve the program objectives.

Christina also advocates for communication with the various user communities that always sends the message "Powered by NASA".

The Applied Sciences Program has been pursuing Private Sector Engagement for ~ 18 months, working on goals, objectives, and practices. They have looked at approaches for evaluating private companies as suitable partners, tools, and methods, and benchmarks for judging effectiveness. The "sweet spot" is where we have common goals/needs.

11.2. NASA Earth Applied Sciences Program Updates, David Green, NASA HQ

David began by reviewing existing NRT products in several of the Applied Sciences Programs areas, as well as potential new sources of low latency data in those areas. For example:

- Health & Air Quality:

    - Currently Aerosols, Trace Gases and other measurements are available from OMI, MODIS, AIRS, MLS, and MOPITT aboard Terra, Aqua and Aura
    - Potential future sources: CALIPSO, TEMPO, AOS, Sentinel-5P TROPOMI
- Ecological Conservation:
    - Currently Active Fire/Thermal Anomalies, Albedo, Black Marble Night-time Light, Cloud, Soil Moisture, Surface Reflectance and Surface Vegetation products are available from MODIS, VIIRS, AIRS, AMSR2, SMAP
    - Potential future source: SBG
- Power/ Energy:
    - Currently Aerosols and Trace Gases, Cloud, Satellite Radiances, Soil Moisture, Surface Precipitation, Temperature, Water Vapor, Wind Speed products are available from AIRS, MODIS, MOPITT, OMI, OMPS, VIIRS, AMSR2
    - Potential future sources: SWOT, TEMPO, PACE, Libera

David then presented summaries and updates on TEMPO and upcoming missions, including NISAR, SBG, and AOS. David emphasized that Applied Sciences would like to hear more from the members of the LANCE UWG on their needs. In particular, he asked which of the TEMPO Level 2 products would be most beneficial to the LANCE user communities.

David quoted Tom Wagner, Earth Science Action lead: “Earth Science Action is more of a guiding principle than a strategy”. David recommends conducting another NRT Workshop either later this year or early next year. He also advised the LANCE team to engage with the Earth Science Division leadership to build advocacy for LANCE.

12. User Needs and Feedback from Applied Sciences Community

Tian Yao, NASA/GSFC

Tian began by showing two use cases of LANCE NRT data products in Disasters Applications. The MODIS NRT Global Flood Map is used in the NASA Disasters Mapping Portal. The Black Marble Nighttime Blue/Yellow Composite is used to detect and monitor recovery from power outages. The specific example presented was the impact on power of the Turkiye 2023 Earthquakes.

Tian then provided feedback acquired from two NRT user sources: SERVIR and an Applied Sciences Water Resources Program survey. SERVIR is a joint initiative between NASA, USAID, and leading geospatial organizations in Asia, Africa, and Latin America. Examples of LANCE NRT product usage by SERVIR include the SERVIR-Hindu Kush Himalaya Hub, which leverages FIRMS fire products to detect and monitor forest wildfires in unpopulated areas. Another example is the use of MODIS/VIIRS data to detect forest change and monitor illegal gold mining activities in Africa. Feedback from SERVIR is that the GIS format in FIRMS is very useful, and consistency and continuity of the Land Cover and Land-Use Change are essential for time-series data analysis to identify short-term and long-term historical changes. General needs expressed by

SERVIR include access to data products via Google Earth Engine and/or Amazon Web Services; low-latency SAR products to reduce cloud cover issues in tropical regions, particularly for deforestation alerts; and tools to select and download specific data in a small geographic area.

Fifteen respondents participated in the Water Resources Program survey. They either use the LANCE data products directly or use value-added products such a models or derived simulators. One third of the respondents said their work requires NRT data (1 to 3 hours latency). Twelve said their work outcomes would be improved if the products had lower latency. Gaps in satisfying their needs with current NRT products include:

- Accurate Snow Water Equivalent observations
- Near-daily hyperspectral observations
- More Thermal observations at the 10-100m resolution
- Daily very high spatial resolution (<3 m) imagery, both spectral and radar
- Better temporal frequency and latency of Landsat-scale thermal imaging for real-time water monitoring applications

Potentially SBG and Landsat-Next will address some of these gaps.

The survey asked respondents to explain how and why lower latency data would improve their Water Resources work. Examples of responses included:

- Optimizing Water Resource management, e.g., providing snow cover information to River Forecast Centers within 24 hours of observation
- Agricultural Monitoring, e.g., support real-time/NRT irrigation management decisions
- Flood Prediction and Monitoring, e.g., aid in predicting hazards and planning timely responses
- Contamination and Harmful Algal Blooms (HABs) Monitoring, to facilitate rapid decision-making

13. End User Applications and LANCE

Lori Schultz, MSFC, Associate Program Manager, NASA Disasters Program

Lori began with an overview of the Disasters Program. The goal is to help communities make smarter decisions for disaster planning. The program works directly with local governments and response teams to support disaster response with Earth observation data. Lori identified the core elements of the program: Disaster Applications, Disaster Response Coordination, and an Open-Access Disasters Portal which includes GIS-enabled capabilities for integration into partner platforms. Lori stressed the importance of providing NASA data in formats that will work in the partner systems and with other data. This is a primary purpose of the Disasters Portal.

Lori provided examples of Disaster Applications, including using SAR data from JPL for mapping and disaster assessment of damage to buildings and infrastructure caused by fires, hurricanes,

etc. She also showed an example of using Earth observation data to feed models that estimate loss due to damage from hazard events such as earthquakes and storm/hail damage from large weather systems.

Lori talked about what is on the horizon for the Disasters Program. There is a focus on fusing data sets, as responders do not usually have time to go through multiple data sets. More GIS services are being developed, and they are developing applications and tools to expand the Portal's capabilities.

14. Strengths, Weaknesses, Opportunities and Threats (SWOT)

Miguel Román, LANCE UWG Chairperson

Day 1 concluded with a discussion led by Miguel of a strategic planning technique for identifying and analyzing an organization or project's Strengths, Weaknesses, Opportunities and Threats (SWOT). This facilitates the evaluation of a project's success in achieving its objectives. Strengths and Weaknesses are internal to the project, whereas Opportunities and Threats are external to the project.

To start things off, Miguel shared a strawman that reflected his perception of LANCE's SWOT:

Strengths:

- Trusted source of NRT data (reliable, consistent, continuous data feeds)
- Excellent user experience (GIBS/Worldview integration)
- Improved data accessibility (FIRMS)

Weaknesses:

- Bias towards traditional disciplines (Wildfires/Imagery/Land)
- Increasing growth comes with complexity and realignment
- Reliance on EOS missions (Terra, Aqua, Aura)

Opportunities:

- Data Harmonization (towards addressing SNWG needs)
- Leverage community-generated tools/services
- Increased uptake from modeling/assimilation communities
- Integration across programs

Threats:

- Scope Creep
- Data Integrity
- Picking Cloud service provider winners/losers, vendor lock-in, pay for processing
- Increased costs with migration to the cloud

Miguel asked that each of the UWG members contribute two Strengths/Weaknesses/ Opportunities/Threats, and two Recommendations.

Discussion addressed the direction LANCE should take in the future, and how to present that to NASA leadership. Miguel presented an Earth Observation Adoption Hype Cycle from TERRAWATCH, and a Market Analysis of companies that have invested in Climate data. Miguel predicts there will be a transition of NRT data streams into the commercial sector. He observed that the EU Copernicus Program has already moved toward joint ventures with commercial companies, and expects this will happen with NASA in the future.

LANCE UWG Day 2: 22 June 2023

15. Opening Comments for Day 2

Miguel Román, Senior Director & Chief Scientist, Leidos Civil Group, and UWG Chairperson

Miguel opened by recommending, when possible, that LANCE enhancement requests be based on a pilot study/prototype. This approach demonstrates progress and potential of the enhancement. Instead of requiring a full funding commitment upfront by NASA Headquarters, this provides a means of increasing confidence in the assessment of the enhancement. Miguel also shared that LANCE has been heavily oriented toward the Land Discipline, and more priority needs to be given to Atmosphere applications.

Miguel concluded by reminding the UWG member to provide two bullets for each of the SWOT categories and two recommendations for enhancements. A summary of the bullets captured in the SWOT exercise can be found in Appendix 3.

16. FIRMS Global and FIRMS US/Canada Update

Brad Quale, US Forest Service

Brad presented a table of Satellite Active Fire Detection data sources used by FIRMS, which includes near real-time (> 3 hours from observation), real-time (> 30 minutes from observation) and ultra real-time (< 1 minute from observation). He then credited the partners that make FIRMS possible, including the University of Wisconsin SSEC, which is providing ultra real-time products via direct downlink from 7 ground stations, with 3 more potential stations (Alaska, Hawaii, Oregon) to be added in the future.

Brad presented updates and new capabilities that are in process, including refinements to the FIRMS Map User Interface. There are 60 layers available, which can be overwhelming to users. A “light” version of the interface will initially be presented, with a menu displaying available modes for various user needs and capabilities. Brad discussed new fire detection filtering capabilities, using the example of the ongoing Donnie Creek fire in British Columbia. Users will be able to filter and display fire detections in their user-defined windows, in 10-minute

increments. In his next filtering example, Brad presented use of temporal filtering with data from Sentinel-2A and geostationary data from GOES-18, allowing users to visualize fire detections from both sensors in the same temporal window. Brad next presented a user interface for visualizing Experimental and Prototype products. He showed an example of a Fire Perimeter product from the NASA Earth Information System (EIS), derived from SNPP and NOAA-20 Fire products that is under consideration for integration with FIRMS. This mode will allow evaluation of experimental products separately from operational products, to avoid/minimize misuse. Brad briefed on efforts to produce a global near real-time Burned Area product using NRT data from VIIRS. There is a high demand for a fire progression map that would support active and post-fire needs. Brad concluded this part of his presentation with a high-level schedule of planned actions to continue improvement of FIRMS over the next 6 to 12 months, as well as some longer-term goals (see Table 1 in Appendix 4).

Brad presented examples of FIRMS Use Cases. In the U.S. and Canada, FIRMS is used for both strategic planning and response to incidents. Brad included example feedback from users:

- Quote from British Columbia (BC) "*the FIRMS service is a key foundation for supporting wildfires in BC. The data provides another level of intelligence when conditions are not favorable on the ground and is used daily to support tactical and strategic decision-making. FIRMS data are extremely important.*"
- Quote from Quebec *"VIIRS hotspots in FIRMS were quite reliable for those fires when they were flying perimeters".*

He provided specific examples of FIRMS value for tactical scale airborne reconnaissance flight planning, as well as fire behavior modeling and decision support.

17. VIIRS Atmosphere SIPS LANCE Status Update

Jessica Braun, SSEC, University of Wisconsin-Madison

Jess began with an overview of the current Atmosphere SIPS VIIRS NRT products from SNPP, which are Deep Blue Aerosol (day), Dark Target Aerosol (day), and Cloud Mask (day/night), each of which is currently Operational with Version 1.1. Version 2.0 of the Deep Blue Aerosol Standard product has been released, and they are in the process of releasing the NRT product. The Dark Target Aerosol Standard Product was delivered; however official release is awaiting an update. The NRT release is expected in the third quarter of 2023. An update of the Cloud Mask is not planned, and Jess noted that the Worldview imagery produced is the Clear Sky Confidence Product. For the VIIRS Atmosphere NRT products from NOAA-20, there are no Version 1.1 products, and the status of Version 2.0 is essentially the same as SNPP. There are currently no operational NRT Atmosphere products for NOAA-21. Both Aerosol and the Cloud Mask teams have indicated they plan to deliver NOAA-21 products by the end of 2023, and the Atmosphere SIPS will work on the NRT products in 2024. Jess presented examples of imagery from the NRT products.

Jess then presented May 2023 Latency metrics for the SNPP NRT VIIRS Version 1.1 Atmosphere products, which show they have been able to deliver within 3 hours from observation over 99% of the time. Regarding the NOAA-20 NRT VIIRS Atmosphere products, the SIPS has been measuring Version 2 latency internally, at 100% within the 3 hours.

18. Updates from Soil Moisture Active Passive (SMAP)

Nga Chung, JPL

Nga presented diagrams of the SMAP Standard Science Product processing, and the NRT processing chain. She presented the product use cases: monitoring drought, predicting floods, assisting crop productivity, weather forecasting, linking water, energy and carbon cycles. She identified the primary NRT users: NOAA, REMISS, Canadian Government Shared Services, U.S. Air Force, and U.S. Navy. Nga highlighted one SMAP application platform, the Flash drought Assessment using SMAP Hydrology (FLASH), which uses SMAP soil moisture data for drought monitoring.

Nga then presented status from the National Snow and Ice Data Center Distributed Active Archive Center (NSIDC DAAC). The SMAP NRT products are now being delivered to NSIDC and imagery products to GIBS for presentation in Worldview. NSIDC has established a redundant system, that is not impacted by the weekly DAAC downtime. However, Nga reported that the SMAP Science Data System (SDS) has not yet asked their current NRT users to switch from the SDS to NSIDC. She expects that to happen in the next few months. Nga presented metrics from NSIDC, that showed growth in NRT users going to NSIDC for NRT SMAP products, particularly since March 2023.

Nga presented an example of SMAP NRT imagery in Worldview. The NRT imagery products are overridden by the Standard processing products after 24 hours.

Nga then presented the status of the SMAP SDS migration to the Cloud. Their plan is to perform processing in the cloud, but archive and distribution will be on-premise, with interfaces remaining the same as now. She expects the migration of standard processing to complete by the end of summer. Currently the science team is validating the products produced in the cloud with the on-premise products. The next priority is Release 19 reprocessing, beginning in Fall 2023. Migration of NRT processing to the cloud will follow the reprocessing campaign. Nga reported that the NRT processing has always been one release behind the standard science processing (i.e., current standard processing is on Release 18, and current NRT processing is being done with Release 17). This will change when NRT processing moves to the cloud – it will also be on Release 19.

19. Worldview and Global Imagery Browse Services (GIBS) Updates

Minnie Wong and Ryan Boller, ESDIS Project, GSFC

Minnie began with an overview of Worldview, GIBS, and Worldview Snapshots. She highlighted some of the unique features of Worldview and GIBS: very responsive performance, very scalable (GIBS supports 100,000 daily users), very large catalog of products (> 1000), many available in NRT, and easy to use. GIBS visualization layers are also used by other GIS Clients, including JPL's State of the Ocean, and FIRMS.

Minnie then reported on new and upcoming products in Worldview. Newly updated products are the SMAP Level 1 Passive Faraday Rotation, Version 5, and SMAP Level 2 Passive Soil Moisture 36 km, Version 7. Upcoming product updates include MAIAC Isotropic Kernel Parameters from 8-day to daily; SNPP/VIIRS Collection 2, Level 2 Land; NOAA-20/VIIRS Collection 2.1 Level 1 and Collection 2 Level 2 Land; and ISS/LIS vectors coming later this year. Minnie then summarized major Worldview accomplishments since the last UWG:

- Worldview migration to cloud under GIBS-in-the-Cloud (GITC) AWS account in NGAP in November 2022
- Migration of GIBS on-premise system to the Cloud in progress
- Exposing layer metadata: standard vs NRT and collection/version information on layers available through GITC
- Tour Story of MODIS NRT Global Flood Product, "Assessing Floodwaters"
- Finalized per-granule / per-swath browsing capability; currently in beta testing
- Overhauled Worldview Build scripts and end-to-end tests
- New User Interface mode: Kiosk Mode, a special unattended mode for use at the Earth Information Center (EIC) display at NASA HQ
- Migration of Worldview Snapshots to the cloud is well underway – transition should be seamless to users.

Minnie provided more details on the Granule/Swath Feature, which is intended to overcome limits on users' ability to access "everything", especially in areas where there are likely to be swath overlap (e.g., near the poles). MODAPS and GIBS have established a pipeline of SNPP and NOAA-20 VIIRS granule imagery on a 15-day rolling window basis. Worldview has operationalized the granule UI/UX. Download of granule imagery will be enabled when Worldview Snapshots migrates to the Cloud (links to the actual data are already provided). Feedback from beta testers has been positive so far, but additional feedback would be helpful, including which products should have this capability; how far back in time should this be available; and any other suggestions. The GIBS/Worldview team would like the UWG members and others interested in this capability to please test the beta release.

Minnie reported on the OPERA Dynamic Surface Water Extent (DSWx) product that may be of interest to NRT users. OPERA DSWx (a Level 3 SNWG product) provides a provisional imagery layer that maps surface water every few days. It has a 30m resolution and 5 classifications: Not Water, Open Water, Partial Water Surface, Snow/Ice, Cloud/Snow. The input data is HLS (Sentinel 2A/2B and Landsat-8 – Landsat 9 has not been included yet).

Minnie provided more insight into the motivation to expose additional layer metadata. For each layer that has NRT and Standard versions, GIBS serves them as NRT, Standard, or "Best Available". Worldview uses the "Best Available" imagery from GIBS, but users were unaware of whether they were seeing NRT or Standard imagery. Also, Collection/Version information was often unavailable. GIBS has been enhanced so that Worldview can interactively display this information for each layer on each date. This capability is presently only available for imagery in the cloud, but all imagery should be in the cloud soon.

Ryan then presented updates on work in progress, beginning with Rapid Creation of Time Series Charts. Ryan acknowledged that this capability had been controversial, as it involves using the pixel colors to "back-out" the data values. The PODAAC prototyped this capability, and the feedback they got from their science team was that the results were actually very close to the same accuracy, and sufficient for exploratory purposes. Ryan is exploring operationalizing the capability.

He then provided more insight into the capabilities LANCE has contributed to the new Earth Information Center (EIC) in the lobby of NASA HQ. It is intended to support outreach by demonstrating NASA's exciting Earth science research and applied sciences capabilities. It includes very large screen displays, including the "Earth Now" dashboard, featuring Worldview/GIBS, FIRMS, and GMAO, showing what the world "looks like" 2 hours ago. The GIBS/Worldview team also provided several Tour Stories for display on the large screen. Ryan noted that the EIC displays will also be installed at the Smithsonian National History Museum later this year.

Ryan touched on Worldview metrics, noting that the number of users has increased by 41% this year. According to Google Scholar, Worldview was cited in over 200 scientific journal articles last year, and over 100 news articles.

Ryan concluded with updates on Dynamic Data Visualization. There have been a number of user requests for additional flexibility in creating custom visualizations, e.g., custom color palettes, band combinations, and visualizations of specific parameters. Ryan noted that Cloud-optimized data stores are enabling the ability to create custom visualizations and lightweight analyses, which are especially important for higher-volume data sets (e.g., HLS, SWOT, NISAR). Ryan presented some examples of efforts underway. He also highlighted the MODIS/VIIRS Interactive Browser that was presented by the SSEC at the MODIS Science Team meeting, and was able to generate Level 3 imagery dynamically.

20. LANCE AMSR2 / ISS LIS

Leigh Sinclair, University of Alabama/Huntsville

Leigh presented status and updates since the last UWG meeting. Some updates were made to the netCDF-CF metadata for the AMSR-U2 Level 2B Rain product. Version 2.2 NRT ISS LIS continues to be available, but unfortunately, ISS LIS will be decommissioned in October 2023[5].

21. LANCE MLS Update

Feng Ding, NASA GES DISC/ADNET Systems

Feng reported on the new MLS NRT algorithm, beginning in January 2023, based on a neural network trained on 17 years of MLS Version 5 production Level-2 processing calculations. It is considerably faster and has been shown to be more accurate than the prior NRT algorithms, which relied on radiative transfer calculations that included significant approximations to meet the NRT latency requirement. The new algorithm is better at capturing features such as strong horizontal gradients. While the MLS NRT H_2O and Temperature products were previously transitioned to this neural network approach, this new update marks the adoption of neural network approaches for all products. Feng provided images derived from the new algorithm and the previous algorithm, and contrasted them using images from AIRS, which showed more consistency for CO between the new algorithm and AIRS. For O3 and S02 there was not as much difference between the old algorithm and the new.

22. ICESat-2 Quicklook Data

Christine Sadlik, ICEsat-2 Project Science Office, Lisa Kaser, NSIDC, University of Colorado

Christine identified the five current ICESat-2 quick look Level 3 products: Sea Ice Height, Land and Vegetation Height, Backscatter Profiles and Atmospheric Layer Characteristics, Sea Ice Freeboard, and Inland Surface Water. The products have a latency of 3 days from acquisition, which makes them "expedited" rather than NRT products, but that compares with the standard products' normal latency of ~ 45 days. Heights of the quick look products are very close to the standard products. The biggest differences are in location: typical errors reported are 10 meters in the cross-track direction and 100 meters in the long track direction. The quick look data files are archived and distributed from the NSIDC DAAC until the standard files are ingested, or for a maximum of 3 months if a standard file is not delivered. The quick look products have been available for over a year. They are distributed to users from 36 countries. There are more than twice as many users downloading the Land and Vegetation Height quick look products than the other 4 products combined, but interest in the Inland Water Surface Height has been increasing rapidly, and may take over the top spot.

The quick look products are now at Version 6. Christine highlighted changes with the latest version:

[5] At the time of the meeting, the ISS LIS was to be decommissioned in December 2023 but this has been moved to October 2023.

- Sea Ice Height (ATL07), Sea Ice Freeboard (ATL10): introduced uncorrected heights to ATL07 to provide results in regions where geophysical data may be missing. ATL07 is using SSMI as a quick look source of sea ice concentration
- Calibrated Backscatter Profiles and Atmospheric Layer Characteristics (ATL09): improved the Density Dimension Algorithm that improves handling of thin cloud layers, and added reporting of diamond dust touching the ground for all wind conditions
- Land and Vegetation Height (ATL06) – improvements in both ground and canopy detection
- Inland Surface Water Data (ATL13) – fixed an issue causing inland water body crossings to be missed, and improved bathymetry processing.

Christine then discussed two future products:

- Gridded Sea Ice Freeboard (ATL20): in development in response to community need for sea ice forecasting
- Lake Ice Freeboard: uses ATLO7/10 retrieval algorithm with new ellipsoidal heights and high pass filter – early phase of development as a standalone product for final and possibly quick look production.

23. Internal Use of Worldview at the ASIPS and UW-SSEC

Zach Griffith, ASIPS Team, University of Wisconsin/Madison

The purpose of Zach's briefing was to describe how the ASIPS is using an internal version of Worldview, as well as how it is being used more broadly at the SSEC. An important role of the ASIPS is to aid the science team in algorithm development. While the primary services that the ASIPS provides include: software delivery; build and test environments; generation of Level 3 products and statistics; and collocation of satellite measurements and creation of matchfiles, another major tool they have provided is the internal Worldview. This has proven to be a very valuable tool for algorithm development. It provides the capability for scientists to get an early view of new versions of their products, well before it goes operational.

Benefits of a local/internal Worldview include the ability to: leverage the Worldview comparison tool suite to evaluate product version differences; identify areas for algorithm improvement through visual inspection; overlay Level 2 products over lower level data; and provide an environment for developing new features. An example of the latter is the Cloud team is developing a Machine Learning methodology to identify severe aerosol and cloud types via convolutional neural network (CNN) over deep ocean. They built a Worldview cloud labeling tool to automate and accelerate the assembly of training data sets.

Another example of the benefits of the ASIPS internal Worldview is the Geo-Worldview tool – an adaptation of NASA worldview for Geostationary data. The Cloud, Aerosol, and Monsoon Processes Philippines Experiment (CAMP2Ex) operations required the same functionality as NASA Worldview, but with Advanced Himawari Imager (AHI) temporal sampling. SSEC

collaborated with the NASA GSFC team to modify the Worldview application to support 10-minute time resolution for the Geostationary data. The SSEC Geo-Worldview instance provided GEO and LEO imagery and L2 products customized for CAMP2Ex. The site was hosted using a local server at the CAMP2Ex hangar to reduce bandwidth and improve latency. Geo-Worldview was the primary tool for directing CAMP2Ex flight operations and is an invaluable resource for post mission analysis.

Zach then explained the implementation process at the ASIPS. The NetCDF data files are converted to Imagery files (GEOTIFF), and aggregated into a daily or per/orbit Tarball. The Tarball was delivered to GIBS, which converted it to tiled imagery (MRF format) using the Open Source tool mrfgen. ASIPS started running mrfgen themselves, so they would have tiled imagery for their development projects' custom layers. Zach then explained the ASIPS Worldview deployment process, which also leverages other Open Source tools from the Worldview Team (e.g., onearth and teraformer). Configuration management for the layers, which are often generated on-the-fly at request of scientists, is susceptible to human error. ASIPS developed tools to augment the tools provided by Worldview and simplify the management of the layers.

Zach then introduced an Open Source tool built by ASIPS, that may be of use to UWG meeting participants: cmrfetch. While CMR has a wealth of client applications, there was none for the command line, which ASIPS needs to use frequently.

Zach concluded his briefing on the ASIPS internal Worldview by acknowledging and thanking the Worldview and GIBS teams for providing the Open Source tools, which made their instantiation possible.

24. Flood Products

24.1. LANCE Flood Product

Dan Slayback, NASA/GSFC/SSAI

Dan opened with a Flood Project image of the flooding in Ukraine the day after the dam was blown up. The image captured 375 square km of flooding. He then provided a brief history of the Flood Product. It began with Bob Brakenridge of the Dartmouth Flood Observatory manually generating flood maps using the MODIS Rapid Response imagery ~ 20 years ago. Circa 2010, the NASA/GSFC Office of Applied Sciences (OAS) initiated a project to automate production. The Daily Terra and Aqua Surface Reflectance product (MOD09) was the input. OAS provided processing code, and a browse and distribution website. Automated global production began at the end of 2011. The production system was PI-owned and maintained, with no redundancy. Circa 2017, LANCE UWG recommends transitioning production to LANCE. The goal was to improve latency, provide redundancy for resilience, and provide for long-term operations. This required a complete rewrite of the system. There was a beta release in January 2021. A topographic mask was added in January 2021, and Operations testing began in June 2023. There are 4 Product Generation Executable (PGE) files, the most important being

the Level-3 1, 2 and 3 day Composites (PGE 159), which apply thresholding, masks, and comparisons with reference water to identify floods.

Dan reported on updates made over the past several months. The first was the Height Above Nearest Drainage (HAND) mask generated from the Copernicus Digital Elevation Model. Terrain shadows can be detected as water. The solution was to mask out areas with significant relief to reduce false positives. Dan presented a set of images that illustrated the reduction in false positives with the HAND map applied. Another enhancement was transitioning from fixed to dynamic thresholding. Inclusion of additional swath observations results in significant cloud-shadow false positive contamination at higher latitudes. The initial (and legacy) product thresholding was based on number of days a pixel was detected as water. Transitioning to dynamic thresholding, based on a number of observations (swaths) has resulted in a significant decrease in false-positives.

In final testing now is the "Ops Code" (versus NRT), which allows back-processing of historical data, and archiving of the product. The reference water map currently being used is out-of-date, with many new reservoirs having been built, and river course changes over the past decade. The historical archive will enable improvement of the reference water map. They also plan to add a "recurring flood" layer to distinguish between expected seasonal flooding and truly unusual floods.

Dan said that they plan to incorporate VIIRS data from SNPP into the Flood Map product. Code development is well underway. The question remains how to bring VIIRS into the product. VIIRS could replace Aqua MODIS when Aqua is decommissioned. Ideally, they would like to continue to have both AM and PM data (flood product quality significantly degrades with loss of less-cloudy Terra MODIS (i.e. AM) observations). Consideration is being given to using Sentinel-3 OLCI data, which provides a morning overpass. Testing of the loss of Terra MODIS demonstrated reduction in flood area observed and poorer continuity through cloudy periods.

Dan wrapped up with a characterization of the users and uses. There are semi-frequent requests for historical/archive data, which is not yet available. Most requests come from PhD students, but some from companies like Morningstar. Dan presented Flood product imagery from several major floods that occurred in the past year, in California, Queensland, Upper Midwest (Mississippi River), and Ukraine.

24.2. Case Study: Using Sentinel-3-A/B OLCI Data Products for Water Detection

Tian Yao, Dan Slayback, NASA/GFSC

Tian reported on a case study of the potential for using OLCI data to provide AM continuity for the Flood Product when Terra is decommissioned. There is only a 30 minute difference between OLCI (Sentinel-3-A/B) and MODIS (Terra) acquisitions. The temporal and spatial resolutions are comparable. ESA produces 3 Sentinel-3/A NRT products (< 3 hours latency): Level-1 Top of Atmosphere Reflectance, Level-2 Water, and Level-2 Land and Atmospheric Geophysical data products. This study evaluated use of the Level-2 Surface Reflectance product,

and found that it was not useful for detecting water, because of missing values, possibly because of inaccurate classifications of pixels as land or water. An OLCI reflectance product was developed by converting OLCI Level 1 radiance to reflectance and generating images for comparison with MODIS. Preliminary results showed that 97.41% of the pixels had identical classifications. The conclusion was that there is potential to transition the MODIS Flood product algorithm to the OLCI instrument.

24.3. NOAA Flood Products and Proving Ground Portal

William Straka III, Cooperative Institute for Meteorological Studies (CIMSS)

William provided an overview of the NOAA Flood products.

The VIIRS 375m NRT Flood Product is currently derived from SNPP and NOAA-20 and provides global coverage between 80ºS and 80ºN. It reflects the current flood status at the time of the overpass (local 2:00-3:00 pm solar time). The SNPP product latency is ~ 3 hours after a pass is complete, and the NOAA-20 product is available ~ 90 minutes after pass completion. VIIRS Composited Flood products are used to filter out cloud cover to derive the maximal flood extent from the VIIRS NRT flood maps. There is a daily composited flood product and a 5-day composited flood map. The VIIRS products from SNPP and NOAA-20 are operational.

The NOAA Geostationary product is a rolling composited product based on the 10-minute ABI and AHI flood maps, with hourly updates. At the end of the day, the ABI and AHI Flood Map is the composited result of all the 10-minute flood maps from each imager and thus shows the flood extent under the daily maximal clear-sky coverage. These products are being operationalized by NOAA, but are currently available from the CIMSS.

The Joint VIIRS/ABI or joint VIIRS/AHI Flood products blend the daily results from VIIRS, ABI, and AHI. They use the VIIRS 375-m daily composited product as the base layer, and use the 1-km ABI or AHI daily clear-sky detection results to fill in the gaps of clouds and cloud shadows in the VIIRS maps. These products are still being operationalized by NOAA, but are being run at CIMSS[6]. There is continued validation being done on the water fraction. The 1-km ABI/AHI flood water fractions have not been fully fused with the VIIRS results, so the resolution of the products vary from 375m to 1km.

William reminded the attendees that all of these are optical products are available for day time hours only. He provided some guidance to help the user select the best product depending on conditions. ABI/AHI flood maps are available from early morning to late afternoon, and are thus recommended for use when VIIRS products are not available. Once the high resolution (375m) VIIRS product becomes available, assessments can be revised. When available, the Joint VIIRS/ABI or AHI products are highly recommended for an initial evening assessment, since they

[6] Cooperative Institute for Meteorological Satellite Studies

provide the best coverage and the more accurate details. When it is partially cloudy during a period, the VIIRS daily or 5-day composited products are recommended.

William provided a brief overview of the NOAA Flood Portal[7], provided links to the portal and training materials[8]. There is an archive of VIIRS daily and 5 day flood maps for the period of 2012-2020 that are available for download to users, as well as an archive of more recent data. NOAA is currently developing SAR-based flood extent and depth maps, as well as a blended low Earth orbit (LEO)/geostationary and SAR map.

24.4. Model of Models - Flood Severity Forecast

Maggi Glasscoe, University of Alabama in Huntsville

Maggi presented on work that was funded by the Disasters Program, via the ROSES-2018 A37 call, to work with the Pacific Disaster Center (PDC) to develop a flood early warning capability. Subsequently, they were awarded additional funding to work with other A37 awardees to develop a more robust NASA-PDC partnership. The goal was to integrate the products from the University of Alabama with Franz Meyers' Surface Water Mapping with SAR project, and Charlie Hykes' Infrastructure and Vulnerability Project. Maggi presented a diagram showing the components of the Model of Models. Results from three flood models were combined to produce an Incident Severity weighting. The team is integrating the MODIS Flood Water Extents from the Dartmouth Flood Observatory, as well as VIIRS products. The intent is to use those observations to validate the forecasts generated by the models. All watersheds are assigned flood severity by the model (Warning, Watch, Advisory Information). The goal of PDC is to create situational awareness and early warning, rather than an alarm system. The PDC's display provides an indication of the severity of the flood, the exposure of population and infrastructure, etc., a text description with the date/time the warning was issued, and an interpretation of the severity and exposure. Maggi showed a current example of a display from Disaster Aware of flooding in Ethiopia.

Maggi said the team would like to integrate the LANCE NRT flood data into the Model of Models to provide another level of validation of the models' severity prediction. She pointed out that the UN World Food Programme is using both the Model of Models and the LANCE NRT Global Flood products for large scale situational awareness. They use the LANCE NRT data because "it is consistently/reliably available, near real time, and typically one of the first large scale observations available".

25. Updates from MODIS/VIIRS LANCE Element

Sudipta Sarkar, NASA/GSFC

[7] https://www.ssec.wisc.edu/flood-map-demo/flood-products/
[8] https://www.meted.ucar.edu/sign_in.php?go_back_to=/satmet/flood_map/navmenu.php

Sudipta provided status updates since the last UWG meeting. VIIRS Collection 2 375m Land Surface Temperature is now running on the MODAPS NRT test system, and has been under evaluation by the VIIRS science team for ~ 6 months. It is expected to be fully operational by late summer. The MODIS Level 1, Atmosphere and Land product suite is now distributing Collection 61 (C61) products. Collection 6 (C6) MAIAC from NRT was phased out and replaced by C61 in May 2023. The DAACS have been asked to decommission the C6 Land products. SNPP VIIRS Land product suite NRT products are still C1. VIIRS GIBS C2 images have only been generated for Land Level 1, Corrected Reflectance and Surface Reflectance. Following Constellation Exit Maneuvers in October 2022, Terra MODIS showed further degradation in cross-talk for detectors in PV LWIR bands (27-30). A new set of revised LUTs were provided for both standard and NRT processing. Otherwise, all instruments are continuing to operate nominally.

Sudipta then briefed on work in progress. MODAPS has been supporting ongoing science improvements and testing of the MODIS/VIIRS Flood products, including the Level 2G Light product. Testing has been underway to transition all SNPP and J1/NOAA-20 NRT VIIRS Land Products to Collection 2 by late summer. All land products will be generated using the cross-calibrated VIIRS L1B data producing continuity with Aqua MODIS. GIBS Global browses for the full suite of VIIRS NRT Land products will be operational after transition to Collection 2. VIIRS GIBS image suite will contain the same suite of images generated for heritage MODIS products. Granule Browses are being generated for the Corrected Reflectance product, currently from SNPP and J1/NOAA-20.

Sudipta then discussed tentative plans for J2/NOAA-21. They do not have a defined timeline for NRT data from J2/NOAA-21. Currently the Level 1 and downstream products are being tested using the latest VCST LUT, and are expecting new LUTs in August, after which the Collection 2 Level 1 reprocessing will start, and is expected to complete in November. Land product reprocessing will follow, but first they will need to address NOAA-21 cross-calibration with MODIS Aqua. They tentatively plan to start Collection 2 Land suite reprocessing later this year or early 2024. When that is complete, they will migrate NOAA-21 Collection 2 to NRT, tentatively from late winter to early spring 2024.

Sudipta concluded with status of the Sentinel-3 – Terra Continuity Pilot study in MODAPS. Sentinel Corrected Reflectance products from the OLCI and SLSTR instruments have been generated and archived in the NRT back-up/test system, following NRT protocols, since May. Louis reported on the progress with the Active Fire product on Day 1 of the meeting. MODAPS has been coordinating with GIBS, with plans to deliver sample products when available.

26. Update from Ozone SIPS

Colin Seftor/ Phil Durbin, NASA/GSFC

Colin began his presentation with a table showing how OMPS factors into the continuity of OMI NRT products. OMI products for which there is a LANCE product currently available from SNPP are:

- Total Column Ozone
- S02 (planetary boundary layer, lower, middle, upper troposphere and stratosphere)
- UV Aerosol Index (also being developed for N20/N21)

However, Colin pointed out that SNPP provides only a short-term continuity, as it is running out of fuel, and could be decommissioned as early as 2024.

OMI Products for which there is no equivalent NRT product from SNPP or J1/NOAA-20 or J2/NOAA-21:

- 388 nm AOD extinction, absorbing, multi-wavelength*
- Average single scattering albedo*
- UV Erythemal Daily Dose (local noon)*
- UV Erythemal Dose Rate (local noon)*
- UV Index (local noon)*
- Cloud Optical Centroid Pressure**

*No standard or NRT equivalent products from SNPP or NOAA-20/21
**Standard product available from SNPP, no equivalent from NOAA-20/21

Regarding the NRT Aerosol Index product, the Atmospheric Chemistry and Dynamics Lab (Code 614) will not provide nadir aerosol products for current and future JPSS missions, including NOAA-20/21. Their focus of work on nadir aerosol products is TROPOMI and future geostationary platforms (GEMS, TEMPO). NASA does not receive TROPOMI data in near real-time. Last year Colin proposed to take on the responsibility for producing the nadir Aerosol Index product for the current and future OMPS instruments, but workload has prevented completion. His goal now is to complete that by the end of this year or early next year. Colin presented Aerosol Index images from June 2023 when smoke from Canadian wildfires caused hazardous conditions in many areas, including the GSFC location. The impact was evident from the images made with OMPS data from SNPP, NOAA-20, and NOAA-21. The spatial resolution of OMPS data from NOAA-20 is significantly higher than SNPP, and NOAA-21 is even higher.

Colin next addressed the opportunity for new NRT products from the OMPS Limb ozone profiler. Code 614 was asked by GMAO, the ECMWF and others to replace a similar product from MLS, and they are currently testing the product in the Ozone SIPS. To reduce processing time, they are only using the center slit of the three on the sensor, and the inputs of ancillary data will be modified from what is used in the standard product. Results are being validated, and performance is being assessed. Current average latency from start of acquisition to retrieval completion is 3 hours, 49 minutes. Average processing time is 1 hour, 2 minutes.

Additionally, Code 614 is developing a NRT Aerosol Extinction Profile product from the Limb. This takes much longer to process than the ozone profile, so focus is on reducing retrieval time by using Machine Learning methods to speed up the Radiative Transfer Model (RTM) calculations. They hope to make the product available by late this year to early next year.

Colin then addressed the feasibility of providing OMI continuity with TROPOMI (instrument on Sentinel 5P). TROPOMI NRT products are available from the Copernicus Data Space Ecosystem. Colin presented a mapping of TROPOMI products to OMI products.

OMI products for which there is an equivalent TROPOMI product:

- Total Ozone Column
- SO2, but not split into atmospheric layers
- UV Aerosol Index: 340/380 nm (heritage product) and 354/388 nm
- Cloud Optical Centroid Pressure – Cloud pressure product, but different algorithm than used in OMI

OMI products for which there is no equivalent TROPOMI product:

- 388 nm AOD – extinction, absorbing, multi-wavelength
- Aerosol single scattering albedo
- UV Erythemal Daily Dose (Local noon)
- UV Erythemal Dose Rate (local noon)
- UV Index (local noon)

Colin included steps involved in accessing TROPOMI data from the Copernicus Dataspace website in his briefing package. However, there is also an API that can be used to pull the data. A positive aspect of TROPOMI is that Sentinel-5P is in the same orbit as SNPP and NOAA-20: local equator crossing time is within 4 to 5 minutes of SNPP. There are plans to move Sentinel 5P to be closer to NOAA-21 when SNPP is decommissioned. Colin felt it was important to note that NASA had full control over the initial calibration of all OMPS sensors, and continues to be responsible for maintaining the calibration of each sensor through the lifetime of the mission, NASA had no control over calibration of TROPOMI, either initially or through the lifetime of the mission.

27. LANCE Overview, Enhancement Proposal Process

Karen Michael, LANCE Manager, ESDIS Project, NASA/GSFC

Karen provided a brief history of LANCE for new members of the UWG. She explained that LANCE is a "system of systems". The approach was to leverage the expertise of the SIPS and Science Teams to process and deliver products in NRT. One of the guiding principles was that each NRT product would be based on a standard science product, with a science team that could validate the products. The Flood Mapping product was the first approved NRT product that was not based on a standard product. Early on, a set of core requirements for LANCE elements was established, including a maximum latency of 3 hours from observation, and system redundancy. The LANCE team recognized that the data would be used by operational applications, and although NASA is not an "operational" agency, per se, the LANCE team wanted the data availability to be robust. The UWG was established at the beginning of the project, to

provide guidance and recommendations for evolution on behalf of application user communities.

Karen presented a diagram of a representative LANCE element, and a LANCE Architecture diagram with all the interfaces.

Karen explained the Latency Definitions that have been adopted by the NASA EOSDIS Specification (423-SPEC-002). It has been recommended that these definitions be used in NASA Proposal Calls to ensure consistent use of terms:

Real-time:	< 1 hour from observation
Near real-time:	1 to 3 hours from observation
Low Latency:	3 – 24 hours
Expedited:	1 – 4 days
Standard (routine Processing)	8 – 40 hours, but up to 2 months for some higher level products

Karen concluded with an explanation of the process for LANCE Enhancement requests. She provided a diagram with step by step instructions for the end-to-end process.

Appendix 1: List of other participants

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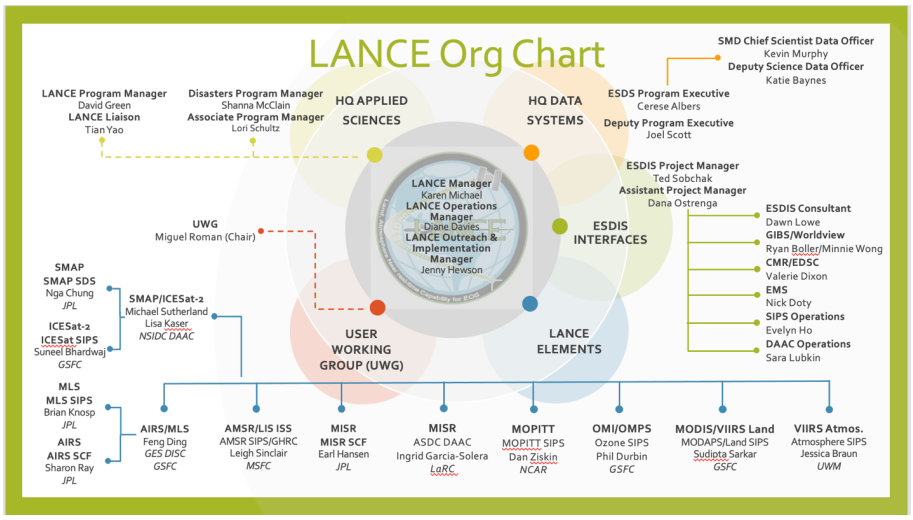
Appendix 2: LANCE Org Chart



Appendix 3: Summary of responses for the Strengths, Weaknesses, Opportunities, Threats (SWOT)- LANCE

Strengths

- Established mechanism to identify the best product to prioritize for low-latency availability
- Easy to communicate with each other and provide feedback and updates
- Have a mature and experienced management team and LANCE runs for more than ten years!
- LANCE maintains NRT, but does not have to contend with what the archives have to contend with
- Worldview, and bringing LANCE products to the audience outside of scientists; never underestimate the value of public support
- Ability to provide even lower latency data to meet operational needs
- LANCE provides products available to communities that are useful NRT

Weaknesses

- What happens when the data (i.e. TAA) goes away?
- Ability to effectively handle "Big Earth Data" and the ever-increasing footprint of government and commercial remote sensing data. Need more NASA/government cloud platforms to access, process and analyze data, both NRT and standard products
- Provide scalable products, technologies, tools, etc., that can be understood and used by potential users. One size does not fit all!
- Lifecycle management for projects/applications. Proposals and plans need to be updated annually and reviewed and prioritized as well
- LANCE doesn't have a water/ocean element
- Lack of a dedicated funding source, like a separate ROSES call
- Lack of clarity and wide knowledge in the community of which products are suitable for LANCE enhancements and the process to request an enhancement

Opportunities

- Potential PSE (private sector engagement?) users/collaborators
- Commercial data availability
- Movement to multi-disciplinary data
- To support more real-time analytics
- Continue to develop products/training/tools and partnerships to agencies/organizations that may not have the ability/expertise/manpower of their own
- Integrate key data from partner agencies and NGOs to provide value-added data and analyzed products

- Now is EOS to ESO transition time. Use this opportunity to set up AART (applied…?) resource from the beginning in the design phase
- Not just the science data….derived products like FIRMS; maybe flood/soil moisture tools
- With new missions moving data processing to AWS, LANCE needs to solidify itself as an *agent* of NRT data as the DAACs are archival *agents* at no cost to missions. LANCE could become the NRT counterpart. Rationale – as missions face budget cuts, NRT capabilities are the first to go. NRT data is not a luxury, the same way data archival is not a disposable option!
- LANCE is well-positioned to play a central advisory role in prioritizing low-latency product development for the relevant Earth Action Strategy elements.
- Better define "applications' as multiple user communities use this word differently
- Bring more applied users to the LANCE UWG; although science teams are users, we seem to be missing outside user perspectives

Threats

- Could LANCE face a political issue like that which happened to NOAA/National Weather Service where they were told to limit their 'products' and just provide data to 3rd party commercial for-profit ventures?
- What are the threats and opportunities…need to be looking outside!
- As moving to the cloud is increasingly expensive, there is a discussion that data can't all follow the *free and open* data policy
- "Free" data not being truly free in the cloud (processing costs, ingress/egress costs, etc.)
- ?Cloud processing cost?
- Moving to the cloud, and charging for data egress! Losing users due to cost
- What does LANCE look like, what is LANCE's role in a cloud-based world!
- Data continuity – in addition to new capabilities provided by new missions, also need to ensure we provide long-term continuity in observations to support long-term studies/applications.
- Quality/pedigree of commercial data
- Data loss due to Aqua/Terra EOL…data continuity using other platforms, process is not leaving a lot of time for solid intercomparison

Miscellaneous Questions

- When does it cost more to be too late?

Appendix 4: FIRMS Planned Objectives / Actions

Anticipated Schedule	Objective/Action
0-6 Months	• Implement updated FIRMS user interface • Outreach/technology transfer sessions • Integrate NASA EIS fire perimeter product (experimental) • Maintain continuity of URT MODIS and VIIRS direct readout active fire data* • Continue evaluation of Sentinel-3 imagery and active fire detection data • Integrate NOAA-21 VIIRS products
6-12 Months	• Maintain continuity of RT Landsat active fire detection data* • Integrate NRT Sentinel-3 imagery and active fire detection data*
> 12 Months	• Develop/implement NRT VIIRS burned area product* • Implement Sentinel-2 RT active fire detection data