

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

28th and 29th November 2023
Virtual Meeting

Date: 12 January 2024



Summary

The Land Atmosphere Near Real-time (NRT) Capability for EO (LANCE) held its biannual User Working Group (UWG) meeting via WebEx on 28-29th November 2023. The meeting was well-attended, with 45 attendees, twenty presentations from NASA HQ, LANCE team leadership members, LANCE Elements, and a new UWG member. There was considerable discussion, reflecting strong community advocacy for the mission and integrity of LANCE. Approximately one third of the meeting was allocated to updates and recommendations from LANCE Elements, including a briefing and demonstration of the new FIRMS interface, and a recommendation on archiving and distributing the NRT Flood product. An interesting and informative briefing on leveraging satellite data to halt deforestation was presented by new UWG member Fred Stole. A proposed enhancement to LANCE to was presented to the UWG regarding STREAM (Satellite-based analysis Tool for Rapid Evaluation of Aquatic Environments), which received strong encouragement to submit a formal Enhancement Request. Multiple presentations and discussions focused on the new Earth Science to Action Strategy and Earth Action organization, and the vital role LANCE can play in meeting the goals of the strategy, including the significant presence of LANCE data and imagery driving the new NASA Earth Information Center. There were also presentations and discussion regarding continuity of measurements and essential NRT capabilities after the decommissioning of the EOS era satellites. An update was presented on findings to-date from the Pilot Study exploring the feasibility of using Sentinel-3 measurements to provide continuity with essential Terra-MODIS AM NRT products. A briefing was given on progress and plans to develop OMPS Aerosol Index products from NOAA-20 and 21, to provide continuity with OMI (Aura) and OMPS (SNPP). The meeting concluded with a presentation on the Satellite Needs Working Group process, and discussion of results to-date.

Table of Contents

1. LANCE UWG Members and Attendees	4
28 November 2023	4
2. Welcome and Keynote Address	4
3. NASA HQ Updates & Perspectives	6
4. Taking Stock of LANCE	7
5. LANCE Metrics, Updates, Impacts and Outreach.....	8
6. Update from the Atmosphere SIPS (A-SIPS)	8
7. Update from MODIS/VIIRS LANCE Element.....	9
8. Earth Action Update	10
9. NASA’s Disasters Program	10
10. Leveraging Spatial Data to Halt Deforestation	12
11. Key Features of the Expanded FIRMS User Interface.....	13
12. Update on Tropics.....	14
13. Sentinel-3 Pilot Study – Terra MODIS Continuity	15
14. Update on OMPS Near Real-Time Products.....	17
15. NRT Flood Product Archive Discussion	18
16. LANCE AMSR2 / ISS LIS Update.....	20
17. Earth Information Center (EIC)	21
18. Worldview and GIBS Update.....	21
19. STREAM: Satellite-based analysis Tool for Rapid Evaluation of Aquatic Environments	24
20. Updates from the Satellite Needs Working Group (SNWG).....	26
21. Closing Remarks.....	28
22. Actions and Recommendations	29
Appendix 1: List of other participants	30

1. LANCE UWG Members and Attendees

Ten members of the Land, Atmosphere Near real-time Capability for EOS (LANCE) User Working Group (UWG) were in attendance (Table 1). 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 and * denotes UWG members that were unable to attend.*

28 November 2023

2. Welcome and Keynote Address

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

Miguel opened the meeting with the following keynote address:

The LANCE User Working Group represents a diverse cross-section of decision science, industry, operational, and research communities. Our meetings serve as a forum for robust discussions and recommendations, all with the overarching goal of enhancing the utility of LANCE for our varied user communities through inclusive dialog and consensus. As the Chair of the UWG, I have witnessed firsthand the collaborative spirit that propels LANCE forward.

LANCE plays a crucial part in our collective efforts to decipher the complexities of our changing planet in a practical and efficient manner. Using a framework based on the three fundamental pillars of scale, data quality, and latency, LANCE is as a cornerstone for our Nation's Earth Science Enterprise.

The integrated collection of satellite instruments, from AIRS, to MISR, to MODIS, AMSR2, Icesat-2, MLS, OMI/OMPS, SMAP, and VIIRS, as well as key front-end components, including GIBS, Worldview, and FIRMS, contribute to generating usable knowledge that is not only powerful but also essential. The global scale, high quality, and speed at which LANCE makes data freely available is a testament to the urgency and effectiveness required to address the challenges facing our society under a changing climate.

The phrase "near-real-time products and services" may sound like a scientific mouthful, but its essence cannot be overstated. In today's world, the ability to access high-quality data, rapidly, at scale, is not a mere convenience; it is a necessity.

In the face of recurrent acute disasters such as wildfires, floods, heatwaves, and other environmental crises, the quality, scale, and speed at which Earth Information is disseminated through LANCE has played a pivotal role in saving lives and preserving keystone services for our most vulnerable.

The UWG has and continues to play a pivotal role in ensuring that LANCE remains at the forefront of NASA Earth Science. Thanks to you, the LANCE user community will continue to freely access high-quality near-real-time data streams from NASA's flagship Terra, Aqua, and Aura missions, as recommended unanimously by the 2023 Earth Science Senior Review panel. This key decision was made possible due to persistent and active advocacy activities from various stakeholder organizations, including members of this UWG.

I'd like to set aside our successes and focus on the challenges ahead. In the past years, LANCE has experienced rapid growth by adding new products from various sources through a process called the LANCE Enhancement request. Typically, a UWG member or a representative from a broad user community initiates a request for a product enhancement. The request is then thoroughly evaluated by the corresponding SIPS Element and LANCE Manager to determine its feasibility. If the request is deemed viable, it is submitted to the UWG, which deliberates and provides recommendations to ESDIS. ESDIS has the final decision on whether the product is added to LANCE.

The LANCE Enhancement request process is purposely designed to meet specific user needs while ensuring compliance with NASA Earthdata policies and procedures. But despite the efforts made by the LANCE Project to streamline this process, the UWG has noticed that the pace and frequency of enhancement requests has dramatically slowed down in recent years.

For instance, there have been major delays in identifying an NRT path to assimilate geostationary aerosol products into the GMAO, and introducing new capabilities for rapid evaluation of aquatic environments using Landsat 8 & 9, which we will hear an update about at this meeting. The UWG is uncertain about the reasons behind this slowdown. Ensuring the delivery of high-quality near-real-time products and services spanning diverse disciplines and sectors remains a cornerstone of the LANCE Charter. In light of these

considerations, I wish to emphasize the importance of fostering open communication channels among the UWG, ESDIS, the SIPS, and ESDS program leaders. Building and maintaining collaborative dialogue will contribute to the continued success and evolution of the LANCE system.

Let's also bear in mind that these capabilities have far-reaching implications, extending well beyond the confines of this meeting and into the realms of crisis centers, advocacy groups, and civil agencies from across the globe.

In closing, as we forge ahead with our agenda in the coming two "half-days," I would like to salute the tireless dedication and unwavering commitment of this powerhouse team—a collective force of experts hailing from diverse NASA field centers and JPL, alongside our invaluable interagency and academic partners, the ESDS team, the Applied Science Program, and the various SIPS. Every single member has poured their heart and soul into making LANCE the triumph it is today. Together, we stand united, and it's your passion and hard work that have fueled the success of LANCE.

Here's to the incredible journey we've undertaken and the even brighter future that awaits! I now officially open this meeting and invite Cerese Albers to share NASA's HQs perspective. Muchas Gracias... Thank you.

3. [NASA HQ Updates & Perspectives](#)

Cerese Albers, Program Executive for Earth Science Data Systems (ESDS) Program

Cerese began with changes in the Earth Science Division (ESD) organization since the last LANCE UWG meeting. Katie Baynes has been named Earth Science Data Officer. Within ESDS, Cerese and Joel Scott continue as Program Executives. Yaitza Luna-Cruz is leading ESDS Connections with other components of ESD. Dr. Stinger Guala is focusing on Equity and Environmental Justice, Outreach programs, and interagency activities. Katherine Saad is a Program Scientist, and Hannah Townley is Project Coordinator. The primary components of the ESDS are the ESDIS Project, the IMPACT Team, the Web Strategy and Communications Team, and the Program Scientists embedded at Goddard.

Cerese provided an update to the UWG on Terra, Aqua and Aura. She reviewed the workshops that were conducted in 2022 and 2023, soliciting input on potential benefits of observations made during the period of orbital drift for the EOS platforms, and need for continuity of measurements. The Senior Review for NASA's Operations Missions (including Terra, Aqua and Aura) was conducted in the summer of 2023. Based on the outputs of the workshops, the Senior Review Panel unanimously recommended extending the missions, and ESD approved the recommended extensions. Cerese also provided an update on the Earth System Observatory (ESO) missions, providing status of AOS-Storm, AOS-Sky, (completed Key Decision Points (KDP) A- in January 2023) SBG, (completed KDP-A in November 2022; and GRACE-C (formerly Mass Change – completed KDP-B in September 2023).

Cerese then outlined the new Earth Science to Action (ES2A) Strategy. She presented a pyramid with a Foundation of Knowledge, Technology, Missions and Data. Above that is Earth System Science and Applied Research, Solutions and Societal Value, and Public Understanding and Exchange at the top. Cerese said there is a high likelihood that NRT observations will be necessary to achieve the ES2A strategies, and she expects LANCE will need to evolve to serve the new communities that ES2A aims to reach.

Cerese concluded by reminding the UWG of the priority of NASA Open Source Science, and the values of getting a NASA Open Source Science certification to learn best practices, tools and strategies for achieving Open Source Science.

There was considerable discussion following Cerese's presentation. She acknowledged that given the current NASA fiscal situation, we are being asked to do more with less. Karen Michael asked whether there would be requirements levied on the ESO missions (AOS and SBG) and documented in their Program Level Requirements Appendix (PLRA) to provide data products in NRT to support the ES2A goals. Cerese said that this is still under discussion with the missions, but Cerese will recommend that any known NRT requirements be included in the PRLAs. There was some discussion regarding the role of Research and Analysis (R&A) in ensuring the quality of the future NRT products. Miguel observed that currently the quality of operational NOAA/EUMETSAT Aerosol products from the geostationary platforms does not match the quality coming out of 20+ years of algorithm improvements in the products from the EOS missions.

4. Taking Stock of LANCE

Karen Michael, ESDIS Mission Systems Manager, LANCE Manager

Karen presented some updates on LANCE. MISR NRT still has not resumed processing since the change in Terra orbit in October 2022. Primary users of the MISR NRT products were NOAA and EUMETSAT. As of November 1, 2023, NOAA-21 has been declared a secondary satellite, with NOAA-20 in primary and SNPP in tertiary mode. The tertiary designation for SNPP means non-nominal issues or ground resource constraints will be addressed by NOAA on a "best effort" basis in the future, unless there is a satellite or instrument health and safety issue. LIS on the ISS has been decommissioned, ending 25 years of Lightning data collection, beginning with TRMM. No decision has been made yet regarding last year's proposal to add support for AMSR-3 standard and NRT products. The GMA proposal identifying a path to assimilate Aerosol data from Geostationary platforms in NRT was not funded in FY2023, but hopefully, given the tremendous support from the ICAP community, it will be considered for funding in FY24. Karen presented a summary of the current LANCE instruments with the expected dates for their termination of mission operations. Karen concluded with a thank you to the UWG members for their support and participation.

5. LANCE Metrics, Updates, Impacts and Outreach

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

Diane presented LANCE bi-weekly average latency for the past year, by instrument. She also provided weekly metrics on the number of unique users accessing data, going back 5 years, and for the past year. Yearly NRT data distribution by volume and files since 2010, and number of files distributed by instrument for the past year were presented. MODIS Aqua and Terra, VIIRS NOAA-20, and VIIRS SNPP continued to be the most popular products. Google Analytics metrics by country of users accessing LANCE websites (excluding Worldview and FIRMS) were presented. Diane analyzed metrics for referrals to FIRMS during the Canadian wildfires. While many are from news media, there were also two Apps linking back to FIRMS: Castanet, a British Columbia news App, and the Ring App. Diane showed a dramatic animation linked from the Washington Post that used GITFIRMS and GEOS-FP (GMAO) to show fires and smoke from the Canadian wildfires over several months.

Jenny continued with more examples of LANCE in the News, including use of FIRMS for assessing risks and impacts. Jenny referred to an article on utility companies using FIRMS data to estimate risk, and another from the Washington Post on the impact of the Canadian wildfires on air quality in the Mid-Atlantic region. There has also been an increase in the use of LANCE data in assessing impacts of conflict. Jenny presented two Black Marble images, one before and one after the start of the Israeli and Palestinian conflict, showing the Gaza strip in almost total darkness compared to prior to the conflict. She also presented examples of LANCE data being used to provide impacts of extreme weather, including results of heavy snowfall, and impacts of moving icebergs.

Jenny then shared recent examples of Outreach by the LANCE team, including presentations at ICAP, COFC-Fire, and the WildfireSAT meeting. Meetings were also held with the U.S. Department of Homeland Security to discuss how FIRMS data could be used, and the Earth-to-Sky Partnership to share FIRMS capabilities. The LANCE team continued to collaborate with the ESDIS Communications Team on feature articles, Webinars, and social media. A very successful outreach activity was the FIRMS Challenge in the NASA International Space Apps Challenge. The FIRMS challenge was based on increasing community-based fire management opportunities. The overall NASA Space Apps challenge drew 58,000 participants from 152 countries. The response to the FIRMS Challenge *broke the Space Apps record* with 82 Global Nominees, of which three are finalists.

6. Update from the Atmosphere SIPS (A-SIPS)

Jess Braun, University of Wisconsin/Madison

Jess provided updates on the three VIIRS Atmosphere NRT products produced by the A-SIPS: Deep Blue Aerosol (day), Dark Target Aerosol (day) and Cloud Mask (day/night). The Worldview imagery is the Clear Sky Confidence Product. Jess provided status on current operational

versions for these products from both SNPP and NOAA-20, including plans for future operational versions, where applicable. The A-SIPS team observed that the Dark Target 2.0 NRT products were exceeding the 3-hour latency requirement, which was found to be due to the GEOS-5 ancillary input file that had been chosen by the science team. The A-SIPS team worked with the science team to move to a different GEOS-5 input, which reduced the latency. There are no VIIRS Atmosphere NRT operational products from NOAA-21 at this time. The aerosol and cloud teams plan to deliver NOAA-21 products by the end of 2023. No new NRT products are anticipated for any of the three satellites. A new web interface has been developed for searching and downloading A-SIP NRT products that will be automatically updated whenever changes are made in CMR. They have also developed a CMR fetch utility for searching and downloading. There is a GitHub link that uses the CMR Search API, and is the recommended link for all A-SIPS NRT users. Minnie Wong said there has been user interest in VIIRS aerosol products with polar projections, particularly in the Arctic region, motivated by the Canadian wildfires. Minnie asked if this was a possibility. Jess clarified that this would just be generating imagery for GIBS with a polar projection, and asked Minnie to forward the request so that she could discuss it with Liam Gumley. Miguel commented that this is a valuable addition, and the Land team already provides imagery products with polar projection. There may be a possibility of reusing their code. Dr. Steven Miller (LANCE UWG Member, CIRA/CSU) concurred that this would be useful.

7. Update from MODIS/VIIRS LANCE Element

Carol Davidson, NASA/GSFC

New since the last LANCE UWG, the NRT 375m VIIRS Land Surface Temperature (LST) is now running operationally. Carol summarized the current Collection levels for the MODIS Level 1 Atmosphere and Land products, the VIIRS Level 1 and Land products from SNPP and NOAA-20, and GIBS imagery for VIIRS Level 1 and 2. The instruments have continued in nominal operations since the last UWG, with impacts to NRT latency on three occasions due to spacecraft resets. Work is underway to transition the NOAA-20 Level 1 and 375m fire products to NRT. Carol provided current status and tentative plans for NOAA-21 processing. The NOAA-21 standard Level 1 products have been processed as part of the VIIRS Collection 2 and are being distributed by LAADS. All downstream products from NOAA-21 are experimental and not yet public. Operational C2 Land reprocessing is pending cross-calibration of NOAA-21 with the other VIIRS instruments. Tentative projections for NOAA-21 VIIRS NRT processing are: January 2024 for the Level 1 and 375m Fire product; February 2024 for the Day/Night Band and GIBS Level 1 layers. They also plan to add the GIBS Layers for NOAA-2020 and 2021 Day/Night Band at the same time.

Carol briefly updated their contributions to the Terra MODIS Continuity via Sentinel-3 pilot study. The Sentinel Corrected Reflectance (CR) products from the OLCI and SLSTR instruments are being generated following NRT protocols, but results are experimental, run for test purposes, not for distribution. An initial version of the true-color RGB CR layer derived from

OLCI has been delivered to GIBS for testing. Work on producing two other CR band combinations, following MODIS and VIIRS heritage, using OLCI+SLSTR bands is underway.

Carol also listed potential new NRT products resulting from ROSES 2020 A.33. Miguel commented on these, and said it would be very helpful to get brief summaries for the UWG from the PIs regarding their plans and status for each of the five potential new NRT products.

8. Earth Action Update

David Green, NASA Headquarters

David provided a brief description of the Earth Action Initiative, which has replaced the Applied Sciences program, but is actually “Applied Sciences Plus”. The new organization will have more breadth, e.g., it will include the Commercial Satellite Data Acquisition program, and the Satellite Needs Working Group. There are three guiding principles of Earth Action:

- Building Bridges across communities, e.g. interdisciplinary
- Scaling – up to global levels; down to community levels
- User Focused perspective

David recommended LANCE document how it supports these principles. He emphasized the importance of identifying NRT requirements early in the mission lifecycle, and ensuring users understand the extent (timeframe) of continuity for NASA applications-oriented data and services. David noted that Early Adopters have provided input to understanding NRT needs. David then gave an update on other missions. NISAR, which will have broad stakeholder communities, will be able to deliver data within 5 hours of observation. TEMPO will have NRT products in 2025, with latency of 2 to 3 hours. The SBG mission will have an Applications Community Meeting in February. PACE, which is scheduled for launch in January 2024, has a data latency requirement of 24 hours, but actual availability is expected to be within 6 to 12 hours.

A discussion between Miguel and David then ensued on the importance of the early adopter programs and multi-mission workshops in fostering more sophisticated users that can leverage data across missions. Miguel observed that many LANCE enhancements have been “pop-ups” – new ways to use data than originally planned. A good example is the Black Marble, but Miguel cautioned that these types of capabilities require support from a healthy combination of ESD elements (i.e., R&A, Data, Flight and Earth Action).

9. NASA’s Disasters Program

Shanna McClain, NASA Disasters Program Manager

Shanna introduced her team members – Lori Schultz (MSFC), Robert Emberson (GSFC) and Laura Giannini (HQ). The Disasters Program is a core element of the Earth Action initiative, and they are formalizing the program plan. The Core Elements of her program are:

- Disaster Applications – writing solicitations, funding proposals that advance decision support mechanisms, disaster risk reduction, and efforts toward resilience
- Disaster Response Coordination System – Global and domestic communities to support Response teams with Earth Observing data and expertise
- Disasters Open Access Portal – geospatial portal that provides data products and serves as a collaboration and technology exchange mechanism, helps build capacity, and supports partnerships

Shanna listed the ten currently active Applications projects from NASA ROSES A.37 Disaster Response and Risk Reduction, that will be concluding this year or early next year. She highlighted an example - the Landslide Risk and Exposure Modeling, led by Dalia Kirschbaum at GSFC, using the Landslide Hazard Assessment for Situational Awareness (LHASA). This is a model that combines satellite precipitation data with topography, machine learning, and exposure data to generate global landslide hazard nowcasts. The approach is user/human-centered. While it is partnered with the Pacific Disaster Center, it is scalable - not developed for a single use purpose. The goal of LHASA is to be broadly adaptable and useable by multiple communities. The Disasters Program is preparing the next ROSES solicitation, which will be released in February 2024. The goal will be to focus on the Earth Action tenets: Scalability, Human-Centered Design, and Building Bridges. They will be focused beyond hazards, looking at vulnerabilities and exposure. Shanna then spoke about the Disaster Response Coordination System (DRCS), having a more formalized approach, with leadership across the agency, from MSFC, GSFC, LaRC, Ames, as well as JSC over the past 18 months. There is a formal vision and statement of purpose. Transitioning to the new DRCS is underway, with the formal launch planned for April 2024. Shanna commented on the importance of LANCE's support to disaster response. Shanna provided an example of NASA's Disaster Response – the response to the Turkiye and Syria earthquakes in 2023. NASA supported 10 partner stakeholders in this case, but Shanna expects the new Disaster Response Coordination System will enable them to support more events occurring in the same time frame. It will also focus on after response assessments including lessons learned – what worked and what didn't work, including the products, which will provide insights that will be beneficial to the LANCE community.

Finally, Shana presented the Disaster Mapping Portal, a central hub that hosts maps, data products and analyses reflecting the program's response efforts. It helps to strengthen partnerships and engagement efforts. It also provides training capabilities, using Storymaps to demonstrate capabilities, data products, and rationale for using one product versus another. The plan is to move the portal into a cloud environment, allowing sandbox environments and improved collaboration. Based on a question from Miguel, there was a conversation about the growing interest in and exploitation of Earth observation data by insurance companies, and how to work with them cooperatively.

10. Leveraging Spatial Data to Halt Deforestation

Fred Stole, World Resources Institute (WRI)

Fred's presentation focused on Land Use Policy, specifically using satellite data to detect and prevent deforestation. The UN Food and Agricultural Organization (FAO) has been monitoring forestation for many decades. Tables are produced showing forest area increase/decrease by country for each decade, but they are self-reported. To be effective for policy enforcement, they need to be updated at least annually. The WRI has been working with the University of Maryland to produce high-resolution global maps of 21st century forest cover change. The four main strategies of the GFW are:

- Enhance global accountability
- Empower forest defenders
- Enable responsible supply chains
- Strengthen national monitoring

The GFW provides data dashboards, analysis tools, and alerts (through subscriptions). New capabilities are being developed to provide net change in tree cover area. Previously they could only detect deforestation. Now, with integration of Landsat and JEDI data, they have the ability to present maps showing high net loss, net loss, neutral, net gain, high net gain. Providing this information to nations on a timely basis is influencing their policies. Fred also stressed the importance of understanding status of trees outside of forests. In many agricultural areas, trees play an important role. Sentinel-2 10 meter data enables monitoring of tree change in these areas.

Timely alerts are critical to the mission of Global Forest Watch. University of Maryland produces Global Land Analysis & Discovery (GLAD) alerts, based on Landsat data, every 8 days. Fred showed an example of an alert generated from Landsat over Peru, followed up with an aircraft image that showed many trucks conducting logging in a protected forest. The alert allowed a quick response from local authorities. The other type of alert generated by GFW is the RAdar for Detecting Deforestation (RADD), using SAR data from Sentinel-1. It is being used to provide alerts in Africa, and currently being developed for Indonesia and Malaysia, where cloud cover is often too extensive to use other observation methods. They have also created integrated alerts, by layering Landsat GLAD layers with Sentinel-2 RADD layers.

Fred described the Prioritization Chain, which alerts intersect with protected areas and intact forest landscape data sets. Areas with the highest overlap are ranked, and the GFW deep dives into the top 10 locations on each continent. The local communities/ authorities are alerted, but they also choose the top five most interesting places to send journalists, in particular Mongabay Reporting. In some areas, where they have MOUs with local authorities, they do Landscape Monitoring. The Landscape Monitoring and Response Initiative monitors collaborative response at the landscape/district level.

The University of MD has been using OPERA (Observational Products for End-Users from Remote Sensing Analysis – an SNWG project from JPL) to provide global, 2-4 day temporal resolution alerts monitoring all vegetation types. OPERA uses HLS data. Fred presented an example of development in the Dulles Airport area, where large areas of grassland and forests are being lost through economic development. Fred provided examples worldwide where GFW alerts based on satellite observation have resulted in local and indigenous people taking action to preserve and recover protected land. He concluded by noting that in Africa, the impact of alerts from NRT satellite data has decreased the likelihood of deforestation by 18%.

11. Key Features of the Expanded FIRMS User Interface

Brad Quayle, USFS and Otmar Olsina, NASA/GSFC

Brad and Otmar demonstrated the features in the new FIRMS user interface. FIRMS is a rich source of data, with many layers and capabilities. The goal of the new interface is to make it easier for users to find existing data, as well as new data products, and be able to provide feedback. They also wanted to make the interface more modular and scaleable. Brad gave a live demonstration of the new interface, beginning with a side-by-side comparison of FIRMS Global and FIRMS US/Canada. While the applications are essentially the same, the US/Canada version has additional layers and alerts, burned area boundary data for U.S., and additional contextual information. Clicking on individual layers provides information on the layer (e.g., data source, how to use it). The new interface adds “group layer” details. Checkmarks have been added so the user can tell which layers have been activated. In order to make the interface more modular, various “Modes” (e.g., Basic, Advanced, Smoke/Aerosols, etc.) have been added from which users can select. An “Experimental Mode” has been added to present new prototype products that users can evaluate and provide feedback.

Brad used the Donnie Creek fire in British Columbia to demonstrate the Sub-Daily tool that allows the user to filter by various time frames. He also showed how detections over time can be visualized. The user can see the directions and trends of the fire based on this display. Brad highlighted the Aerosol Index data from OMPS, by displaying the smoke and Aerosols that resulted from the Donnie Creek fire. He concluded with a demonstration of the monthly Burned Area product. The FIRMS team is exploring a path to generating a VIIRS NRT Burned Area product, updated daily.

Otmar continued with the demonstration, focusing on the web map services and APIs to access real-time (within 60 minutes of satellite overpass) and ultra-real-time (less than 60 seconds of satellite flyover) data from FIRMS. The Web Features service allows users to download data in easy to ingest formats. The Web Map service provides actual map information, with multiple layers. For more advanced users, an API service is provided where the user identifies the latitude/longitude values of a rectangle and downloads a subset of data up to 10 days back. Another API endpoint has been added to allow subsetting by a specific country (requested by the UN).

Fire Data Academy is a new service to help potential new users learn how to use FIRMS fire detection data in Python using Jupyter Notebook files and Google Colab (although Google Colab is not required). Users can navigate the steps and provide documentation at the same time. Three Python code examples are provided: Data Ingest and Manipulation, Use FIRMS API, and Data Visualization.

After the day's meeting, David Green complimented the demonstration of new FIRMS features, but asked if the UWG could get more insight into the actual impacts of these features, as that is a key aspect of the Earth to Action initiative. As an example, Brad Quayle described feedback the USFS has received on the value of the FIRMS detection and monitoring capability from Canadian response organizations.

29 November 2023

12. Update on Tropics

Jess Braun, University of Wisconsin/Madison SSEC, Vince Leslie, MIT/Lincoln Labs

Jess provided an overview of the **Time-Resolved Observations of Precipitation structure and storm intensity with a Constellation of Smallsats (TROPICS)** mission, including the ground system. KSAT acquires the data from the satellites. Mission operations is conducted at Blue Canyon Tech. At the same time, the SSEC at the University of Wisconsin performs all science data processing, and MIT/Lincoln Labs is responsible for the science and payload operations. The Goddard Earth Science Data and Information Services Center (GES DISC) will serve as the DAAC for TROPICS. A pathfinder was launched in 2021, in a traditional polar orbit. The Cubesats are in an inclined (33 deg.) orbit. Of the six Cubesats launched, four made it into orbit, but one is not currently providing data. Jess then provided an update on the status of the mission. Regarding the Pathfinder, the Level 1B validated products are being released to Early Adopters and NRT users. Patrick Duran is the coordinator for Early Adopters and can be contacted by any potential Early Adopters. Updates to reduce orbital bias are underway on some channels. She expects validated products to be released to the public in early 2024.

The constellation data is available in NRT at beta maturity for imagery purposes only. Jess presented science data products status for the four Cubesats:

- TROPICS-03 and 06 L1A/L1B is at provisional maturity with the data record starting in June 2023. This is the nominal 12-hour latency data stream distributed by GES DISC. Data is currently limited to early adopters, with public release expected in January 2024
- TROPICS-05 provisional maturity is under development and expected in early 2024.
- TROPICS-07 only has data from mid-June to the end of July, and will be provisional after TROPICS-05.

TROPICS has received funding from several organizations, including NOAA and NRL, for additional ground contacts to enable NRT processing. Current plans are for the TROPICS NRT

data to be supported through LANCE and Worldview from the TROPICS Data Processing Center (DPC) at the SSEC when the data becomes public. Jess presented preliminary TROPICS imagery from the Pathfinder in the SSEC internal Worldview instantiation. Future plans include working with MIT/LL Science teams to determine initial channel selection for eventual delivery to GIBS/Worldview. The NetCDF format will have all twelve channels when the data becomes public. In the future, they will determine if there are any Level 2 products for which imagery should be produced. They have started work on generating imagery from the constellation and planning for integration of the LANCE NRT products with CMR and EMS.

Miguel asked Jess about the potential user community that will be ready to use the TROPICS data on a routine basis. Jess said there has been significant interest from Assimilation, the National Weather Service and other users of AWIPS for operational weather forecasting, the National Hurricane Center, NRL, and the Joint Typhoon Warning Center. Patrick Duran added that there is interest from “non-traditional” user communities including flood forecasting in tropical regions that don’t have good radar coverage. Patrick also mentioned that they have been working with other missions, such as CYGNSS (with which they held a joint user workshop), GPM and TEMPO to investigate research that can be done using data from multiple sources. Steve Miller offered some additional potential communities that might benefit from TROPICS in Worldview. He suggested augmenting precipitable water products like blended and layered precipitable water. There likely would be interest in visualization of atmospheric rivers. He also commented that the 204 GHz band may be very interesting to the microwave community. Worldview would be a useful way for them to engage with that band and compare with other products with which they are familiar. Ryan responded that this would be a good subject for a Worldview Story Tour.

13. Sentinel-3 Pilot Study – Terra MODIS Continuity

Louis Giglio, University of Maryland

Louis outlined the goals of the pilot study towards ensuring continuity of Earth System Data Records (ESDRs) from Terra-AM MODIS:

1. Evaluate Sentinel-3 (S3) NRT Fire products, and import the active fire data into the FIRMS database for display and distribution in LANCE FIRMS and Worldview
2. Generate S3 NRT Level 2 Corrected Reflectance (CR) product plus Terra-AM MODIS heritage CR imagery from S3 CR for distribution and display on LANCE and GIBS/Worldview
3. Prototype standard S3 Land Surface Reflectance (LSR) product in SIPS
4. Support, as appropriate, program-wide engagement with CEOS WGCV on ESA/NASA bilateral activities

Louis summarized the progress that has been made with the CR, LSR, and Active Fire Products from S3. Good progress has been made with the CR from both the OLCI and SLSTR instruments. Eric Vermote has delivered the code for CR, which is generally adequate for NRT applications. LSR work is still in progress.

Louis then addressed findings with the NRT and science-quality Not Time Critical (NTC) Active Fire products, produced by EUMETSAT and ESA, respectively. The relevant sensor is the SLSTR, and the NRT product is most relevant for the pilot study focus on FIRMS, but the NTC product has also been examined. Unlike NASA products, the European two Active Fire products (generated by ESA and EUMETSAT) are largely independent and based on different algorithms. Louis discussed practical issues about the EUMETSAT NRT “as-is” product. The data format is cumbersome, with four fire products/files in one big zip file, so with this scheme, each granule is a zip file. The production software is proprietary, and detailed descriptions of the NRT detection algorithms are not yet available. Some shared product layers between the multiple products must be sorted out by the user. While these issues can be dealt with for the most part, the most significant observation is that the Level 2 SLSTR products are generated from *regridded* swath pixels. This scheme is different than NASA Level 1B swath products used to generate Level 2 products. The result is that not every pixel has a value in the regridded cells, and some grid cells contain multiple pixels. Production software would need to address this issue, and fires are sometimes lost because some swath pixels are effectively discarded, which is a serious concern for FIRMS. Also, the daytime detection and FRP retrieval is complicated by misregistration between the low-gain/high-gain MWIR channels. The product does not yet reach the quality and rigor that FIRMS requires.

The goal is to use S3 data in place of Terra MODIS within the existing systems (e.g., FIRMS) that the user community expects and needs. Louis and his colleagues are exploring multiple options for making the S3 fire product more mature and easier to use and interpret -i.e., more comparable to the MODIS product. The key is to deal with the regridding artifacts, ideally eliminating them, and ensuring no fires are lost. Louis and his team have been working with EUMETSAT and ESA, providing feedback and recommendations. The current pilot study will wrap up in early 2024, but a proposal for a second phase will be submitted to NASA HQ.

Discussion followed regarding a MODIS comparable Fire Radiative Power (FRP) product, and when that might be available. Louis said it depends on the path selected for going forward. One possibility is for ESA or EUMETSAT to address the issues with regridding. An alternative would be for NASA to produce a Sentinel-3 product in-house. There is a complication with that solution, as EUMETSAT does not distribute the swath data – the Level 1B is currently only available in the regridded format. There are issues and challenges with undoing the regridding. Regarding the possibility of NASA making their own Level 2 product, Steve Miller asked about gaps and cosmetic filling done through the regridding. He expressed concern about modification of the radiances themselves. Louis responded that EUMETSAT is using nearest neighbor resampling, so it is possible to undo the regridding, but they have found non-unique values for the same pixel, which needs to be addressed. There was agreement that getting access to the true Level 1B (pre-regridding) would be the best solution. In response to a question from Crystal Schaaf on whether, in addition to the next nearest neighbor, there is sufficient view angle to deal with undoing the regridding, Louis replied yes – the Level 1B is essentially a simplified Level 2G product, so it can be done, but involves a fair amount of effort, given the number of files in each zip file. Miguel concluded the discussion by complimenting the Sentinel

3 Pilot study team's efforts and his optimism that a solution will be found for providing a high-quality product from Sentinel-3 to provide continuity with the MODIS AM.

14. Update on OMPS Near Real-Time Products

Colin Seftor, NASA/GSFC

Colin provided an update on the OMPS Aerosol Index (AI) product. In addition to the OMI (Aura) AI, there is currently an OMPS AI NRT product from SNPP, but that platform is also reaching end of life. Both NOAA-20 and 21 have OMPS instruments, but there are currently no NRT products from those platforms. The OMPS team has developed code for NRT AI products from NOAA-20 and 21, and it is now undergoing testing. The algorithm used for these products is the "heritage" definition of AI – defined in a manner similar to instruments that were in orbit before OMPS and OMI – specifically TOMS. This will allow continuity with the heritage TOMS products and the current TROPOMI sensor. It will make comparisons between current and historical events easier, especially for user communities like PyroCb. The plan is to have the products available by late Winter/early Spring 2024. The current AI formulation for the products from SNPP OMPS is different, but once the NOAA-20 and 21 AI products are operational, the OMPS team plans to revert the SNPP OMPS formulation to the heritage form. Colin presented images showing the increased resolution of OMPS on NOAA-20 and NOAA-21 over SNPP.

Colin presented metrics for the NRT AI product from SNPP over the period of February to September 2023. There was a significant spike in uptake of OMPS AI in February, coinciding with the fires in Chile, and even more dramatic increase in May through September 2023 due to the fires in Canada.

Colin then discussed the value of AI in detecting and confirming the occurrence of Pyrocumulonimbus (pyroCB) events. There were a record-breaking 142 confirmed pyroCB events in Canada this year, far exceeding any year to date. Colin presented imagery from both SNPP OMPS illustrating the ability of AI to detect and track aerosols over all land surfaces, as well as clouds, aiding in monitoring the development and movement of smoke, ash and dust. The imagery showed smoke plume from the fires in Canada was transported across the Atlantic to Europe, from May to September.

Colin also provided an update on new OMPS Limb Profiler (LP) NRT products. Development of a product to provide stratospheric aerosol optical depth and extinction at specific altitudes is underway. The algorithm used to generate the standard product has been modified to use machine-learning techniques that significantly reduce the processing time, and is expected to meet the LANCE 3-hour latency window. Colin anticipates submitting this product to the UWG for inclusion in LANCE in early 2024. In addition, the OMPS Science Team has already developed a NRT OMPS LP Ozone Profile Product. This was done at the request of GMAO to provide continuity for MLS. It is currently being tested by GMAO and others, and could be submitted to the LANCE UWG for inclusion in LANCE.

Miguel endorsed NRT production of OMPS LP aerosol products, which would help seasonal/sub-seasonal aerosol and weather predictions. Arlindo daSilva agreed that this would enable capture of large injections into the stratosphere that could last for a long time. Miguel encouraged Colin to submit these products to the UWG, with backing from at least two NASA HQ program managers. Mike Fromm asked Colin whether there were any plans to link the OMPS Nadir pixels with the Limb stratospheric data in LANCE. Colin said they could explore this with the PI, but it will depend on resources. Steve Miller raised a concern about returning to the heritage AI algorithm for the NOAA-20/21 Aerosol products, and whether the improvements made in the SNPP algorithm's radiative transfer model for accounting for clouds, surface reflection, and sun glint would be lost. Colin said this is a complicated issue, but those improvements won't be available, as there is no agency or plan in place to generate those products for NOAA-20 and 21. Without Colin's team's efforts, there would be no NRT or standard AI product when OMI and SNPP OMPS end. Miguel stressed the importance of having a comprehensive strategy underpinning these measurements. He added that a deep dive is needed into issues tied to continuity. There wasn't enough time during the UWG meeting to pursue these complex issues, but Miguel recommended continuing the discussion.

15. NRT Flood Product Archive Discussion

Dan Slayback, NASA/GSFC

Dan started by reporting on improvements made to the Level 3 code to remove false positives at high latitudes, and enable running historical data in the "Ops Mode". By running the historical data for at least 10 years, an updated reference water layer will be generated, which is used to determine whether water detections are the result of flooding. The primary topic of Dan's presentation was whether the archive generated by this process can be retained and distributed. From the perspective of NRT applications, historical events are important for understanding the context of current flood events. A record of these events answers questions such as whether the flood is unusual, whether areas are at risk based on previous events, or whether this an extreme event or a normal seasonal flood. Regarding scientific applications, the archive would be useful in studies of local and global changes in surface water, flooding, and flood model training and validation. There also would be policy, government, industry (e.g., insurance) applications related to flood risk.

Before the LANCE NRT Flood product, there was a legacy product archive managed by Fritz Policelli, the PI, accessible from the web until the server was retired in 2021. Users continue to request the historical data, on average once weekly, which Dan provides manually on a "one-off basis". GIBS/Worldview provide a visual archive of the product since early 2022, but the corresponding data product files are not accessible, beyond the short term NRT archive.

Dan presented a proposal to the UWG to establish a Flood Product archive storage location and web interface. He recommends using the LAADS archive storage and distribution channels, and export the metadata to CMR to support Earthdata search. The plan is to reprocess the archive

to update the reference water mask, ideally going back to the start of Aqua (June 2002), but at least 10 years. Going forward, the NRT HDF products would be ingested into the archive.

Dan presented some statements of support from current and potential Flood product users, briefly summarized below:

- Bob Brakenridge asserted there is no competing water surface area product. The long term record is essential to distinguishing extreme events from “normal” seasonal flooding.
- Maggie Glasscoe said the archive would be useful for training flood models.
- Matthew Pressier, NASA FINNEST fellow, UT/Austin stated having data going back 10 years would be invaluable in testing scenarios, modeling flood extent and depth.
- UK Centre for Ecology & Hydrology said historical flooding would be valuable to modeling of disease risk in India
- Morningstar is developing climate risk guidelines for government financial institutions that would benefit from the historical data.

Dan concluded by noting that the Flood product is unique in LANCE, as it is an applications product, not a science product. His assessment is that the storage resource impact would not be significant, since the product volume only requires ~1 TB/year.

Miguel said the proposal has merit, but we must determine the appropriate discipline-specific repository location to ensure adequate user support. Miguel opined that the Land Processes (LP) DAAC might be a more suitable home, better able to provide user support than LAADS.

Lori Schultz said with the advent of the OPERA Project, and the DSWE algorithm being applied to the HLS, there an argument to be made that reprocessing of MODIS and VIIRS should be performed using similar algorithms, such as the DSWE algorithm, to enable more opportunity for inter-comparison. Alternatively it could be easier to take the current MODIS algorithm and apply it to the other options (i.e. VIIRS (which is what is currently being done)). Optical flood detection is hindered by clouds, so the ability to have a multi-satellite processing stream gives more usability and applicability to looking backwards at an event using every possible pass. She asked how do other people feel about this?

Dan said this points out the long-standing community need which is a robust comparison of the different products. It's a difficult problem because there is no real ground truth on flooding. USGS developed the related DSWE mod product using MODIS data, but this has only been used for research purposes / is not operational. Lori agreed with Dan's observation.

Miguel responded that as the Chair of the Land Product Validation group, there are many standard products that are validated. A core component is a product inter-comparison exercise to reach stage 3 validation CEOS guidelines. Creating a flood standard product requires committing to the 3 stage validation process. If we are to have a home for a standard flood product, we would need to form a focus area for flood inter-comparison and validation. Miguel's recommendation is to lean on the NISAR science team to conduct those inter-

comparisons. NISAR will help bring more attention to how we create a long-term data record for floods. He observed that it would have been possible with Sentinel-1. LANCE and the Code 619 team have been very accommodating of the obvious need for the NRT flood product, but going into standard product territory has to be done right, and that requires a project that is committed to the standard product.

Dan agreed that establishing a standard product would be the best approach, but in the meantime, can or should we archive and distribute the data? If so, then the easiest path is to use LAADS. William Straka from CIMSS reported that the NOAA VIIRS flood products are archived. NGOs are using the data. William said his experience is that users do want the archived data, for example to identify number of days flooded, to help identify where to build schools, etc. William has discussed with Sean Helfrich/NOAA the need to reprocess the MODIS flood product with the algorithm from George Mason University. William believes (but needs to be confirmed) that part of the Infrastructure Bill funding that NOAA received is for a flood product archive.

It was suggested:

- Sean Helfrich be contacted about NOAA plans regarding Flood product archive
- Explore with NISAR project the need for a Flood validated standard product
- Consider the interim solution to archive the MODIS NRT at LAADS
- A paper is needed on what should be included with a standard Flood Product – e.g., it should not be just a count. Need to be able to characterize the legacy conditions, and the gap between previous and subsequent floods, and a more nuanced understanding of the conditions. As we heard from Shanna McClain, under Earth to Action it is not just about the hazards, it's also about the response, recovery actions taken over that pixel. We need a strategy.

16. LANCE AMSR2 / ISS LIS Update

Leigh Sinclair, University of Alabama/Huntsville

Leigh provided a brief summary of updates on AMSR-2 Level 2B Rain, Ocean, and Snow products that are now in operations. AMSR-2 NRT products are all nominal. Leigh then presented the NRT Hurricane Tracker Tool that the SIPS has developed. It enables monitoring of tropical storm activity in the North Atlantic basin. It is based on a combination of MODIS NRT and AMRS2 NRT data, providing daytime and nighttime images. The animation consists of twice per day images for the past 10 days. Future work will improve the visualization. When the MODIS data is not available, the tool is temporarily unavailable.

Leigh then discussed the LIS instrument status. Originally two LIS instruments were designed by the Lightning Team at the Global Hydrology and Meteorological Climate Center and manufactured at MSFC. One was installed on the TRMM satellite in 1999 and operated until 2015. The other (spare) LIS instrument was installed on the ISS in February 2017, and was decommissioned on November 12, 2023. Originally envisioned as a 2 year mission, the LIS

provided a record of 22 years of lightning data. The orbit of the ISS allowed LIS to see lightning at higher latitudes globally, providing data every 2 minutes. The LIS data serves as an accepted “benchmark” for global lightning climatology intercomparisons. The data was used by the Aviation Weather Center, and for GOES Lightning Mapper (GLM) Cal/Val, since GLM’s lightning detection approach traces to LIS heritage, and the LIS data are well characterized. The LIS SIPS team has started working on the preservation process, and performing quality assurance on the standard products.

17. Earth Information Center (EIC)

Nicole Ramberg-Pihi, EIC Project Manager, NASA HQ

The first instantiation of a physical location of the EIC opened in the former East lobby at NASA HQ on June 26, 2023. One of the primary goals is to raise awareness that NASA has been studying Earth for over 50 years. The EIC is an interagency (NOAA, FEMA, EPA, USAID, USGS, USDA) and interdisciplinary initiative. Nicole briefly covered the Earth to Action strategy (also addressed on Day 1 of the UWG meeting). EIC’s role is public understanding and exchange, targeting end users (e.g., decision-makers) as well as the science-curious. The EIC highlights actionable information from NASA Earth observation. Nicole briefly described the nine thematic areas: Agriculture, Biodiversity, Disasters, Energy, Greenhouse Gases, Sea Level Rise, Water Resources, Wildfire, Air Quality. The EIC’s goal is to highlight the applications of NASA and partner data/resources at regional and global scales. Nicole presented a video of the EIC Hyperwall displays, including NRT data, dashboards and stories. The EIC is and will be expanding to other physical locations, and their online presence through Earth.gov. At the conclusion, David asked how well understood the dependencies of the EIC are on LANCE data and services. He raised the question: If those data and services are unavailable in the future, how would EIC be impacted? Nicole said that while she could not comment in detail on the question, the Data Visualization Studio is coordinating all of the data and visualization at GSFC, and they keep track of all the sources. David observed that the value stream of the Earth science to action pyramid needs to be well understood, as the top, “Public Understanding and Exchange” is dependent on the middle and bottom layers, which include the LANCE data and services. Miguel concurred with David’s observations and stressed that it is important that the requirements of the EIC that flow down to the NASA data and service providers be clearly understood, captured, and communicated.

18. Worldview and GIBS Update

Ryan Boller, Minnie Wong, NASA/GSFC

Minnie began with a brief introduction on Worldview - an open source web mapping application; GIBS – a set of fast and open services providing access to over 1000 NASA imagery products; and Worldview Snapshots – a lightweight tool for creating image snapshots from a selection of popular NASA satellite imagery base levels. Minnie reviewed NRT product updates since the last LANCE UWG:

- Daily MAIAC Isotropic Kernel Parameters (vs. previous 8-day)

- Land: SNPP/VIIRS C2 L2 and NOAA-20 C2.1 L1 and C2 L2
- Atmosphere: SNPP/VIIRS V2 upgrade; NOAA-20 VIIRS V2 new layers (soon)

Upcoming product Updates: ISS/LIS vectors – full mission

As a follow-on to Nicole’s presentation, Ryan discussed Worldview’s role as a key component of the EIC. Worldview displays NRT visualizations of Earth science data in the new “Kiosk Mode” using imagery from LANCE, NOAA, and SPoRt via GIBS. The most recent NRT imagery is continuously updated in EIC’s “Earth Now” and “Air Quality” dashboards. Worldview imagery is also displayed by the “Earth News” dashboard. Worldview “tour stories” are used to explain scientific processes and natural events. Worldview was adapted for the EIC’s physical installations and the NASA Traveling Hyperwall. Ryan presented several examples of the Worldview imagery on the Hyperwall and demonstrated the Virtual Earth Information Center with an example from Earth Now.

Ryan then discussed new capabilities since the last UWG. Users can now toggle on “hidden classifications” in Worldview imagery for certain layers to gather more context. He showed an example of a sea ice visualization, clicking on view options, and toggling on Cloud Classification, which shows regions where clouds were detected. The user could conclude that the cloud’s presence is why no sea ice is apparent in areas where it was expected. Ryan offered this as a partial option for viewing QA flags. He also demonstrated a Dynamic Data Visualization of HLS, piggy-backing on some of the work done by FIRMS and the NASA IMPACT team to do false-color band combinations. These are done on-the-fly versus pre-generated. This is a direction the GIBS-Worldview team is considering going forward, especially with high-resolution, high-volume products. Ryan then provided status on migration to the cloud. Worldview migrated to the AWS cloud last year. Worldview Snapshots moved to the cloud in September, and GIBS has migrated 98% migrated as of mid-November. This should be transparent to users.

Ryan also reported on work in progress. The team is onboarding Sentinel-3A/B Corrected Reflectance as part of the Terra/MODIS continuity pilot study. They are also onboarding some OPERA products, including the Surface Disturbance product suite, and the Radiometric Terrain Corrected SAR Backscatter product. They are bringing on TEMPO Level 2 products (NO₂, Ozone, and Formaldehyde). In the future they will work with TROPICS, TROPOMI, PACE, NISAR, PREFIRE and MERIS/SeaWiFS.

Ryan discussed R&D efforts underway, including identifying optimal use scenarios for pre-generation versus dynamic generation. They are comparing frontend vs. backend rendering: when is it better for the Client to do the heavy lifting? A new team member is focusing on Machine Learning, using a Large Language Model (LLM) extract information about EOSDIS tool usage from scientific journals automatically.

Future work under consideration includes the integration of AERONET sites into Worldview. AERONET has requested this linkage as a way for users to compare satellite data with insitu measurements. The team is also evaluating the feasibility of adding external products to

Worldview – allowing users to bring their own data, be it raster products, shapefiles, web services (e.g., WMS).

Ryan presented an example of scientific use of Worldview, from Leslie Ott's team at GMAO. During an airborne campaign looking at carbon measurements over the Midwest, they saw what they thought was an anomaly in OCO-2 data, because it did not show up in the airborne measurements. But when they compared it with the MODIS and VIIRS imagery, observed a smoke plume that was caused by a fire on a parcel of farm land. They included this story in their paper.

Ryan concluded with several examples of usage of Worldview imagery in media, particularly related to natural events.

Considerable discussion followed Ryan's presentation. Crystal Schaaf raised her concern regarding exposing QA flags in the NRT products used to generate LANCE imagery. Crystal's view is that with users leaning on Worldview so heavily, the QA flags need to be available. Arlindo observed that it might be necessary to simplify them, as they can be quite complex, especially for more casual users. Ryan recommended a requirements gathering meeting be organized. Sudipta Sarkar/MODAPS recommended that careful consideration be given to determining which flags should be exposed, as different products have different levels of QC flags – should they be abstracted at some level? He also pointed out that there will be some level of effort required and a better understanding of level of effort versus utility to users is needed. Sudipta seconded Ryan's recommendation for a meeting. Miguel agreed with this recommendation. He cautioned about ensuring the QA flags exposed in Worldview correspond to the NRT product used to generate the imagery – avoid mixing and matching quality flags across standard and NRT products. He argued against generalizing too much, which could result in deciding on thresholds that are subjective. The QA teams need to decide which quality flags should be provided, but it will be up to users to interpret them for their application areas. He also warned to bear in mind the importance of reproducibility, and how that could be impacted by selective use of QA flags. He observed that there are already MODIS QA layers in Worldview, and proposed an action item to the UWG to recommend other NRT products for which quality flags should be generated. At the start of the discussion, Crystal mentioned concerns about HLS Surface Reflectance, which is caused by clouds from the Landsat products. Miguel acknowledged the issues with HLS, and agreed that there is a need to get Surface Reflectance at a basic level of quality. But it is complicated by multiple players (USGS, IMPACT, Worldview), not just a single science team, and a solution will require greater participation. It is a separate activity from MODIS and VIIRS in Worldview.

Ed Hyer stressed that metadata is a vital aspect of the challenge to determine which QA flags should be exposed. He observed that the Worldview tool needs to be considered in development of metadata standards, because Worldview is now a "real destination" for systematic translation of quality flags. Up to this point, the metadata standards for quality flags have been understood to be used by expert users – now we have a system that can automatically process and utilize the flags on a public facing site. Ed's view is that the metadata

teams need to set standards for how the products and metadata are designed, so that tools like Worldview can be readily integrated and use. To summarize, Ed is a proponent of Worldview, but believes the metadata standards for quality flags need to be updated, so they can be used without a great deal of manual interaction and engineering.

19. STREAM: Satellite-based analysis Tool for Rapid Evaluation of Aquatic Environments Nima Pahlevan, SSAI, Freshwater Sensing Team, NASA/GSFC Code 619

Nima briefed the UWG on STREAM, a web-based NRT water-quality monitoring system that began in 2017, out of a NASA Water Quality Workshop supported by NASA HQ Applied Sciences. The representatives came from various water quality sectors, including Public Health, Army Corps of Engineers, EPA and NOAA. The goal was to build a system using Landsat-8/9 and Sentinel-2 data to monitor water quality and provide some visualization tools. It was requested by NASA HQ to support the UN EO STG-6.3.2 for Water Quality Monitoring, allowing nations to report on their water quality conditions. STREAM is based on FIRMS and the Flood Mapping project, and is intended to be complementary to other systems, by focusing on narrow aquatic ecosystems. STREAM is producing 20-meter resolution products, with a latency of 3 to 6 hours, including:

- Chlorophyll-a (Chla), an indicator of biomass and water column
- Total suspended Solids, an indicator of inorganic concentration
- Secchi Disk depth (Zsd), the fundamental water transparency measure

There will be downloadable Geotiff maps, visualizations, and time-series analyses (daily/weekly/monthly) on a per-pixel basis as well as area-based (lake-wide). There will also be a notification system. STREAM was released to Early Adopters (Water Authority of Peru and Ministry of Environment in Uruguay) in early 2021. Stakeholder targets for STREAM are:

- Water utilities (e.g., minimize disinfection byproducts)
- Aquaculture/Fisheries (site identification, operations and restoration)
- Ecosystem monitoring (e.g., Harmful Algal Blooms)
- Sustainable development goals (proportion of waterbodies with good ambient water quality)
- Science:
 - Carbon cycle and ecosystem
 - HAB-related studies
 - Forecasting and Modeling

A study based on results from the Early Adopters was published and a significant finding was the need to develop an Atmospheric Correction process for STREAM, as this was the main source of uncertainty in the entire processing workflow. Aquaverse was developed based on ML/AI models. An extensive validation process to verify reflectance products over water has been conducted using Aeronet ocean color instruments as well as field campaign data. Nima presented comparative charts verifying a significant improvement in the quality of the Surface

Reflectance products was achieved. The median uncertainties were within the 30% (the community-recommended threshold). This increased the team's confidence in going public with STREAM. Besides quantitative assessments from in-situ observations, cross-validation with other well-known map products (SeaDAS, POLYMER, ACOLITE) has shown consistency. STREAM also provides pixel uncertainties by percentage, providing confidence about how and where the model performs, and allowing masking of uncertain pixels to provide the most accurate and reliable products.

Nima was asked to address how STREAM complements and fills the gaps with other services. The most well-known system is Cyanobacteria Assessment NetWork (CyAN), jointly funded by NOAA, EPA, NASA, and USGS, based upon Sentinel-3 OLCI observations. It is very effective at detecting HABs, and has successfully gained the user community's trust. However, it only covers < 6% of US in-land waterbodies, and only ~50% of US estuaries, thus not adequate regarding spatial resolution. Data from Landsat and Sentinel-2 would complement the coverage of CyAN. It also has not been rigorously/statistically validated with global in situ data, since it is intended for high biomass conditions and detecting presence versus absence. It's detection limit is restricted to impacted areas. For example, Nima included a CyAN image of the Utah Lake, where most of the pixels were black (did not contain any information) as the chlorophyll-a was < 10 mg m⁻³. CyAN is limited to CONUS, whereas STREAM aims to provide global coverage. There are a few other similar services, (e.g., Freshwater Explorer, Copernicus Global Land Service) but they are not rigorously validated and do not provide information about uncertainties. Nima also provided comparisons of coverage of inland water bodies in the U.S. by Sentinel-3 OLCI versus Landsat OLI, clearly showing the need for data from Landsat and Sentinel-2. Nima also presented histograms indicating the annual cost avoidance with OLCI (\$2 – 4 Million) versus OLI (\$20 – 70 million).

Nima summarized that STREAM is based on over six years of R&D, offers globally validated products, supported by over 15 peer-reviewed articles describing and validating the STREAM workflow. Results will be published in a scientific journal in early 2024. Validation continues, assembling more data across the globe, reprocessing with the Aquaverse engine is underway, and the web interface is being revamped to improve performance and functionality. The STREAM team anticipates gradual public release by World Water Day (March 22, 2024) with full coverage of select regions of the U.S., and full coverage of Peru and Uruguay. STREAM has benefited from funding from a variety of sources, including the UN Earth Observation for Sustainable Development Goals (EO4SDG). There has been strong support from the USGS Landsat Science Team, and NASA HQ Program Managers (e.g., Jared Entin, Laura Lorenzoni, and Woody Turner), who have funded STREAM through various related programs, e.g., Ocean Biology and Biogeochemistry (OBB), ROSES 2021 Remote Sensing Water Quality (RSWQ) and PACE. The STREAM team is preparing a LANCE enhancement request for submission to the UWG. Nima's recommendation for archiving the products is with HLS. Nima concluded by pointing out that the Aquaverse processing system is transferable to other missions. One example is the PACE Science Data System, which will be using the Aquaverse code base to process coastal/freshwater swaths.

Miguel observed that Nima’s charts on cost avoidance are very relevant and increasingly important. The NASA Chief Financial Officer has asked that justifications for funding going to Congress include statements on how science processing costs actually result in taxpayer savings. Miguel then asked a rhetorical question: With all the support from NASA HQ Program managers and major stakeholders, and Nima’s prominent role on several relevant science teams, what could prevent STREAM from getting through the LANCE UWG Enhancement Request process? Nima appreciated Miguel’s endorsement, but pointed out that while they are still being supported by the ROSES 21 RSWQ, the Landsat and PACE science teams have ended, EO4SDG has completed, and OBB funding is ending. They will continue submitting proposals to continue funding. Nima asserted that STREAM will be a game-changer for aquatic ecosystems, and that there is considerable anticipation from the stakeholder communities for water quality products at the STREAM resolution and 2-3 day revisit rate.

20. Updates from the Satellite Needs Working Group (SNWG)

Pontus Olofsson, SNWG Management Office, NASA/MSFC

Pontus introduced the SNWG, which is a U.S. Government effort involving multiple agencies, specifically NASA, USGS, and NOAA. Gerald Bawden is the NASA Headquarters Science lead for SNWG. The working group’s purpose is to understand and respond to the remote sensing needs of other Federal agencies. Solutions leverage either existing or future satellite missions. There is a Biennial Life Cycle with nine stages, depicted below:

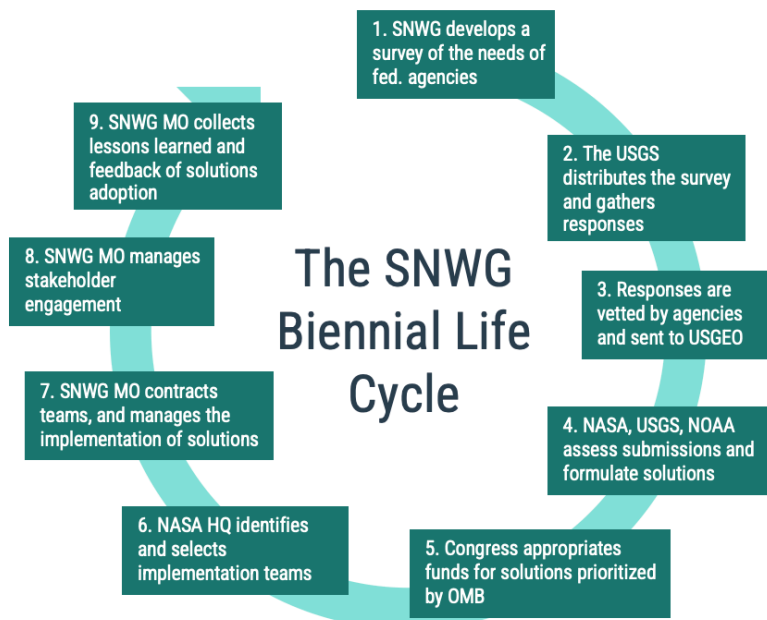


Figure 1: The SNWG Biennial Life Cycle

The first SNWG cycle began in 2016, and has continued with the fourth and current cycle of 2022. The USGS distributes the surveys to the federal agencies and collects the responses. The responses are vetted by the U.S. satellite agencies, and the results are forwarded to USGEO (step 3). Step 4 is assessing and formulating potential solutions by NASA, USGS and NOAA, which is an extensive effort, involving dozens of interviews with representatives of the requesting agencies. The 2022 cycle assessment recently completed, had a significant increase in lower latency requests (daily/sub-daily observations, with 27% needing data within 3 hours or less of observation.) Eighty solutions were formulated, with prioritization and cost estimates presented to OMB, for which decisions are pending. The next, fifth stage is appropriation of funds by Congress based on OMB recommendations. NASA HQ then identifies and selects the implementation teams, which has been done for the 2016, 2018 and 2020 cycles. The SNWG Management office contracts the implementation teams, and manages the implementation process and stakeholder engagement (Steps 7 and 8). Implementation schedules are typically five years from solution formulation to operations. Three of the four solutions from the 2020 cycle are related to Air Quality and Atmospheric Science, one of which is the TEMPO NRT products (relevant to LANCE). The NASA Short-term Prediction Research and Transition (SPoRT) Center at MSFC has been managing the stakeholder engagement for these three 2020 cycle solutions. The final step (9) involves feedback and lessons learned to improve the process on future cycles.

Pontus summarized NRT solutions from previous SNWG cycles:

- Cycle 2018: ICESat-2 Quick Look products over the Great Lakes, producing products within 3 days of observation (in comparison to 45 days for standard products), distributed by the NSIDC, and discoverable via LANCE
- Cycle 2020 : TEMPO/GOES near real-time and enhanced products. Contracting is underway with the Smithsonian Astrophysical Observatory:
 - NRT L1B, 1 – 1.5 hours to enable NOAA to produce NRT Aerosol product
 - OE-02 Cloud, 1.5 – 2 hours
 - NO₂, 2 - 3 hours
 - HCHO, 2 – 3 hours

NASA is interested in distribution via LANCE, but this needs to be coordinated through a formal process with the other partners.

Pontus provided insight into potential 2022 SNWG Cycle Solutions, which are pending appropriation requests by OMB. Two NRT solutions are of particular interest and highly recommended to OMB by NASA leadership:

- TEMPO/GOES NRT and enhanced products;
 - Hourly SO₂ concentration (the only NRT product)
 - Adapt established algorithms from NASA's OMI to produce additional trace gas measurements from TEMPO (UVAOD, aerosol height, H₂O, UVB, CHOCHO, and BrO)

NASA is interested in distribution by LANCE, but as with above, will need to go through a formal decision process with partners

- Low-Latency HLS (< 6 hours) using NRT VIIRS data – NASA is interested in distribution via LANCE (most likely a secondary product, in addition to the HLS science product)

Miguel observed that Landsat science algorithms are based on Terra MODIS and other coarser observations to enhance the Atmospheric Correction. But he questioned how the HLS low latency product could be produced using VIIRS data from an afternoon orbit (whereas Landsat crosses the equator in the morning)? Pontus acknowledged that one possible approach would be not to do Atmospheric Correction. Miguel expects the community consensus to maintain continuity by replacing Terra MODIS with Sentinel-3, not VIIRS. At the Senior Review, USGS stated they could not generate Landsat products without Terra MODIS or an equivalent product from a morning orbit.

Steve Miller asked about how the SNWG fits in with the Decadal Survey. He views the SNWG process to get cross-agency requirements as a very positive initiative, and suggested that the SNWG survey results could be fed into the Decadal Survey. Cerese thanked Steve for his comments, and pointed out that the SNWG is one of four working groups that the USGEO relies upon. SNWG is targeted specifically at how NASA and other space observation partners can serve other agencies' needs. Through the SNWG process, many needs are identified, including some that are beyond the scope of the SNWG (which is aimed at meeting needs through current or future planned capabilities). But NASA book-keeps these needs, and has been keeping track of trends through the four cycles to date. The SNWG results are also provided to the Senior Review. Cerese pointed to TEMPO as a good example of how the SNWG process works. TEMPO was a cost-capped mission. The specific TEMPO NRT requirements that came from the SNWG were dealt with as separate, new requirements. But she also cautioned that the SNWG should not be viewed as a path to scope growth for a mission. Miguel added to Cerese's characterization of the TEMPO NRT requirements coming out of the SNWG. He observed that NOAA has publicly stated that the TEMPO NRT data is critical for risk reduction of GEO-XO. Miguel also commented that instead of the Flight Projects or ESTO, ESDS has been the advocate of user requirements for NRT data from new missions, to make the missions as helpful as possible. Cerese has been urging the ESO missions to focus on applications, but gets pushback that it is too early for them to determine and commit to NRT requirements.

21. Closing Remarks

Karen thanked the speakers for excellent presentations, and observed that there was significant, useful discussion, that can be hard to achieve during a virtual meeting. She also expressed her appreciation for the participation of NASA Headquarters, particularly Cerese, in the meeting. Diane and Jenny concurred and said there would be action items resulting from the discussions. Karen thanked Miguel for his exceptional leadership, Diane and Jenny for their organizational skills and efforts to make the meetings so productive, and the rest of the attendees for their participation. Miguel thanked the UWG members for their service, and observed that transformational changes are going on within the NASA Earth Science program that all need to embrace and support.

22. Actions and Recommendations

1. The Geostationary Aerosol Enhancement Request is still pending and should be considered by NASA HQ in FY24
2. Minnie to forward request for VIIRS aerosol product polar projection to Jess to discuss with Liam Gumley.
3. Coordinate with PIs to generate brief summaries for the UWG regarding their plans for potential new NRT products resulting from ROSES 2020 A.33.
4. FIRMS should continue to explore a path to generate a VIIRS NRT Burned Area product.
5. Consider generating two TROPICS 'applicability' case studies, given the relevance particularly to underrepresented countries, with examples generated using: a) atmospheric rivers and b) early warning systems. Note: Ryan Bollar thought visualization of atmospheric rivers would make a good Worldview Story Tour.
6. Colin Seftor is encouraged to submit LANCE UWG enhancement request for NRT OMPS Limb Profiler aerosol products, with backing from at least two NASA HQ program managers.
7. Miguel recommended a wide assessment/analysis of issues tied to continuity be undertaken, with a specific focus on the AI product from OMPS/OMI.
8. Consider archiving the historic flood product as an interim solution in addition to the NRT archive at LAADS/the LANCE MODIS-VIIRS element.
9. Miguel recommended the NISAR project be contacted to articulate the need for a Flood validated standard product.
10. Contact Sean Helfrich about NOAA plans regarding Flood product archive
11. Explore with NISAR project the need for a Flood validated standard product.
12. Consider documenting/writing a paper on what should be included with a standard Flood Product (i.e. not just a count but a contribution to a more nuanced understanding the legacy of flood conditions).
13. Follow-up with EIC Project Management, LANCE/Worldview leadership, and other parties (Data Visualization Lab?) to ensure the dependencies of the EIC on LANCE data are well understood .
14. Gather requirements on what QA flags should/could be available in Worldview in both NRT and standard products (action for GIBS/Worldview, MODAPS and key science team members)
15. Nima Pahlevan is encouraged to submit a LANCE UWG enhancement Request.

Appendix 1: List of other participants

Name	Attendee Email
Aaron Kaulfus	aaron.s.kaulfus@nasa.gov
Angela Li	angela.w.li@nasa.gov
Bandana Kar	bandana.kar@ee.doe.gov
Bruce Mclemore	bruce.d.mclmore@nasa.gov
Carol Davidson	carol.c.davidson@nasa.gov
Cerese Albers	cerese.m.albers@nasa.gov
Christina Moats-Xavier	christina.d.moats-xavier@nasa.gov
Christine Sadlick	christine.e.sadlik@nasa.gov
Colin Seftor	colin.seftor@ssaihq.com
Crystal Schaaf	crystal.schaaf@umb.edu
Dan Kahn	daniel.kahn@ssaihq.com
Dan Slayback	dan.slayback@nasa.gov
Dan Ziskin	ziskin@ucar.edu
David Green	david.s.green@nasa.gov
Dawn Lowe	dawn.r.lowe@nasa.gov
Diane Davies	diane.k.davies@nasa.gov
Ed Hyer	Edward.Hyer@nrlmry.navy.mil
Fred Stolle	fstole@wri.org
Hazem Mahmoud ASDC	hazem.mahnmoud@nasa.gov
Jenny Hewson	jennifer.h.hewson@nasa.gov
Jennifer Wei	jennifer.c.wei@nasa.gov
Joanne Hall	jhall1@umd.edu
Karen Michael	karen.a.michael@nasa.gov
Karl Rittger	karl.rittger@colorado.edu
Leigh Sinclair	slb0012@uah.edu
Lisa Kaser	lisa.kaser@colorado.edu
Louis Giglio	lgiglio@umd.edu
Minnie Wong	min.m.wong@nasa.gov
Nga Chung	nga.t.chung@jpl.nasa.gov
Nicole Ramberg-Phil	nicole.c.ramberg-pihl@nasa.gov
Nima Pahlevan	nima.pahlevan@nasa.gov
Otmar Olsina	otmar.olsina@nasa.gov
Phil Durbin	phillip.durbin@nasa.gov
Pontus Olofsson	olofsson@bu.edu
Ranjay Shrestha	ranjay.m.shrestha@nasa.gov
Ryan Boller	ryan.a.boller@nasa.gov

Sadashiva Devadiga	sadashiva.devadiga-1@nasa.gov
Sudipta Sarkar	sudipta.sarkar@nasa.gov
Tandi Vettel	tandi.vettel@nasa.gov
Terri Wood	terri.wood-1@nasa.gov
Tandi Vettel	tandi.vettel@nasa.gov
Tian Yao	tian.yao@nasa.gov
William Straka	wstraka@ssec.wisc.edu
Yaromyr Zinkewych	yaromyr.a.zinkewych@nasa.gov
Zhaouhi Zhang	zhaohui.zhang@nasa.gov