LANCE User Working Group Meeting Summary

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The Land, Atmosphere Near real-time Capability for EOS (LANCE) User Working Group (UWG) held its fourth annual meeting at NASA's Goddard Space Flight Center (GSFC) and via WebEx, on September 23, 2014. LANCE is the near-real-time (NRT) component of the Earth Observing System Data and Information System (EOSDIS); it provides data and imagery from the Aqua, Terra, and Aura spacecraft to various end users—including the applications user community, scientists, and operational agencies. Summaries of the previous LANCE workshops can be found in previous issues of *The Earth Observer*[1] and at *earthdata.nasa.gov/data/nrt-data/user-community/user-working-group-uwg*.

The LANCE UWG is composed of a representative selection of LANCE users who help steer the development of the LANCE program. In addition to UWG members, others who attended the meeting represented NASA Headquarters (HQ), the Earth Science Data and Information System (ESDIS), the LANCE elements[2], and other data providers. The purpose of the meeting was to review the status of LANCE and the progress made on previous UWG recommendations, and to identify and discuss potential enhancements and upgrades to the LANCE system.

Kevin Murphy [GSFC, ESDIS] opened the meeting, welcoming the attendees and identifying the scope and objectives of the meeting. **Chris Justice** [University of Maryland, College Park—*LANCE UWG Chair*] reminded the group that the UWG's role is to provide community feedback and guidance to LANCE, and that this could be done verbally at the meeting or by e-mail. Justice commented that LANCE has a strong applied science component and is an important part of NASA's data systems. Justice stated that some EOS instruments are getting old and that with new missions coming online, such as the Suomi National Polar-orbiting Partnership (NPP) and Soil Moisture Active Passive (SMAP), there are opportunities to broaden the NRT capability to these instruments. He encouraged attendees to consider new NRT applications from new missions, as well as providing continuity for existing products. To date, LANCE products have had a strong science algorithm heritage and associated maturity and are supported by NASA Science Teams. As LANCE transitions to new instruments, Justice suggested that the group should evaluate this approach, recognizing that product quality control is important and that LANCE needs to find a way to ensure continued support for any product enhancements.

Lawrence Friedl [NASA HQ—*Director of the Applied Sciences Program (ASP)*] introduced **David Green** [NASA HQ] as the new ASP Disasters Program Manager; he will also be the new LANCE Program Scientist. Friedl commented on the importance of LANCE to the ASP, echoing the perspective of the Applied Sciences Advisory Committee (ASAC), which released a report in May 2014 commenting that a constant and overriding theme throughout the ASAC meetings was the growing importance of applications to NASA's core mission—a natural outcome of NASA's multidecade commitment to understanding Earth from space.

Looking forward, Friedl said preparations are underway for the second Earth Science Decadal Survey, the first having been published in 2007. He estimated the publication release would be scheduled for 2017, which would require community input by 2015. As part of the preparations for the decadal survey, an *ad hoc* committee will review the needs for continuity of NASA-sustained remote sensing observations of the Earth from space[3]. He suggested the UWG should review the findings of this committee and make the case for continued NRT access from new missions as appropriate.

Friedl emphasized the need for early input on mission design to enable NRT access. As NASA has recently signed an agreement to distribute some data from the European Commission and European Space Agency (ESA) partnership's Sentinel[4] series of satellites, Friedl also suggested that the UWG might consider what NRT products they would like to see from future Sentinel satellites, as NASA will be distributing some of these data.

Reflecting on these comments, the discussions within the UWG acknowledged that LANCE is on track to expand beyond EOS—and beyond land and atmosphere data—and that an assessment of NRT data needs and the associated instrument and data systems requirements need to be addressed early in mission planning. The composition of the UWG will need to

[1] The most recent LANCE UWG was summarized in the September-October 2013 issue [**Volume 25, Issue 5**, pp. 17-20].

[2] The LANCE elements provide expedited processing using special algorithms for near-real-time processing. More information is available at *earthdata.nasa.gov/about-eosdis/science-system-description/eosdis-components/lance*.

[3] To review the framework for analyzing these needs, visit *sites.nationalacademies.org/SSB/CurrentProjects/SSB_084713.htm*.

[4] To learn more about the Sentinel missions please see "An Overview of Europe's Expanding Earth-Observation Capabilities" in the July–August 2013 issue of *The Earth Observer* [**Volume 25**, **Issue 4**, pp. 4-15].

be revisited, or augmented, to provide guidance for new NASA data systems coming online. **Jeanne Behnke** [GSFC, ESDIS] suggested that the UWG might revisit the definition of NRT. As new applications and datasets become available, the definition could be expanded based on user needs for data prior to science data availability, rather than just "three hours after acquisition," which is the current LANCE latency requirement.

Diane Davies [GSFC, ESDIS—*LANCE Operations Manager*] gave an overview of LANCE's status, actions, and accomplishments. She reported that LANCE is operating well within its three-hour latency requirement and that the number of users and the amount of NRT data and imagery downloaded continues to rise. Since October 2013 there has been a three-fold increase in the NRT product downloads from Global Imagery Browse Services (GIBS), a core EOSDIS component. In July 2014 LANCE started generating new Vegetation Index (VI) and Surface Reflectance (SR) products, following requests from the dust modeling and agricultural monitoring communities. The new Moderate Resolution Imaging Spectroradiometer (MODIS) products are a daily eight-day rolling VI product, which includes both Normalized Difference Vegetation Index (NDVI) and Enhanced Vegetation Index (EVI), and an eight-day rolling SR product. She also stated that LANCE is continuing to prototype secure http (*https)* data distribution, and that the LANCE Core Requirements are being revised in the Configuration Management EOSDIS Tool (COMET). The intent is to make the core document more generic, with separate appendices to manage information specific to each element. This modular approach will enable new sensors to be added to LANCE more easily. Davies also reminded the group that in 2013 EOSDIS initiated an American Customer Satisfaction Index (ACSI) Survey to assess customer satisfaction with LANCE. She reported that overall, the satisfaction rate among LANCE users was high, with a baseline score of 78[5]. A second ACSI survey will be conducted in the fall of 2014.

Kathryn Regner [University of Alabama in Huntsville] reported that LANCE is working to provide NRT data from the Advanced Microwave Scanning Radiometer 2 (AMSR2) instrument onboard the Japan Aerospace Exploration Agency's (JAXA) Global Change Observation Mission – Water (GCOM-W1). Regner provided an update on progress, stating that Level 1R (resampled) data are ingested from JAXA and that the U.S. AMSR2 Science Team is providing preliminary algorithms. So far, two algorithms are ready for testing: a Snow Water Equivalent (SWE) algorithm and a GSFC Profiling (GPROF2010) retrieval code for NRT AMSR2 precipitation and nonraining parameters. The first NRT AMSR2 products likely will be made available in early 2015, subject to products being approved by the Science Team.

Feng Ding [GSFC] provided an update on Aqua's Atmospheric Infrared Sounder (AIRS) and Aura's Microwave Limb Sounder (MLS). Both instruments are stable, with the exception of a single event upset that caused a loss of AIRS data for about one week in March 2014. Ding highlighted a study that demonstrated the contribution of NRT AIRS data in successfully predicting Hurricane Sandy, via numerical models.

Phil Durbin [GSFC] said that Aura's Ozone Monitoring Instrument (OMI) experienced a row anomaly around August 13, 2014, effectively blocking another 6 (out of 60) pixels in the part of the orbit greater than 50° N latitude. Unfortunately, this means that OMI cannot be used to monitor volcanic eruptions such as that from the Bardabunga volcano currently active in Iceland. An improved product that measures sulfur dioxide (SO_2) loads in the planetary boundary layer (PBL) should be available by mid-October 2014.

Ed Masuoka [GSFC] provided an update on MODIS Collection 6 (C6) reprocessing. Testing and reprocessing of atmosphere products are complete for Aqua, and almost complete for Terra. For land products, C6 Product Generation Executables (PGEs) are currently being prepared for NRT delivery, and expected to be operational within six months after the start of reprocessing at the MODIS Adaptive Processing System (MODAPS). Unless advised otherwise by the Science Team, all C6 PGEs will be run in parallel with Collection 5 (C5) version for one year to allow applications users time to make the transition to the new collection. Additional resources are being added to meet the latency requirement and the needed redundancy. Masuoka said that overall, MODIS NRT products are being generated within two hours of data acquisition for most Level 2 (L2) products, but latency varies for Level 3 (L3) products, ranging from 12-18 hours.

Crystal Schaaf [University of Massachusetts, Boston] and **Zhuosen Wang** [GFSC] provided an update on the rolling NRT Bidirectional Reflectance Distribution Function (BRDF) product that was requested at the May 2013 LANCE UWG to support worldwide air quality and atmospheric modeling communities. The NRT BRDF/Nadir BRDF-Adjusted Reflectance (NBAR)/Albedo algorithm is derived from the current (i.e., V006) MODIS algorithm (*MCD43*) and will be made available after the MODIS C6 NRT forward processing begins. There will be small differences between the NRT and the standard product due to the temporal weights applied to the algorithm. The NRT version emphasizes the last most recent day of the eight-day

[5] This score is on par with other information providers that have taken similar surveys, and is 10 points above the Federal Government average.

period, whereas the standard product will emphasize the middle of the day.

Louis Giglio [University of Maryland] presented a request to include per-pixel geolocation coordinates in the NRT Thermal Anomalies and Fire Algorithm (*MOD14*), as this would be useful for a range of NRT application users. The C6 MODIS fire code can optionally append geolocation layers (e.g., latitude and longitude) to swath products via a command-line switch. File sizes would be larger; however, as the NRT archive is a rolling archive, this would not have any significant impacts on production or hardware. The UWG approved this request.

Lalit Wanchoo [GSFC, ESDIS] presented an overview of the EOSDIS Digital Object Identifiers (DOIs) process[6], followed by a discussion in which the UWG was asked to consider whether they would recommend that DOIs be adopted for NRT data. DOIs are generally assigned to data products that are to be archived for a long time to ensure that data users can retrieve the data using DOIs cited in literature. Short-lived data products do not usually get DOIs, as the exact data product will not be available until after the data have been deleted. However, the UWG agreed that DOIs promote discoverability, accessibility, and reproducibility, and would help users distinguish between NRT and Standard Science Quality datasets. The UWG agreed there is no intent to archive NRT data. The UWG recommended DOIs be assigned to NRT datasets.

Kevin Murphy highlighted a number of updates from EOSDIS that are relevant to LANCE, as LANCE leverages a number of existing EOSDIS components, including the Earthdata website (*earthdata.nasa.gov*), the User Support Tool, and the User Registration System (URS).

Andrew Molthan [NASA's Marshall Space Flight Center] commented that finding data using LANCE is very easy and user-friendly; however, finding tools to process the data is more complicated. **Kevin Murphy** added that the Earthdata Code Collaborative (ECC) should make this easier—but there are some legal issues that have to be considered for tools not developed by NASA. He added that the provenance of science products is recorded through the algorithm theoretical basis documents (ATBDs), and that a similar approach should be sought to capture provenance for tools and nonscience products such as true-color images.

Pamela Rinsland [NASA's Langley Research Center, Atmospheric Science Data Center] presented an update on progress to make NRT Multi-angle Imaging SpectroRadiometer (MISR) data available. MISR NRT L2 winds products are available as HDF and BUFR files through OPeNDAP[7], within 2 hours and 20 minutes of satellite overpass time. Steps are underway to make the data available through LANCE.

Dan Slayback [GSFC] provided an update on how LANCE NRT data are being used for global flood mapping. The product is proving to be very useful to a wide range of organizations, but some improvements still need to be implemented before the product is considered to be robust enough for transition to an operational partner. These include a seasonal water layer to better identify floods, and better identification of terrain and shadow as they can be misclassified as flooded land. More information can be found on GSFC's Office of Applied Science (OAS) website at *oas.gsfc.nasa.gov/floodmap*.

Andrew Molthan reported that the Short-term Prediction Research and Transition Center (SPoRT) makes extensive use of LANCE products for weather, climate, and disaster applications—see *LANCE Data Being Used by NASA's SPoRT Center to Identify Hail or Tornado Damage* on page 40[8]. Molthan commented that SPoRT highly values the streamlined Applications Programming Interfaces (APIs) that allow for global search and acquisition of MODIS products. Futhermore, SPoRT would like to see these capabilities extended to Suomi NPP datasets and other NASA missions such as the Global Precipitation Measurement (GPM) mission. He said SPoRT applications that make use of data from Suomi NPP and GPM continue to grow, and there are plans to use data from the SMAP missions. LANCE-like data access would therefore be beneficial. SPoRT is highly interested in developing closer, collaborative partnerships to test and evaluate new LANCE capabilities for Suomi NPP, GPM, and other instruments. Reflecting on the presentation, the UWG considered the challenges of managing NRT products with varying levels of maturity, developed without NASA Science Team heritage; this is something LANCE has not dealt with in the past, but may need to consider moving forward.

Alfreda Hall [GSFC—*ESDIS Science Data Segment Manager and Suomi NPP Manager*] gave an update on Suomi NPP. Hall stated that it is too early to know which NASA NRT products will be produced from Suomi NPP data; it is anticipated more will be known in mid-November 2014. It was estimated that global Suomi NPP products would not be available before late

[6] To learn more, please see "Digital Object Identifiers for NASA's Earth Observing System" in the September–October 2012 issue of *The Earth Observer* [**Volume 24**, **Issue 5**, pp. 10-15].

[7] HDF stands for Hierarchical Data Format and BUFR stands for Binary Universal Form for the Representation; both are common file types for Earth science data. OPeNDAP stands for the Open-source Project for a Network Data Access Protocol, and is a well known data transport architecture and protocol widely used by Earth scientists.

[8] To learn more about SPoRT, please see "Transitioning NASA Earth-observing Satellite Data to the Operational Weather Community" in the May–June 2013 issue of *The Earth Observer* [**Volume 25**, **Issue 3**, pp. 4-11].

2015, but that the Direct Readout Laboratory (DRL) would provide an interim source for nonglobal products. It was agreed that the UWG should consider ways to fast-track products to LANCE when they are ready.

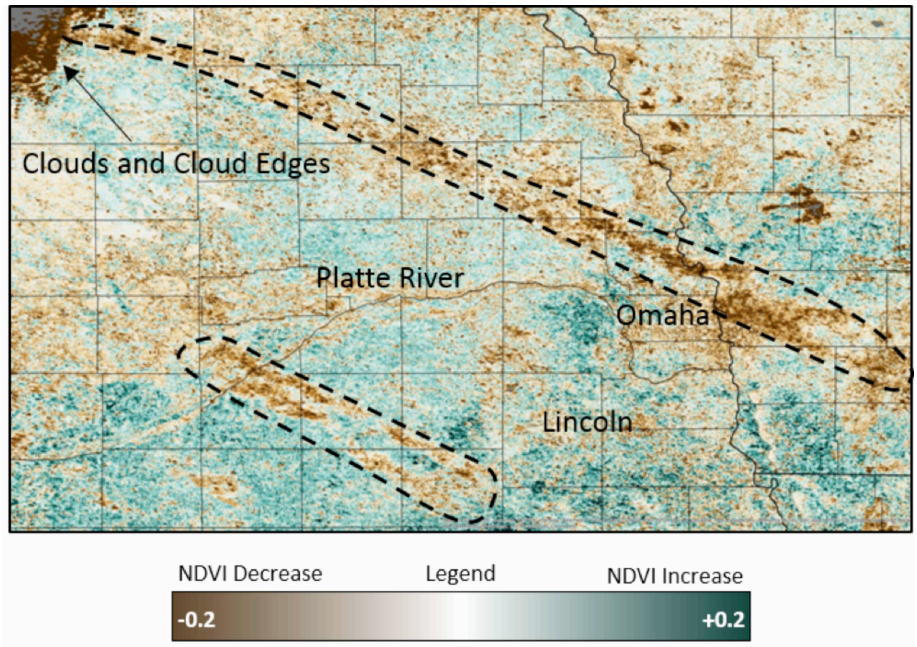
Kevin Murphy informed the group that NASA ESDIS would become a distribution hub for data from the Synthetic Aperture Radar onboard ESA's Sentinel 1. NASA will develop a Sentinel Data Gateway, which will pull Level 1 data from the Copernicus Data Hub. Sentinel 1 data will not be distributed in NRT.

Chris Justice closed the meeting by saying that overall, LANCE is doing well and has good visibility. LANCE seems to be coming to a turning point where it will move beyond EOS data; in the short term, this will include data from Suomi NPP and SMAP. Justice suggested the UWG look at possible NRT applications from Suomi NPP and suggested we invite a science team lead for SMAP to the next LANCE UWG meeting to highlight SMAP NRT applications. Justice ended by summarizing the UWG recommendations:

- The UWG should provide input in to the upcoming Decadal Survey on Earth Science;
- add per-pixel geolocation coordinates to the NRT Thermal Anomalies and Fire product (*MOD14*);
- create DOIs for LANCE data;
- meet the LANCE core requirements to enable NRT MISR to be distributed through LANCE; and
- explore which planned NASA Suomi NPP Science Products could have a NRT equivalent and could be made available through LANCE. ■

LANCE Data Being Used by NASA's SPoRT Center to Identify Hail or Tornado Damage

NASA's SPoRT is a long-term user of LANCE data to provide NRT information for weather and disaster applications where direct broadcast MODIS data are unavailable. Recently, SPoRT started using NRT MODIS observations to identify short-term NDVI change following severe weather to show hail or tornado damage scars when corroborated with other storm information. This information is provided to the National Weather Service Damage Assessment Toolkit for use in the field.



Using data from LANCE, SPoRT created this image showing hail damage scars across Nebraska. The image was created using NRT Surface Reflectance data from Terra that were used to create a 14-day maximum NDVI composite ending in June 10, 2014. The image shows the difference between NDVI observed on June 11, 2014 and the previous 14 days ending June 10. Contiguous areas of NDVI decrease (darkest browns) are oriented from northwest to southeast along the paths of severe thunderstorms from June 3 that produced widespread wind damage and damage from hail up to 4.25 in (~10.8 cm) in diameter in parts of eastern Nebraska. Portions of the hail swaths are apparent in the days immediately following the storms; however, results from June 11 are shown here as the area was generally cloud-free.