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Editor's Corner

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At present, there are nearly 22 petabytes (PB) of archived Earth Science data in NASA's Earth Observing System Data and Information System (EOSDIS) holdings, representing more than 10,000 unique products. The volume of data is expected to grow significantly—perhaps exponentially—over the next several years, and may reach nearly 247 PB by 2025. The primary services provided by NASA's EOSDIS are data archive, management, and distribution; information management; product generation; and user support services. NASA's Earth Science Data and Information System (ESDIS) Project manages these activities.[1] An invaluable tool for this stewardship has been the addition of Digital Object Identifiers (DOIs) to EOSDIS data products.

DOIs serve as unique identifiers of objects (products in the specific case of EOSDIS). As such, a DOI enables a data user to rapidly locate a specific EOSDIS product, as well as provide an unambiguous citation for the product. Once registered, the DOI remains unchanged and the product can still be located using the DOI even if the product's online location changes. Because DOIs have become so prevalent in the realm of NASA's Earth

[1] To learn more about EOSDIS and ESDIS, see "Earth Science Data Operations: Acquiring, Distributing, and Delivering NASA Data for the Benefit of Society" in the March–April 2017 issue of *The Earth Observer* [**Volume 29**, **Issue 2**, pp. 4-18].

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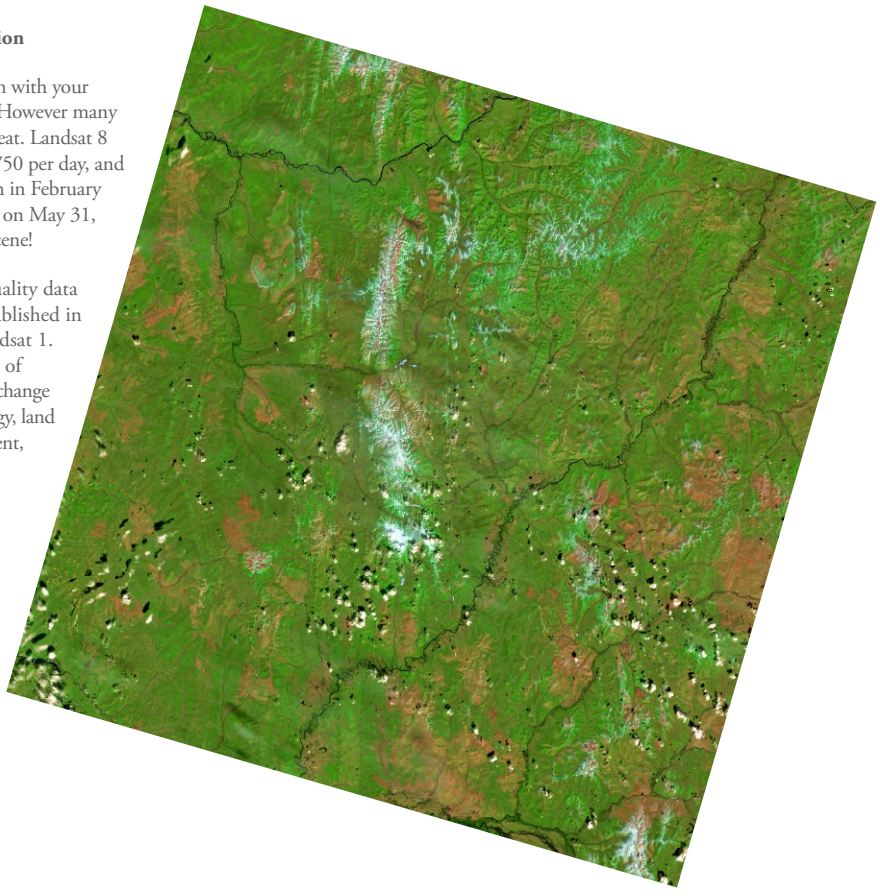
Landsat 8 Scenes Top One Million

How many pictures have you taken with your smartphone? Too many to count? However many it is, Landsat 8 probably has you beat. Landsat 8 acquires images at a rate of about 750 per day, and just a little over 4 years after launch in February 2013, the Earth-observing satellite on May 31, 2017, acquired its one millionth scene!

Landsat 8 provides the highest quality data since the Landsat archive was established in July 1972 with the launch of Landsat 1. Landsat data support a vast range of applications in areas such as global change research, agriculture, forestry, geology, land cover mapping, resource management, water, and coastal studies.



This Landsat 8 scene is located northwest of the Sea of Okhotsk, Russia, and was acquired on May 31, 2017. It is one of the first almost cloud-free acquisitions after the one millionth scene was made available for download. **Image credit:** USGS-NASA

editor's corner

In This Issue

Reminder: To view newsletter images in color, visit *eospso.nasa.gov/earth-observer-archive.*

Science data and information, an update to an earlier article in *The Earth Observer*, which described initial efforts to assign DOIs to EOSDIS data, seemed appropriate.[2] The new article (see page 4 of this issue) reviews the basic DOI structure and discusses the assignment of DOIs to EOSDIS data products.

The last two issues reported on the progress of NASA's Cyclone Global Navigation Satellite System (CYGNSS)[3]—a constellation of eight microsatellites that will provide detailed surface windspeeds in the region of tropical cyclone cores. CYGNSS launched in December 2016, and has been going through its On-Orbit Commissioning phases. On March 23, 2017, CYGNSS moved into the Science Operations phase. The spacecraft began delivering initial science data to the Physical Oceanography Distributed Active Archive Center (PO.DAAC) on May 22—just in time for the start of the 2017 Atlantic hurricane season on June 1.

Over the past several decades, forecasters have improved hurricane path prediction significantly, but their ability to predict the intensity of storms has lagged. CYGNSS will make frequent measurements of ocean surface winds in and near a hurricane's inner core—an area that up until now has proven impossible to probe accurately from space. Scientists hope these new data will lead to a better understanding of the physical mechanisms that control hurricane intensification, leading to improved models of hurricanes, and, in turn, improved intensity forecasts. Turn to page 33 to learn more about CYGNSS as it begins Science Operations, and to view some initial data collected from Tropical Cyclone Enawo.

May 4, 2017 marked the fifteenth anniversary of the launch of the EOS Aqua[4] mission. Aqua, named for its significant observations of the Earth's water cycle, far exceeded its original six year prime mission and is now entering its tenth year of extended operations. Four of its six instruments are still functioning nominally and continue to send back high-quality science data: AIRS, AMSU, CERES, and MODIS. AMSR-E suffered a major anomaly in October 2011 and was turned off until December 2012, when it was restarted but at a much slower rotation rate (2 rpm) than its original 40 rpm. With the slower rotation rate, it no longer produced high quality science data but did produce important data for cross-calibration with the AMSR2 instrument on GCOM-W1 that flies with Aqua in the international Afternoon Constellation (a.k.a., the A-Train). AMSR-E was powered off and ended its mission in March 2016. The sixth Aqua instrument, HSB,

[2] 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].
[3] To learn more, see the Editorials of the January–February 2017 and March–April 2017 issues of *The Earth Observer* [**Volume 29**, **Issues 1** and **2**].
[4] The mission was originally named PM-1, signifying its afternoon equatorial crossing time (1:30 PM/1:30 AM), to distinguish it from AM-1 (later changed to *Terra*), which has a morning equatorial crossing time (10:30 AM/10:30 PM). The "1" distinction was because early plans for EOS called for a series of identical AM and PM spacecraft, one launching every five years, so there might have been a PM-2, and so on.

collected approximately nine months of data but failed in February 2003. The science achievements of Aqua have been described in many scientific journal articles, outreach exhibits and articles,[5] websites, and so forth, over the years—too numerous to summarize here. The list continues to grow. Congratulations to the entire Aqua team–past and present–on reaching this milestone! To learn more about Aqua, visit *https://aqua.nasa.gov*. On a related note, please see the Aqua AIRS instrument News story on page 34 of this issue.

Aqua was the first mission launched into what became the A-Train. It was joined by Aura (2004), Cloudsat and CALIPSO (2006), the CNES PARASOL mission (2004–2013), the JAXA GCOM-W1 mission (2012), and finally OCO-2 (2014). Formation flying enables the missions to operate collectively as a virtual platform having near coincident science measurements. This concept lowers total mission risk, increases the overall science return, and adds flexibility to mission evolution plans. The Third A-Train Symposium was held April 19-21, 2017, in Pasadena, CA, and was an opportunity to reflect on the remarkable scientific achievements of the constellation. *The Earth Observer* plans a full report on the symposium in its July–August 2017 issue.[6]

Another venerable mission is the joint NASA–USGS Landsat 7 mission, which continues to age gracefully as it enters its eighteenth year of operations—collecting about 430 scenes a day. Because of fuel limitations, by the fall of 2020 Landsat 7's orbit will degrade to an orbital mean local time of between 9:15 and 9:30 AM, so plans are underway for the inevitable end of mission. The Landsat Science Team is making every effort to maintain eight-day coordinated imaging with Landsat 8 and the USGS is working to extend the Landsat 7 mission until the launch of Landsat 9—currently planned for 2020.

Meanwhile, Landsat 8 has been in orbit for more than four years, and continues to operate nominally—with up to 740 scenes acquired each day—see front cover image for example. The performance of the Operational Line Imager (OLI) continues to exceed requirements, and the alternate operations concept developed for the Thermal Infrared Spectrometer (TIRS) established after the 2015 scene-select mirror encoder issue is providing useful thermal imagery.

Progress is also being made toward the next member of the Landsat series: Landsat 9. Ball Aerospace and Technologies Corporation in Boulder, CO, is moving forward with detector-module testing, focal-plane assembly construction, and other fabrication activities for OLI-2. Meanwhile, GSFC is working to develop TIRS-2 and has redesigned the telescope to include baffles that mitigate the stray-light issues that impacted Landsat 8's TIRS. Orbital ATK in Gilbert, AZ, was awarded the Landsat 9 spacecraft contract; initial reviews have already been held. Launch vehicle procurement is expected this summer (2017). The Landsat 9 ground-system requirements review took place recently, with approval to proceed to the Preliminary Design Review stage. Please turn to page 21 to learn more about the current status of Landsat 7 and 8, plans for Landsat 9, and the overall plans for the future of U.S. land imaging.

The joint NASA–JAXA Global Precipitation Measurement (GPM) Core Observatory has now been in orbit well over three years, and its GPM Microwave Imager and Dual-frequency Precipitation Radar instruments continue to perform well. The GPM mission released Version 05 of its data products in May 2017, and is well poised to successfully pass its End-of-Prime Review scheduled for late June 2017. The GPM mission consists of the Core Observatory and an international ten-member satellite constellation of microwave radiometers. The combined measurements from all the satellites are providing unprecedented retrievals of rain and falling snow characteristics—every three hours—and thereby increasing our knowledge of Earth's water and energy cycles. GPM is a science mission with integrated applications goals. Data from the GPM mission have been used for a broad range of applications across different societal benefit areas, including water resource management, disaster response, public health, ecological monitoring, and weather forecasting.

As an example of the applications focus of GPM, on March 22, NASA and the World Bank convened a workshop on GPM Applications in Washington, DC. Twenty-seven participants from the World Bank, primarily from the Environment and Natural Resources Global Practice group, as well as six representatives from NASA participated in this three-hour workshop, which the World Bank hosted. The workshop was organized to engage the water management community at the World Bank and increase awareness of NASA's water resources data—specifically focusing on precipitation. Additional goals were to promote a dialogue on the challenges to using these data on the World Bank side as well as the client/user level, and discuss opportunities for increasing capacity to utilize remote sensing products for improved situational awareness and decision making at the practitioner level. Please turn to page 13 to learn more about the workshop. ■

[5] See for example "Aqua 10 Years After Launch" in the November–December 2012 issue of *The Earth Observer* [**Volume 24**, **Issue 6**, pp. 4-17].
[6] Learn more about the A-Train at *https://atrain.gsfc.nasa.gov*.

See page 38 for list of undefined acronyms used in the editorial and table of contents.

feature article

Enhancing the Discoverability of NASA Earth Science Data Through Digital Object Identifiers (DOIs)

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Since DOIs are becoming so prevalent in the realm of NASA's Earth Science data and information, it seems fitting to examine some of the "nuts and bolts" of their usage in the specific context of the Earth Observing System.

Introduction

NASA's Earth Observing System Data and Information System (EOSDIS) currently is responsible for almost 22 petabytes (PB) of archived data and more than 10,000 unique research products, which are managed by NASA's Earth Science Data and Information System (ESDIS) Project.[1] The volume of data in this vast archive is expected to grow significantly over the next several years, and may be almost 247 PB in size by 2025, according to estimates by NASA's Earth Science Data Systems Program. A prime responsibility of EOSDIS and the ESDIS Project is ensuring that these data can be discovered easily and cited accurately by data users. A key response to addressing these needs is the addition of *Digital Object Identifiers* (DOIs) to EOSDIS data products.

DOIs were developed in the 1990s as a means for managing the identification and location of content over digital networks, and are internationally standardized through the International Organization for Standardization (ISO) publication 26324:2012.[2] Two important attributes of DOIs are their permanence and their uniqueness, which are essential for facilitating the discoverability of DOI-assigned EOSDIS data products, as will be shown later in this article.

Of particular interest for readers of *The Earth Observer* is the adoption of DOIs for data products produced, archived, and distributed by the EOSDIS. These DOIs enable data users not only to rapidly locate specific EOSDIS data products for their research and applications, but also to easily provide valid citations for these products.[3]

Once registered, a DOI can never be changed or deleted. This means that even if the Internet location of the object changes, the DOI remains unchanged and the object can still be located using the DOI. DOIs also serve as unique identifiers of objects in that they identify a specific object without ambiguity. In addition, DOIs enable data users to provide valid citations for the data they use in research since anyone using or replicating the research can use the DOI to locate the exact data and data products cited.

The ESDIS Project began assigning DOIs in 2010, and a formal process for assigning and registering DOIs was implemented in 2012.[4] The more than 10,000 unique EOSDIS research products available to data users include not only standard products with the processing required for scientific research, but also near-real-time (NRT) products that are generally available within three hours after the raw data are collected. As of May 2017, a total of 5161 EOSDIS data products have registered DOIs, and many more are on the way.

Since DOIs are becoming so prevalent in the realm of NASA's Earth Science data and information, it seems fitting to examine some of the "nuts and bolts" of their usage in

[1] To learn more about EOSDIS, the ESDIS Project, and other elements discussed in this article see "Earth Science Data Operations: Acquiring, Distributing, and Delivering NASA Data for the Benefit of Society" in the March-April 2017 issue of *The Earth Observer* [**Volume 29, Issue 2**, pp. 4-18].

[2] ISO 26324:2012 contains information and documentation on the DOI system, which can be found at *https://www.iso.org/standard/43506.html.*

[3] Initial work on assigning DOIs to EOSDIS data has been detailed previously in "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].

[4] More technical information about EOSDIS DOI efforts can be found in the article recently published by Wanchoo, L., N. James, and H. Ramapriyan, 2017. "NASA EOSDIS Data Identifiers: Approach and System." *Data Science Journal,* 16, p. 15, doi:10.5334/dsj-2017-015. [*Note the use of a DOI in this context—Ed.*]

this specific context. We begin with a review of the basic DOI structure and then proceed to specific details about assigning DOIs to EOSDIS data products.

Prefixes, Suffixes, and More—Understanding DOI "Grammar"

An object's DOI has two parts: a prefix and a suffix. The prefix begins with the number 10 (which is called a *handle* and identifies the string of numbers and letters after the *10* as being part of a DOI) followed by a number identifying the organization or agency registering the DOI, called the *registration agent*.[5] For example, the ESDIS Project has been assigned the registration agent number 5067. This means that all DOIs for EOSDIS data products start with *10.5067*. The DOI suffix (which is separated from the prefix by a forward slash) uniquely identifies the object, and its format is assigned and managed by the body or organization submitting the DOI for formal registration, such as the ESDIS Project. (Please see page 7 for specific details for *Assigning DOIs to NASA's EOS Data*.)

A suffix is either *opaque*, i.e., a string of seemingly random numbers and letters, or *structured*, i.e., the suffix has some meaningful content that follows a specified format. As is explained in the previously referenced *Data Science Journal* article by Wanchoo, *et al.*, one reason for data providers to use a structured DOI is that this may increase the ability of automated searches to identify articles citing specific mission, instrument, or program datasets. It is important to note that even if the DOI suffix is structured, the DOI is permanent and cannot be changed if the meaning of the suffix changes in the future. For example, a structured suffix might be written to contain the name of the specific data center originally responsible for the data product, but the data product could be moved to another data center. The use of content such as data center names or data locations in a DOI suffix is discouraged for this reason.

...one reason for data providers to use a structured DOI is that this may increase the ability of automated searches to identify articles citing specific mission, instrument, or program datasets.

Both opaque and structured suffixes are used in DOIs for EOSDIS data products. The choice of using an opaque suffix or a structured suffix (along with the structured suffix model used) depends on the preference of the EOSDIS Distributed Active Archive Center (DAAC)[6] providing the information for registering the data product DOI. The ESDIS Project recommends that a suffix be kept simple and short for ease of use, and suggests several suffix models that may be used, such as:

- [name of mission]/[name of instrument]/data[m][n]
- [name of campaign]/[name of platform]/data[m][n]
- [name of program]/[name of measurement group]/data[n]

where [m] denotes the processing level of the data product (e.g., Level-1, Level-2, etc.) and [n] indicates a sequence number.

A specific example can help demonstrate the naming convention and the value of a DOI:

The structured DOI assigned to the MODIS/Terra Land Surface Temperature and Emissivity Monthly Level-3 Global 6 km Grid SIN Version 6 product at NASA's Land Processes DAAC (LP DAAC) is *10.5067/MODIS/MOD11B3.006*. The prefix *10.5067* indicates that this is an EOSDIS data product. The suffix *MODIS/MOD11B3.006* indicates that this is a MODIS product, the product name is MOD11B3, and this is MODIS Version 6 data.

While a data user could use the Uniform Resource Locator (URL) for the LP DAAC landing page (*lpdaac.usgs.gov/dataset_discovery/modis/modis_products_table/mod11b3_v006*) to accesses this dataset, this URL could change or the data could be moved,

[5] Detailed information about the DOI numbering system is available through the International DOI Federation's *DOI Handbook*, Chapter 2, Numbering (*www.doi.org/doi_handbook/2_Numbering.html*).

[6] Information about EOSDIS DAACs and their datasets is available through the NASA Earthdata website at *earthdata.nasa.gov/about/daacs.*

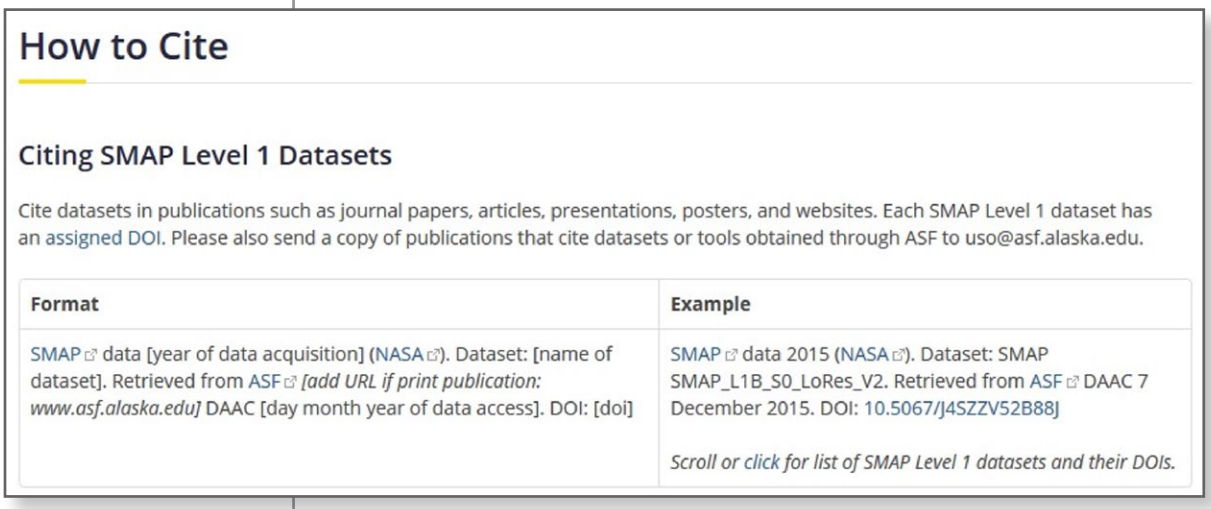
Using DOIs in data citations helps data become more discoverable. This, in turn, helps increase data distribution and, through this, fosters new and additional research using the data.

resulting in the dreaded *404: Page Not Found* error. However, by using the dataset's DOI (*dx.doi.org/10.5067/MODIS/MOD11B3.006*) a data user always will be directed to this specific dataset—regardless of where it exists on the Internet—since a valid URL is required by the ESDIS Project as part of the DOI registration process. To further ensure the accuracy of URLs associated with EOSDIS data products, the ESDIS Project periodically checks the validity of URLs for registered DOIs and receives monthly broken-links reports listing DOIs with *404: Page Not Found* errors. The ESDIS Project requests updated URLs from the DAACs for links that are not resolved.

A DOI is an integral component of a data product's *metadata*, which are data about the data, that help describe or identify them (e.g., when the data were collected or the instrument used to collect them). Metadata also make it easy to find information about the creation and history of a data product, which is called the data's *provenance*. EOSDIS DAACs are responsible for providing the ESDIS Project with data product metadata.

A DOI also has metadata associated with it, which are necessary for registering an EOSDIS data product DOI. One of the metadata elements required for DOI registration is the URL that provides the location of the data product's landing page. One benefit of having the URL as part of a data product's DOI metadata is that this enables the ESDIS Project to quickly and easily update a particular data product's URL when necessary. Along with the URL for the landing page, additional metadata required by the ESDIS Project for registering a data product DOI are the DOI name, data product title or name, the data product creator, the name of the DAAC distributing the data product, the data product publication year, the type of digital object being registered (e.g., dataset, text, services, or software), the type of DOI (i.e., new or update), and whether the DOI is ready for registration (yes or no).

As noted earlier, DOIs also make it easy to properly cite data used for research.[7] Since a DOI is assigned to a specific data product, there is no confusion about which data product or which version of the data product is being cited. The ESDIS Project requires DAACs to publicize citation policies on their websites and in communications accompanying data, including the proper use of DOIs in data citations—see **Figure 1**. Using DOIs in data citations helps data become more discoverable. This, in turn, helps increase data distribution and, through this, fosters new and additional research using the data.



How to Cite

Citing SMAP Level 1 Datasets

Cite datasets in publications such as journal papers, articles, presentations, posters, and websites. Each SMAP Level 1 dataset has an assigned DOI. Please also send a copy of publications that cite datasets or tools obtained through ASF to uso@asf.alaska.edu.

Format	Example
SMAP data [year of data acquisition] (NASA). Dataset: [name of dataset]. Retrieved from ASF *[add URL if print publication: www.asf.alaska.edu]* DAAC [day month year of data access]. DOI: [doi]	SMAP data 2015 (NASA). Dataset: SMAP SMAP_L1B_S0_LoRes_V2. Retrieved from ASF DAAC 7 December 2015. DOI: 10.5067/J4SZZV52B88J *Scroll or click for list of SMAP Level 1 datasets and their DOIs.*

Figure 1. The ESDIS Project requires DAACs to publicize citation policies, including the proper use of DOIs. This example shows a portion of the Soil Moisture Active Passive (SMAP) citation guidelines page at NASA's Alaska Satellite Facility (ASF) DAAC—*https://www.asf.alaska.edu/smap/how-to-cite*. Notice the explanation of how DOIs should be noted when citing SMAP Level-1 data. Note also that the suffix for the DOI cited in the example [*right box*] is opaque. **Credit:** NASA's ASF DAAC

[7] For the EOSDIS position on the importance of proper data citations, read "Open Data and the Importance of Data Citations: The NASA EOSDIS Perspective," available online at *https://earthdata.nasa.gov/open-data-and-the-importance-of-data-citations-the-nasa-eosdis-perspective.*

Assigning DOIs to EOSDIS Data[8]

The criteria used by the ESDIS Project to identify EOSDIS data products and supporting documents that are to receive a DOI are straightforward:

1. Is the product in question a standard data product, a NRT data product, or documentation related to a data product?
2. Is the data product planned as part of a mission or is the product already being generated, archived, and/or distributed?
3. Is the product supported by NASA's Earth Science Division?

If the answer to all of the above questions is yes, then a DOI is assigned. The end-to-end EOSDIS DOI assignment process involves three organizations:

- *the ESDIS Project* is responsible for managing DOIs as they are created and providing guidance to the DAACs in developing DOI suffixes, ensuring the completeness of DOI names and associated metadata, and reserving, registering, and updating DOIs;
- *the DAACs* are responsible for providing the ESDIS Project with data product metadata, developing data product landing pages, and providing changes in product metadata or landing page Internet locations; and
- *the California Digital Library EZID system*[9] registers EOSDIS DOIs and provides 24/7 access to the DOI handling system that enables the ESDIS Project to manage DOIs.

As stated previously, as of May 1, 2017, DOIs for 5161 data products have been registered—see **Table**.[10] An additional 458 DOIs have been created by the ESDIS Project and are reserved, but not yet registered. Unlike a registered DOI, which is permanently assigned to a specific data product, a reserved DOI can be changed or even deleted. A DAAC may wish to reserve a DOI for a data product that is not yet publicly available or for which a landing page has not been completed.

Unlike a registered DOI, which is permanently assigned to a specific data product, a reserved DOI can be changed or even deleted. A DAAC may wish to reserve a DOI for a data product that is not yet publicly available or for which a landing page has not been completed.

	Registered DOIs	Reserved DOIs	Total
ESDIS	3620	458	4078
ORNL	1267	0	1267
SEDAC	274	0	274
Total	5161	458	5619

Table. Registered and reserved EOSDIS DOIs as of May 1, 2017. All 12 EOSDIS DAACs are part of EOSDIS DOI efforts. The Oak Ridge National Laboratory (ORNL) DAAC and the Socioeconomic Data and Applications Center (SEDAC) are listed separately since they already were assigning DOIs to their data products before the EOSDIS effort began. ORNL and SEDAC continue to register DOIs for their own products directly with EZID. **Credit**: NASA's ESDIS Project

Along with the DAACs, six additional NASA entities that are involved in the processing of ESDIS Project science data are part of EOSDIS DOI efforts. These are the Land, Atmosphere, Near real-time Capability for EOS (LANCE)[11] Fire Information for Resource Management System (FIRMS);[12] NRT data from the Advanced Microwave Scanning Radiometer 2 (AMSR2), which are available through LANCE;

[8] More detailed information about the EOSDIS DOI process is available at *wiki.earthdata.nasa.gov/display/DOIsforEOSDIS/Digital+Object+Identifiers+%28DOIs%29+for+EOSDIS.*
[9] To learn more about the EZID system, visit *https://ezid.cdlib.org.*
[10] For the most current EOSDIS DOI metrics, please see the EOSDIS DOI Status and Listing page at *wiki.earthdata.nasa.gov/display/DOIsforEOSDIS/EOSDIS+DOIs+Status+and+Listing.*
[11] To learn more about LANCE, visit *earthdata.nasa.gov/earth-observation-data/near-real-time.*
[12] For information about FIRMS, visit *earthdata.nasa.gov/earth-observation-data/near-real-time/firms.*

The DOI assignment process developed by the ESDIS Project is now largely automated.

NRT data from the Moderate Resolution Imaging Spectroradiometer (MODIS), which are available through LANCE; the Land Product Validation Subgroup (LPVS);[13] the Ozone Product Evaluation and Test Element (PEATE);[14] and the Precipitation Processing System (PPS).[15]

The DOI assignment process developed by the ESDIS Project and currently in use is largely automated—see **Figure 2**. After a data product is identified by a DAAC as needing a DOI, product metadata required for DOI registration is generated by the DAAC responsible for the data. The product metadata and data landing page are checked for completeness and any updates are incorporated. DOI information is then processed automatically and final DOI information is automatically sent to EZID for registration.

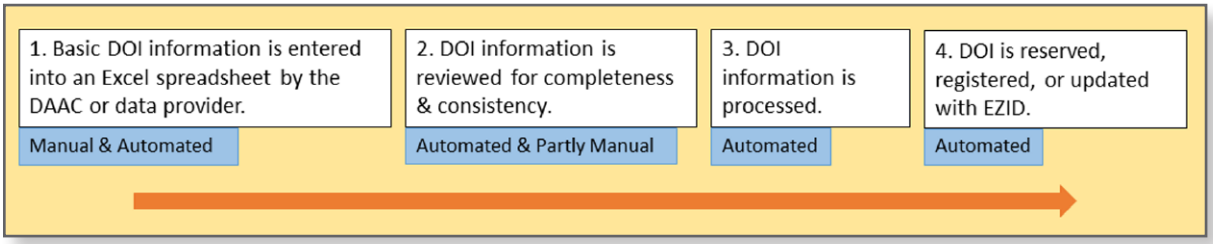


Figure 2. Programs written by the ESDIS Project (in the Perl programming language) handle automated processes, including reviewing and validating DOI metadata and checking for DOI name uniqueness within the ESDIS Project database and with EZID. An Oracle database is used to store DOI information along with some processing-related metadata (e.g., the dates of DOI submission, registration, and updates). **Credit:** NASA's EOSDIS

An upgraded system to fully automate this process is being tested at selected DAACs and will be operational for all DAACs in the next few weeks. This upgraded system features web-based submission of DOI metadata files, replacing the current approach of submitting a DOI metadata spreadsheet via email. Through this web-based submission upgrade, single or bulk DOI requests are processed in minutes with immediate email responses notifying the DAAC providing the information of any errors. The upgraded system also places a 72-hour hold on all new DOI requests before automatically registering a DOI for public use.

Summary and Conclusions

Since the implementation of the formal EOSDIS DOI process in 2012, approximately 50% of EOSDIS data products have registered DOIs. The establishment of an automated system to handle a majority of the processes for evaluating, registering, and updating DOIs has greatly sped up this effort and provides a system for organizing these data products that will become ever more important as the volume of data managed by the ESDIS Project continues to grow. ■

[13] To learn more about the LPVS, visit *lpvs.gsfc.nasa.gov*.
[14] The Ozone PEATE is now the Suomi National Polar-orbiting Partnership (NPP) Ozone Science Investigator-led Processing System (SIPS), but is still listed as Ozone PEATE on the EOSDIS DOI Status and Listing page for consistency with previous records.
[15] For more information about the PPS, visit *pps.gsfc.nasa.gov*.

April Showers of Outreach Lead to a Flowering of Public Awareness of NASA's Science Activities

Heather Hanson, NASA's Goddard Space Flight Center, heather.h.hanson@nasa.gov

Introduction

The old adage that *April showers bring May flowers* may be true, but two recent outreach activities in Washington, DC, which NASA's Science Communications Support Office (SCSO) supported, offered "showers" of a different sort. Those who participated in these events were offered the opportunity to soak up information about how NASA uses the vantage point of space to achieve a "flowering" of scientific discovery, leading to deeper understanding of: the workings of our home planet; the sun and its effects on the solar system, other planets and solar system bodies; the interplanetary environment; and the universe beyond our solar system.

Earth Day

The first line of "April showers" passed through Washington, DC's Union Station on Thursday, April 20. The SCSO organized and supported a large public Earth Day event that ran from 9:00 AM to 5:00 PM. The SCSO has supported several Earth Day celebrations in our Nation's capital, usually on the National Mall, dating back to 1994. Since 2013, however, NASA has picked Union Station to host the event. This central transportation hub attracts some 25,000 to 30,000 individuals a day, allowing NASA potential to reach a larger cohort of citizens who were not already planning to attend the event.

To kick off the event, **Michael Freilich** [NASA Headquarters—*Director of the Earth Science Division*], **William Werkheiser** [U.S. Geological Survey (USGS)—*Acting Director*], and **Beverley Swaim-Staley** [Union Station Redevelopment Corporation—*President and CEO*] took turns providing opening remarks and welcoming attendees to the celebration—see **Photo 1**.

With participation from the U.S. Department of State (DOS) and USGS, NASA offered a full schedule of Science Stories on the Hyperwall,[1] 20 hands-on activities (see **Table 1**), and a special appearance by **Former NASA Astronaut Scott Altman**, who presented exciting information in front of the Hyperwall and held a one-hour autograph-signing session—see **Photos 2-4**. There were 22 Hyperwall Science Stories told by individual scientists and outreach personnel throughout the day. Each story lasted about 15 minutes, covering a variety of Earth-science topics, the August 2017 solar eclipse, planetary exploration, and the universe.

Photo 1. Participants gathered in front of NASA's Hyperwall for a special kickoff celebration. **Michael Freilich** provided opening remarks, explaining that Earth is a complex system and in order to understand it we need to continuously observe a variety of parameters on a global scale, and that NASA's Earth-observing fleet has been designed to do just that. **Photo credit:** NASA

Photo 2. Lawrence Friedl [NASA Headquarters—*Director of the Applied Sciences Program, Earth Science Division*] interacted with student participants and described ways the public uses NASA data to make informed decisions. **Photo credit:** NASA

Photo 3. Tim Newman [USGS—*Land Remote Sensing Program Coordinator*] talked about the USGS–NASA Landsat Program. **Photo credit:** NASA

Photo 4. Former NASA Astronaut **Scott Altman** signed autographs and took photos with the general public. **Photo credit:** NASA

[1] NASA's Hyperwall is a video wall capable of displaying multiple high-definition data visualizations and/or images simultaneously across an arrangement of screens. Functioning as a key component at many NASA exhibits, the Hyperwall is used to help explain phenomena, ideas, or examples of world change.