



EOSDIS Update

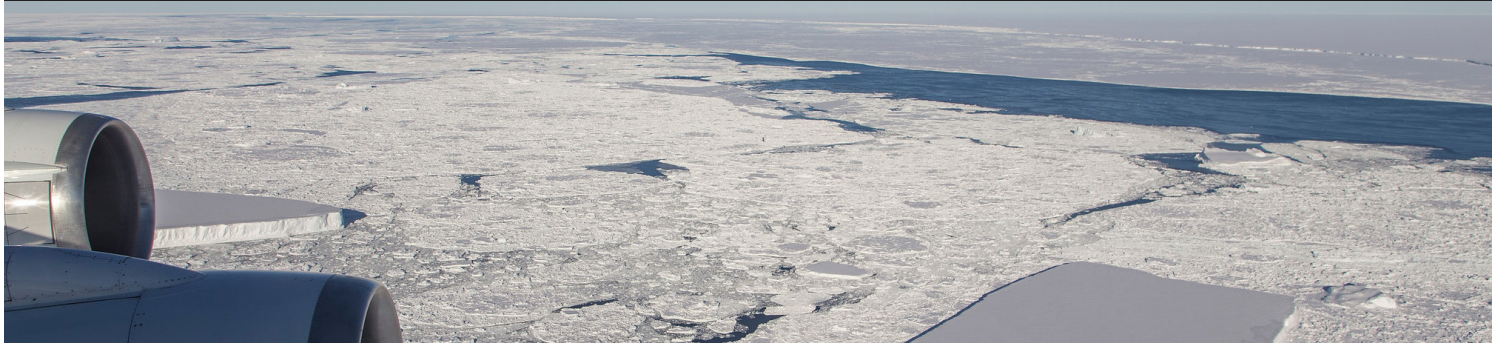
Earth Science Data and Information System (ESDIS) Project

National Aeronautics and Space Administration



WINTER 2018-2019

A PUBLICATION OF THE EARTH OBSERVING SYSTEM DATA AND INFORMATION SYSTEM (EOSDIS), CODE 423

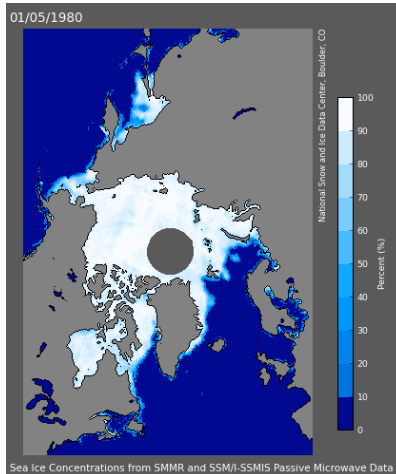


TOP STORY

NASA's NSIDC DAAC Celebrates 40 Years of Modern Satellite Sea Ice Data

The 1978 launch of NASA's Nimbus-7 satellite carrying the SMMR passive microwave sensor ushered in the modern satellite sea ice data record.

The modern satellite sea ice data record was launched, literally and figuratively, on October 25, 1978, with NASA's [Nimbus-7 satellite](#) (operational 1978 to 1995). While instruments for observing and sensing sea ice had been launched previously, Nimbus-7 carried the [Scanning Multichannel Microwave Radiometer](#) (SMMR), an advanced sensor using multiple microwave frequencies to more accurately observe sea ice concentration and extent. SMMR data are one of the foundations of the sea ice data collection at NASA's [National Snow and Ice Data Center Distributed Active Archive Center](#) (NSIDC DAAC). NSIDC DAAC is NASA's Earth Observing System Data and Information System (EOSDIS) DAAC responsible for NASA Earth science data related to snow, sea ice, glaciers, ice sheets, ice shelves, frozen ground, soil moisture, cryosphere, and climate interactions. SMMR data are available from October 1978 through August 1987, when the Nimbus-7 SMMR scanner was turned off.



Northern Hemisphere sea ice concentration for January 5, 1980. Image: Cavalieri, D.J., Parkinson, C.L., Gloersen, P. & Zwally, H.J. (1996, updated yearly). Sea Ice Concentrations from Nimbus-7 SMMR & DMSP SSM/I-SSMIS Passive Microwave Data, Version 1. Boulder, CO USA. NASA NSIDC DAAC. DOI: 10.5067/8GQ8LZQVLOVL. Accessed Nov. 7, 2018.

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Unless otherwise noted, all articles written by Josh Blumenfeld, EOSDIS Science Writer.

A recent [NSIDC article](#) describes the significance of SMMR data and how the sea ice data record has developed over the past 40 years. Data from NASA's recently launched [Ice, Cloud and land Elevation Satellite-2](#) (ICESat-2) will provide an even more detailed and accurate assessment of ice thickness. ICESat-2 data soon will be available through NSIDC DAAC. ■

Read the full article: <https://nsidc.org/nsidc-monthly-highlights/2018/10/modern-sea-ice-satellite-record-turns-40>.



Explore SMMR data: <https://nsidc.org/data/smmr/ssmi>.

USER PROFILES:

NASA Earth Science Data User Profiles highlight our diverse end-user community worldwide and show you not only how these data are being used for research and applications, but also where these data are being used – from the plains of West Texas to the Sea of Oman and everywhere in between. You'll also learn where you can download the data sets in each feature. <https://earthdata.nasa.gov/user-resources/who-uses-nasa-earth-science-data-user-profiles>

Dr. Piyush Agram

Who uses NASA Earth science data? Dr. Piyush Agram, for developing Synthetic Aperture Radar (SAR) data products.

Signal Analyst, Radar Algorithms and Processing Group, Radar Science and Engineering Section, NASA's Jet Propulsion Laboratory (JPL)



Research interests: Developing algorithms for processing data from the upcoming joint NASA/ Indian Space Research Organization (ISRO) NISAR mission; developing new techniques for using and interpreting Synthetic Aperture Radar (SAR) and Interferometric SAR (InSAR) imagery.

<https://earthdata.nasa.gov/user-resources/who-uses-nasa-earth-science-data-user-profiles/user-profile-dr-piyush-agram>

David Mocko

Who uses NASA Earth science data? David Mocko, for using land-surface models to study drought.

Senior Research Scientist (Science Applications International Corporation [SAIC]) supporting the Hydrological Sciences Laboratory at NASA's Goddard Space Flight Center, Greenbelt, MD



Research interests: Using and evaluating land-surface models to study soil moisture, snow depth/cover, surface fluxes, and drought.

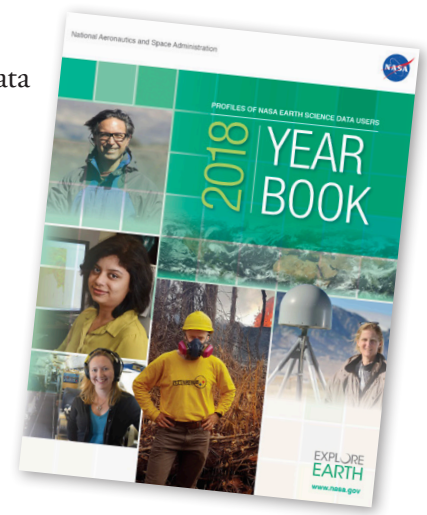
<https://earthdata.nasa.gov/user-resources/who-uses-nasa-earth-science-data-user-profiles/user-profile-david-mocko>

ANNOUNCEMENTS

NASA EOSDIS 2018 Data User Profile Yearbook Released!

NASA's Earth Observing System Data and Information System (EOSDIS) is pleased to present the *2018 EOSDIS Data User Profile Yearbook*. From developing new ways of using GPS technology to track water resources to helping emergency managers respond to volcanic eruptions, EOSDIS data users are applying NASA [Earth observing data](#) to a wide range of research. The EOSDIS [Data User Profile series](#) showcases these scientists,

researchers, managers, and educators along with the data products that make their work possible. Our *Data User Profile Yearbook* gives you a taste of the breadth of research enabled by the vast NASA EOSDIS data collection. [Download your copy of this year's edition!](#) ■



2018 NASA Space Apps Challenge Finalists

Out of more than 1,350 submitted apps, 25 apps were nominated for Global Awards in the 2018 NASA Space Apps Challenge.



Over an intense weekend in mid-October, almost 18,000 participants representing 2,729 teams created more than 1,350 projects in response to NASA challenges for solving problems on Earth and in space.

[The 2018 NASA Space Apps Challenge](#) took place at a record number of locations (200 venues, including virtual teams) and countries (75), and featured more teams and submitted projects than ever before.

[Global Finalists](#) were nominated in six categories:

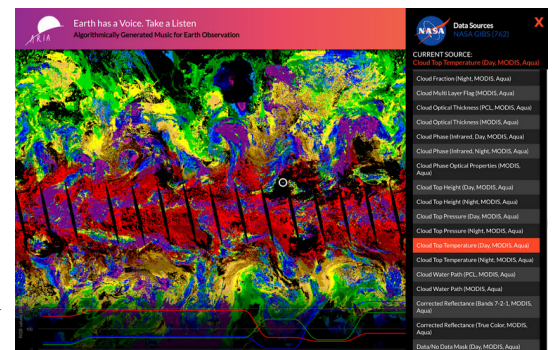
- **Best Use of Data:** The solution that best made data accessible or leveraged data to a unique application.
- **Best Use of Hardware:** The solution that exemplified the most innovative use of hardware.
- **Best Mission Concept:** The solution with the most plausible solution concept and design.
- **Galactic Impact:** The solution with the most potential to improve life on Earth or in the universe.

- **Most Inspirational:** The solution that captured judge's hearts.
- **Best Use of Science:** The solution that made the best and most valid use of science and/or the scientific method.

Many participating teams used data and services available through NASA's [Earth Observing System Data and Information System \(EOSDIS\)](#).

EOSDIS provides end-to-end capabilities for managing NASA's Earth science data collection. These data represent some of the most complex and diverse Earth science datasets on

the planet, and are acquired from satellites, aircraft, field measurements, and numerous other programs.



Global Finalist Aria EarthMOOG (Best Use of Data) uses color values of web map tile images coupled with individual pixel RGB (Red, Green, Blue) values in imagery available through the EOSDIS Global Imagery Browse Services (GIBS) to generate unique sounds and melodies. Aria EarthMOOG was created in response to the challenge to "Use NASA Earth imagery data to create 1) an art piece, or 2) a tool that allows the imagery to be manipulated to create unique pieces of art."

Judging took place at each Challenge location (including virtual teams), and apps were evaluated based on impact, creativity, validity, relevance, and presentation. Each local event could nominate up to two projects to advance to global judging, which resulted in 339 nominees for global awards. A panel of NASA experts narrowed the nominees to the selected finalists. In addition to global awards, many Space Apps Challenge venues also provided local awards.

[Six Global Award winners](#) were just announced and are featured on the Space Apps Challenge website. Global Winners receive an invitation to visit NASA's Kennedy Space Center in Cape Canaveral, Florida, with the Space Apps Global Organizing Team. ■

New West Africa Coastal Zone Data Collection at SEDAC

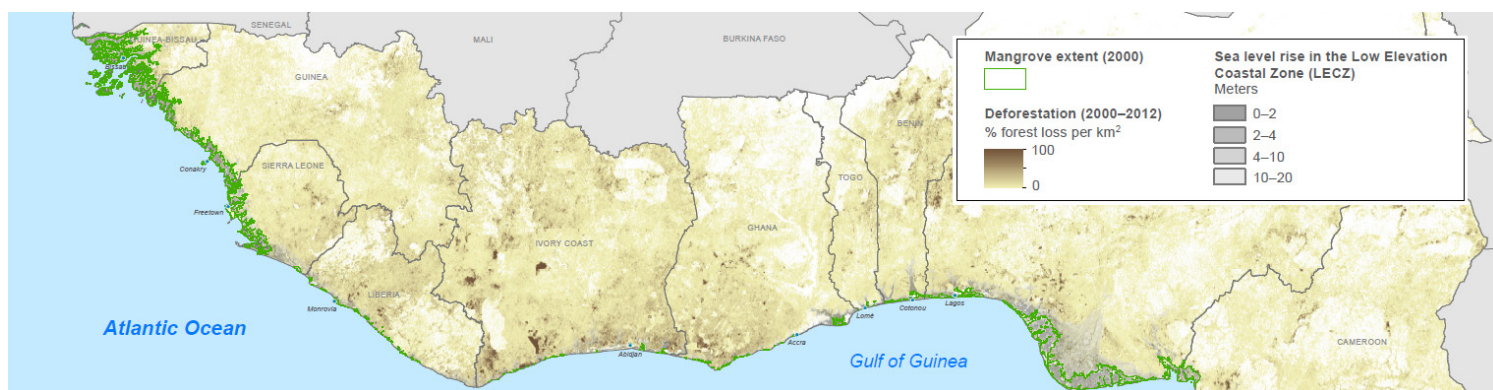
The 16 datasets in the West Africa Coastal Vulnerability Mapping collection provide a wealth of information about the stresses affecting this important region.

A new data collection distributed by NASA's [Socioeconomic Data and Applications Center](#) (SEDAC) provides insight into the vulnerability of West Africa's coastline to climate stresses. The 16 datasets comprising the [West Africa Coastal Vulnerability Mapping](#) data collection are part of a larger study looking at the economic, social, and natural systems in West Africa that will be exposed to future sea-level rise, storm surge, and riparian floods. Collection datasets include information ranging from crop production, demographic and health survey data, population projections through 2050, and a subset of global mammal and amphibian

richness grids for the West African coastal zone.

The area covered in the collection extends from Guinea-Bissau in the Northwest to Cameroon in the Southeast, a 200-kilometer coastal zone that is larger than what might normally be construed as "coastal." This large area was used because the economic impacts of climate change will not be confined to the coastline itself, but will extend further inland. In fact, almost half of the region's population—24 million people—live within 200 kilometers of the coast.

SEDAC is the Earth Observing System Data and Information System (EOSDIS) Distributed Active Archive Center (DAAC) responsible for archiving and distributing socioeconomic data in the EOSDIS collection, and is hosted at Columbia University's [Center for International Earth Science Information Network](#) (CIESIN). SEDAC synthesizes Earth science and socioeconomic data and information in ways useful to a wide range of decision makers and other applied users, and serves as an "Information Gateway" between the socioeconomic and Earth science data and information domains.



Example map from the collection depicting known mangrove areas from the year 2000 (shown in green) and deforestation from 2000 to 2012 (brown shades, with darker brown indicating areas of greater forest loss) overlain on the Low Elevation Coastal Zone (LECZ) of West Africa (shown in grayscale). The LECZ approximates areas that could be affected by varying degrees of sea level rise and storm surge. This map was produced by CIESIN at the Earth Institute of Columbia University under contract to Tetra Tech ARD for the USAID-funded African and Latin American Resilience to Climate Change (ARCC) project (September 2014). All maps and reports/documentation can be found at <http://ciesin.columbia.edu/data/wa-coastal>. Map and text courtesy of CIESIN.

Explore the SEDAC West Africa Coastal Vulnerability Mapping collection: <http://sedac.ciesin.columbia.edu/data/collection/wacvm>.

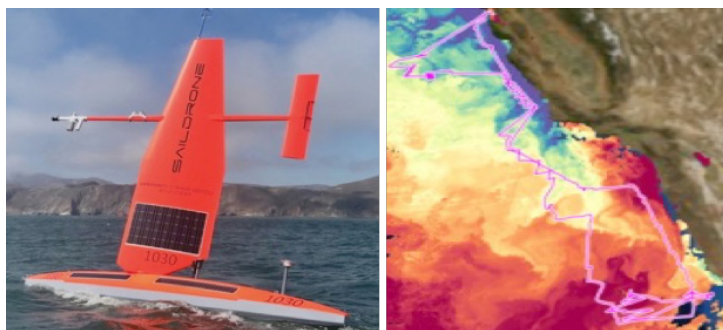
For maps representing the climate exposure and vulnerability indices from this collection, visit the CIESIN web page “[Mapping the Exposure of Socioeconomic and Natural Systems of West Africa to Coastal Climate Stressors](#).” ■

Saildrone Baja Field Campaign Data Available at PO.DAAC

Data collected by the autonomous Saildrone unmanned surface vehicle (USV) during its 60-day cruise along the California coast and Baja Peninsula are now available at PO.DAAC.

A unique unmanned surface vehicle (USV) called Saildrone conducted a two-month cruise during the spring of 2018 along the California coast and Baja Peninsula collecting data about upper ocean physics and ecology. Data from the 60-day [Saildrone Baja Field Campaign](#) are now available through NASA’s [Physical Oceanography Distributed Active Archive Center](#) (PO.DAAC).


[Saildrone](#) is a remotely-controlled platform that can be configured with a variety of instruments to collect data over long distances on deployments lasting up to 12 months and relay live data wirelessly to research teams. During the Baja Field Campaign, Saildrone collected data about sharp ocean water temperature boundaries along the U.S. West Coast and Mexico’s Baja Peninsula, where very cold water mixes with warm water. In addition, Saildrone explored air-sea interactions along its deployment track, with an emphasis near San Francisco, CA, and at Guadalupe Island off the west coast of the



Saildrone generates power through solar panels mounted on its 23-foot-long float and 20-foot-tall “sail.” The pink line on the map at right is the Saildrone track during the Baja campaign; colors indicate sea surface temperature (SST): yellow, orange, and red indicate warmer temperatures (such as along the Baja Peninsula in the south); blue and green indicate cooler temperatures (such as along the California coast in the north). Image: PO.DAAC.

Baja Peninsula. Saildrone data also helped validate data from ocean buoys and satellite-based sensors, including sea surface temperature, sea surface salinity, and chlorophyll-a concentrations.

PO.DAAC is the NASA Earth Observing System Data and Information System (EOSDIS) Distributed Active Archive Center (DAAC) responsible for data and related information pertaining to the physical processes and conditions of the global oceans, including measurements of ocean winds, temperature, topography, salinity, circulation and currents, and sea ice. PO.DAAC is located at NASA’s Jet Propulsion Laboratory in Pasadena, California. ■

 **Explore Saildrone Baja Field Campaign data:**
<https://dx.doi.org/10.5067/SDRON-SURF0>

Updated Dataset for Boreal and Tundra Surface Water Extent

The dataset, which is part of NASA's Arctic Boreal Vulnerability Experiment (ABOVE), enables comparisons of changes in surface water extent spanning 20 years.

A recently updated dataset at NASA's [Oak Ridge National Laboratory Distributed Active Archive Center](#) (ORNL DAAC) provides the location and extent of surface water for the entire Boreal and Tundra regions of North America and enables comparisons of changes in water extent over 20 years. The Surface Water Extent, Boreal and Tundra Regions, North America, 1991-2011, dataset (DOI: [10.3334/ORNLDAAC/1324](https://doi.org/10.3334/ORNLDAAC/1324)) was first released in June 2016; this update corrects spatial reference information for GeoTIFF files and supersedes all earlier data files.

The dataset is part of NASA's [Arctic Boreal Vulnerability Experiment](#) (ABOVE) field campaign that is being conducted in Alaska and Western Canada to study environmental change in this rapidly-changing region and the implications of these changes on social-ecological systems. The dataset features data covering 20 years in three decadal time steps: 1991, 2001, and 2011, which are referred to as "epochs." The overall dataset objective is to generate a map of the nominal extent of water for a specific epoch (1991, 2001, or 2011), where "nominal" depicts the representative water extent for that time period. Images for each epoch were generated using at least three years of ice-free imagery from Landsat 4 and 5 Thematic Mapper (TM) data and Landsat 7 Enhanced Thematic Mapper (ETM+) data.

The ORNL DAAC is NASA's archive for Earth observing data related to biogeochemical and ecological data and

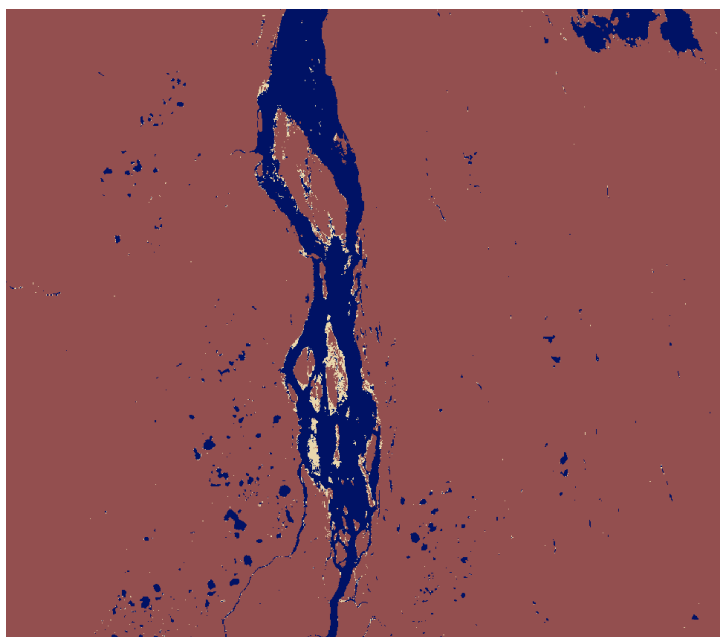


Image of a portion of the Churchill River, Manitoba, Canada, from the dataset showing changes in surface water extent from 1991 to 2011. Areas that were water in 2011 are blue; areas that were water in 1991 but changed to land by 2011 are yellow (such as in the center of the image); areas that were land in 1991 are red. ORNL DAAC image.

models. The ABOVE: Surface Water Extent, Boreal and Tundra Regions, North America, 1991-2011, dataset is part of the ORNL DAAC's [Land Use & Human Dimensions](#) science theme, which comprises 285 topic-related datasets. ■



Explore the ABOVE: Surface Water Extent, Boreal and Tundra Regions, North America, 1991-2011, dataset using the ORNL DAAC's [Spatial Data Access Tool](#) (SDAT): https://webmap.ornl.gov/ogc/dataset.jsp?ds_id=1324



Explore ORNL DAAC ABOVE datasets: <https://daac.ornl.gov/above>

New Sea Surface Temperature (SST) Product

The public release of the NAVO GHRSSST Level 4 K10-SST GDS2.0 product provides global daily analyzed SST at a 1-meter reference depth.

A new global Sea Surface Temperature (SST) product from the [Group for High Resolution Sea Surface Temperature](#) (GHRSSST) is now publicly available through NASA's [Physical Oceanography Distributed Active Archive Center](#) (PO.DAAC).

GHRSSST Level 4 K10_SST Global 10 km Analyzed Sea Surface Temperature (Jan. 9, 2019) from Naval Oceanographic Office (NAVO)

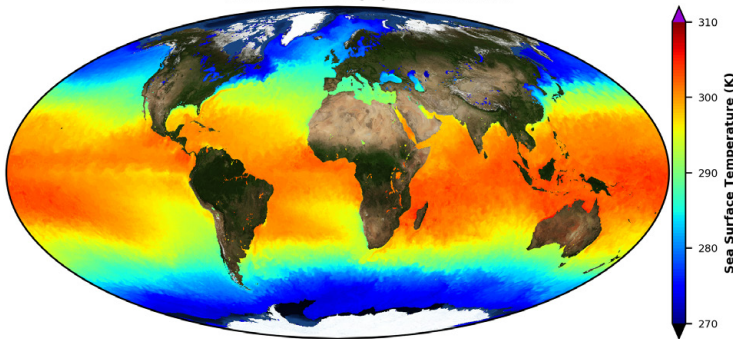


Image from the new GHRSSST product showing global SST for January 9, 2019. Warmer SST values are indicated in yellow, orange, and red; cooler SSTs are indicated in green and blue. Note that SST values are given in degrees Kelvin (K). PO.DAAC image.

The Naval Oceanographic Office (NAVO) GHRSSST Level 4 K10_SST version 1.0 using the GHRSSST Data Specification (GDS) 2.0 product (DOI: [10.5067/GHK10-L4N01](#)) provides daily global analyzed SST at a reference depth of 1-meter. Data are available from

January 9, 2019, and are formatted as NetCDF-4. The product incorporates SST observations from the following instruments: [Advanced Very High Resolution Radiometer](#) (AVHRR), aboard the joint European Space Agency/European Organization for the Exploitation of Meteorological Satellites (EUMETSAT) MetOp-A and MetOp-B as well as the National Oceanic and Atmospheric Administration (NOAA) NOAA-19 satellites; [Visible Infrared Imaging Radiometer Suite](#) (VIIRS), aboard the joint NASA/Japan Aerospace Exploration Agency Suomi National Polar-orbiting Partnership (Suomi-NPP) satellite; and [Spinning Enhanced Visible and InfraRed Imager](#) (SEVIRI), aboard the EUMETSAT Meteosat-8 and Meteosat-11 satellites.

This product is an update to an earlier product that also used the NAVO K10 algorithm, but used different instrument data. Major updates in this product include updated and enhanced granular metadata information; conversion of the SST file from GDS v1.0 to v2.0 (with updates to the filename convention for compliance with GDS v2.0), and addition of the `sea_ice_fraction` variable to the product.

The objective of the GHRSSST is to provide the best quality SST data for applications in short, medium, and decadal/climate time scales through international collaboration and scientific innovation. GHRSSST data products are available through NASA's PO.DAAC, which is responsible for archiving and distributing Earth observing data related to measurements focused on SST, ocean surface topography, ocean winds, sea surface salinity, gravity, ocean circulation, and sea ice. ■

Basic Demographic Characteristics Dataset in GPW

The addition of a Basic Demographic Characteristics dataset to SEDAC's Gridded Population of the World (GPW) product is a highlight of GPW version 4.10.

Along with updated versions of eight datasets, the current revision to the [Gridded Population of the World](#)

(GPWv4.10) includes a new dataset on Basic Demographic Characteristics (DOI: [10.7927/H45H7D7F](#)).

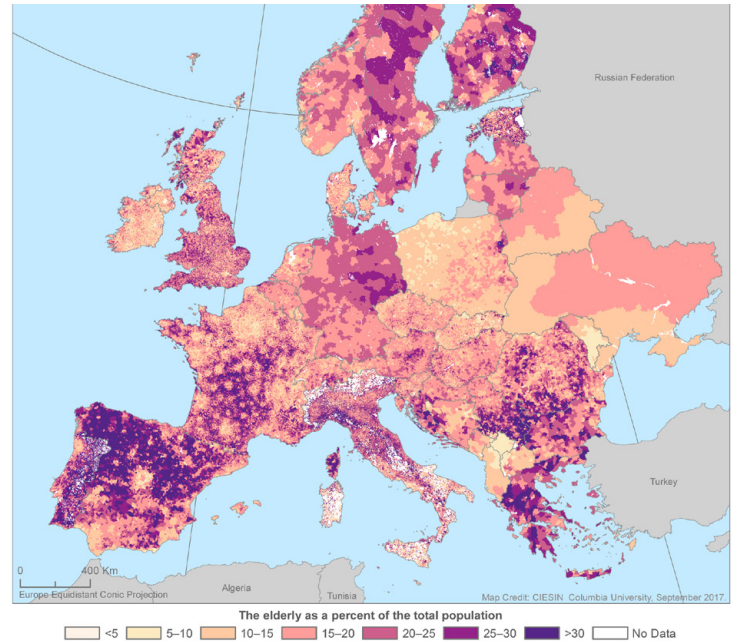
The Basic Demographic Characteristics dataset is the first global dataset to have data for all countries on the spatial distribution of population broken down into different age groups by sex (male and female). The dataset provides estimates of human population by age and sex as counts (number of persons per pixel) and densities (number of persons per square kilometer), consistent with national censuses and population registers, for the year 2010. Data can be viewed as [eight Basic Demographic Characteristics](#)

[maps](#) or can be downloaded in ASCII, GeoTIFF, and NetCDF formats.

The GPW data collection is the flagship product of NASA's [Socioeconomic Data and Applications Center](#) (SEDAC), and the nine datasets in v4.10 incorporate boundary or population updates for 64 countries, additional attributes in the centroids and national identifier datasets, an updated water mask, and additional format and resolution options. The purpose of GPW is to provide a spatially disaggregated population layer that is compatible with datasets from social, economic, and Earth science disciplines as well as with remote sensing. It provides globally consistent and spatially explicit data for use in research, policy-making, and communications.

SEDAC is NASA's Earth Observing System Data and Information System (EOSDIS) Distributed Active Archive Center (DAAC) responsible for archiving and distributing socioeconomic data in the EOSDIS collection, and is hosted at Columbia University's Center for International Earth Science Information Network (CIESIN). SEDAC synthesizes Earth science and socioeconomic data and information in ways useful to a wide range of decision makers and other applied users, and serves as an "Infor-

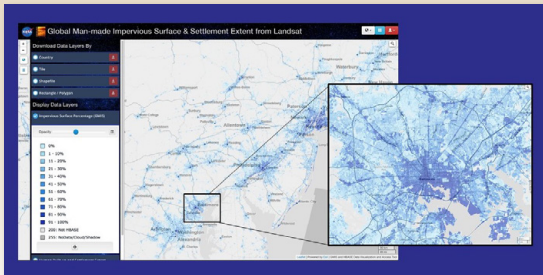
mation Gateway" between the socioeconomic and Earth science data and information domains. ■



GPWv4.10 Basic Demographic Characteristics map of Europe showing the elderly (age 65+) as a percent of total population. Darker colors are areas where the elderly make up a higher percentage of the population. Image: CIESIN - Columbia University, 2017. GPWv4.10: Basic Demographic Characteristics. Palisades, NY: NASA SEDAC. Accessed January 25, 2019.



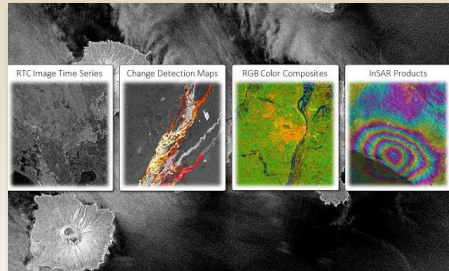
WEBINARS NASA EARTHDATA



11/14/18

Mapping Global Urbanization from Landsat Data and High-Resolution Reference Data

https://youtu.be/AgPN9N_g_XI



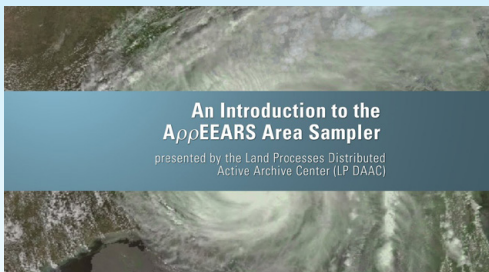
11/28/18

Making SAR Data Accessible: New Sensors, Tools and Services

<https://youtu.be/3df76EZJQnw>

SPECIAL FEATURE VIDEOS

An Introduction to the NASA AppEEARS Area Sampler



An Introduction to the AppEEARS Area Sampler

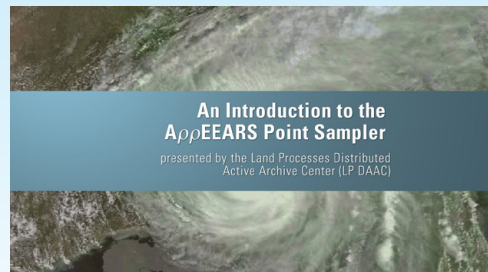
presented by the Land Processes Distributed Active Archive Center (LP DAAC)

This short video provides a quick demonstration of the Area Sampler using the Application for Extracting and Exploring Analysis Ready Samples (AppEEARS).

AppEEARS provides a simple and efficient way to subset, transform, and visualize geospatial data distributed from a variety of federal archives. The following topics are discussed in the video: how to submit an Area Sample request, how to visualize the request output, and how to download the output data.

<https://youtu.be/Gb9E4TkTdrc>

An Introduction to the AppEEARS Point Sampler



An Introduction to the AppEEARS Point Sampler

presented by the Land Processes Distributed Active Archive Center (LP DAAC)

This short video provides a quick demonstration of the Point Sampler using the Application for Extracting and Exploring Analysis Ready Samples (AppEEARS).

AppEEARS provides a simple and efficient way to subset, transform, and visualize geospatial data distributed from a variety of federal archives. The following topics are discussed in the video: how to submit a Point Sample request, how to visualize the request output, and how to download the output data.

<https://youtu.be/z6DlldM9I8A>



DATA Recipes

How to Geocode Sentinel-1 GRD Products



Image Credit: Copernicus Sentinel data 2017, processed by ESA.

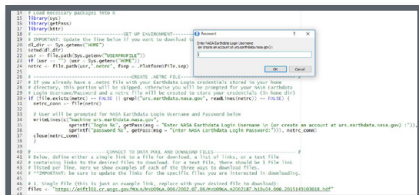
These recipes are designed to help users geocode Sentinel-1 Ground Range Detected (GRD) data to a map projection. Geocoding allows for synthetic aperture radar (SAR) data to be compared or integrated with other types of data (satellite images, maps, etc.) and used for GIS analysis.

Download Recipes: <http://bit.ly/2CYqvOZ>

These recipes were developed by the Alaska Satellite Facility Distributed Active Archive Center (ASF DAAC).

To view additional data tutorials/recipes: <https://www.asf.alaska.edu/asf-tutorials/data-recipes>

How to Access the LP DAAC Data Pool using R

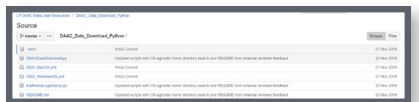


The **DAACDataDownload.R** script demonstrates how to configure a connection to download data directly in R from an Earthdata Login-enabled server, specifically the **LP**

DAAC Data Pool. The script allows users to submit either a single URL to a file to be downloaded, or the location of a text file containing multiple URLs to files on the LP DAAC Data Pool to be downloaded.

Download R Script: <https://go.nasa.gov/2zyZZvu>

How to Access the LP DAAC Data Pool with Python



The **DAACDataDownload.py** script demonstrates how to configure a connection to download data directly in Python

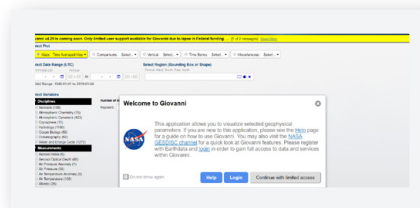
from an Earthdata Login-enabled server, specifically the **LP DAAC Data Pool**. The script is a command line executable, where a user will submit either a single URL to a file to be downloaded, or the location of a text file containing multiple URLs to files on the LP DAAC Data Pool to be downloaded, and a desired directory to which files can be downloaded.

Download Python Script: <https://go.nasa.gov/2DVdKb9>

These data recipes were developed by the Land Processes DAAC (LP DAAC).

To view additional LP DAAC data tutorials/recipes: https://lpdaac.usgs.gov/user_resources/e_learning

New Giovanni User Interface Tutorial



This video tutorial takes viewers on a tour and provides step-by-step instructions on how to navigate the new Welcome Screen and Earthdata login registration for the

Giovanni (Geospatial Interactive Online Visualization AND aNalysis Infrastructure) web-based application.

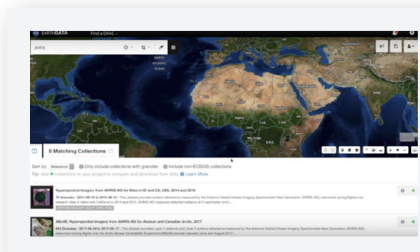
View Tutorial: <https://www.youtube.com/watch?v=Zy5BvEfWTE>

This video tutorial was developed by the Goddard Earth Sciences Data and Information Services Center (GES DISC).

To view additional GES DISC data tutorials/recipes: <https://disc.gsfc.nasa.gov/information/howto>

To view video tutorials: <https://www.youtube.com/user/NASAGESDISC>

Accessing ABoVE Airborne Data using Earthdata Search



This video tutorial demonstrates how to use Earthdata Search to access and download data from the NASA Arctic-Boreal Vulnerability Experiment (ABoVE) airborne campaign for a spatial region of interest. Earthdata

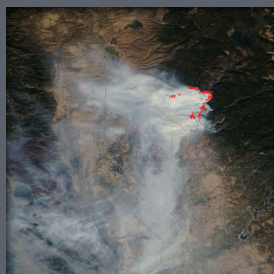
Search is a NASA Earth Observing System Data and Information System application for discovering, searching, visualizing, and retrieving Earth science data.

View Tutorial: <http://bit.ly/2MZ5qcl>

This tutorial was created by the Oak Ridge National Laboratory DAAC (ORNL DAAC).

To access additional data tutorials/recipes: <https://daac.ornl.gov/resources/learning/>

Latest NASA Earthdata Images



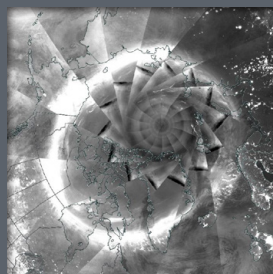
Fires and Smoke from the Camp Fire in California

<https://earthdata.nasa.gov/fires-and-smoke-from-the-camp-fire-in-california>



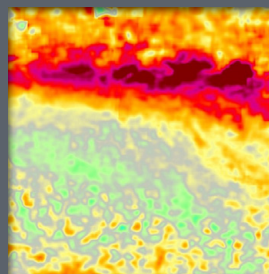
Autumn in the Midwest

<https://earthdata.nasa.gov/mastheads>
(Published 11/13/18)



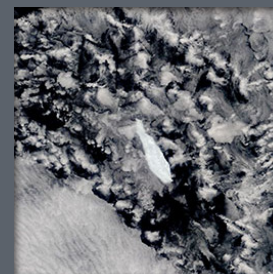
Aurora over the Northern Hemisphere

<https://earthdata.nasa.gov/aurora-over-the-northern-hemisphere>



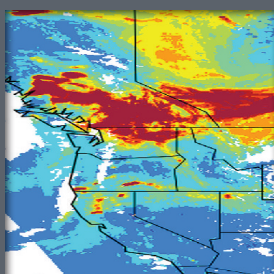
Sea Surface Temperature in the Pacific Ocean

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Iceberg B15T in the South Atlantic Ocean

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Tracking Atmospheric Carbon Monoxide

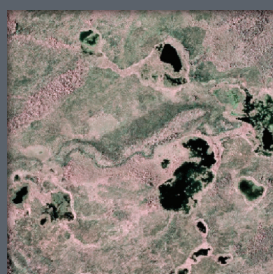
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Volcanoes of Kamchatka

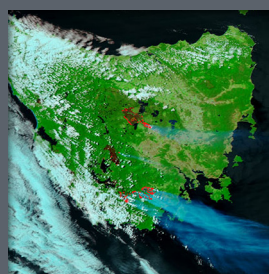
<https://earthdata.nasa.gov/volcanoes-of-kamchatka>



Sensing Surface Water

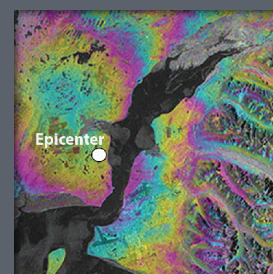
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Fires in Tasmania

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Sensing Post-Earthquake Land Displacement

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