National Aeronautics and Space Administration

PROFILES OF NASA EARTH SCIENCE DATA USERS

2015 YEAR BOOK

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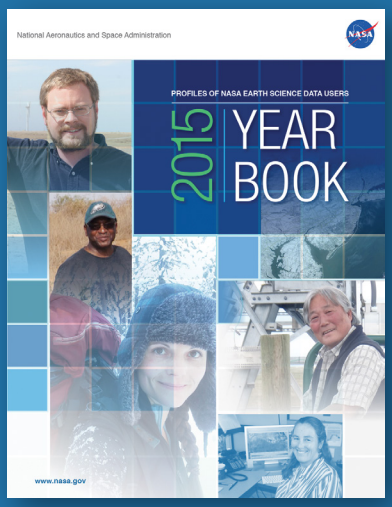

COVER: (Counterclockwise from upper left) Eric Bruning, Greg Jenkins, Kelly Gleason, Cara Wilson, and Dennis Ojima

NASA's Earth Observing System Data and Information System (EOSDIS) is pleased to announce the 2015 EOSDIS Data User Profile Yearbook. From investigating harmful biologic blooms in the Sea of Oman to tracking demographic impacts of climate-related hazards, 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, and managers 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.

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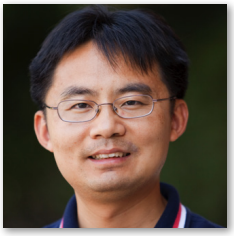

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All profiles written by Josh Blumenfeld, NASA EOSDIS Science Writer

Who Uses Earth Science Data?

John Lehrter

Research Ecologist, U.S. Environmental Protection Agency (EPA) Office of Research and Development

Research interests: Estuarine and coastal nutrient biogeochemistry and ecosystem responses to nutrient loading.

Current research focus: NASA's Applied Sciences Program funded a recently completed five-year research effort in which Lehrter and his colleagues developed new methods to retrieve water quality information in estuarine and coastal environments from satellite observations. The objective of this research was to integrate remote sensing technologies into water quality assessment and standards development decisions by water-quality management organizations, including the U.S. EPA and the state of Florida. Building upon this work, new efforts include developing and applying satellite data products for managing water quality across the nation.

Current research by Lehrter also includes observing and modeling coastal ecosystem response and recovery to nutrient loading. These models are used to predict the impacts to water quality and aquatic life from land-based nutrients and other local and global factors that can create stress on aquatic environments.

Data products and analysis tools used:

- Moderate Resolution Imaging Spectroradiometer (MODIS) (1km) ocean color products available through NASA's Ocean Biology Distributed Active Archive Center (OB.DAAC) (doi: 10.5067/TERRA/MODIS_OC.2014.0 [Terra] and 10.5067/AQUA/MODIS_OC.2014.0 [Aqua])
- Processing tools provided in NASA's Sea-Viewing Wide Field-of-View Sensor (SeaWiFS) Data Analysis System (SeaDAS) through NASA's OB.DAAC
- Tropical Rainfall Measuring Mission (TRMM) data products available through NASA's Goddard Earth Sciences Data and Information Services Center (GES DISC)
- Visualized TRMM data products available through the GES DISC TRMM Online Visualization and Analysis System (TOVAS)
- Sea surface temperature and sea surface topography (altimetry) data from multiple NASA and NOAA satellites available through NASA's Physical Oceanography DAAC (PO.DAAC)
- MODIS hi-resolution band data (250m [MOD02QKM] and 500m [MOD02HKM]) available through NASA's Level 1 and Atmosphere Archive and Distribution System (LAADS)
- European Space Agency Medium Resolution Imaging Spectrometer (MERIS) data (300m)
- Landsat imagery (30m)

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Research findings: Areas with higher nutrients can lead to blooms of phytoplankton and other small organisms that, in turn, consume oxygen in these areas, leading to the death of other organisms. These areas are described as being eutrophic or hypoxic. Lehrter and his colleagues used remote sensing time-series to better understand the contributions of Mississippi River nutrient loading to eutrophication and hypoxia, and were the first to observationally relate nutrient loads to remotely-sensed phytoplankton biomass and the contributions of this to hypoxic areas. This is a key metric used by the Mississippi River/Gulf of Mexico Hypoxia Task Force to manage Mississippi River nutrient loads. Research by Lehrter and his colleagues also demonstrated the usefulness of remote sensing data for developing numeric water quality standards for nutrients and for assessing water quality in estuarine and coastal settings.

Read about the research:

Le, C., **Lehrter, J.C.**, Hu, C., Murrell, M.C. & Qi, L. (2014). "Spatiotemporal chlorophyll-a dynamics on the Louisiana continental shelf derived from a dual satellite imagery algorithm." *Journal of Geophysical Research: Oceans,* 119(11) [doi: 10.1002/2014JC010084].

Lehrter, J.C., Ko, D.S., Murrell, M.C., Hagy, J.D., Schaeffer, B.A., Greene, R.M., Gould, R.W. & Penta, B. (2013). "Nutrient distributions, transports, and budgets on the inner margin of a river-dominated continental shelf." *Journal of Geophysical Research: Oceans,* 118(10) [doi: 10.1002/jgrc.20362].

Schaeffer, B.A., Hagy, J.D., Conmy, R.N., **Lehrter, J.C.** & Stumpf, R.P. (2012). "An approach to developing numeric water quality criteria for coastal waters using the SeaWiFS satellite data record." *Environmental Science & Technology,* 46(2) [doi: 10.1021/es2014105].

Who Uses Earth Science Data?

Kevin Gallo (R) with co-investigator Philip Schumacher (NOAA/National Weather Service, L) at a 2011 storm survey.

Kevin Gallo

Physical Scientist, National Oceanic and Atmospheric Administration (NOAA)/National Environmental Satellite, Data, and Information Service

Research interests: Gallo uses satellite and *in situ* data to validate NOAA operational satellite data and products. He is a member of the NOAA Geostationary Operational Environmental Satellite R-Series (GOES-R) Land Algorithm Working Group and is co-lead on developing the NOAA-U.S. Geological Survey (USGS) Land Product Characterization System (LPCS). The LPCS helps facilitate the characterization and validation of land-related products from GOES-R and the Joint Polar Satellite System (JPSS) Visible Infrared Imaging Radiometer Suite (VIIRS).

Current research focus: Gallo and his colleagues are working on developing hail validation and assessment products for the Advanced Baseline Imager (ABI), which is the primary GOES-R instrument for imaging Earth's weather, oceans, and environment.

Data products used:

Moderate Resolution Imaging Spectroradiometer (MODIS) data sets from NASA's Terra and Aqua satellites available through NASA's Land Processes Distributed Active Archive Center (LP DAAC) at https://lpdaac.usgs.gov/dataset_discovery/modis/modis_products_table:

- Daily surface reflectance and vegetation index products with 500 m and 1000 m spatial resolution (Terra: MOD09GA; Aqua: MYD09GA)
- Daily Land Surface Temperature utilized at 1000 m spatial resolution (Terra: MOD11A1; Aqua: MYD11A1)
- Combined Land Cover product on an annual time scale (MCD12Q1)

Additional data products Gallo uses include:

- Daily VIIRS gridded products (500 m spatial resolution), available through NASA's MODIS Adaptive Processing System (MODAPS) Level 1 and Atmosphere Archive and Distribution System (LAADS)
- Landsat 7 Enhanced Thematic Mapper Plus and Landsat 8 Operational Land Imager (OLI) 30 m data products, available through the USGS EarthExplorer website

Research findings: The ABI includes a near-infrared channel that permits computation of vegetation indices at five-minute intervals over the conterminous U.S. Gallo and his colleagues used MODIS and Landsat data to simulate GOES-R ABI vegetation index data. By comparing these simulated vegetation indices with observer- and radar-based assessments of hail damage and size, they found that GOES-R ABI vegetation index products—if available at a 1000 m spatial resolution—may be useful in validating the spatial extent and severity of hail events.

(Continued)

Read about the research:

Gallo, K., Dwyer, J., Foga, S., Jenkerson, C., Longhenry, R. & Stensaas, G. (2015). "NOAA-USGS Land Product Characterization System." STAR JPSS 2015 Annual Science Team Meeting. Presentation available online at http://www.orbit.nesdis.noaa.gov/star/documents/meetings/2015JPSSAnnual/dayFour/18_Session7c_Gallo_LPVS.pdf.

Gallo, K., Schumacher, P. & Boustead, J. (Principal Investigators) (2014). "Development of GOES-R ABI Hail Validation and Assessment Products." NASA GOES-R Proposal Abstract. Available online at http://www.goes-r.gov/users/risk-reduce/abstracts/Gallo_abstract.pdf.

Gallo, K., Smith. T., Jungbluth, K. & Schumacher, P. (2012). "Hail Swaths Observed from Satellite Data and Their Relation to Radar and Surface-Based Observations: A Case Study From Iowa in 2009." *Weather and Forecasting,* 27(3) [doi: 10.1175/WAF-D-11-00118.1].

Schumacher, P., **Gallo, K.** & Jungbluth, K. (2010). "Severe storm assessment using satellite data: Case studies from Iowa in 2009." American Meteorological Society 25th Conference on Severe Local Storms. Abstract available online at https://ams.confex.com/ams/25SLS/webprogram/Paper176192.html.

Who Uses Earth Science Data?

Cara Wilson

Research Scientist, Environmental Research Division of the Southwest Fisheries Science Center, National Oceanographic and Atmospheric Administration

Research interests: Understanding the biological and physical processes responsible for anomalous phytoplankton blooms, particularly summer blooms in the North Pacific. Wilson looks at several parameters, including sea surface height (SSH), sea surface temperature (SST), salinity, and ocean color. Ocean color is the only satellite parameter that measures a component of the biological system, and increased biological activity (such as blooms of organic material) can be assessed through these ocean color images.

Earlier in her career, Wilson participated in a number of cruises on scientific research vessels. These included examinations of silicon cycling in the North Pacific Subtropical Gyre; water sampling to locate hydrothermal sites in Antarctica; and surveys using the ALVIN submersible to locate hydrothermal vent sites on the Lucky Strike seamount in the Mid-Atlantic Ridge.

Current research focus: Along with her work on anomalous phytoplankton blooms, Wilson uses ocean color data to look at chlorophyll concentrations around Peninsula Valdes, Argentina. This location is an important calving ground for southern right whales. Since 2005, there has been an increase in right whale mortality in this area, with more than 90% of the deaths being calves less than three months old.

In another project, Wilson is working with Tracy Villareal of the University of Texas at Austin to compare satellite-detected ocean data with observations collected by Wave Gliders that crossed the Pacific Ocean. Wave Gliders are wave-propelled autonomous vehicles consisting of a float (which sits on the surface) and an underwater sub (which is connected to the float by a long tether). Four Wave Gliders were released in San Francisco in 2011; two had technical problems, but two arrived in Australia more than a year later.

Data products used:

- Moderate Resolution Imaging Spectroradiometer (MODIS) and Visible Infrared Imaging Radiometer Suite (VIIRS) chlorophyll concentrations derived from ocean color data. These data are available through NASA's Ocean Biology Distributed Active Archive Center (OB.DAAC).
- Salinity data from the Aquarius satellite (a joint NASA/Argentinean Space Agency mission), which are available through NASA's Physical Oceanography DAAC (PO.DAAC).
- SSH and SST data, both of which are available through NASA's PO.DAAC.

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Research findings: Wilson's research has led her to develop a hypothesis that internal waves generated off the Hawaiian Islands are breaking at the latitude where anomalous algal blooms occur. This process may be supplying additional nutrients to the surface layer, which contributes to the anomalous blooms. In her Peninsula Valdes study, Wilson and her colleagues found a statistical relationship between monthly densities of a specific species if phytoplankton (a diatom called *Pseudo-nitzschia* spp.) and the deaths of southern right whale calves.

In her comparison of satellite and Wave Glider data, Wilson and Villareal found good correlation between the satellite and Wave Glider SST and salinity data. A comparison of satellite sea surface salinity from Aquarius data and glider-measured salinity revealed thin areas of low salinity in the southwestern Pacific Ocean.

Read about the research:

Wilson, C., Sastre, A.V., Hoffmeyer, M., Rowntree, V.J., Fire, S.E., Santinelli, N.H., Ovejero, S.D., D'Agostino, V., Marón, C.F., Doucette, G.J., Broadwater, M.H., Wang, Z., Montoya, N., Seger, J., Adler, F.R., Sironi, M. & Uhart, M.M. (2015). "Southern right whale (*Eubalaena australis*) calf mortality at Península Valdés, Argentina: Are harmful algal blooms to blame?" *Marine Mammal Science* [doi: 10.1111/mms.12263].

Villareal, T.A. & **Wilson, C.** (2014). "A comparison of the Pac-X trans-Pacific Wave Glider data and satellite data (MODIS, Aquarius, TRMM and VIIRS)." *PLoS ONE,* 9(3) [doi: 10.1371/journal.pone.0092280].

Wilson, C., Villareal, T.A., Brzezinski, M.A., Krause, J.W. & Shcherbina, A.Y. (2013). "Chlorophyll bloom development and the subtropical front in the North Pacific." *Journal of Geophysical Research: Oceans,* 118(3) [doi: 10.1002/jgrc.20143].

Wilson, C. (2011). "Chlorophyll anomalies along the critical latitude at 30°N in the NE Pacific." *Geophysical Research Letters,* 38(15) [doi: 10.1029/2011gl048210].

Who Uses Earth Science Data?

Image courtesy of the University of Nebraska-Lincoln.

Jun Wang

Associate Professor, Department of Earth & Atmospheric Sciences, University of Nebraska-Lincoln

Research interests: Atmospheric composition and climate change; remote sensing of aerosols, clouds, and trace gasses and the effects of these on global weather and climate. Wang has been a science team member of NASA's Glory; Suomi National Polar-orbiting Partnership (Suomi-NPP); Tropospheric Emissions: Monitoring of Pollution, Aura, Deep Space Climate Observatory; and Climate Absolute Radiance and Refractivity Observatory missions, and is the co-lead of the aerosol working group for NASA's GEOstationary Coastal and Air Pollution Events mission.

Current research focus: Wang and his colleagues are studying the impacts and contributions of atmospheric aerosols and other particulates to atmospheric composition, global climate, and storm formation. This research includes examining the contributions of biomass burning in Central America to Southeastern U.S. weather patterns; satellite-depicted decadal change of Asian aerosol emissions and the effects of this on regional and global climate; and the use of satellite data to study changes in global surface particulate concentrations since 1999. "I hope to integrate satellite data with atmospheric chemistry models to understand how atmospheric aerosols are changing and how this change affects climate," says Wang.

Data products used:

- Moderate Resolution Imaging Spectroradiometer (MODIS) active fire data, which are available through the Earth Observing System Data and Information System (EOSDIS) Land, Atmosphere Near real-time Capability for EOS (LANCE) Fire Information for Resource Management System (FIRMS)
- MODIS aerosol product data (Terra: MOD04; Aqua: MYD04), which are available through NASA's Level 1 and Atmosphere Archive and Distribution System (LAADS) Distributed Active Archive Center (DAAC)
- Multi-angle Imaging SpectroRadiometer (MISR) data available through NASA's Atmospheric Science Data Center (ASDC) DAAC
- NASA Suomi-NPP Visible Infrared Imager Radiometer Suite (VIIRS) data
- Ozone Monitoring Instrument (OMI) sulfur dioxide and nitrogen dioxide data available through NASA's Goddard Earth Sciences Data and Information Services Center

(Continued)

Research findings: Wang and his colleagues used satellite data to build a conceptual model to help demonstrate the contributions of smoke and other aerosols from the burning of Central American biomass to severe storms in the Southeastern U.S. In another research project, Wang developed methods of explicitly modeling aerosol phase transitions and quantitatively investigating the implications of these phase changes to atmospheric aerosol forcing, visibility, cirrus cloud formation, and heterogeneous chemistry. Wang and his colleagues also devised methods of using satellite data to characterize wildfires, study fire weather, estimate aerosol emissions, and improve prediction of volcanic sulfur dioxide transport.

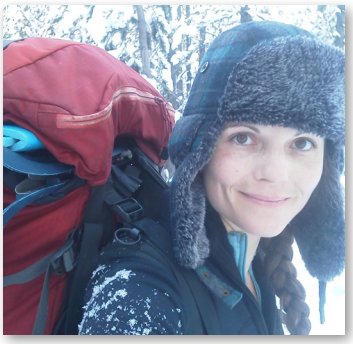
Read about the research:

Wang, J., Xu, X., Henze, D.K., Zeng, J., Ji, Q., Tsay, S.-C. & Huang, J. (2012). "Top-down estimate of dust emissions through integration of MODIS and MISR aerosol retrievals with the GEOS-Chem adjoint model, Geophys." *Geophysical Research Letters,* 39(8) [doi: 10.1029/2012GL051136].

Wang, J., Xu, X., Spurr, R., Wang, Y., Drury, E. (2010). "Improved algorithm for MODIS satellite retrievals of aerosol optical thickness over land in dusty atmosphere: Implications for air quality monitoring in China." *Remote Sensing of Environment,* 114(11) [doi: 10.1016/j.rse.2010.05.034].

Wang, J. & Christopher, S.A. (2006). "Mesoscale modeling of Central American smoke transport to the United States: 2. Smoke regional radiative impacts on surface energy budget and boundary layer evolution." *Journal of Geophysical Research: Atmospheres,* 111(D14) [doi: 10.1029/2005JD006720].

Who Uses Earth Science Data?



Kelly Gleason

Postdoctoral Research Ecologist, U.S. Geological Survey (USGS)

Research interests: Interactions of ecosystem disturbance and mountain hydroclimatology along with the associated implications for water resource availability in a changing climate.

Current research/work focus: For the past four years, Gleason has studied forest fire disturbance on snowpack energy balance and snowpack ablation in a recently burned forest in Oregon's Cascade Mountains. Her research seeks to shed new light on the effects forest fires have on snow hydrology. "I hope to improve our overall understanding of ecosystem disturbance and snowpack hydrology interactions," Gleason says. "This will provide useful tools to resource managers to better predict not only interactions of ecosystem disturbance, but also climate change effects to water resources in forested snow-dominated regions."

Data products used:

- Moderate Resolution Imaging Spectroradiometer (MODIS)/Terra Snow Cover 8-Day L3 Global 500m Grid, Version 5 (MOD10A2), which is available through NASA's National Snow and Ice Data Center (NSIDC) Distributed Active Archive Center (DAAC)
- MODIS vegetation continuous fields collection at a spatial resolution of 250 m. This collection, which is created from MODIS data available through NASA's Land Processes DAAC, provides proportional estimates for vegetative cover types: woody vegetation, herbaceous vegetation, and bare ground and is available through the Global Land Cover Facility at the University of Maryland
- National Monitoring Trends in Burn Severity (MTBS) burned area boundaries data set, which is vector polygon data derived from Landsat data

Research findings: Gleason found that between 2000 and 2014 80% of forest fires in the western U.S. occurred in the seasonal snow zone and that these fires were 4.4 times larger than those occurring outside the seasonal snow zone. Almost half (48%) of the forest fires in the seasonal snow zone occurred in the Columbia River Basin of the Pacific Northwest, which is an area with a vulnerable snowpack due to the warming climate.

From observational research, Gleason determined that in the winters following forest fires the more open canopy allowed 60% more sunlight to reach the snowpack surface, while the sloughing of charred debris from standing dead trees darkened the snowpack surface and reduced the snow albedo by 40%. These two factors led to a 200% increase in the amount of sunlight absorbed by the snowpack surface, which resulted in faster snowmelt in the burned forest. As a consequence, snow disappearance occurred three weeks earlier in burned areas than in the adjacent unburned forest.

Read about the research:

Gleason, K., Nolin, A. & Roth, T. (2013). "Charred forests increase snowmelt: Effects of burned woody debris and incoming solar radiation on snow ablation." *Geophysical Research Letters,* 40(17) [doi: 10.1002/grl.50896].

Who Uses Earth Science Data?

Lars Bromley

Principal analyst and a research advisor at the United Nations (UN) Institute for Training and Research Operational Satellite Applications Programme (UNITAR-UNOSAT)

Research interests: Bromley helps to improve the integration of satellite imagery and geospatial data in supporting global UN operations and activities in the areas of disaster response, humanitarian support, human security, and human rights. His work also involves using Moderate Resolution Imaging Spectroradiometer (MODIS) thermal anomaly data products to monitor violent conflicts and for human rights applications. "Imagery from MODIS and Landsat plays an almost daily role in UNOSAT activities," says Bromley.

Current research/work: Bromley monitors conflict dynamics and humanitarian operations in Syria, South Sudan, and elsewhere to support UN and non-governmental organization (NGO) operations. He recently completed an analysis of commercial high-resolution imagery in the eastern Democratic Republic of the Congo to document possible 2002-2003 settlement destruction to support the Office of the Prosecutor at the International Criminal Court. Bromley also is developing a Web-based system for analyzing the MODIS record of thermal anomalies to enable crowdsourced conflict monitoring and is advising a European Union-funded computing project that is developing tools for crowdsourced analysis of media from disasters, refugee settlements, and other issues of interest to the UN.

Data products used:

- MODIS Active Fire data, distributed by the Earth Observing System Data and Information System (EOSDIS) Land, Atmosphere Near real-time Capability for EOS (LANCE) Fire Information for Resource Management System (FIRMS)
- MODIS Near Real-Time imagery (250 m resolution, twice daily) from LANCE Rapid Response
- Landsat 5, 7, and 8 imagery accessed using the U.S. Geological Survey (USGS) EarthExplorer search engine

Research findings: Bromley's research linked MODIS-detected fires and thermal anomalies to reports of violence in the Darfur region of Sudan in 2003-2004, which formed the basis for the use of MODIS and other thermal anomaly detection systems for monitoring violent conflict. This method has been used to understand conflict dynamics in remote areas. Bromley presented these findings as evidence at the International Criminal Court in 2014 in relation to the 2007-2008 post-election violence in Kenya.

Read about the research:

Bromley, L. (2010). "Relating violence to MODIS fire detections in Darfur, Sudan." *International Journal of Remote Sensing,* 31(9) [doi: 10.1080/01431160902953909].

Bromley, L. (2009). "Eye in the sky: Monitoring human rights abuses using geospatial technology." *In Georgetown Journal of International Affairs: Women in Power,* Winter/Spring 2009, Volume X(I). Available online at http://issuu.com/gjia/docs/10.1_-_women_in_power/157.

Who Uses Earth Science Data?

Image of Deborah Balk courtesy of Morgado.

Deborah Balk

Professor, Baruch School of Public Affairs, City University of New York (CUNY) Graduate Center Doctoral Programs in Public Health, Sociology, and Economics; Associate Director, CUNY Institute of Demographic Research

Research interests: Urbanization in the developing world, including demographic behavior such as urbanization, fertility, and mortality (and related characteristics such as poverty). Balk's research uses a spatial framework to study the demographic impacts of climate-related hazards and adaptations to climate change.

Current research/work focus: Most of Balk's research is global, with a strong focus on Asia, Africa, and Latin America. Balk and her colleagues are working to create new, demographically informed methods to forecast city growth, both spatially and demographically. Balk also is looking at the determinants of spatial population change across scales, and examining if the factors that lead to changes in urbanization rates at the national level are the same as those driving city-growth throughout the rural-to-urban continuum. In a project with NASA's Jet Propulsion Laboratory, Balk is examining change in megacities in perspectives ranging from the geophysical to the demographic to characterize urban change vertically and horizontally.

Data products used: Data sets from NASA's Socioeconomic and Data Applications Center (SEDAC) at Columbia University, including:

- Gridded Population of the World
- Global Rural-Urban Mapping Project
- Shuttle Radar Topography Mission-derived Low Elevation Coastal Zone data

Additional data sets include:

- Scatterometer data from QuikSCAT
- National Oceanic and Atmospheric Administration (NOAA) Defense Meteorological Satellite Program nighttime lights and Visible Infrared Imaging Radiometer Suite (VIIRS), which are available through NOAA's Earth Observation Group
- Global Human Settlement Layer from the European Commission's Joint Research Centre

Research findings: Balk and her colleagues found that coastal zones are disproportionately urban. While 1 in 10 persons globally live in Low Elevation Coastal Zones (contiguous areas along a coast less than 10 meters [32.8 feet] above sea level) and thus are at greater risk of climate-related seaward hazards, 1 in 8 urban residents live in these zones. These ratios are much higher in Asia, where almost two-thirds of urban settlements with populations greater than 5 million occur in these zones. Climate change in these coastal settlement areas could lead to disasters that can be mitigated through a combination of migration and settlement modification.

In work on urbanization using satellite data to define urban extents in combination with demographic data, Balk found that city growth is driven by fertility, and that small cities are growing at much higher rates than large cities. Furthermore, cities are no longer effectively defined by an urban-rural dichotomy. By combining demographic and satellite data, urbanization is much better described as a continuum that incorporates peri-urban growth, the emergence of large urban agglomerations, and the development of small towns with urban characteristics.

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Balk also is examining the impacts of urban growth and its impact on freshwater availability. By 2050, almost 1 billion people will live in cities with perennial water shortages. At this point midcentury, climate change rather than demographic factors will cause water shortage for an additional 100 million people living in urban areas.

Read about the research:

Balk, D., et al. (2014). "The rising tide: assessing the risks of climate change and human settlements in low elevation coastal zones." In *Oceans and Human Health: Implications for Society and Well-Being*, edited by R.E. Bowen, M.H. Depledge, C.P. Carlarne & L.E. Fleming. New York: Wiley Blackwell.

Dorélien, A., **Balk, D.** & Todd, M. (2013). "What is urban? Comparing a satellite view with the demographic and health surveys." *Population and Development Review,* 39 [doi: 10.1111/j.1728-4457.2013.00610.x].

McDonald, R.I., Green, P., **Balk, D.,** Fekete, B.M., Revenga, C., Todd, M. & Montgomery, M. (2011). "Urban growth, climate change, and freshwater availability." *Proceedings of the National Academy of Sciences,* 108(15) [doi: 10.1073/pnas.1011615108].

Balk, D., Montgomery, M.R., McGranahan, G., Kim, D., Mara, V., Todd, M., Buettner, T. & Dorelien, A. (2009). "Mapping urban settlements and the risks of climate change in Africa, Asia, and South America." In *Population Dynamics and Climate Change,* edited by J.M.Guzmán, G. Martine, G. McGranahan, D. Schensul and C. Tacoli. New York: UNFPA; London: IIED. Available online at www.iied.org/pubs/pdfs/G02650.pdf.

Nghiem, S.V., **Balk, D.,** Rodriguez, E., Neumann, G., Sorichetta, A., Small, C. & Elvidge, C.D. (2009). "Observations of urban and suburban environments with global satellite scatterometer data." *ISPRS Journal of Photogrammetry and Remote Sensing,* 64(4) [doi: 10.1016/j.isprsjprs.2009.01.004].

McGranahan, G., **Balk, D.** & Anderson, B. (2007). "The rising tide: assessing the risks of climate change and human settlements in low elevation coastal zones." *Environment & Urbanization,* 19(1) [doi: 10.1177/0956247807076960].

Who Uses Earth Science Data?

Fred Huemmrich

Research Assistant Professor, Joint Center for Earth Systems Technology and affiliated with the Geography and Environmental Sciences Department, University of Maryland Baltimore County

Research interests: Ecosystem functions and how ecosystems respond to environmental conditions. Huemmrich's interests also include studies of plant physiological conditions through the use of optical signals from plant spectral reflectance and fluorescence.

Current research/work focus: Use of ground, aircraft, and satellite measurements of spectral reflectance and fluorescence to estimate the movement of carbon through an ecosystem. While Huemmrich is interested in developing approaches that are globally applicable, his fieldwork focuses on agricultural systems and high latitude ecosystems, including measurements of leaf canopy reflectance and carbon movement in a cornfield near NASA's Goddard Space Flight Center along with fieldwork in the boreal forests of Canada and the tundra of Alaska.

Data products used:

- Moderate Resolution Imaging Spectroradiometer (MODIS) subsets from the Oak Ridge National Laboratory Distributed Active Archive Center (ORNL DAAC), particularly Collection 6 MODIS surface reflectance data [doi: 10.5067/MODIS/MOD09A1.006, 10.5067/MODIS/MOD09CMG.006, 10.5067/MODIS/MOD09GA.006, 10.5067/MODIS/MOD09GQ.006, and 10.5067/MODIS/MOD09Q1.006]
- Carbon movement and meteorology data from Fluxnet, which are available through ORNL DAAC. These are tower measurements from specific sites, generally at 30 minute intervals
- Hyperion imaging spectrometer imagery available through the U.S. Geological Survey (USGS) EarthExplorer data search engine. Hyperion is an instrument on NASA's Earth Observing-1 (EO-1) satellite and provides globally distributed hyperspectral imagery

"This research would just not be possible without data from the NASA Earth science support of aircraft and spacecraft data collection platforms," Huemmrich says. "I am interested in studying the entire terrestrial biosphere, and satellite observations are the tool that allows this science."

Research findings: Huemmrich's high-latitude studies show that there are strong variations in the light use efficiency of different types of tundra plants (mosses, lichens, and vascular plants). This results in over three-fold differences in productivity occurring within just a few meters. As climate change will affect the relative growth rates of these different plant types, Huemmrich's research leads him to expect significant changes in tundra productivity patterns.

Huemmrich also has found that optical data as inputs into simple models can describe over 80% of the variance in ecosystem productivity without the use of any other inputs. In addition, the use of hyperspectral imagery can be used to observe spatial variability in productivity that is difficult to measure on the ground.

(Continued)

Read about the research:

Campbell, P.K.E., Middleton, E.M., Thome, K.J., Kokaly, R.F., **Huemmrich, K.F.,** Lagomasino, D., Novick, K.A., Brunsell, N.A. (2013). "EO-1 Hyperion reflectance time series at calibration and validation sites: stability and sensitivity to seasonal dynamics. *IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing,* 6(2) [doi: 10.1109/jstars.2013.2246139].

Huemmrich, K.F., Gamon, J.A., Tweedie, C.E., Campbell, P.K.E., Landis, D.R. & Middleton, E.M. (2013). "Arctic tundra vegetation functional types based on photosynthetic physiology and optical properties." *IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing*, 6(2) [doi: 10.1109/jstars.2013.2253446].

Who Uses Earth Science Data?

Cecile S. Rousseaux

Research Scientist,
Universities Space Research Association/NASA Global Modeling and Assimilation Office (GMAO)

Research interests: Effects of climate variability on phytoplankton composition using satellite data and global biogeochemical models. She also is working on a project addressing the effects of ice melt on the ocean biogeochemistry of the Arctic. As Rousseaux notes, "Changes in sea ice cover and runoff could potentially change the stratification, light, and nutrient levels of the Arctic waters. For example, increasing runoff in the future could deliver more nutrients and therefore support a higher production of organic matter in the waters of this region than currently observed."

Rousseaux is a member of the Suomi National Polar-orbiting Partnership and the Pre-Aerosol, Clouds, and ocean Ecosystem Science Teams.

Current research focus: Effects of climate on ocean biogeochemistry, specifically on phytoplankton. This includes the effects of periodic events such as El Niño and La Niña as well as constant changes such as the effects of increasing atmospheric carbon dioxide on the oceans.

Data products and tools used:

- NASA Ocean Biogeochemical Model (NOBM), daily, 2/3x1.25 degree resolution
- GMAO Modern-Era Retrospective Analysis for Research and Applications (MERRA), 2/3x1/2 degree resolution
- Moderate Resolution Imaging Spectroradiometer (MODIS) Aqua (Chlorophyll, Particulate Inorganic Carbon, Reflectance), daily, 9km available through NASA's Ocean Biology Distributed Active Archive Center (OB.DAAC)
- Sea-Viewing Wide Field-of-View Sensor (SeaWiFS) (Chlorophyll, Particulate Inorganic Carbon, Reflectance), daily, 9km available through NASA's OB.DAAC
- Visible Infrared Imager Radiometer Suite at 4km resolution (Chlorophyll, Particulate Inorganic Carbon, Reflectance), daily, 9km available through NASA's OB.DAAC
- MODIS Aqua and Terra (Clouds, Aerosols), monthly, 1 degree resolution
- Ozone Monitoring Instrument, daily, 1 degree resolution available through NASA's Goddard Earth Sciences Data and Information Services Center (GES DISC)

Research findings: Rousseaux and her colleagues detected a shift in phytoplankton composition during the El Niño to La Niña transition. Previously, researchers knew that the total phytoplankton concentration declines during El Niño events. Using the NOBM and the assimilation of SeaWiFS Ocean Color data, the team found that this decline was mostly a reflection of a decline in large, nutrient demanding phytoplankton (e.g., diatoms). While these large diatoms were declining, smaller, less nutrient-demanding cyanobacteria were able to take advantage of these conditions.

Read about the research:

Rousseaux, C.S. & Gregg, W.W. (2014). "Interannual variation in phytoplankton primary production at a global scale." *Remote Sensing,* 6(1) [doi: 10.3390/rs6010001].

Rousseaux, C.S. & Gregg, W.W. (2012). "Climate variability and phytoplankton composition in the Pacific Ocean." *Journal of Geophysical Research*: *Oceans,* 117(C10) [doi: 10.1029/2012JC008083].

Who Uses Earth Science Data?

Dennis Ojima collecting field data near the National Ecological Observatory Network (NEON) tower site on the Central Plains Experimental Range (CPER) in northeastern Colorado. Image courtesy of Dennis Ojima.

Dennis Ojima

Professor in Ecosystem Science and Sustainability and Senior Research Scientist, Natural Resource Ecology Laboratory at Colorado State University

Research interests: Ecosystem response to climate and land use change and biogeochemical responses to land use and climate changes. Ojima also has been involved with several regional efforts, including the Monsoon Asia Integrated Regional Study (MAIRS), the Northern Eurasian Earth System Partnership Initiative (NEESPI), the Global Land Project (GLP), and the North Central Climate Science Center (NC CSC).

As a member of the Intergovernmental Panel on Climate Change (IPCC), Ojima was part of the team that shared in the 2007 Nobel Peace Prize "for their efforts to build up and disseminate greater knowledge about man-made climate change, and to lay the foundations for the measures that are needed to counteract such change."

Current research focus: Ojima currently is examining natural resource management response strategies to climate change in the North Central U.S. In addition, he is studying pastoral system impacts and responses to climate and land use changes in the drylands of East Asia. Ojima's goal is to develop an increased understanding of the rate of changes taking place and to inform managers and decision makers of potential impacts and possible response options.

Data products used:

- Moderate Resolution Imaging Spectroradiometer (MODIS) Evapotranspiration (ET) data at 1 km resolution. Available through the Oak Ridge National Laboratory Distributed Active Archive Center (ORNL DAAC)
- MODIS Gross Primary Productivity (GPP) data at 1 km resolution. Available through the Land Processes DAAC (LP DAAC)
- MODIS Normalized Difference Vegetation Index (NDVI) and Enhanced Vegetation Index (EVI) data. Available through the LP DAAC
- Landsat landcover data available through the U.S. Geological Survey (USGS)

Research findings: Ojima's research reveals that the impacts of drought vary for different resource management entities. This, in turn, requires more nuanced information on the spatial and temporal aspects of drought. In addition, his research has shown that the vulnerability of social-ecological systems require more integrated process studies, and that land use and climate interactions need to be studied as part of the system matrix in order to understand the response of the system to perturbations.

(L to R) Greg Jenkins with Howard University students Ashley Henry, Virginia Cooper, and Mecca Islam in Senegal in 2013. Image courtesy of Greg Jenkins.

Greg Jenkins

Professor,
Department of Physics and Astronomy, Howard University

Research interests: Weather, climate, atmospheric chemistry, and air quality of West Africa.

Current research focus: Impact of dust aerosols on cloud microphysics and precipitation as it relates to mesoscale convective systems (MCSs) and tropical cyclones over the Eastern Tropical Atlantic Ocean; impact of dust aerosols on seasonal and inter-annual variability of rain in West Africa; relationship between dust content and vertical profiles of tropospheric ozone; prediction of winter/spring and summer dust storms using regional models; and the linkage between Saharan dust storms and respiratory disease.

This summer, Jenkins plans to participate in a field experiment in the Cape Verde Islands called Ice in Clouds Experiment-Dust (ICE-D). ICE-D will help improve the understanding and representation in models of the contributions from Saharan dust aerosols to the formation of ice nuclei and the contributions of these ice nuclei to cloud development.

Data products and tools used:

- Moderate Resolution Imaging Spectroradiometer (MODIS) (Terra and Aqua) aerosol products, available through the MODIS Level 1 and Atmosphere Archive and Distribution System (MODAPS LAADS) Distributed Active Archive Center (DAAC)
- Ozone Monitoring Instrument (OMI) aerosol products available through the Goddard Earth Sciences Data and Information Services Center (GES DISC)
- AErosol RObotic NETwork (AERONET); satellite-based products can be viewed interactively at http://giovanni.gsfc.nasa.gov/giovanni

"NASA Earth science data has been instrumental in data poor regions of the Sahara and eastern Atlantic, where the intensity and scale of dust events can only be quantified from satellite platforms and validated at AERONET sites," says Jenkins.

Research findings: Jenkins and his team note that Saharan dust may have a positive influence on tropical cyclone development through stronger updrafts, but the negative influences of the Saharan air layer can inhibit tropical cyclone development. In addition, they found that Saharan dust acts to reduce ozone concentrations in the middle troposphere (most likely due to heterogeneous chemical interactions on dust surfaces); however, there may also be a biogenic source of nitrogen, which may increase ozone concentrations at altitudes just below regions of losses. They also found a possible linkage between high aerosol optical depth (AOD) from MODIS/AERONET data and meningitis cases in Senegal based on data from 2012 and 2013.

Who Uses Earth Science Data?

Adnan Al-Azri

Associate Professor, Department of Marine Sciences & Fisheries, Sultan Qaboos University, Oman

Research interests: Phytoplankton ecology, long-term time series and biogeography, physical regulation of biological systems, algal blooms and phycotoxins in coastal zones, biogeochemical cycles and processes of the coastal zone and their impact on the marine food chain.

Current research focus: Al-Azri and his team are working to unlock the secrets of why periodic harmful blooms of algae, plankton, and other microorganisms are occurring in the Sea of Oman and the Arabian Sea—and what these blooms may mean for the biodiversity and industry of Oman and other Persian Gulf countries.

"Almost all the countries bordering the Persian Gulf are impacted by these blooms," notes Al-Azri. "For Oman, these harmful algal blooms pose a unique problem as our country … is not a major producer of oil but relies on fisheries, aquaculture, and tourism for its economy. Thick blooms have also been seen to cause coral reef mortality and impact the diversity of marine life."

Data products and tools used:

- Moderate Resolution Imaging Spectroradiometer (MODIS)-Aqua and Sea-Viewing Wide Field-of-View Sensor (SeaWiFS) Sea Surface Temperature and Chlorophyll Concentrations. Resolution: 4 km and 9 km. Data are distributed by the NASA Ocean Biology Processing Group
- Topography Experiment/Poseidon (TOPEX/Poseidon), Jason-1, Jason-2, Sea Surface Height Anomalies (merged data products). These data are distributed by NASA's Physical Oceanography Distributed Active Archive Center (PO.DAAC)
- Time series analysis and visualization of satellite data through the Goddard Earth Sciences Data and Information Services Center (GES DISC) Giovanni interactive data browser

"We use NASA's ocean color chlorophyll products to routinely study the evolution of these blooms and track their movement along the coast," notes Al-Azri.

Research findings: From an analysis of satellite sensor data and data collected at research stations along the coast of Oman, Al-Azri discovered that blooms caused by one species of harmful algae (*Cochlodinium polykrikoides*) are being triggered by low oxygen and nutrient-rich water brought to the surface by cyclonic eddies. In addition, it appears that human activities coupled with the unique oceanographic features of the Sea of Oman and the Arabian Sea also are contributing to the expansion of these blooms.

Who Uses Earth Science Data?

Rowena Lohman

Assistant Professor
Department of Earth and Atmospheric Sciences,
College of Engineering,
Cornell University

Research interests: Earthquake physics, inverse theory, satellite remote sensing, finite element modeling, ground displacements from a variety anthropogenic and natural causes, and the tectonics of southern California, Louisiana, the Cascadia subduction zone, and Iran. Her teaching interests focus on global geophysics, seismology, earthquake record reading, remote sensing, and active tectonics.

Lohman received a NASA New Investigator Program grant in 2011 to study subsiding deltas and sea level rise worldwide using space-based geodetic observations.

Current research focus: Global research related to fault zone behavior during and between earthquakes. Her primary area of interest involves the observation of fault behaviors that lie outside the standard 'stick-slip' model, where faults creep transiently in response to external stress changes. Lohman's research aims to improve our understanding of the constitutive laws governing stress release along fault zones, as well as the stress within the subsurface. In the future, she hopes to incorporate recent advances by researchers working on the contribution from tides and the hydrologic cycle into her models of fault zone behavior and stress histories.

Data products used:

- Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER) Digital Elevation Map (DEM) and Global Digital Elevation Map (GDEM) with variable resolutions. Data are available through the NASA Land Processes Distributed Active Archive Center (LP DAAC) or via NASA Earthdata Search
- Synthetic Aperature Radar (SAR) imagery (primarily Level 0 and 1). Data are distributed by the NASA Alaska Satellite Facility (ASF) DAAC
- Shuttle Radar Topography Mission (SRTM) DEMs, 30 and 90 meter. Available through the NASA LP DAAC or via the Global Data Explorer (GDEx)
- Landsat imagery, Level 1 with variable temporal and spatial resolutions. Available through the U.S. Geological Survey (USGS) Earth Explorer and the USGS Global Visualization Viewer (GloVis)

Research findings: "I have focused on small, shallow sources of deformation, including a M3.2 earthquake that occurred at ~700 meters depth in response to a local quarry blast in Chicago and a weeks-long shallow (<2 km) slip episode in a geothermal area in southern California," notes Lohman. "Both are areas where the depth range and thermal gradients are such that earthquakes should not nucleate; rather, stable sliding should dominate (i.e., they are 'velocity strengthening'). Only in the case of sudden stress changes or, potentially, material heterogeneities, should an earthquake be able to occur."

Image courtesy of Liz Inskip-Paulk, National Wind Institute, Texas Tech University

Eric Bruning

Assistant Professor of Atmospheric Science,
Department of Geosciences,
Texas Tech University (TTU),
Lubbock, TX

Research interests: Relationships of storm electrification and lightning to the thermodynamics, microphysics, kinematics, and dynamics of thunderstorms; impact of environmental thermodynamics on electrification and the conditions for lightning initiation and propagation.

Current research focus: Bruning was a member of the joint NSF/NASA/NOAA Deep Convective Clouds and Chemistry, or DC3, experiment, which investigated how lightning was a source of oxides of nitrogen and the contribution of this greenhouse gas to the ozone cycle. He currently participates as a member of the GOES-R Geostationary Lightning Mapper Science Team.

On a more local level, Bruning works with the West Texas Lightning Mapping Array (WTLMA) team to transition lightning science research into operations at the National Weather Service office in Lubbock, TX. He uses TTU's mobile Ka-band radars with WTLMA data to understand how turbulence in thunderstorms controls the size of lightning flashes in order to lay the foundation for future applications that relate thunderstorm meteorology and lightning production.

"The fluid and precipitation physics of the storm are inextricable from the lightning activity," he notes. "By understanding this link, we can improve our expectation of where lightning will start, where it will go, and how energetic it will be. These sound like very simple things, but we only now have the data to really relate the inner working of the cloud to the lightning activity."

Data products used:

- NASA's archive of optical lightning detection datasets from orbit, specifically the Optical Transient Detector (OTD) and Lightning Imaging Sensor (LIS), both of which are available through NASA's Global Hydrology Resource Center (GHRC) Distributed Active Archive Center (DAAC)
- Data from the ground-based Washington, DC, and North Alabama Lightning Mapping Arrays (LMA)

"The OTD/LIS climatology is also great for teaching," notes Bruning. "It is the best record we have of where and how much lightning happens around the globe."

Research findings: "We were excited to discover a pattern in the way electrical energy is distributed—it's in the same way that turbulence distributes kinetic energy," Bruning notes. "A region of the storm with more turbulence is expected to have a higher number of smaller flashes."

Bruning recently was awarded a National Science Foundation (NSF) CAREER grant to continue his research into how electrical energy is distributed in storm clouds and whether it covaries with measurements of turbulence in storms.

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