NASA Biodiversity & Ecological Forecasting

Understanding biological diversity and its effects on the Earth system to forecast changes and develop resource management strategies

Fall 2019

Updates Reminder

Please send us manuscripts that have been accepted to journals.

The best time to email is
- After manuscript is accepted
- Before it appears in print.

Please let us know of awards. This includes recognition from your institution or community for your (or your team's) research.

These updates help us advertise our program to the public, administration, and community.

NASA-CI Partnership

Over the last year, NASA ESD has continued it's partnership with Conservation International. This activity has fostered relationships with governments and on the ground stakeholders in Liberia, Botswana, Gabon, Vietnam, and elsewhere to advance the use of Earth Observation for global environmental protection.

Our teams are currently scoping broader efforts in the Okavango Delta and have recently made in-country visits to understand how this partnership can better serve the people living in this region. Please let us know of overlapping activities that might synergize.

(Right) Elephant herd at dawn in the Okavango. Image captured by NASA scientist Chris Neigh during NASA-CI engagement trip to Botswana.

An Ocean of Opportunity: OceanObs19

OCEAN OBS'19
AN OCEAN OF OPPORTUNITY
September 16-20, 2019

OceanObs is held every decade to **develop observation roadmaps and guide research and education for the marine community.** This year's OceanOps 19 (Sept 16-20th) was attended by approximately 1500 participants from around the world.

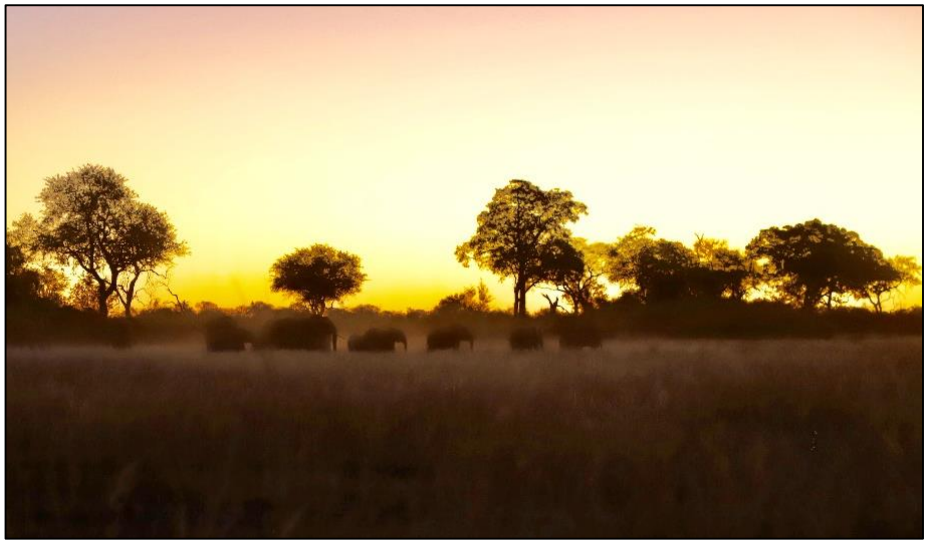
The NASA Ecological Forecasting Program and interagency MBON supported the Ecosystem Health and Biodiversity session, which generated three recommendations:

1) **Integrate biological observations into the global observing system** as an integral and necessary component of ocean ecosystem science and understanding,

2) Implement available technologies for biological observing now, **maximizing access to biological data and information** to quantify, explain, and forecast biodiversity changes,

3) Advance decadal plans for a fully encompassing **global ocean observing system that integrates biology, biodiversity, physical and biogeochemical observations**.

The OceanOb19 conference statement includes more details on the relevance of biodiversity. http://www.oceanobs19.net.



Solicitation Award Announcement

ECOSTRESS Science and Applications Team
NASA SMD solicited proposals for membership on the science and applications team for the ECOSTRESS instrument. Of 73 proposals received, NASA selected 15 awardees (listed below). For details on each of these projects, please check the NSPIRES website here.

Chuanmin Hu, University Of South Florida, Tampa
Thermal stress in South Florida estuaries: A multi-sensor assessment

Nicholas DeFelice, ICAHN School Of Medicine at Mount Sinai
Developing Spatial Real-Time Forecasts of Mosquito-Borne Diseases

Christine Lee, Jet Propulsion Laboratory
ECOSTRESS surface temperature for aquatic ecosystems

David Wethey, University of South Carolina
Heat and Desiccation Risk Prediction in Intertidal Shellfisheries

Dennis Baldocchi, University of California, Berkeley
How Much Water is Evaporated Across California?

Christoph Hecker, Universiteit Twente
Optimizing Geothermal Hotspot Detection

Kerry Cawse-Nicholson, Jet Propulsion Laboratory
Evaluating a CONUS-wide disALEXI Evapotranspiration product

Mary Whelan, Rutgers University, New Brunswick
New estimates of terrestrial Carbon and Water fluxes

Daniel Otis, University Of South Florida, Tampa
Temperature regimes and biodiversity in coastal upwelling zones

Helen Poulos, Wesleyan University
Predicting wildfire effects in an Arizona pine-oak forest

Jingfeng Xiao, University of New Hampshire, Durham
Understanding diurnal cycles of plant water use and carbon uptake with existing and new products

Christian Frankenberg, California Institute of Technology
Exploiting Diurnal Cycles in ECOSTRESS Observations

Joshua Fisher, Jet Propulsion Laboratory
Improvements to ECOSTRESS data for science and applications

Soe Myint, Arizona State University
Urban Greening and Water Conservation

Christopher Doughty, Northern Arizona University
Drivers of plant water use across tropical savannah-forest transitions

Upcoming Conferences

GEO Week 2019
Canberra, Aus. (11/4–11/9/19)

AGU 2019
San Francisco, CA (12/9–12/13/19)

American Meteorological Society
Boston, MA (1/12–1/16/20)

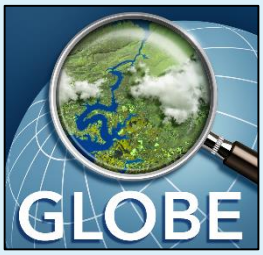
Society for Integrative and Comparative Biology
Austin, TX (1/3–1/7/20)

International Association for Landscape Ecology
Toronto, Canada (5/10–5/14/19)

Upcoming Training

GLOBE Data Fundamentals

Oct 31, 2019 (13:00-14:00 ET)
Registration: http://bit.ly/GLOBE-Data



This virtual training will **teach research scientists about GLOBE data and how to access them online**.

The Global Learning & Observations to Benefit the Environment (GLOBE) Program is an international, NASA-sponsored program with more than 150 million cumulative observations contributed by 150,000 citizen scientists across 120 countries. These include measurements of land cover, tree height, cloud formation, and more. The virtual training includes demonstrations of GLOBE's free online data access and visualization tools. Training is 60 minutes. No prior experience with GLOBE required.

Future Training - 2020 NASA ARSET Opportunities

January: **Tracking Vegetation Phenology with Remote Sensing**

Introductory Training - Use of remote sensing to understand phenology. Through the use of case studies, this training will guide participants on how to identify, integrate, and analyze phenological patterns.

March: **Using EO to Support National Conservation & Sustainable Development Priorities**

Webinar Series - How do countries use UN Biodiversity Lab to accelerate actions toward CBD and the 2030 Sustainable Development agenda? This training will be offered in English, Spanish, and French.

May: **Using SAR Data for Forest Monitoring**

Advanced Webinar Series - Use of SAR data for mapping land cover, mapping deforestation and forest degradation, and monitoring forest loss. This training will be offered in English & Spanish.

New Ecological Datasets

Recently published ecologically-relevant datasets in the ORNL DAAC:

PhenoCam Dataset v2.0
Vegetation Phenology from Digital Camera Imagery, 2000-2018.

Mexico EFT Map
Ecosystem Functional Type Distribution Map for Mexico, 2001-2014.

USA EFT Map
Ecosystem Functional Type Distribution Map for Conterminous USA, 2001-2014.

Global SIF Estimates
High Resolution Global Contiguous SIF Estimates from OCO-2 SIF and MODIS.

Awards and Recognition

2019 Blavatnik National Award for Young Scientists

*Heather Lynch (*Stony Brook University*)* was named Laureate of the Blavatnik award for her unique synthesis of cutting-edge statistics, mathematical models, satellite remote sensing and field biology to understand and predict the future of Antarctic penguins. Lynch is the first ecologist to win the award.

2019 NASA Government Invention of the Year Award

Ved Chirayath (Ames Research Center) and team members received second place award for their "Multispectral Imaging, Detection and Active Reflectance (MiDAR)" technology. This next-gen instrument demonstrates high frame-rate, signal-to-noise ratio multispectral imaging with hyperspectral potential.

2019 NASA Early Career Public Achievement Medal

Christine Lee (Jet Propulsion Laboratory) received this NASA Honor Award for her achievement developing and advancing applied science concepts for NASA programs, missions, and projects. Her work has improved water quality monitoring through partnerships with the management community.

70th Annual Arthur S. Flemming Award

John Bolten (Goddard Space Flight Center) received this award for his work in applying satellite remote sensing, land surface modeling and data assimilation to water resources management, agricultural forecasting and flood monitoring.

2019 Ames Honor Awards - Group Achievement Award

Jay Skiles (Ames Research Center) and the ARC Export Control team received the Group Achievement Award for commendable execution of the Scientific and Technical Information Program, supporting advancement of aerospace knowledge and US competitiveness in aerospace research and development.

Fellow of The Oceanography Society

Steven Ackleson (Naval Research Laboratory) was selected as a Fellow of The Oceanography Society. This award recognizes his fundamental contributions to understanding phytoplankton optical properties, radiative transfer models and the development and application of autonomous ocean observing systems.

2019 NASA Headquarters Team Excellence Award

Jaime Favors (NASA Headquarters) and the Earth Science Partnerships team received the Team Excellence Award for their work creating substantive outcomes in partnership with commercial and non-governmental organizations (including Conservation International, Google, Microsoft, and Mercy Corps)

Research Briefs

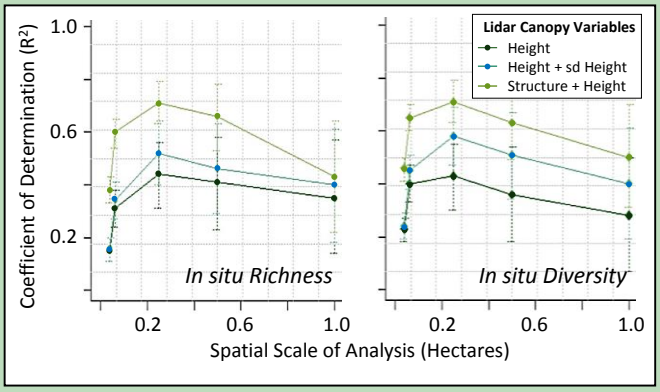
Forest Structure Predicts Tree Diversity

Marselis et al (2019) Environ Res Lett

The authors tested the ability of airborne LIDAR data products to predict tree species richness and diversity (Shannon-Wiener) measures gathered from four study sites in Gabon.

- Canopy height (used as a theoretical proxy for niche volume) predicted 44% of richness and 43% of diversity using linear models.
- Adding vertical canopy structure (used as a theoretical proxy for niche occupation) further improved the predictive capability to 71% for both dependent variables.

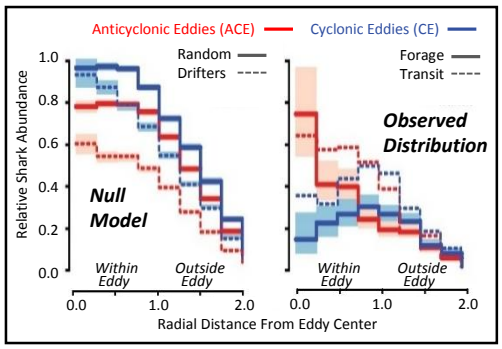
The modeling results are encouraging in the context of developing pan-tropical structure-diversity models applicable to data from current and upcoming spaceborne remote sensing missions.



The scale of analysis (spatial resolution of dependent and independent variables) determines the strength of the relationship between LIDAR canopy variables and in situ estimates of tree species richness and diversity. Variables with 0.25 ha pixels showed the strongest relationship for all combinations.

Blue Sharks Use Eddies To Forage in the Ocean Twilight Zone

Braun et al (2019) PNAS



Shark abundance within and outside ACE and CE under two null models (left) and as observed in reality when foraging and in transit (right). The figure shows sharks prefer the inner cores of ACE relative to CE.

Sharks leverage swirling ocean vortices (mesoscale eddies) as a means of diving and foraging in deeper waters. *Combining **shark movement data** gathered though satellite-transmitters and remotely sensed observations of **sea surface height variation***, the authors quantified specific shark–eddy interactions and explore the influence of these dominant oceanographic features on a model marine predator, blue shark.

This predator dives deep in warm, swirling water masses called warm-core (anticyclonic) eddies that have traditionally been considered ocean 'deserts.' Sharks use these warm features as a conduit to forage in the ocean twilight zone, a region of the deep ocean that contains the largest fish biomass on Earth, highlighting the importance of these deep ocean prey resources and their importance to this species.

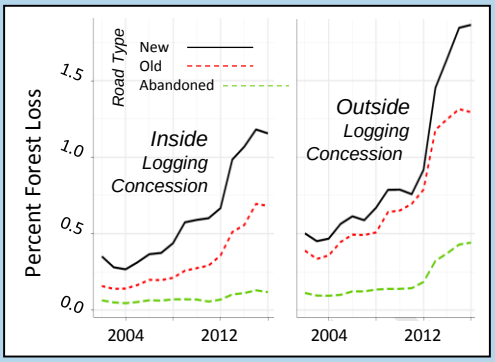
Roads and Deforestation Explode in the Congo Basin

Kleinschroth et al. (2019) Nat Sustain

Logging roads are expanding dramatically in the Congo Basin of Central Africa. Comparing Landsat derived road data, the authors found that

- Since 2003 the total length of road networks has increased by nearly 100,000 km—from 144,000 to 231,000 km overall.
- Deforestation rates have more than doubled along active roadways, particularly in areas outside of well managed logging concessions.

While road expansion has advanced at a faster rate within government granted logging concessions, deforestation rates are significantly reduced (from 2.5 to 0.9% per year) due to better management. This includes blocking access to roadways following extraction to allow forest regeneration.



Increase in forest loss within 1km of new, old, and abandoned roads in the Congo Basin of Central Africa.

Researcher Spotlight

Ben Carlson

PhD Candidate,
Yale University

Ben Carlson studies how individual animals respond to their environments and the patterns, causes, and consequences of variation in these “individual environmental niches” within and among populations. Individual variation influences species’ responses to global change, but many popular methods, such as species distribution modelling, ignore variation among individuals. Ben’s work leverages recent advances in the availability and resolution of both remotely sensed environmental data and animal tracking data, as well as platforms that aggregate and can link these data together, such as Movebank and Google Earth Engine. Pairing these data types enables analyses that relate fine-scale animal responses (like movement) to the local conditions that an animal actually experiences, as opposed to long-term mean variables which are uninformative at this scale. Time-series remote sensing data is essential to Mr. Carlson’s analyses, as it provides long-term, cross-comparable independent variables that can be matched with movement datasets gathered across space, time, and taxa. Mr. Carlson is a NESSF awardee, completing his dissertation in the lab of Dr. Walter Jetz.

- Mr. Carlson’s Website

Danielle Wood

Assistant Professor,
Massachusetts Institute of Technology

Dr. Danielle Wood leads the Space Enabled Research Group, whose mission is to advance justice in Earth's complex systems using designs enabled by space. One aspect of this work is to tailor space based technology to allow better decision making and foster work toward the UN SDGs. Their work includes designing applications of satellite earth observations and developing small satellite subsystem technology to explore how space activity can be more affordable and sustainable in the future. Dr. Wood’s work is interdisciplinary, combining design, art, social science, complex systems, satellite engineering, and data science. Through NASA support, she has partnered with governments and social entrepreneurs in Ghana and Benin to better manage forests, reduce illegal mining, and control invasive plants. This activity leverages time series of Landsat and Sentinel imagery to track forest cover loss, the spread of invasive species, and gold mining that causes water and soil degradation. Her work informs government and business decision making within both nations. Dr. Wood is as a professor at the MIT Media Lab and holds a joint appointment with the Dept. of Aeronautics and Astronautics.

- Dr. Wood’s Website

Recent Publications From The Program

Anhalt-Depies, C., J. Stenglein, B. Zuckerberg, P. Townsend, and A. Rissman. "Tradeoffs and tools for data quality, privacy, transparency, and trust in citizen science." Biological Conservation 238 (2019): 108195.

Bausell, J., and R. Kudela. "Comparison of two in-water optical profilers in a dynamic coastal marine ecosystem." Applied Optics 58, no. 27 (2019): 7319-7330.

Brancalion, P., A. Niamir, E. Broadbent, R. Crouzeilles, F. Barros, A. Almeyda, A. Zambrano, A. Baccini , J. Aronson, S. Goetz, J. Reid, B. Strassburg, S. Wilson, and R. Chazdon. "Global restoration opportunities in tropical rainforest landscapes." Science advances 5, no. 7 (2019): eaav3223.

Braun, C., P. Gaube, T. Sinclair-Taylor, G. Skomal, and S. Thorrold. "Mesoscale eddies release pelagic sharks from thermal constraints to foraging in the ocean twilight zone." PNAS 116, no. 35 (2019): 17187-17192.

Recent Publications From The Program (Continued)

Canonico, G., P. Buttigieg, E. Montes, C. Stepien, D. Wright, A. Benson, B. Helmuth, M. Costello, I. Sousa-Pinto, et al. "Global observational needs and resources for marine biodiversity." Frontiers in Marine Science 6 (2019): 367.

Chirayath, V., and A. Li. "Next-Generation Optical Sensing Technologies for Exploring Ocean Worlds-NASA FluidCam, MiDAR, and NeMO-Net." Frontiers in Marine Science 6 (2019): 521.

Gomes, H., Q. Xu, J. Ishizaka, E. Carpenter, P. Yager, and J. Goes. "The influence of riverine nutrients in niche partitioning of phytoplankton communities–a contrast between the Amazon River Plume and the ChangJiang (Yangtze) River diluted water of the East China Sea." Frontiers in Marine Science 5 (2018): 343.

Hobday, A., B. Muhling, E. Hazen, H. Arrizabalaga, J. Eveson, M. Roffer, and J. Hartog. "Bluefin Tunas in a Changing Ocean." The Future of Bluefin Tunas: Ecology, Fisheries Management, and Conservation (2019): 270.

Kleinschroth, F., N. Laporte, W. Laurance, S. Goetz, and J. Ghazoul. "Road expansion and persistence in forests of the Congo Basin." Nature Sustainability (2019): 1.

Kudela, R., S. Hooker, H. Houskeeper, and M. McPherson. "The Influence of Signal to Noise Ratio of Legacy Airborne and Satellite Sensors for Simulating Next-Generation Coastal and Inland Water Products." Remote Sensing (2019).

Marselis, S., H. Tang, J. Armston, K. Abernethy, A. Alonso, N. Barbier, et al. "Exploring the relation between remotely sensed vertical canopy structure and tree species diversity in Gabon." Environmental Research Letters (2019).

Maximenko, N., P. Corradi, K. Law, E. Van Sebille, S. Garaba, R. Lampitt, F. Galgani, V. Martinez-Vicente, L. Goddijn-Murphy, et al. "Toward the integrated marine debris observing system." Frontiers in Marine Science 6 (2019).

Pearlman, J., M. Bushnell, L. Coppola, J. Karstensen, P. Buttigieg, F. Pearlman, P. Simpson, M. Barbier, F. Muller-Karger, C. Munoz-Mas, P. Pissierssens, C. Chandler, J. Hermes, E. Heslop, R. Jenkyns, et al. "Evolving and sustaining ocean best practices and standards for the next decade." Frontiers in Marine Science 6 (2019): 277.

Seidel, V., D. Dourte, and C. Diamond. "Applying Spatial Mapping of Remotely Sensed Data to Valuation of Coastal Ecosystem Services in the Gulf of Mexico." Water 11, no. 6 (2019): 1179.

Serbin, S., J. Wu, K. Ely, E. Kruger, P. Townsend, R. Meng, B. Wolfe, A. Chlus, Z. Wang, and A. Rogers. "From the Arctic to the tropics: multi-biome prediction of leaf mass per area using leaf reflectance." New Phytologist (2019).

Shankar, A., C. Graham, J. Canepa, S. Wethington, and D. Powers. "Hummingbirds budget energy flexibly in response to changing resources." Functional Ecology (2019).

Suttidate, N., M. Hobi, A. Pidgeon, P. Round, N. Coops, D. Helmers, N. Keuler, M. Dubinin, B. Bateman, and V. Radeloff. "Tropical bird species richness is strongly associated with patterns of primary productivity captured by the Dynamic Habitat Indices." Remote Sensing of Environment 232 (2019): 111306.

Wilson, S., N. Hawco, E. Armbrust, B. Barone, K. Björkman, A. Boysen, M. Burgos, T. Burrell, J. Casey, E. DeLong, et al. "Kīlauea lava fuels phytoplankton bloom in the North Pacific Ocean." Science 365, no. 6457 (2019): 1040-1044.

Yan, J., W. Zhou, and G. Jenerette. "Testing an energy exchange and microclimate cooling hypothesis for the effect of vegetation configuration on urban heat." Agricultural and Forest Meteorology 279 (2019): 107666.

Yan, Y., T. Jebara, R. Abernathey, J. Goes, and H. Gomes. "Robust learning algorithms for capturing oceanic dynamics and transport of Noctiluca blooms using linear dynamical models." PloS one 14, no. 6 (2019): e0218183.

Zhang, J., G. Okin, and B. Zhou. "Assimilating optical satellite remote sensing images and field data to predict surface indicators in the Western US: Assessing error in satellite predictions based on large geographical datasets with the use of machine learning." Remote Sensing of Environment 233 (2019): 111382.

NASA Biodiversity and Ecological Forecasting

Woody Turner – Program Scientist, NASA HQ
Maury Estes – Program Associate, Marshall Space Flight Center
Cindy Schmidt – Program Associate, Ames Research Center
Jay Skiles – Program Associate, Ames Research Center
Keith Gaddis – Deputy Program Scientist, NASA HQ