

Landsat Data Reveals Greening Trend in the Arctic Tundra

When people think of the Arctic tundra, they may envision a chilly, dry region. The Earth Observatory site states that “Tundra is found in the regions just below the ice caps of the Arctic, and ... much of Alaska and about half of Canada are in the tundra biome. Temperatures are frequently extremely cold but can get warm in the summers.” Temperatures are cold enough that permafrost thrives in this environment. “In tundra summers, the top layer of soil thaws only a few inches down, providing a growing surface for roots of vegetation. Also, mosses, sedges, and lichens are common, while few trees grow in the tundra.” So: why are researchers finding grasses and shrubs in tundra are growing thicker and denser in a biome that is known for being bitterly cold?

On June 2, 2016, the NASA/Landsat site featured an article and video about research and discoveries by remote sensing scientist **Junchang Ju** (USRA) and Jeffrey Masek (GSFC), both in Code 618 at NASA Goddard Space Flight Center, on the greening of the Arctic. Their publication in *Remote Sensing of the Environment* was titled “The vegetation greenness trend in Canada and US Alaska from 1984–2012 Landsat data”: <http://dx.doi.org/10.1016/j.rse.2016.01.001>. Drs. Ju and Masek used 29 years’ worth of Landsat data to examine the changes in vegetation in Canada and Alaska, which are especially evident in the extensive greening in Quebec and western Alaska. This 4-million-square-mile area contains Arctic tundra, but shows that 30% of the region “greened up”, especially in shrublands, while about 3% showed a decline in vegetation productivity, or “browning”, found mostly in the boreal forests of eastern Alaska. They examined tens of thousands of images from Landsat data to examine this area. Dr. Ju explains that “[We] chose the tundra and boreal forest of North America because in 2015 NASA’s Terrestrial Ecology Program began conducting a field campaign in this area known as ABoVE – the Arctic-Boreal Vulnerability Experiment (<http://above.nasa.gov/>). In fact, our results have been used by a few ABoVE teams to guide their selection of sampling plots.”

For parts of the Arctic tundra biome located in higher latitudes, the temperature would decrease and as a result the vegetation would become sparser, perhaps to the point of disappearing. Dr. Ju states, “It is well known that temperature is the primary limiting factor for vegetation growth in the high latitudes; any change in vegetation is taken as an indication of temperature change. Of course, there are also secondary, local factors.” Note, while Landsat has the capability of measuring temperature, it is too infrequent to capture the temperature changes. Dr. Ju added that “at the lower latitudes (where forests are present), higher temperatures are believed to have caused “browning” in the forest, probably due to the temperature-induced water deficit.”
 (cont’d on page 2)



Dr. Ju: “The biggest surprise in the Landsat results is the extensive greening of tundra in Quebec. In northern Quebec, the tundra biomass is still very low, but Landsat data suggest that it is becoming higher with a strong trend.” The darker green indicates this strong trend in increased vegetation while brown indicates a decrease.

Image Credit: NASA’s Scientific Visualization Studio

(Arctic, cont'd)

From the research, however, Landsat data are reflecting different regional results. “With temperatures warming faster in the Arctic than anywhere else on Earth,” according to Dr. Masek, “[There is] a climate impact on vegetation in the high latitudes.” For example, plants have longer growing seasons and soils have undergone changes. As described in their article, shrublands are growing denser. These changes in climate can affect water and carbon cycles, and can include the melting of permafrost, thawing of soil, reduction in sea ice and other changes throughout the ecosystem. Other sources confirm this claim of warming temperatures in the Arctic, such as long-term weather records from globally distributed stations, e.g., the Climatic Research Unit Timeseries (CRU TS): <https://climatedataguide.ucar.edu/climate-data/cru-ts321-gridded-precipitation-and-other-meteorological-variables-1901>. Dr. Masek is Project Scientist for the upcoming Landsat-9, scheduled to launch in the early 2020s, and was the Project Scientist for LDCM (Landsat Data Continuity Mission) which launched in 2013 and became known as Landsat-8 in May 2013 when USGS took over operations.

Says Dr. Ju, “Earlier studies using coarser spatial-resolution data, such as AVHRR, first discovered the greening in the Arctic tundra and browning in the boreal forest, as we mentioned in the RSE paper. But when we look at the vegetation change pattern at the local scale, our Landsat results often do not agree with the AVHRR results. [For example,] ... the extensive greening of tundra in Quebec in the Landsat results [was not suggested by] the AVHRR results.” Further, “The Landsat data before 1984 are from earlier satellites and they are not accurately calibrated and corrected for analysis yet.”

Landsat is a joint NASA/U.S. Geological Survey program. According to the Landsat site, “the Landsat program [plays] a critical role in monitoring, understanding and managing the resources needed for human sustenance such as food, water and forests. As our population surpasses seven billion people, the impact of human society on the planet will increase, and Landsat monitors those impacts as well as environmental changes.” Landsat-1 launched July 23, 1972, with the goal of remote sensing of land from space. Forty-plus years of continuous data provide insight to changes in land use and land cover, as well as a global overview of human effects on land.

The satellites identify the amount of healthy plants on the ground by detecting visible and near-infrared light reflected by the green, leafy vegetation of crops, grasses, shrubs and trees. These findings will help scientists investigate what other environmental factors might impact plant growth in the Arctic. The research conducted by Drs. Ju and Masek provided an overview of the change in vegetation “by calculating per-pixel NDVI trend from all available 1984–2012 peak-summer Landsat-5 and -7 surface reflectance data.” As stated in their article, “Correlation studies with local environmental factors, such as topography, glacial history and soil condition, will be needed to understand the heterogeneous greenness change at the Landsat scale.” Going forward, Dr. Ju says, “We will correlate the satellite-measured vegetation change with temperature records and aerial-photo-derived vegetation height. Also, we’ll explore information content of satellite data other than the commonly used NDVI. Our priority is to establish a very reliable satellite-derived vegetation change record.”



Artist's rendering of LDCM. *Image Credit: NASA/GSFC Conceptual Image Lab*

Related Videos: “Vegetation Greening Trend in Canada and Alaska: 1984 – 2012”: <https://svs.gsfc.nasa.gov/4452>, posted on SVS, June 2, 2016; “Details of Arctic Greening in North America”: <https://svs.gsfc.nasa.gov/12225>, posted on Goddard’s YouTube channel, June 2, 2016; “The Changing Arctic”: <https://svs.gsfc.nasa.gov/12276>, posted on NASA Viz, June 7, 2016.

EVENTS

April is a busy time for earth sciences and science in general in the Washington, DC area. On April 16 and 17, 2016, the USA Science and Engineering Festival was held at the Walter E. Washington Convention Center and drew about 350,000 people. **Javier Concha** (616/USRA) helped out at the Earth Expeditions booth and CORAL activity. **Kristen Weaver** (612/USRA) staffed the GPM table with others from the GPM Outreach Team, where an estimated 2,500-3,000 people stopped by to learn about precipitation measurement and the water cycle. The **Science Program Support Office (SPSO) staff**, led by **Winnie Humberson** (610/GST), created various communication products and 23 hyperwall presentations were held during the event. **Matt Radcliff** (130.1/USRA) volunteered at the Landsat table, and discussed remote sensing with visitors to the exhibit.

A few days later, the Earth Day Festival was held at Union Station, Washington, DC from April 21 – 22. The NASA Viz app was featured at this event, and **Kayvon Sharghi** spoke with hundreds of people about the app and NASA's exploration of the solar system. Again, **Kristen Weaver** and the GPM Outreach Team staffed a table to discuss GPM-related items with the public. **Javier Concha** and **Ivona Cetinic** (616/USRA) along with others worked at the Ocean Ecology Lab table called "What Color is the Ocean?" Visitors to this exhibit worked with a hands-on activity involving a spectrophotometer and participated in Q&A with the scientists. Additionally, **Matt Radcliff** photographed several Landsat scientists and edited photographs of other Goddard Earth scientists that were part of a social media campaign of scientists at work created by the cross-agency Earth Right Now.

SPSO staff again this year coordinated activities for the Earth Day festival at Union Station. Several communication products were designed, produced and distributed to participants. **Kevin Miller** and **Heather Hanson** worked together to create a "Passport" Activity Guide, which listed all the hands-on activities on Earth Day – approximately 2,500 people completed hands-on activities to earn a special NASA information packet. Kevin, **Debbi McLean** and **Sally Bensusen** worked on posters, signage and hyperwall speaker schedules. **Eric Sokolowsky** assisted with the 40 hyperwall presentations. SPSO staff also included the



Tree of Thoughts at AGU 2015, San Francisco, CA (photo credit: NASA; image provided by SPSO.)

Tree of Thoughts, which made its debut at the AGU Fall Meeting in December 2015. The public is invited and encouraged to post their experiences of science in their everyday lives.

In late April, Dr. Piers Sellers, Deputy Director of Sciences & Exploration Directorate (600/GSFC), joined the Operation Ice Bridge Spring Arctic Campaign in Greenland. While with the OIB team, he was interviewed by several outlets, including WBEZ-91.5-Chicago for their project about climate change, Heat of the Moment. **Jefferson Beck** (130/USRA) spent much time supporting WBEZ in Greenland and contributing some photos to WBEZ's article: <http://www.heatofthemoment.org/features/astronaut>.



Piers Sellers in Greenland. Photo Credit: J. Beck, used in WBEZ's article "The Thin Blue Line".

The Sunday Experiment is a monthly program held on the third Sunday afternoon at NASA Goddard Space Flight Center's Visitor Center (see info here: <https://www.nasa.gov/content/goddard-visitor-center-events-and-programs>). The Visitor Center also holds monthly rocket launches on the first Sunday. *(Events, cont'd on page 5)*

AWARDS & ACCOLADES

On March 22, 2016, the 2015 Robert H. Goddard (RHG) Honor Awards Ceremony was held in Building 8 Auditorium. Of the 320 nominations received, 32 awardees were selected, including 3 GESTAR members. There were a variety of categories: Award of Merit, Engineering, Leadership, Mentoring, Mission & Enabling Support, Outreach, Professional Administrative, Quality & Process Improvement, Science (Individual and Team) and Technicians.

Outreach: **Helen-Nicole Kostis** (606.4/USRA) was recognized “For outstanding performance and implementation of a unique outreach program for a NASA mission and engagement of university students and faculty.”

Science: **Lok Lamsal** (614/USRA) was recognized “For exemplary satellite atmospheric composition retrieval development, scientific analysis, and promotion of NASA data to the scientific and sciences community.”

Exceptional Achievement in Engineering: **Jinzheng Peng** (555/USRA) was recognized as part of the SMAP Radiometer Level 1 Algorithm Development Team.

In May 2016, in a new category called “Data Stories”, the AAAS/Science prize was awarded to three videos, one created by a team from NASA GSFC’s Scientific Visualization Studio. For the video “Martian Atmosphere Loss Explained by NASA”, the SVS/Mars Atmosphere and Volatile Evolution (MAVEN) Science Team earned the Corporate Award and the People’s Choice Award. **Dan Gallagher, Joy Ng, Michael Lentz, Brian Monroe** (all 130/USRA), **Ernie Wright** (606.4/USRA) and others were recognized for efforts in visualizing data from a MAVEN spacecraft observing Mars and using animation to illustrate how solar winds may have helped to erode the upper atmosphere of early Mars.

On June 9, 2016 at NASA GSFC’s Rec Center, Code 130 (Office of Communications) held its Peer Award ceremony. Among those recognized were GESTAR/USRA members **Jefferson Beck** – For Excellence in Leadership, **Ryan Fitzgibbons** – For Collaboration and Teamwork, and **Robert Garner** – For Innovation and Improvement. Each awardee received a 2016 Peer Recognition Award signed and presented by the Office of the Director, Chris Scolese.

IN THE PRESS

In April, on DISCOVERY NEWS, President Barack Obama explained the effect of air pollution on our planet using OMI data. The video is just over a minute long and includes research by **Lok Lamsal** (614/USRA) and Bryan Duncan (614/GSFC) and work by SVS members **Trent Schindler, Sophia Roberts** and **Kayvon Sharghi** (of 606.4 and 130/USRA). Take a minute to check it out: <https://www.youtube.com/watch?v=LKe5FdKInJs>. (If this information looks familiar, Dr. Lamsal’s work on measurements of NO₂ was featured in the last issue of the GESTAR Newsletter.)

Also in April, the team at Earth Observatory (EO) featured **Santiago Gasso’s** (613/MSU) research on dust in this article: <http://earthobservatory.nasa.gov/blogs/earth-matters/2016/04/21/santiago-gasso-following-the-patagonian-dust-trail/>. (Previously in late February, Dr. Gasso had been featured on nasa.gov: “Santiago Gasso - Chasing Patagonian Dust to Volcanic Belches”: <http://www.nasa.gov/feature/goddard/2016/santiago-gass-chased-patagonian-dust-to-volcanic-belches>.)

On May 11th, EO’s Image of the Day (IOTD) titled “Studying Smoke Above the Clouds” featured research by **Kerry Meyer** (613/USRA), **Hiren Jethva** (614/USRA) and **Andy Sayer** (613/USRA): <http://earthobservatory.nasa.gov/IOTD/view.php?id=88013&src=iotdrss>.

Also in May, the work of Marangelly Cordero-Fuentes (610.1/SSAI) and **Oreste Reale** (610.1/USRA) was featured in this nasa.gov article: <http://www.nasa.gov/feature/goddard/2016/nasa-scientists-explain-the-art-of-creating-digital-hurricanes>, which included a video titled “Hurricane Forecasts Rely on Modeling the Past” (<http://svs.gsfc.nasa.gov/cgi-bin/details.cgi?aid=12206> (credits include **Ryan Fitzgibbons** (130/USRA), **Alex Kekesi** (606.4/GST) and **Kel Elkins** (606.4/USRA)).

On May 31st, **Joy Ng** (130/USRA) was profiled by nasa.gov; her interview can be found here: <http://www.nasa.gov/feature/goddard/2016/joy-ng-everything-s-impossible-until-somebody-does-it>.
(*Press, cont’d on page 5*)

maniac talk

GESTAR thanks the following scientists who recently presented talks: *Florence Tan*, NASA/GSFC (Apr 2016), *Jagadish Shukla*, NASA/GSFC (May 2016), *Richard Fisher*, NASA Headquarters (May 2016) and *Cynthia Rosenzweig*, NASA GISS (June 2016). These and other past talks are available online at the Maniac Talk site: <http://maniac-talk.gestar.usra.edu/> or at the SED Highlights page under Presentations: <http://science.gsfc.nasa.gov/sed/>. Please visit the Maniac Talk site to see the rest of the 2016 lineup. Thanks again to **Charles Gatebe** and Bill Hyrbyk for their ongoing efforts with these events.

(Events, cont'd)

This past March, **Erica McGrath-Spangler** (610.1/USRA) and **Manisha Ganeshan** (613/USRA) both participated in the Sunday Experiment titled “Clouds”, which addressed the questions What are clouds? Why do some clouds look different than others? The afternoon included activities, demonstrations and scientist presentations. Dr. McGrath-Spangler presented on satellites, astronauts on the ISS, modeling at GMAO, etc. and Dr. Ganeshan presented on the role of clouds in climate, why clouds need to be studied, and how NASA’s missions contribute to these studies.

Two months later on May 15th, over 130 adults and children attended the Sunday Experiment titled “Tour of the Electromagnetic Spectrum”. Among the volunteers presenting, **Erica McGrath-Spangler** along with Mike Taylor (618/SSAI) led an IR (infrared) Google demonstration so that participants could see near-infrared waves reflecting off healthy vegetation.

Also related to clouds, but in a different vehicle, a short summary and video were prepared by DEVELOP students who discuss the GOM-Air Quality project. These students were supervised by Rob Levy (613/GSFC) and **Pawan Gupta** (613/USRA). See <http://earthzine.org/2016/04/06/send-in-the-clouds-examining-air-quality-in-the-gulf-of-mexico/>. (Note: Dr. Gupta’s work with ARSET was profiled in the previous GESTAR newsletter.) To learn more about NASA’s DEVELOP program, visit <http://develop.larc.nasa.gov/index.php>.

(Press, cont'd)

On June 2nd, the EO’s IOTD titled “Arabian Peninsula Primed for Rift Valley Fever” featured work by **Assaf Anyamba** (618/USRA): http://earthobservatory.nasa.gov/IOTD/view.php?id=88125&eoqn=home&eoci=iotd_readmore. He and his colleagues have been researching RVE, a mosquito-borne disease, using remote sensing indicators for disease surveillance, work that is supported by the Department of Defense.

New Hires

GESTAR welcomes the following members:

Saulo de Freitas (Code 610)

Karla Longo de Freitas (Code 610)

SeungKuk Lee (Code 618)

Lisa Poje (Code 130)

Bridget Seegers (Code 616)

Moving On

Anika Cartas - SSAI

Charls Cote - SSAI

Lynn Parnell

Cynthia Randles

Sophia Roberts

GESTAR Holds Proposal Writing Seminar

GESTAR hosted an all-day proposal writing seminar on May 3, 2016 at NASA GSFC in Building 34. Drs. Peg AtKisson and David Morrison of the Grant Writers’ Seminars & Workshops, LLC led sections of the seminar titled “Write Winning Grant Proposals”. Attendees were provided with a handout and The Grant Application Writer’s Workbook. Of the 39 people who participated, two were with USRA in a different capacity, one was a manager, and the others represented NASA GSFC Codes 555, 606.4, 610.1, 610.2, 612, 613, 614, 615, 616, 617 and 618, which encompasses the breadth of GESTAR research and activities.

Overall, feedback was very positive, with comments such as “I wish I had heard this presentation years ago”, and “Very useful seminar”, as well as constructive comments such as “Would like a stronger focus on NASA vs. NSF proposals”, and “Would like to see examples of awarded proposals”. Several commented that they would apply what was learned to their next proposals.

Grants Awarded

Yuekui Yang (PI, 613/USRA), CloudSat/CALIPSO Science Team Reconnect, “Study of Longwave Radiative Effects of Antarctic Blowing Snow: a Synergy among CALIPSO, CERES, MODIS and Model Data,” includes **Manisha Ganeshan** (Co-I, 613/USRA) and several scientists from NASA/GSFC, SSAI, and University of Washington, 10/01/16 - 09/30/19.

Edward Nowottnick (Co-I/Collaborator, 614/USRA) will be a Co-I/Collaborator on the three-year grant titled “Evaluating the vertical variability of clouds and aerosols over large and small horizontal scales,” Matt McGill (PI, 612/GSFC), 04/08/16-04/08/19.

James Wang (614/USRA) was awarded a USRA PI Support Fund grant for his proposal titled “Simulations of Natural

Methane Fluxes for Improved Prediction of Carbon Cycle-Climate-Atmospheric Chemistry Feedbacks”. Funds will enable Dr. Wang to conduct initial studies and to develop additional grant proposals targeting funding opportunities within and outside of NASA.

Amanda Armstrong (618/USRA) also was awarded a USRA PI Support Fund grant for her proposal titled “Opportunity to Code a Forest Model at Helmholtz Center for Environmental Research → UFZ, Leipzig, Germany”. She will be working with a modeling group in Germany to develop a model in support of both the EO-1 Hyperion Vegetation Indices and Modeling project and the Remote Sensing Theory research.

Recent Publications

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GESTAR CELEBRATES

5!

In May 2011, USRA was awarded a five-year Cooperative Agreement for Goddard Earth Sciences Technology and Research (GESTAR). And in late May, NASA extended GESTAR for another five years through 2021! On Monday, May 9th, GESTAR celebrated the final year of its first five years. Members from USRA, MSU, GST, IMSG and JHU attended the anniversary party at the Rec Center at NASA GSFC to reminisce and look ahead. As part of the ceremony, which included toasts and short speeches, several people were recognized with GESTAR Annual Excellence Awards:

Susan Strahan: “For her exceptional contribution to stratospheric research and the study of trace gases.”

Yehui Chang: “For his expertise in two complementary facets of GMAO science: navigating GMAO computing systems and interpreting the results.”

Qingyuan Zhang: “For his progress in developing the fAPARchl remote sensing product.”

Sergey Korkin: “For his contribution in radiative transfer modeling and his successful development and application of SORD and IPOL models.”

Lynette Queen: “For her dedication, attentiveness and effort in successfully supporting and arranging travel for 20+ Earth Sciences Seminar Speakers.”



*Oreste Reale presents award to Susan Strahan.
 Photo Credit: A. Houghton*



Roger Shi presents award to Melanie Follette-Cook. Photo Credit: A. Houghton

Melanie Follette-Cook: “For her support of the NASA Earth Venture Suborbital DISCOVER-AQ project for five years.”

Pawan Gupta: “For his outstanding contributions to both the NASA Applied Remote Sensing Training (ARSET) program and the MODIS science team.”

(GESTAR, cont'd on page 10)

(GESTAR turns 5, cont'd)

Michelle Handleman: “For tirelessly working to share NASA stories with the widest possible audience through the live shot program.”

NASA SPSO Group Award: “For NASA’s Science Program Support Office’s instrumental role in NASA’s outreach efforts.” This award was presented to each of the following: **Winnie Humberson, Ryan Barker, Sally Bensusen, Steve Graham, Heather Hanson, Marit Jentoft-Nilsen, Mark Malanoski, Debbi McLean, Kevin Miller, Amy Moran, Ishon Prescott, Cindy Trapp, and Alan Ward.**



Jefferson Beck presents award to Michelle Handleman. Photo Credit: A. Houghton



SPSO Staff: Back Row - Ryan Barker, Alan Ward, Mark Malanoski, Jarrett Cohen; Middle Row - Amy Moran, Kevin Miller, Cindy Trapp, Debbi Mclean, Ishon Prescott and Steve Graham; Front Row - Sally Bensusen and Winnie Humberson. Photo Credit: A. Houghton

The GESTAR Team: Universities Space Research Association (USRA), Morgan State University (MSU), I.M. Systems Group (IMSG), Johns Hopkins University (JHU), Global Science & Technology, Inc.(GST), and Science and Technology Corporation (STC).
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The GESTAR Newsletter is published by GESTAR/USRA. Any comments/suggestions/ideas can be forwarded to Amy Houghton, Editor at ahoughton@usra.edu.