meeting/workshop summaries

The Spring 2010 NASA Land-Cover Land-Use Change Science Team Meeting

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The Spring 2010 NASA Land-Cover Land-Use Change (LCLUC) Science Team Meeting took place from April 20-22, 2010, in Bethesda, MD. The meeting involved 120 attendees, providing an opportunity for investigators to present their research results in the form of review talks and posters, and discuss the enhancement of the NASA Landsat Global Land Survey (GLS) projects. The presentations, posters, and breakout group reports from the meeting can be downloaded from: *ftp://ftp.iluci.org/LCLUC/LCLUCMeetings/2010_APR/*.

Opening Remarks

Garik Gutman [NASA Headquarters (HQ—*LCLUC Program Manager*] opened the meeting with an overview of the LCLUC program outlining the current relationships with other NASA programs and the national and international land cover related programs, as well as his plans for program expansion. Gutman expressed the need to refine the current scope of the LCLUC program to further enhance the social science component, while balancing the program thematically and geographically and with greater emphasis on non-forest land cover types. He noted the current tension between straight-line funding for the program and an increasing interest in this research area by the community—as indicated by the large number of submissions. Gutman asked for feedback on the program's two-step approach to the Research Opportunities in Space and Earth Sciences (ROSES) proposals, which is aimed at increasing the funding success ratio for the program.

Chris Justice [University of Maryland—*LCLUC Program Scientist*] identified a number of emerging issues for science team consideration, including:

- Higher order data products from the Landsat Data Continuity Mission (LDCM) and potential synergy with the European Space Agency (ESA) Sentinel 2 mission;
- the Committee on Earth Observation Satellites (CEOS) Land Surface Imaging Constellation;
- Land-Cover Change and the United Nations Collaborative Programme on Reducing Emissions from Deforestation and Forest Degradation in Developing Countries (UN-REDD);
- the Group of Earth Observations (GEO) Forest Carbon Tracking Task;
- the United Nations Framework Convention on Climate Change (UNFCCC) Essential Climate Variable process; and
- the possibility of a fine-resolution science data initiative with the National Geospatial-Intelligence Agency (NGA). Justice introduced a new *Hot Spots of Land-Use Change* initiative on the LCLUC program web page and invited program Principal Investigators (PIs) and their students to participate.

LCLUC 2010 Spring Meeting participants

Jonathan Smith [U.S. Geological Survey (USGS)] delivered an overview of the U.S. Global Change Research Program (USGCRP) and the activities of the Land Use Inter-Agency Working Group (LUIWG). The USGCRP is establishing new program management and has an emphasis on adaptation, mitigation, decision-support, and climate services. Smith emphasized continued participation by the various agencies in coordinating land-use research, demonstrating the importance of observations, refining global change dataset requirements, and enhancing national data collection capabilities.

Science Presentations

LCLUC in the Monsoon Asia Integrated Regional Study (MAIRS)

Atul Jain [University of Illinois, Urbana-Champaign] and **Hanqin Tian** [Auburn University] described two LCLUC projects which incorporate modeling to study land-cover changes and regional carbon and nitrogen interactions in monsoon and Southeast Asia. A land surface Integrated Science Assessment Model (ISAM) is being used to understand the impacts of LCLUC on ecosystems and carbon and nitrogen dynamics and emissions, and a Population-Economy-Technology (PET) model links trade to the biophysical feedbacks. A combination of Landsat, Moderate Resolution Imaging Spectroradiometer (MODIS), and Indian Remote Sensing Satellite (IRS) data is being used to quantify land-cover change and the associated carbon fluxes in India. This research points to the importance of nitrogen deposition and secondary forests as a major carbon sink in this region. Land-use change studies are projecting regional changes in the area of agricultural, primary, and secondary forest through to 2050 and evaluating the associated dynamics of surface roughness, irrigation, albedo, and latent heat.

Deforestation and urbanization are two key components of land-use change in monsoon Asia. **Annemarie Schneider** [University of Wisconsin-Madison] and **Peilei Fan** [Michigan State University] gave a review of urbanization in China describing the economic drivers of these changes and a climate modeling study being used to examine the impact of land-use changes since 2000. **Jefferson Fox** [East West Center] gave a review of LCLUC in mainland Southeast Asia, highlighting the importance of understanding both the biophysical and socioeconomic processes associated with LCLUC. Fox explained the widespread use of swidden agriculture and the recent expansion of rubber plantations. He emphasized that land-use change is pervasive throughout the region, much of which cannot be detected solely with remote sensing. Fox stressed the need to address the social and environmental consequences of LCLUC holistically, rather than through a series of individual case studies.

LCLUC in the Northern Eurasian Earth Science Partnership Initiative (NEESPI)

Volker Radeloff, with input from **Mutlu Ozdogan** [University of Wisconsin] and **Kirsten de Beurs** [Virginia Polytechnic Institute], described multi-scale influences of institutional change including open markets, subsidy withdrawal, and privatization, on farmland abandonment and logging in Eastern Europe. The extent and impact of institutional change is vastly different between countries in the region, although rural depopulation and agricultural sector decline are common. The strength of the institution appears to be the strongest explanatory variable. Permanent changes from complete farmland abandonment and decreased agricultural intensity are occurring in all countries of the region, with the highest abandonment rates closer to cities and at lower elevations on low slopes. Logging rates changed rapidly after the collapse of the Soviet Union, caused by several factors including decreased forest management and enforcement.

LeeAnn King, **Chris Justice**, and **Alyssa Whitcraft** [University of Maryland]

Bruce Forbes [University of Lapland] with input from **Skip Walker** [University of Alaska, Fairbanks] presented land-use changes and sea-ice cover decline in the Yamal Peninsula. Air temperature has warmed in the area over the last 30 years, adding to the changing social pressures of economic development. These factors are negatively affecting habitat of the reindeer population and thus the livelihood of the indigenous population. The research identified an average loss of 25% of sea ice, with as much as a 44% reduction resulting from the increase in summer warm temperatures.

Keith Eshleman [University of Maryland], with input from **Alexander Shiklomanov** [University of New Hampshire], **Vladimir Aizen** [University of Idaho], and **Sassan Saatchi** [NASA/Jet Propulsion Laboratory (JPL)/University of California, Los Angeles (UCLA)], presented the progress of projects at various scales and

with multiple data streams that are evaluating the effects of LCLUC and climate change on hydrological processes in the NEESPI region. A historical analysis has been undertaken on changes in components of the water cycle and the associated impacts of land cover and water use. The analysis points to the importance of climate change, although comparison of scenarios generated by different global climate models have exposed a wide variability in precipitation projections for the region. In general though, projections of future water balance show a wetter climate and higher runoff for most of the NEESPI region. This is in contrast to the overall drier conditions projected for Central Asia and Southern Europe. Further investigation of the drivers and impacts of LUC in the region are needed.

Breakout Sessions

Three breakout discussions groups were formed to discuss the role of case study *synthesis* in the LCLUC program, the LCLUC science needs for higher-order Landsat class products, and scoping adaptation and vulnerability research in the LCLUC program. Findings from these breakout sessions are outlined below and summarized in the meeting presentations.

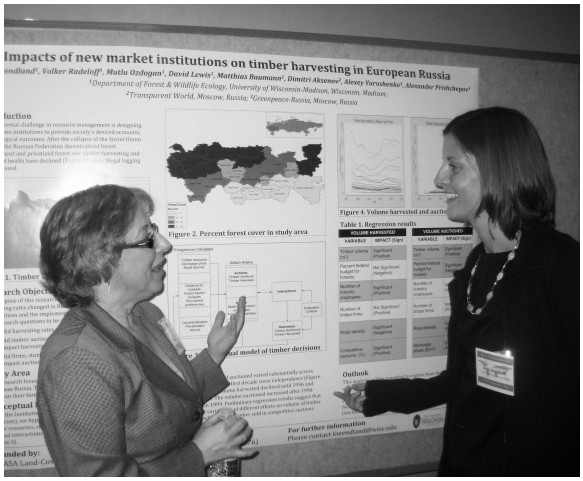
The *Case Study Synthesis* breakout group, co-chaired by **Jefferson Fox** and **Dave Skole** [Michigan State University], proposed to build *synthesis* by generalizing with an emphasis on causes and feedbacks. Two types of *synthesis* were identified: *vertical*, where social and physical studies are combined for an area; and *horizontal*, where various research projects of a similar nature are compared across a region. In general, the theme for LCLUC *synthesis* is understanding the drivers and consequences, their commonalities, and differences. The goal is to understand the implications of land management on land cover and use, biogeochemistry and climate, and the coupled natural/human systems. This type of synthetic analysis requires interdisciplinary collaboration from both social and physical sciences and is necessary, for example, for the study of carbon and hydrology in the various biomes and land-use systems.

The framework for *synthesis* could include across-scale analyses integrating from local to regional, urban, and rural interactions, land/water interfaces, and data integration and fusion. One approach suggested was to provide funding support for two to three larger integrated teams specifically for *synthesis*. Each regional team would be required to include individuals or groups with strong social science, natural science, modeling, and remote sensing. Linking established groups together on regional *synthesis* projects, rather than relying on individuals to incorporate *synthesis* within one project, could provide enhanced collaboration. Such integrated teams would require proof of already established and funded collaboration between social and physical scientists, producing quantitative results in the LCLUC arena. Suggested *synthesis* topics included interactions between urban and rural land-use and agriculture and forests. To facilitate such projects, the group expressed the necessity of having a community LCLUC model, identifying emerging or increasingly important drivers along with data synthesis in support of the model. Some near-term synthesis support activities were suggested including data exchange, mini-workshops for regional synthesis working groups, and targeted special issues.

The *Adaptation and Vulnerability* breakout group, co-chaired by **Kirsten de Beurs** and **Volker Radeloff**, identified a number of challenges associated with evaluating *adaptation* and *vulnerability* at any scale, including the varying definitions and contexts. The question was raised on how to focus adaptation and vulnerability for LCLUC. The discussion resulted in a working definition of *adaptation* as long-term changes in land-use as a response to changes in institutional policy, economic development, and climate and their interactions, with ranging impacts on agriculture, grazing, forestry, etc. A land-use *adaptation* matrix was developed to help guide program implementation. Additional dimensions of *vulnerability* and *adaptation* identified included the social scale, the temporal scale, regional variability, and differences between developing and developed countries, etc.

A key *adaptation* question is to establish which stressors trigger the most land-use change and identify the main *adaptations* to each stressor. A synthesis workshop series was suggested for the LCLUC program to identify past examples of *adaptation* using the strength of the satellite data record to identify where the major *adaptations* will take place in the future and which areas are most vulnerable to each stressor/land-use combination. These workshops would each result in a review paper.

The *LCLUC Requirements for Higher-order Landsat-class Products* breakout group was co-chaired by **Jeff Masek** [NASA Goddard Space Flight Center (GSFC)] and **David Roy** [South Dakota State University]. The group identified the current Landsat products being generated by the USGS and the Global Land Survey Project, as well as the evolving plans for LDCM to generate standard *surface reflectance* products. It was pointed out that a suite of higher order science products could be developed from LDCM, as was done for MODIS, but that some products would require other data fusion, integration, or calibration to be generated reliably. The group recognized that L1T processing, atmospheric and bidirectional reflectance distribution function (BRDF) correction, cloud and snow masks, and per pixel quality assurance are all prerequisites to the generation of higher order products. Pan-sharpened imagery are needed as standard products.



Kelly Wendland [University of Wisconsin-Madison] and **Olga Krankina** [Oregon State University]

The group also identified the need for individual path-row products, as well as continental mosaics, composited and near-real-time products, and the recent progress in these areas. The group noted that the NASA Earth Science Data Record (ESDR) Whitepaper for Land Cover and Change is still relevant in terms of products and that there is a growing expectation for *Essential Climate Variables* to be generated at Landsat resolutions. A number of new products associated with LCLUC were identified. The group identified areas for research on new product development, including automated change detection and object oriented classification. It was recognized that further research is needed to develop the standard products that could be generated in the LDCM era and that some of the underpinning product development could be supported under LCLUC projects.

Fellowship Presentations

NASA Earth and Space Science Fellowship (NESSF) fellows gave short presentations explaining their LCLUC related research topics and the progress made since their NASA funding began. **Marcia Macedo** [Columbia University] presented her project aimed at improving the understanding of how land-use change effects the connectivity of streams and the health of freshwater fish communities. **Maxim Dubinin** [University of Wisconsin-Madison] presented his work on evaluating the effect of land-use change on fire, vegetation, and wildlife dynamics in arid grasslands of Southern Russia. Presentations were also provided by scientists receiving funding from NASA's New Investigators Program. **Yufang Jin** [University of California, Irvine] described fire-induced changes in albedo and the associated radiative forcing for boreal Canada and the Australian tropical savannas. **Robert Kennedy** [U.S. Forest Service] is working to detect differences in anthropogenic and natural changes in landscape vegetation of national parks in the western United States.

The Global Land Survey (GLS) and Related Product Research

Major objectives of the meeting included review and status of projects supported to develop regional land cover and change products utilizing the GLS. **Jeff Masek** gave an overview of the GLS program. Project updates were then presented by:

- **Matt Hansen** [South Dakota State University], on regional scale estimation of forest-cover change in humid tropics using multi-scale data;
- **Dave Skole**, on using Landsat data to enhance global observations and information on tropical forest change;
- **John Townshend** [University of Maryland, College Park], on LCLUC and NASA Making Earth System data records for Use in Research Environments (MEASURES) funded research that evaluates three decades of forest-cover change in the Americas using Geocover and GLS datasets;
- **Chandra Giri** [USGS], on the global mapping of mangrove forests;
- **Xiangming Xiao** [University of Oklahoma], on the development of classification products for monsoon Asia using Landsat and Advanced Land Observing Satellite (ALOS)/Phased Array type L-band Synthetic Aperture Radar (PALSAR) imagery; and
- **David Roy,** on the status of a MEASURES Web-enabled Landsat data (WELD) project that generates continental scale Landsat composites. An open discussion on LCLUC data initiative priorities and future steps followed. There was a consensus that LCLUC should continue the development of the GLS, the use of multiple sources of Landsat-class data, and the associated regional and continental scale higher-order science products.

Landsat, Data Gap Studies, LDCM, and Beyond

Presentations provided an overview on sensor performance for LCLUC observations, discussing data gap and data fusion studies, and systematic geometric effects. **Gyanesh Chander** [Earth Resources Observation and Science (EROS) Data Center] reported on the evaluation and comparison of IRS-P6 Advanced Wide Field Sensor (AWiFS) and the Landsat sensors while **Mary Pagnutti** and **Robert Ryan** [Innovative Imaging and Research] explained BRDF impact in AWiFS data. **Sam Goward** [University of Maryland] presented analysis on the assessment and removal of systematic geometric effects on IRS AWiFS/Satellite Pour l'Observation de la Terre (SPOT) images.

Jim Irons [GSFC] discussed the status of Landsat 5/7 and the progress of the LDCM. The NASA Agency Management Council confirmed that the LDCM is ready for the final design and fabrication phase of mission development following a December 16, 2009 review. The confirmed LDCM payload now includes a Thermal Infrared Sensor (TIRS) in addition to the Operational Land Imager (OLI) with a target December 2012 launch date. **Curtis Woodcock** [Boston University—*Landsat Science Team and Global Observation of Forest and Land Cover Dynamics (GOFC-GOLD) Land Cover Co-Chair*] presented the priorities of the Landsat science team and his work on systematic land-cover validation, explaining that the maturity of the land-cover community results in an increasing emphasis on validation and accuracy, which is essential for progress.

Gyanesh Chander reported on recent developments with the CEOS Land Surface Imaging Constellation.

Bryant Cramer [USGS] presented different aspects of USGS involvement with Landsat. Current efforts include developing a multi-source data acquisition plan to mitigate a potential Landsat data gap and augmenting the single data stream from LDCM. In the latter context, USGS is working with the ESA on possible joint operations of LDCM and Sentinel 2. He noted that additional funding is needed for USGS LDCM operations and any data buys associated with filling a Landsat data gap; he also stated that the funding pathway for an operational Landsat program is not evident. Following his talk, there was an animated discussion from the community on the need to build two OLI instruments while a plan for the future of U.S. land imaging is being formulated; the need for NASA to stay actively engaged at the highest level in the future of the Landsat program; the requirement for higher temporal frequency from Landsat class observations (2-3 day coverage); and the comparatively rapid deployment of Landsat class systems by other nations.

Garik Gutman made concluding remarks for the meeting. Gutman emphasized the need for continued community participation in developing the LCLUC Program through science team meetings and welcomed feedback on: the program direction and research priorities, the observations and datasets needed for LCLUC, the current two-step proposal process, and the format for the meetings. He highlighted plans for future meetings and, in particular, the Fall LCLUC Regional Science Workshop in Tartu, Estonia (August 25-28, 2010). ■

Atmospheric Infrared Sounder Science Team Meeting Summary

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Sharon Ray [JPL] described recent AIRS education and public outreach activities. These include AIRS views of the eruption material from Iceland's Eyjafallajökull volcano, a "Best of Green 2010" Award from *TreeHugger.com* for CO_2 data, and a press conference at the Fall AGU meeting that led to articles in the New York Times and other national media outlets.

Session 7: Calibration Status ***[Chair**: Denis Elliott]*

Denis Elliott [JPL] summarized the development of a new set of calibration coefficients to be used in the *Version 6* Level 1C software. The primary reason for the new coefficients is to improve the absolute calibration of AIRS and associated uncertainties. The new coefficients result in small changes to AIRS radiances that have no impact on the use of AIRS for weather prediction, but do have the potential for improving AIRS' utility for the detection of climate trends.

Evan Manning [JPL] described Level 1B and Level 1C status. Level 1B for *Version 6* will have an improved determination of instantaneous channel frequencies. Changes include real-time monitoring of narrow spectral lines and better monitoring of dead and very noisy channels. These changes will be implemented in *Version 6* Level 1B. Manning also described Level 1C spectral processing using ECMWF as a stability standard. Tests of the new spectral calibration show that the cleaning and resampling algorithms work very well.

Steven Broberg [JPL] described a proposed on-board channel-by-channel gain and circumvention threshold table for the AIRS instrument. The table has been replaced three times since launch—but has not been updated since November 2003. Since then, the build up of total radiation dosage and degraded noise performance have led to the loss of some channels. Analysis of special calibration sequences showed that 163 channels could be significantly improved by the proposed weight changes.

Session 8: Version 6 Wrap Up and Action Items; Version 7 Ideas and Plans ***[Chairs**: Tom Pagano and Steve Friedman]*

This session was a group discussion of additional changes to *Version 6* and possible modifications for *Version 7*. ■

Adios El Niño, Hello La Niña?

Alan Buis, NASA Jet Propulsion Laboratory, alan.buis@jpl.nasa.gov

The latest image of Pacific Ocean sea surface heights from the NASA/European Ocean Surface Topography Mission/Jason-2 oceanography satellite, dated June 11, 2010, shows that the tropical Pacific has switched from warm to cold during the last few months. The lightest area in the center of the image depicts the recent appearance of cold water hugging the equator, which the satellite measures as a region of lower-than-normal sea level. Remnants of the El Niño warm water pool, shown here in dark pixels, still linger north and south of the equator in the center of the image.

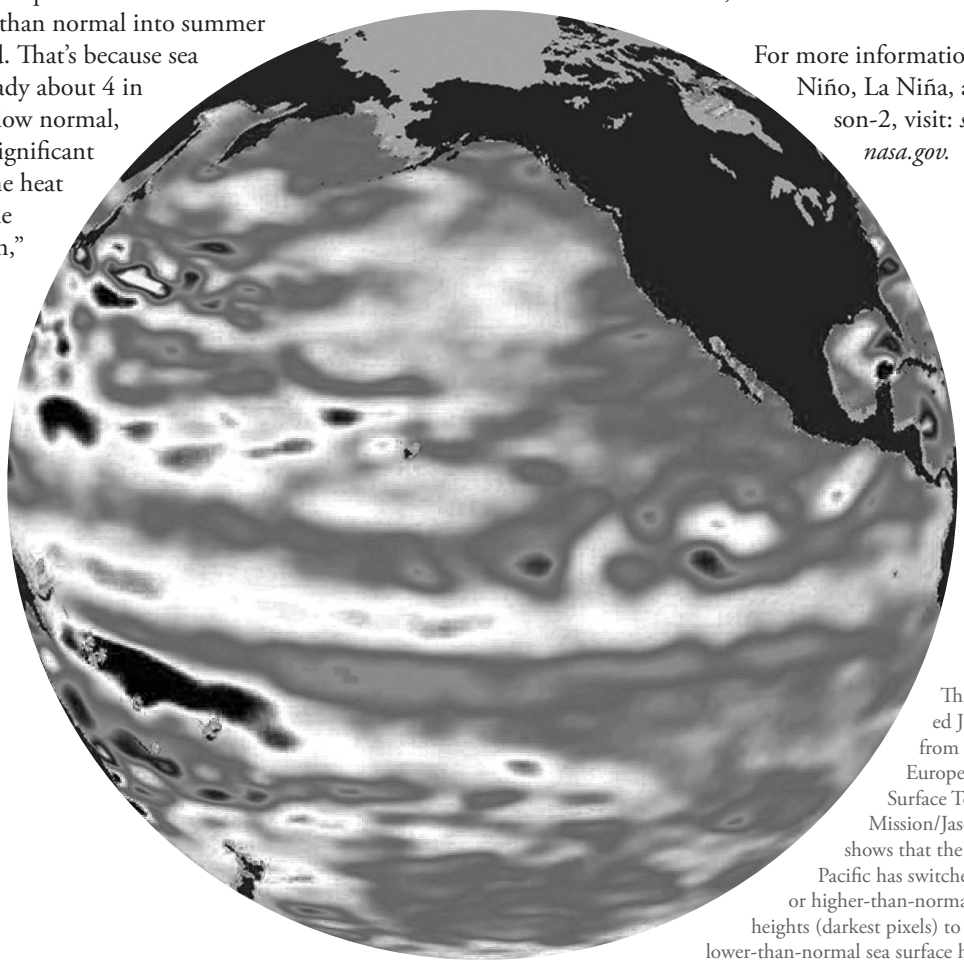
The image shows sea surface height relative to normal ocean conditions. The darkest areas are about 4 in (10 cm) above normal. Mid toned areas indicate near-normal conditions. Lightest areas are 2–5 in (5–13 cm) below normal.

"The central equatorial Pacific Ocean could stay colder than normal into summer and beyond. That's because sea level is already about 4 in (10 cm) below normal, creating a significant deficit of the heat stored in the upper ocean," said JPL oceanographer and climatologist **Bill Patzert**. "The next few months will reveal if the current cooling trend will eventually evolve into a long-lasting La Niña situation."

A La Niña is essentially the opposite of an El Niño. During a La Niña, trade winds in the western equatorial Pacific are stronger than normal, and the cold water that normally exists along the coast of South America extends to the central equatorial Pacific. La Niñas change global weather patterns and are associated with less moisture in the air, resulting in less rain along the coasts of North and South America. They also tend to increase the formation of tropical storms in the Atlantic.

"For the American Southwest, La Niñas usually bring a dry winter—not good news for a region that has experienced normal rain and snowpack only once in the past five winters," said Patzert.

For more information on El Niño, La Niña, and Jason-2, visit: *sealevel.jpl.nasa.gov.* ■



This image, dated June 11, 2010, from the NASA/European Ocean Surface Topography Mission/Jason-2 satellite shows that the tropical Pacific has switched from warm, or higher-than-normal sea surface heights (darkest pixels) to cold, or lower-than-normal sea surface heights (shown in lightest pixels) during the last few months. To view this image in color, please visit: *www.nasa.gov/topics/earth/features/laninaImage20100622.html.* **Image Credit:** NASA/JPL Ocean Surface Topography Team