National Aeronautics and Space Administration

2012 Annual Report

NASA Earth Science Applied Sciences Program

Letter from the Director

Lawrence Friedl, Director, Applied Sciences Program

Welcome to the NASA Applied Sciences Program's 2012 Annual Report. The year was full of progress and results in applying Earth science data and models to improve decision making, productivity, and quality of life. The Program continues to promote novel applications, build capacity, and engage people in satellite mission planning. This report features some of our accomplishments in 2012.

A number of projects addressed major events and challenges. In response to Hurricane Sandy, a project employed data from *Suomi NPP* to identify areas without power. The information aided FEMA, USACE, and others to assess power restoration efforts, allocate resources, and distribute relief supplies more effectively. Based on another project, the U.S. Forest Service rolled out a NASA-developed carbon assessment tool to the National Forest System. Using *Landsat* data to create maps of forest disturbance, the tool helps forest managers monitor carbon stocks and make decisions on timber use, grassland management, and habitat conservation.

Several projects outside the public eye informed decision making and policy. Applying data from *Aqua*, *Terra*, and NASA's LIS system, a project involving the National Drought Mitigation Center characterized a "flash drought" in Alabama and its impact on corn yields. The project's results led to Alabama irrigation tax credit legislation passed in 2012. In partnership with CDC, a project integrated satellite-based environmental data sets into CDC's online WONDER information system, assisting health professionals to account for environmental risks and promote public health. Initiatives in Africa expanded the use of the CREST hydrological model and *TRMM* data to aid local authorities with farming practices, water management, and early warnings of floods.

The past year was noteworthy for awards. Inside this report are stories of a project that won awards for technology transfer and science delivery, a team that won a Wildlife Society award, and a DEVELOP mentor who won NASA's Exceptional Public Achievement Medal. You'll also learn that NASA gained a place in a GIS hall of fame.

We continued key initiatives and pursued new activities in 2012. We completed more socioeconomic impact analyses of our projects and hosted events on socioeconomic benefits of Earth observations. ARSET and DEVELOP had record-breaking years in participation and scope, and SERVIR launched a new website. We supported more climate risk workshops with NASA Centers on their climate adaptation planning. We initiated bimonthly program reviews and introduced associate program managers to further our engagement with project teams. We again sponsored an Ignite-style event at the American Geophysical Union annual meeting, and we launched a mobile app.

We want to thank Cassandra Nuñez, who was the AAAS Science & Technology Policy Fellow with Applied Sciences in 2011–2012, for her contributions. We also remember Greg Leptoukh and Rob Raskin, who passed away in 2012. Each of them supported broader efforts to make data readily accessible and usable to inform decisions.

On behalf of the Program, I want to thank our project teams and partners for their innovation, enthusiasm, commitment, and rigor in applying Earth observations for societal benefit.

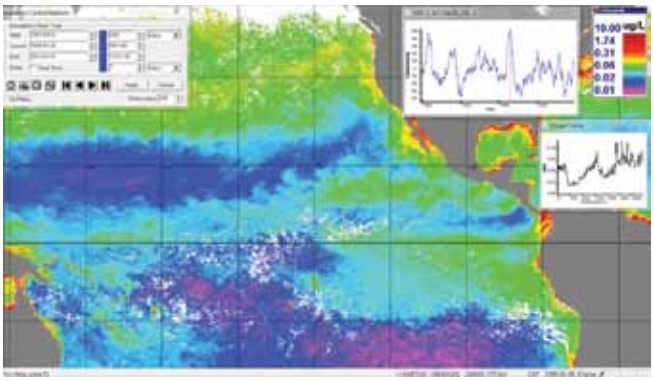
Building on a very productive year, we're enthusiastic to continue demonstrating the value of Earth observations and eager to pursue new opportunities and effective ways to apply Earth science to serve society.

The Applied Sciences Program is part of the Earth Science Division of the NASA Science Mission Directorate.
To learn more about the Applied Sciences Program, visit http://AppliedSciences.NASA.gov.

Table of Contents

Definitions of some acronyms appear in the text; others appear in the acronym list on page 100.

"Some people find working with satellite and environmental data a big morass of intractability," said Michael Hinton, IATTC senior scientist. "PHAM gives them the ability to take these satellite products and use them in their statistical analysis."



PHAM image of chlorophyll at the midpoint of a 30-year (1981–2012) time series run. Warmer colors indicate higher concentrations (ug/L). Trends in an associated time series of SST and in chlorophyll on a user-defined transect appear in line-graph displays. PHAM runs on the EasyGIS system that provides the software tools to download, store, and analyze the broad range of fishery and oceanographic data needed to define fish habitat.

The project completed the design and implementation phases in 2012. IATTC received the fully operational software package as well as training from the project team. As a result of the training, IATTC scientists have used PHAM to improve identification of the habitat of skipjack, bigeye, and yellowfin tuna. The team also released PHAM Lite, a simplified version of the software.

In the coming year, the project team will continue to enhance the software. The team will also continue to conduct training to support PHAM's adoption in the IATTC stock assessment process, and to expand the end user community, which could take two to three years for full implementation.

Dale Kiefer leads this project: *kiefer@dornsife.usc.edu*. To learn more about the Pelagic Habitat Analysis Module, visit *www.phamlite.com*. Pages 81–82 describe a socioeconomic impact analysis of the PHAM project.

Enhancing Estimates of Water Supplies and Seasonal Availability

An Applied Sciences project is working with the California Department of Water Resources (CDWR) to assess applications of MODIS snow cover data to improve water supply forecasting.

Estimating the amount of water stored in snow (snow water equivalent, or SWE) helps inform seasonal water availability. Typically, hydrologists measure mountain SWE at middle elevation locations using snow pillows, which are large bladders that measure the weight of the overlying snowpack. Such measures provide detailed information at point locations.

Together with CDWR, the project team is combining snow pillow data in the Sierra Nevada with satellite observations of snow-covered areas. The team developed a re-analysis model using MODIS snow cover observations to map the distribution of SWE at 500-meter resolution at the seasonal peak (March 1) to the end of the snowmelt season.

The project team also developed a real-time SWE product (beta version), which blends past years' MODIS-based spatial patterns of SWE with surface observations from snow pillows. In 2012, the team generated weekly SWE maps as well as weekly SWE reports by watershed and elevation band for the Sierra Nevada.

The project's data supplemented information CDWR used for forecasting water availability from snowmelt. "It is also useful to see how the estimated SWE compares to the SWE on our reports derived from directly observed data or pillows. . . . The comparison from one week to the next is handy because our forecasts are done weekly," said Steve Nemeth, an engineer and water supply forecaster at CDWR.

In 2012, CDWR found the MODIS-based snow data, including the percentage of average peak SWE at various elevations, offered significant additional insight into early to late season runoff. For example, early in the season when snowmelt at lower elevations is not recorded by the mid-elevation snow pillows, CDWR has little snowpack information for forecasting early spring runoff. Similarly, late in the season when the middle-elevation snow pillows register zero SWE, CDWR has difficulty forecasting late season runoff.

CDWR is developing GIS-based, precipitation-runoff models for most Sierra Nevada basins. The department envisions bolstering the models with SWE data from the Applied Sciences project. "The idea is that we can better

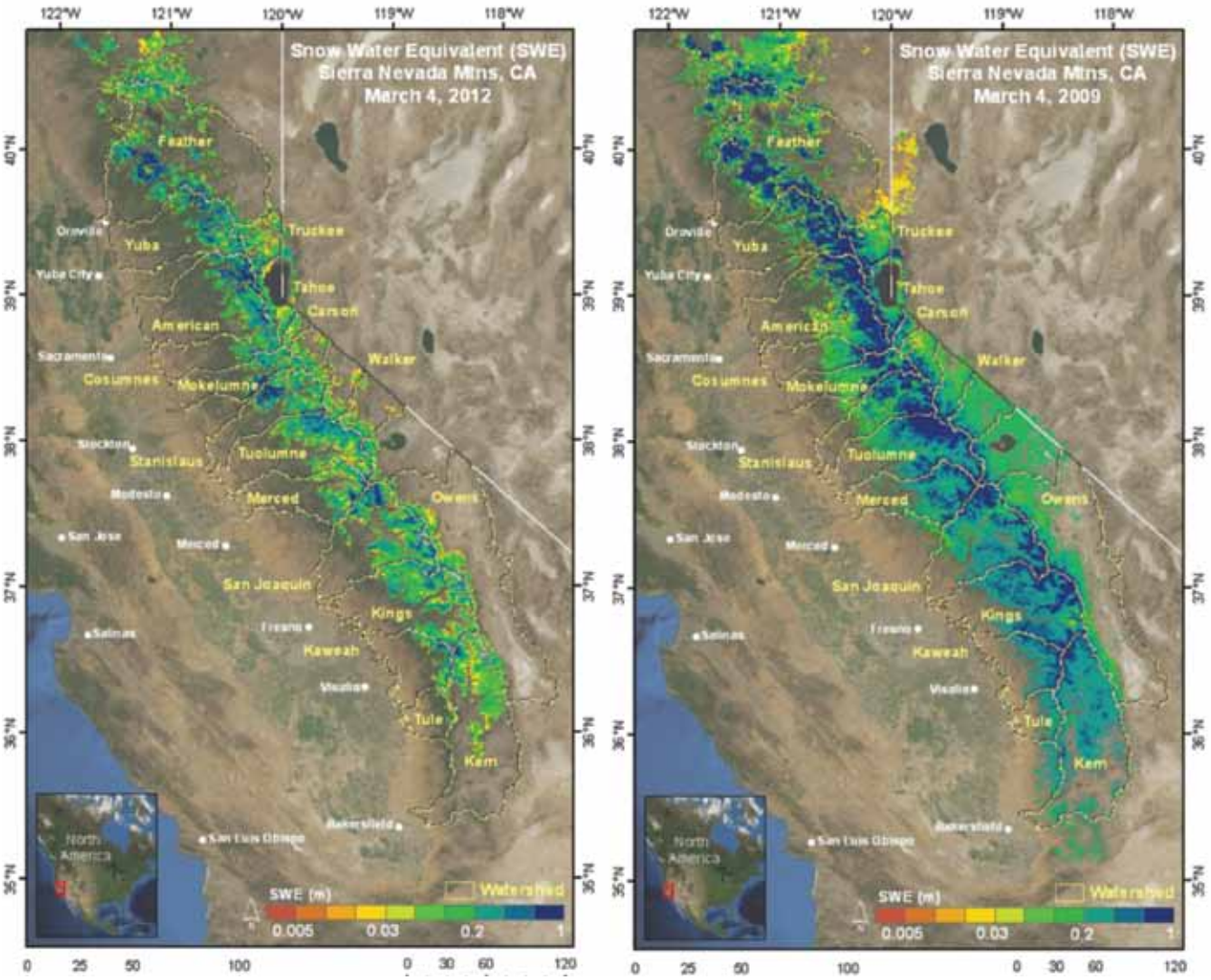
'tune' the physical parameters within the model using observed data," said David Rizzardo, chief of CDWR snow surveys.

In 2013, the project will finalize adjustments to its data processing procedures based on CDWR feedback. CDWR and the team will continue to assess methods for augmenting the manual and automated systems for snow surveying to develop water forecasts. The team also plans to collaborate with organizations in the Colorado River Basin to examine similar applications there to inform flood and drought predictions, irrigation planning, and reservoir use.

Noah Molotch leads this project: *noah.molotch@colorado.edu*. To learn more about the project and related work, visit *http://instaar.colorado.edu/research/labs-groups/mountain-hydrology-group*.

"Your [NASA project team's data product] gives us a clue to the snow above the highest instrument and the elevation at which there is no snow. . . . Knowing the snow where there is no instrument is handy to estimate whether or not we are near base flow. If your maps show that there is still snow up high, we can conclude that we are not yet at base flow."

Steve Nemeth,
California Department of Water Resources



Maps of snow water equivalent in the Sierra Nevada, comparing conditions in 2012 (left) and 2009 (right).