Wildfires:
2013 Annual Summary

March 2014

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Discovering and Demonstrating
Innovative and Practical Applications
of Earth Observations

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Wildfires: 2013 Annual Summary

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NASA Earth Science Division Applied Sciences Program
Wildfires program management team
Lawrence Friedl, Program Manager (lfriedl@nasa.gov)
Vince Ambrosia, Associate (vincent.g.ambrosia@nasa.gov)
Amber Soja, Associate (amber.j.soja@nasa.gov)
I. Introduction
The ESD Applied Sciences Program promotes efforts to discover and demonstrate innovative and practical uses of Earth observations. The Program funds applied science research and applications projects to enable near-term uses of Earth observations, formulate new applications, integrate Earth observations and related products in practitioners’ decision making, and transition the applications. The projects are carried out in partnership with public- and private-sector organizations to achieve sustained use and sustained benefits from the Earth observations.

The Applied Sciences Program’s applications themes are currently focused on four of the nine Societal Benefit Areas of the interagency U.S. Group on Earth Observations: Health (including Air Quality), Disasters, Ecological Forecasting, and Water Resources. The Program includes climate-related influences and impacts within each of these themes.

Fires, especially wildland fires (“wildfires”), constitute a cross-cutting issue in Earth system science and touches on aspects of many applications areas. From 2002 to 2011, the Applied Sciences Program supported numerous projects and activities related to wildfires in several applications areas. In 2011, the Program created an element focused specifically on wildfires, addressing issues from pre-fire through active-fire to post-fire stages. The Program issued a dedicated solicitation and selected 17 projects in 2012.

II. Overview of 2013
This past year was the first full year for the 17 projects. The projects teams completed the feasibility portion of their projects, producing and delivering status reports on their Phase 1 feasibility studies and proposed plans and partnerships for the Phase 2 applications development efforts (aka, implementation phase).

In addition, Applied Sciences selected Vince Ambrosia and Amber Soja as new associate program managers to help track projects, engage with the project teams and partners, and improve the likelihood of project success. They made immediate contributions to improve communications with the project teams and organize overall Wildfires program activities.

At the request of NASA’s Legislative Affairs Office, Applied Sciences held a Wildfires Lunch and Learn in May on Capitol Hill to inform Congressional staffers about NASA’s wildfire support. With a special ceremony, the U.S. Forest Service (USFS) and NASA completed the transfer of the Autonomous Modular Sensor to USFS for operational wildfire management. Later in the year, Applied Sciences sponsored the International Smoke Symposium, which was a venue to explore the complex issues surrounding increasing wildland fire and smoke. In addition, the Wildfires associates arranged for the Wildfires project teams to present their activities to the Tactical Fire

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1 The nine USGEO SBAs are Agriculture, Climate, Disasters, Ecological Forecasting, Energy, Health, Oceans, Water Resources, and Weather.
Remote Sensing Advisory Committee (TFRSAC), a multi-agency consortium of fire community partners engaged in capabilities evaluations for improved wildfire observation strategies.

In 2013, parts of the western United States experienced a particularly severe wildfire season. Major early fires occurred in Southern California, including one in a forest that was the focus of one of the feasibility projects. The activities of the project aired on CBS News (http://www.cbsnews.com/video/watch/?id=50150368n). Additionally, in the mid- to late-fire season, the Rim Fire in California was one of the largest in the state’s history, burning more than 255,000 acres and sending smoke plumes across several states, which affected air quality.

In 2014, major activities planned include conducting the selection of a subset of the 17 proposals for continuation and the initiation of their applications development. The Wildfires program plans a peer-review panel in January with announcements of those Phase 2 projects by April. The program will likely hold a meeting with the selected project teams in 2014 to articulate and communicate objectives and plans.

III. Major Accomplishments
From both technical and organizational perspectives, a major accomplishment for 2013 was the successful transfer of a NASA multispectral sensor to USFS for its use in wildfire response. Associate Vince Ambrosia led the efforts in 2012-2013 to reach an agreement between NASA and USFS on the handover of the NASA Autonomous Modular Sensor (AMS) and advanced downlink capabilities to USFS for wildfire mapping and response in 2014. NASA hosted an AMS transfer ceremony and workshop at NASA Ames Research Center on April 18, 2013; the event included a demonstration flight for the media of the USFS B-200 aircraft with the operational AMS aboard. The AMS scanning spectrometer supported a number of USFS project objectives in vegetation assessment and post-fire analysis, and USFS will likely expand this role in 2014.

The 2013 wildfire season, although below normal for the number of reported wildfires in the United States (65 percent of the 10-year average), was severe in some areas of the country (Alaska, Colorado, and California in particular). More than 47,500 wildland fires burned 4.32 million acres in the United States (59 percent of the national 10-year average), according to the National Interagency Fire Center. The Rim Fire burned in California in August and September and was the third-largest fire in the state’s historical records (257,314 acres). NASA Earth Science provided satellite observations of the Rim and numerous other fires in the United States. For example, NASA provided LANCE-based MODIS data products and VIIRS Day/Night band products and time series data in June for Colorado’s Black Forest Fire, and it provided MODIS and VIIRS products for the Rim Fire, American Fire, and Beaver Creek fires in California and Idaho. (MODIS fire data are easily accessible and used by incident command teams across the nation and internationally.)

IV. Program Management Assessment
Overall in 2013, the Wildfires element within Applied Sciences became a more mature “program of activities,” adding program management, communication, and partnership
engagement efforts to the collection of projects. The addition of the associate program managers had a direct effect on this development. Their contributions were immediate and significant toward enabling better engagement and communication with the project teams and partner organizations.

One of the original goals of the Wildfires initiative was to broaden the application and applicability of Earth science data, models, and knowledge beyond the traditional area of active wildfire response. The set of feasibility projects included several studies focused on supporting pre-fire and post-fire management decisions and actions. Results in the Phase 1 feasibility reports indicated such applicability and interest by managers and users from partnering management organizations that address pre- and post-fire issues (e.g., Burned Area Emergency Response, BAER).

A minor setback in 2013 was a delay in the initiation of Phase 2 of the projects, primarily as a result of the government shutdown in October. Originally, the Phase 1 reports were due in mid-October, and the Wildfires program management team planned a November peer-review panel to evaluate the reports and down-select for the implementation portion of the projects. With the government shutdown, we delayed the due date of the proposals and scheduled the review panel for January 2014. Thus, the selection of projects to continue Phase 2 will likely occur in March 2014, delaying the initiation of the projects, their benefits, and the obligation of funds.

Regarding the substance of the projects, the program management team was very pleased with the progress and results the projects achieved in the feasibility stage. By and large, the management team assessed that the reports were generally quite strong, demonstrated feasibility, and aligned with the solicitation goals; although, some of the partnership arrangements and funding commitments seemed under-developed. There were some concerns that the timing of the government shutdown may have affected the project teams’ ability to secure financial commitments from the partners in time to include that information in the project reports. The management team may need to revisit this topic in 2014 with the down-selected projects and/or conditionally accept projects pending identification of significant partner cost sharing for projects. Overall, the program management team expects the down-select of projects for Phase 2 implementation will be challenging, and Applied Sciences may be forced to cut some very good, productive efforts.

Building on a positive 2013, the team will seek to coordinate and collaborate more with community organizations, such as the International Association of Wildland Fire (IAWF), and key government groups, such as the Joint Fire Science Program (JFSP) and the USFS Remote Sensing Applications Center (RSAC). A survey of key groups and an assessment and prioritization of potential value-added intermediaries (aka, boundary organizations) will be a key first step. The team will be involved with the review of projects received through the

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2 The management team identified these items of particular interest for the peer-review panel’s comments and assessment.
ROSES-13 *Suomi NPP* data products solicitation. In addition, the team will likely support a project team meeting and possible workshop(s), especially based on results and findings from the peer-review panel. Finally, the team will continue to engage the Applied Remote Sensing Training (ARSET) effort within Applied Sciences to examine the possible development of wildfire training modules.

V. Project Portfolio

In 2013, the project portfolio for the ad hoc Wildfires program element contained 17 projects in their Phase 1 feasibility stage. The majority of projects started in late 2012, and two began in early 2013. These projects all initiated through the ROSES-11 Wildland Fires solicitation, which was specifically focused on Earth observations applications addressing multidisciplinary issues associated with wildland fires in support of management strategies and actions, business practices, policy analysis, and management decision support.

The projects cover a range of wildland fire topics. Four projects have a particular focus on fuels, three projects on air quality, three on wildfire response, three on wildfire behavior and risk, two on post-fire remediation, and two on pre-fire ecosystem assessments. A brief description of each project is below, and the appendix of this report has additional information on each project. The organizations for the principal investigators of the projects include universities (9), government (6), a private company, and a nongovernmental organization. All the projects had partner organizations as co-investigators or collaborators as part of the design of the solicitation. Regarding the Earth observations applied in the projects, the majority of projects focused on use of MODIS, VIIRS, and *Landsat* data products (and combinations of them). Collectively, projects also used data products from space-based sensors and satellites ASTER, AMSR-E, MOPITT, CALIPSO, OMI, GLAS, and SMOS; data from aerial imagery, airborne LiDAR scanning (ALS), AVIRIS, and UAVSAR; data from community databases, such as MTBS and LANDFIRE; and numerous models and model outputs.

Each project recorded its Application Readiness Level (ARL) during 2013. At the end of 2013, the portfolio had eight projects in the ARL 1-3 range, nine projects in the ARL 4-6 range, and none above ARL 6. The mean ARL was 3.75 and the mode was ARL 3. The figure to the right has the specific breakdown.

For the FY 2013 performance year, 15 projects (88 percent) advanced one or more ARL, and 11 projects (65 percent) advanced two or more levels.

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Each of the Wildfires Phase 1 projects is highlighted below:

**Wildfire Risk and Treatment Effectiveness of Protecting Highly Valued Resources and Assets with Fuels Management; Principal Investigator: Mark Cochrane, South Dakota State University:** The project integrated MODIS and Landsat data into wildfire simulation modeling, to demonstrate the feasibility of quantifying fuel treatment effectiveness in terms of HVRA (highly valued resource and asset) exposure, linking past treatments to incident decision making and suppression activities, and exploring treatment impacts on fire behavior under alternative fire weather conditions.

**Automated Fuels Treatment Effectiveness Evaluation Using Remote Sensing Information (AFTEERS); Principal Investigator: Stacy A. Drury, Sonoma Technology, Inc.:** This project demonstrated that it is feasible to use Earth observations products such as MODIS and MTBS to evaluate the ability of fuels treatments to mitigate wildfire hazard. The project team created a set of methods that provide land manager partners (USFS, National Park Service, and Bureau of Indian Affairs) with easy-to-use, cost-effective data products that use satellite observations to evaluate fuels treatment options.

**Daily Forecasts of Wildland Fire Impacts on Air Quality in the Pacific Northwest: Enhancing the Air Indicator Report for Public Awareness and Community Tracking (AIRPACT) Decision Support System; Principal Investigator: Steve L. Edburg, Washington State University:** This study examined the feasibility of coupling a dynamic fire-atmosphere model (WRF-SFire) with the project’s air quality decision support system, AIRPACT, to improve the representation of fire dynamics and plume rise in air quality forecasts. The project used Earth observations from MOPITT, OMI, and other NASA sources, and engaged partners from NW-AIRQUEST consortium members, EPA Region 10, the Nez Perce Tribe, Idaho Department of Environmental Quality, Oregon Department of Environmental Quality, Lane Regional Air Protection Agency, Washington Department of Ecology, and others.

**Improving Agricultural and Wildland Fire Source Emission Products and Access to Information for Atmospheric Science and Smoke Modeling Applications; Principal Investigator: Nancy French, Michigan Tech Research Institute:** This project focused on developing models to determine the feasibility of the Wildland Fire Emissions Information System as a viable and efficient tool for addressing the decision-making challenge of mapping wildland and agricultural fire emissions across regional scales. It engaged partners from the regional air quality community, such as the National Wildfire Coordinating Group–Smoke Committee, EPA/CMAQ, USFS RSAC and the carbon modeling community (e.g., CASA-GFED, NASA-CMS, CarbonTracker).

**TOPOFIRE: A System for Monitoring Insect and Climate Induced Impacts on Fire Danger in Complex Terrain; Principal Investigator: Zachary A. Holden, USFS:** This
project demonstrated the feasibility of integrating NASA remote sensing and climate products into a decision support tool, Topofire, which delivers a suite of high spatial resolution real-time information sets essential to wildland fire management. The end user/partners community includes the modeling community employing the Wildland Fire Assessment System (WFAS) and the Wildland Fire Decision Support System (WFDSS).

**Utilization of Multi-sensor Active Fire Detections to Map Fires in the United States: The Future of Monitoring Trends in Burn Severity; Principal Investigator: Stephen Howard, U.S. Geological Survey (USGS):** This project examined the feasibility of using fire detection data from MODIS, AVHRR, GOES (fire and smoke sensors), federal fire occurrence data, and NOAA Hazard Monitoring System information to identify undocumented fires, improving the Monitoring Trends in Burn Severity (MTBS) mapping process, and developing user-friendly tools and applications that can be installed locally to support local fire assessments. The end users/partners include the two major entities that provide the MTBS products for the fire community: USFS RSAC, and USGS.

**Development of New Geospatial Tools for Wildland Fire Management and Risk Reduction; Principal Investigator: Siamak Khorraram, University of California at Berkeley:** This project explored the feasibility of using satellite and airborne remote sensing data to substantially improve the Emission Estimation System and the First Order Fire Effects Model, leading to better estimates of emissions from wildland fires. The overall goal was to enhance resource managers’ capabilities in their decision making for fire and smoke management related to wildland fires, and to support improved public notification of air quality effects of those smoke and fire events.

**Linking Remote Sensing and Process-based Hydrological Models to Increase Understanding of Wildfire Effects on Watersheds and Improve Post-fire Remediation Efforts; Principal Investigator: Mary Ellen Miller, Michigan Tech Research Institute:** This project tested the feasibility of creating an online spatial database to instantaneously provide end users with the basic tools and data needed to incorporate Earth observations (Landsat 8, ASTER, MODIS, VIIRS, process-based hydrological models, spatial dry ravel model) into process-based erosion models. Improving accessibility of both modeling capabilities and the required data sets could lead to better assessment tools and support post-fire remediation through erosion modeling. The project focused on supporting end users and partners from the Burned Area Emergency Response (BAER) teams, land managers, and researchers.

**Enhancing Wildland Fire Decision Support and Warning Systems; Principal Investigator: Son Nghiem, Jet Propulsion Laboratory:** This project used satellite data (QuikSCAT/Oceansat-2/AMSRE) to derive soil moisture products and showed the utility of the future SMAP higher-resolution soil moisture information capabilities for improving predictions of wildfire danger. Coupling the soil moisture data with high-
resolution weather forecast and fire behavior models allowed the project team to test the feasibility of improving fire risk and danger assessments months prior to fire incidents in Southern California. The partners involved in the project included the National Fire Danger Rating System, WFDSS, National Weather Service (NWS) and other agencies.

**Enhanced Wildland Fire Management Decision Support Using Lidar-infused LANDFIRE Data; Principal Investigator: Birgit Peterson, USGS:** This feasibility study is developing a tool to incorporate lidar data (ALS and GLAS) and data from the LANDFIRE program. The Creating Hybrid Structure from LANDFIRE/lidar Combinations (CHISLIC) tool allows users to automatically generate a suite of improved vegetation structure and wildland fuel parameters from lidar data and infuse these into existing LANDFIRE data sets, ensuring the best data are available to support tactical and strategic wildland fire management decisions. The end user community involves those that utilize both WFAS and WFDSS in their assessment tools.

**Wildland Fire Behavior and Risk Forecasting; Principal Investigator: Sher Schranz, Colorado State University:** This feasibility study used data from MODIS and VIIRS to derive NDVI and NDWI maps, and government databases (LANDFIRE and fuel moisture from the network of Remote Automated Weather Stations) to test the probability of providing forecasting of wildland fire behavior and risk, integrated within NOAA fire weather forecasting systems. This effort supports the decision making by providing integrated local numerical prediction of weather, fuel properties, fire risk, and fire behavior.

**Development and Application of Spatially Refined Remote Sensing Active Fire Data Sets in Support of Fire Monitoring, Management and Planning; Principal Investigator: Wilfrid Schroeder, University of Maryland:** This project built on proven science algorithms (fire detection from MODIS) to test the feasibility of new spatially refined satellite active fire detection products from the VIIRS and Landsat 8 sensors that yield significantly improved fire information. The project team used these products to initialize and validate fire growth predictions in a coupled weather-fire model, an approach that can be applied to monitor and predict the growth of a fire or a group of simultaneous wildfires in a management unit from first detection until containment. The partners involved include USFS, NWS, and WFDSS.

**An Integrated Forest and Fire Monitoring & Forecasting System for Improved Forest Management in the Tropics; Principal Investigator: Karyn Tabor, Conservation International:** This project tested the feasibility of building a prototype near real-time alert system (Firecast) that incorporates active fire identification from VIIRS and MODIS to improve decision making related to forest and fire management in “under-served” communities and better addresses the challenges decision makers face in making timely decisions related to wildland fire management and prevention that have immediate
conservation impacts. The partners in this effort include Servicio Nacional de Áreas Naturales Protegidas por el Estado in Peru, the Ministry of Environment and Forests in Madagascar, the Department of Conservation Areas Wildlife Reserves in Indonesia, and Flora and Fauna International based in the U.K.

Tabor reported the following about the fire alert system. In the Kirinchi Seblat national park in Indonesia, the system directly led to 12 park rangers dispatched and the arrest of 81 people illegally clearing land. In Santa Cruz Bolivia, the MODIS/TRMM-based daily forest flammability warnings have resulted in farmers posting signs in villages to signal elevated fire risk. In Madagascar and Bolivia, the government is fining land owners for illegal agricultural burning during the high-risk fire season, which has provided an incentive to prevent agricultural fires from spreading into natural habitats.

**Classification of Whitebark Pine and Spruce-Fir Forests to Improve Wildland Fire Decision Support Tools in the USFS Northern Region; Principal Investigator: Linda Vance, University of Montana:** This project investigated the feasibility of using Earth observations tools (Landsat and high resolution aerial imagery) to address accurate and precise mapping of whitebark pine (*Pinus albicaulis*) and spruce-fir (*Picea engelmannii/Abies lasiocarpa*) forests to enhance wildland fire modeling decision support tools in the USFS Northern region. The partnerships include USFS, USGS, and the Greater Yellowstone Ecosystem Coordinating Committee.

**Improving National Shrub and Grass Fuel Maps Using Remotely Sensed Data and Biogeochemical Modeling to Support Fire Risk Assessments; Principal Investigator: James Vogelmann, USGS:** This project assessed the feasibility of using Landsat and MODIS data to improve shrub and grassland mapping for fire applications, develop frequent data sets, and therefore determine if improvements in shrub and grassland data layers will alter and improve fire behavior model results. The end user partners include the USFS, Bureau of Land Management (BLM), and Multi-Resolution Land Characteristics Consortium.

**Applications of Satellite Measurements to Improve Prescribed Fire Management; Principal Investigator: Yuhang Wang, Georgia Institute of Technology:** This project employed MODIS satellite observations and models to examine the feasibility of quantitative forecasting for air quality impacts of prescribed fires, which will provide prescribed fire management guidance to the Georgia Forestry Commission, Georgia Environmental Protection Division, and EPA. This system will improve the activities of near real-time air quality forecasts and lead to improved human health in limiting prescribed burning when the weather is conducive to poor air quality.

**An Automated Burned Area Emergency Response Decision Support System for Post-fire Rehabilitation Management of Savanna Ecosystems in the Western United States; Principal Investigator: Keith T. Weber, Idaho State University:** This feasibility study
integrated the rapid resource allocation capabilities of cloud computing to automatically collect Earth observations data (*Landsat 8*, MODIS, AMSR-E, MERRA), derived decision products, and historic biophysical data for BAER teams to have a comprehensive RECOVER (Rehabilitation Capability Convergence for Ecosystem Recovery) data set in a GIS analysis environment that is customized for the target wildfire, thus reducing the time required to assemble and deliver crucial wildfire-related data from days to a matter of minutes. The partners include the BLM, Idaho Department of Lands, and BAER teams.

Representatives from BLM indicated that the maps resulted in a four-day decrease in the data gathering process and a 29 percent increase in assessment/analysis time, which directly led to more informed post-fire rehabilitation management decisions.

**Wildfire Research and Applications Partnership**

NASA continued collaborations with the California Department of Forestry and Fire Protection (CAL FIRE), National Interagency Fire Center (NIFC), USFS, and other organizations through the Wildfire Research and Applications Partnership (WRAP) project. The WRAP project explores the development, sharing, and application of technologies related to improving wildfire information collection, analysis, and use. WRAP has sustained a partnership with CAL FIRE (as well as other agencies) since 2003, and provides a twice-annual meeting focused on evaluating, sharing, and exchanging innovative NASA-derived tools, models, and data for use in improving wildfire management strategies.

**Rim Fire Incident Management**

The Rim Fire in California was the third-largest fire (257,314 acres) in California history. During the active burning stage NASA provided both MODIS and VIIRS data to support the incident management planning teams (see figure on page 12). Post-fire imagery was collected from both the NASA Airborne Visible/Infrared Imaging System (AVIRIS) and the MODIS/ASTER Airborne Simulator (MASTER) sensor to provide information on burn severity and remediation efforts. The EPA used NASA and NOAA satellite data and models to update the public on the hazardous fire conditions and dangerous air quality ([http://blogs.kqed.org/newsfix/2013/08/28/rim-fire-air-quality/](http://blogs.kqed.org/newsfix/2013/08/28/rim-fire-air-quality/)).

In 2013, USFS continued to make sensor targeting and tasking requests for *EO-1* data to support wildfire observations and post-fire assessments. USFS made about 75 targeting and tasking requests for NASA *EO-1* data to support wildfire observations and post-fire recovery burn area assessments. The data requests were made from the USFS RSAC and helped support both the USFS needs for fire assessment on National Forest lands and its USGS partners with post-fire
burn severity mapping efforts on DOI-managed lands. The requests were the largest number per annum for EO-1 data, and show continued use of NASA products for filling data and information gaps.

<<< Nighttime thermal infrared imagery of the Rim Fire taken from the VIIRS instrument on board the Suomi NPP satellite. The image sequence shows the advances of the active fire front from August 23 through August 26. The border of Yosemite National Park is superimposed on the data for location reference. The faint details of Lake Tahoe, on the CA/NV border can be seen north of the Rim Fire. City lights of Reno, Carson City, and other environs can be seen east and northeast of Lake Tahoe.

VI. Program Management
In 2013, Applied Sciences selected two associate program managers for the ad hoc Wildfires program: Vince Ambrosia (NASA Ames) and Amber Soja (NASA Langley). They each managed a portfolio of projects to track progress, financials, and performance, and they began more routine Applied Sciences communications with the PIs, project teams and their partner organizations. Among their activities, the associates discussed projects and program objectives with the project teams; evaluated project progress; assessed ARLs; described expectations and the Phase 1 review process; and addressed PI questions and concerns. In August 2013, the associates organized a Web-based teleconference with the PI/project teams to explain the expected contents of the Phase 1 report and the review process. Additionally, the associates reviewed project reports and ARLs, supported community events, prepared materials for program reviews, organized the receipt of the Phase 1 reports, and identified reviewers for the peer-review panel.

Capitol Hill Lunch & Learn
The NASA Office of Legislative and Intergovernmental Affairs (OLIA) arranged for a Wildfires Lunch & Learn in May on Capitol Hill. The primary purpose was to inform Congressional staffers about NASA support to wildfires management and response. OLIA reported that 51 people attended the event. Following an introduction of NASA Earth Science and the Applied Sciences Program, Vince Ambrosia gave an in-depth presentation highlighting NASA support to wildfires. He discussed the capabilities and use of satellites and airborne platforms to support strategic and tactical fire management, and he emphasized that NASA data, research, and models support pre-fire and post-fire phases of fire events as much as fire detection and response. He showed examples of NASA support to USFS, states, and other organizations across several years, and he highlighted the transfer of the AMS instrument to USFS as a research-to-
operations transition (see below). He also highlighted NASA’s work and technology demonstrations with UAS platforms for wildfire response and real-time data collection and delivery.

Autonomous Modular Sensor Instrument Transfer to USFS
A major wildfires-related activity in 2013 involved events completing the handover of the NASA AMS scanning spectrometer to USFS. AMS operated on NASA manned aircraft as well as the *Ikhana* UAS, and NASA transferred the instrument to USFS in late 2012 through a cooperative transfer agreement between NASA Ames and USFS Fire and Aviation Management. The official ceremony for the transfer occurred on April 18, 2013, at NASA Ames Research Center.

USFS integrated the AMS on a USFS Cessna Citation jet aircraft to support wildfire observations and other resource inventory efforts. The AMS (a 16-channel multispectral instrument) is capable of active- and post-fire assessments. In addition, the sensor can support other resource management assessments, such as vegetation inventories, forest health, and pest management. The sensor and associated operations systems extend the capabilities of NIFC to operate during the day and night over wildfire events providing near real-time, fully processed information to fire incident teams. Additionally, these capabilities allow for rapid post-fire assessments to support burned area remediation activities. Effectively, the instrument will be operational on USFS aircraft, providing fire data to NIFC in Boise, Idaho, and all incident command centers. The AMS, managed by USFS RSAC (located in Salt Lake City) will be operated on various USFS aircraft by the National InfraRed OPerations Group (NIROPS) located at NIFC.

In conjunction with the semi-annual meeting of TFRSAC, Vince Ambrosia scheduled an AMS sensor workshop at NASA Ames on April 18 associated with the official AMS handover ceremony. The USFS Citation jet equipped with the AMS was present for the community and media event. NASA and USFS issued a press release to highlight the transfer, as well as a media advisory to invite the community to view, photograph and video the aircraft during the ceremony. Also, the media and the larger community were invited in an effort to communicate the value of the system and its integration into operational utility to support national wildfire assessment efforts and to interview and meet with the sensor engineers, operators, USFS, NASA, and CAL FIRE personnel.

For the event, Michael Freilich, Director of NASA Earth Science, stated:

“For a research standpoint we’ve learned nearly all that we can from AMS. However, the AMS instrument has proven its continuing value for operational fire support. Thanks to the engineers and scientists who designed, built, and refined AMS over the years. We are pleased to be able to transition AMS from its NASA-supported research phase to its USFS-supported mature operational phase.”

In 2013, USFS did not directly use the AMS to support wildfire events. USFS indicated to NASA that its staff training was too short for adaptation into immediate operations in 2013. Thus, 2013 was a training year for USFS on the sensor system. In preparation for more extensive
mission operations in 2014, USFS integrated the AMS on a USFS Cessna Citation and trained engineers to use the system. The AMS flew a series of missions in support of data collection for partners in USDA Agricultural Research Service for thermal analysis of vegetation for crop condition assessment and USGS for water quality and thermal discharge plume assessment. In addition, USFS invested more than $100,000 with NASA (Ames Research Center) to support FY 2013-2015 training, sensor calibration, and software enhancements.

Also in 2013, USFS evaluated a NASA-supported Small Business Innovation Research (SBIR) airborne wildfire imaging system (Wide Area Imager, WAI) and successfully operated the instrument over wildfires in Idaho to assess system capabilities. USFS expects to operationally employ the WAI in late 2014 under an agreement with NASA. An additional NASA SBIR sensor effort, focused on development of a small, autonomous wildfire instrument for UAS use or as a prototype for a small-satellite system is also being closely watched by the fire community (USFS and others) for direct applications in their strategic wildfire observations. 

Communications
Some of the Wildfires projects engaged the media to convey the nature of their projects and preliminary results of their feasibility studies. On July 6, 2013, CBS News aired a national story based on a feasibility study led by Son Nghiem from NASA JPL. The CBS News lead-in read, “The western U.S. is experiencing one of the worst fire seasons on record. In California, scientists are using new weapons to fight fires before they even start.” The link to the story is http://www.cbsnews.com/video/watch/?id=50150368n

In August, local media in Idaho aired a story based on the RECOVER project led by Keith Weber of Idaho State University. The KIDK lead-in read, “Idaho State University’s Geographic Information Systems program is helping the Bureau of Land Management plan recovery efforts faster in fire-ravaged areas of Idaho.” The link to the story is http://www.localnews8.com/video/ISU-GIS-helps-BLM-RECOVER-with-NASA-grant/-/461276/21711632/-/pjsu5jz/-/index.html

VII. Community Leadership
The Wildfires program element sponsored and supported numerous activities in 2013 as part of overall efforts to enhance the use of Earth observations and wildfire science in wildfires management decisions and actions.

International Smoke Symposium
NASA co-sponsored the first International Smoke Symposium that was held in College Park, Maryland, October 21-24, 2013, with the National Wildfire Coordinating Group, JFSP, USFS, Air Sciences, and Coalition of Prescribed Fire Councils Inc., and hosted IAWF. This symposium was unique in having its entire focus on creating an international forum that connects communities to discuss the complex issues surrounding smoke, both from wildland and agriculture burning.

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3 These activities relate to the Applied Sciences Wildfires program but are not directly funded by Applied Sciences.
The symposium served as a nexus of interdisciplinary research and management, mitigation and policy, acting to bring together closely linked groups that had not previously interacted.

The symposium addressed the science and application of smoke from wildland and agricultural fires, air quality and modeling, and interactive climate impacts, including uses of remote sensing in each of these endeavors. Seeking to advance the dissemination of information to operational professionals working on smoke and wildfire issues, the symposium examined the connections among ecological needs for fire, land management goals, health and air quality, and mitigation of impacts of smoke and emissions. The symposium hosted a diverse group of participants such as individuals active in firefighting, researchers who view fires and smoke from space, people who investigate the molecular constituents of smoke to global transport, climate modelers, air quality and human and ecosystem health specialists, and professionals who focus on management and mitigation policies and practices to control smoke.

Amber Soja served on the steering committee for the symposium, acting to highlight NASA’s unique capability to use Earth science data and knowledge to provide innovative, practical benefits to enhance decision making. As a direct result of NASA funding, the symposium was virtual, enabling remote access to presentations at a time when funding was limited, travel restrictions were in place and the government had just reopened. Of the 242 participants, more than 40 percent attended virtually, actively interacting online with the in-house speakers. Thirty of the participants requested virtual access after the conference, so the symposium continues to be an active success. The virtual aspect of this symposium was a direct result of the NASA E.2 Topical Workshops, Symposia and Conferences program. Additionally, to increase awareness of NASA data and product applicability, Soja arranged for NASA ARSET to provide an introductory training opportunity for managers and operational professionals designed to feature remote sensing products for air quality applications.

Numerous agencies (e.g., BLM, NOAA, Canadian Forest Service, National Institute of Standards and Technology, U.S. Air Force, and National Park Service), nonprofit organizations (e.g., Nature Conservancy and National Institute of Aerospace), and national and international universities were represented at the symposium. The keynote speaker was Robert Bonnie, the under secretary for natural resources and environment. Other notable speakers included Dr. Christopher Justice, current chair of the Department of Geographical Sciences at the University of Maryland, Dr. Wayne E. Cascio, director of the EPA Environmental Public Health Division, Dr. Allen R. Riebau, from the JFSP Smoke Science Plan Coordination Team, and Janice E. Nolen, assistant vice president of national policy for the American Lung Association.

The symposium created an international forum to discuss complex smoke issues surrounding both wildland and agricultural fires, including research gaps and priorities for smoke science; air quality and public health considerations; increasing awareness of ongoing smoke science; and showcasing contemporary science, technologies; and the diversity of management, policy, and mitigation strategies. One broader implication was that as funding becomes increasingly limited, by working together to identify and define primary research goals, which could include
related or joint solicitations, research objectives could be broadened and advanced, while
decision-making activities within applied communities could be further developed and
progressed. Another added benefit of this timely symposium was the opportunity provided to
identify potential reviewers for the upcoming peer-review panel.

**NASA/USFS Tactical Fire Remote Sensing Advisory Committee (TFRSAC)**
Vince Ambrosia continued to serve as a co-chair of the NASA/USFS TFRSAC. TFRSAC met twice
in 2013: in April at NASA Ames Research Park, and at NIFC in early November. At the April
meeting, Ambrosia organized a one-day AMS workshop as part of the AMS transfer event (see
above). That workshop shared the sensor capabilities with the community and discussed and
highlighted the mechanisms to operationally integrate the system into scientific and
applications use by the fire and resource management communities. Key issues at the April
TFRSAC meeting were in training the USFS flight engineering staff in AMS systems operation,
identifying USFS aircraft for continued AMS sensor integration, and building knowledge in the
non-fire USFS community of AMS capabilities to increase its mission utility. The attendees’
discussions focused on the various non-fire uses of the AMS to support and improve national
resource assessments and inventories. One major outcome was an amendment to the
Reimbursable Space Act Agreement between the entities (USFS and NASA ARC) to fund (from
USFS) various AMS system enhancements, operations training, system calibration and
maintenance (by NASA ARC staff).

Ambrosia co-organized the November TFRSAC meeting to coincide with the November 5-6 NIFC
National Infrared Operations 2013 Fire Season Closeout in Boise, Idaho. The NIFC event
reviewed the 2013 fire season and USFS airborne response. Key issues at the event involved the
upkeep of the operational airborne sensor systems (Phoenix systems); the integration of the
AMS for operational use; acquisition of an additional USFS aircraft to support AMS integration
and use for wildfire imaging; and capability enhancements to improve the airborne fire support
to wildfires, beyond active fire mapping (supporting post-fire assessments with AMS). These
discussions provide the basis for an expansion of the mission role of the NIFC NIROPS program.

In addition, the November TFRSAC meeting focused on issues related to the AMS inclusion in
the USFS/NIFC-NIROPS operational mission portfolio, the evaluation of new satellite-derived
(VIIRS) fire products into operational use, reports from the community on SBIR-developed
sensor systems, and information on various non-traditional satellite assets (DoD) for emergency
fire observations. One of the key outcomes of the meeting was the establishment of a small
committee to address the acquisition of an additional USFS aircraft (B200 King Air) for a
dedicated AMS installation to support wildfire events as a “surge” platform for Southeast U.S.
wildfires, and as an imaging asset for non-fire-related resource inventory assessments within
the USFS and sister agencies. Ambrosia and Soja arranged for the NASA Wildfire project teams
to present their activities and capabilities at TFRSAC, and 13 of the 17 projects were able to
present, either remotely or onsite. A key outcome of the project teams’ presentations was the
interaction with potential partners, which led to a number of formal collaborations moving
forward in the Phase 2 planning efforts of those projects.
American Geophysical Union (AGU) Fall Meeting
At the AGU event in December 2013, more than 200 sessions included wildfire-related topics, and several NASA ROSES-2011 Wildfire project teams gave oral or poster presentations. Vince Ambrosia presented the NASA Wildfires project portfolio at the NASA Hyperwall exhibit.

Wildland Fire Science and Technology Working Group
The Wildfires program management team had initial engagement in 2013 with the Wildland Fire Science and Technology Working Group. This working group was recently established by action of the National Science and Technology Council (NSTC) Committee on Environment and the Natural Resources, and Sustainability (CENRS) Subcommittee on Disaster Reduction (SDR). The purpose of this working group is to draft a document with federal wildland fire management and wildland fire science and technology organizations that identifies opportunities and mechanisms for increased coordination and cooperation to support the development, access to, and application of science and technology in wildland fire management, response, and recovery.

VIII. International Activities
The Group on Earth Observations (GEO) is an intergovernmental organization working to improve the availability, access, and use of Earth observations to benefit society. GEO coordinates efforts to build a Global Earth Observation System of Systems (GEOSS). GEOSS incorporates national, regional, and international observation systems to provide coordinated Earth observations from thousands of ground, airborne, in situ, and space-based instruments. GEO and its GEOSS implementation focuses on Earth observations for nine areas of societal benefit: Agriculture, Biodiversity, Climate, Disasters, Ecosystems, Energy, Health, Water, and Weather.

In 2013, GEO updated its multi-year work plan. In this work plan, GEO formulated a new wildfires task component, Global Wildfire Information System (aka, DI-01-C4). The objective of this task component is to provide a platform for harmonized information and to enable the exchange and coordination of information among major national and regional fire information providers (e.g., existing systems in the United States, Canada, South Africa, Russia, Australia, and China). This platform, the Global Wildfire Information System (GWIS), aims at provide information on the different phases of fire management, from pre-fire danger forecast to active-fire monitoring and post-fire assessments, including burned area maps, land cover damage, damage in protected areas, fire emissions, and potential soil erosion. The task builds on existing fire communities, such as the Global Observation of Forest Cover Fire Implementation Team and its regional networks. Part of the task follows the scheme of the European Forest Fire Information System.

The task component leads listed in the work plan are the Canadian Forest Service, European Commission’s Joint Research Center (JRC), and South Africa’s Council for Scientific and Industrial Research. This task component was proposed to GEO by the European Commission,
and Jesus San Miguel from the Joint Research Center will be the coordinator. (Note: San Miguel has commented that developing such a GWIS is a significant research and development undertaking. When the research and development efforts are mature, there will be a need for a long-term institutional commitment beyond JRC, such as FAO.) Activities for GWIS involve: a review of wildfire information systems building on existing reviews of operational systems for fire danger information; networking of major national and regional fire information providers; a workshop of key national and regional providers; linking fire communities dealing with fire aspects at global scale, such as burned area assessments and emissions estimation.

GEO will review and likely accept the updated work plan at its January 2014 Plenary Session. Vince Ambrosia and/or Amber Soja will likely be NASA’s contributor to this new effort.

IX. Looking Ahead
In 2014, the major activity will be the initiation of the in-depth, application development phase (aka, Phase 2) for the feasibilities studies selected to continue. The Wildfires program plans a peer review panel in late January to review the Phase 1 reports. These reports will contain two parts: Part A articulates the fire-related challenge and decision-making activity, application of Earth observations, proposition tested in the study, starting and ending ARLs, results of the feasibility study, and baseline performance. Part B provides a preliminary plan for Phase 2 activities, including the approach to implement the application, potential benefit and measurable impact, partner organization involvement and commitment, preliminary transition approach, key milestones, key milestones and challenges, and estimated cost.

For this peer review, we plan to have each project team present virtually at the first half of the panel’s consideration of the project. Each team will have 10-12 minutes to present its project, and the panel will have 8-10 minutes to query the proposal team. Following this period, the project team will disengage from the teleconference, and the panel will discuss and evaluate the project internally. In addition, after the project review, the panelists will have an opportunity to identify issues and needs of the wildfire community to encourage their broader use of Earth observations in wildfire management, mitigation, and applications science. The program may consider pursuing workshops or other activities in 2014 and later based on the issues and needs identified.

The Wildfires program management team will assess the results of the peer review and identify project recommendations for continuation in Phase 2. An announcement of awards is expected in March/April. The Applied Sciences Program will likely hold a kickoff meeting with the selected project teams in 2014 to articulate and communicate objectives, review the Phase 2 implementation plans, and promote synergies between projects.

In 2014, the Wildfires program management team will also connect with the National Research Council’s Board on Earth Sciences and Resources (BESR), which is forming a study to develop an action plan for integrating science into planning and decision making for wildland fire management and policy making. BESR has a meeting in mid-February to receive community
input on the scope of work and discuss plans for the study; the NASA Wildfires program plans to participate in the meeting and may consider possible support of the study.

The Wildfires program team also expects to have in-depth discussions with USFS RSAC and JFSP, among other groups, concerning further collaborations, joint solicitations, and improving inter-agency communications on wildfire science and applications. The team will pursue further activities with the Wildland Fire Science and Technology Working Group, and it will formulate its approach to the GEO GWIS task component.

In 2014, the Earth Science Division plans to launch five missions: GPM, OCO-2, CATS, RapidScat, and SMAP. While products from these missions may not be available in 2014 due to calibration, validation, and product processing timelines, the Wildfires program team will support efforts to examine potential uses and value for wildfires applications.
X. Appendix

A. Project Description and Highlights
This appendix presents information on each of the projects in the Wildfires program portfolio, including project highlights from 2013.

Project: Wildfire Risk and Treatment Effectiveness of Protecting Highly Valued Resources and Assets with Fuels Management

Principal investigator: Mark Cochrane, South Dakota State University

Project year: 1

Year-end ARL: 6 (final)

Description: Integrating MODIS and Landsat data into wildfire simulation modeling, this project demonstrated the feasibility of quantifying fuel treatment effectiveness in terms of changed HVRA (highly valued resource and asset) exposure, linking past treatments to incident decision making and suppression activities, and exploring treatment impacts to fire behavior under alternative fire weather conditions.

End users/partners: U.S. Forest Service (USFS) fire and fuels managers

Data sources, models, technology: Landsat imagery (burn severity and fuels data), MODIS (active fire detection and progression maps)

Major accomplishments in CY 2013:
- Parameterized a stochastic fire spread model with satellite-derived data to provide geospatial analyses of how probability of burning and threats to HVRAs have been altered by fuels treatments in numerous real wildfires.
- Incorporated fire modeling results into a comparative exposure analysis framework and quantified the likelihood of fire-susceptible HVRAs interacting with fire under treated and untreated landscape conditions.
- Explored data availability and opportunities for analyzing the linkages between fuel treatments and enhanced suppression activities, and the relationships between alternative weather scenarios and fuel treatment effectiveness.
- Demonstrated analytical approaches in relevant environments, i.e., in the context of actual historical treatment-wildfire interactions.

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Project: Automated Fuels Treatment Effectiveness Evaluation Using Remote Sensing Information (AFTEERS)
Principal investigator: Stacy A. Drury, Sonoma Technology, Inc.

Project year: 1

Year-end ARL: 3 (final)

Description: This project determined that it is feasible to use Earth observations products such as MODIS and MTBS to evaluate the ability of fuels treatments to mitigate wildfire hazard.

End users/partners: USFS and U. S. National Park Service (NPS) land managers, Joint Fire Science Program, Bureau of Indian Affairs

Data sources, models, technology: MODIS (land cover type, vegetation continuous fields, fire detect); LANDFIRE (existing vegetation type, topographic data); MTBS, etc.

Major accomplishments in CY 2013:
• Identified, visually and quantitatively, differences in how treated and untreated land areas burned.
• Manually analyzed fuels treatment effectiveness on four large fires (greater than 3,000 acres) and three small fires (less than 500 acres), using the process outlined in the AFTEERS Phase 1 proposal. Each data set investigated had to be easily accessible and the analysis easily automatable within the context of an existing decision support system, the Interagency Fuels Treatment Decision Support System (IFTDSS).
• Solicited direct input from our federal agency partners throughout this feasibility study, presenting case studies in which real data were analyzed manually and shown as it would appear within a decision support system.
• Went to great lengths to ensure that any product built could be included in existing decision support systems, such as IFTDSS and the Wildland Fire Decision Support System, to be useful for conducting fire-related resource management operations.
• Created a set of feasible methods that provide land managers with easy-to-use, cost-effective data products that use satellite observations to evaluate fuels treatment options.

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Project: Daily Forecasts of Wildland Fire Impacts on Air Quality in the Pacific Northwest: Enhancing the Air Indicator Report for Public Awareness and Community Tracking (AIRPACT) Decision Support System

Principal investigator: Steve L. Edburg, Washington State University

Project year: 1

Year-end ARL: 3 (final)
Description: This study examined the feasibility of coupling a dynamic fire-atmosphere model (WRF-SFire) with the project’s air quality decision support system, AIRPACT, to improve the representation of fire dynamics and plume rise in air quality forecasts. The project used Earth observations from MOPITT, OMI, and other NASA sources.

End users/partners: NW-AIRQUEST consortium members: EPA Region 10, Nez Perce Tribe, Idaho Department of Environmental Quality, Oregon Department of Environmental Quality, Lane Regional Air Protection Agency, Washington Department of Ecology, etc.

Data sources, models, technology: Terra/MOPITT (CO); SMARTFIRE fire aggregator; Aura/OMI (NO₂); WRF and CMAQ models, etc.

Major accomplishments in CY 2013:
- Demonstrated the feasibility of using WRF-SFire by coupling it to the BlueSky framework.
- Demonstrated that this enhancement of the BlueSky framework improved forecasts of fire spread and plume rise for a historical fire within the project’s modeling domain.

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Project: Improving Agricultural and Wildland Fire Source Emission Products and Access to Information for Atmospheric Science and Smoke Modeling Applications

Principal investigator: Nancy French, Michigan Tech Research Institute

Project year: 1

Year-end ARL: 5 (final)

Description: This project developed models to determine the feasibility of the Wildland Fire Emissions Information System (WFEIS) as a viable and efficient tool for addressing the decision-making challenge of mapping wildland and agricultural fire emissions across regional scales.

End users/partners: Regional air quality community (e.g., National Wildfire Coordinating Group–Smoke Committee, EPA/CMAQ) and continental- to global-scale carbon modeling community (e.g., CASA-GFED, NASA-CMS, CarbonTracker), USFS RSAC, EPA

Data sources, models, technology: MCD45, MOD/MYD14, FIRMS (Fire Information for Resource Management System), CASA-GFED (vegetation dynamics), and BlueSky and WFEIS (fuels mapping, consumption modeling, and emissions)

Major accomplishments in CY 2013:
- Evaluated methods to integrate additional fire occurrence data into decision system.
- Developed methods to quantify wildland fire emissions from mapped fires spatially within the United States (excluding Hawaii and territories).
• Explored methods to create dynamic fuels maps.
• Developed improvements in the Consume model, including integration of available emissions factors and development of uncertainty estimation methods.
• Created products and demonstration materials to review with potential operational partners and cooperators.

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Project: TOPOFIRE: A System for Monitoring Insect and Climate Induced Impacts on Fire Danger in Complex Terrain

Principal investigator: Zachary A. Holden, USFS

Project year: 1

Year-end ARL: 5 (final)

Description: This project demonstrated the feasibility of integrating NASA remote sensing and climate products into a decision support tool, Topofire, which delivers a suite of high spatial resolution real-time information essential to wildland fire management.

End users/partners: Wildland Fire Assessment System (WFAS), Wildland Fire Decision Support System (WFDSS)

Data sources, models, technology: North American Land Data Assimilation System (NLDAS2), FASST hydrologic model, Real Time Mesoscale Analysis, MODIS, LANDFIRE

Major accomplishments in CY 2013:
• Developed methods for downscaling coarse-resolution NLDAS and incorporated these data into fuel moisture and fire danger models.
• Incorporated MODIS snow cover into fuel moisture and fire danger models.
• Integrated downscaled gridded climate data with WindNinja wind speed and solar radiation model outputs into the FASST hydrologic model.
• Developed and tested methods for detecting historical and emerging mountain pine beetle outbreaks.
• Developed map products useful to fire managers in assessing and anticipating the potential effects of beetle attacks on fire behavior.

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Project: Utilization of Multi-sensor Active Fire Detections to Map Fires in the United States: The Future of Monitoring Trends in Burn Severity

Principal investigator: Stephen Howard, U.S. Geological Survey (USGS)
**Project year:** 1

**Year-end ARL:** 4 (final)

**Description:** This project tested the feasibility of using fire detection data to identify undocumented fires in Florida, improve the Monitoring Trends in Burn Severity (MTBS) mapping process, and develop user-friendly tools and applications that can be installed locally to support local fire assessments.

**End users/partners:** USFS RSAC, U.S. Department of the Interior

**Data sources, models, technology:** MODIS, AVHRR, GOES (fire and smoke sensors), federal fire occurrence data, NOAA Hazard Monitoring System (HMS), MBTS, Landsat scenes

**Major accomplishments in CY 2013:**
- Discovered polygons exceeding the MTBS 500-acre minimum threshold; when compared with MTBS data, it appears that there are many unreported fires.
- Completed regionally based analyses of all 1984–2010 historical MTBS analyst-determined burn severity breakpoints for each vegetation type National Land Cover Dataset (2006) throughout the United States to determine the regional average burn severity breakpoints for each vegetation type, which will be used to automatically create preliminary MTBS burn severity products.

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**Project:** Development of New Geospatial Tools for Wildland Fire Management and Risk Reduction

**Principal investigator:** Siamak Khorram, University of California at Berkeley

**Project year:** 1

**Year-end ARL:** 1 (final)

**Description:** This project explored the feasibility of using satellite and airborne remote sensing data to substantially improve the Emission Estimation System (EES) and the First Order Fire Effects Model (FOFEM), leading to better estimates of emissions from wildland fires. The overall goal was to enhance resource managers’ capabilities in their decision making for fire and smoke management related to wildland fires.

**End users/partners:** USFS, Bureau of Land Management (BLM), NPS, California Air Resources Board

**Data sources, models, technology:** EES, FOFEM, AVIRIS, Landsat ETM+
Major accomplishments in CY 2013:

• Accomplished the proof of concept for using advanced remote sensing platforms and analytical techniques calibrated to extensive field data, to provide the data stream needed to improve the quality of data in the FOFEM fire model as well as in the EES fire emission system.
• Assessed the technical feasibility of using refined fuel moisture variables.
• Evaluated the utility of a suite of sensors (UAVSAR, AVIRIS, Landsat 8, and MODIS/VIIRS) for regression between satellite data and ground measurements (fuel and foliar moisture, fuel load, and post-burn severity).

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**Project:** Linking Remote Sensing and Process-based Hydrological Models to Increase Understanding of Wildfire Effects on Watersheds and Improve Post-fire Remediation Efforts

Principal investigator: Mary Ellen Miller, Michigan Tech Research Institute

Project year: 1

Year-end ARL: 6 (final)

Description: This project tested the feasibility of creating an online spatial database to instantaneously provide end users with the basic tools and data needed to incorporate Earth observations into process-based erosion models. Improving accessibility of both modeling capabilities and the required data sets could lead to better assessment tools and support post-fire remediation through erosion modeling.

End users/partners: Burned Area Emergency Response (BAER) team specialists, land managers, and researchers

Data sources, models, technology: Landsat 8, ASTER, MODIS, VIIRS, process-based hydrological models, spatial dry ravel model

Major accomplishments in CY 2013:

• Identified and prepared the spatial data (DEM, soils and land cover data) needed by process-based post-fire erosion models.
• Built a sample online geodatabase containing spatial inputs needed by BAER team hydrologists to run either GeoWEPP or the Water Erosion Prediction Project (WEPP) Watershed online GIS interface.
• Built prototype Web-based GIS tools to import post-fire burn severity maps and used them to reclassify the soil and land cover data.
• Demonstrated that with preparation, the data needed to model post-fire erosion can be prepared almost instantaneously.
• Created a prototype database for the state of Colorado containing the spatial inputs needed to model post-fire erosion and runoff with burn severity maps derived from Earth observation data.

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**Project:** Enhancing Wildland Fire Decision Support and Warning Systems

Principal investigator: Son Nghiem, Jet Propulsion Laboratory

Project year: 1

Year-end ARL: 3 (final)

Description: This project used satellite data together with high-resolution weather forecast and fire behavior models to test the feasibility of improving fire risk and danger assessments ahead of time (months to pre-incident).

End users/partners: National Fire Danger Rating System (NFDRS), WFDSS, National Weather Service (NWS)

Data sources, models, technology: satellite soil moisture and vegetation products, Regional Atmospheric Modeling System (RAMS), Fire Area Simulator (FARSITE)

Major accomplishments in CY 2013:
• Developed initial data processing systems to obtain soil moisture products from *QuikSCAT/Oceansat-2/AMSR-E* and showed the utility of *SMAp* high-resolution soil moisture for wildfire danger applications.
• Developed initial data system to obtain vegetation products from MODIS and demonstrated the potential use of VIIRS from real-time data received by the Chapman antenna.
• Proved satellite capability to replicate critical parameters for fire risk/danger assessment.
• Performed RAMS/FARSITE model simulations in multiple wildfire case studies recommended by the wildfire community.
• Obtained from fire agencies/partners the specifications and requirements for Phase-2 products to enhance FWW, RFW, NFDRS, WFDSS systems.
• Issued double jeopardy warning for wildfire danger in 2013, resulting in a NASA press release and wide coverage by ABC, CBS, NBC, *Los Angeles Times*, etc.

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**Project:** Enhanced Wildland Fire Management Decision Support Using Lidar-infused LANDFIRE Data

Principal investigator: Birgit Peterson, USGS
Project year: 1

Year-end ARL: 4 (final)

Description: This feasibility study built a tool to incorporate lidar data and data from the LANDFIRE program. The Creating Hybrid Structure from LANDFIRE/lidar Combinations (CHISLIC) tool allows users to automatically generate a suite of vegetation structure and wildland fuel parameters from lidar data and infuse these into existing LANDFIRE data sets, ensuring the best data is available to support tactical and strategic wildland fire management decisions.

End users/partners: WFAS, WFDSS

Data sources, models, technology: lidar data (vegetation structure and fuel attributes), ALS, GLAS, LANDFIRE

Major accomplishments in CY 2013:
- Acquired and processed ALS and GLAS data sets and integrated the various components of the CHISLIC system (structure and fuel algorithms, updating of landscape files, and infusion of lidar-based maps with LANDFIRE data).
- Released alpha versions of CHISLIC tool in June, August, and September of 2013 for testing and assessment by project team members.
- Released beta version of CHISLIC tool to external reviewers in September 2013. Along with the CHISLIC tool and user’s guide, end users were provided with a review form to make it easier for reviewers to provide useful, standardized feedback, which was overwhelmingly positive.

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Project: Wildland Fire Behavior and Risk Forecasting

Principal investigator: Sher Schranz, Colorado State University

Project year: 1

Year-end ARL: 3 (final)

Description: This feasibility study used data from satellites and government databases to test the probability of providing forecasting of wildland fire behavior and risk, integrated within NOAA fire weather forecasting systems. The role of the proposed system is to support decision making by providing integrated local numerical prediction of weather, fuel properties, fire risk and fire behavior.

End users/partners: NOAA, USFS
Data sources, models, technology: MODIS, VIIRS, LANDFIRE, NDVI and NDWI maps, fuel moisture from Remote Automated Weather Station

Major accomplishments in CY 2013:
- Evaluated satellite fire detection for data assimilation suitability.
- Completed preliminary version of initialization of fuel moisture fields from satellite NDVI and NDWI.
- Provided prototypes for all major subsystems, established availability of online data, and estimated the demands on computational resources.

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Principal investigator: Wilfrid Schroeder, University of Maryland

Project year: 1

Year-end ARL: 5 (final)

Description: This project built on proven science algorithms to test the feasibility of new spatially refined satellite active fire detection products that yield significantly improved fire information. The project team used these products to initialize and validate fire growth predictions in a coupled weather-fire model, an approach that can be applied to monitor and predict the growth of a fire or a group of simultaneous wildfires in a management unit from first detection until containment.

End users/partners: NWS, WFDSS, Geographical Area Coordination Centers

Data sources, models, technology: VIIRS, MODIS, Landsat, Coupled Atmosphere-Wildland Fire Environment model

Major accomplishments in CY 2013:
- Provided full characterization of the integrated use of new spatially refined satellite fire data and a coupled weather-fire model framework applied to an actual wildfire complex in the western United States.
- Demonstrated remote sensing and modeling techniques proposed for various wildfire events in 2012 and 2013 in the United States and abroad provided further evidence supporting the viability of the application concept.
- Performed offline testing and verification of the components of this project and addressed technical issues concerning the assimilation of satellite fire perimeter information by the coupled weather-fire model.
**Project:** An Integrated Forest and Fire Monitoring & Forecasting System for Improved Forest Management in the Tropics

Principal investigator: Karyn Tabor, Conservation International

Project year: 1

Year-end ARL: 3 (final)

Description: This project tested the feasibility of building a prototype near real-time alert system (Firecast) that improves decision making related to forest and fire management and better addresses the outstanding challenges decision makers face in making timely decisions related to wildland fire management and prevention that have immediate conservation impacts.

End users/partners: Servicio Nacional de Áreas Naturales Protegidas por el Estado (SERNANP) in Peru, the Ministry of Environment and Forests (MEF) in Madagascar, the Department of Conservation Areas Wildlife Reserves (BKSDA) in Indonesia, Flora and Fauna International based in the U.K.

Data sources, models, technology: VIIRS, MODIS (active fire data), Fire Alert System, Fire Risk System and Encroachment Alert System

Major accomplishments in CY 2013:
- Identified the outstanding challenges national governments and in-country organizations face when attempting to identify and implement measures that reduce wildland fire impacts.
- Developed a new and improved early warning system that optimizes functionality for users and provides additional near real-time Earth observation products key to the adoption of Firecast into the business practices of the organizations.
- Identified recommended actions that will enable the adoption of Firecast by in-country institutions.

**Project:** Classification of Whitebark Pine and Spruce-Fir Forests to Improve Wildland Fire Decision Support Tools in the USFS Northern Region

Principal investigator: Linda Vance, University of Montana

Project year: 1

Year-end ARL: 4 (final)
Description: This project investigated the feasibility of using Earth observation tools to address accurate and precise mapping of whitebark pine (*Pinus albicaulis*) and spruce-fir (*Picea engelmannii/Abies lasiocarpa*) forests to enhance wildland fire modeling decision support tools in the USFS Northern region.

End users/partners: USFS, USGS, Greater Yellowstone Ecosystem Coordinating Committee

Data sources, models, technology: WFDSS, USFS Northern region’s Integrated Restoration and Protection Strategy, *Landsat*

Major accomplishments in CY 2013:
- Found that spruce associations can be mapped accurately using the same methods employed to map single species, and successfully combined mapping with downscaled climate change scenarios.
- Selected qualitative feasibility criteria for integration of data sets with downscaled climate models.
- Incorporated prototype into a decision support scenario, which garnered a letter of support.

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**Project**: Improving National Shrub and Grass Fuel Maps Using Remotely Sensed Data and Biogeochemical Modeling to Support Fire Risk Assessments

Principal investigator: James Vogelmann, USGS

Project year: 1

Year-end ARL: 3 (final)

Description: This project assessed the feasibility of using *Landsat* and MODIS data to improve shrub and grassland mapping for fire applications, develop frequent data sets, and therefore determine if improvements in shrub and grassland data layers will alter and improve fire behavior model results.

End users/partners: USFS, BLM, Multi-Resolution Land Characteristics Consortium

Data sources, models, technology: LANDFIRE, MODIS, Daymet, MTBS, *Landsat*

Major accomplishments in CY 2013:
- Demonstrated that fire activity is more likely in areas where the differential between spring and summer NDVI values is high.
• Found that live and dead biomass could be modeled through the combination of MODIS NDVI and NPP data, existing LANDFIRE land cover information, and field data obtained from multiple sources including published literature.
• Discovered fire activity tends to be most prevalent where live and dead biomass is the highest, which relates to one-hour fuel loads.
• Recognized that programs such as STARFM and their derivatives could be effectively used to use combine the temporally rich attributes of MODIS data (which has relatively low spatial resolution for LANDFIRE applications) with spatially detailed Landsat data (which has relatively low temporal resolution for intra-annual fire applications).
• Found that employing the newly derived fuel loads in fire behavior models greatly altered the values of standard fire behavior indices used by practitioners (e.g., flame length), as compared with default (i.e., existing LANDFIRE) fuel loads.

**Project:** Applications of Satellite Measurements to Improve Prescribed Fire Management

Principal investigator: Yuhang Wang, Georgia Institute of Technology

Project year: 1

Year-end ARL: 3 (final)

Description: This project used satellite observations to examine the feasibility of quantitative forecasting for air quality impacts of prescribed fires, which will provide guidance to the Georgia Forestry Commission prescribed fire management. This system will also improve the activities of air quality forecast and event identification by the Georgia Environmental Protection Division and enable better public inspection of prescribed burning.

End users/partners: Georgia Forestry Commission, Georgia Environmental Protection Division, EPA

Data sources, models, technology: Georgia burning permit data, HMS and GFED4 burned area, Global Biomass Burning Emissions Product estimates, EPA CMAQ, MODIS

Major accomplishments in CY 2013:
• Found that prescribed fire management could benefit from quantitative air quality impact forecast due to the large spatial and temporal variations in prescribed fires and their air quality effects.
• Discovered that satellite burn-scar products severely underestimate burned areas of understory prescribed fires. The bottom-up burning permit data are still the best data source for fire emission estimates. Since the real-time burning permit data are only available in Georgia, to properly represent PM2.5 transported from fires in other Southeast
states, fire emissions based on near real-time satellite observations are clearly necessary in assessment of the air quality risk for a requested burning permit.

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Project: An Automated Burned Area Emergency Response Decision Support System for Post-fire Rehabilitation Management of Savanna Ecosystems in the Western United States

Principal investigator: Keith T. Weber, Idaho State University

Project year: 1

Year-end ARL: 5 (final)

Description: This feasibility study examined the rapid resource allocation capabilities of cloud computing to automatically collect Earth observation data, derived decision products, and historic biophysical data for BAER teams to have a comprehensive RECOVER (Rehabilitation Capability Convergence for Ecosystem Recovery) data set and GIS analysis environment that is customized for the target wildfire. RECOVER is transforming this information-intensive process by reducing from days to a matter of minutes the time required to assemble and deliver crucial wildfire-related data.

End users/partners: BLM, Idaho Department of Lands, BAER teams

Data sources, models, technology: Landsat 8, MODIS, AMSR-E, MERRA

Major accomplishments in CY 2013:
- Validated the RECOVER system in the context of active fires.
- Estimated potential improvements to target decision-making processes and project impacts on cost, functionality, and delivery options.
- Reduced the time to minutes or hours at the most improved quality of science understanding and management decision making that can result from shifting valuable staff resources away from the mundane task of data gathering to the crucial jobs of analysis, planning, and monitoring.
B. Abbreviations

AIRPACT: Air Indicator Report for Public Awareness and Community Tracking
ALS: airborne laser scanner
AMS: Autonomous Modular Sensor
AMSR-E: Advanced Microwave Scanning Radiometer-EOS
ARC: Ames Research Center
ARL: Application Readiness Level
ARSET: Applied Remote Sensing Training
ASTER: Advanced Spaceborne Thermal Emission and Reflection Radiometer
AVHRR: Advanced Very High Resolution Radiometer
AVIRIS: Airborne Visible/Infrared Imaging Spectrometer
BAER: Burned Area Emergency Response
BESR: Board on Earth Sciences and Resources
BLM: Bureau of Land Management
CAL FIRE: California Department of Forestry and Fire Protection
CALIPSO: Cloud-Aerosol Lidar and Infrared Pathfinder Satellite Observations
CATS: Cloud-Aerosol Transport System
CHISLIC: Creating Hybrid Structure from LANDFIRE/lidar Combinations
CMAQ: Community Multi-scale Air Quality
CY: calendar year
DoD: Department of Defense
DOI: Department of the Interior
EES: Emission Estimation System
EPA: United States Environmental Protection Agency
ESD: Earth Science Division
FAO: Food and Agriculture Organization of the United Nations
FARSITE: Fire Area Simulator
FASST: Fast All-season Soil Strength
FOFEM: First Order Fire Effects Model
FY: fiscal year
GEO: Group on Earth Observations
GEOSS: Global Earth Observation System of Systems
GFED: Global Fire Emissions Database
GIS: geographic information system
GLAS: Geoscience Laser Altimeter System
GOES: Geostationary Operational Environmental Satellite
GWIS: Global Wildfire Information System
HMS: Hazard Monitoring System
HVRA: highly valued resource and asset
IAWF: International Association of Wildland Fire
IFTDSS: Interagency Fuels Treatment Decision Support System
JFSP: Joint Fire Science Program