

# Summary of 2014 GOFC-GOLD Fire Implementation Team Meeting

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## Introduction

The Global Observation of Forest and Land Cover Dynamics (GOFC-GOLD) program provides an international forum to exchange information, coordinate observations and data handling, and provide a framework to establish necessary long-term monitoring systems. The GOFC-GOLD Fire Mapping and Monitoring Theme is aimed at refining and articulating relevant international observational requirements and making the best possible use of fire data products from existing and future satellite observing systems for fire management, policy decision-making, and global-change research. GOFC-GOLD Fire, in a joint effort with the Committee on Earth Observation Satellites (CEOS) Working Group on Calibration and Validation (WGCV), Land Product Validation (LPV) subgroup, is pursuing the coordinated validation of fire products by standardized protocols.

The GOFC-GOLD Fire Implementation Team (IT) Meeting was held July 29-31, 2014; the National Oceanic and Atmospheric Administration's (NOAA) Center for Weather and Climate Prediction (NCWCP) hosted the meeting in College Park, MD. The SysTem for Analysis, Research and Training (START) and the University of Maryland, College Park (UMd) cosponsored the meeting, the overall goal of which was to promote collaboration among U.S. and international

researchers focusing on satellite remote sensing of fires. The approach used was to review current status, recent developments, and future prospects of satellite-based fire monitoring and science. Specifically, the meeting focused on reviewing the new and planned satellite fire sensing systems, e.g., the Visible Infrared Imaging Radiometer Suite (VIIRS) onboard the joint NASA/NOAA Suomi National Polar-orbiting Partnership (NPP) platform and planned for future Joint Polar Satellite System (JPSS) satellites, European Space Agency (ESA)'s Sentinel missions, and the Deutsches Zentrum für Luft und Raumfahrt's (DLR) [German Space Agency] Technologieerprobungsträger-1 (TET-1) Technology Experiment satellite.

The presentations summarized here, can be downloaded from [gofc-fire.umd.edu/meeting/static/GOFC\\_Fire\\_IT\\_2014/index.php](http://gofc-fire.umd.edu/meeting/static/GOFC_Fire_IT_2014/index.php).

## Meeting Summary

After a welcome by **Ivan Csiszar** [NCWCP], **Chris Justice** [UMd] presented the objectives of the meeting and an overview of the evolution of fire monitoring from space, from its start in the 1980s to the present. He recounted the initial efforts to develop algorithms and global datasets at 1-km (~0.6-mi) resolution from the Advanced Very High Resolution Radiometer (AVHRR) onboard NOAA Polar-Orbiting Environmental Satellites (POES) and the



2014 GOFC-GOLD Fire Implementation Team Meeting participants. **Photo credit:** Kris Lasko, UMd

major advances in fire monitoring achieved by NASA's Moderate Resolution Imaging Spectroradiometer (MODIS) onboard Earth Observing System (EOS) satellites, Terra and Aqua. Justice highlighted the various internationally generated data products and field campaigns associated with advancing fire monitoring and our understanding of fire emissions over the years, and concluded with the operational outlook for the Suomi NPP VIIRS and future JPSS, the Geostationary Operational Environmental Satellite (GOES)-R, and the Sentinels.

**Ivan Csiszar** presented information on the Suomi NPP mission and the VIIRS fire detection capabilities, on behalf of **Mitch Goldberg** [NOAA—*JPSS Program Scientist*], who was unable to attend the meeting. He stated that VIIRS incorporates fire-sensitive channels, including a dual-gain, high-saturation temperature, 4- $\mu\text{m}$  channel, enabling active fire detection and characterization.

**Louis Giglio** [UMd] described the 750-m (~2460-ft) VIIRS active fire product, which is based on VIIRS's 16 moderate-resolution (750-m) "M-bands," and is one of the standard Environmental Data Records generated by the NOAA JPSS ground system. This fire product builds on an earlier *Collection 4* version of the MODIS fire algorithm. The VIIRS active fire product has shown more fire detections than MODIS—due to improved spatial resolution. Further development is in progress to ensure high-quality VIIRS fire products that extend the MODIS data record.

**Wilfrid Schroeder** [UMd] showcased the emerging 375-m (~1230-ft) VIIRS "I-band" product. He described the potential of 375-m middle- and thermal-infrared imagery data in fire detection, noting small, but variable, commission errors (< 1.2%) for nominal-confidence fire pixels. These data improve detection performance as compared to the VIIRS 750-m baseline fire product. The VIIRS 375-m fire data resulted in superior mapping capabilities with improved consistency of fire perimeter delineation as compared to current MODIS fire data.

**Mark Ruminski** [NOAA] presented details on the NOAA Hazard Mapping System (HMS). The HMS was developed in 2001 by the National Environmental Satellite, Data, and Information Service (NESDIS) as an interactive tool to identify fires and the smoke emissions over North America in an operational environment. The HMS incorporates data from two geostationary satellites (GOES-East/West) and seven polar-orbiting systems (Terra, Aqua, NOAA-15, -18, and -19, and METOP-A and -B<sup>1</sup>). Automated fire detection algorithms are employed for each satellite sensor, which

are then addressed by analysts, who apply quality control procedures for automated fire detection and then manually added smoke plume detection. Further, determination of the smoke concentration values is aided by the GOES Aerosol and Smoke Product (GASP). More details about the fire and smoke product can be found at [www.ospo.noaa.gov/Products/land/hms.html](http://www.ospo.noaa.gov/Products/land/hms.html).

**Olivier Arino** [ESA, Italy] gave an update on the Sentinel program. Launched in April 2014, Sentinel-1A is a polar-orbiting, day-and-night radar imaging mission with a 5-m (~16-ft) ground resolution and 12-day repeat cycle at the equator, designed for land and ocean services. He showcased the potential of Sentinel-1A data for deforestation studies in Brazil, and vegetation regeneration after burn scarring in Greece. He also presented the details on the instrument characteristics of the planned Sentinels 2 through 6<sup>2</sup>.

**Emilio Chuvieco** [University of Alcalá, Spain] reported on the new ESA-supported Fire-Climate Change Initiative (CCI) burnt-area product that relies on Envisat's Medium Resolution Imaging Spectrometer (MERIS) data and an algorithm that merges data from three sources: MERIS, Satellite Pour l'Observation de la Terre (SPOT) Vegetation, and Along Track Scanning Radiometer (ATSR<sup>3</sup>). The spatial resolution of the gridded product is 0.5 x 0.5°, with information on total burned area, percent observed area, number of patches, and burned area of each land cover. The burned area pixel product includes information on the date of detection, confidence level, percent observed areas, and burned cover.

**Martin Wooster** [Kings College London (KCL), U.K.] provided an update on near-real-time (NRT) geostationary fire products. Currently, the Fire Radiative Power (FRP) product from the Meteosat Second Generation satellite's Spinning Enhanced Visible and Infrared Imager (SEVIRI) data covering Europe, Africa, and parts of South America is available via *ftp* from the Land Surface Analysis Satellite Application Facility (LSA SAF) website ([landsaf.meteo.pt](http://landsaf.meteo.pt)). Also, the NRT GOES FRP product over North and South America is available on request from KCL. He stated that the MODIS FRP datasets have uncertainty of 26.6% at one standard deviation, and the uncertainties are driven by fire location; thus one should be cautious when estimating the emissions from FRP. He also discussed the Global Fire Assimilation System (GFAS) that provides global emissions of biomass burning at 0.5° and 1° resolution ([www.gmes-atmosphere.eu/about/project\\_structure/input\\_data/d\\_fire](http://www.gmes-atmosphere.eu/about/project_structure/input_data/d_fire)). He outlined plans for EUMETSAT's Meteorological Satellite (Meteosat)

<sup>2</sup> To learn more about the plans for Sentinel read "An Overview of Europe's Expanding Earth-Observing Capabilities" in the July-August 2013 issue of *The Earth Observer* [Volume 25, Issue 4, pp. 4-15].

<sup>3</sup> ATSR flies onboard SPOT-4.

<sup>1</sup> METOP is an operational meteorological satellite system operated by the European Organisation for the Exploitation of Meteorological Satellites (EUMETSAT).

Third Generation Imager and Sounder, to be launched in the 2016-18 timeframe, and the NOAA GOES-R, to be launched in 2015.

**Peter Roohr** [NOAA] addressed current fire-weather research and challenges. He explained the National Weather Service's (NWS) vision for developing high-resolution fire-weather information and services in close collaboration with agency partners. Developing such services has benefits to the user community in minimizing firefighter fatalities due to unpredicted fire behavior, cost savings with more efficient use of resources, better understanding of growth of existing fires to prevent loss of life, and other uses. He called for more research to address information gaps to enhance the fire-weather systems such as limited observations and measurements near fires, improved high-resolution weather forecasts, and smoke prediction. To address the above concerns, Roohr suggested strong partnerships with land-management agencies through joint fire science programs, integrating VIIRS data into coupled fire-weather models, and improved funding for NWS.

**Eckehard Lorenz** [DLR, Germany] provided an update on TET-1, the first satellite of the FireBird constellation of microsattellites ("CubeSats"). TET-1 is a technology demonstration microsattellite that was launched in July 2012. The TET-Bus is based on the BISpectral Infrared Detection (BIRD) satellite, with a primary goal of sensing "hot phenomena" such as wildfires, volcanoes, gas flares, and industrial hotspots. Notably for its size, the satellite is equipped with cameras with 42-m (~138-ft) ground pixel size in the red, green, and near infrared spectral range; and 370-m (~1214-ft) ground pixel size in the mid- and thermal-infrared, with a swath of 185 km (~115 mi). The satellite can be pointed toward a target to enhance observation frequency. The second satellite in the series, Berlin infraRed Optical System (BiROS), is scheduled for launch in 2015 and will deliver quantitative information on FRP at a spatial resolution of 350 m (~1148 ft).

**David Roy** [South Dakota State University] discussed the status of Landsat-8, with emphasis on improvements over Landsat 7's capabilities in terms of scenes-per-day global coverage, higher quantization, and improved geolocation capabilities. These improvements make Landsat-8 more useful for detecting changes in surface properties than its predecessor. Roy stated that efforts are underway to generate surface reflectance products and stressed on the need for generation of "higher-level" 30-m (~98-ft) Landsat products—similar to those generated for MODIS. He provided details on the Web-Enabled Landsat Data Record (WELD) project, where Landsat data are being processed at a global scale to provide weekly, monthly, seasonal, and annual products. More details can be found at [globalmonitoring.sdstate.edu/projects/weldglobal](http://globalmonitoring.sdstate.edu/projects/weldglobal).

**Mark Carroll** [NASA's Goddard Space Flight Center/ Science Systems and Applications, Inc.] presented details on the Rehabilitation Capability Convergence for Ecosystem Recovery (RECOVER) project that brings together disparate information necessary to address post-fire rehabilitation through a decision support system. RECOVER uses cloud computing capabilities to automatically and rapidly gather Earth observational data, derived decisions, and historic biophysical layers. The project is being designed in close collaboration with the U.S. Department of Interior's Bureau of Land Management and the Idaho Department of Lands.

**Chris Justice** gave an update on the GOF-C-GOLD Fire program, which has been providing inputs on the Group on Earth Observations (GEO) Wildfire Task (*DI-01-C4*). This task informs risk management and disaster reduction applications; supports international meetings and partner program activities; helps to coordinate regional networks and workshops; and performs outreach and communication through the website ([gofc-fire.umd.edu](http://gofc-fire.umd.edu)). Justice highlighted priorities for GOF-C-GOLD Fire IT for the coming years, which include: working with interagency and international partners to incorporate operational fire-monitoring capabilities into upcoming missions; providing data and product continuity through NOAA/ESA/NASA—including NRT data access; promoting space agency coordination of global moderate-resolution data processing and access (e.g., from Landsat-8 and Sentinel 2); continuing to advocate for meteorological agency support to establish a Global Geostationary Fire Network; implementing and providing regional calibration of operational Global Fire Early Warning Systems; working on Global Burned Area Products and Validation (Stage 3); and garnering support for the Regional Fire Networks and developing capacity building programs on the use of satellite fire data through START and NASA.

**Johann Goldammer** [Freiburg University, Germany] described international cooperation and coordination for wildland fire management through the Global Wildland Fire Network (GWFN). Objectives include developing common international principles for fire management; a global and regional set of agreements on transboundary cooperation in fire management; sharing resources in capacity building in fire management, including cooperation in wildfire emergency response; and establishing international policies to address global change and fires. He called for more active involvement of GOF-C-GOLD regional Fire IT capabilities to develop NRT fire early warning and monitoring information and establishing joint activities with regional fire management resource centers to address fire concerns.



**Luigi Boschetti** [University of Idaho] discussed the GOF-C-GOLD sourcebook for Reducing Emissions from Deforestation and forest Degradation Plus (REDD+) in developing countries activities. The sourcebook is currently being updated in collaboration with the United Nations Food and Agriculture Organization (FAO) to include training material with country examples and lectures. He stressed the need for more improvements in data formats and distribution systems, including use of 30-m (98-ft) Landsat data to estimate emissions through international funding.

**Kevin Tansey** [University of Leicester, U.K.] presented updates on the development of the Global Climate Observing System (GCOS) 2016 Implementation Plan. The inputs to the new GCOS plan are several, e.g., the 2013/2014 Intergovernmental Panel on Climate Change (IPCC) Fifth Assessment Report (AR5), the 2011 World Climate Research Program (WCRP) conference, the 2013 Stratosphere–troposphere Processes And their Role in Climate (SPARC) data workshop, the 2014 EUMETSAT/WCRP climate symposium, and GCOS/WCRP panel assessments. Specific to the fire datasets, Tansey stated that a review of user requirements in the context of GCOS was recently published<sup>4</sup>. He highlighted new issues for the implementation plan, such as: representation of fire in IPCC-class models; validation and uncertainty characterization of fire products; improved fire-product spatial resolution and accuracy; and fire-product trend analysis, including a rolling review of requirements.

The next three presentations focused on Global Fire Early Warning Systems. **Bill de Groot** [Natural Resources Canada] presented new developments to the Canadian Global Fire Early Warning System, which is being refined to include fire behavior characteristics, e.g., spatial rainfall, fire radiative energy (indicating fuel consumption and emissions), fire intensity from fuel consumption, and rate of fire spread from FRP and fuel-load-affecting emissions. **Tim Brown** [Desert Research Institute, Nevada] discussed meteorological data for fire danger products, stating that *Version 2* of the Climate Forecast System is being developed for use in early warning systems; the new version features 1° horizontal resolution and a Global Forecast System with 13-km (~8-mi) resolution. **Jesus Ayanz** [Joint Research Center (JRC), Italy], gave an update on the Global Wildfire Information System (GWIS), which builds on earlier work of the European Forest Fire Information System (EFFIS), developed by JRC in close collaboration with the fire services in several European countries. This system provides “harmonized” information on

forest fires in Europe, and is being expanded to global coverage as the GWIS. Currently, GWIS is included in the GEO Work Plan, and integrating the Copernicus web services with GWIS is being planned.

**Krishna Vadrevu** [UMd] presented an overview of the biomass burning focus area—with contributions from **Guido van der Werf** [Vrije Universiteit, Netherlands] who could not attend the meeting. Specific issues with respect to NRT estimates of emissions include FRP-to-fire radiative energy conversion, fuel consumption estimation, and variability in emission factors. He highlighted the need to address emissions from small fires by employing higher-spatial-resolution data and using the Landsat burned-area archive to validate new approaches. Vadrevu also discussed satellite monitoring of pollutants from biomass burning events, noting that FRP-Aerosol Optical Depth relationships in agricultural systems are weak and need more investigation. His results highlighted the need for more work on small-mode fraction products and Greenhouse gases Observing SATellite (GOSAT) carbon dioxide (CO<sub>2</sub>) data for fire emission studies. On the topic of fire emissions, **Shobha Kondragunta** [NOAA] provided an update on the global biomass burning emissions product that uses geostationary datasets from multiple satellites to estimate emissions. The emission product can be downloaded from [satepsanone.nesdis.noaa.gov/pub/FIRE/GBBEPx](http://satepsanone.nesdis.noaa.gov/pub/FIRE/GBBEPx).

Several presentations describing GOF-C-GOLD Regional Networks around the world came next. Included were representatives from South Africa, Latin America, Mexico, Southeast Asia, and the Balkan regions. **Philip Frost** [Council for Scientific and Industrial Research, South Africa] described the status of the Southern Africa Fire Network (SAFNET), stating that a new MODIS direct-broadcast reception station will be installed in Kenya, and that the Advanced Fire Information System (AFIS) has been enhanced with an Android application to provide fire alerts. **Alberto Setzer** [Instituto Nacional de Pesquisas Espaciais (INPE), Brazil] described the Red Latinoamericana de Teledetección e Incendios Florestales (RedLaTIF), stating that INPE’s fire system is helping to locate illegal deforestation and burning in Amazonia, and that there is a need to refine global fire products through ground validation, since most of them underestimate burned area for Brazil. **Isabel Cruz** [Comisión Nacional para el conocimiento y uso de la Biodiversidad (CONABIO), Mexico] described how CONABIO is developing a fire early warning system to include fire detections from VIIRS data. **Krishna Vadrevu** stated that the Southeast Asia Regional Research and Information Network (SEARRIN) network is quite active and has been organizing meetings every year jointly with Japan’s National Institute of Environmental Studies (NIES). The latest

<sup>4</sup> Mouillot, F., Schultz, M. G., Yue, C., Cadule, P., Tansey, K., Ciais, P., and Chuvieco, E. (2014). “Ten years of global burned area products from spaceborne remote sensing—A review: Analysis of user needs and recommendations for future developments,” *International Journal of Applied Earth Observation and Geoinformation*, 26, 64-79.

meeting results can be found at [gofc-fire.umd.edu/meeting/static/Vietnam\\_workshop\\_2014/index.php](http://gofc-fire.umd.edu/meeting/static/Vietnam_workshop_2014/index.php). **Ioannis Gitas** [Aristotle University of Thessaloniki, Greece] reported that the Balkan Network is currently developing a Balkan Wildland Fire Observatory, useful for fire monitoring in the region. He also noted that the tenth European Association of Remote Sensing Laboratories Fire Special Interest Group meeting is planning to meet in Cyprus in October 2015.

**Sylvia Wilson** [U.S. Geological Survey] presented information on the SilvaCarbon program, which is focused on REDD+ and a contribution to the GEO Global Forest Observation Initiative (GFOI). SilvaCarbon partners with developing countries to improve monitoring of forest and terrestrial carbon fluxes; improve understanding of methodologies and collection and dissemination of data; and coordinate U.S. science, innovation, and technical expertise. More information about the SilvaCarbon program can be found at [egsc.usgs.gov/silvacarbon/node/30.html](http://egsc.usgs.gov/silvacarbon/node/30.html).

**Vincent Ambrosia** [NASA's Ames Research Center] described the NASA Applied Sciences Wildfire Program and the Research Opportunities in Space and Earth Sciences (ROSES) 2011 selections and the nine projects selected for Phase-2 implementation with three-year funding. He also discussed the NASA airborne Autonomous Modular Sensor (AMS), transferred to the U.S. Foreign Service (USFS) National Infrared Operations (NIROPS) and USFS Remote Sensing Applications Center (RSAC) for operational support. Further details on the AMS were presented by **Everett Hinkley** [U.S. Department of Agriculture (USDA)] that can be found at [nirops.fs.fed.us/ams](http://nirops.fs.fed.us/ams) and

implemented through USDA's Forest Service Remote Sensing Applications Center's (RSAC) program.

**Tim Lynham** [Canadian Forest Service] presented details on the New Infrared Sensor Technology (NIRST) wildfire-monitoring tool, highlighting the low cost and excellent fire detection with a 350-m (1148-ft) spatial resolution. Measurement limitations include mid-infrared calibration, accuracy concerns regarding FRP, and inability to measure subpixel changes in radiances. He also presented details on the Polar Communications and Weather (PCW) Mission Molniya Orbit, which can be found on the GOFC-GOLD Fire IT website ([gofc-fire.umd.edu/meeting/static/GOFC\\_Fire\\_IT\\_2014/index.php](http://gofc-fire.umd.edu/meeting/static/GOFC_Fire_IT_2014/index.php)).

### Conclusion

The GOFC-GOLD Fire IT meeting was successful in bringing researchers together to review progress and recent developments in satellite fire-sensing systems, including calibration and product validation. The GOFC-GOLD Fire IT will continue to as well as promoting open data policies and free sharing of Earth-observations data for scientific research; as well as promoting generation of higher-order fire products from different satellites. The Team will also support regional fire networks and develop capacity-building programs on the use of satellite fire data; coordinate with international agencies to develop best practices and protocols for fire observations in support of measuring and understanding essential climate variables, REDD, and international conventions; and facilitate satellite fire data outreach and dissemination activities. ■

## SMAP: Mapping Soil Moisture and Freeze/Thaw State from Space

*continued from page 19*

### Human Health

Improved seasonal soil moisture forecasts using SMAP data will directly benefit famine early warning systems, particularly in sub-Saharan Africa and South Asia, where hunger remains a major human health factor and because the population harvests its food from rain-fed agriculture in highly monsoonal (i.e., seasonal) conditions. Indirect benefits will also be realized, as SMAP data will enable better weather forecasts that lead to improved predictions of heat stress and virus-spreading rates. In addition, SMAP will benefit the emerging field of *landscape epidemiology* (identifying and mapping vector habitats for

human diseases such as malaria), where direct observations of soil moisture can provide valuable information on vector-population dynamics.

### Summary

The SMAP mission will bring new data and consequent new perspectives on the freeze/thaw state of soil, with spatial resolution far greater than what has come before. The impacts on our understanding of terrestrial processes and phenomena will be large, as will practical, applications-level benefits.

Given the mission requirements, SMAP's unique data will provide new perspectives on our planet for years to come. For more details about SMAP, refer to the SMAP Handbook at [smap.jpl.nasa.gov/files/smmap2/SMAP\\_Handbook\\_FINAL\\_1\\_JULY\\_2014\\_Web.pdf](http://smap.jpl.nasa.gov/files/smmap2/SMAP_Handbook_FINAL_1_JULY_2014_Web.pdf). ■