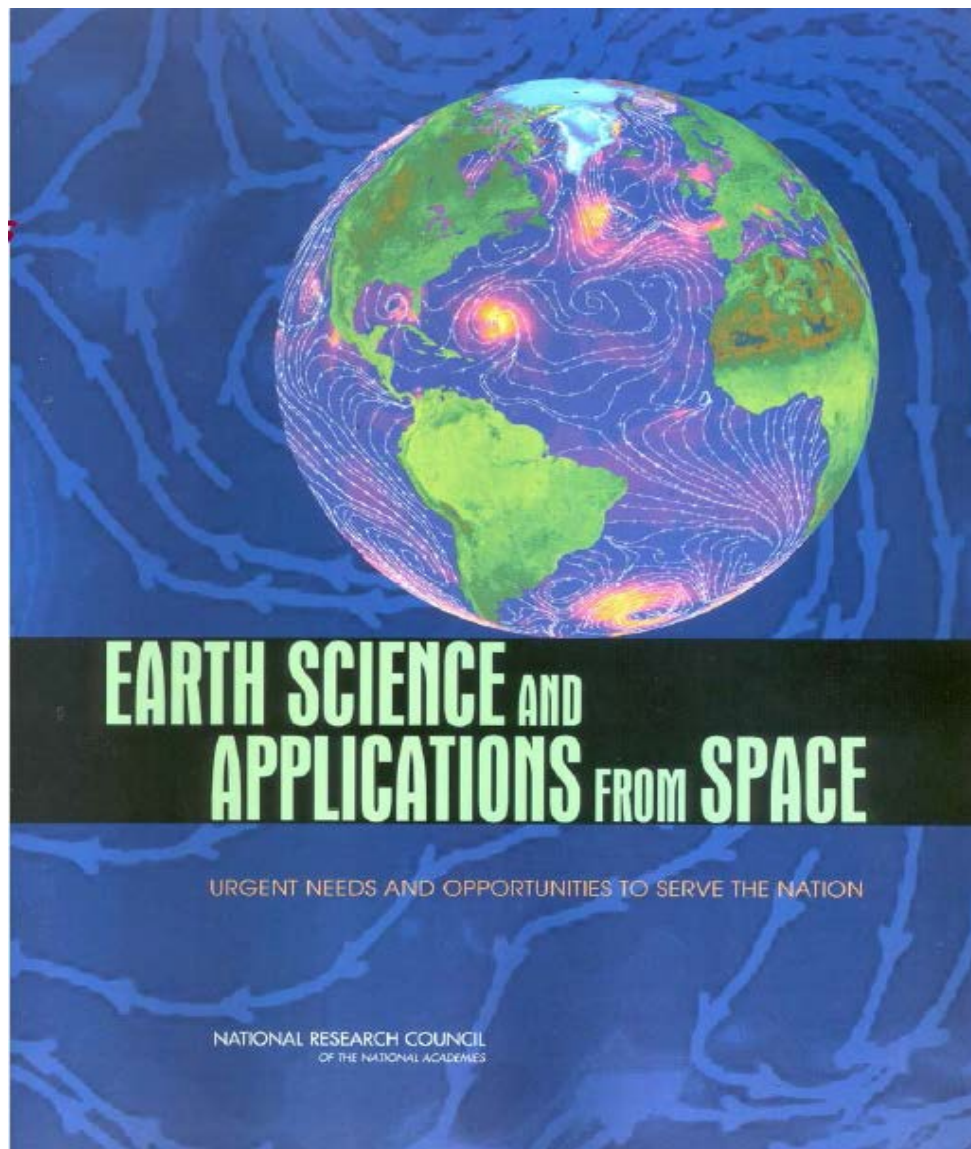


# Opportunity to Provide Input to Current Decadal from VSWIR and TIR Community

Robert Green, Simon Hook, Betsy Middleton and The HypsIRI Community



# EARTH SCIENCE AND APPLICATIONS FROM SPACE

URGENT NEEDS AND OPPORTUNITIES TO SERVE THE NATION

NATIONAL RESEARCH COUNCIL  
OF THE NATIONAL ACADEMIES



# Opportunity (Thank you Kevin)



## Biogeosciences Section Announcement: Request for Input on Earth Science and Applications from Space

Dear Biogeosciences Members:

On behalf of the Committee on Earth Science and Applications From Space ([ESAS 2017](#)) from the National Academies of Sciences, Engineering and Medicine, we would like to bring to your attention a request for community input on the role of space-based observations in addressing the key challenges and questions for Earth System Science in the coming decade. Recognizing the importance of capturing the suggestions and perspectives and thoughts from as wide a swath of the community as possible, the deadline has been extended through [30 June 2016](#). The RFI request may be found [online](#).

**The steering committee also takes this opportunity to encourage interested members of the community to consider organizing at their institution a town hall meeting that would provide a local forum for colleagues to discuss and consider any aspect of the survey. (These town hall meetings would precede those the steering committee will host at the 2016 AGU Fall and 2017 American Meteorological Society meetings.) Following the town hall meeting, the steering committee invites the organizers to send a short report (no longer than 10 pages) that summarizes the key outcomes of the meeting.**

**In thinking about holding such town hall meetings, please consider whether it would be valuable to extend an invitation to colleagues in other nearby institutions. Summary town hall reports can be sent via [email](#) until 31 October 2016 and will be posted on the survey's web page. Organizers should feel free to focus town hall meetings on any aspects of the survey they think are important, such as key science opportunities in the decade ahead, how Earth system science can continue to provide knowledge important to key societal challenges, and the role of technology development and other forms of innovation in the execution of our science.**

All of the white papers received to date in response to the two requests for information are available via links within the RFI solicitation posted on the [survey website](#). The steering committee welcomes your continued input through the RFI call and the holding of community-organized town hall meetings in the coming months, after which the next series of critical panel and steering committee meetings will take place.

Marilyn Fogel  
AGU Focus Group President, Biogeosciences

Ariel Anbar  
AGU Focus Group President-Elect, Biogeosciences



## More Follow Up on Opportunity (T. K.)



- There isn't a hard deadline for submission of supplemental material to the survey.
- The period to respond to RFIs has closed, but the mailbox is always open for communication to the committees.
- The next meeting of the survey steering committee is Nov. 7-10 in Irvine, CA.
- Something submitted prior to the meeting that would be ideal.
- Steering committee and panels will be holding additional meetings through May 2017.



# Decadal Survey Steering Committee



**Waleed Abdalati**, *Co-Chair*, University of Colorado, Boulder

**William Gail**, *Co-Chair*, Global Weather Corporation

**Steven Battel (NAE)**, Battel Engineering

**Stacey Boland**, Jet Propulsion Laboratory

**Robert Braun (NAE)**, Georgia Institute of Technology

**Shuyi Chen**, University of Miami

**William Dietrich (NAS)**, University of California, Berkeley

**Scott Doney**, Woods Hole Oceanographic Institution

**Christopher Field (NAS)**, Carnegie Institution for Science

**Helen Fricker**, Scripps Institution of Oceanography

**Sarah Gille**, Scripps Institution of Oceanography

**Dennis Hartmann (NAS)**, University of Washington

**Daniel Jacob**, Harvard University

**Anthony Janetos**, Boston University

**Everette Joseph**, University at Albany, SUNY

**Joyce Penner**, University of Michigan

**Soroosh Sorooshian (NAE)**, University of California, Irvine

**Graeme Stephens (NAE)**, California Institute of Technology

**Byron Tapley (NAE)**, University of Texas at Austin

**W. Stanley Wilson**, NOAA/NESDIS (retired)



# Decadal Survey Panels



- I. Global Hydrological Cycles and Water Resources
- II. Weather and Air Quality: Minutes to Subseasonal
- III. Marine and Terrestrial Ecosystems and Natural Resource Management
- IV. Climate Variability and Change: Seasonal to Centennial
- V. Earth Surface and Interior: Dynamics and Hazards



## Global Hydrological Cycles and Water Resources

- Dr. Ana P. Barros - (Co-Chair), Duke University
- Dr. Jeff Dozier - (Co-Chair), University of California, Santa Barbara
- Dr. Newsha Ajami, Stanford University
- Dr. John D. Bolten, NASA Goddard Space Flight Center
- Dr. Dara Entekhabi, Massachusetts Institute of Technology
- Dr. Graham E. Fogg, University of California, Davis
- Dr. Efi Foufoula-Georgiou, University of Minnesota
- Dr. David C. Goodrich, U.S. Department of Agriculture
- Dr. Terri S. Hogue, Colorado School of Mines
- Dr. Jeffrey S. Kargel, University of Arizona
- Dr. Venkat Lakshmi, University of South Carolina
- Professor Andrea Rinaldo, Ecole Polytechnique Federale de Lausanne
- Dr. Edwin Welles, Deltares
- Professor Eric F. Wood, Princeton University





## Weather and Air Quality: Minutes to Subseasonal

- Dr. Steven A. Ackerman - (Co-Chair), University of Wisconsin-Madison
- Dr. Nancy L. Baker - (Co-Chair), Naval Research Laboratory
- Dr. Philip E. Ardanuy, INNOVIM, LLC
- Dr. Elizabeth A. Barnes, Colorado State University
- Dr. Stanley G. Benjamin, National Oceanic and Atmospheric Administration
- Dr. Mark A. Bourassa, Florida State University
- Dr. Bryan N. Duncan, NASA Goddard Space Flight Center
- Dr. Charles E. Kolb, Aerodyne Research, Inc.
- Dr. Ying-Hwa Kuo, University Corporation for Atmospheric Research
- Dr. W. Paul Menzel, University of Wisconsin-Madison
- Ms. Maria A. Pirone, Harris Corporation
- Dr. Armistead G. Russell, Georgia Institute of Technology
- Ms. Julie O. Thomas, Scripps Institution of Oceanography UCSD
- Dr. Duane Waliser, California Institute of Technology
- Dr. Xubin Zeng, University of Arizona





## Marine and Terrestrial Ecosystems and Natural Resource Management

- Dr. Compton J. Tucker - (Co-Chair), NASA Goddard Space Flight Center
- Dr. James A. Yoder - (Co-Chair), Woods Hole Oceanographic Institution
- Dr. Gregory P. Asner, Carnegie Institution for Science
- Dr. Francisco Chavez, Monterey Bay Aquarium Research Institute
- Dr. Scott Goetz, Woods Hole Research Center (soon N. Arizona)
- Dr. Patrick N. Halpin, Duke University
- Dr. Eric Hochberg, Bermuda Institute of Ocean Sciences
- Dr. Christian J. Johannsen, Purdue University
- Dr. Raphael M. Kudela, University of California, Santa Cruz
- Dr. Gregory W. McCarty, U.S. Department of Agriculture
- Dr. Linda O. Mearns, National Center for Atmospheric Research
- Dr. Mary Jane Perry, University of Maine
- Dr. David A. Siegel, University of California, Santa Barbara
- Dr. David L. Skole, Michigan State University
- Dr. Susan L. Ustin, University of California, Davis
- Dr. Cara Wilson, National Oceanic and Atmospheric Administration



## Climate Variability and Change: Seasonal to Centennial

- Dr. Carol Anne Clayson (Co-Chair), Woods Hole Oceanographic Institution
- Dr. Venkatachalam Ramaswamy (Co-Chair), NOAA GFDL
- Dr. Arlyn E. Andrews, NOAA Earth System Research Laboratory
- Dr. Enrique Curchitser, Rutgers University
- Dr. Lee-Lueng Fu, Jet Propulsion Laboratory
- Dr. Guido Grosse, Alfred-Wegener-Institute for Polar and Marine
- Dr. Randal D. Koster, NASA Goddard Space Flight Center
- Dr. Sonia Kreidenweis, Colorado State University
- Dr. Emilio F. Moran, Michigan State University
- Dr. Cora E. Randall, University of Colorado
- Dr. Philip J. Rasch, Pacific Northwest National Laboratory
- Dr. Eric J. Rignot, University of California, Irvine
- Dr. Christopher Ruf, University of Michigan
- Dr. Ross J. Salawitch, University of Maryland
- Dr. Amy K. Snover, University of Washington
- Julienne C. Stroeve, University of Colorado Boulder
- Dr. Bruce A. Wielicki, NASA Langley Research Center
- Dr. Gary W. Yohe, Wesleyan University



## Earth Surface and Interior: Dynamics and Hazards

- Douglas W. Burbank, NAS (Co-Chair) University of California, Santa Barbara
- David T. Sandwell, NAS (Co-Chair) Scripps Institution of Oceanography
- Robin E. Bell, Columbia University
- Emily E. Brodsky, University of California, Santa Cruz
- Donald P. Chambers, University of South Florida, St. Petersburg
- Lucy Flesch, Purdue University
- George E. Hilley, Stanford University
- Kristine M. Larson, University of Colorado Boulder
- Stefan Maus, University of Colorado Boulder
- Michael S. Ramsey, University of Pittsburgh
- Jeanne Sauber, NASA Goddard Space Flight Center
- Khalid A. Soofi, ConocoPhillips
- Howard A. Zebker, Stanford University



# Decadal Survey Panels



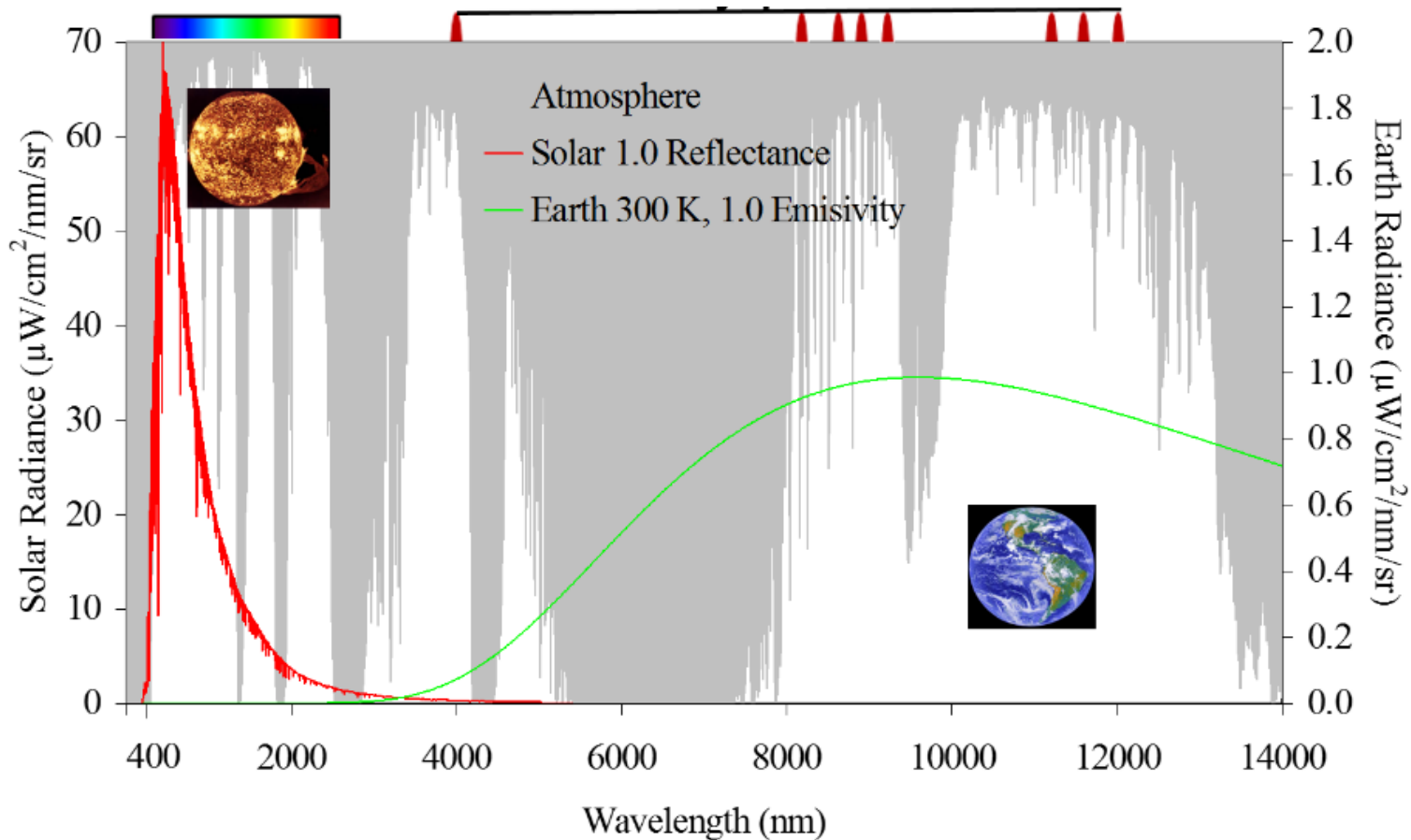
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- II. Weather and Air Quality: Minutes to Subseasonal
- III. Marine and Terrestrial Ecosystems and Natural Resource Management
- IV. Climate Variability and Change: Seasonal to Centennial
- V. Earth Surface and Interior: Dynamics and Hazards



# VSWIR and TIR Measurements



- Global terrestrial and coastal VSWIR spectroscopy at 30 m, 16 days and multispectral TIR at and 60 m, 4 days with real-time downlink of selected products.





# VSWIR, TIR and Combined Related Decadal Survey RFI 2 Inputs



Luvall	Jeffrey	A Thermodynamic Paradigm For Using Satellite Based Geophysical Measurements For Public Health Applications
Heidi	Dierssen	Assessing Transient Threats and Disasters in the Coastal Zone with Airborne Portable Sensors
Ryan	Pavlick	Biodiversity
Simon	Hook	Carbon Emissions from Biomass Burning
Eric	Hochberg	Coral Reefs: Living on the Edge
Wendy	Calvin	Earth Surface Geochemistry and Mineralogy: Processes, Hazards, Soils, and Resources
Joshua	Fisher	Evapotranspiration: A Critical Variable Linking Ecosystem Functioning, Carbon and Climate Feedbacks, Agricultural Management, and Water Resources
Tamlin	Pavelsky	From the Mountains to the Sea: Interdisciplinary Science and Applications Driven by the Flow of Water, Sediment, and Carbon II
Philip	Dennison	Global Measurement of Non-Photosynthetic Vegetation
Kevin	Turpie	Global Observations of Coastal and Inland Aquatic Habitats
Philip	Townsend	Global Terrestrial Ecosystem Functioning and Biogeochemical Processes
Dale	Quattrochi	High Spatial, Temporal, and Spectral Resolution Instrument for Modeling/Monitoring Land Cover, Biophysical, and Societal Changes in Urban Environments
Steve	Greb	Inland Waters
Natalie	Mahowald	Measuring the Earth's Surface Mineral Dust Source Composition for Radiative Forcing and Related Earth System Impacts
Frank	Muller-Karger	Monitoring Coastal and Wetland Biodiversity from Space
Robert	Wright	Predicting Changes in the Behavior of Erupting Volcanoes, and Reducing the Uncertainties Associated with their Impact on Society and the Environment
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Thomas	Painter	Understanding the controls on cryospheric albedo, energy balance, and melting in a changing world



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comment

# Monitoring plant functional diversity from space

The world's ecosystems are losing biodiversity fast. A satellite mission designed to track changes in plant functional diversity around the globe could deepen our understanding of the pace and consequences of this change, and how to manage it.

Walter Jetz, Jeannine Cavender-Bares, Ryan Pavlick, David Schimel, Frank W. Davis, Gregory P. Asner, Robert Guralnick, Jens Kattge, Andrew M. Latimer, Paul Moorcroft, Michael E. Schaepman, Mark P. Schildhauer, Fabian D. Schneider, Franziska Schrodt, Ulrike Stahl and Susan L. Ustin

**T**he ability to view Earth's vegetation from space is a hallmark of the Space Age. Yet decades of satellite measurements have provided relatively

time that such a mission would provide has the potential to transform basic and applied science on diversity and function, and to pave the way to a more mechanistically

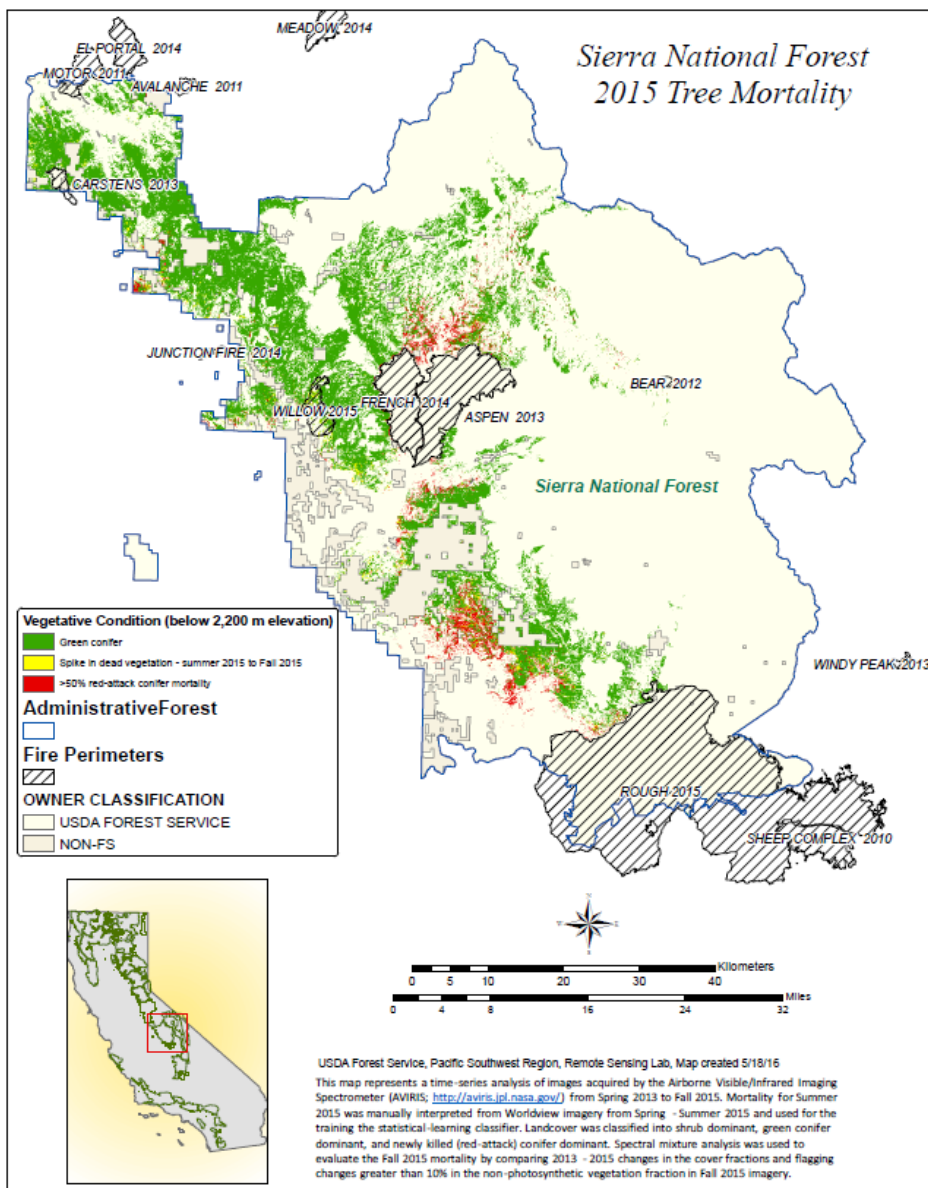
mass to leaf area. These attributes are related functionally to the uptake, allocation and use of resources such as carbon and nutrients within the plant, and to the defence against





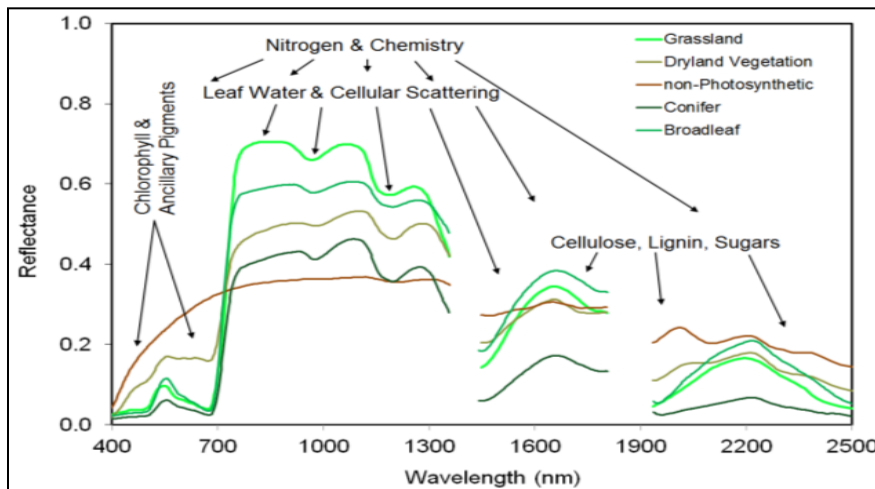
# Measurement of Non-Photosynthetic Vegetation

## Recent Applications Result from HypsIRI Airborne Campaign



USDA Forest Service, Pacific Southwest Region, Remote Sensing Lab, Map created 5/18/16

This map represents a time-series analysis of images acquired by the Airborne Visible/Infrared Imaging Spectrometer (AVIRIS; <http://aviris.jpl.nasa.gov/>) from Spring 2013 to Fall 2015. Mortality for Summer 2015 was manually interpreted from Worldview imagery from Spring - Summer 2015 and used for the training the statistical-learning classifier. Landcover was classified into shrub dominant, green conifer dominant, and newly killed (red-attack) conifer dominant. Spectral mixture analysis was used to evaluate the Fall 2015 mortality by comparing 2013 - 2015 changes in the cover fractions and flagging changes greater than 10% in the non-photosynthetic vegetation fraction in Fall 2015 imagery.





# Carbon Emissions from Biomass Burning

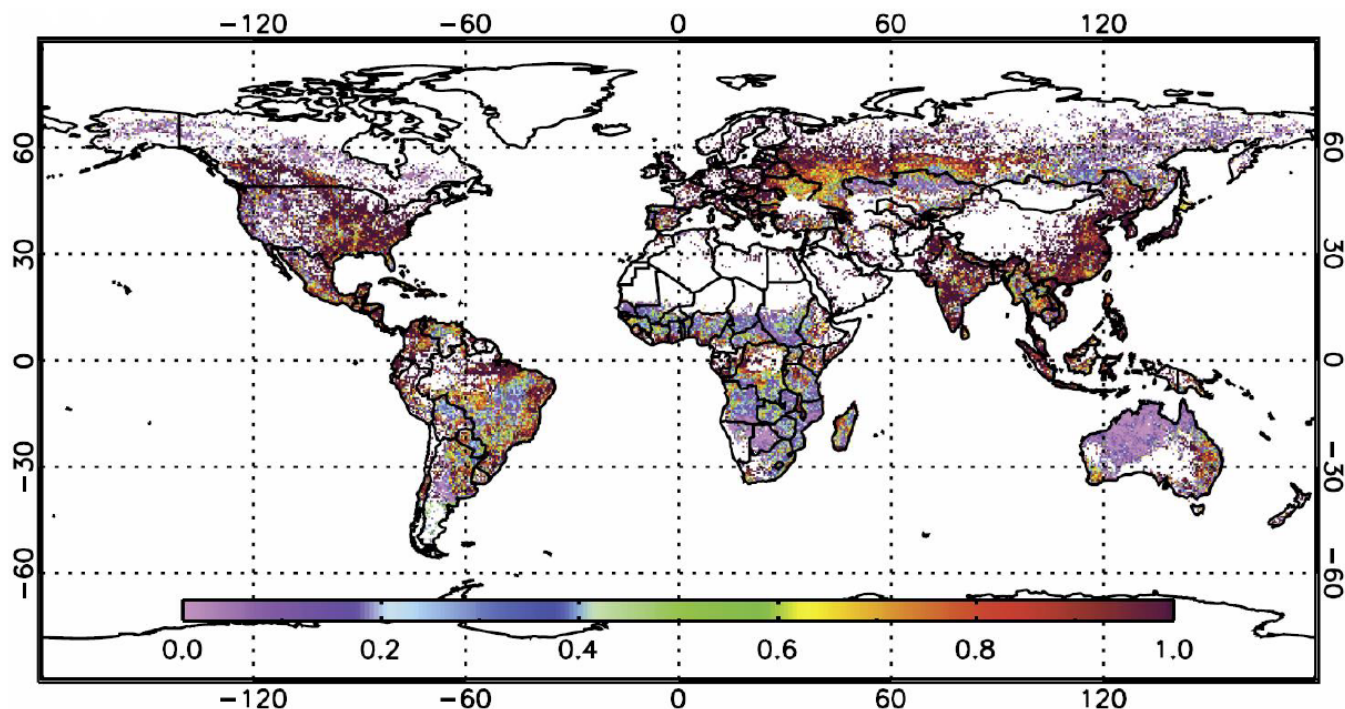


Figure 1 Small fire fraction of total burned area (Randerson et al. 2013). Red and yellows highlight areas where many smaller fires were detected.

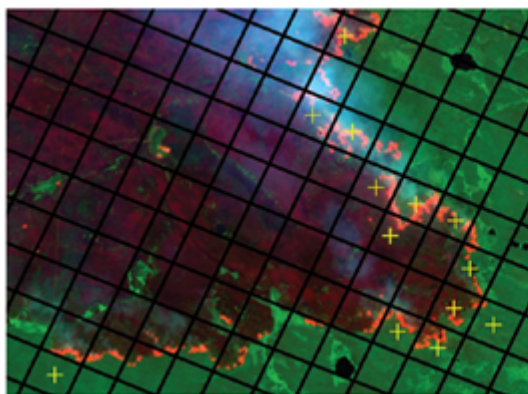


Figure 2. Simultaneous higher resolution 90-m ASTER image with black boxes overlaid corresponding to 1-km MODIS imagery. Yellow crosses represent MODIS pixels where fires were detected. Notice that many pixels where fire is clearly visible in the ASTER image remain undetected in the MODIS image.





# PREDICTING CHANGES IN THE BEHAVIOR OF ERUPTING VOLCANOES, AND REDUCING THE UNCERTAINTIES ASSOCIATED WITH THEIR IMPACT ON SOCIETY AND THE ENVIRONMENT



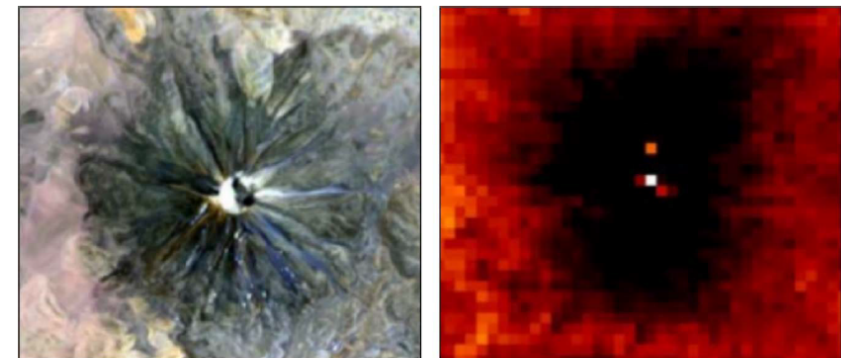
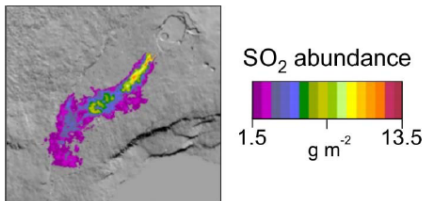
- Gas emissions:
- Low temperature thermal anomalies:
- The color, temperature, and size of crater lakes:
- Lava effusion rate:
- Temperature and cooling rate of active lavas:
- Spatio-temporal variations in the amount and concentration of ash in the atmosphere:
- The spatio-temporal distribution of H<sub>2</sub>SO<sub>4</sub> aerosol:

Figure 1. Distribution of Earth's active and potentially active volcanoes (source: Sigurdsson, H. (2015). *Encyclopedia of volcanoes*, 2<sup>nd</sup> edition. San Diego: Academic Press.



Figure 5. Left: Reflective false color composite of Chilikue Volcano, Chile, obtained by Terra ASTER. Right: thermal infrared night-time image of the same volcano showing subtle thermal anomaly at the summit (source: Pieri, D.C., and Abrams, M. (2004). ASTER watches the world's volcanoes: a new paradigm for volcanological observations from orbit. *J. Volcanol. Geotherm. Res.*, 135, 13-28).

Figure 3. SO<sub>2</sub> column abundance calculated from Terra ASTER data at Kilauea volcano (source: [https://hyspirci.jpl.nasa.gov/downloads/2013\\_Workshop/day1/18\\_HyspIRI\\_VJR\\_2013.pdf](https://hyspirci.jpl.nasa.gov/downloads/2013_Workshop/day1/18_HyspIRI_VJR_2013.pdf))





# HyspIRI Related Decadal Survey RFI 2 Inputs



Luvall	Jeffrey	A Thermodynamic Paradigm For Using Satellite Based Geophysical Measurements For Public Health Applications
Heidi	Dierssen	Assessing Transient Threats and Disasters in the Coastal Zone with Airborne Portable Sensors
Ryan	Pavlick	Biodiversity
Simon	Hook	Carbon Emissions from Biomass Burning
Eric	Hochberg	Coral Reefs: Living on the Edge
Wendy	Calvin	Earth Surface Geochemistry and Mineralogy: Processes, Hazards, Soils, and Resources
Joshua	Fisher	Evapotranspiration: A Critical Variable Linking Ecosystem Functioning, Carbon and Climate Feedbacks, Agricultural Management, and Water Resources
Tamlin	Pavelsky	From the Mountains to the Sea: Interdisciplinary Science and Applications Driven by the Flow of Water, Sediment, and Carbon II
Philip	Dennison	Global Measurement of Non-Photosynthetic Vegetation
Kevin	Turpie	Global Observations of Coastal and Inland Aquatic Habitats
Philip	Townsend	Global Terrestrial Ecosystem Functioning and Biogeochemical Processes
Dale	Quattrochi	High Spatial, Temporal, and Spectral Resolution Instrument for Modeling/Monitoring Land Cover, Biophysical, and Societal Changes in Urban Environments
Steve	Greb	Inland Waters
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Riley	Duren	Understanding anthropogenic methane and carbon dioxide point source emissions
Thomas	Painter	Understanding the controls on cryospheric albedo, energy balance, and melting in a changing world



- Community Town Hall (Ecosystem, Aquatic, Snow Hydrology, Volcanos, Atmosphere, Coral, ...)
- Focus on global science not currently addressed
- Cross cutting
- Examples
- Uses VSWIR, TIR and combined.



- Draft and circulate initial version next week
- Finish first week of Nov
- Send to Steering committee the 4<sup>th</sup> of November