meeting summaries

ECOSTRESS Science Team Meeting

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Introduction

The first ECOsystem Spaceborne Thermal Radiometer Experiment on Space Station (ECOSTRESS) Science Team meeting took place on December 14, 2014, at the SF Green Space[1] in San Francisco, CA. Attendees included **Simon Hook** [NASA/Jet Propulsion Laboratory (JPL)—*Principal Investigator (PI)*], **Joshua Fisher** [JPL—*Science Lead*], **Glynn Hulley** [JPL], **Martha Anderson** [U.S. Department of Agriculture (USDA)], **Andrew French** [USDA], **Rick Allen** [University of Idaho], **Eric Wood** [Princeton University], and **Christopher Hain** [University of Maryland].

ECOSTRESS is one of two instruments chosen from the second Earth Venture Instrument (EVI-2) Pathfinder Program Announcement of Opportunity (AO)[2]. The ECOSTRESS radiometer is currently planned for delivery to NASA's Johnson Space Center in 2017, with launch to the International Space Station (ISS) scheduled for shortly thereafter from Kennedy Space Center with Space X. The mission will provide a high-resolution spatial and temporal view into vegetation-water dynamics and how ecosystems respond to changes in climate. It will be the first mission that will be able to observe diurnal changes in global vegetation.

Meeting Highlights

The purpose of the meeting was for the science team to review mission science specifications, milestones, and schedules, and to further detail the roles and responsibilities of each science team member.

Simon Hook kicked off the meeting with an overview of the ECOSTRESS mission. As PI, Hook is responsible for the complete science investigation and for ECOSTRESS instrument development and activities necessary to deliver the science results, as agreed to in the Program Level Requirements Appendix (PLRA) of the AO. The mission leverages the successful design, construction, and testing of the Prototype HyspIRI Thermal Infrared Radiometer (PHyTIR), which was initially developed to support testing and assessment for the Hyperspectral Infrared Imager (HyspIRI[3]) under the auspices of the Earth Science Technology Office (ESTO). ECOSTRESS consists of a cross-track, push-whisk-broom, scanning, multiband filter radiometer with five spectral bands between 8 and 12.5 µm, and a high spatial resolution of 38 m (125 ft, in-track) by 69 m (226 ft, cross-track), and will be deployed on the Japanese Experiment Module – External Facility on the ISS—see **Figure**. Because of the precessing orbit of the ISS, the ECOSTRESS will enable vegetation water stress assessments on a diurnal scale[4].

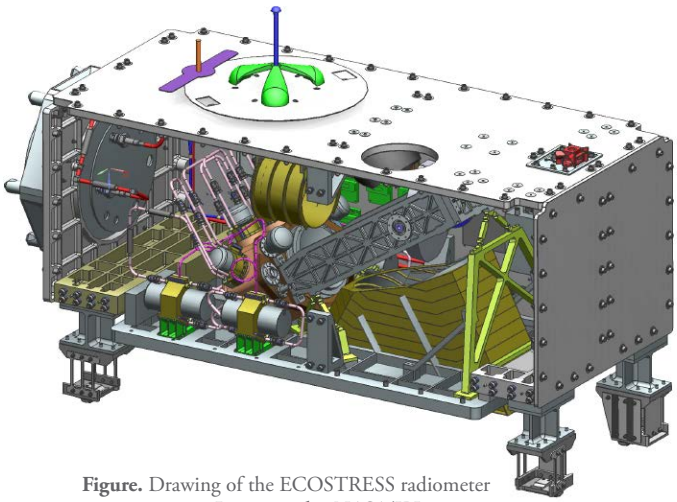

Figure. Drawing of the ECOSTRESS radiometer in its container. **Image credit**: NASA/JPL

Joshua Fisher then presented the science questions that ECOSTRESS will address, which include:

- How does the terrestrial biosphere respond to changes in water availability?
- How do changes in diurnal vegetation water-stress impact the global carbon cycle?

[1] For more information, visit *www.sfgreenspace.com/greenspace/the-space*

[2] The Science Mission Directorate (SMD) at NASA Headquarters selected two proposals from among those submitted in response to the Second Stand Alone Mission of Opportunity Notice (SALMON-2), Program Element Appendix (PEA) M: Earth Venture Instrument-2, *NNH12ZDA0060-EVI2.* The other instrument chosen was the Global Ecosystem Dynamics Investigation (GEDI).

[3] The 2007 National Research Council's (NRC) 2007 Decadal Survey report, *Earth Science and Applications from Space: National Imperatives for the Next Decade and Beyond*, identified HyspIRI as a *Tier-2* priority. The most recent update on the progress of HyspIRI appears in the March–April 2015 issue of *The Earth Observer* [**Volume 27**, **Issue 2**, pp. 32-33].

[4] The sidebar, *Changes Throughout the Day*, in the article "ISS RapidScat: Measuring Ocean Winds from the International Space Station" in the September–October 2014 issue of *The Earth Observer* [**Volume 26**, **Issue 4**, p. 8] explains how the unique orbit of ISS allows for full sampling of diurnal and semidiurnal wind cycles. Similar sampling will be used to study diurnal water stress changes in vegetation. ECOSTRESS will be able to capture a diurnal cycle within a short period of time.

- Can agricultural vulnerability be reduced through advanced monitoring of agricultural water consumptive use and improving drought estimation?

As Science Lead, Fisher will help ensure that each of the science objectives are met and captured within the mission's measurements and algorithms.

Glynn Hulley covered the planned ECOSTRESS data products—see **Table**. Specifically, he discussed how ECOSTRESS data will be processed to Level-2 [surface temperature and emissivity], which will allow for the development of Level-3 [Evapotranspiration (ET)] and Level-4 [Water Use Efficiency (WUE), Evaporative Stress Index (ESI)] products. **Martha Anderson** then presented details about how she will use the ALEXI[5] model to develop ET products and work with JPL to produce Level-4 ESI measurements. These products can be used to study vegetation water stress or develop applications such as early warnings to farmers and water resource managers of impending drought. Typical users may include water resources agencies in the Western U.S. and farmers, who can use this information to help in their response to drought conditions, water availability, and agricultural water requirements. Other users may be the U.S. Department of Agriculture and the U.S. Agency for International Development. Examples of how this kind of information has been used in the past include planning food aid interventions, improving irrigation water use efficiency practices, and estimating historical water use for negotiating water rights transfer.

Table. Planned ECOSTRESS data products

Data Product	Description
Level-0	Raw collected telemetry
Level-1	Calibrated geolocated radiances
Level-2	Surface temperature and emissivity
Level-3	Evapotranspiration (ET)
Level-4	Water Use Efficiency (WUE); Evaporative Stress Index (ESI)

Expected Contributions of ECOSTRESS

In addition to introducing the new mission, many of the discussions highlighted the contributions expected from ECOSTRESS data. The mission will significantly contribute to our ability to monitor water stress in vegetation on a field-to-continental scale with considerable implications for understanding Earth's water and energy cycles, as well as applications in global water and food security issues. ECOSTRESS will have a revisit frequency of four days for most of the continental U.S. and will also sample other key regions throughout the world with various sampling times each day; this sampling pattern will thus allow for evaluations of vegetation water stress on a diurnal scale, which no other mission has done at a global scale with such resolution and accuracy. Some of the specific contributions include:

- detecting differences in plant water use among highly heterogeneous landscapes, both natural and human-dominated;
- detecting where and when plants shut down[6] during the day due to water stress;
- detecting which plants are more water-use efficient than others, with implications to mortality susceptibility under increasing droughts;
- helping inform agricultural management decisions;
- helping account for longwave contributions to energy balance/net radiation calculations;
- investigating ET response to global drought events, to allow downscaling of regional evaporative stress indices, yielding impacts on phenology due to such stress.

Conclusion

The first ECOSTRESS science team meeting provided an opportunity to discuss the ECOSTRESS science goals and objectives and refine the plans and schedules for delivering ECOSTRESS data and science results. Going forward, the ECOSTRESS team anticipates holding annual open meetings before the Fall American Geophysical Union Meetings, and contributing to ongoing HyspIRI meetings.

Additional information about ECOSTRESS is available online at *ecostress.jpl.nasa.gov*. ■

[5] ALEXI stands for Atmosphere-Land-Exchange Inverse, which is used to model evapotranspiration.

[6] Morphological, biochemical, physiological, and molecular processes can stop functioning properly when plants are under stress. If the stress is long term, this can lead to fallowed areas or death of these plants. More specifically, plants close their leaf pores (*stomata*) when water-stressed. This cuts off their ability to take up carbon dioxide and conduct photosynthesis; thus, the carbon-uptake and water-release process is "shut down" when stomata are closed.