**Advanced geostationary measurements: Diurnal Land Surface Emissivity**

Description (< 350 character - currently 327!):

A geostationary hyperspectral infrared sounder would add diurnal variations to the land surface emissivity products. The high temporal resolution would help better characterize accurate emissivity, which will benefit many applications: land surface modeling, radiance assimilation, and many satellite remote sensing products.

Body: (limit 1500 words -- currently at 923 !!!)

Land surface emissivity (LSE) is the relative ability of the land surface to emit energy by radiation. It is defined as the ratio of the energy radiated by the land surface to energy radiated by a blackbody at the same temperature. Infrared (IR) LSE varies with land surface type, viewing angle, and time following changes in the state of soil moisture, vegetation, and weather conditions, such as dew/frost formation, evaporation, rainfall, or snowfall.

Accurate IR LSE are needed by many applications in weather, climate, and environmental studies, such as land surface modeling, numerical weather prediction (NWP), as well as deriving other satellite products. Land surface models, an important component in weather and climate models, can have significant errors in lower atmosphere simulation (e.g. land surface energy budget, land surface temperature etc) with incorrect LSE. These errors can lead to decreased predictive skill for near surface operational products (e.g. 2-meter temperature, Jin and Liang 2006). Progress has been made in assimilating satellite IR radiances to improve weather forecasting skills (Le Marshall et al., 2006). However, current LSE products do not meet the requirement to allow assimilating satellite radiances in thermal IR region (8-12 micron). Radiances from this spectral region contain critical information about surface and lower atmosphere, where storms usually originate. Currently, LSE diurnal variation is not considered in both NWP and climate models, and emissivity diurnal information is needed from space-based observations for weather and climate modeling and prediction.  Accurate IR LSE is also needed for deriving many other satellite products, such as temperature and moisture soundings, total precipitable water, land surface temperature, radiation budget, trace gas retrievals, dust and aerosol property retrievals, and the cloud-top pressure (CTP) product.

LSE can be measured through laboratory analysis or estimated through satellite remote sensing. LSE varies temporally, spatially, and spectrally. It is practically impossible for laboratory analysis to capture these variations on a global scale. Methodologies for extracting LSE from radiance observations from polar orbiting broadband and hyperspectral IR sounders have been developed (Li et al. 2007; Zhou et al. 2011). Several monthly global LSE databases (e.g. MODIS, AIRS, and IASI) have been generated and are available publicly for research and operational use. Studies have shown that these global emissivity spectra depict surface type properties very well (Li and Li 2008).

Compared with polar orbits, geostationary orbits offer a unique advantage to further improve LSE products. With geostationary high-spectral-resolution IR radiances, hemispheric surface emissivity spectra could be derived hourly. The high temporal resolution from geostationary orbits not only adds one additional dimension of the emissivity products, but also offers an opportunity to further improve the retrieval quality for single time step. Such an algorithm to take advantage of geostationary high temporal resolution has been developed for the Advanced Baseline Imager (ABI) onboard the Nation’s next generation of geostationary satellites, the GOES-R (called GOES-R ABI LSE algorithm, Li et al. 2011) and has been successfully tested with SEVIRI. The so-called time continuity, which assumes LSE does not vary during a short period of time while land surface temperature varies, was taken into consideration to strength the emissivity signal, and has been proven useful to improve the emissivity quality.

Application of GOES-R ABI LSE algorithm to SEVIRI (Li et al. 2012) reveals a wavelike LSE diurnal variation----LSE decreases with reduced soil moisture due to evaporation during the day, and increases with increased soil moisture due to adsorption in the evening. This new finding is contradictory to previous understandings. Before, it was widely accepted that LSE only changes very slowly with vegetation cover when there is no precipitation; there should be no strong temporal variations in LSE in a short period of time (e.g. days to weeks). This new finding indicates that the existing monthly LSE databases are not accurate enough for many applications due to the lack of diurnal variation. This is one important reason why the utilization of existing LSE databases is limited.

While SEVIRI is able to accurately characterize the LSE to show the diurnal variations, it is only valid for three broadband window channels. For a broader application, a geostationary hyperspectral IR sounders is needed in order to better characterize the LSE with high temporal, high spatial, and high spectral resolutions. And such LSE products can only be derived from geostationary hyperspectral IR sounders.

A hyperspectral IR sounder, called Hyperspectral Environmental Suite (HES), was originally planned for GOES-R program, but later was dropped due to budget issues. While ABI with 10 IR spectral bands will be able to continue the legacy products of GOES satellites (Schmit et al. 2005), it is nowhere near what a hyperspectral IR sounder can provide. A geostationary hyperspectral IR sounder would improve all existing products dramatically, and likely produce new products that are not possible with traditional GOES broadband IR sensors. For example, Although conventional imagers such as ABI can detect dust events, a high-spectral-resolution instrument can better characterize the plume. Information can be retrieved regarding the height, loading, and possibly the composition (Hong et al. 2006). A geostationary hyperspectral IR sounder will surely help the National Weather Service (NWS) to fulfill its goal of a “Weather-Ready Nation” and support its new Impact-based Decision Support Services (IDSS).

References:

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(add name as it is to appear)

The present RFI is being issued to inform the initial organization and structure of the committee and panels that will conduct the survey, as well as to provide direct input to the work of those groups. Toward that end, we are requesting input from the broad community on the following questions:

1. What are the key challenges or questions for Earth System Science across the spectrum of basic research, applied research, applications, and/or operations in the coming decade?
2. Why are these challenge/questions timely to address now especially with respect to readiness?
3. Why are space-based observations fundamental to addressing these challenges/questions?

In your responses to these questions, please focus on the role of space-based observations and comment on:

a. Whether existing and planned U.S. and international programs will provide the capabilities necessary to make substantial progress on the identified challenge and associated questions. If not, what additional investments are needed?

b. How to link space-based observations with other observations to increase the value of data for addressing key scientific questions and societal needs;

c. The anticipated scientific and societal benefits; and

d. The science communities that would be involved.

*(Please limit your response to approximately 1500 words or less): Tools / Word Count*

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