Mapping land-surface fluxes of carbon, water and energy from field to regional scales

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Abstract: A multi-scale and multi-sensor framework for routine mapping of land-surface fluxes of carbon, water, and energy at the field to regional scales has been established in an effort to improve drought monitoring, water resource management, and agricultural monitoring capabilities. The framework uses the ALEXI/DisALEXI suite in conjunction with remotely sensed data from Landsat, MODIS, and GoES. By taking advantage of the high temporal and spatial resolution of GOES (Geostationary Operational Environmental Satellite), the daily resolution data can be extended to long-term seasonal simulations with the use of multiple Landsat and MODIS archives. The combination of multi-sensor data sets is used to develop a more accurate and continuous estimate of land-surface fluxes of carbon and water. We provide an example application to drought monitoring and agricultural monitoring over the mid-western USA using the ALEXI/DisALEXI framework.

Motivation and methods

Agriculture and water resource management require information about soil moisture and irrigation water transport over a wide range of temporal and spatial scales. These are one satellite currently operated that can accommodate such requirements. Fortunately there is an increasing number of satellite systems providing observations in the near infrared, shortwave and longwave regions of the electromagnetic spectrum, and now also at higher spatial resolution but lower temporal resolution.

We present a modeling framework for estimating evapotranspiration (ET) from satellite data using the ALEXI model, a modeling framework for synthesizing multi-scale, multi-platform spatial and temporal resolution data. The ALEXI model is used to estimate ET at a higher spatial resolution (1 km) over an extensive study area. A schematic of the modeling framework is shown below.

Routine flux mapping

Satellite acquisition and data preparation

Conclusion

The modeling framework appears to be a successful approach for routine ET estimates at regional and national scales.

- The fusion of Landsat and MODIS data using STARFM allows us to reduce errors on modeled fluxes in the gaps between consecutive Landsat acquisitions, as demonstrated by the comparison with flux tower measurements.
- The TSEB-LUE model is to be able to provide coupled transpiration and carbon fluxes over temporal and spatial scales.
- Incorporating Cab-LUE relationships will allow for improved estimates of carbon over stressed conditions.

Future directions

- Incorporate 250 m ET into the ALEXI/disALEXI framework
- Improve thermal sharpening techniques
- Update the modeling to improve area of complex morphology
- Improve ET modeling over snow
- Incorporate LUE-based submodel of canopy resistance into the ALEXI/DisALEXI framework to simulate the coupled flux of transpiration and canopy uptake of carbon
- Enhance carbon fluxes through the use of hyperspectral data

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References