ECOSTRESS Significantly Improves Agricultural Water Management
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Motivation: Evapotranspiration (ET) is critical for agricultural water management applications. The US Department of Agriculture (USDA) operationally works with agricultural water managers to improve crop production with remotely sensed ET data. Historically, Landsat has been used due to the field-scale <100 m resolution. However, the poor temporal revisit of Landsat introduces vulnerabilities in the ability to track water during key times of crop growth.

Results: This study used new ECOSTRESS data to quantify improvement in ET estimation across key USDA agricultural application sites. Relative to Landsat-only, ECOSTRESS improved accuracy and reduced error in agricultural water consumptive use and ET estimates by up to 65%. These improvements were notable for sites under high cloud cover—the increased temporal resolution of ECOSTRESS (1-5 days) enabled critical observations missed by Landsat particularly during times of peak growth.

Implications: These results address ECOSTRESS Science Objective #3, focused on improving agricultural water management. Additionally, we find that temporal offset between the ECOSTRESS TIR and ancillary Landsat VSWIR measurements introduces uncertainties in ET estimation; this has important implications for a future mission focused on Surface Biology & Geology. We recommend concurrent TIR and VSWIR measurements in future missions.


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Citation:

Data Sources:
CFSR, MODIS, ECOSTRESS, Landsat, AmeriFlux, GRAPEX

Technical Description of Figure:
Model – measurement intercomparison at the OPE3 tower site. Photographs are from a phenocam in OPE3 and show soybean canopy conditions on key dates highlighted in the upper panel. Study domains included in the model intercomparisons. Background map shows ETd from ALEXI (4 km), while inset maps are 30-m resolution maps from DisALEXI over flux tower sites. Comparison of RMSE in ET developed with and without ECOSTRESS over the ECOSTRESS era.

Scientific significance, societal relevance, and relationships to future missions:
We showed significant improvement in ET where clear-sky Landsat images were not available during periods of rapid moisture change and vegetation development. In the case of one flux site in MD, mean absolute errors in ET improved by 65% at the daily timestep when critical ECOSTRESS retrievals during the peak soybean crop growth stage were included.

The absence of VSWIR sensors collocated with the TIR bands on ECOSTRESS creates challenges in applications of physically based surface energy balance models that require albedo and LAI or fraction vegetation information consistent with the LST inputs. In this study, VSWIR inputs were obtained from the closest Landsat overpass, and cases where inconsistencies impacted ET retrievals are noted, particularly in landcovers with rapidly changing biomass or moisture limitations. Ongoing work utilizing the Harmonized Landsat-Sentinel dataset for VSWIR inputs will reduce, but not eliminate, the occurrence of significant discrepancy. A major challenge for future possible thermal free-flying sensor architectures will be the development of a rigorous cloud-detection algorithm based only on TIR band information. Inclusion of one or more collocated SWIR bands (e.g. at 1.38 for cirrus and 1.6 \( \mu m \) for cloud/snow) would enhance cloud detection capabilities as well as geolocation accuracy with VSWIR characterizations of the land-surface.