BRC Science Highlight
March 2020

BESS-STAIR: A Framework to Estimate Daily, 30-Meter, and All-Weather Crop Evapotranspiration Using Multi-Source Satellite Data for the U.S. Corn Belt

Background/objective

Evapotranspiration (ET) consumes up to 90% of total water inputs (precipitation plus irrigation) in agro-ecosystems in the western and midwestern United States. Existing methods of large-scale ET estimation are inadequate due to limitations in existing models and satellite data. Reliable tools are urgently needed to estimate, map, and monitor the total amount and spatial and temporal variation in cropland ET.

Approach

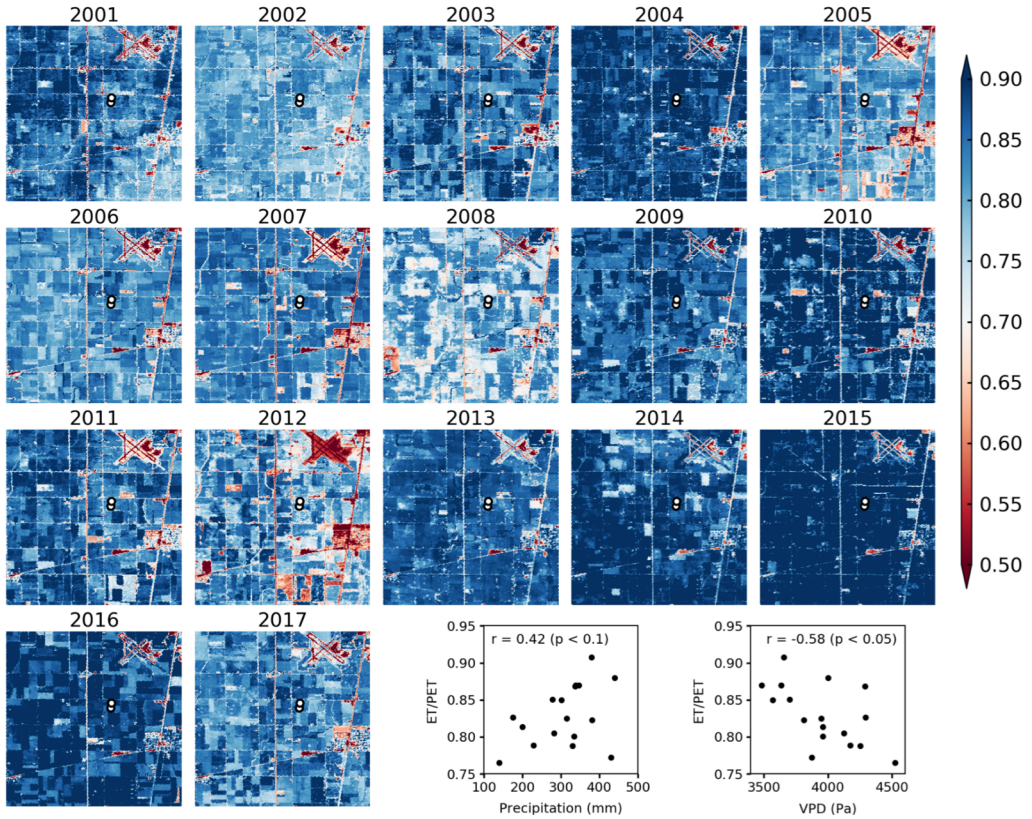
- We developed BESS-STAIR, which provides a novel ET estimation frame-work, integrating BESS, a satellite-driven water–carbon–energy coupled biophysical model, and STAIR, a generic and fully automated multi-satellite data fusion algorithm, to generate gap-free, 30-m resolution, daily ET.
- We applied BESS-STAIR from 2000-2017 for six areas in the U.S. Corn Belt and validated it using flux tower measurements from 12 sites (85 site years).

Results

- BESS-STAIR achieved an overall R^2 of 0.75, with RMSE = 0.93 mm•d^{-1} and relative error = 27.9% when benchmarked with flux measurements.
- BESS-STAIR captured spatial patterns, seasonal cycles, and interannual dynamics in the different sub-regions.

Significance

BESS-STAIR provides significant advancements in daily field-level estimations of ET at regional and decadal scales. It has the potential to be a valuable tool for water resources management and precision agriculture, advancing the sustainability of cropping systems in the U.S. Corn Belt and beyond.



The ratio of actual to potential ET (ET/PET), an indicator of agricultural drought, shows interannual variability at Bondville, IL.

[1]*Jiang, et al. 2020.* "BESS-STAIR: A framework to Estimate Daily, 30-Meter, and All-Weather Crop Evapotranspiration Using Multi-Source Satellite Data for the U.S. Corn Belt." ***Hydrology and Earth System Sciences***, 24, 1251–1273. *DOI:*10.5194/hess-2019-376.

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