



Jet Propulsion Laboratory
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ECOSTRESS: Applications for agriculture

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Institute of Technology


Credit: NASA




ECOSTRESS

Maximizing Earth's Precious Resources


Prime Mission Goals



How do plants
respond to
changing water
availability?



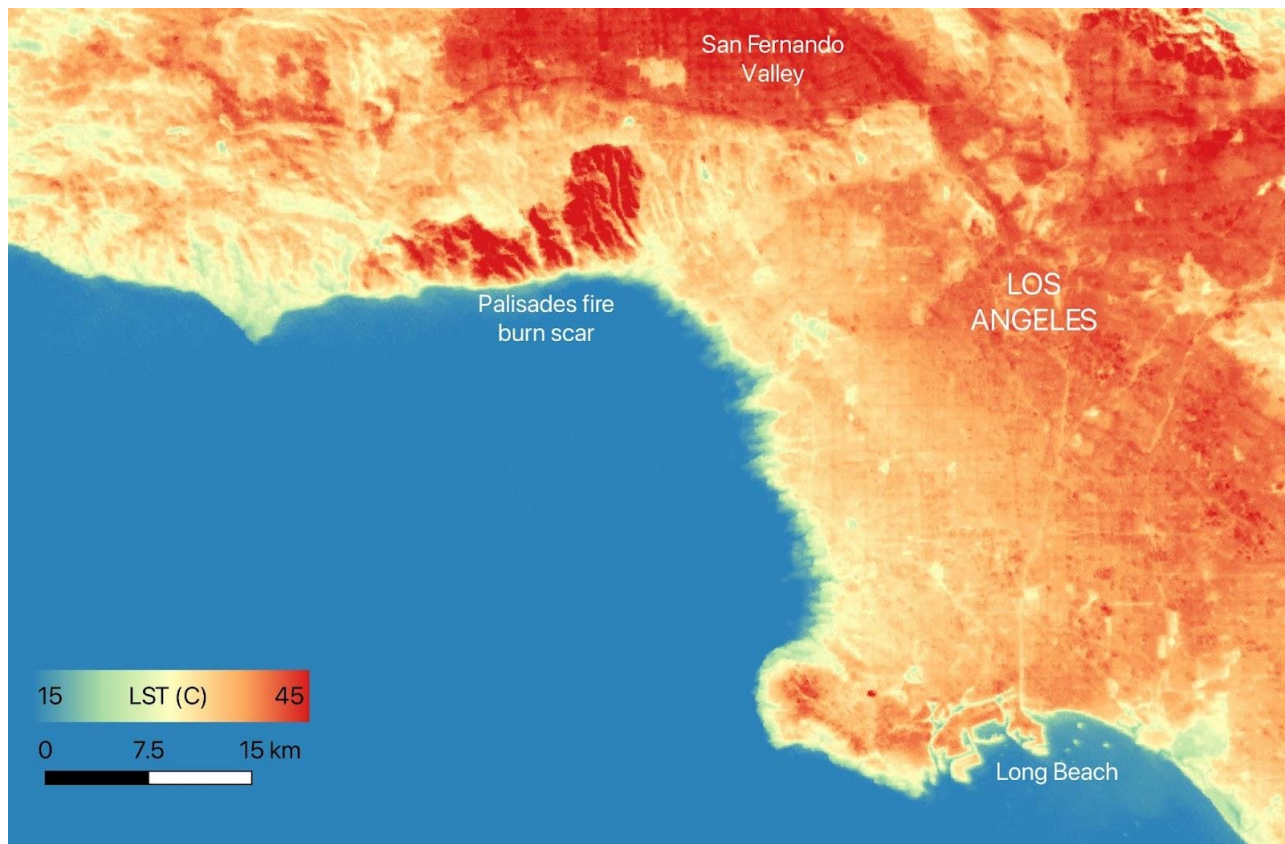
How do changes in
evapotranspiration (ET)
throughout the day
affect vegetation growth?



Can we use ET
measurements to
optimize agricultural
water use?



Original Measurement: Temperature



ECOSTRESS maps the temperature of the land or water surface

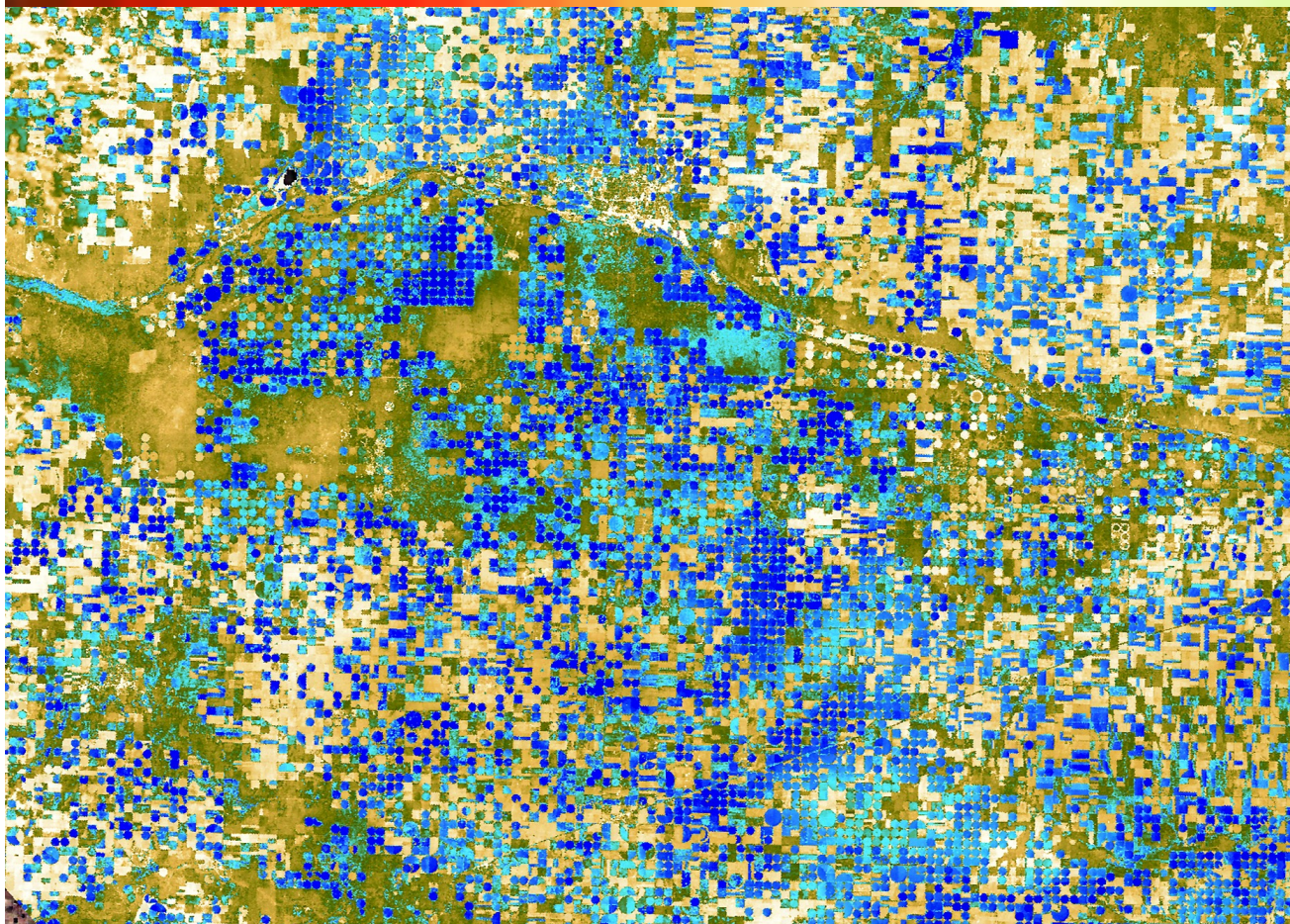
Urban heat is a significant health concern

ECOSTRESS has been used to measure the impact of mitigation efforts, such as street coatings and urban planting

*Red colors show hotter areas, blue colors show cooler areas



Original Mission: Evapotranspiration



ECOSTRESS produces an evapotranspiration (ET) product, which is a measure of plant water use

ECOSTRESS ET can be used to optimize irrigation strategies in agriculture

Thus, we can maximize crop yields “per drop”

*Blue colors show higher water-use, and beige colors show low water-use



Determining critical temperature thresholds



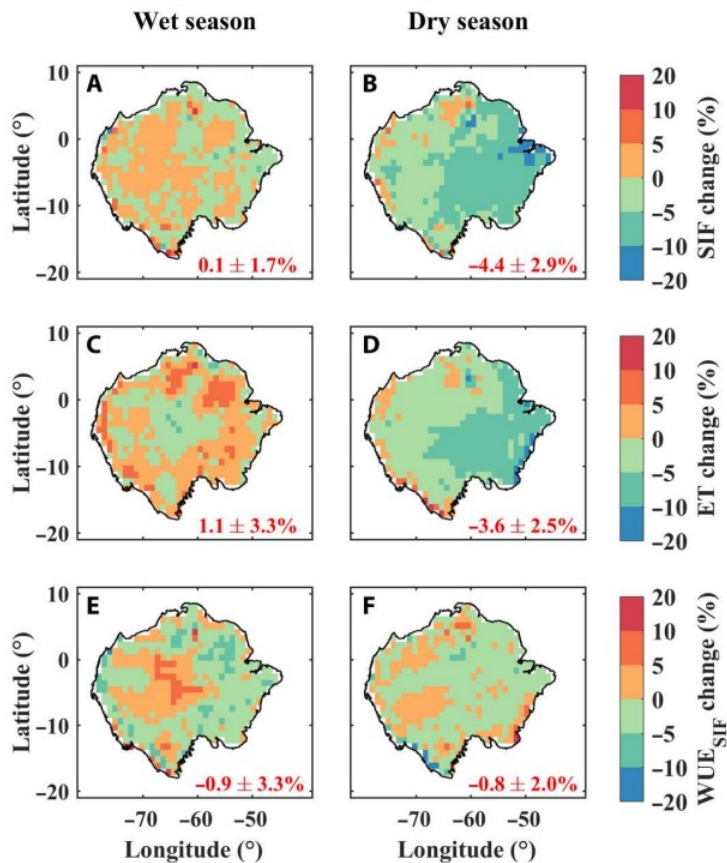
Problem: Tropical forests are warming. How much heat can they withstand before they experience mass die-offs?

Findings: Using ECOSTRESS and field data, the study found that tropical forests can withstand up to a 3.9 ± 0.5 °C increase in temperatures before a potential tipping point in metabolic function.

Impact: The 4.0 °C estimate is within the 'worst-case scenario' of climate change predictions for tropical forests and therefore it is still within our power to decide the fate of these critical realms.



New diurnal water-carbon relationships



Problem: Photosynthesis and evapotranspiration are critical drivers of the carbon and water cycles. How do these functions respond to drought?

Findings: This study used OCO-3 and ECOSTRESS to reveal a strong depression of dry season afternoon photosynthesis and evapotranspiration, compensated by morning increases in future dry seasons.

Impact: Ecosystems adapt to drought by optimizing water use at times of day when that water is most easily available. These effects can't be observed by polar orbiting satellites.



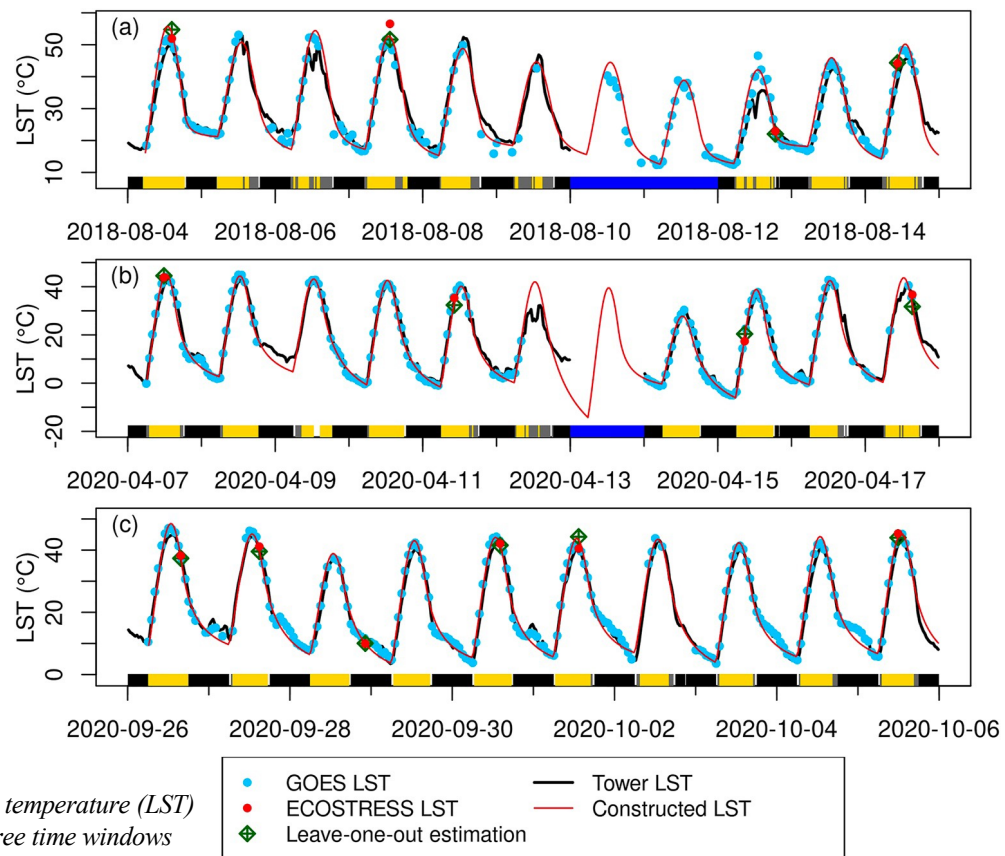
ECOSTRESS observes the diurnal cycle



Problem: A diurnally resolved evapotranspiration (ET) product with high spatial resolution (<100 m) is critically needed for agricultural and ecological monitoring

Findings: This study resolved the full diurnal cycle of ET and Land Surface Temperature (LST) from ECOSTRESS observations at different times of day.

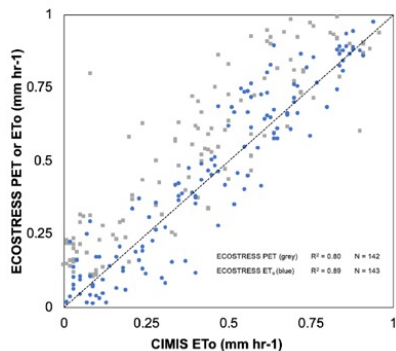
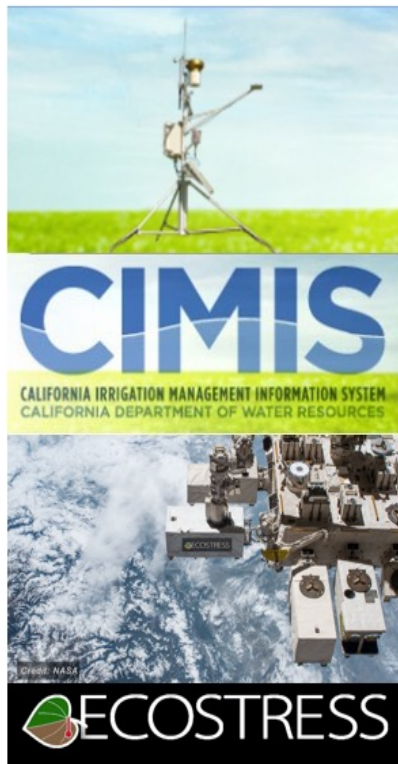
Impact: The constructed diurnal time series captured the temporal variability of in-situ measurements, critical for ecosystem monitoring and management.



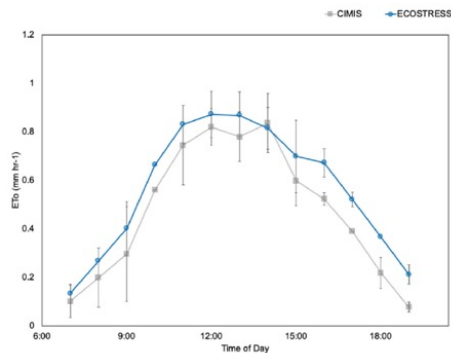
The constructed diurnal land surface temperature (LST) at the US-Seg field site during the three time windows (corresponding to three distinct phenological stages).



ECOSTRESS utility for operational water agencies



Strong correlation between ECOSTRESS and CIMIS estimates of reference ET ($R^2=0.89$)



Diurnal variability of reference evapotranspiration conditions are captured by ECOSTRESS and CIMIS

Problem: The Eastern Municipal Water District (EMWD) uses the ground-based California Irrigation Management Information System (CIMIS) for ET. Can ECOSTRESS fill spatial and temporal gaps?

Findings: CIMIS and ECOSTRESS were strongly correlated and both captured similar seasonal patterns and diurnal variability.

Impact: These results that ECOSTRESS complements ground-based networks in support of water use applications and conservation decision-making.



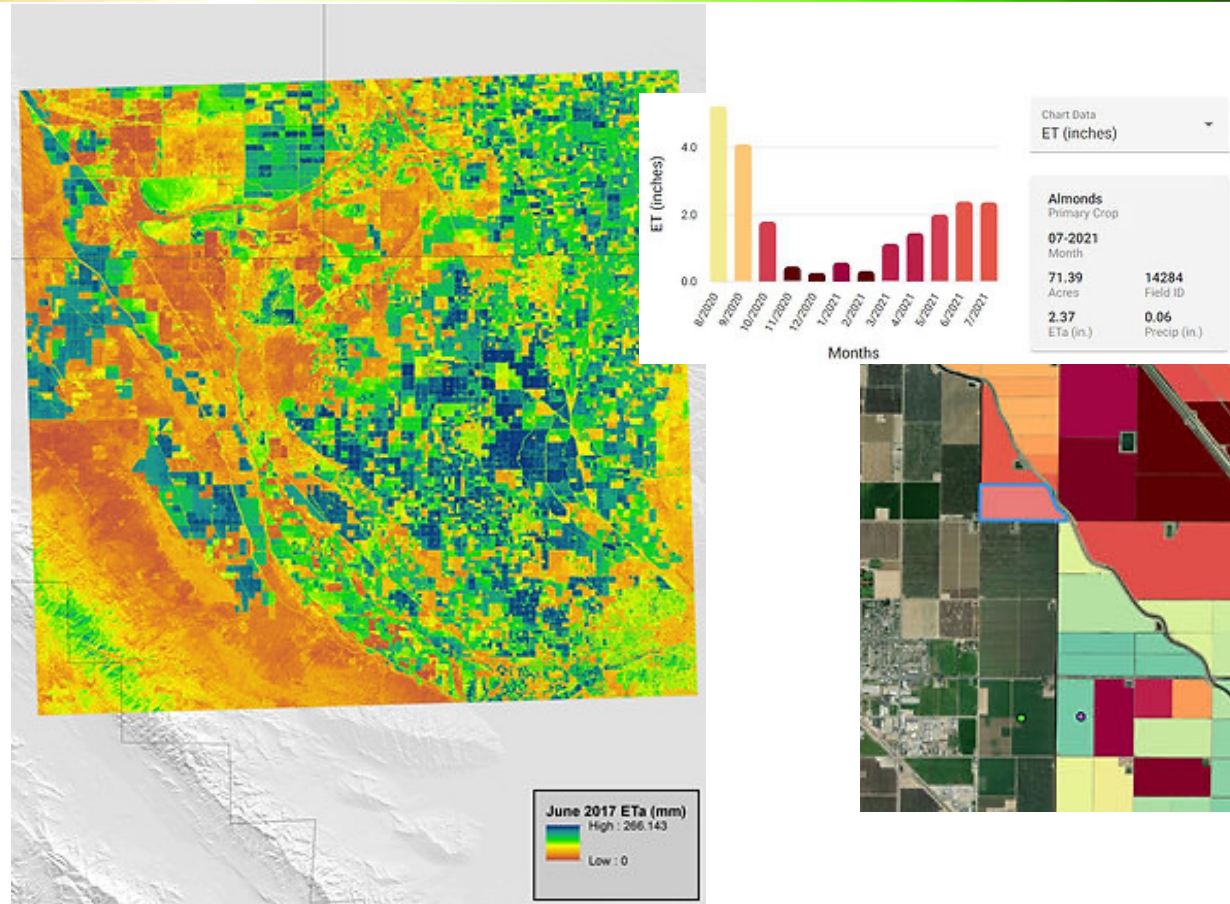
Application: Irrigation Optimization



ECOSTRESS monitors water use in California central valley

Land IQ uses ECOSTRESS surface temperature as one of its inputs to produce field-by-field evapotranspiration for 3.3M acres in the Central Valley of California. These data are used by 40 groundwater sustainability agencies and irrigation districts to support overall water management, regulatory compliance, fee structures, water trading, and land management decisions related to California's Sustainable Groundwater Management Act implementation.

- Joel Kimmelshue, LandIQ





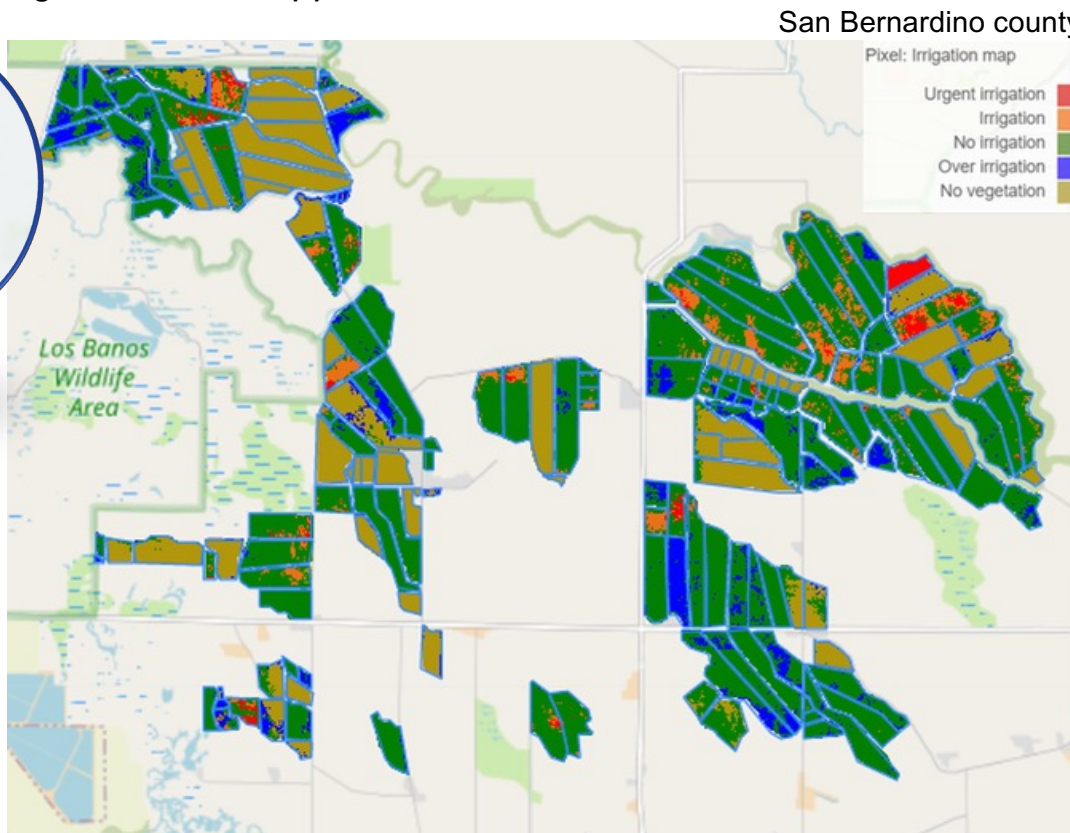
Providing irrigation advisories for agriculture



Maximize the “crop per drop” using commercial apps



Data sources:

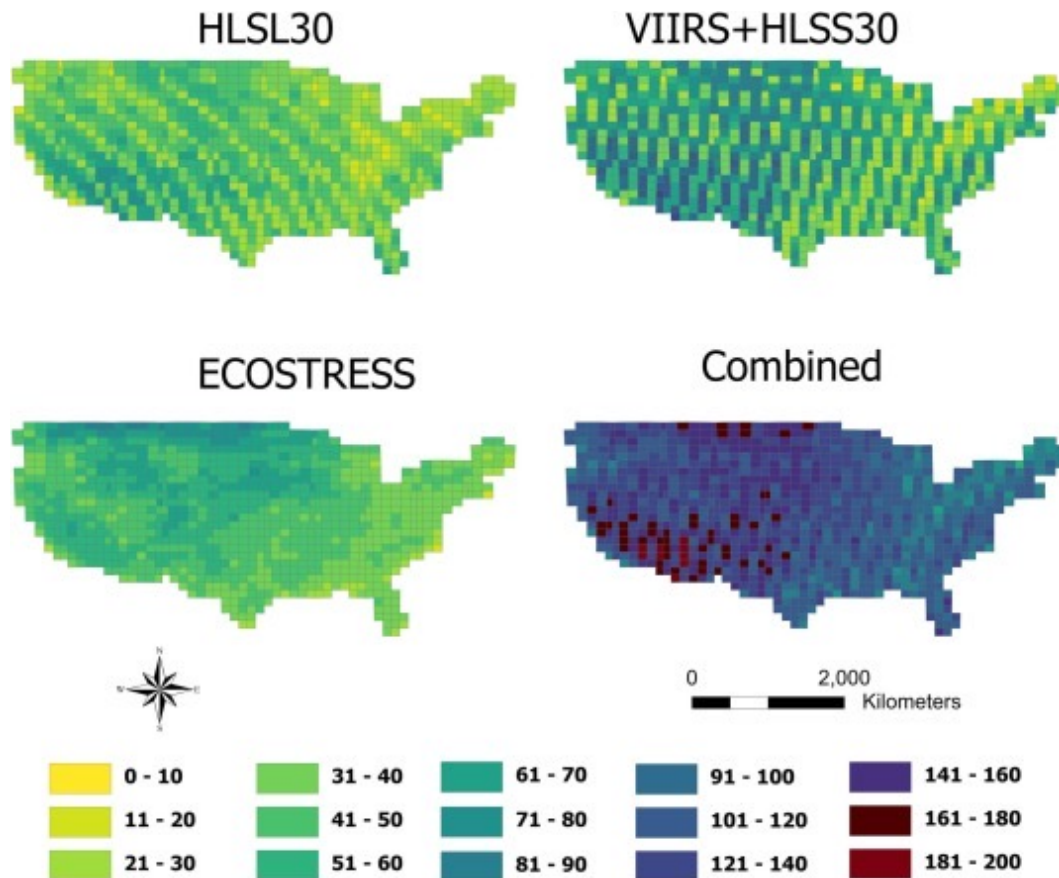


IrriWatch integrates ECOSTRESS data into high quality estimates of water use and delivers irrigation advisories to over 18,000 fields in 25 countries around the world.

- IrriWatch CEO Wim Bastiaanssen



ECOSTRESS can transform Landsat-only OpenET



Problem: OpenET is based on Landsat, however, Landsat 8+9 provides one image every 8 days. ECOSTRESS provides data every 3 days but at varying viewing angles. Can ECOSTRESS and Landsat be combined to provide weekly ET?

Findings: Large-sample analysis confirms strong agreement between Landsat-based and ECOSTRESS-derived daily ET across 10 land-cover types.

Impact: ECOSTRESS significantly reduces gaps in Landsat-only OpenET.



The future



 **agenzia spaziale italiana**

SBG-TIR
Wide-swath TIR imager and ASI VNIR camera

Sun-sync orbit (early PM)
6 bands TIR, 2 bands MIR, 2 bands VNIR
935 km swath, 3-day revisit
60-meter GSD
0.2K NeDT

SBG-VSWIR
Wide-swath VSWIR spectrometer

Sun-sync orbit (late AM)
185 km swath
16-day revisit
10 nm, 200+ bands
30-meter GSD
High SNR and radiometric performance





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