A Framework for Mapping Global Evapotranspiration using 375-m VIIRS LST

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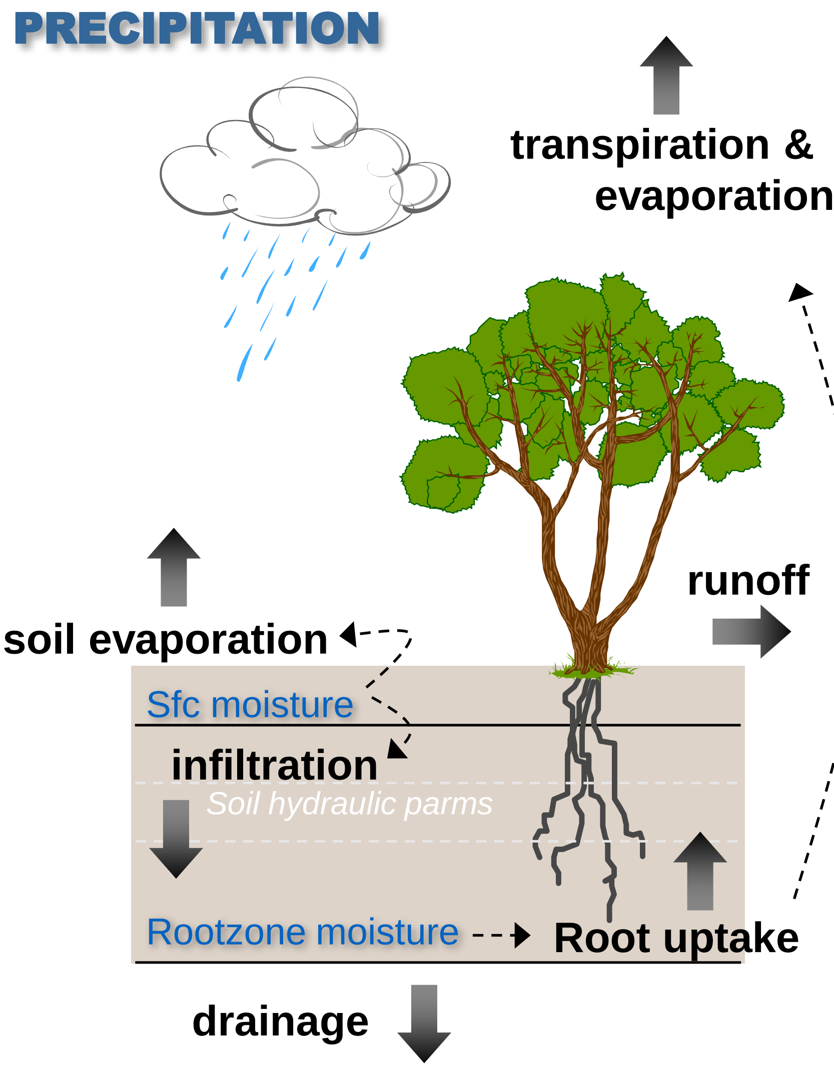
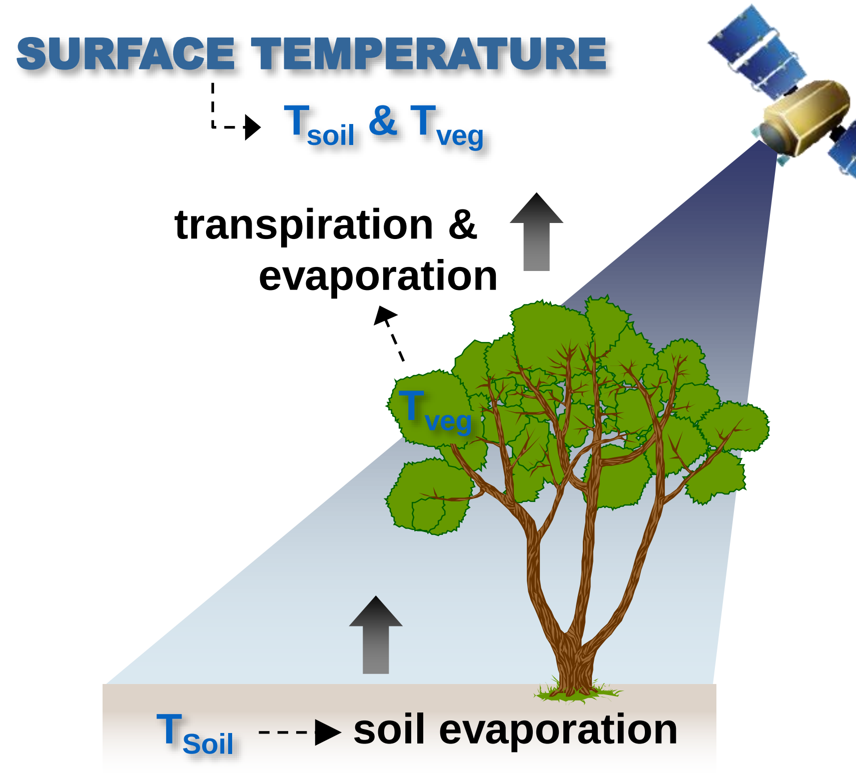
Approaches to mapping ET



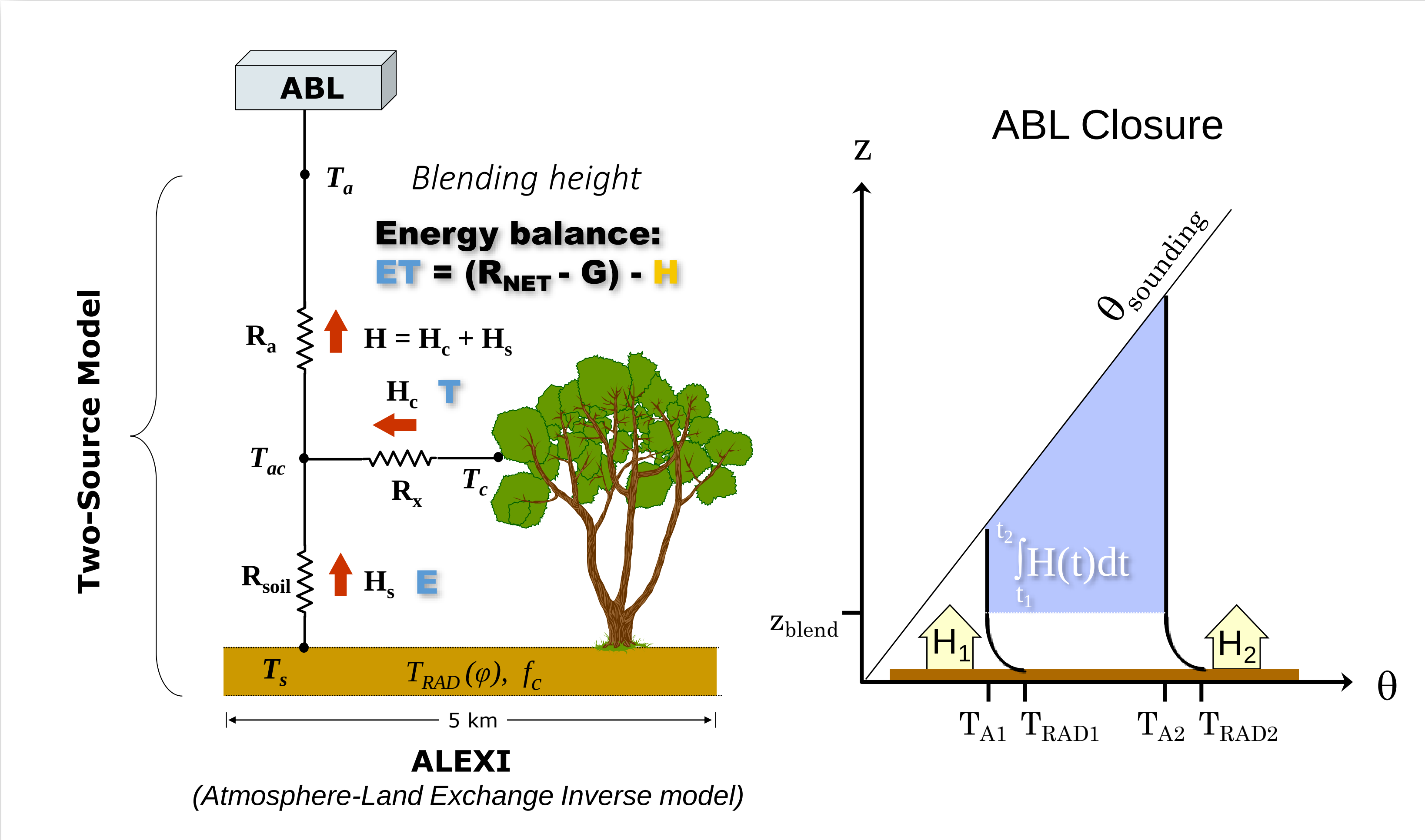
WATER BALANCE APPROACH
(prognostic modeling)



Given known radiative energy inputs, how much water loss is required to keep the soil and vegetation at the observed temperatures?

ENERGY BALANCE APPROACH
(diagnostic modeling)

ALEXI: regional ET modeling system



Regional scale

Surface temp:	ΔT_{RAD}	- Geostationary
Air temp:	T_a	- ABL model

Comparison of ET approaches

COMPARISON of ET from energy and water balance models (ALEXI vs. Noah)

(Green indicates energy balance ET is persistently wetter than expected based on local water balance)

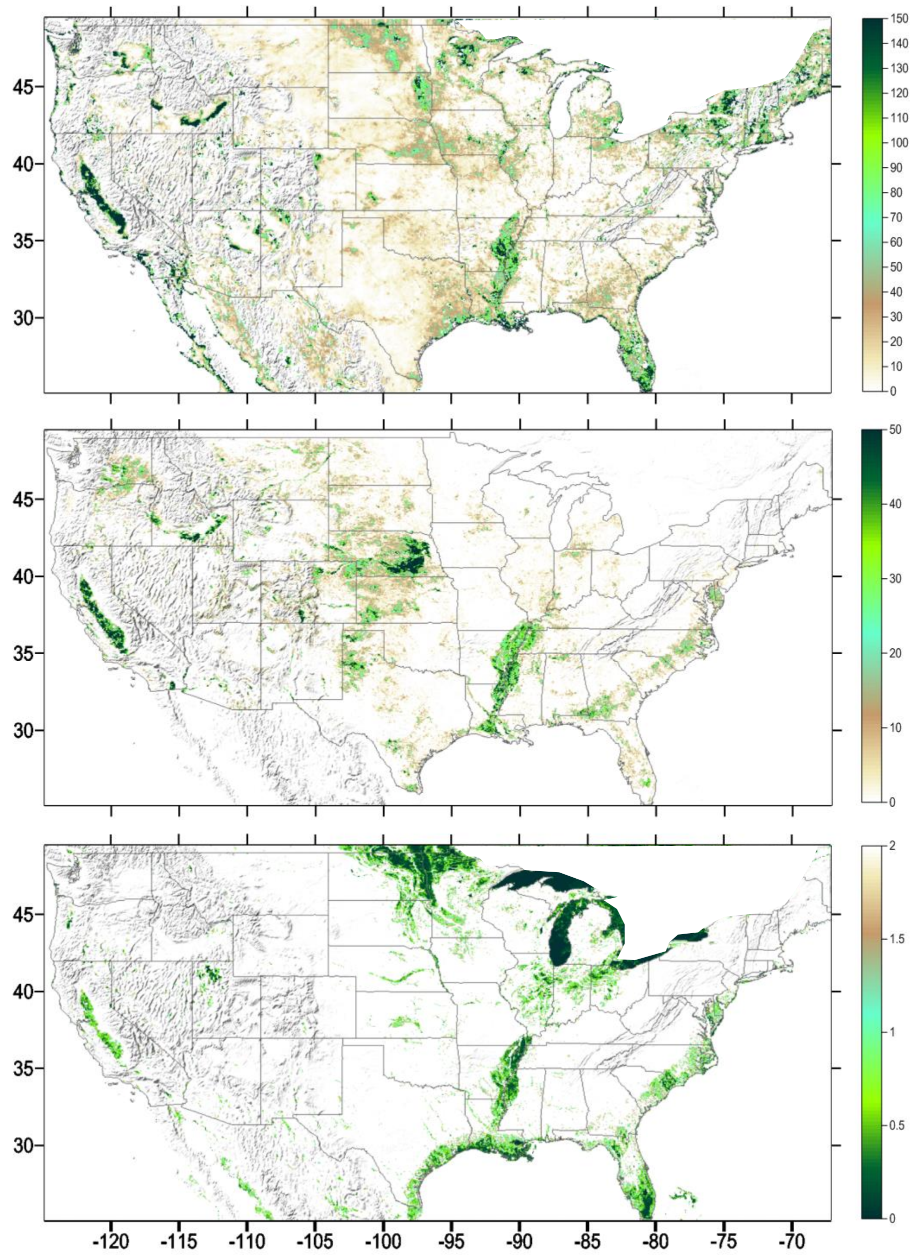
Differences are primarily related to:

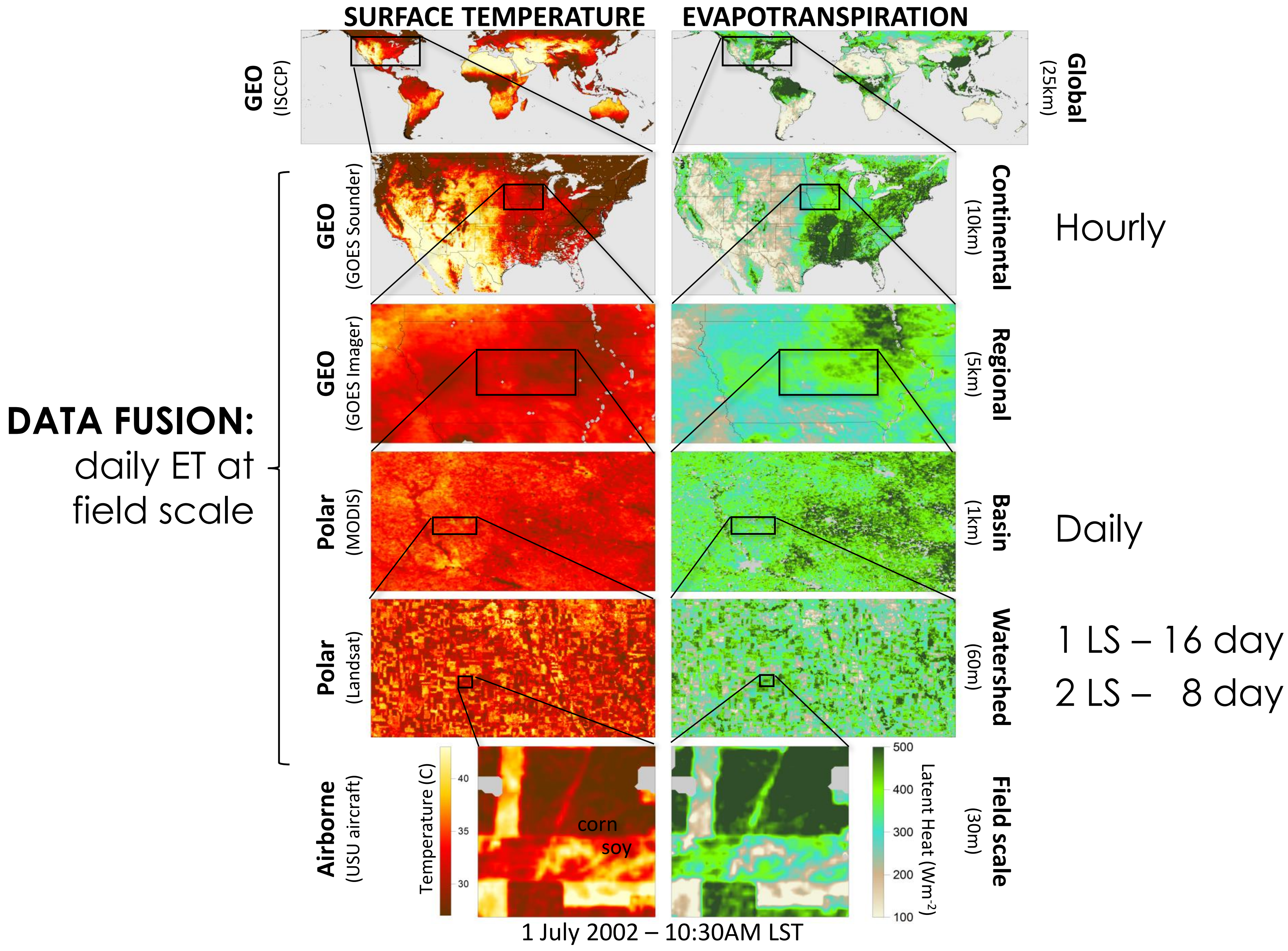
% Irrigation

Depth to water table (m)

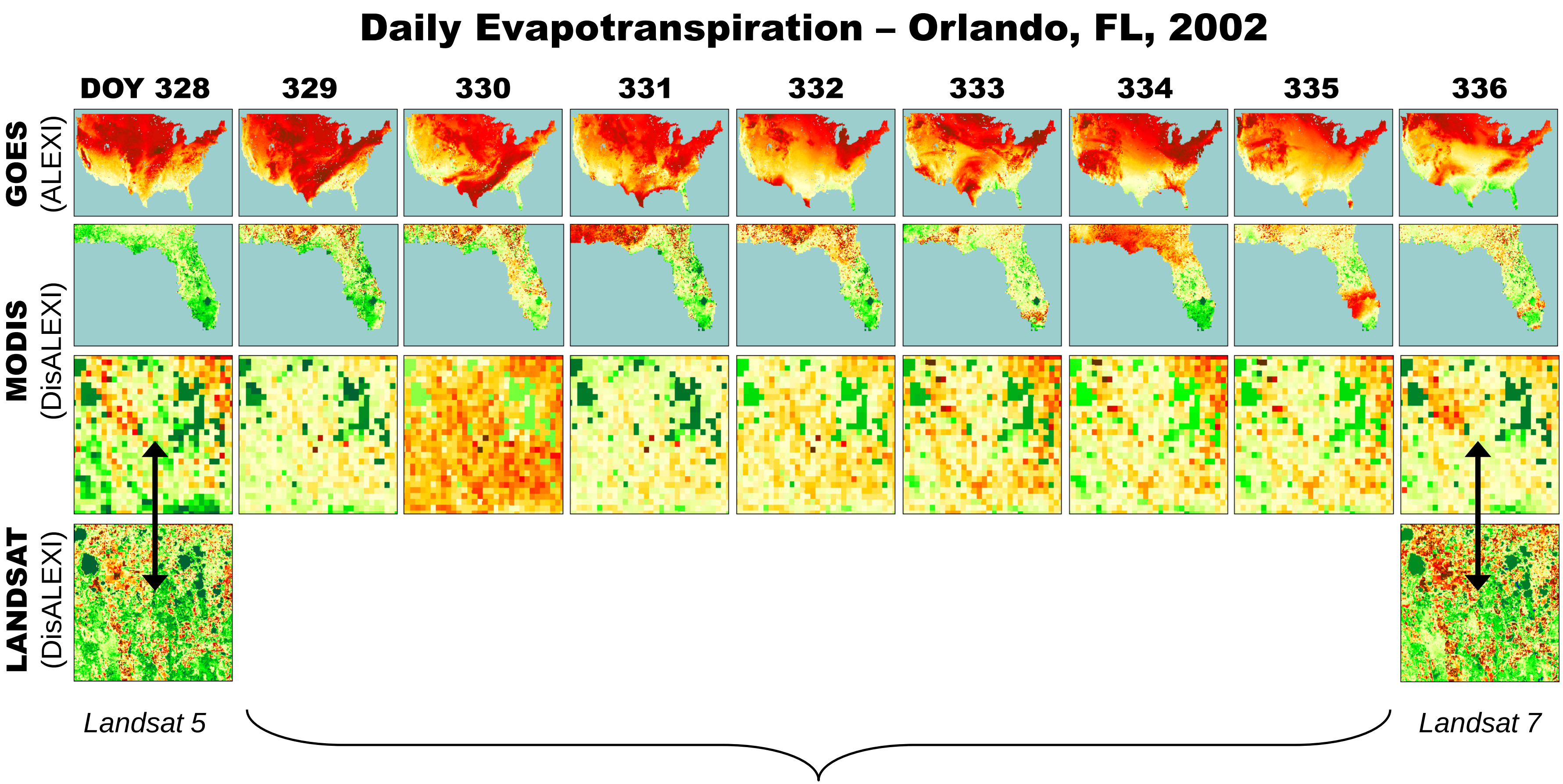
(as well as density of subpixel water bodies)

Hain, et al. (2014)



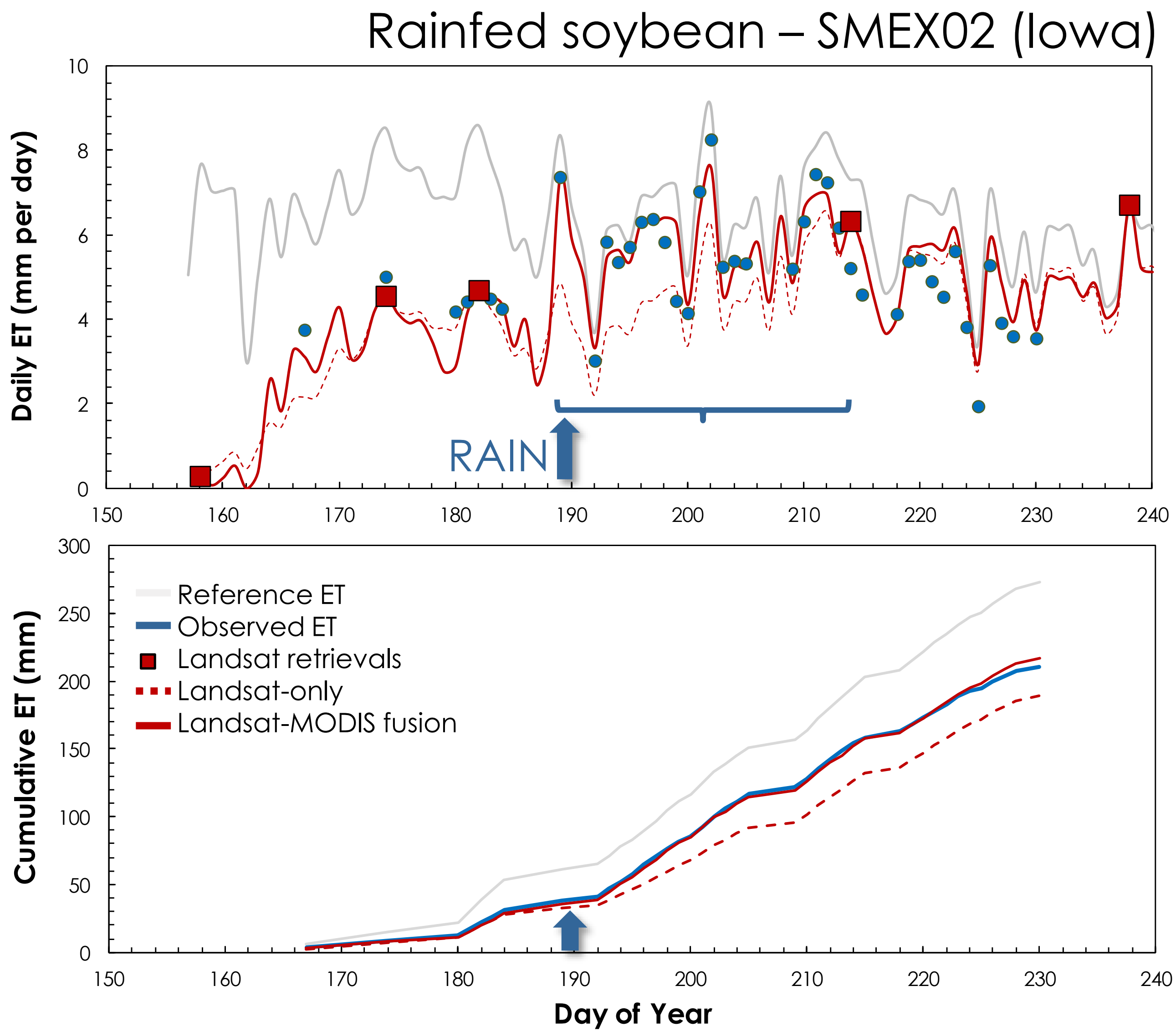

SURFACE TEMPERATURE
EVAPOTRANSPIRATION
GEO (ISCCP)
Global (25km)
GEO (GOES Sounder)
Continental (10km)
Hourly
GEO (GOES Imager)
Regional (5km)
DATA FUSION:
daily ET at field scale
Polar (MODIS)
Basin (1km)
Daily
Polar (Landsat)
Watershed (60m)
1 LS – 16 day
2 LS – 8 day
Airborne (USU aircraft)
Temperature (C)
40
35
30
corn
soy
500
400
300
200
100
Latent Heat (Wm-2)
Field scale (30m)
1 July 2002 – 10:30AM LST

GOES/MODIS/Landsat FUSION



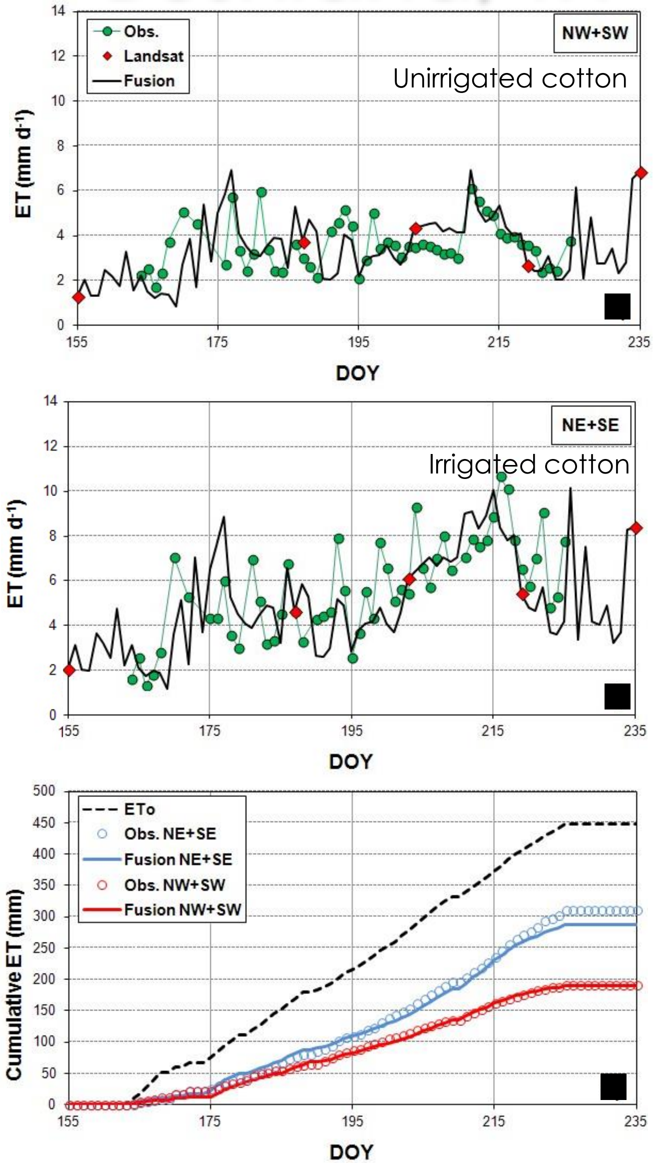
Spatial Temporal Adaptive Reflectance Fusion Model (STARFM) *(Gao et al, 2006)*

Sampling Improvements from Data Fusion

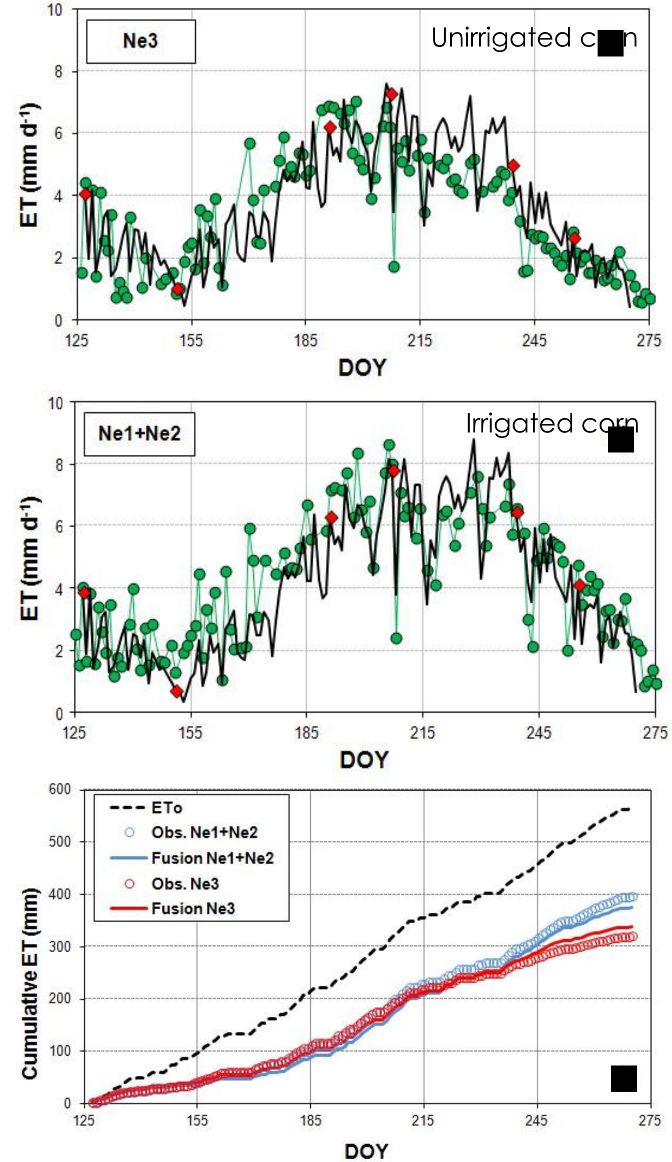


Irrigated vs. rain-fed crop water use

Bushland, TX

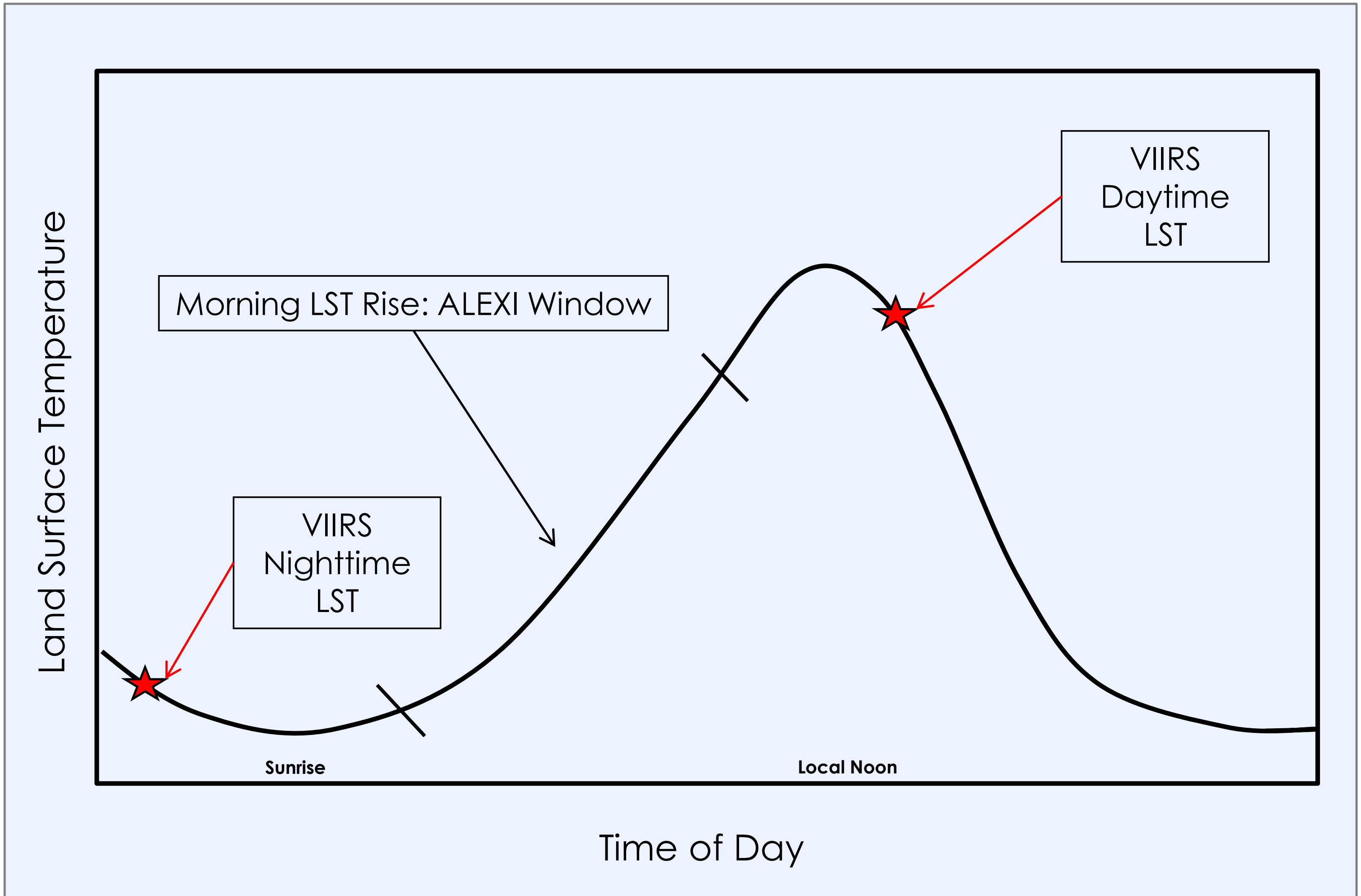


Mead, NE



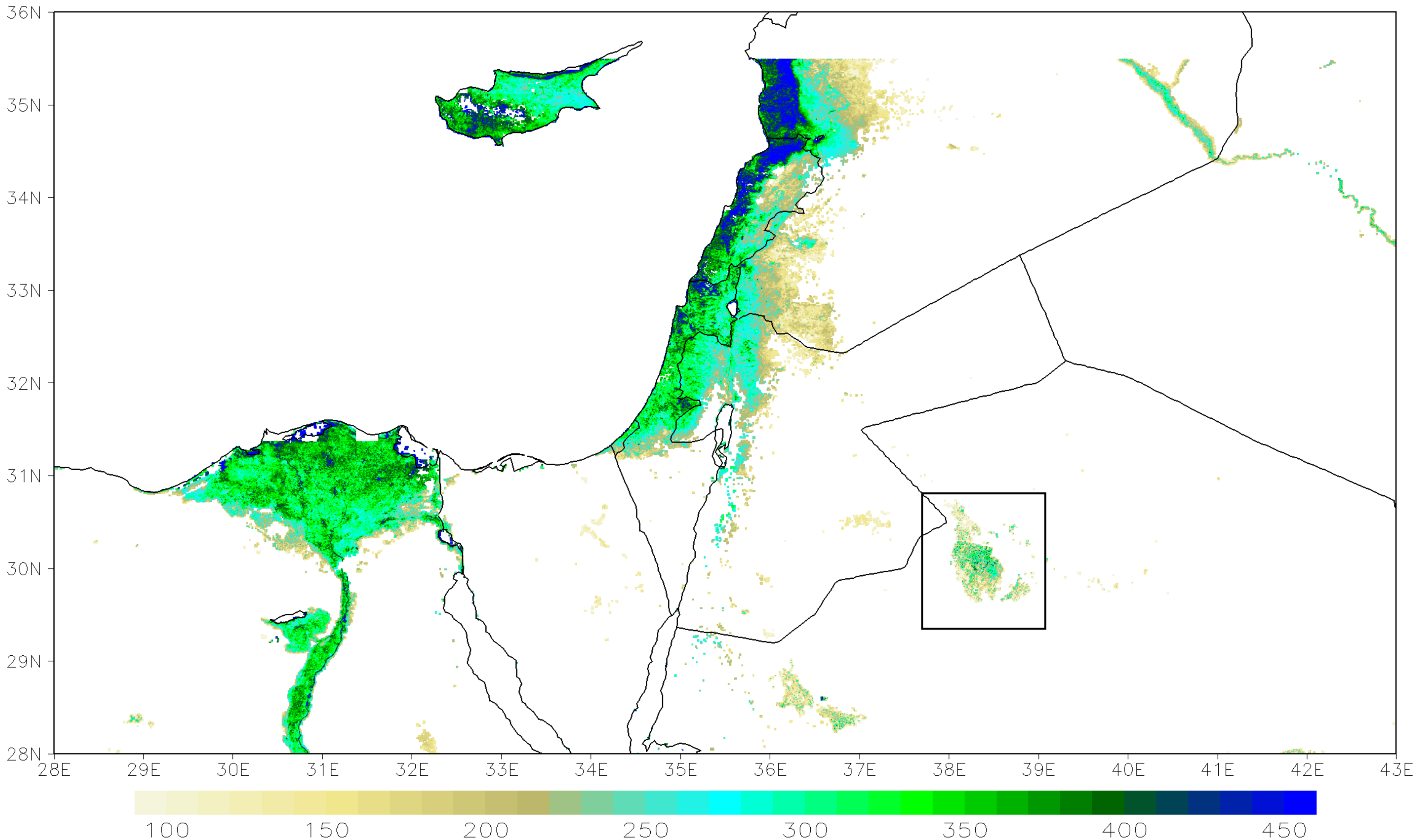
Supplementing ALEXI Capabilities with Polar Orbiting Sensors

A technique has been developed and evaluated using GOES data to train a regression model to use day-night LST differences from MODIS to predict the morning LST rise needed by ALEXI.

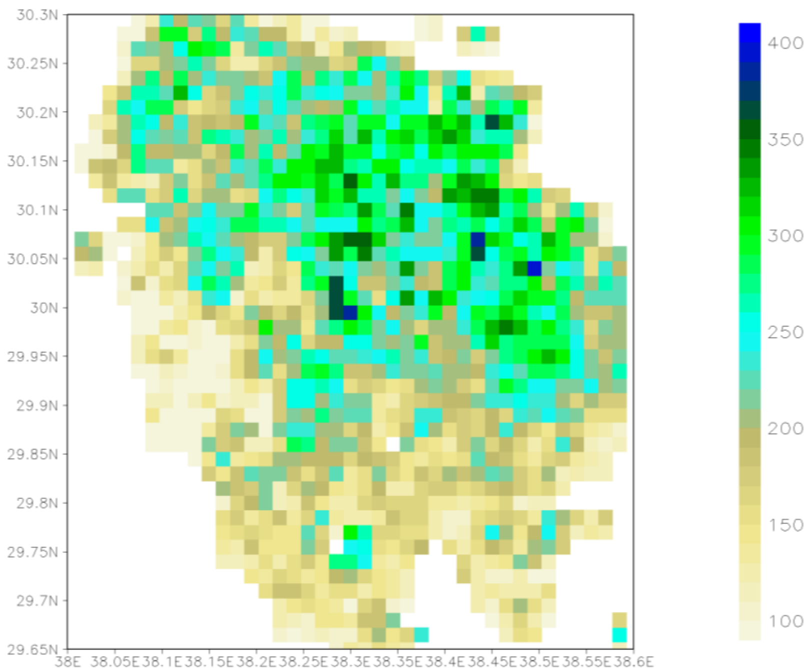


Supplementing ALEXI Capabilities with Polar Orbiting Sensors

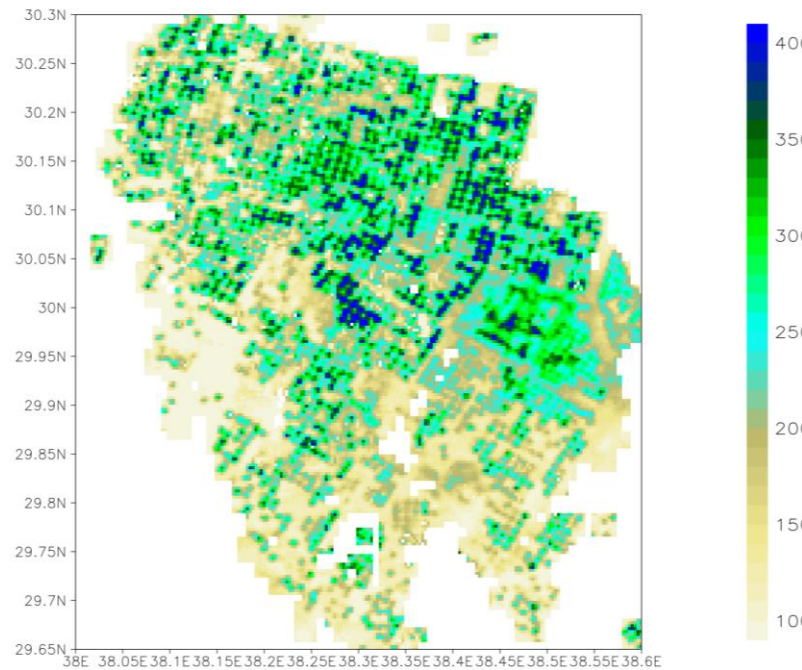
VIIRS Clear-sky Latent Heat Flux (Wm^{-2}) 2015155



Resolution Improvements over MODIS



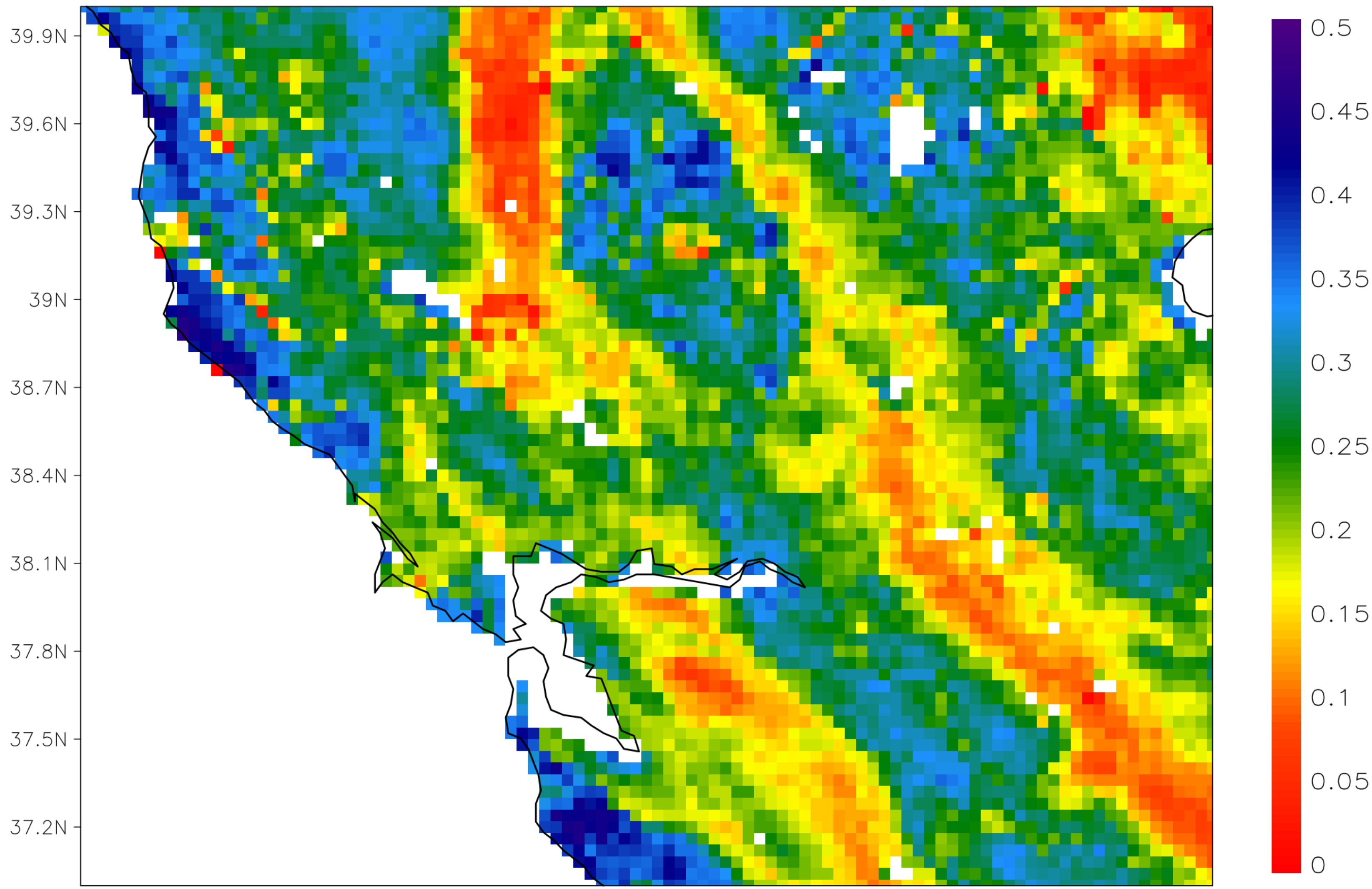
MODIS



VIIRS

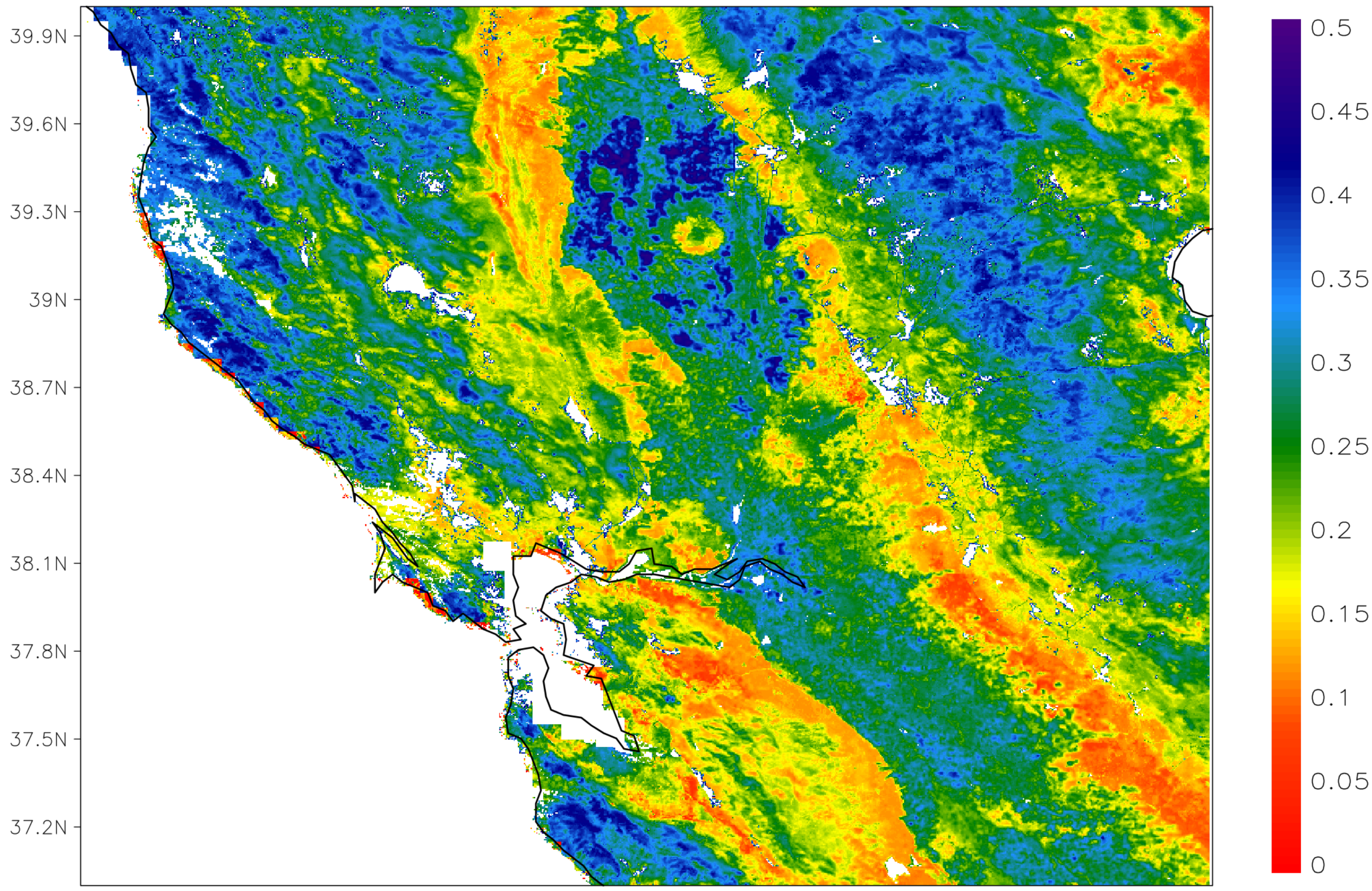
Resolution Improvements over MODIS

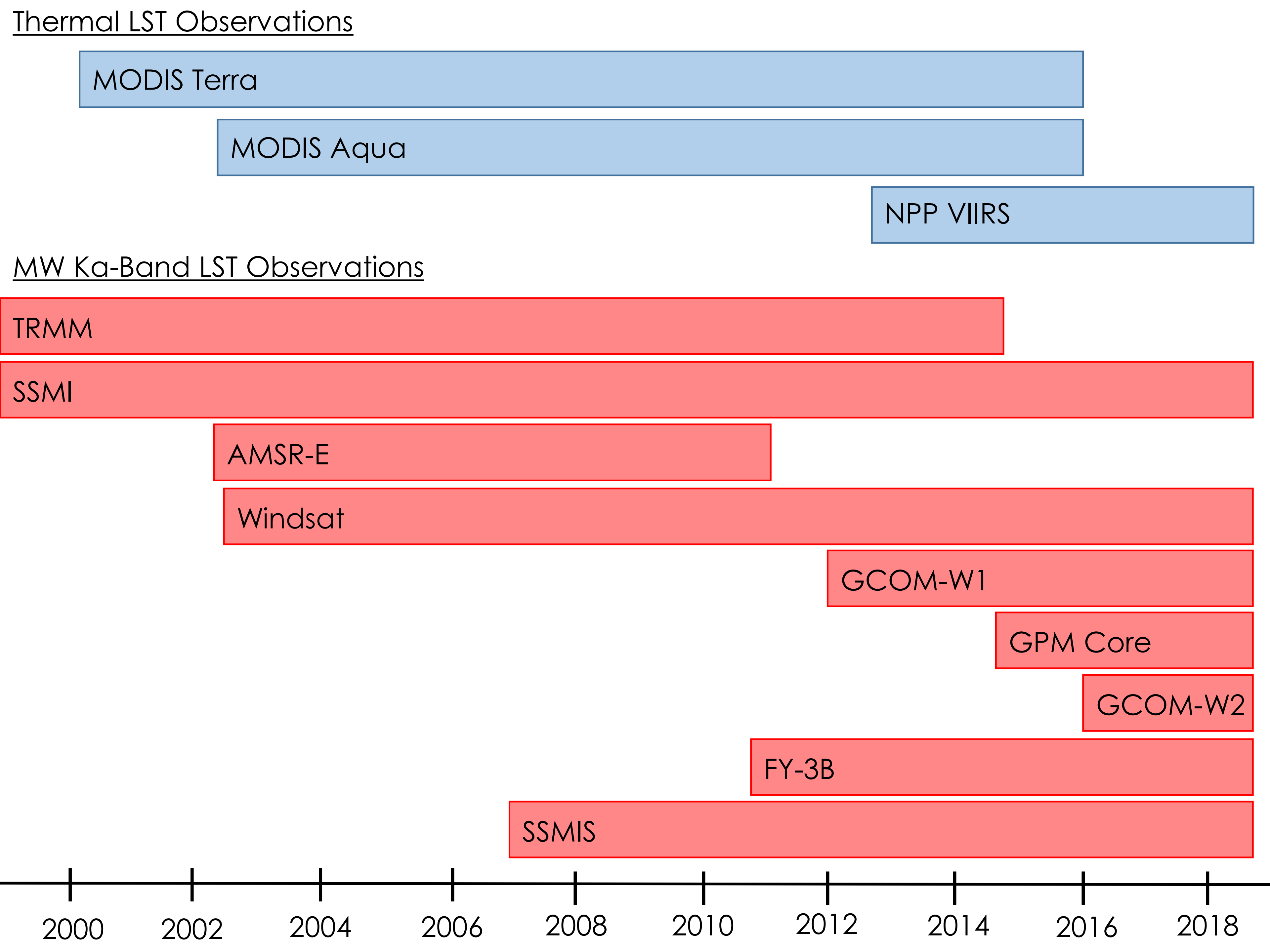
GOES 4-km Evaporative Fraction (EF) for August 2014



VIIRS 375-m Evaporative Fraction (EF) for August 2014

Resolution Improvements over MODIS





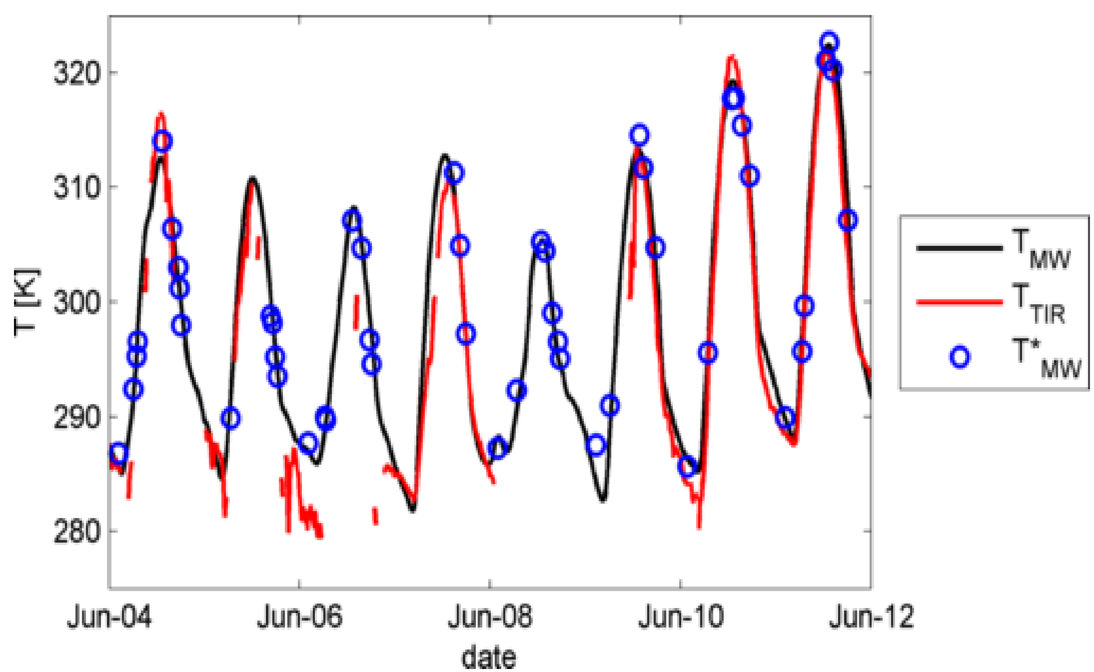
Thermal LST Observations
MODIS Terra
MODIS Aqua
NPP VIIRS
MW Ka-Band LST Observations
TRMM
SSMI
AMSR-E
Windsat
GCOM-W1
GPM Core
GCOM-W2
FY-3B
SSMIS
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018

Coupled Thermal / MW ALEXI System

The synergy between TIR and MW observations is further being exploited by the development of LST observations from MW observations(Ka-band).

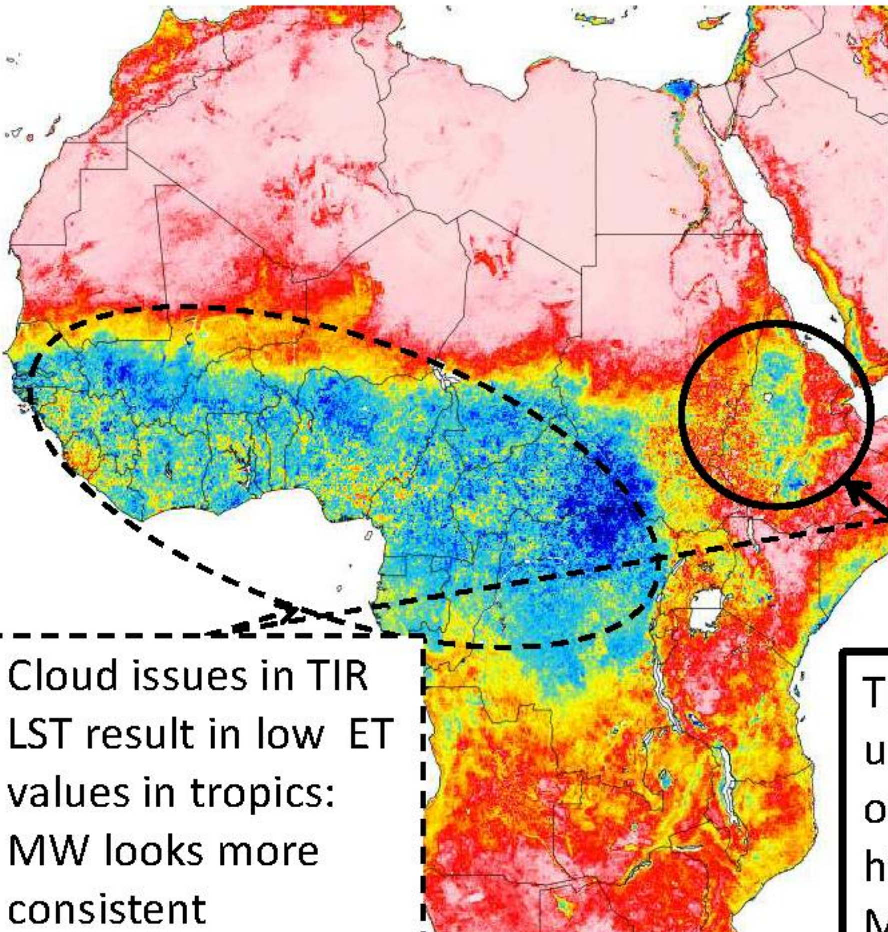
The integration of MW LST into a coupled TIR/MW ALEXI system will allow for retrieval of surface fluxes under cloud cover (where TIR-only retrievals are not possible).

This capability fills in a significant gap in a TIR-only system over tropical equatorial regions where clear-sky retrievals may only be possible 1 to 3 times per month, particularly during the wet season .

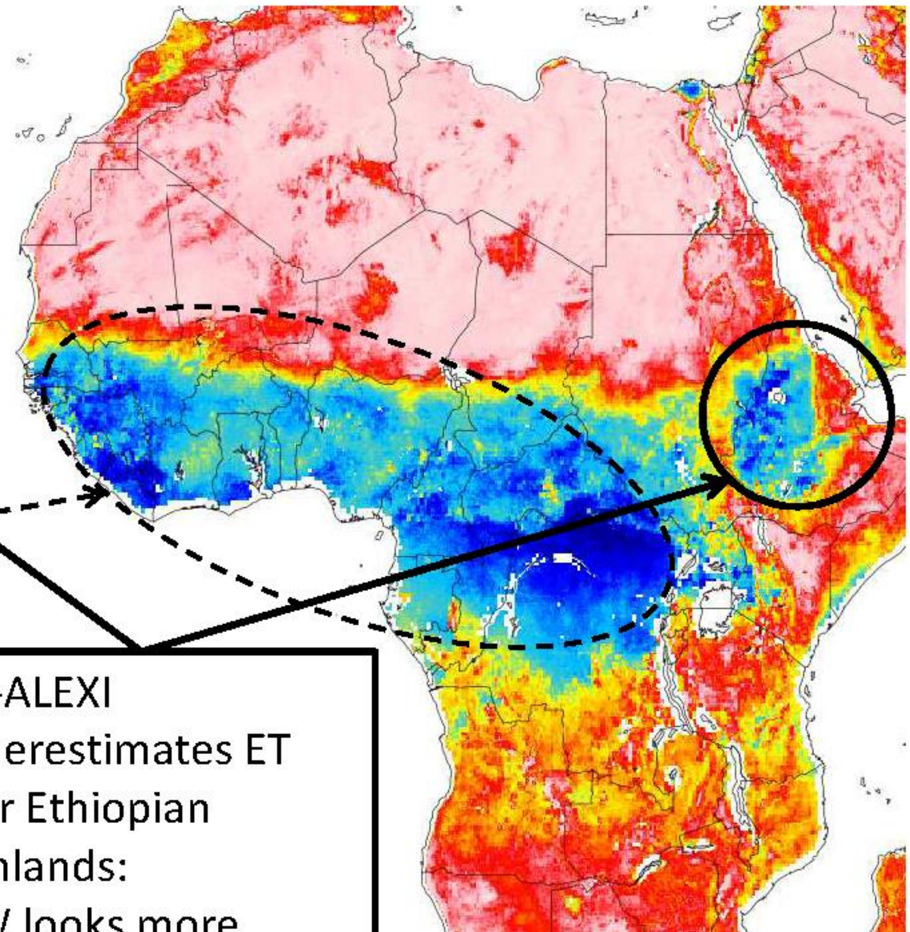


Cumulative - Clear Sky - Evapotranspiration (mm)
Jul/Aug/Sep (2004)

TIR-ALEXI



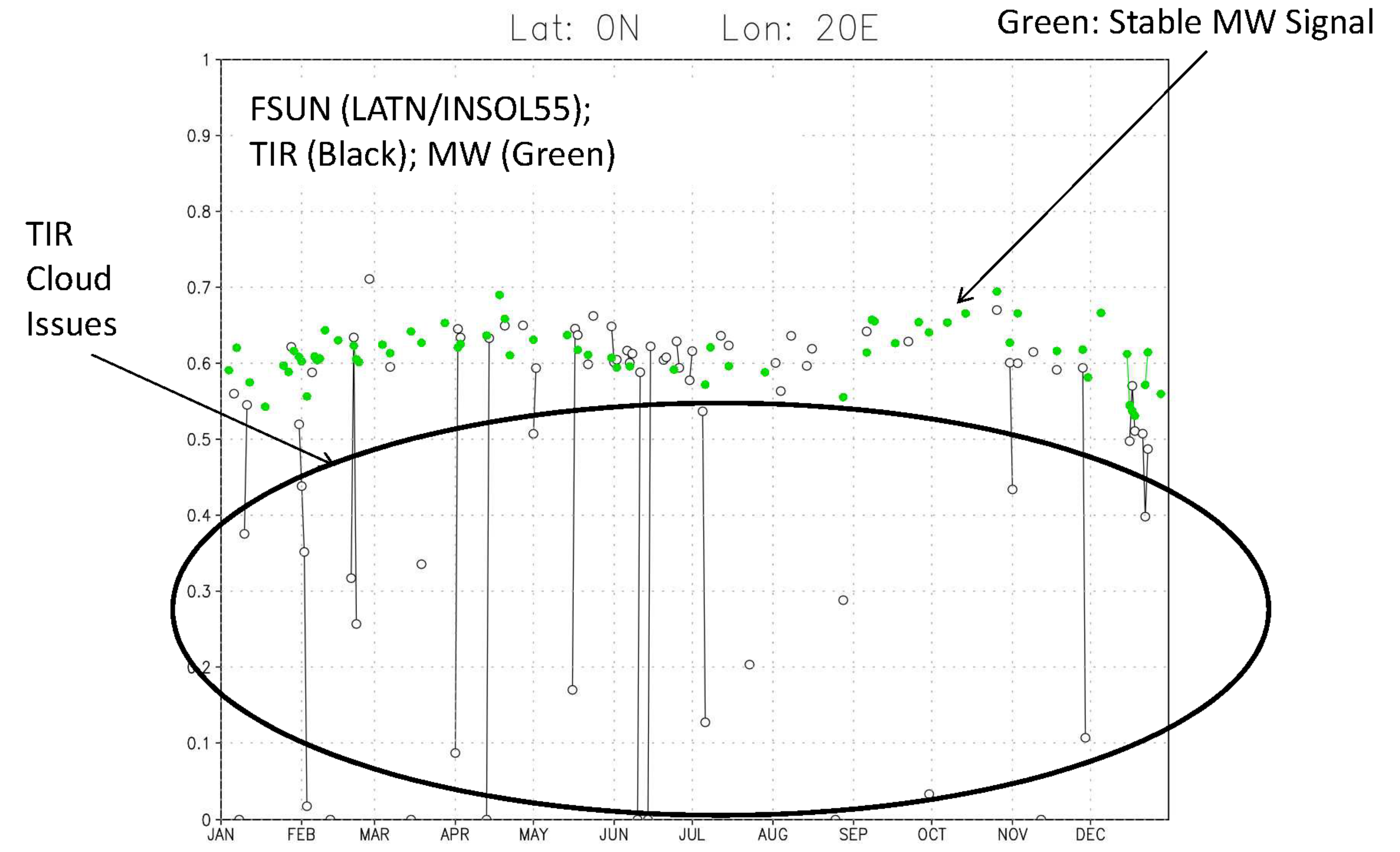
MW-ALEXI



Cloud issues in TIR LST result in low ET values in tropics: MW looks more consistent

TIR-ALEXI underestimates ET over Ethiopian highlands: MW looks more realistic

MW-LST for ET: Clear Sky compared



LST-Based Evapotranspiration

- Diagnostically captures non-precipitation related moisture sources/sinks (irrigation, shallow groundwater, drainage)
- Capacity to map from global to sub-field scales using TIR-based data fusion
- Can be combined with remotely sensed soil moisture and precipitation data to interpret changes in other hydrologic variables

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