Multi-scale Remote Assessment of Land-surface Hydrologic Response to Stress

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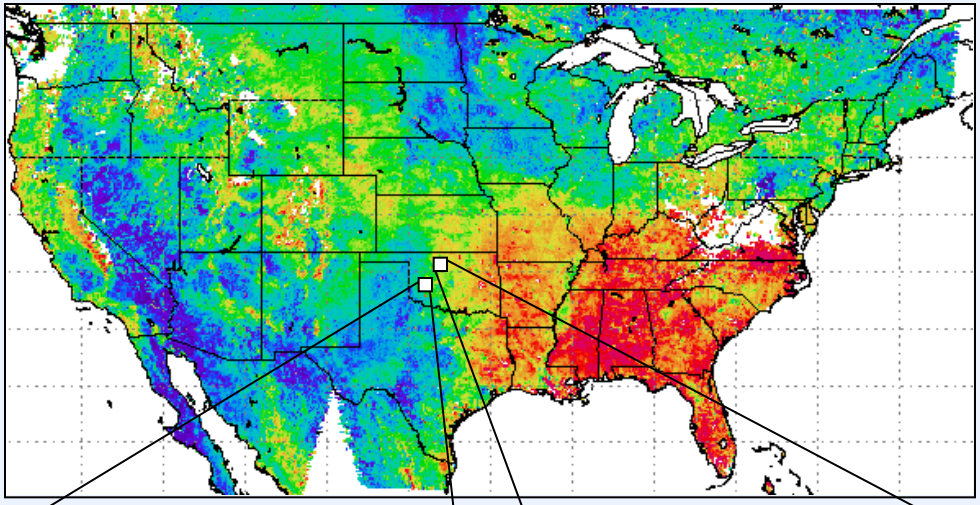
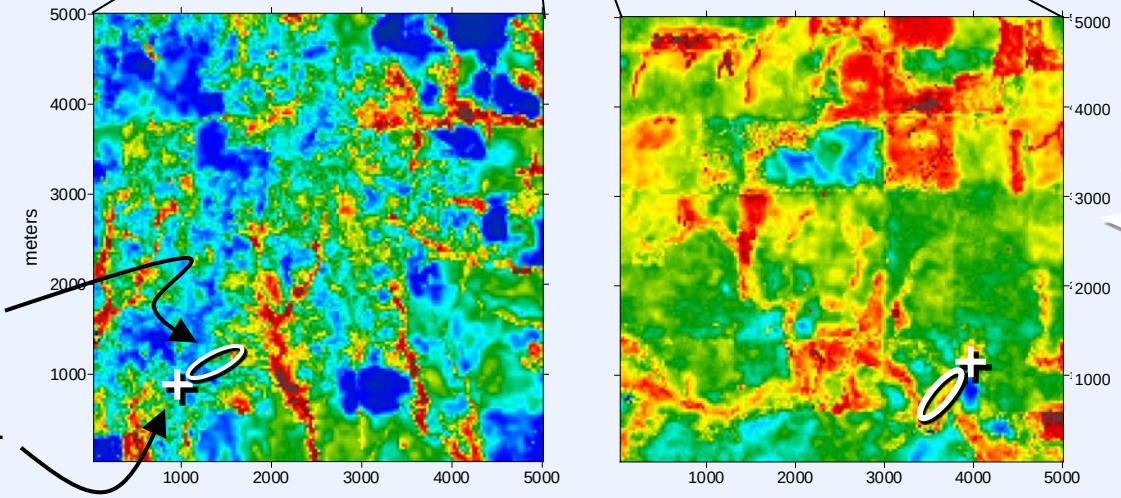
Multi-scale flux modeling strategy

GOES-DERIVED FLUXES (10 km)



Hourly



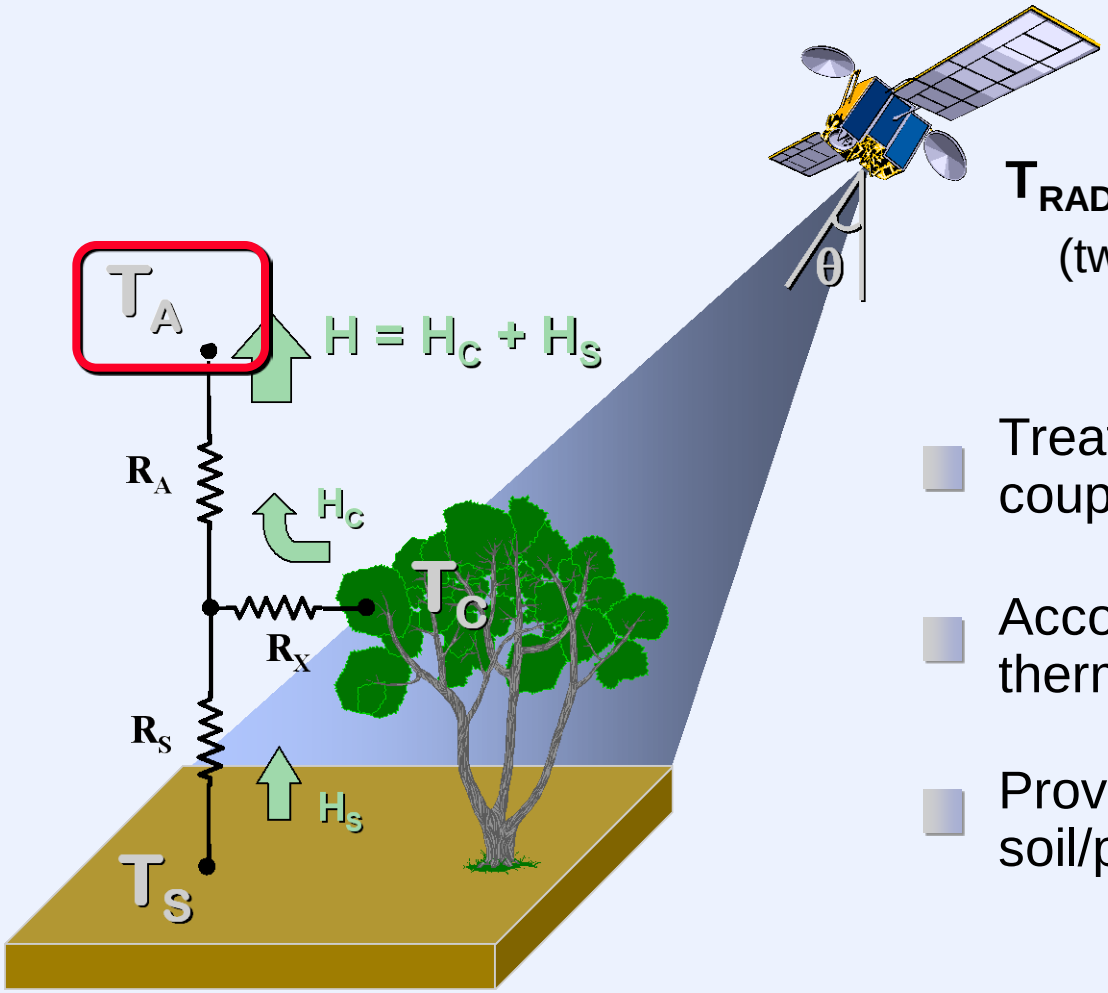
source footprint

tower

When available

LANDSAT-DISAGGREGATED FLUXES (30 m)

Two-Source Energy Balance Model (TSEB)



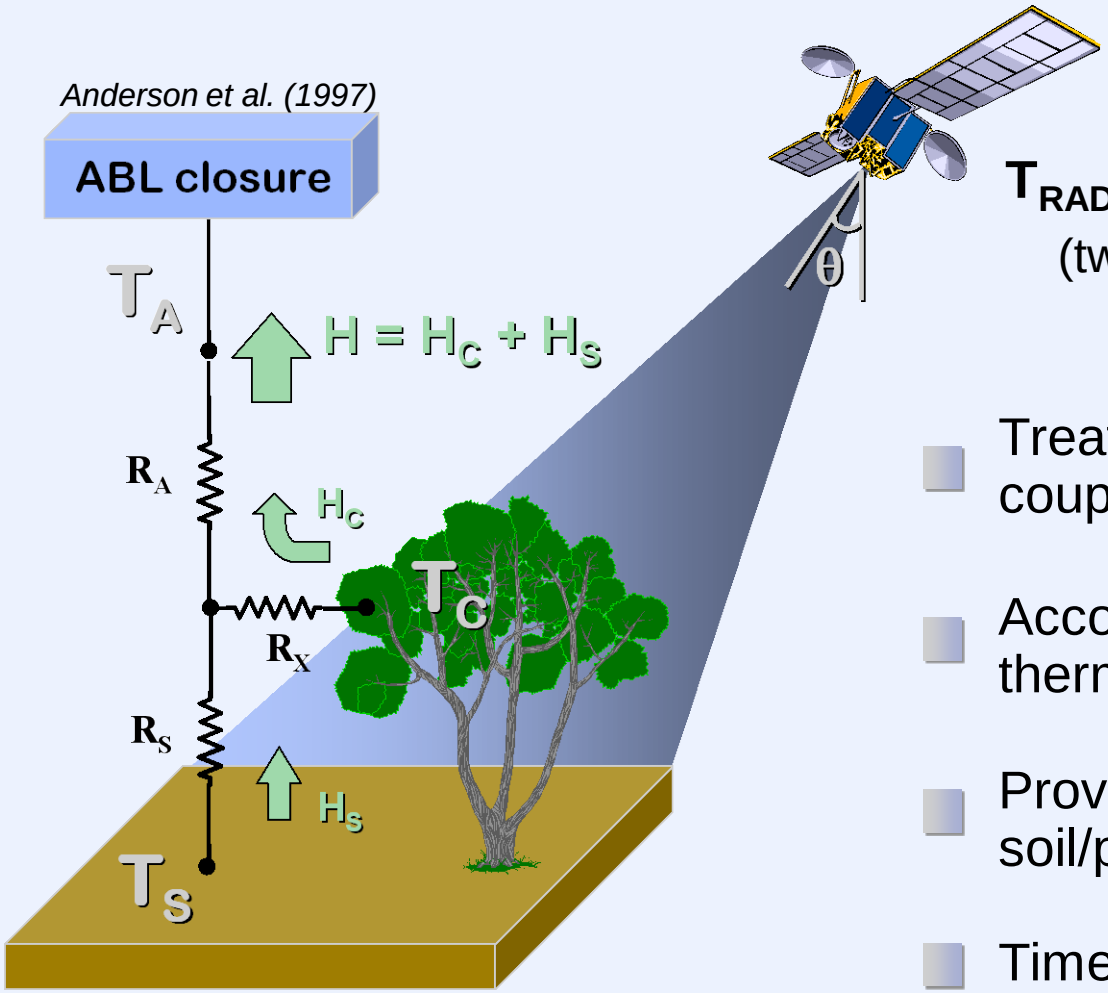
$$T_{RAD}(\theta) \sim f_c(\theta)T_c + [1-f_c(\theta)]T_s$$

(two-source approximation)

Norman, Kustas et al. (1995)

- Treats soil/plant-atmosphere coupling differences explicitly
- Accommodates off-nadir thermal sensor view angles
- Provides information on soil/plant fluxes and stress

Atmosphere-Land Exchange Inverse Model (ALEXI)



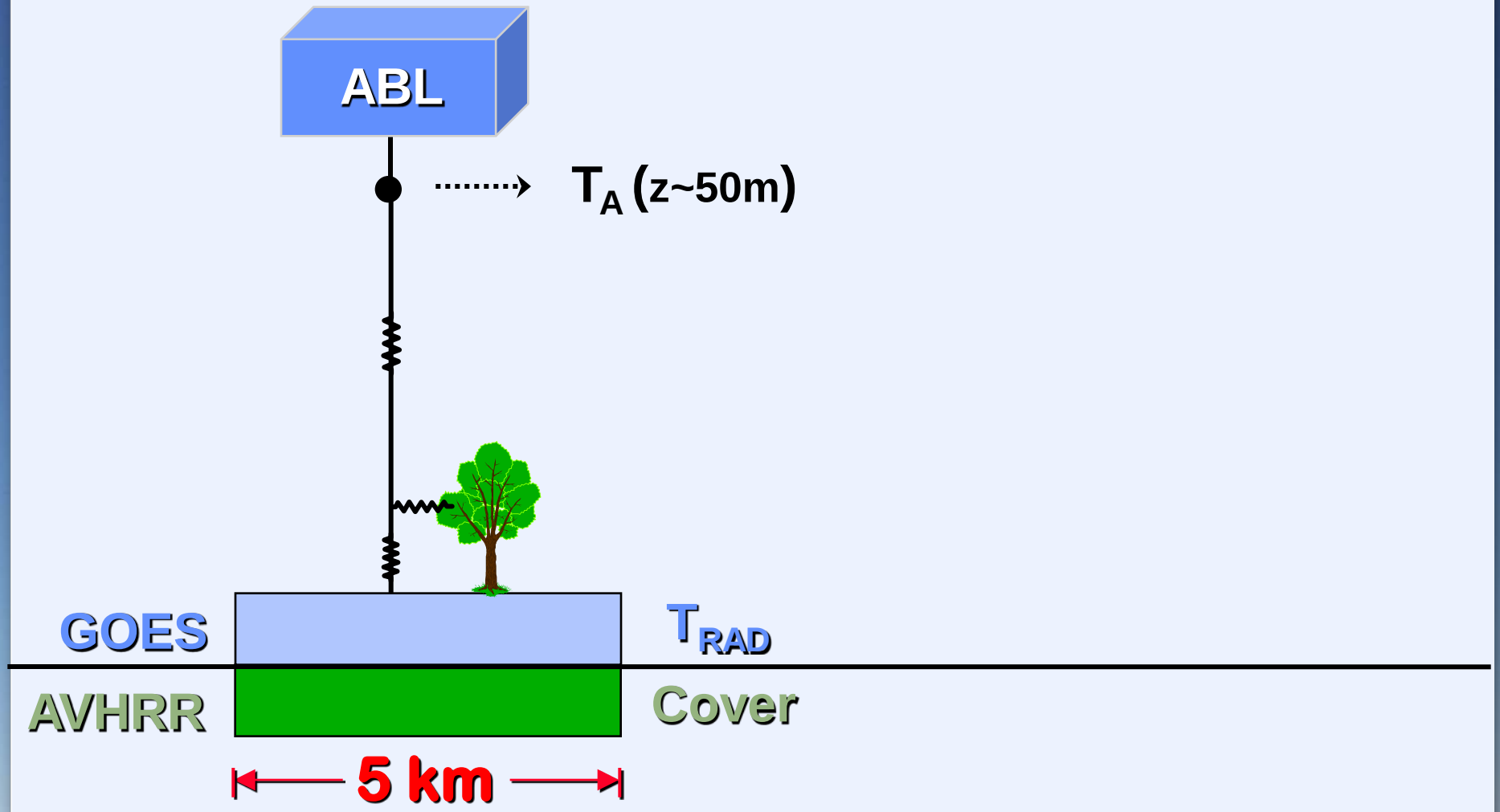
$$T_{RAD}(\theta) \sim f_c(\theta)T_c + [1-f_c(\theta)]T_s$$

(two-source approximation)

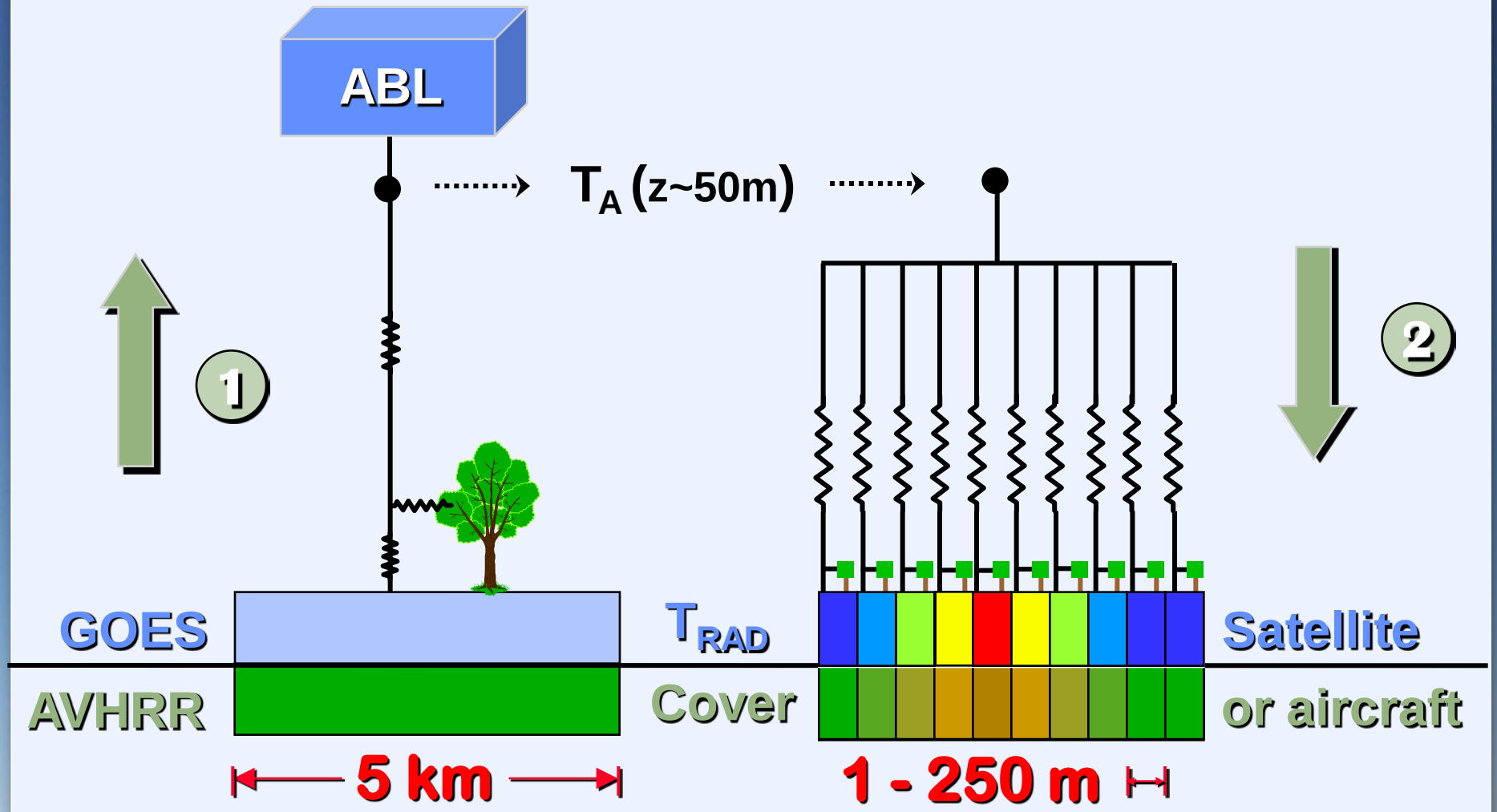
Norman, Kustas et al. (1995)

- Treats soil/plant-atmosphere coupling differences explicitly
- Accommodates off-nadir thermal sensor view angles
- Provides information on soil/plant fluxes and stress
- Time-differential ABL closure

Atmosphere-Land Exchange Inverse Model (ALEXI)

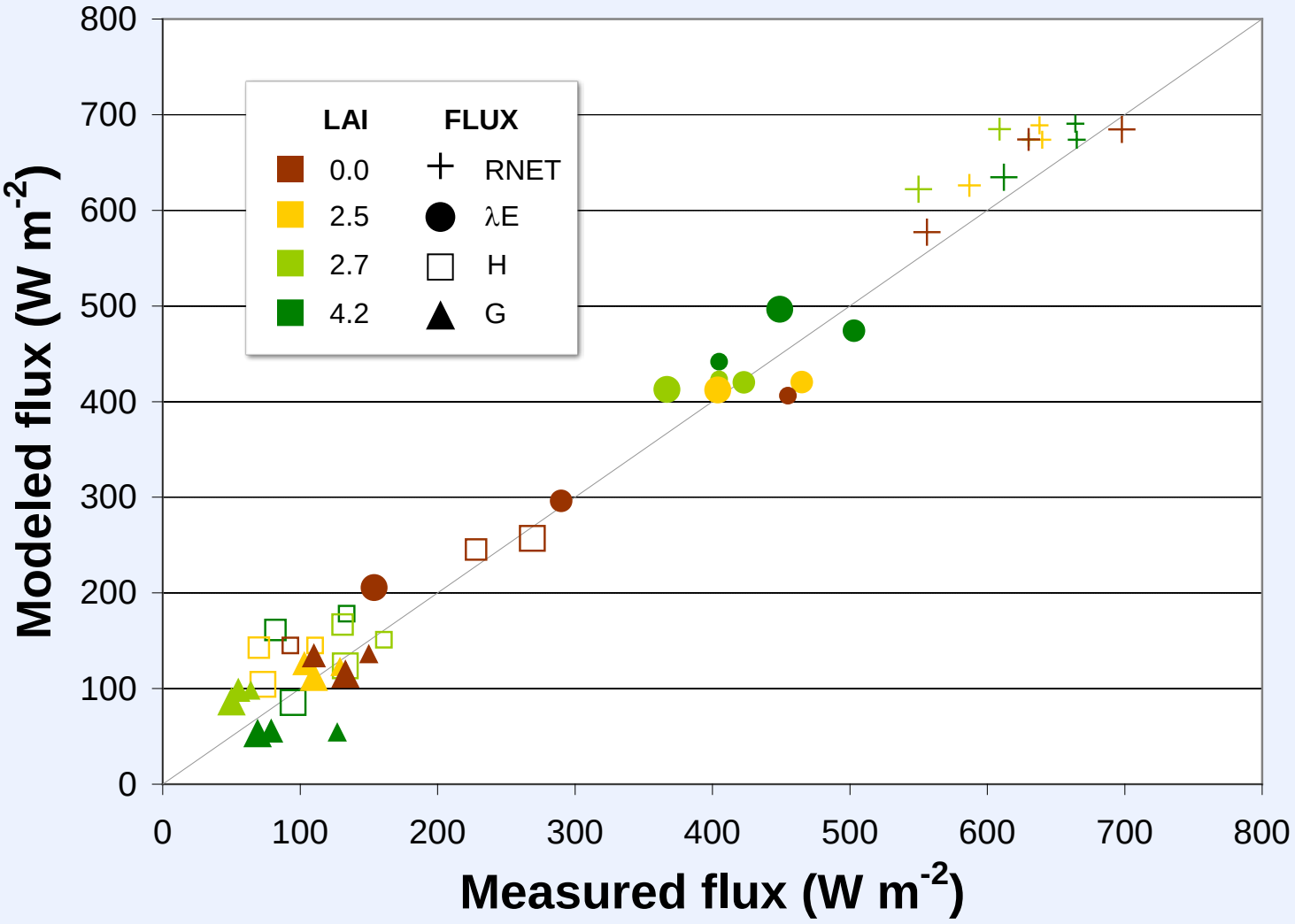


Disaggregated ALEXI model (DisALEXI)



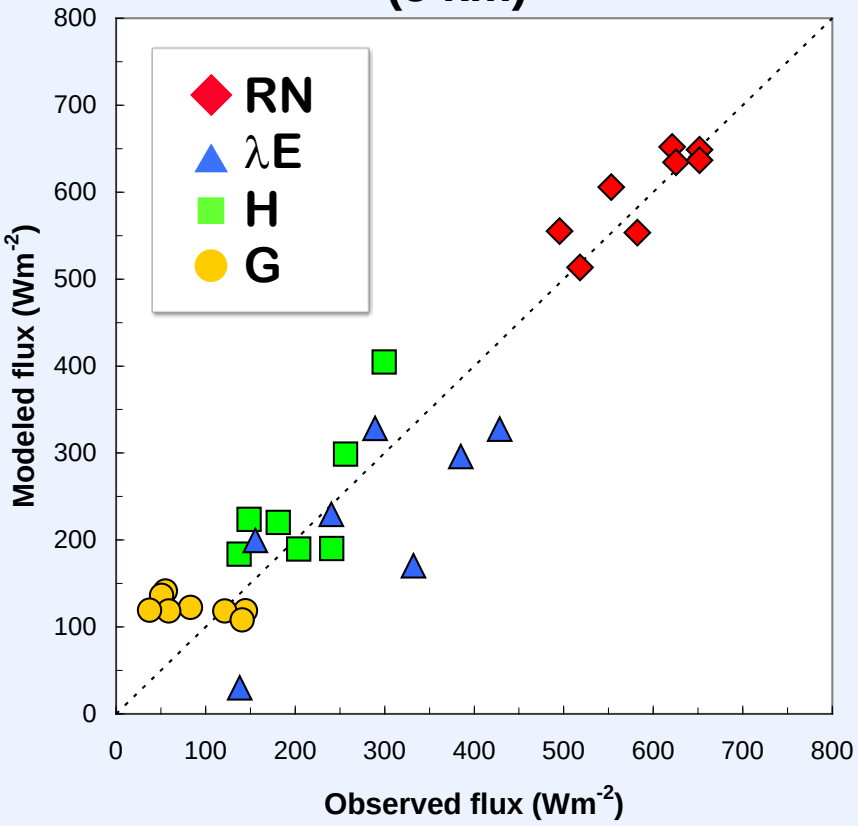

LOCAL VALIDATION

DisALEXI vs. tower fluxes *SGP97*

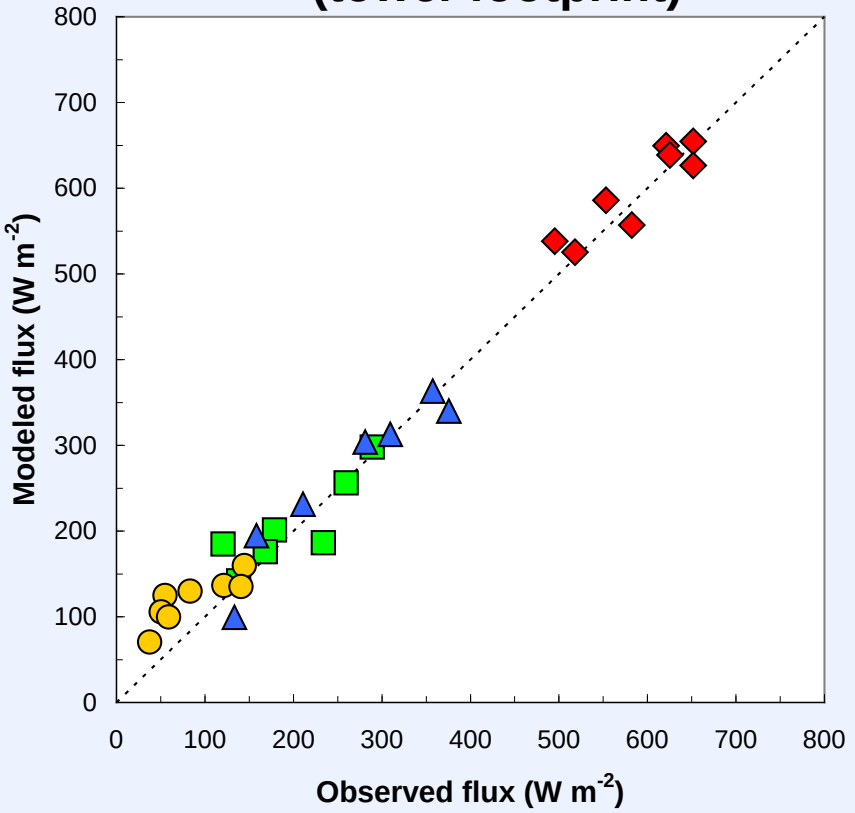


(Dis)ALEXI vs. tower fluxes *Mesonet*

ALEXI
(5 km)

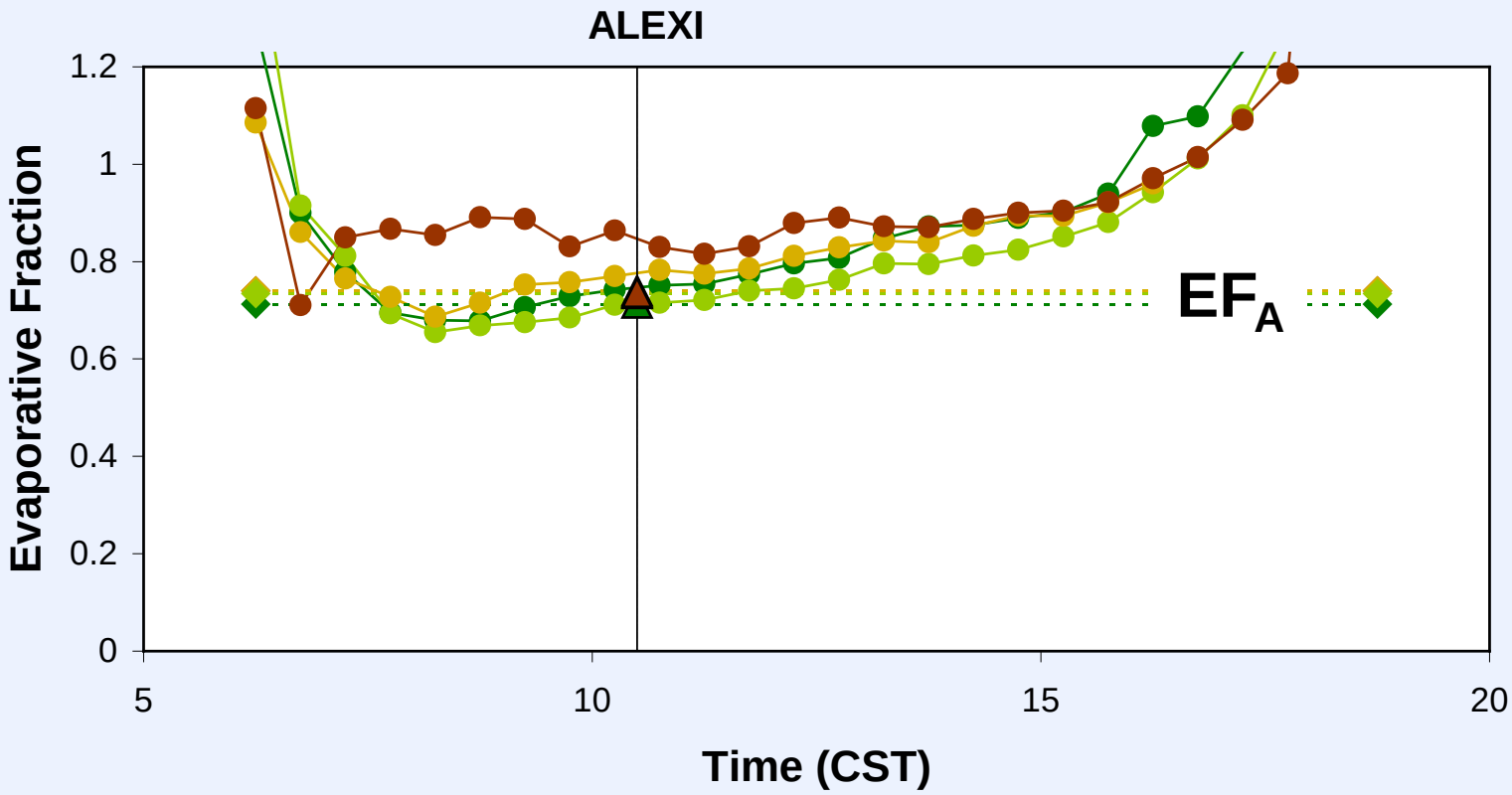


DisALEXI
(tower footprint)



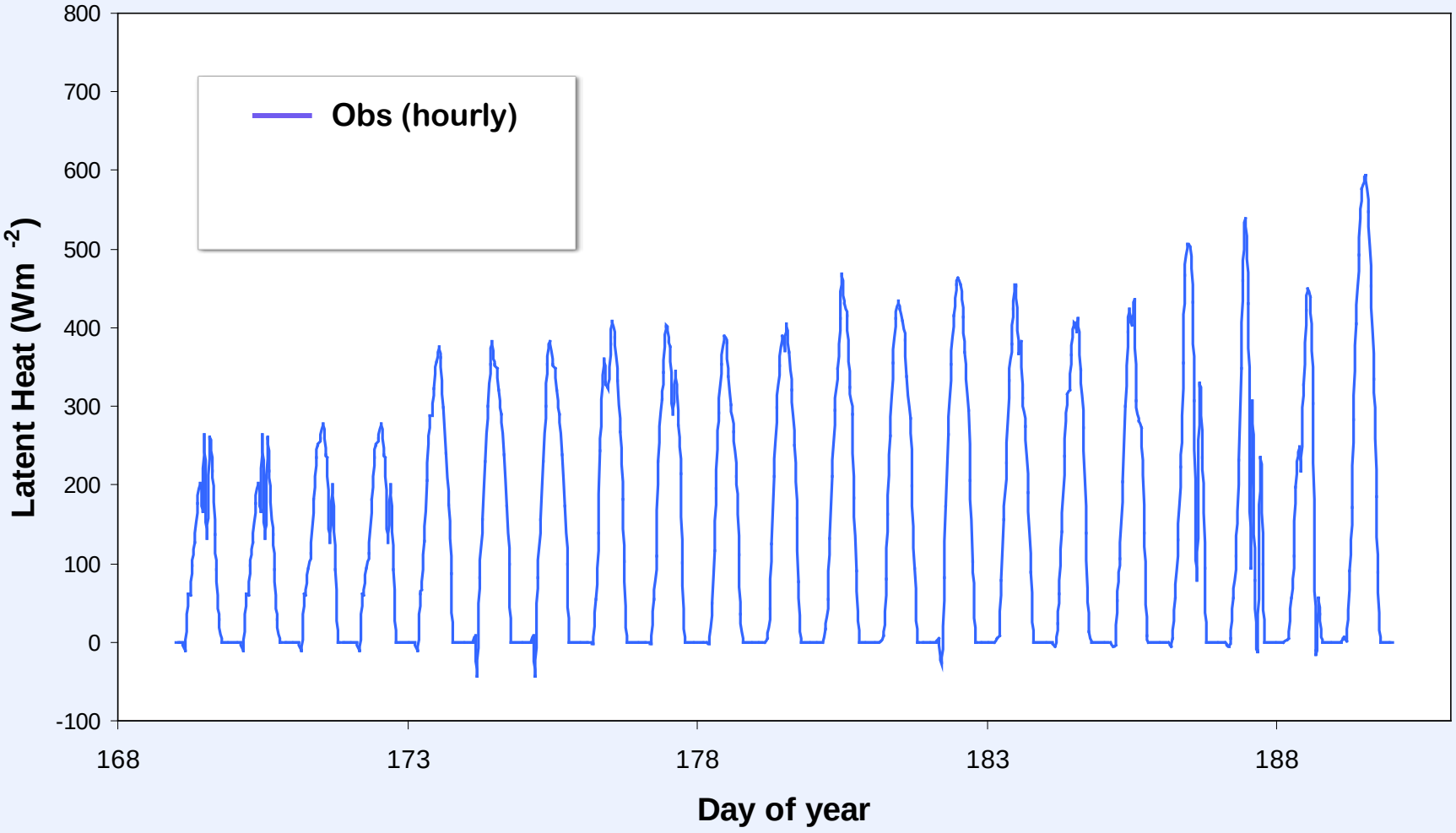

REGIONAL VALIDATION
... gap filling

Daily extrapolation assuming constant EF

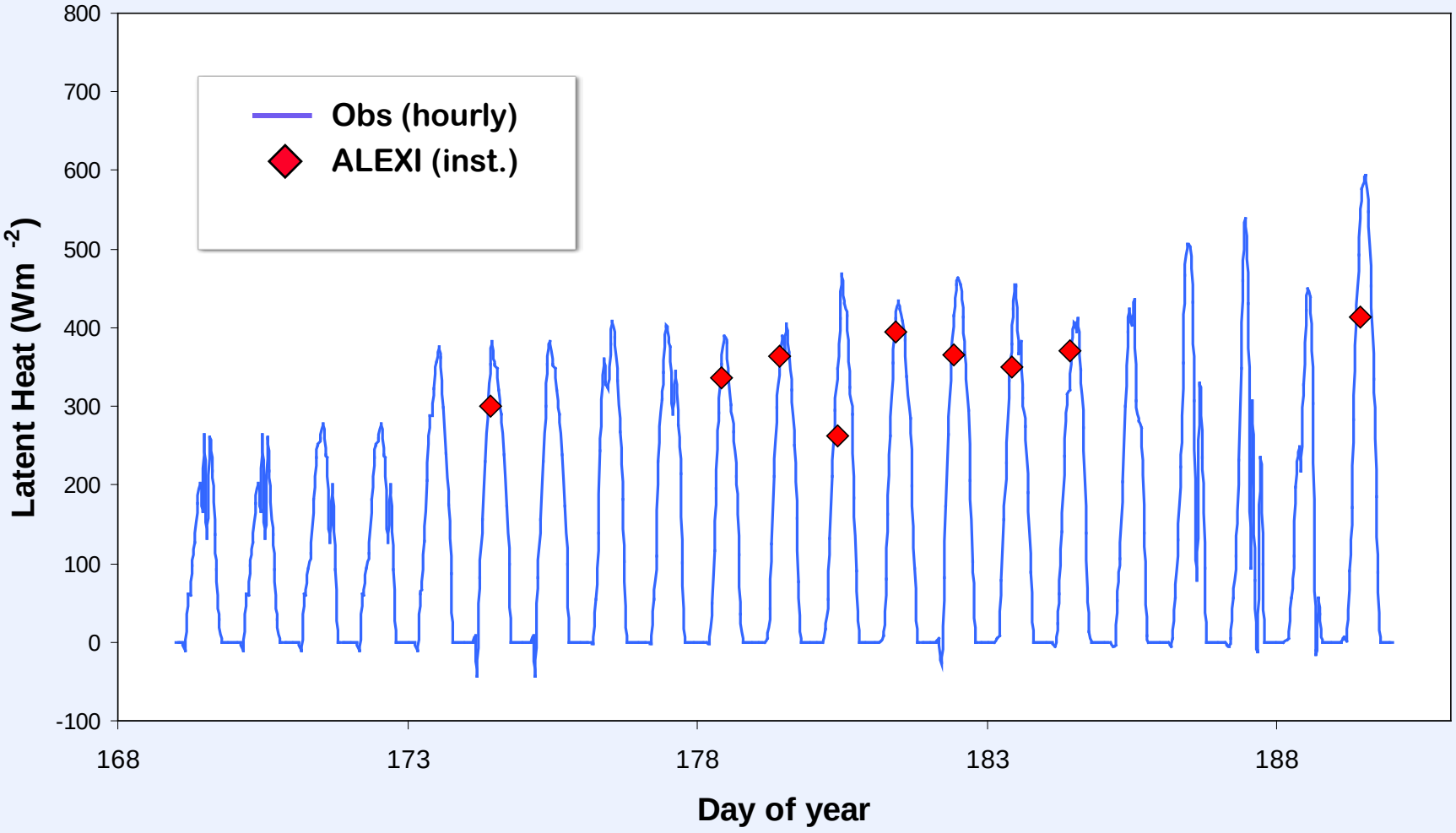


$$EF_A = \frac{\lambda E_A}{RN_A - G_A} \Rightarrow \lambda E(t_i) = EF_A * [\underbrace{RN(t_i) - G(t_i)}_{\textit{from GOES}}]$$

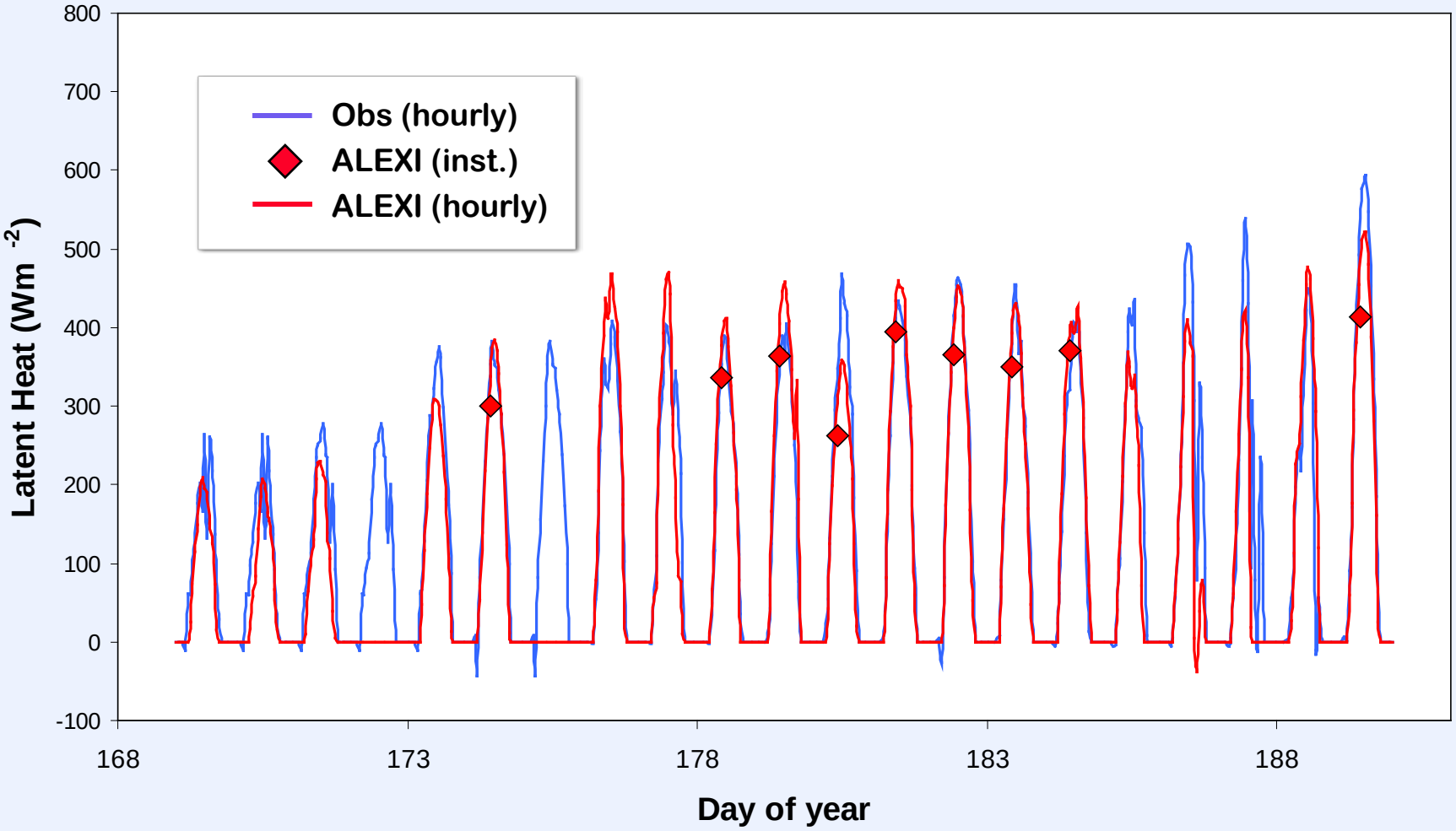
Gap-filling algorithm



Gap-filling algorithm



Gap-filling algorithm

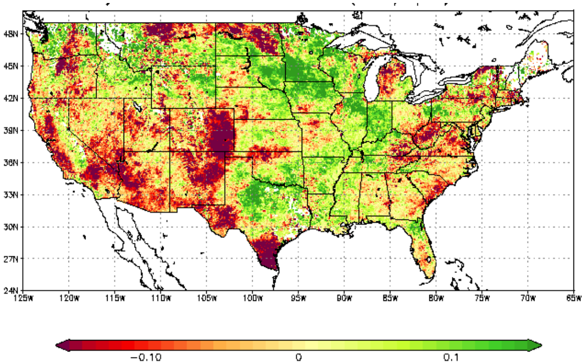


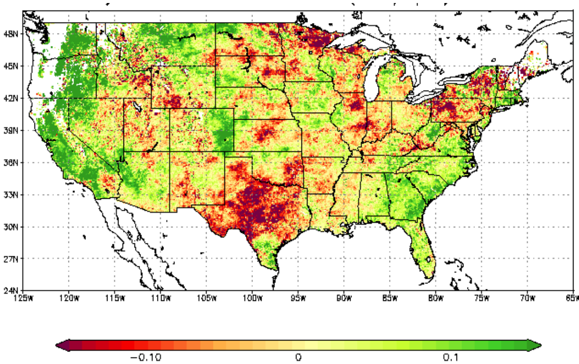

REGIONAL VALIDATION
... stress detection

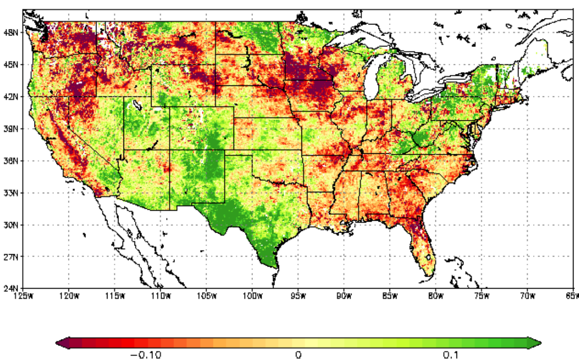
APRIL

“Climatological” deviation in f_{PET}

28-day ALEXI composite

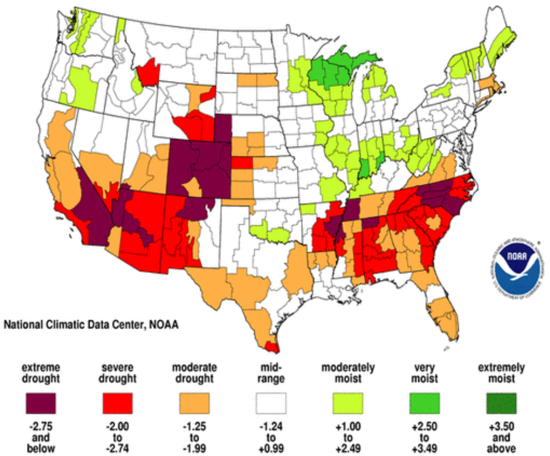


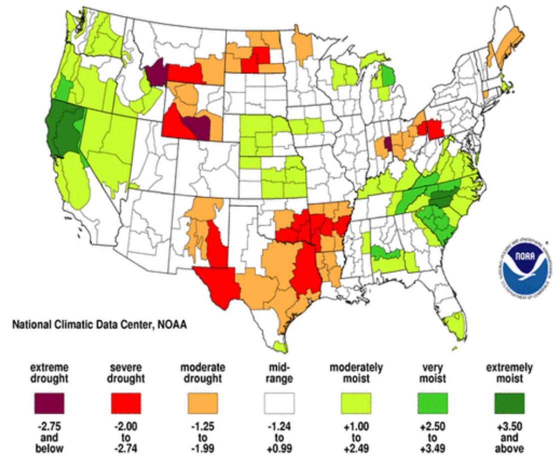


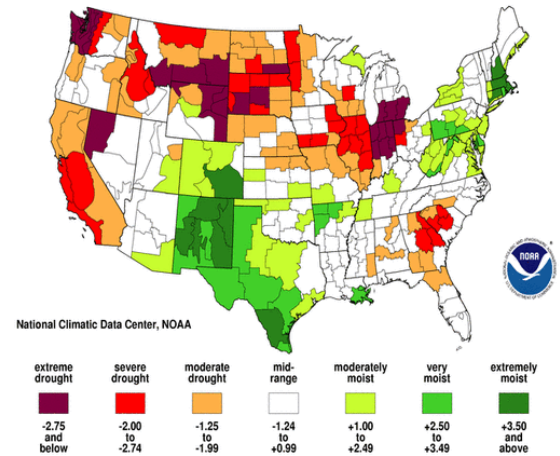


Drought **Moist**

Palmer Drought Index

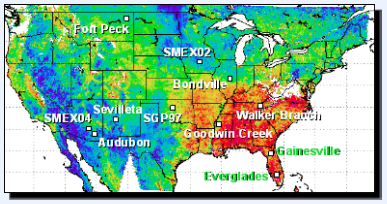






2002 2003 2004

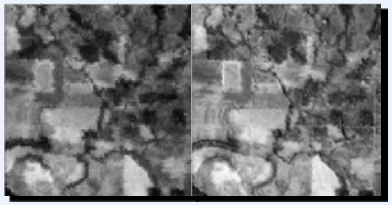
Project Objectives



Validation

Target multiple biomes and climates

Ameriflux and EOS validation sites



Algorithm Enhancement

Improve spatial and temporal coverage

Thermal sharpening and daily extrapolation

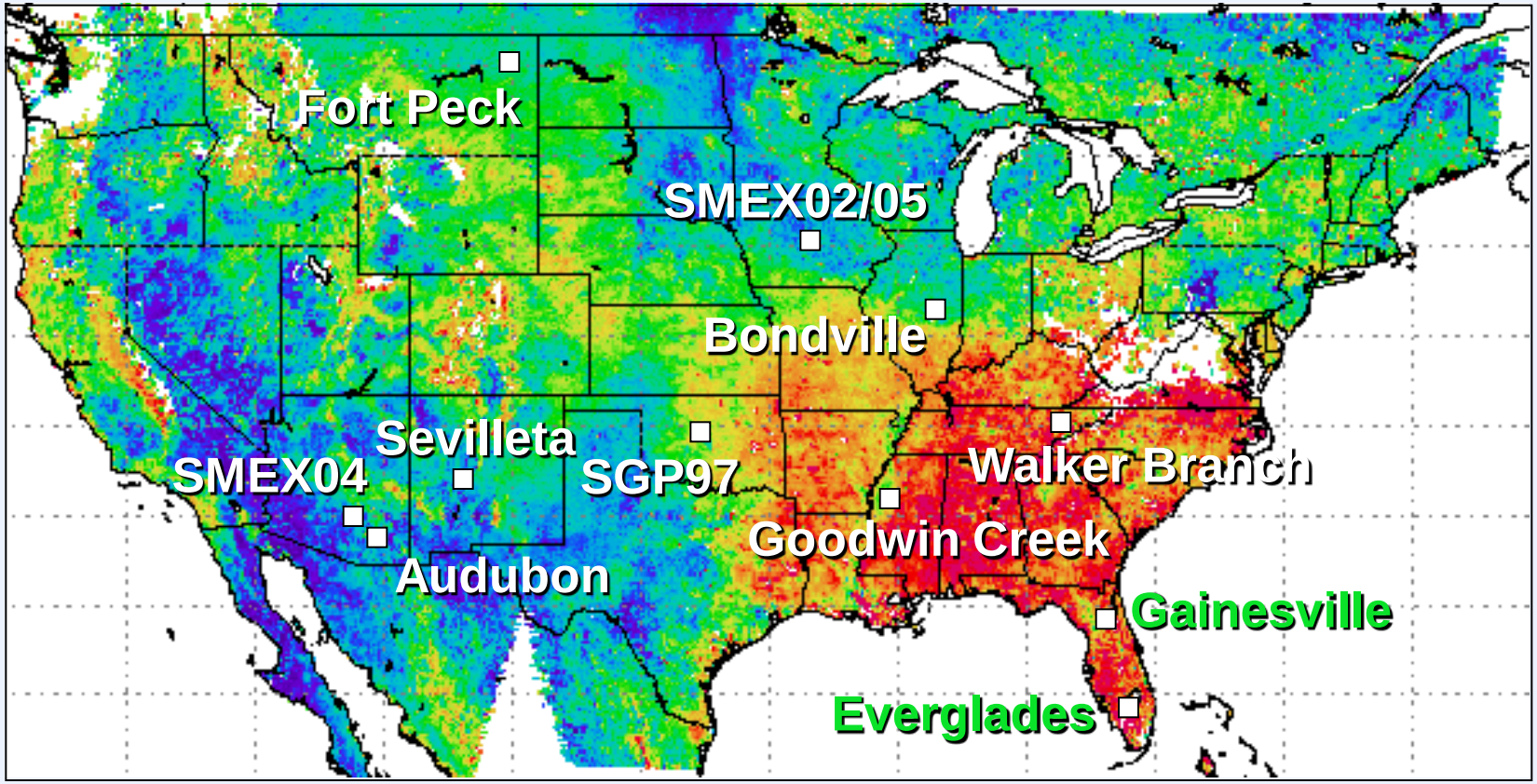
Case Study Application

Identify stress detection capabilities

Florida Everglades

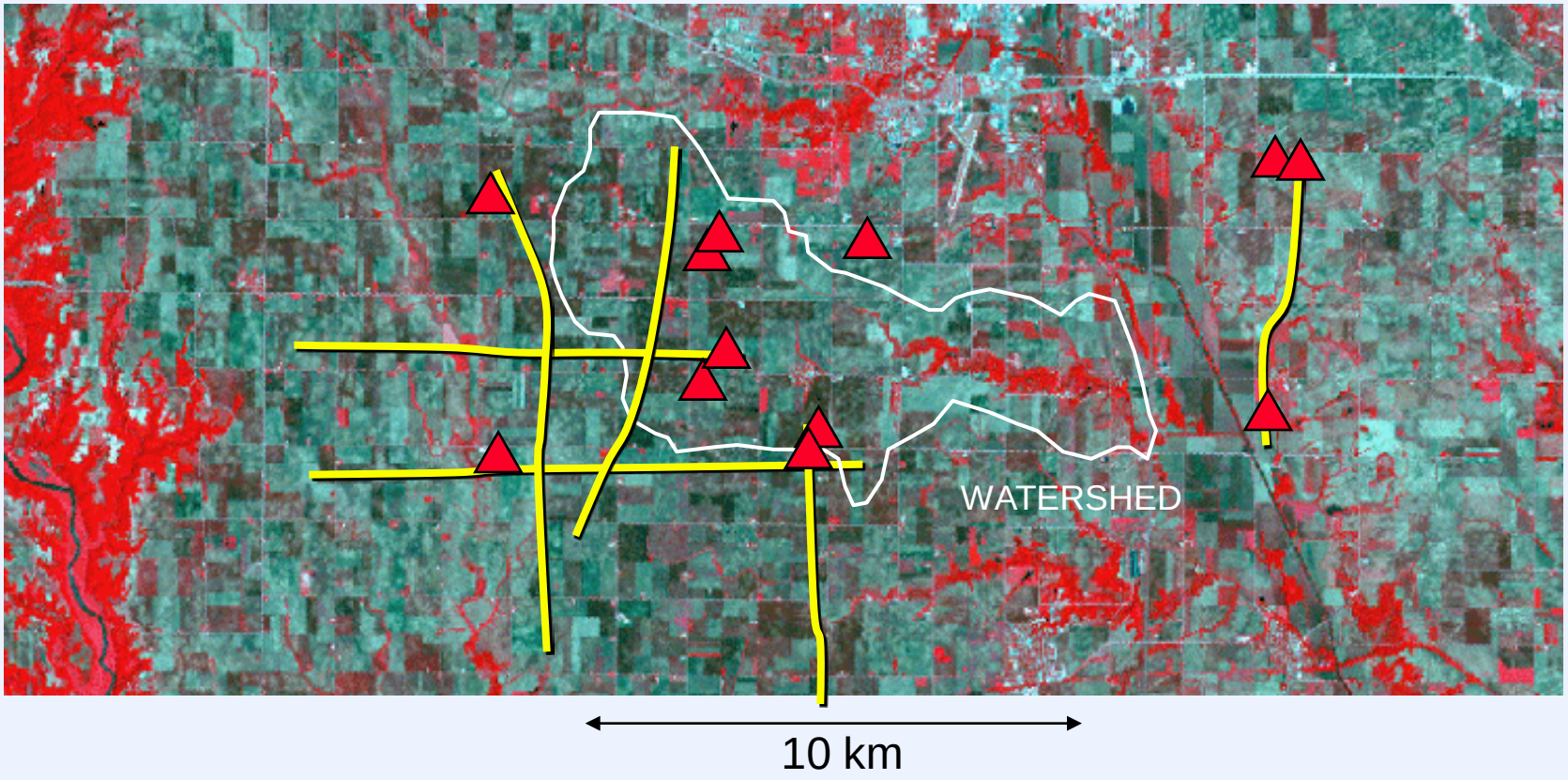
ALEXI validation sites

ALEXI LATENT HEAT FLUX – June 2003

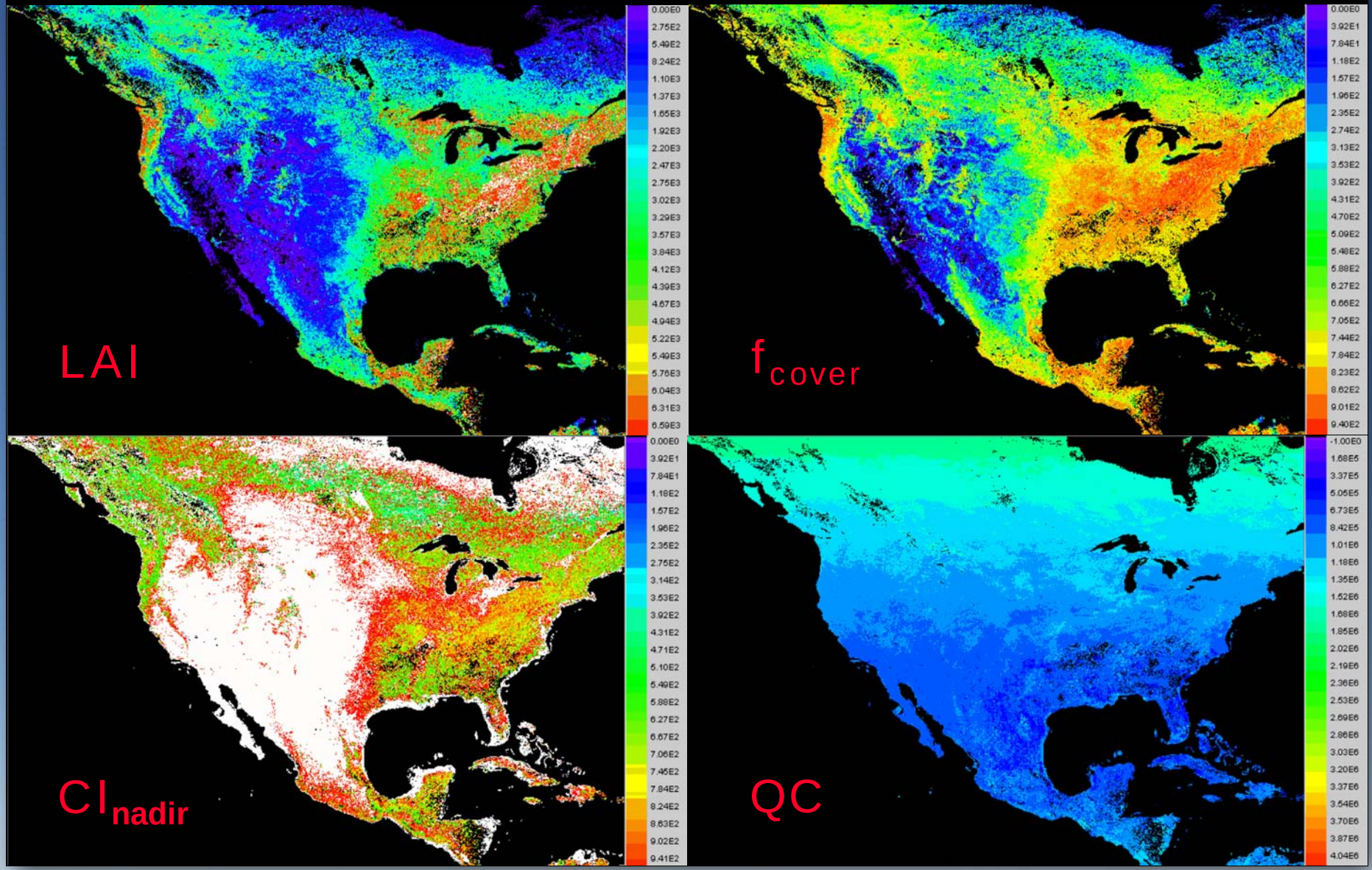


SMEX02 flux measurements

SOIL MOISTURE EXPERIMENT 2002 (SMEX02) – WALNUT CREEK WATERSHED, IA

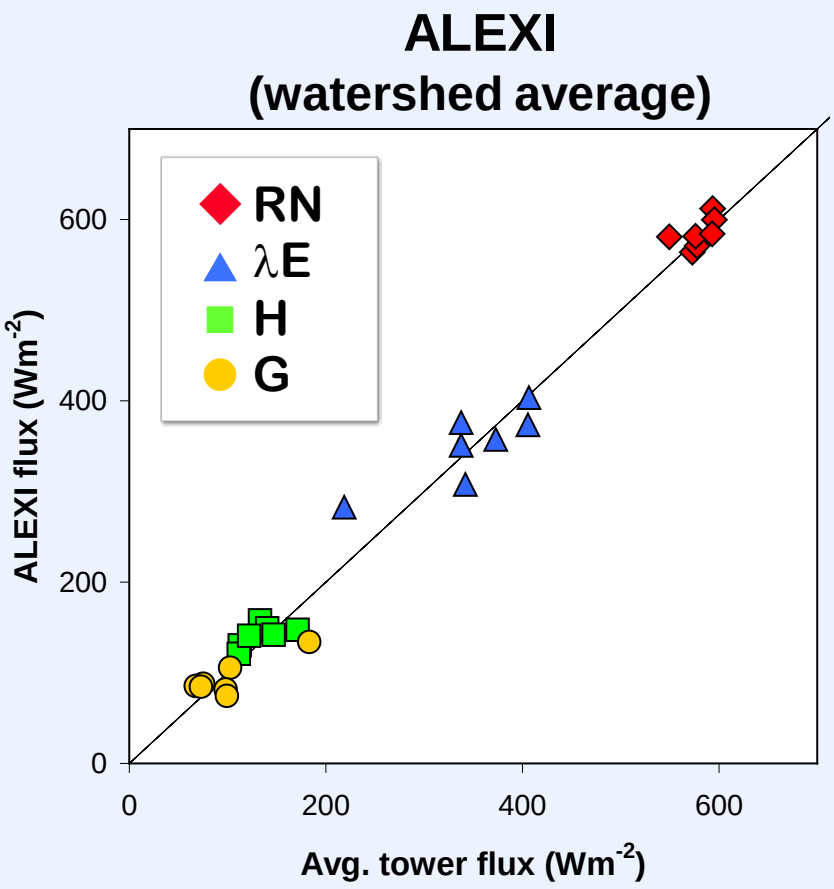


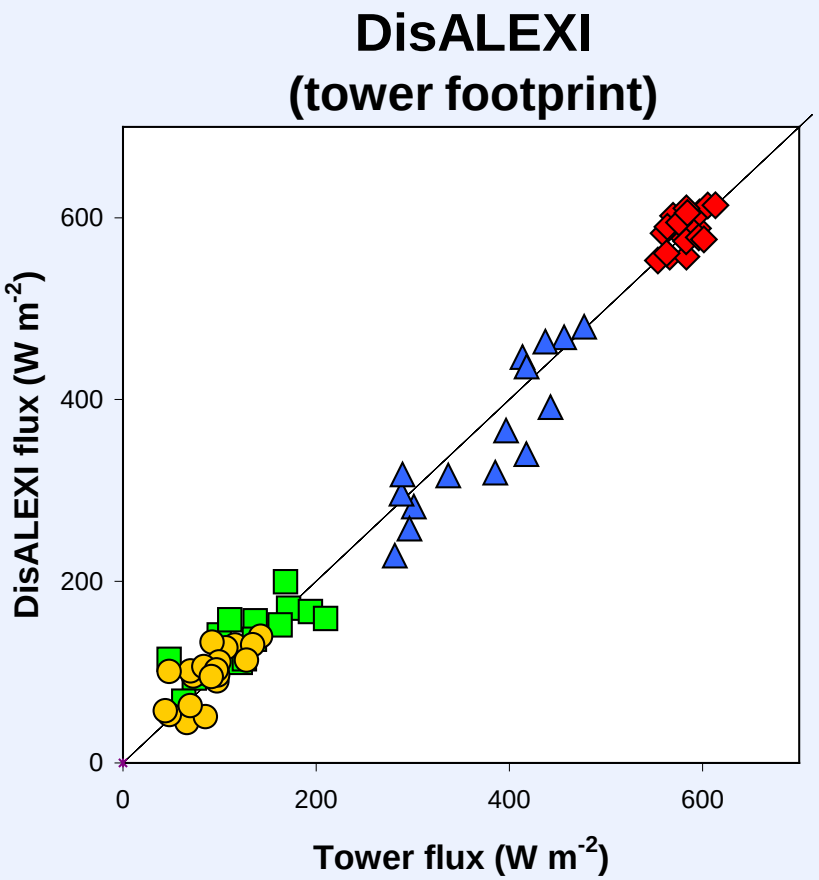
MODIS-based vegetation clumping index June 2004



Courtesy of J.-L. Roujean

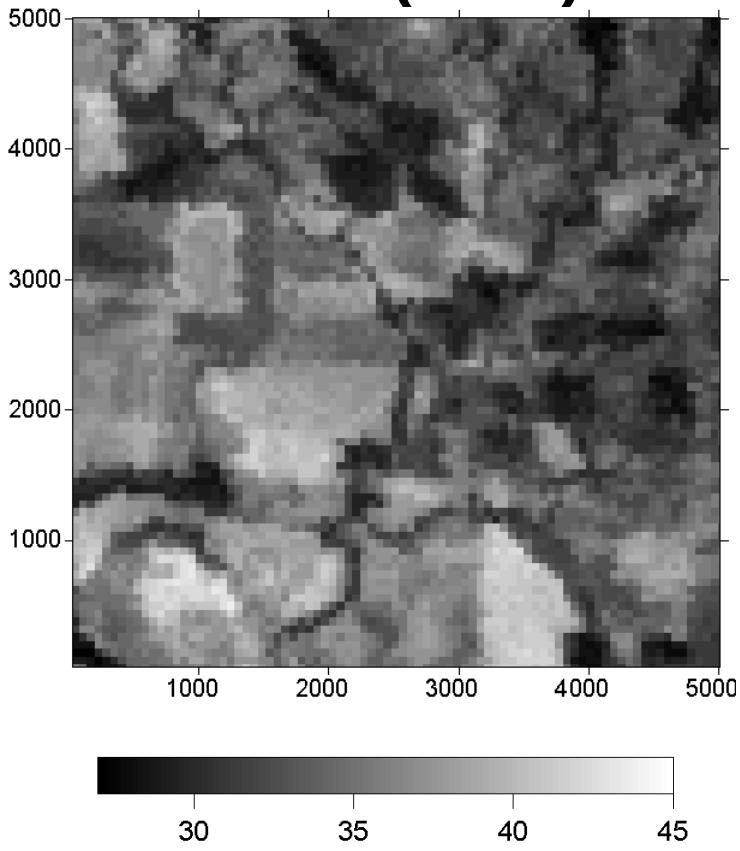
(Dis)ALEXI vs. tower fluxes

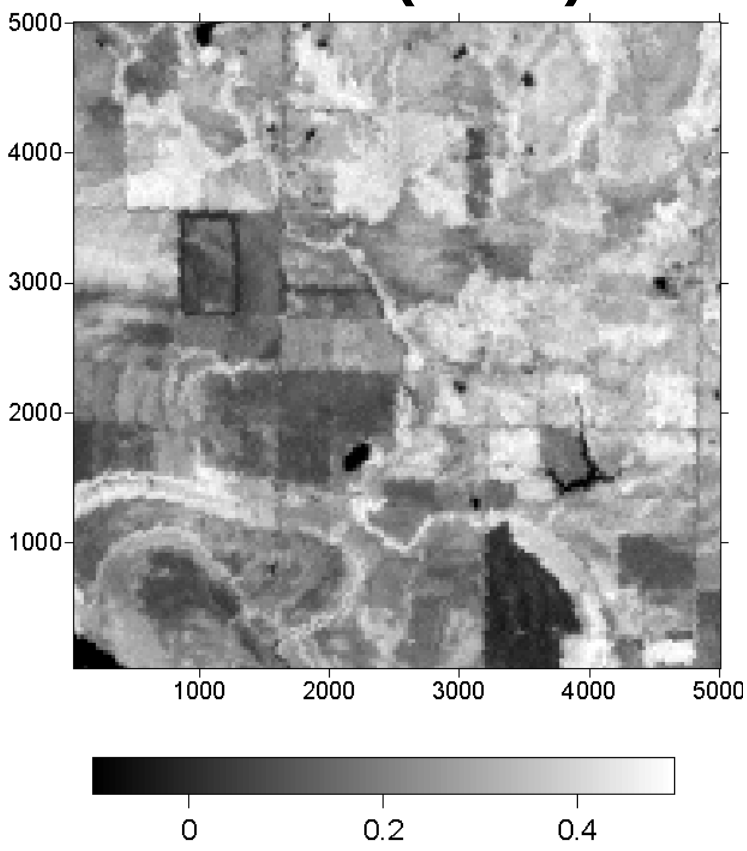




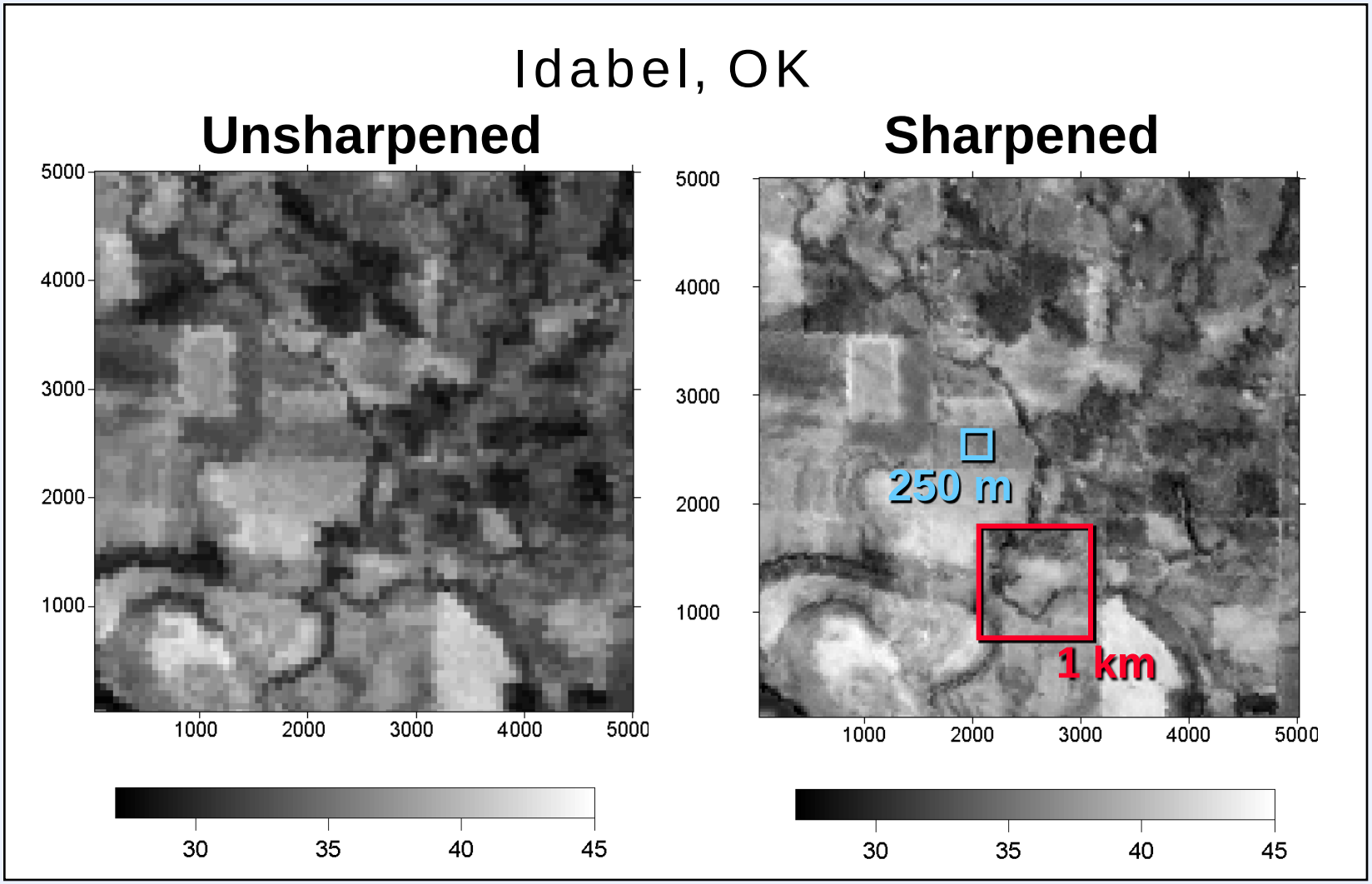
Landsat-7 thermal/shortwave imagery

Idabel, OK



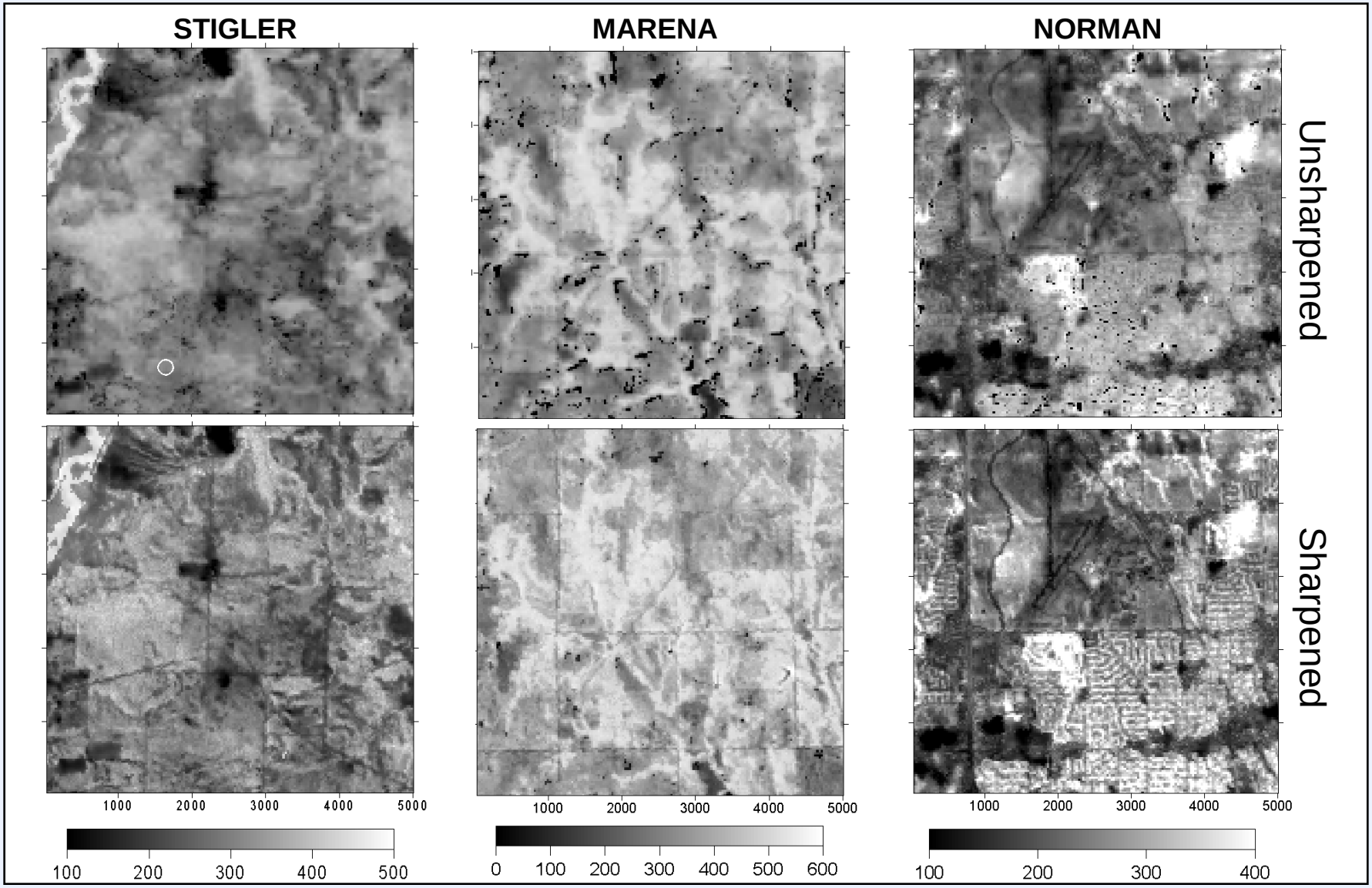


Thermal sharpening

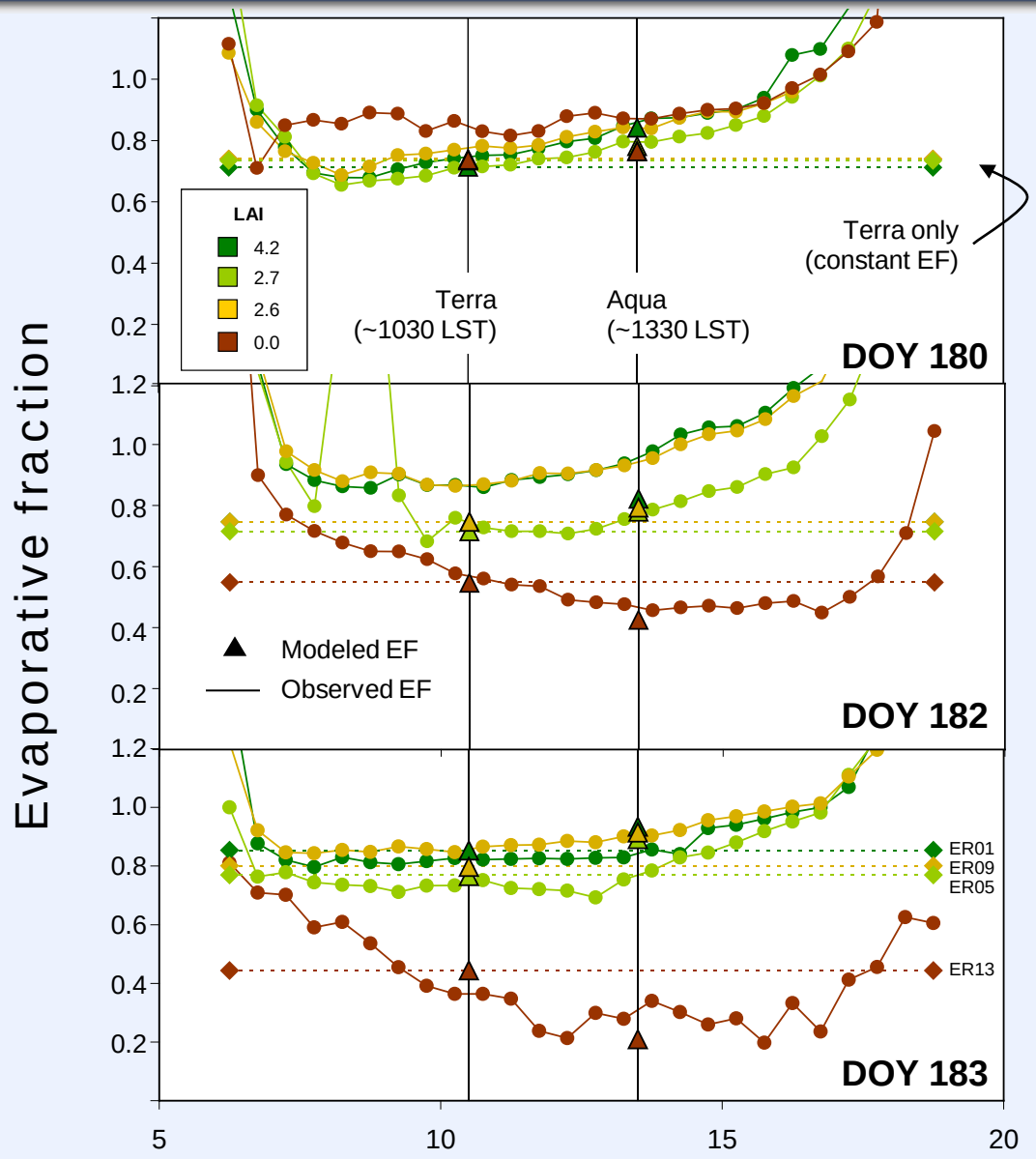


*Kustas et al. 2003, RSE, **85**, 429-440*

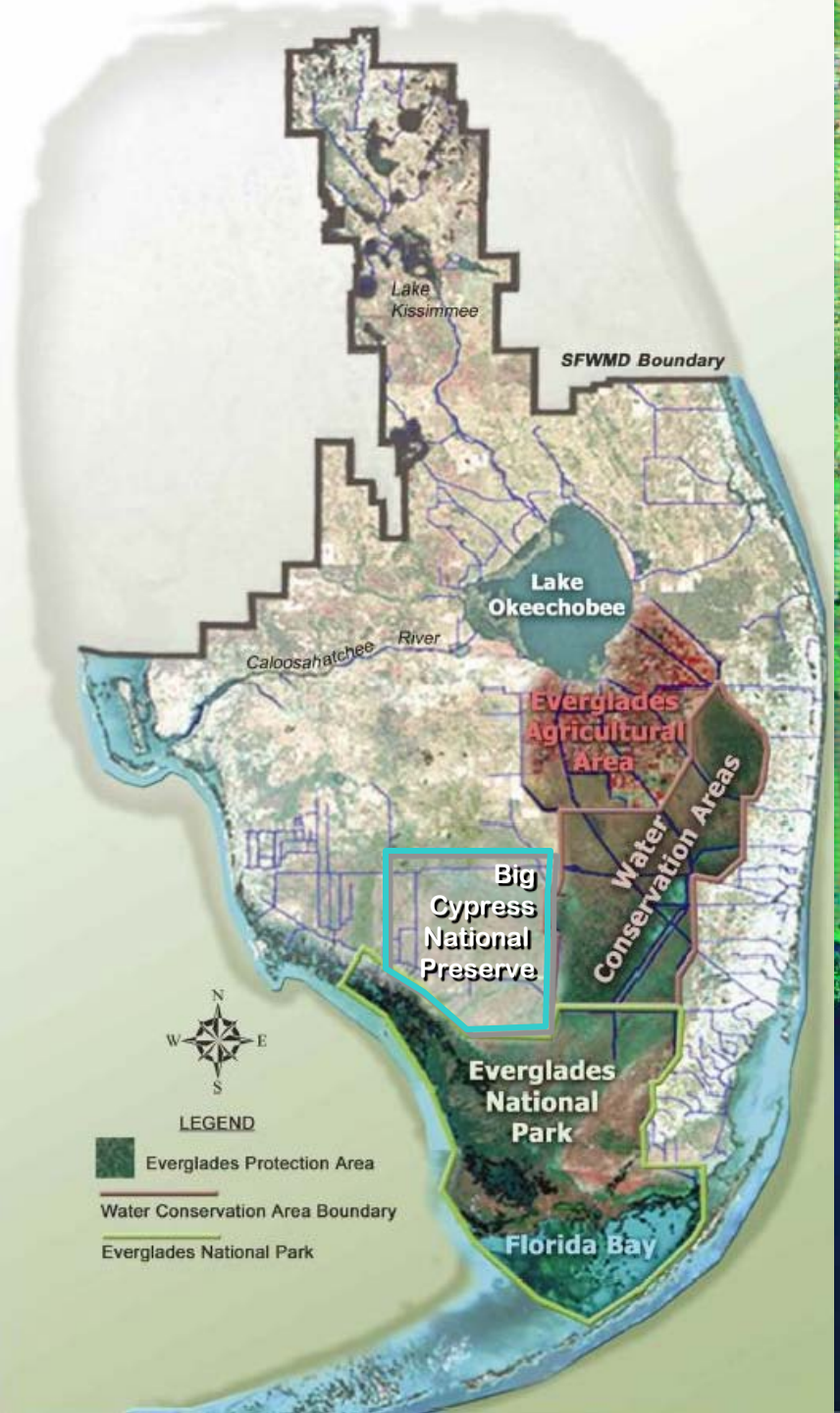
Latent heat with thermal sharpening

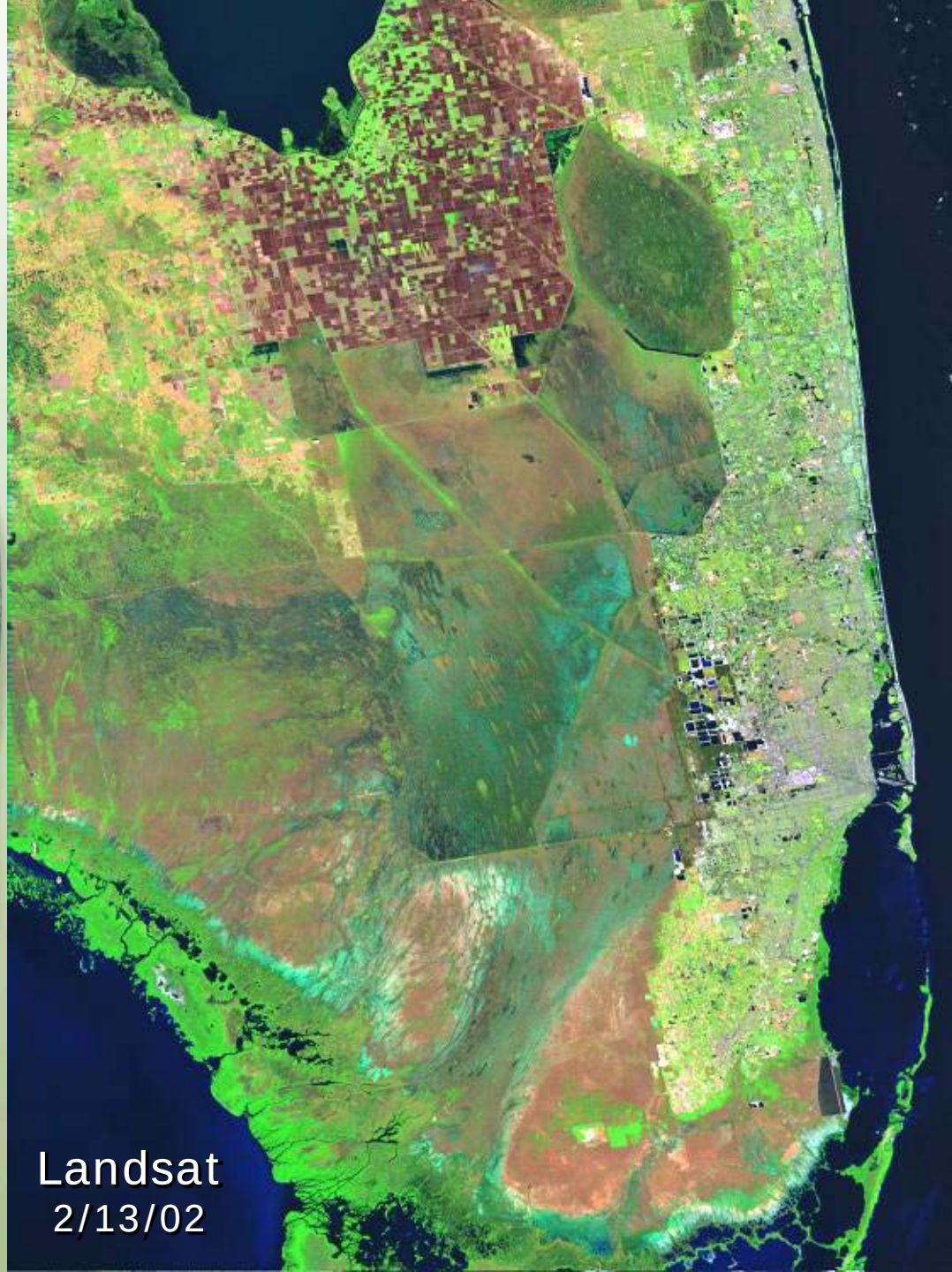


Daily extrapolation



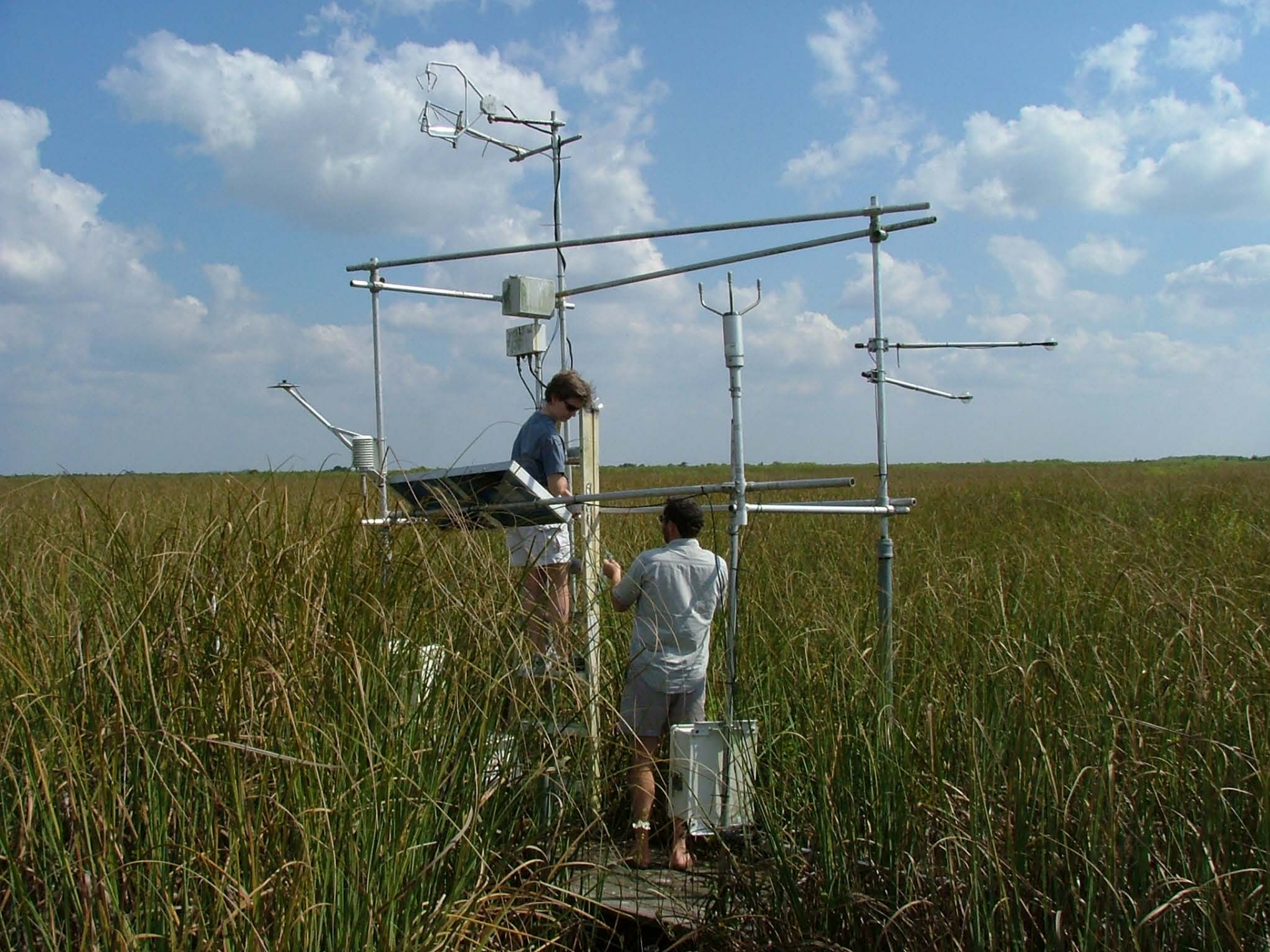
$$EF = \frac{\lambda E}{RN\text{-}G}$$

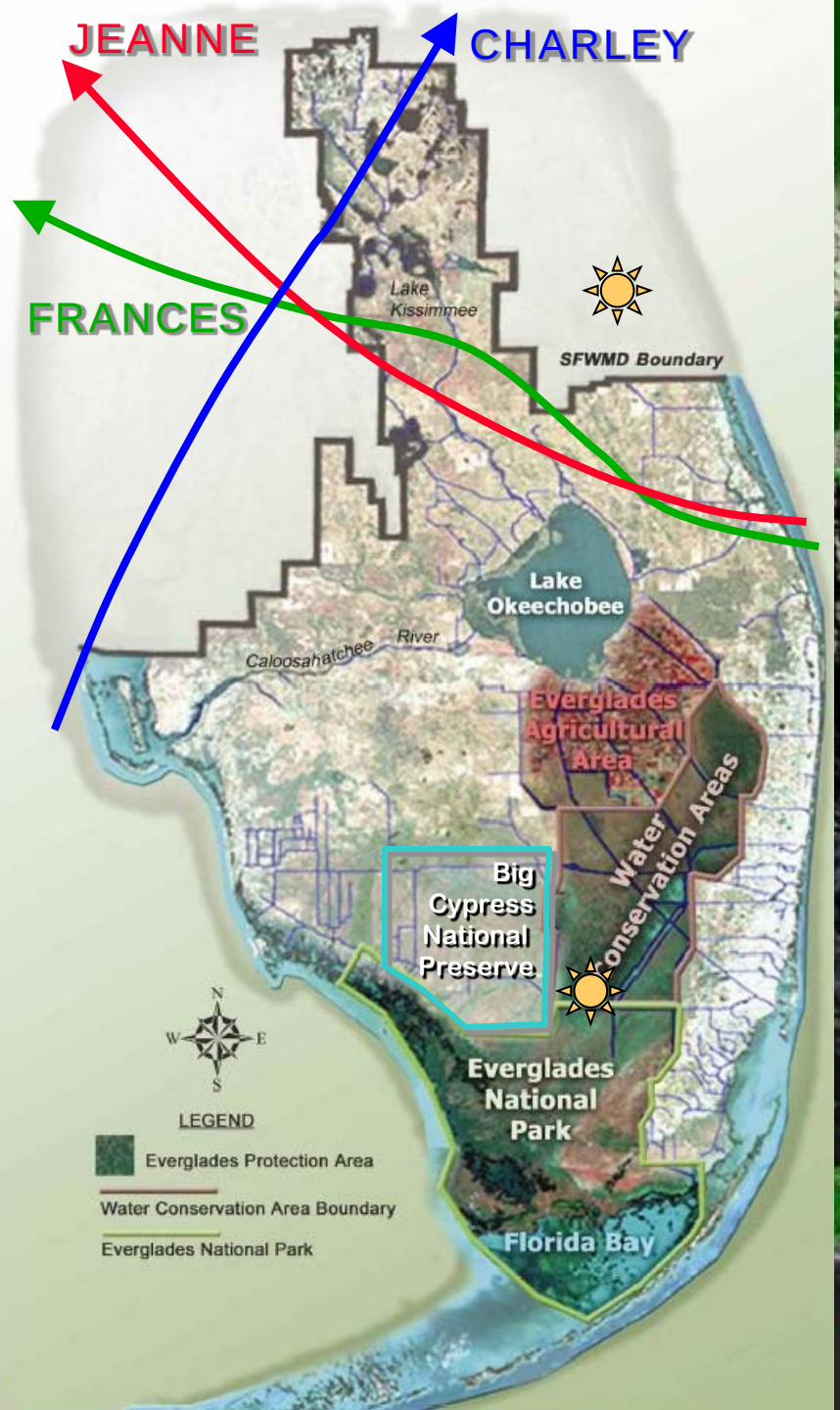

Lake Kissimmee
SFWMD Boundary
Lake Okeechobee
Caloosahatchee River
Everglades Agricultural Area
Water Conservation Areas
Big Cypress National Preserve
Everglades National Park
Florida Bay
N
W
E
S
LEGEND
Everglades Protection Area
Water Conservation Area Boundary
Everglades National Park

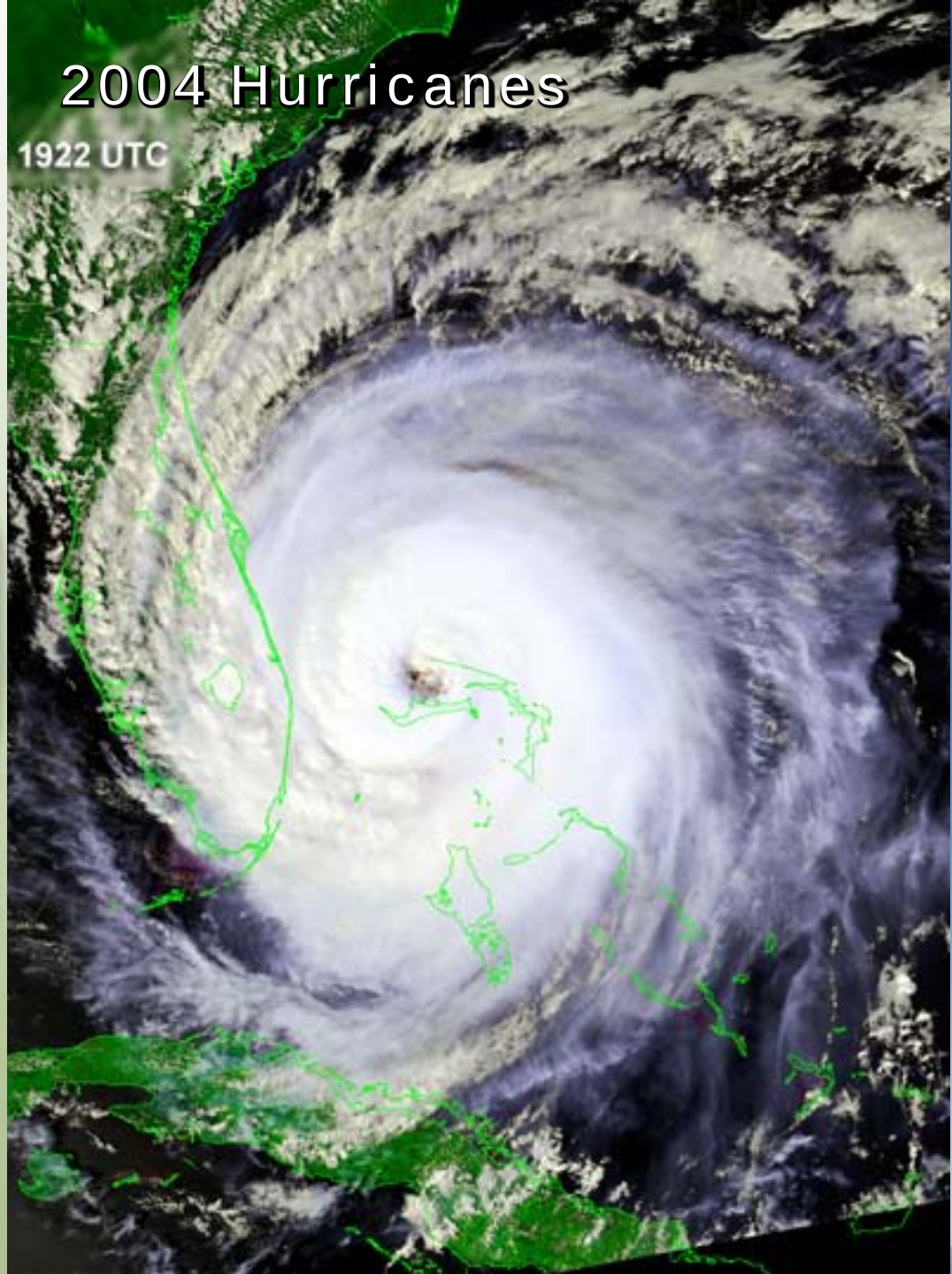

Landsat
2/13/02

Blue Cypress Lake
USGS flux site

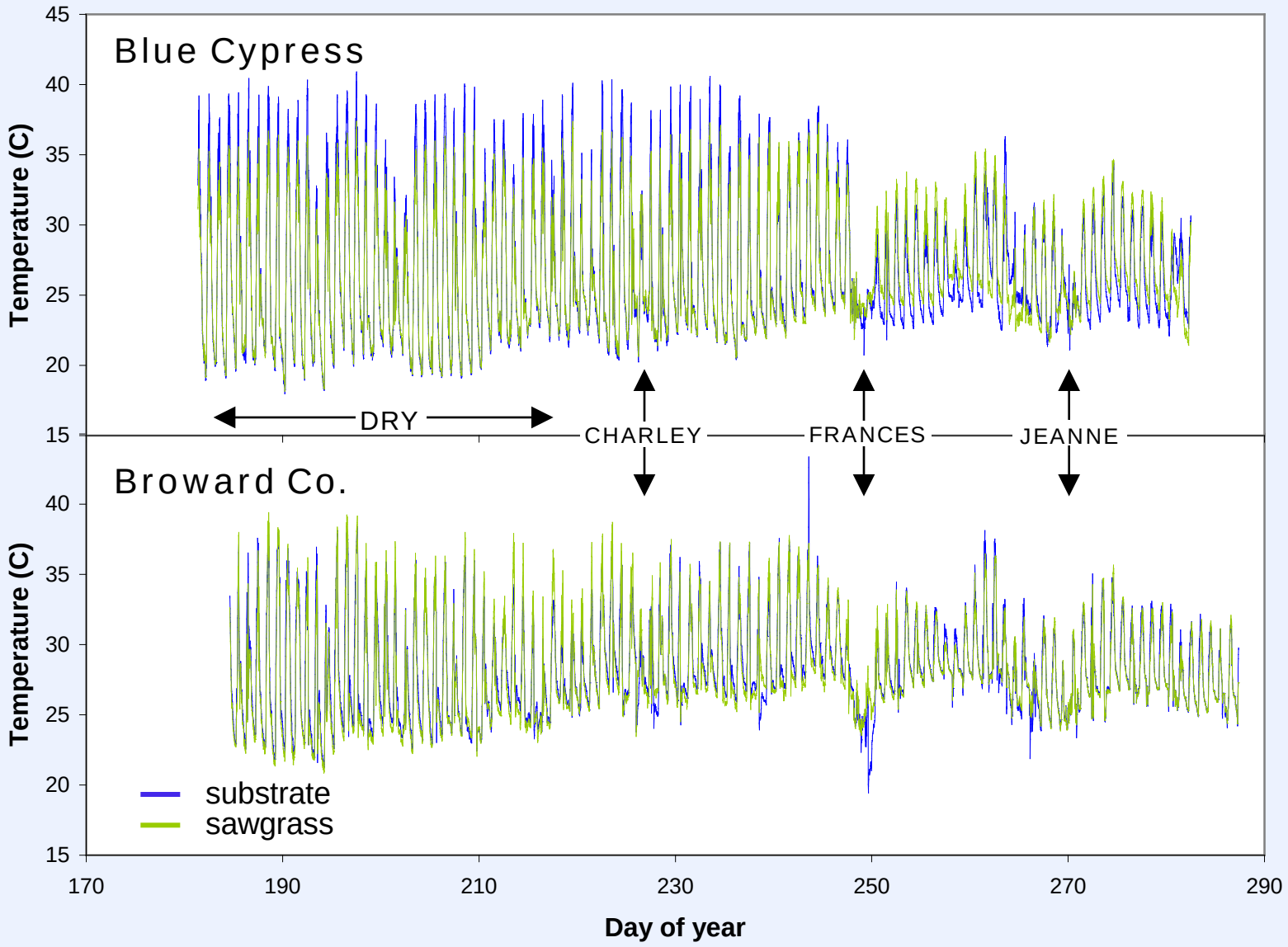
Broward County USGS flux site




JEANNE
CHARLEY
FRANCES
Lake Kissimmee
SFWMD Boundary
Lake Okeechobee
Caloosahatchee River
Everglades Agricultural Area
Water Conservation Areas
Big Cypress National Preserve
Everglades National Park
Florida Bay
N
W
E
S
LEGEND
Everglades Protection Area
Water Conservation Area Boundary
Everglades National Park


2004 Hurricanes
1922 UTC

IRT data at USGS stations

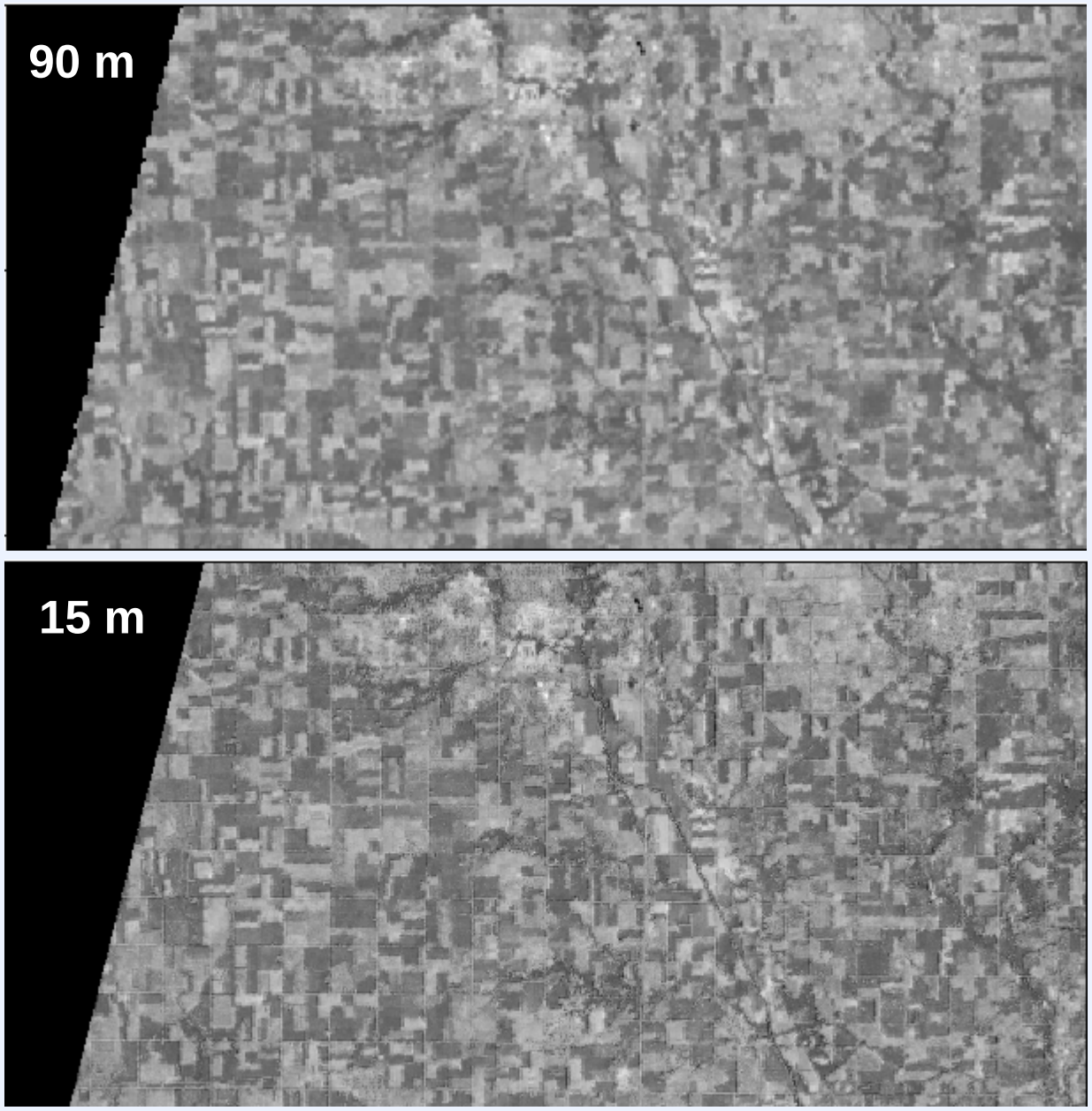


High-resolution thermal is a valuable asset …

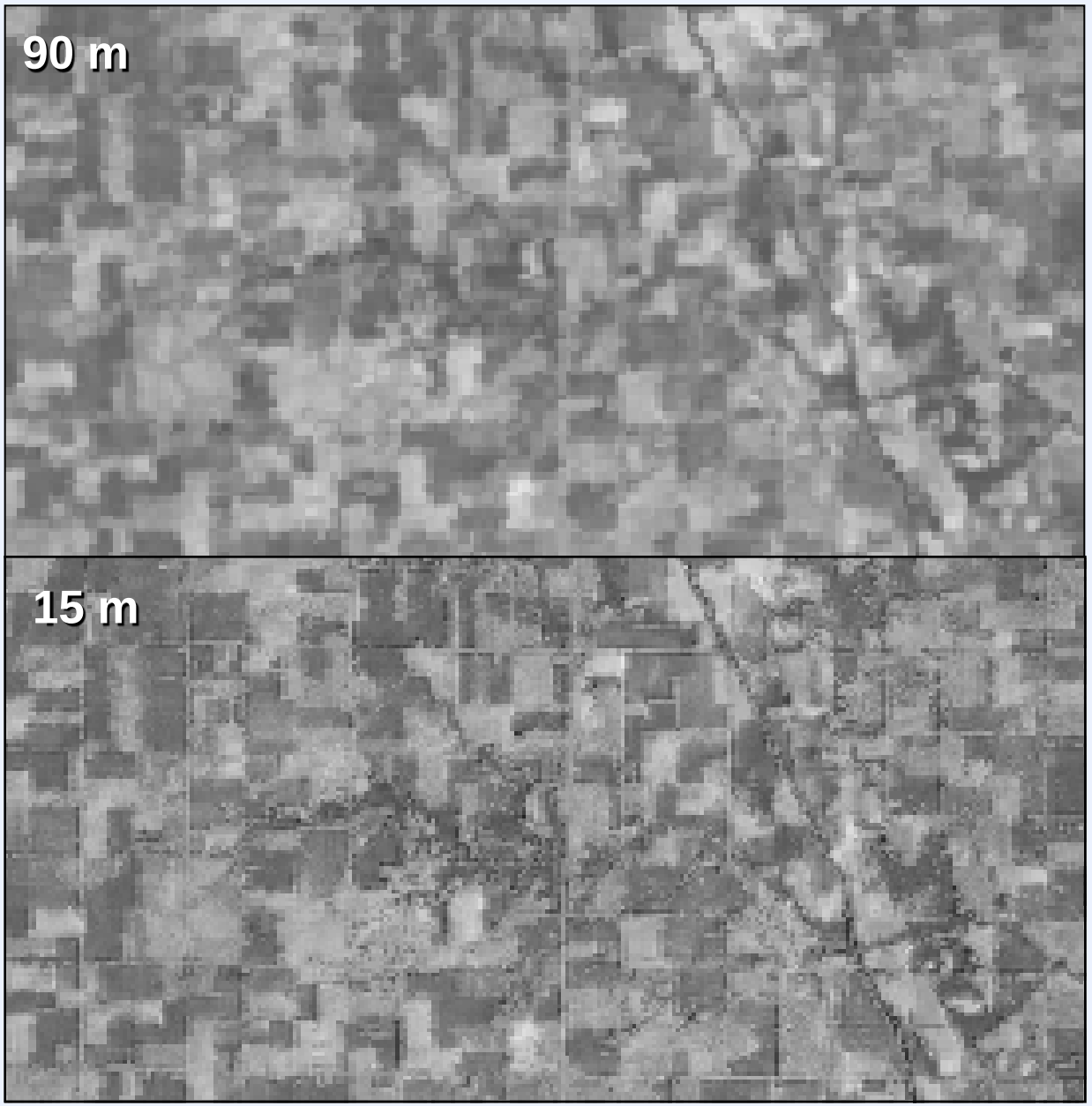
www.soils.wisc.edu/alexi

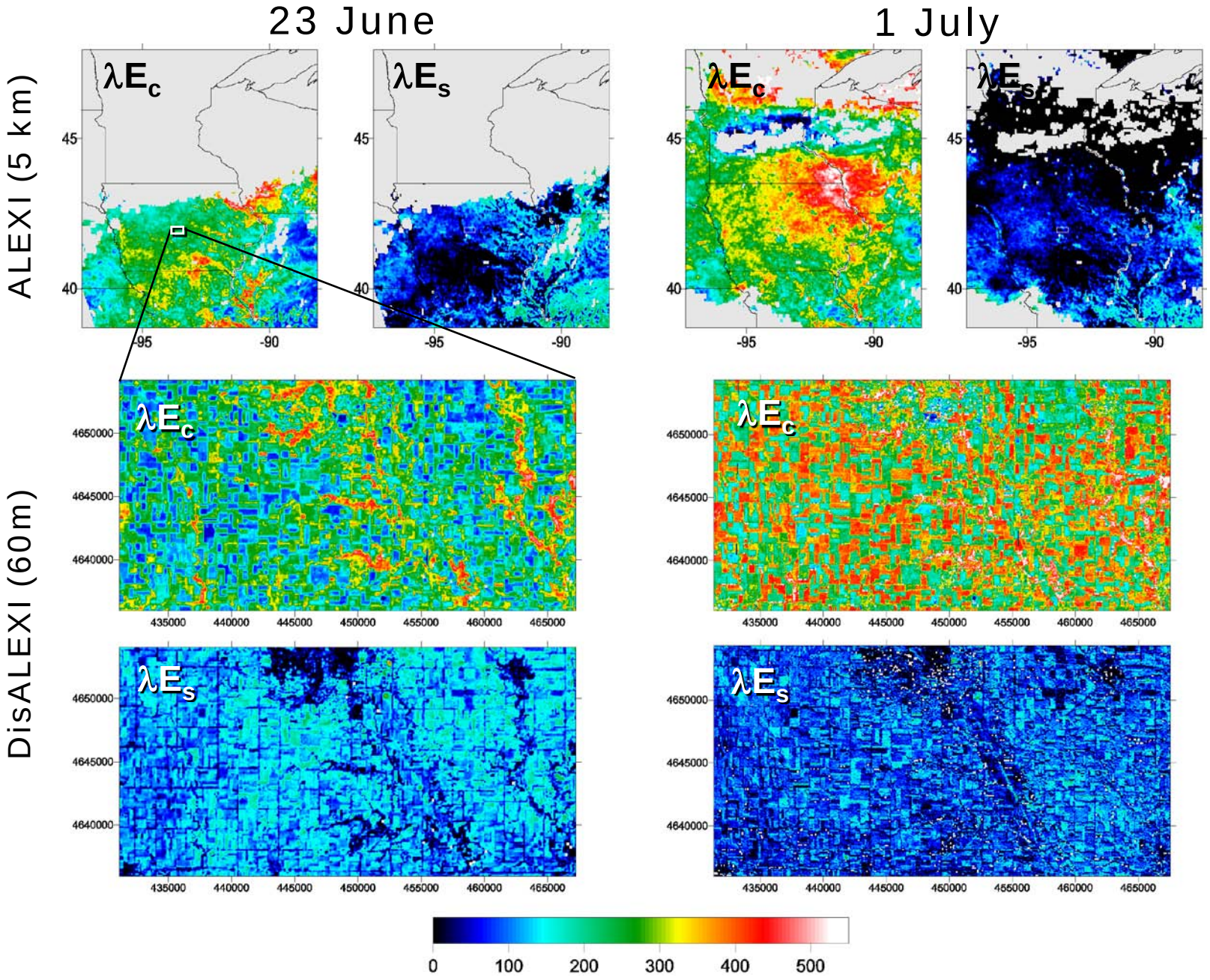
mcanders@wisc.edu

Sharpened ASTER thermal imagery



Sharpened ASTER thermal imagery




23 June
1 July
ALEXI (5 km)
DisALEXI (60m)
λE_c
λE_s
45
40
-95
-90
4650000
4645000
4640000
435000
440000
445000
450000
455000
460000
465000
0
100
200
300
400
500