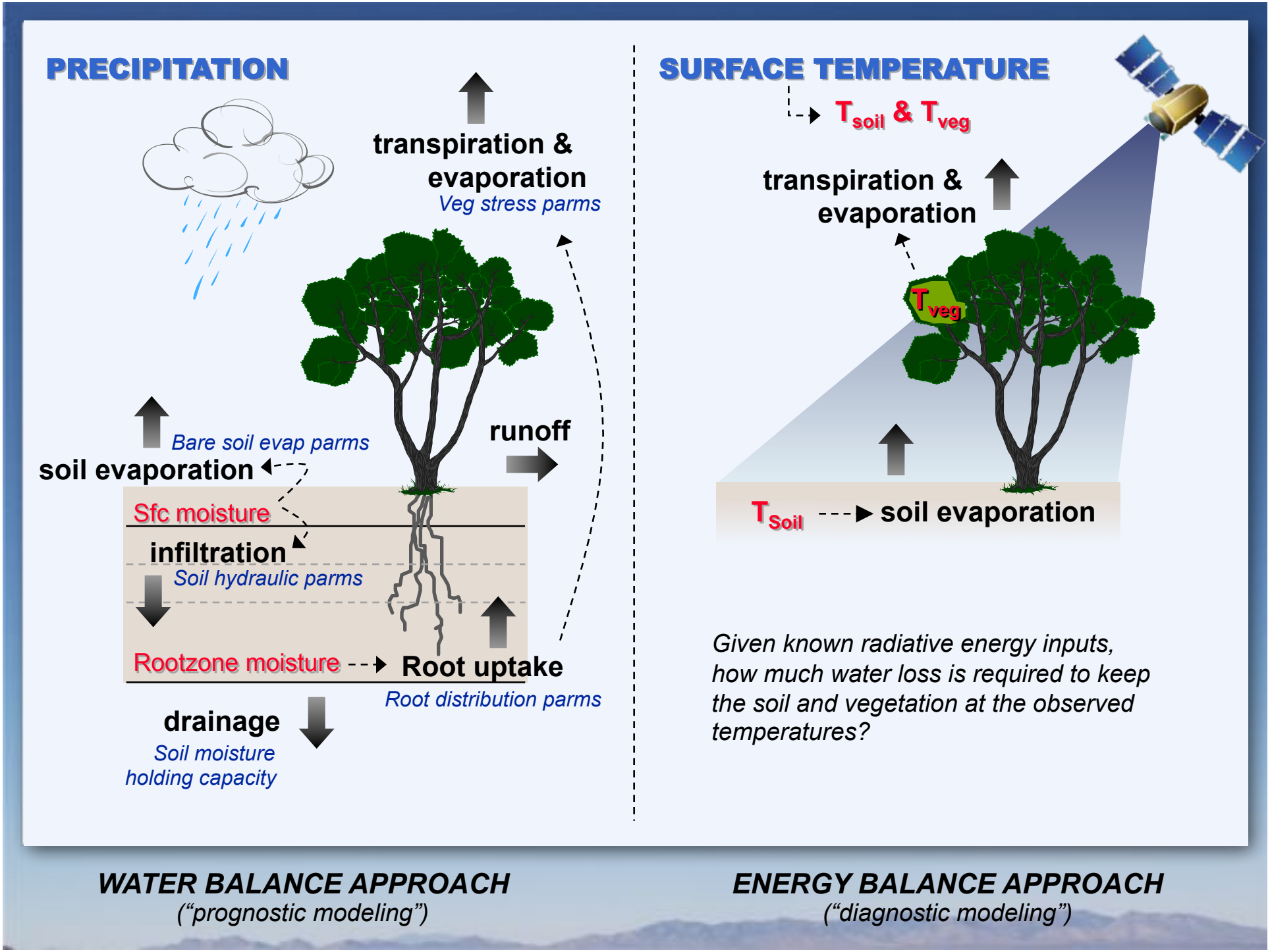
A GOES-based Drought Product using Thermal Remote Sensing of Evapotranspiration

M.C. Anderson, W.P. Kustas
USDA-ARS, Hydrology and Remote Sensing Laboratory

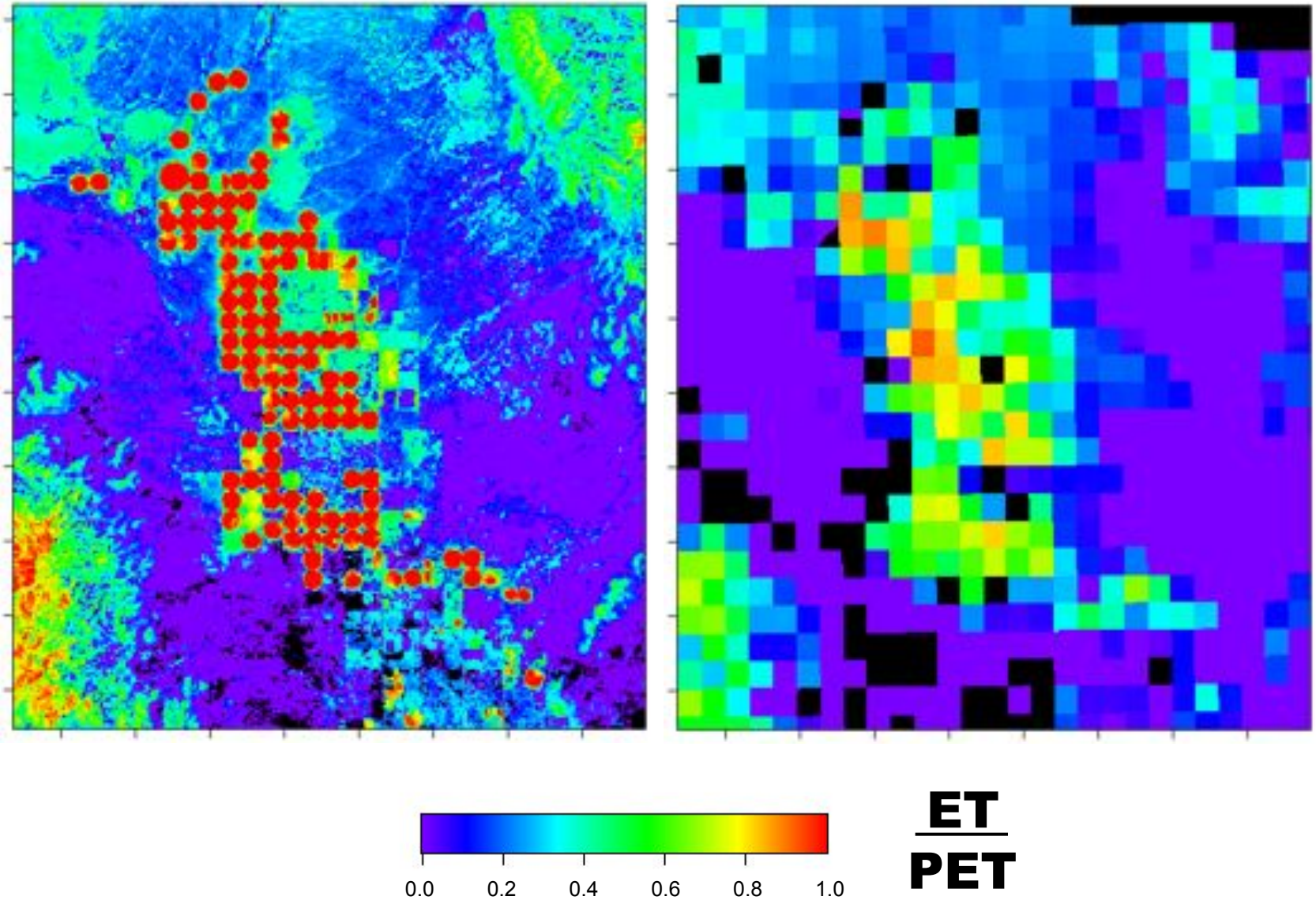
C. Hain, X. Zhan
NOAA - NESDIS


PRECIPITATION
transpiration &
evaporation
Veg stress parms
runoff
Bare soil evap parms
soil evaporation
Sfc moisture
infiltration
Soil hydraulic parms
Rootzone moisture
Root uptake
Root distribution parms
drainage
Soil moisture
holding capacity
SURFACE TEMPERATURE
T_{soil} & T_{veg}
transpiration &
evaporation
T_{veg}
T_{Soil}
soil evaporation
Given known radiative energy inputs, how much water loss is required to keep the soil and vegetation at the observed temperatures?
WATER BALANCE APPROACH
("prognostic modeling")
ENERGY BALANCE APPROACH
("diagnostic modeling")

Sensitivity to irrigation

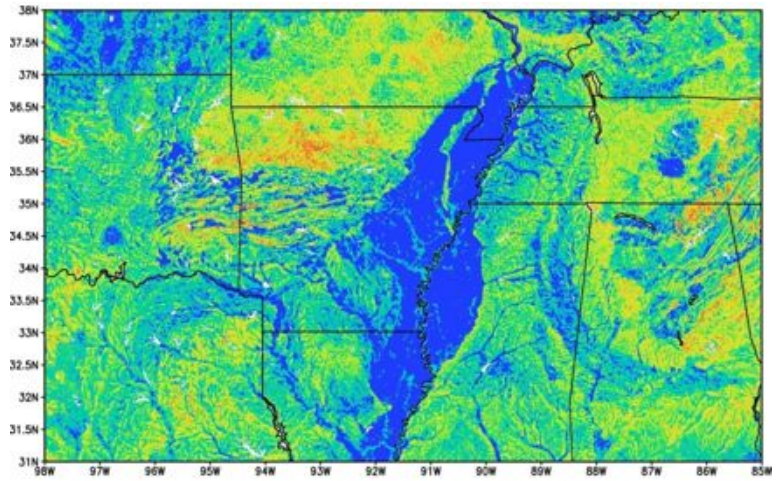
Landsat 7 – 60m

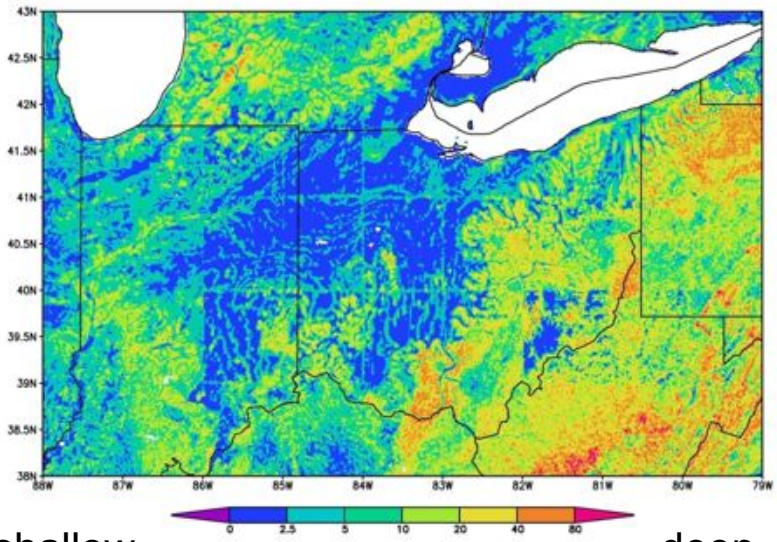
MODIS – 1km



Sensitivity to shallow water tables

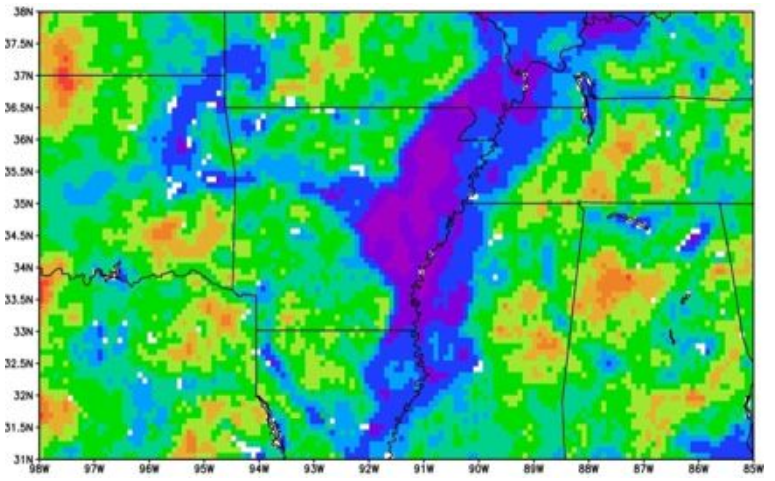
Simulated climatological water table*

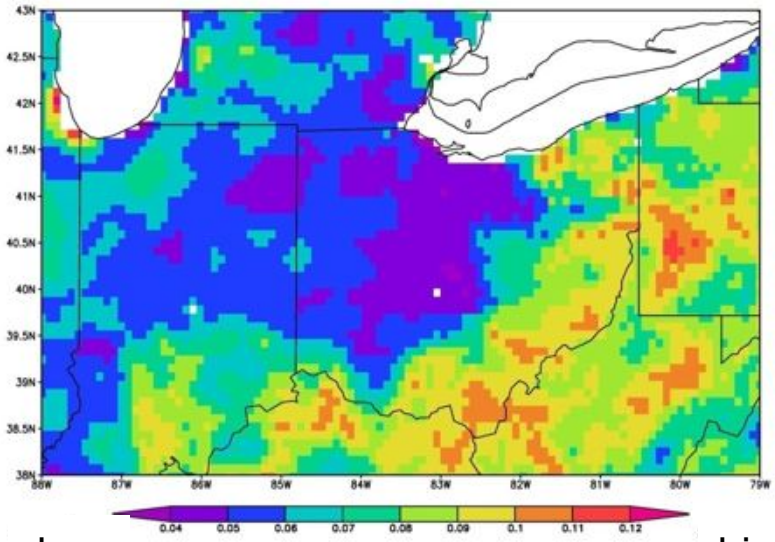




shallow deep

Temporal variability in ET/PET



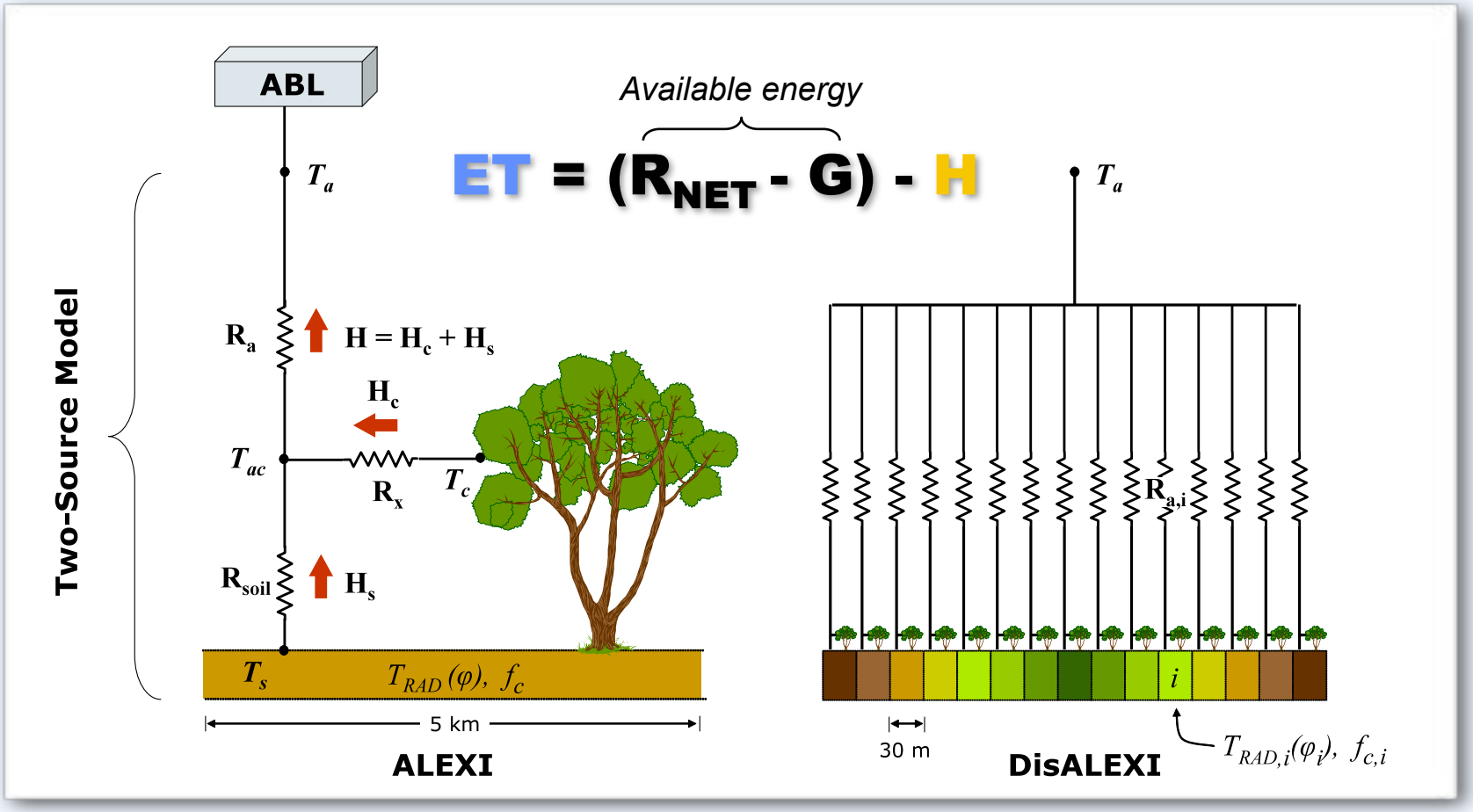


low high

* Miquez-Macho et al, BAMS, 90, 663-672

APPLICATIONS
... evapotranspiration
ALEXI – Atmosphere-Land Exchange Inverse Model
(Anderson et al, JGR, 2007)

Atmosphere-Land Exchange Inverse (ALEXI)



Regional scale

Surface temp: ΔT_{RAD} - GOES

Air temp: T_a - ABL model

Landscape scale

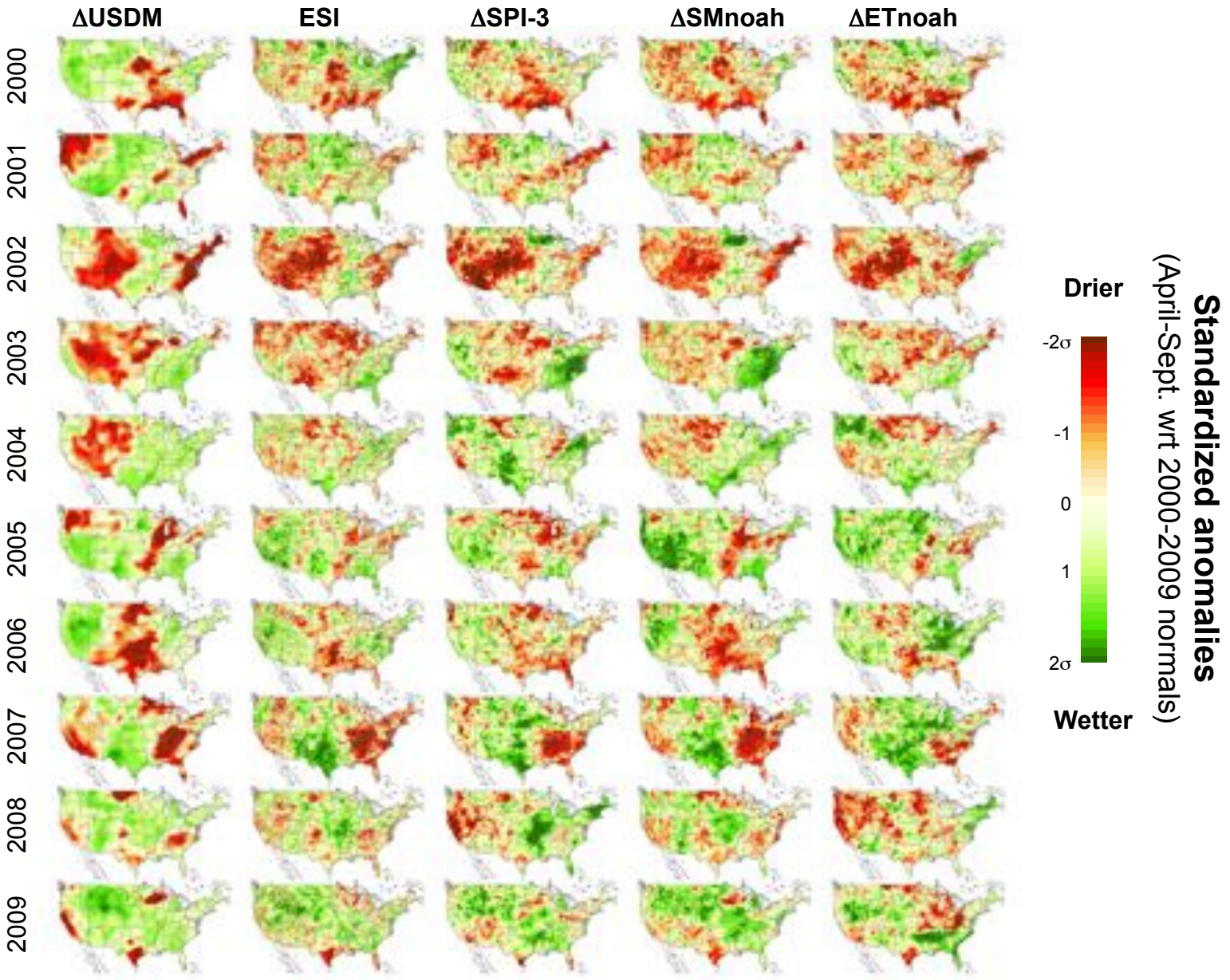
T_{RAD} - TM, MODIS, HyspIRI

T_a - ALEXI

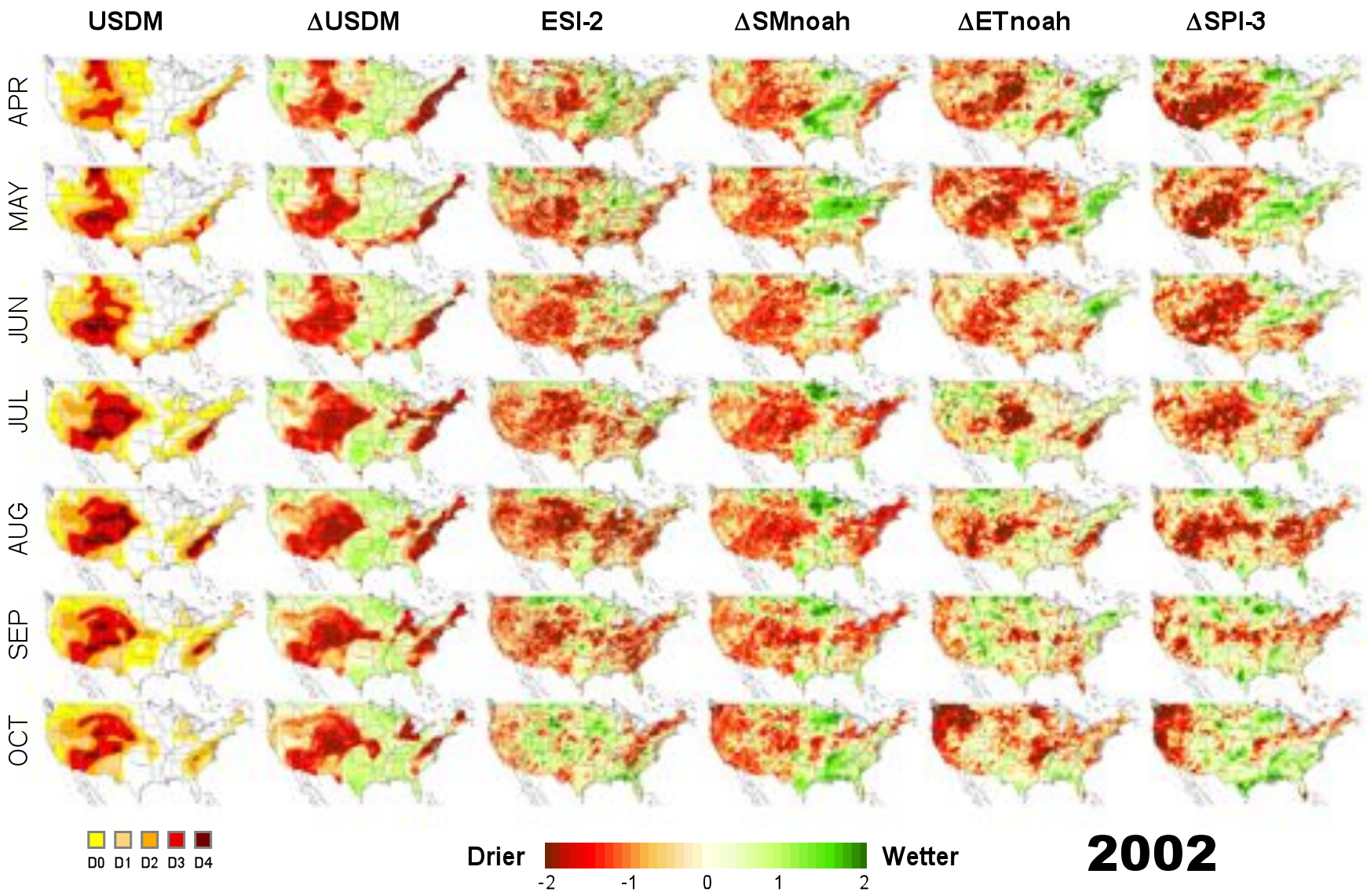
SURFACE TEMPERATURE
EVAPOTRANSPIRATION
ALEXI
(ISCCP)
Global
(25km)
ALEXI
(GOES Sounder)
Continental
(10km)
ALEXI
(GOES Imager)
Regional
(5km)
DisALEXI
(MODIS)
Basin
(1km)
DisALEXI
(Landsat)
Watershed
(60m)
DisALEXI
(aircraft)
Field scale
(30m)
corn
soy
Temperature (C)
40
35
30
Latent Heat (Wm-2)
500
400
300
200
100
1 July 2002 – 10:30AM LST

APPLICATIONS
... monitoring drought
Anomalies in AET/PET
Evaporative Stress Index

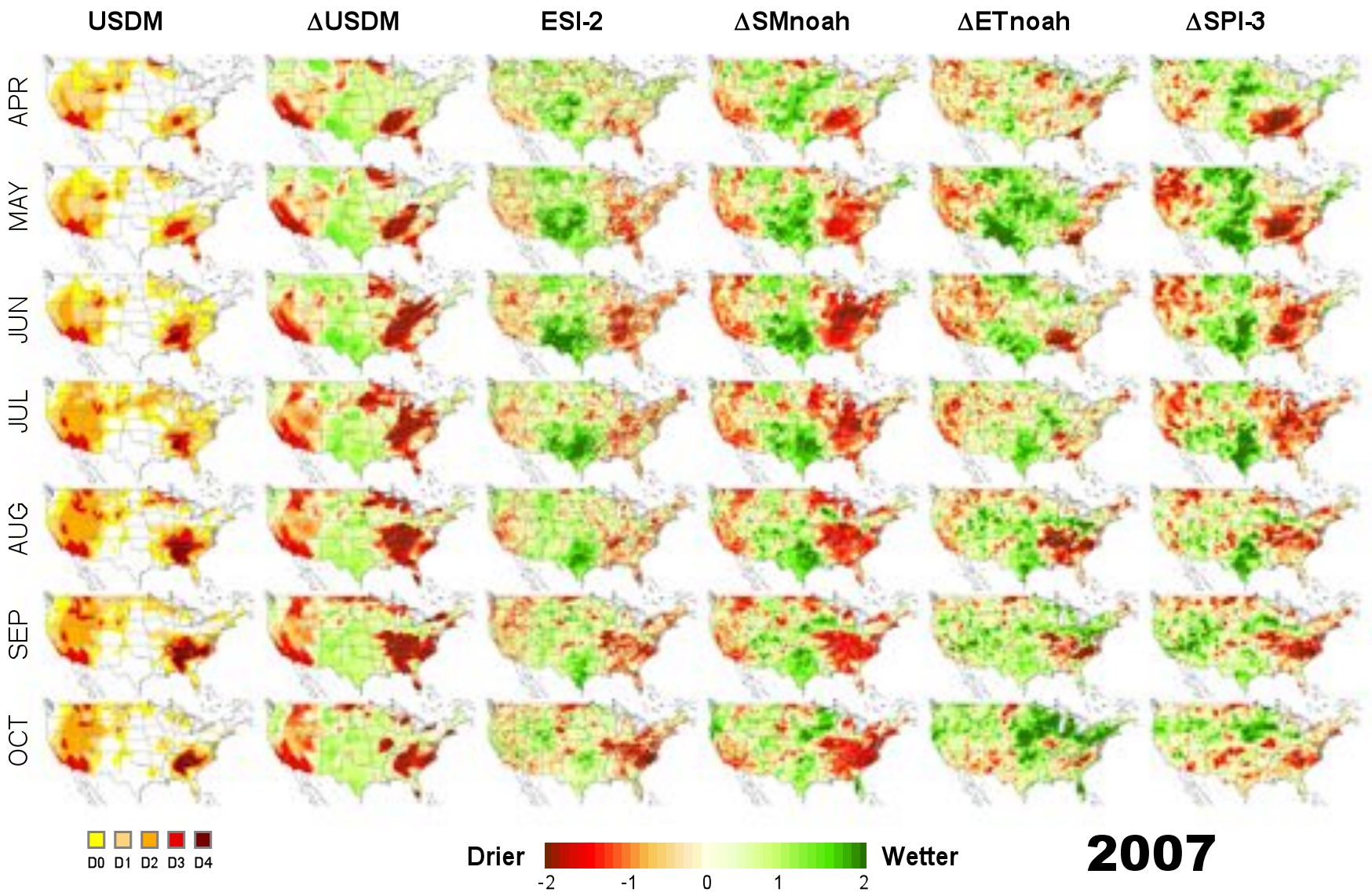
SEASONAL ANOMALIES



MONTHLY ANOMALIES

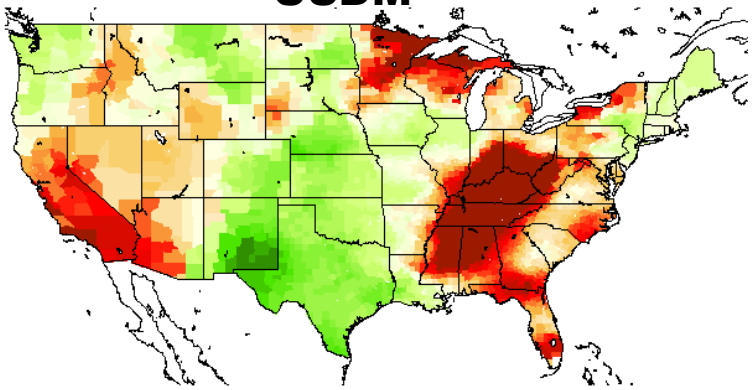


MONTHLY ANOMALIES

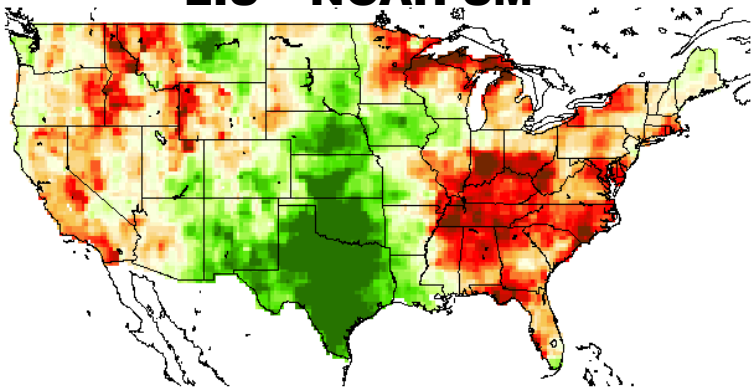


2007 SEASONAL ANOMALIES

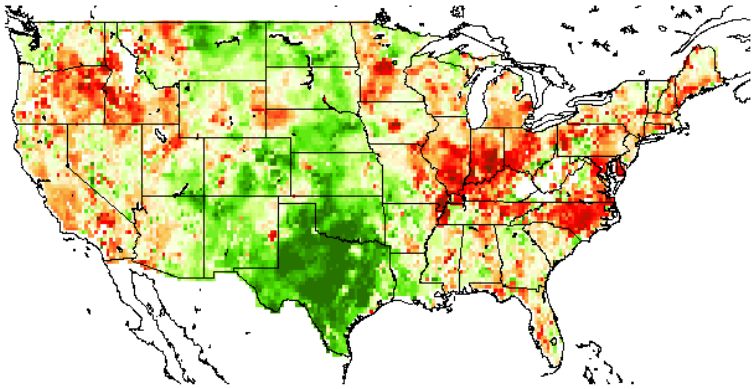
USDM



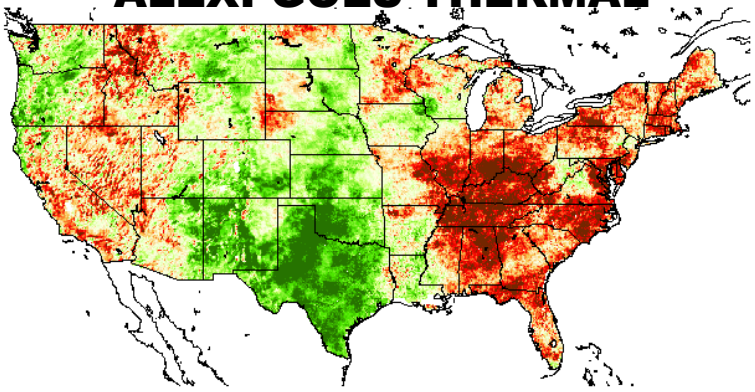
LIS – NOAH SM



USDA AMSR-E MICROWAVE



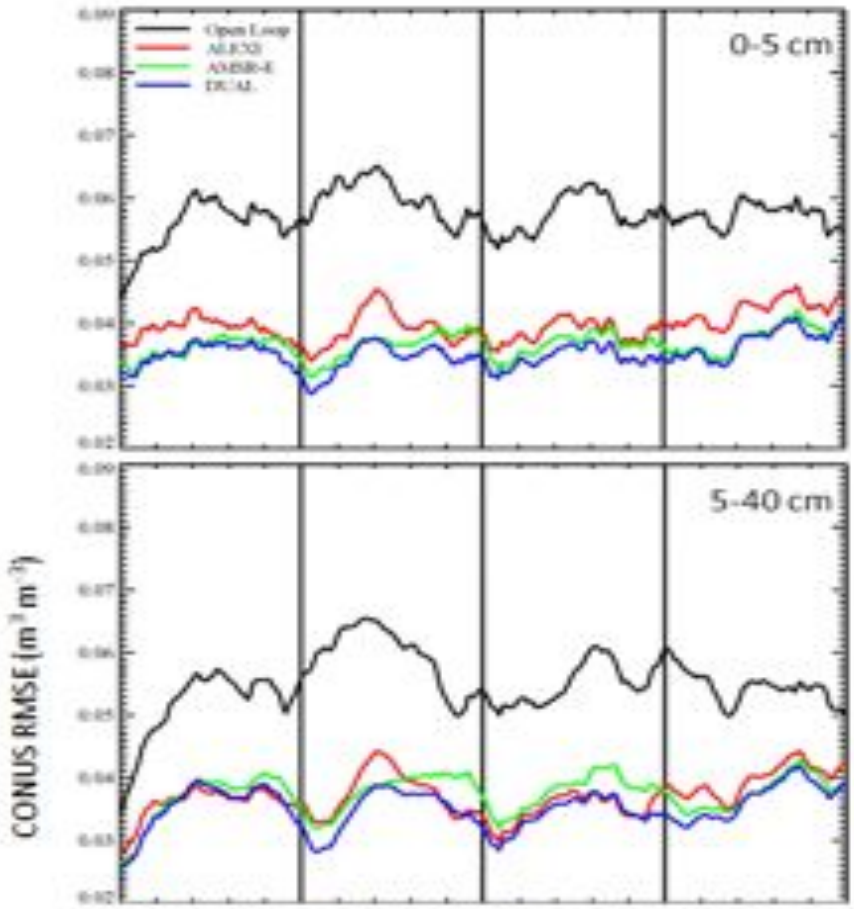
ALEXI GOES THERMAL

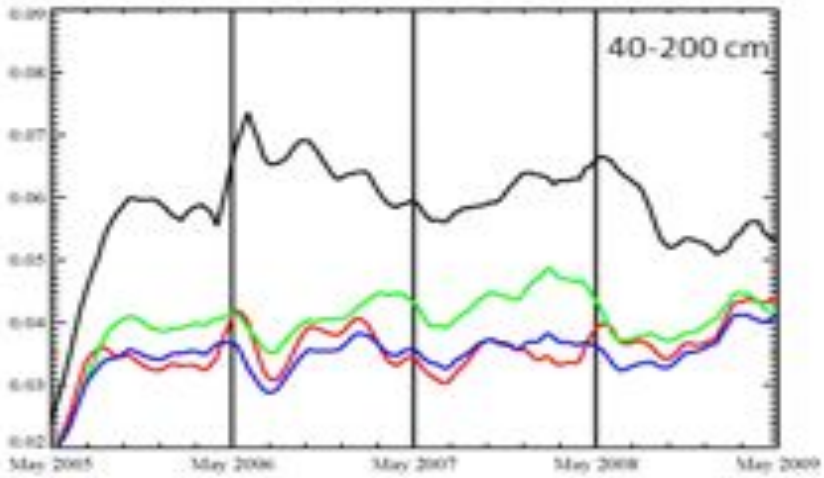


- samples 5cm layer
- 50km pixels (AMSR)
- ~2-day coverage
- light vegetation cover

- samples ~1-2m layer
- 60m - 5km pixels (L7, GOES)
- ~15-day coverage (90%)
- low to high vegetation cover

DUAL ASSIMILATION INTO NOAH





Noah run with degraded precip

Noah assimilating microwave SM

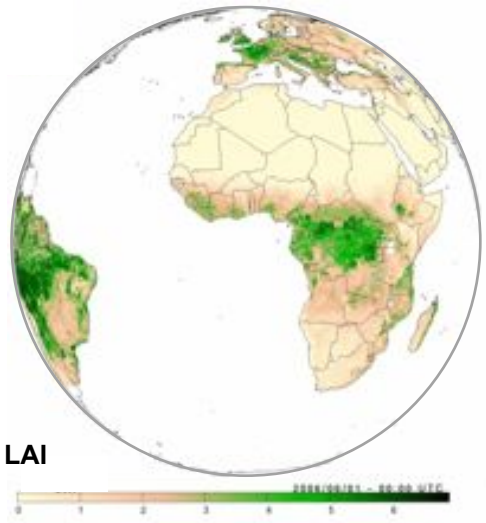
Noah assimilating TIR SM

Dual assimilation

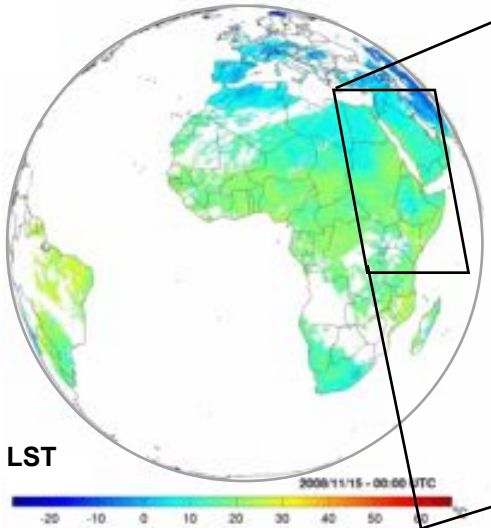
METEOSAT APPLICATIONS
... Africa

Northeast Africa

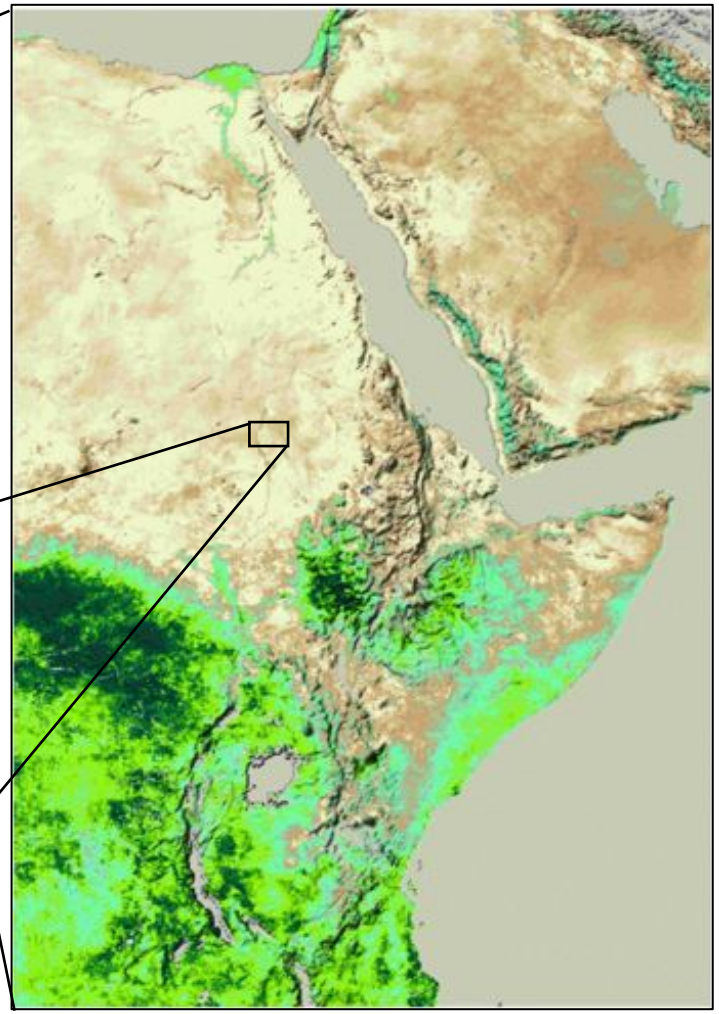
METEOSAT COVERAGE

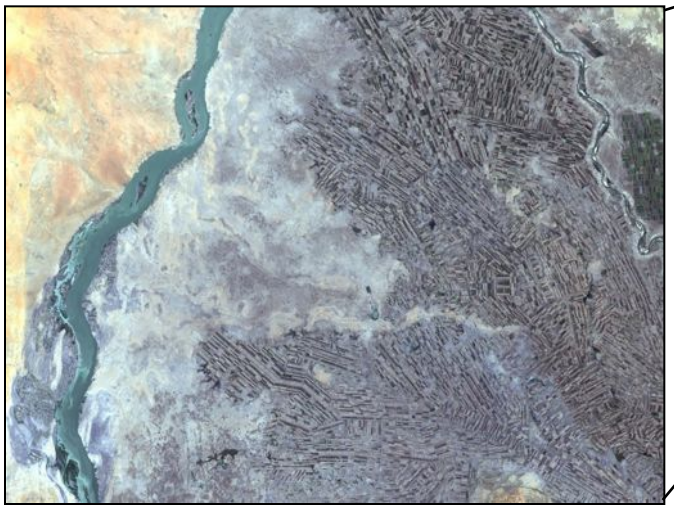


LAI



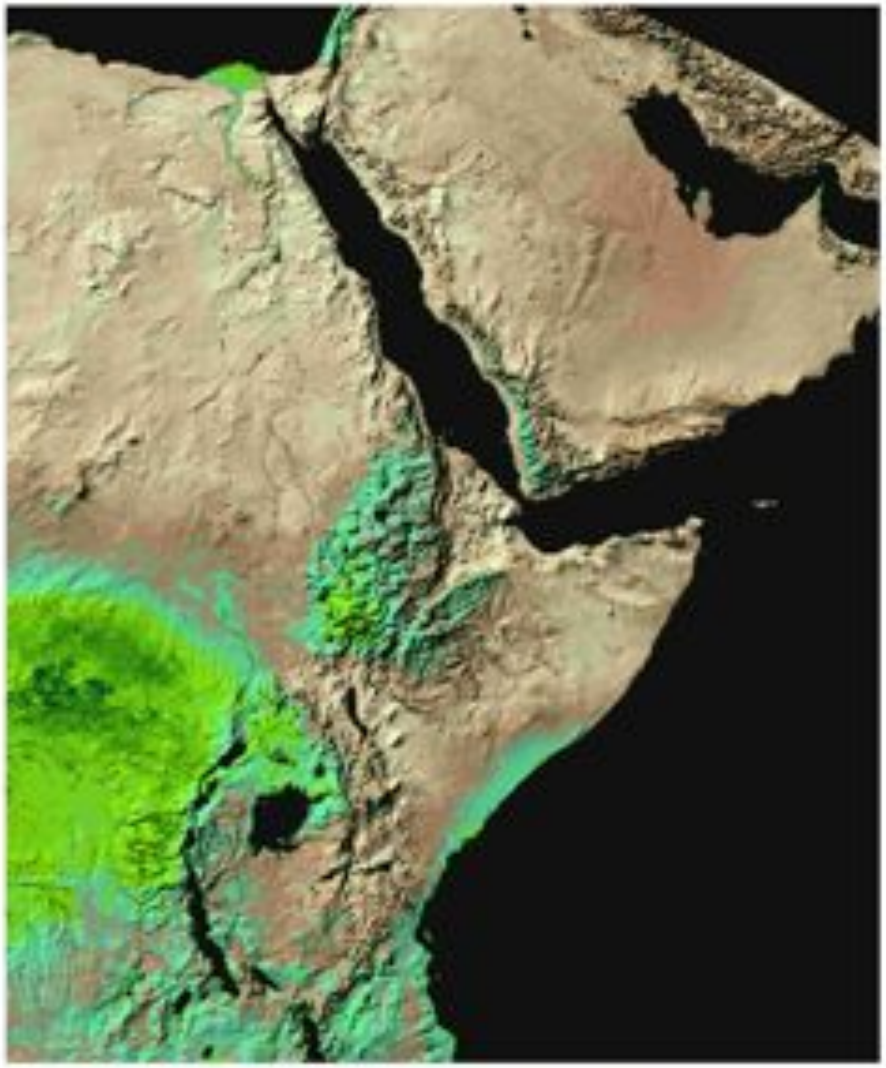
LST

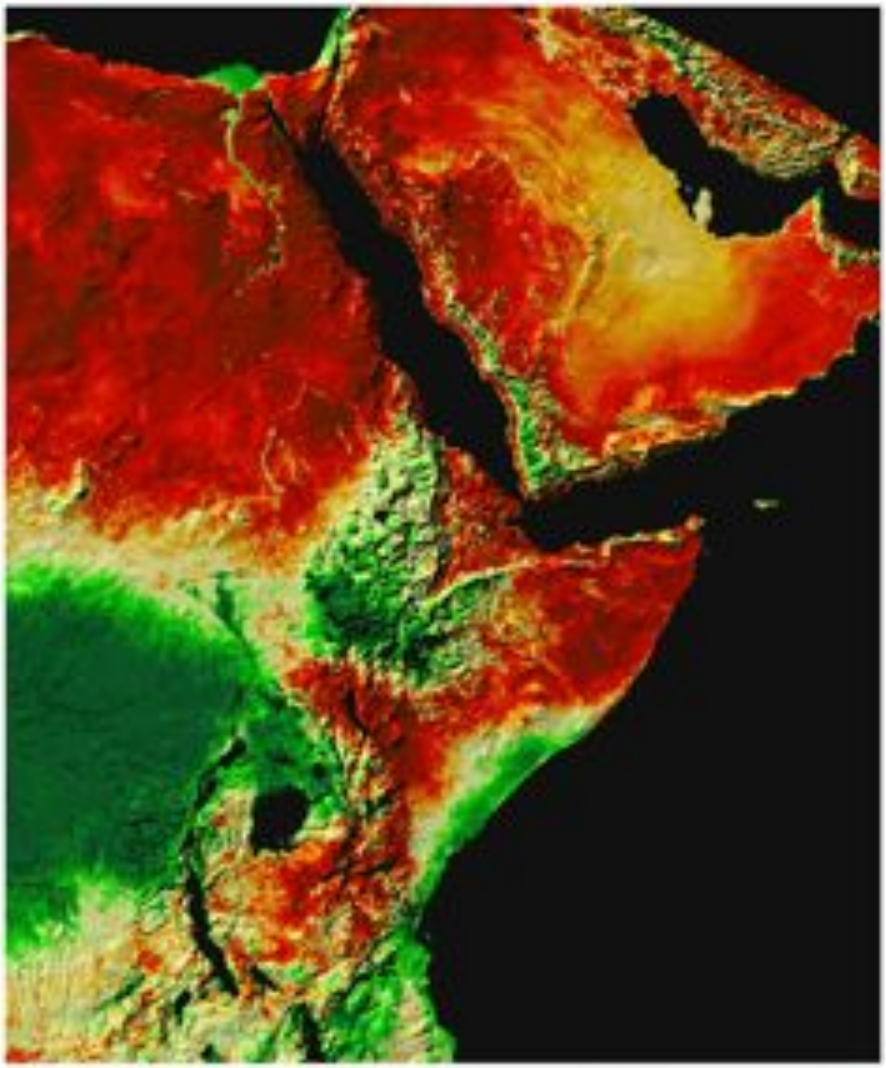




L7-ETM+ 1/12/02 USGS Image Gallery

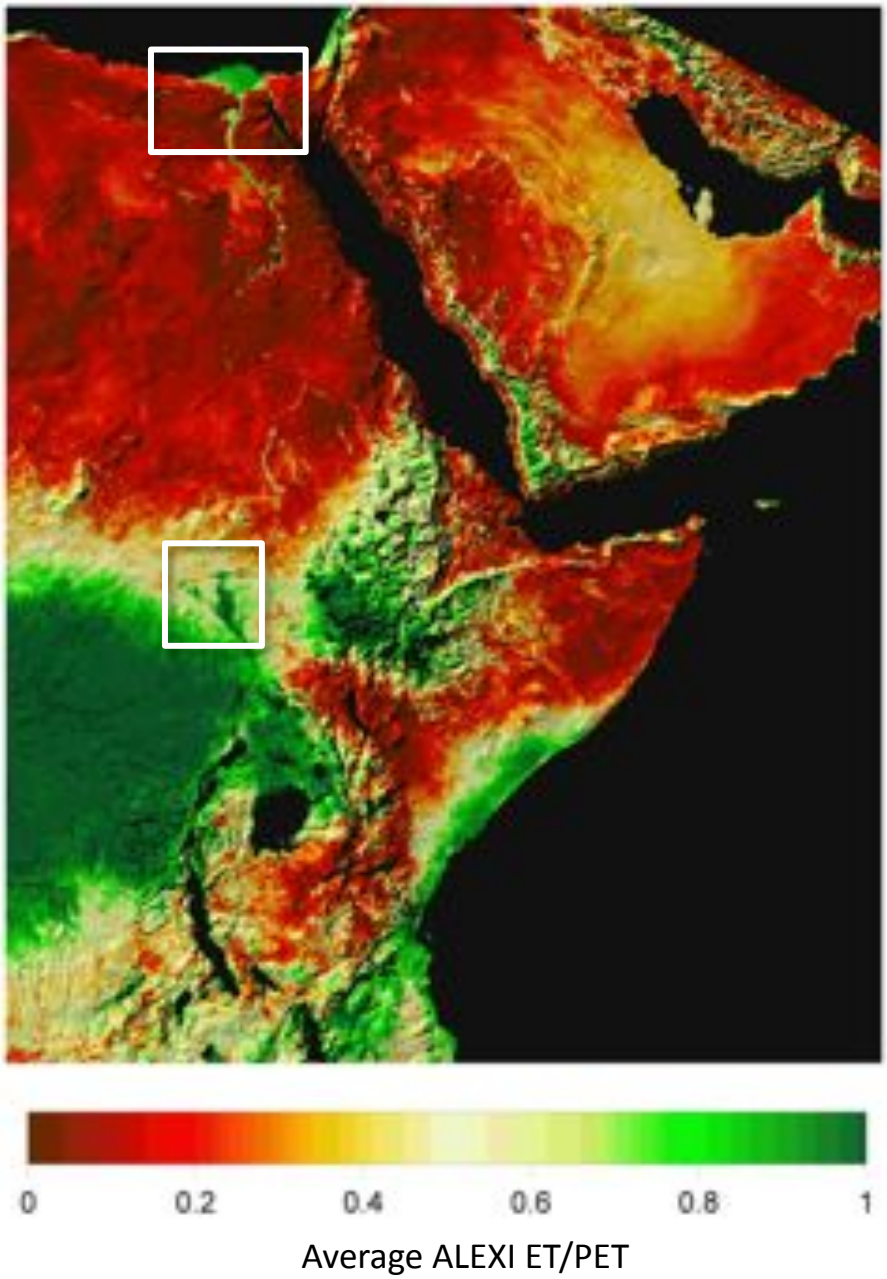
2009 APRIL-SEPTEMBER





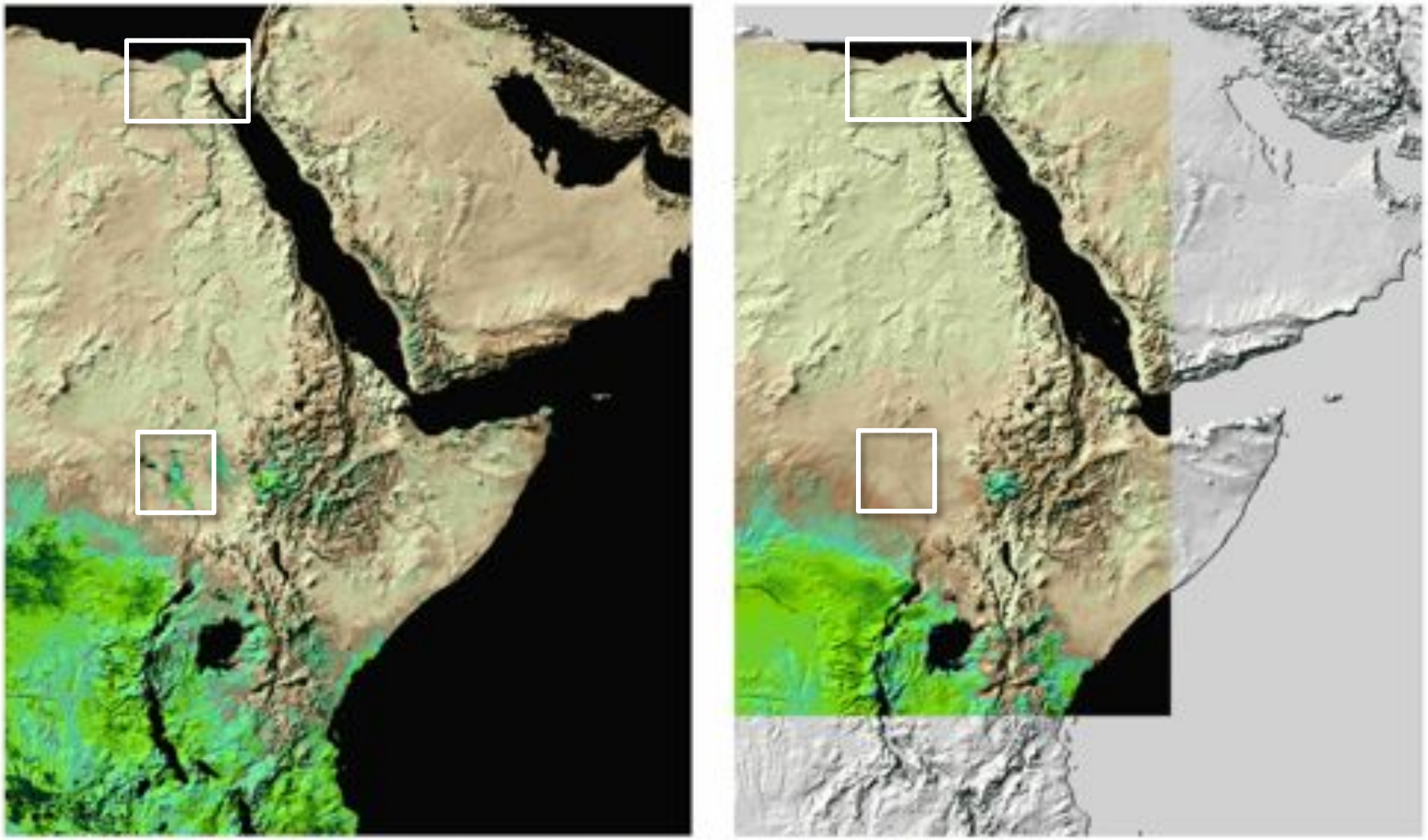
Average ALEXI ET (MJ m^{-2} d^{-1})

Average ALEXI ET/PET



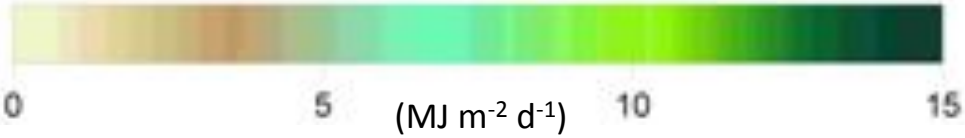
Average ALEXI ET/PET

2009 FEBRUARY

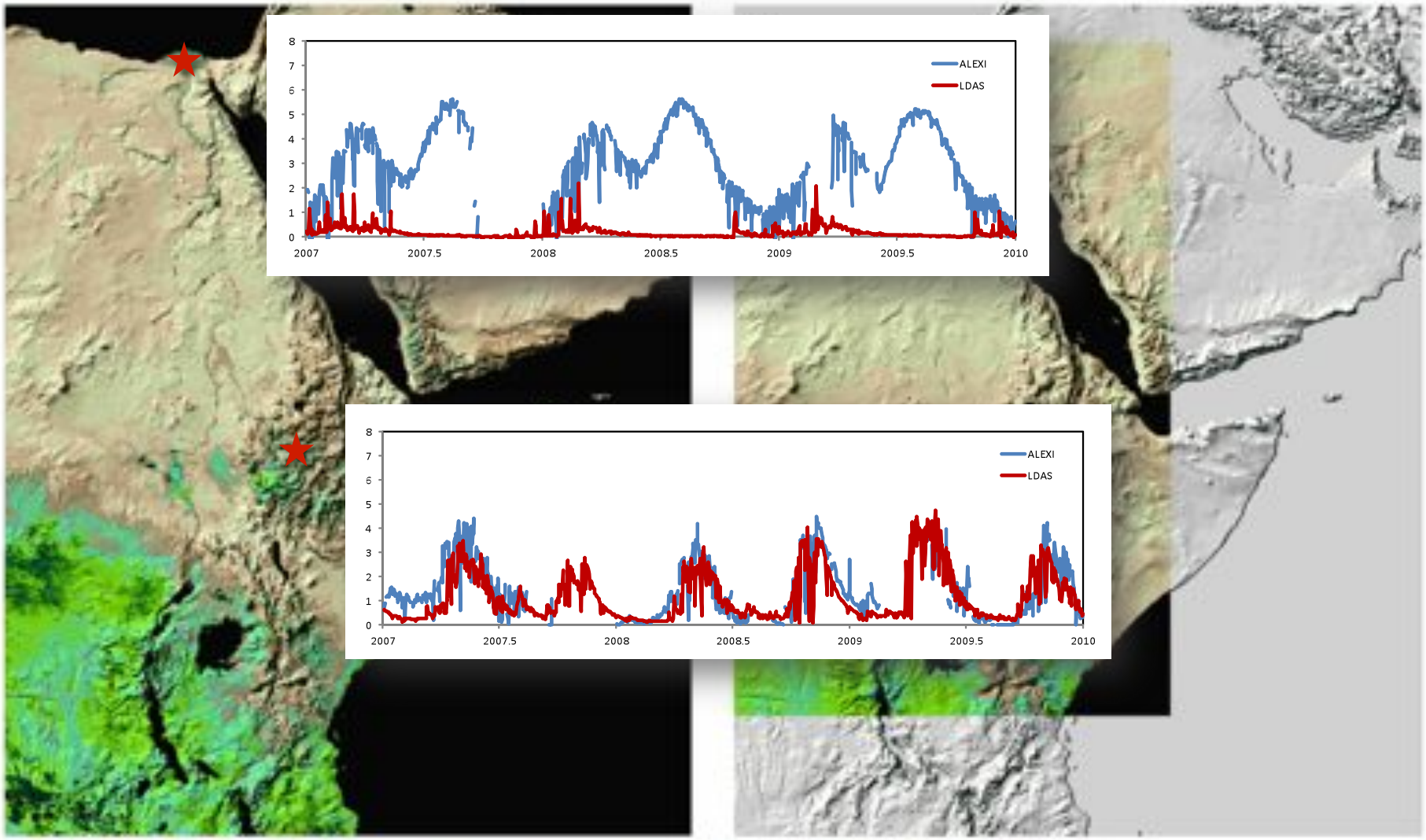


Average ALEXI ET

Average LDAS ET



2009 FEBRUARY

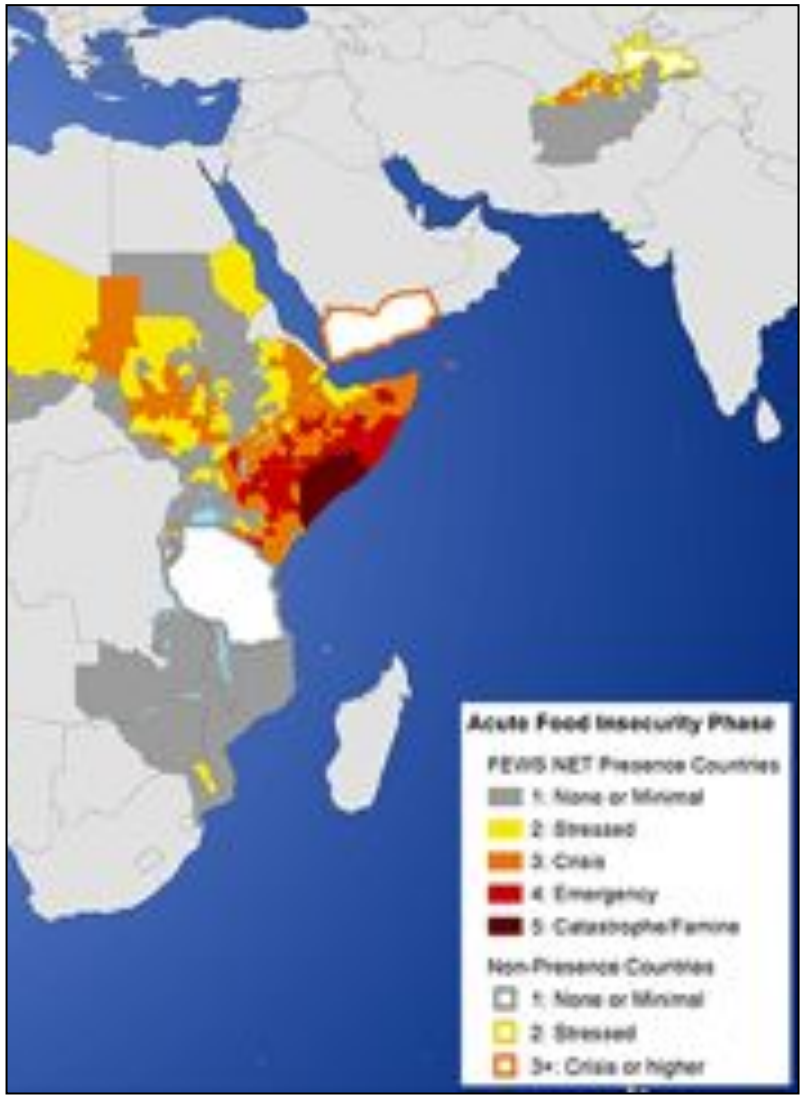


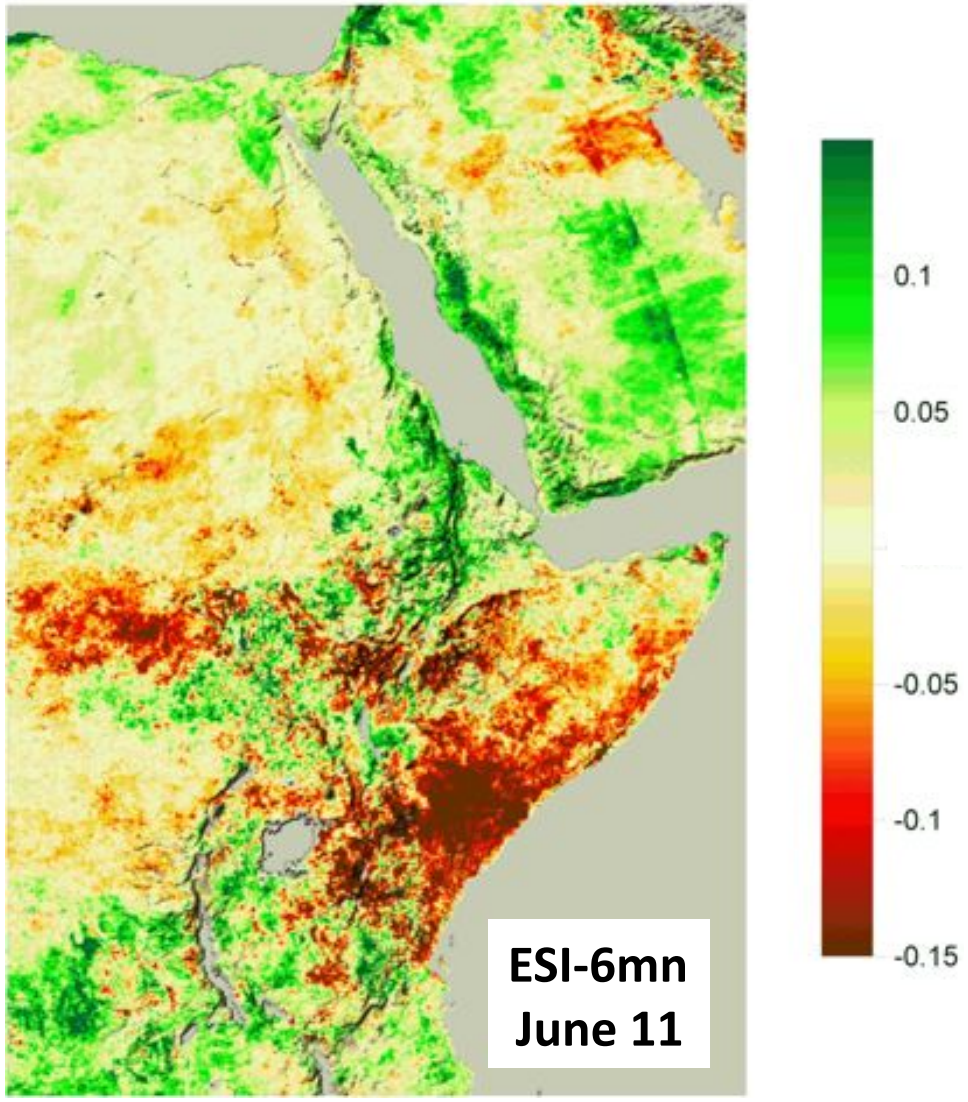
Average ALEXI ET

Average LDAS ET

0 5 10 15

(MJ m^{-2} d^{-1})


Acute Food Insecurity Phase
FEWS NET Presence Countries
1: None or Minimal
2: Stressed
3: Crisis
4: Emergency
5: Catastrophe/Famine
Non-Presence Countries
1: None or Minimal
2: Stressed
3+: Crisis or higher


ESI-6mn
June 11
0.1
0.05
-0.05
-0.1
-0.15

CONCLUSIONS

- **THERMAL REMOTE SENSING DATA HAVE GREAT UTILITY:**
  - ***... multi-scale ET mapping***
  - ***... drought monitoring***
  - ***... soil moisture mapping***

COMPLEMENTS INFORMATION FROM PRECIPITATION DATASETS

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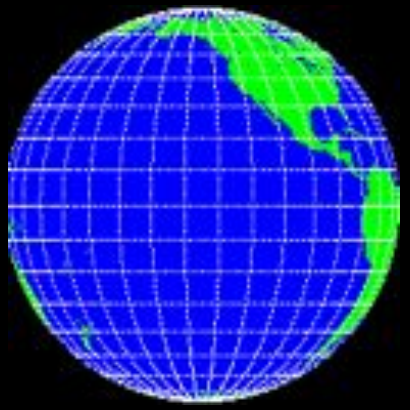
Martha.Anderson@ars.usda.gov

Geostationary Satellite Coverage



GOES W 135°W
NOAA (US)

GOES E 75°W
NOAA (US)

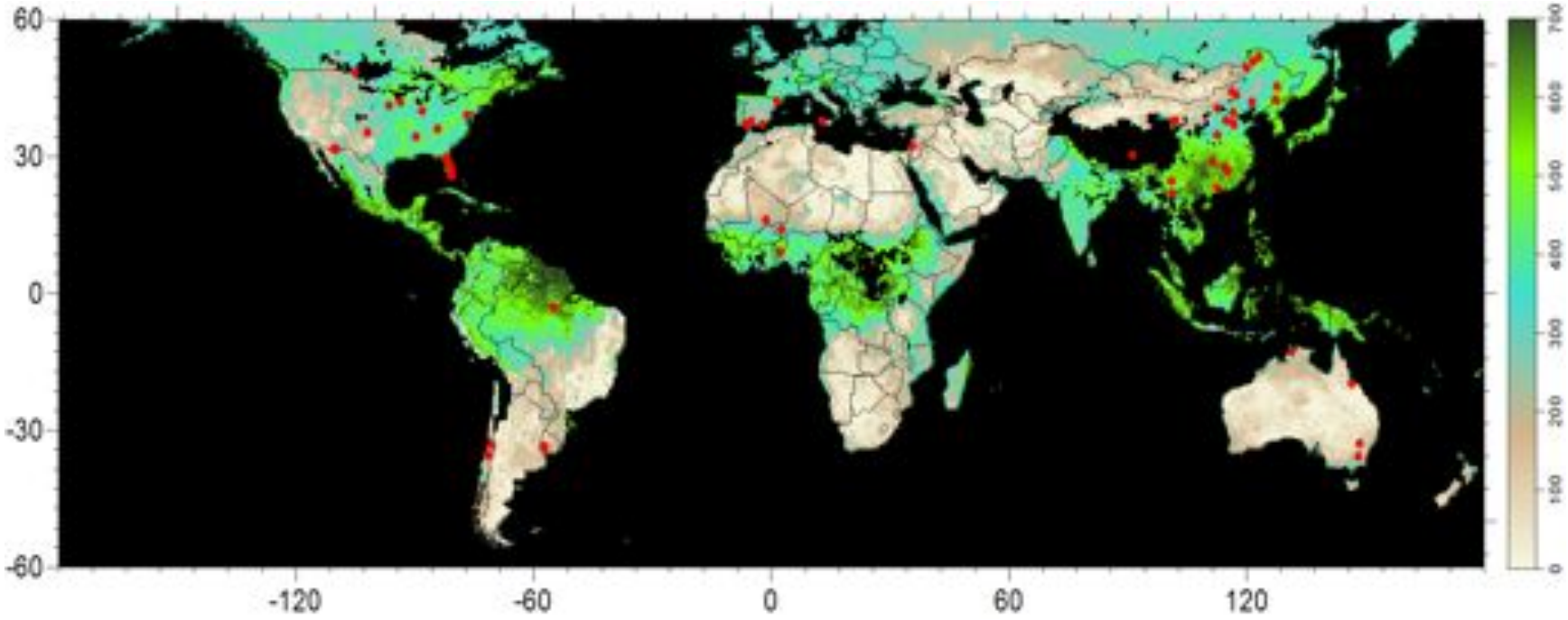
Meteosat 0°
Eumetsat (EU)

Meteosat 63°E
Eumetsat (EU)

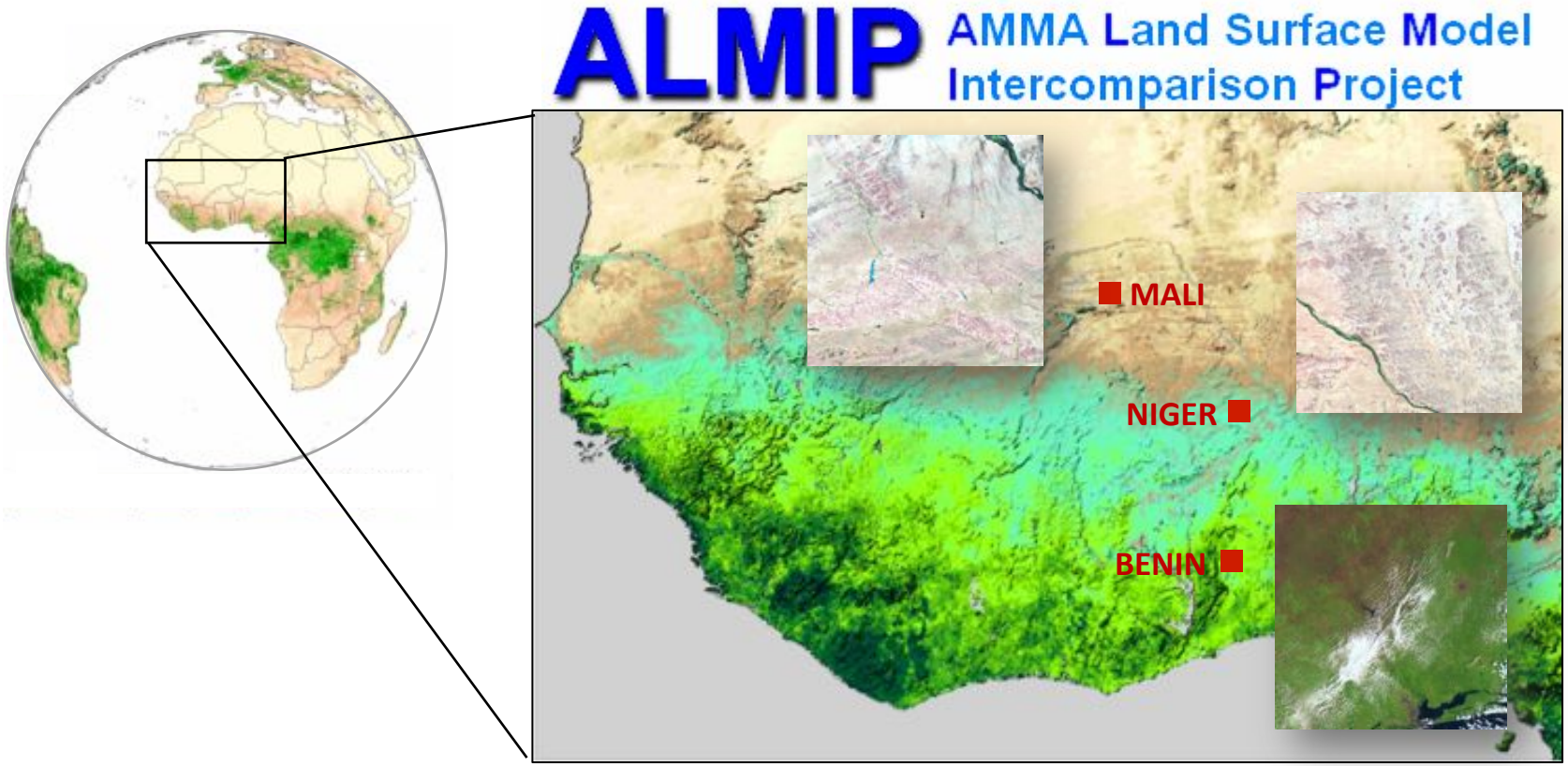
GMS 140°E
JAXA (Japan)

August 2004

Midday latent heat flux (clear-sky composite)

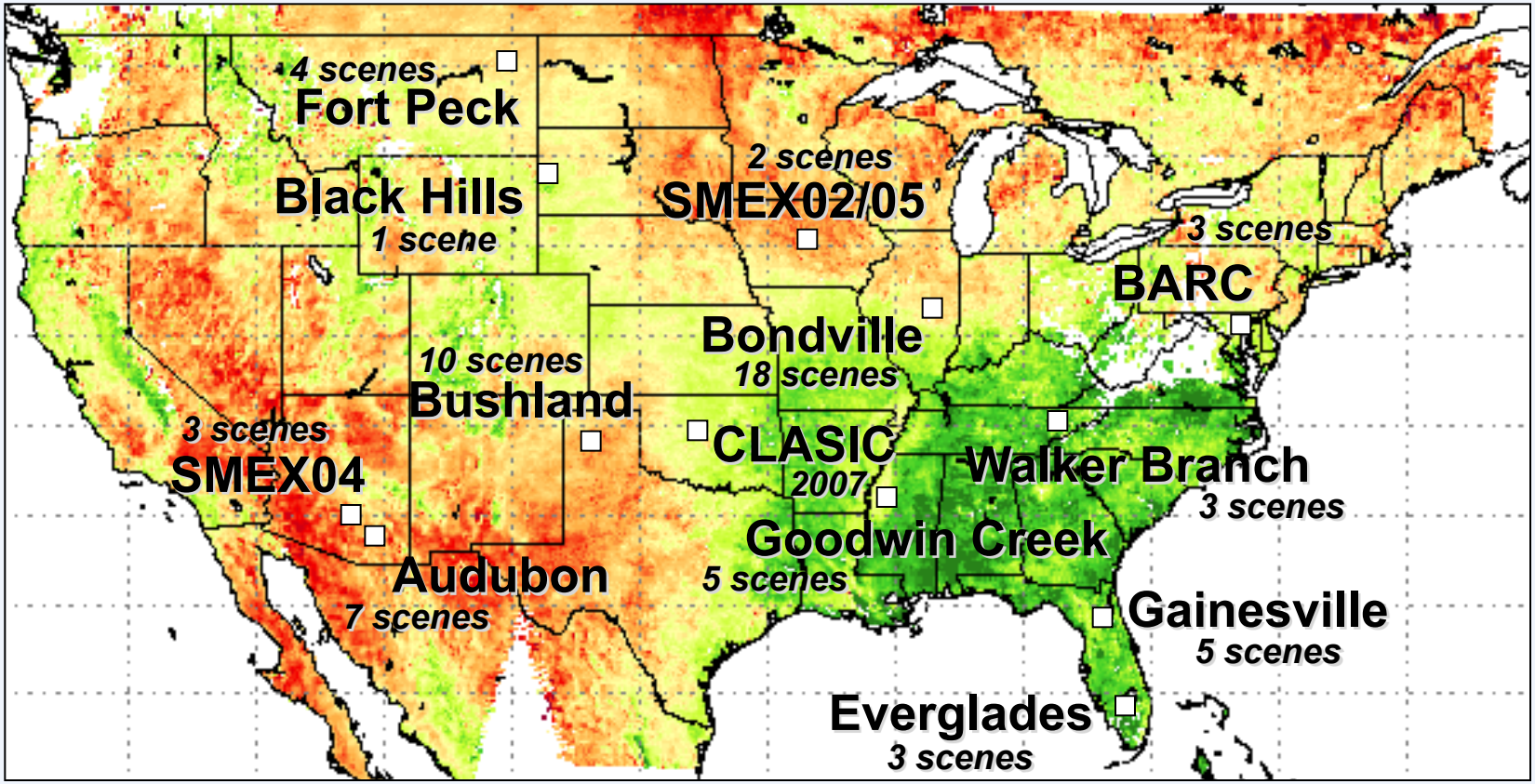


Western Africa



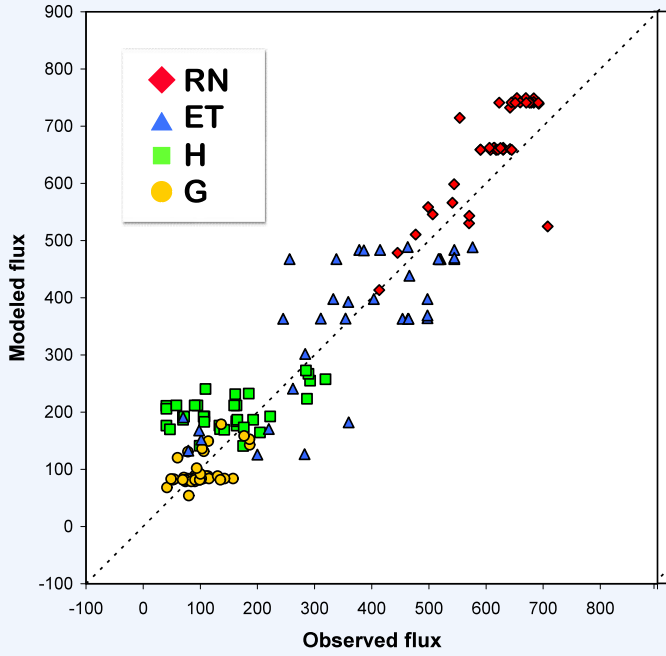
African Monsoon Multidisciplinary Analysis (CNRM, CESBIO)

ALEXI validation sites



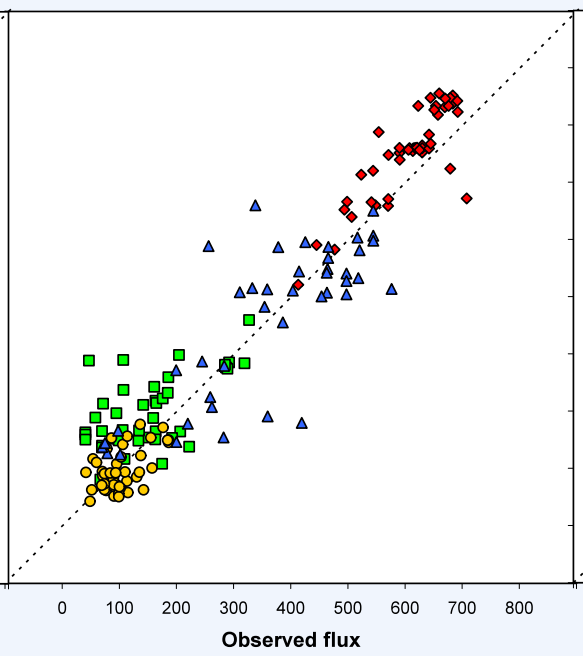
Effect of TIR resolution on validation

GOES (10 km)



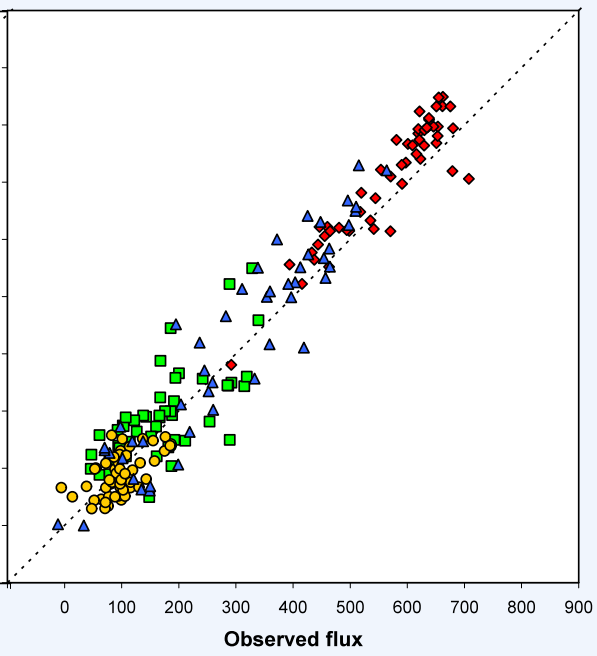
MAD: 75 Wm^{-2} (25%)

MODIS (1 km)



MAD: 63 Wm^{-2} (20%)

Landsat (~100 m)



MAD: 47 Wm^{-2} (15%)