Mapping Water Use and Drought with Satellite Remote Sensing

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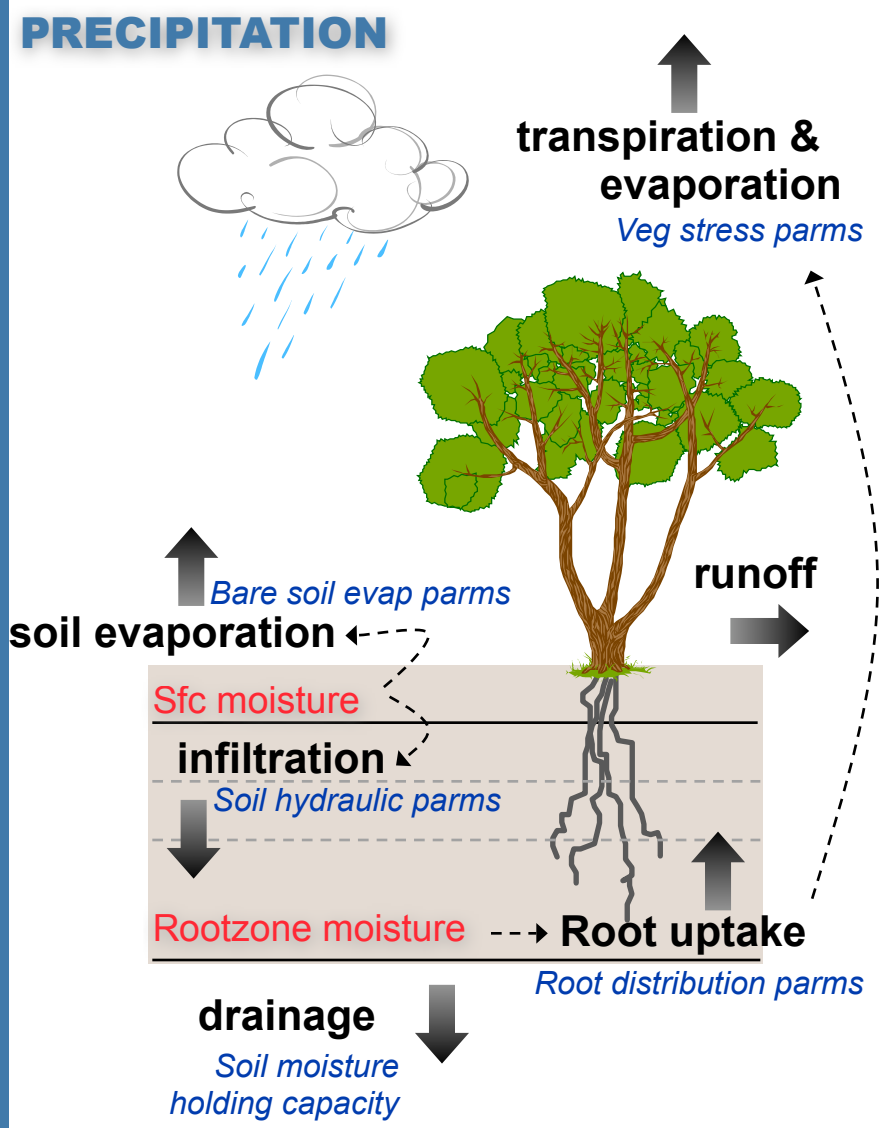
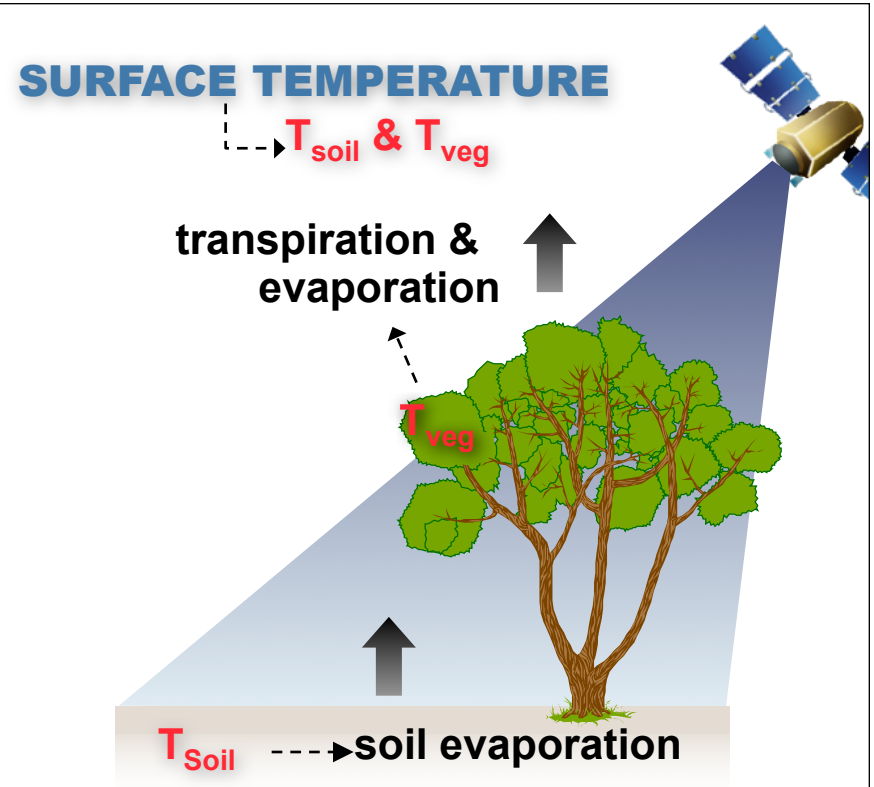
Approaches to modeling ET



WATER BALANCE APPROACH

(hydrologic modeling)



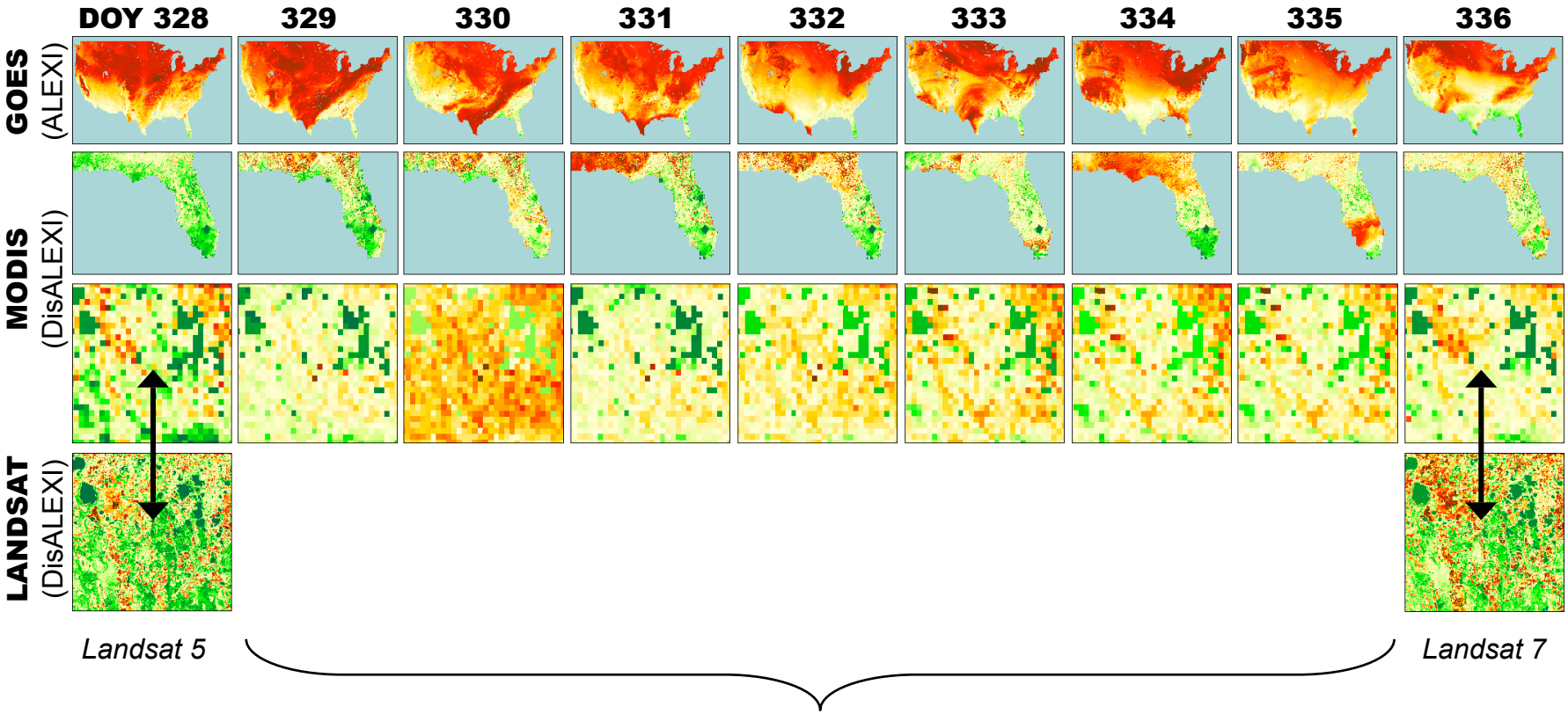
Given known radiative energy inputs, how much water loss is required to keep the soil and vegetation at the observed temperatures?

ENERGY BALANCE APPROACH

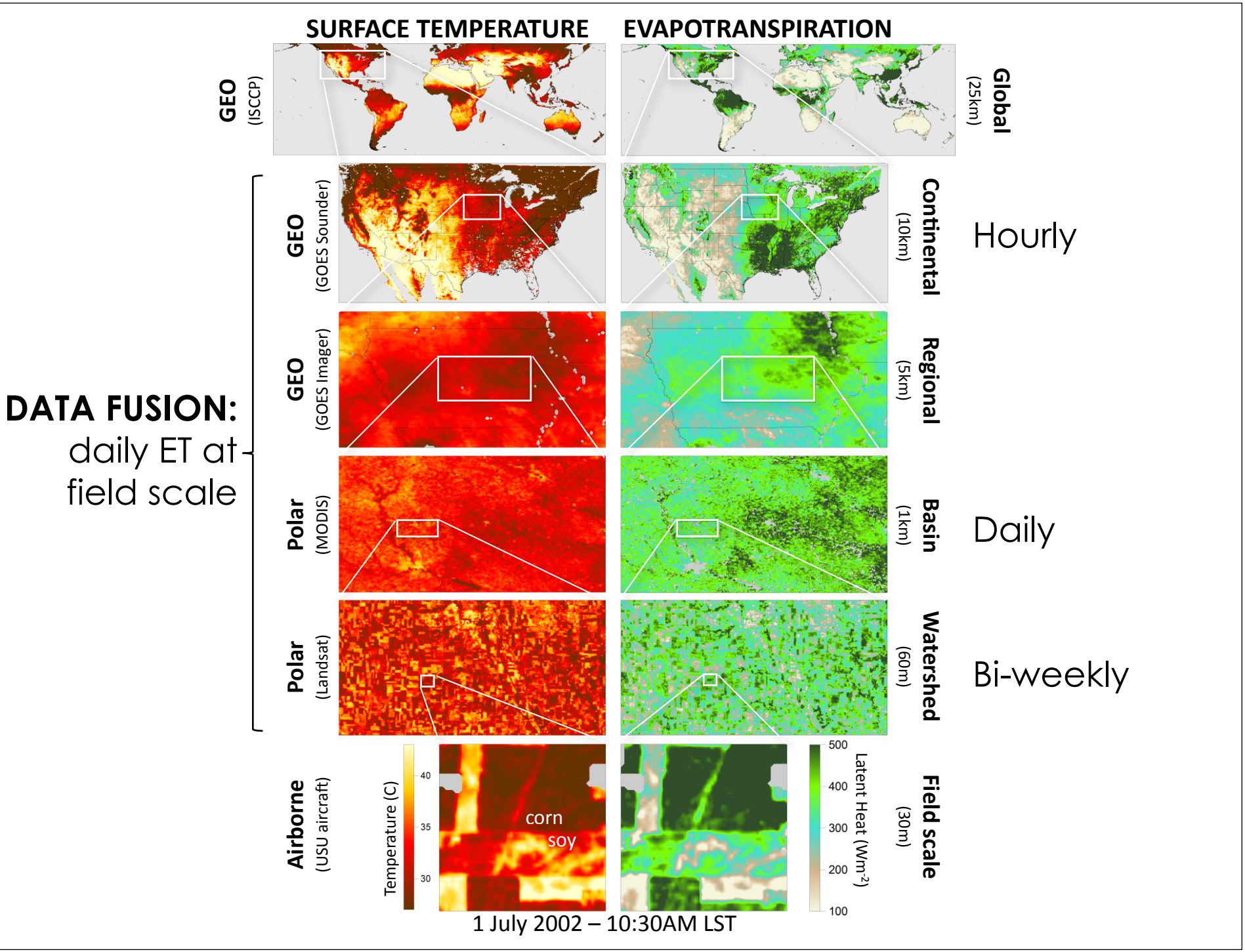
(remote sensing)

GOES/MODIS/Landsat FUSION

Daily Evapotranspiration – Orlando, FL, 2002



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

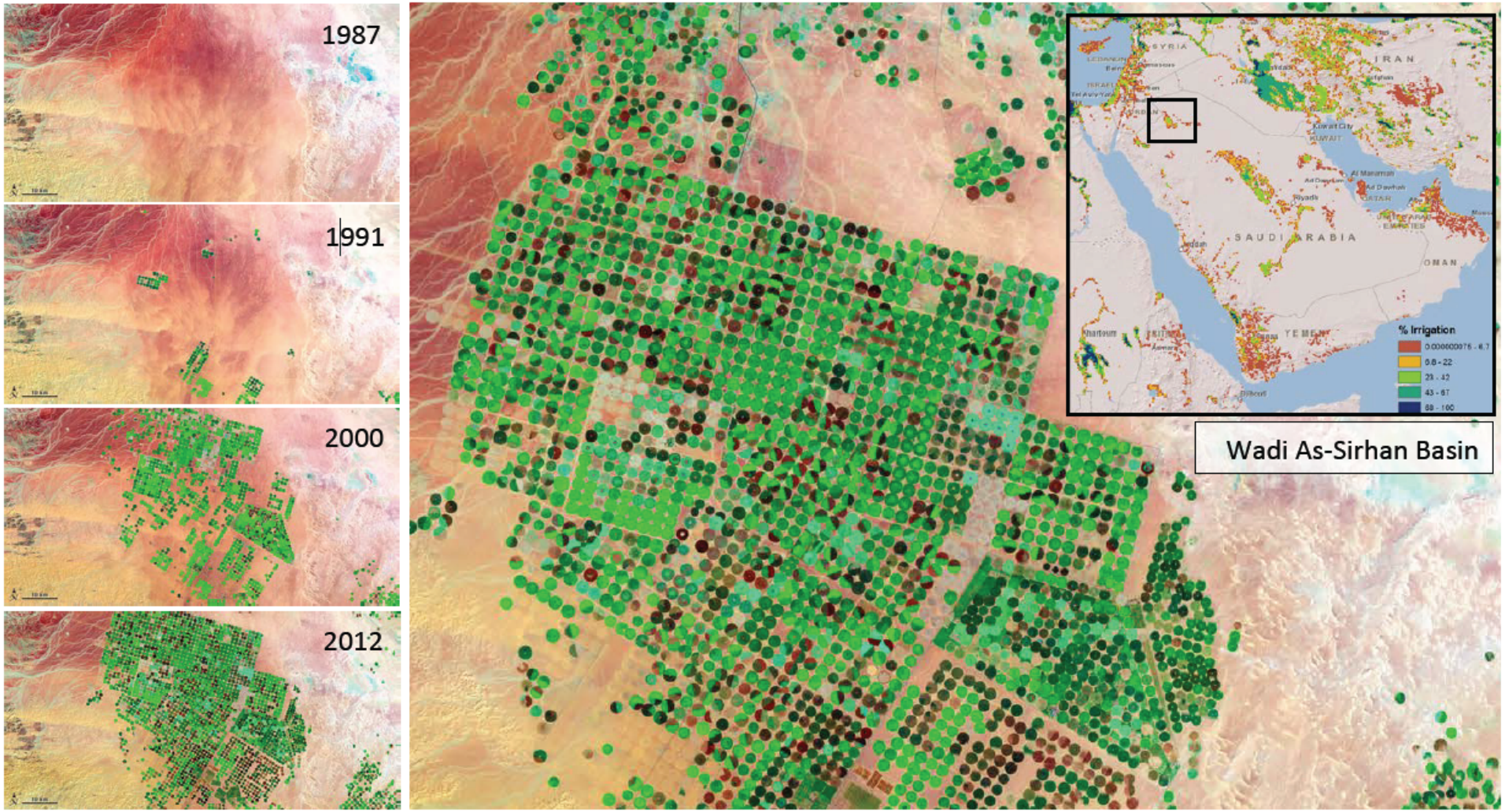

SURFACE TEMPERATURE
EVAPOTRANSPIRATION
GEO (ISCCP)
Global (25km)
GEO (GOES Sounder)
Continental (10km)
Hourly
GEO (GOES Imager)
Regional (5km)
DATA FUSION:
daily ET at field scale
Polar (MODIS)
Basin (1km)
Daily
Polar (Landsat)
Watershed (60m)
Bi-weekly
Airborne (USU aircraft)
Field scale (30m)
Temperature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

WATER ACCOUNTING AND FOOD SECURITY

- Improved accounting for water diversions/sinks
- Monitoring and managing agricultural water use and distribution within irrigation districts
- Improved hydrologic monitoring (flood, drought, runoff)
- Early detection of crop stress/failure
- Improved crop modeling and yield estimation

We can't manage what we can't measure …

EXPANSION of IRRIGATION

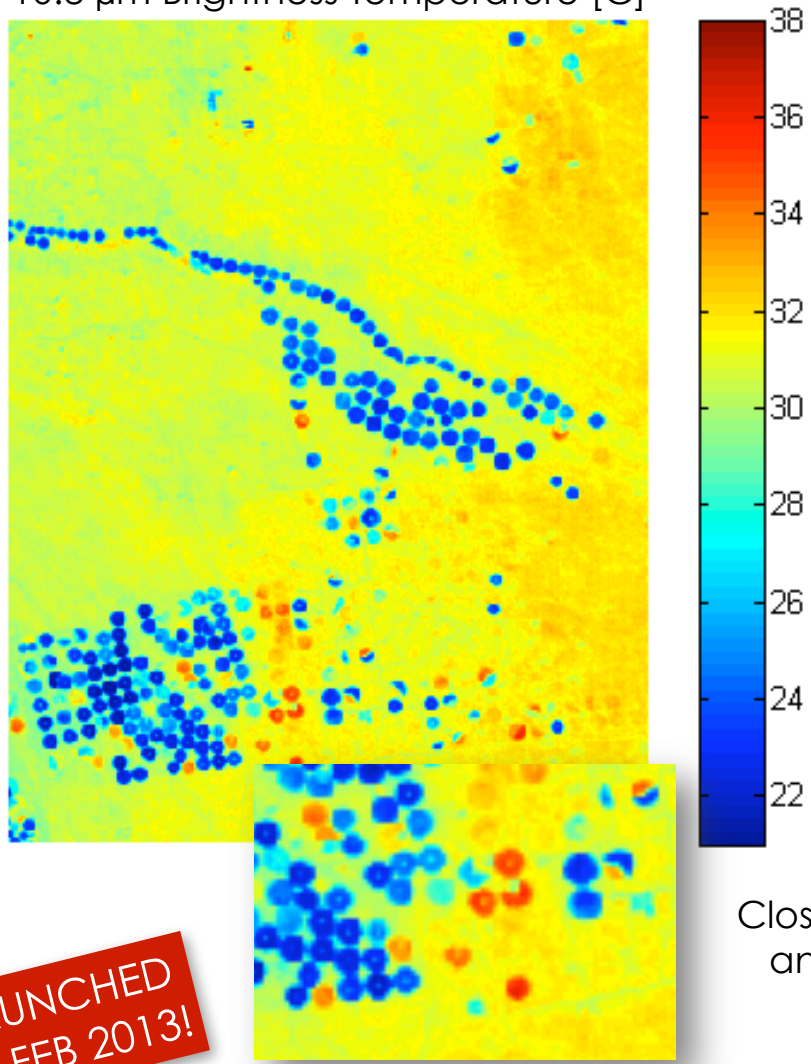


http://earthobservatory.nasa.gov/IOTD/view.php?id=77900

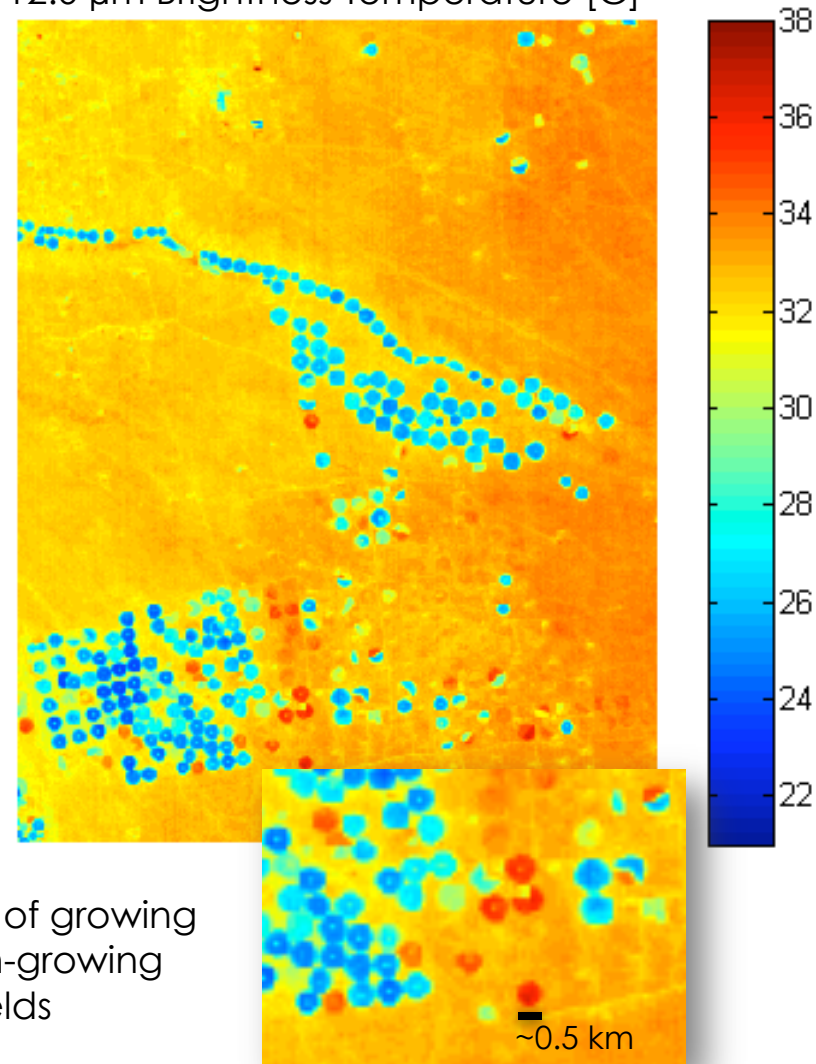
Landsats 4,5,7 – visible, near infrared bands: vegetation amount

CONSUMPTIVE WATER USE

10.8 µm Brightness Temperature [C]



12.0 µm Brightness Temperature [C]



Close-ups of growing and non-growing fields

LAUNCHED 11 FEB 2013!

Landsat 8 – thermal infrared bands: vegetation status and water use

Applications for Remotely Sensed ET

WATER MANAGEMENT

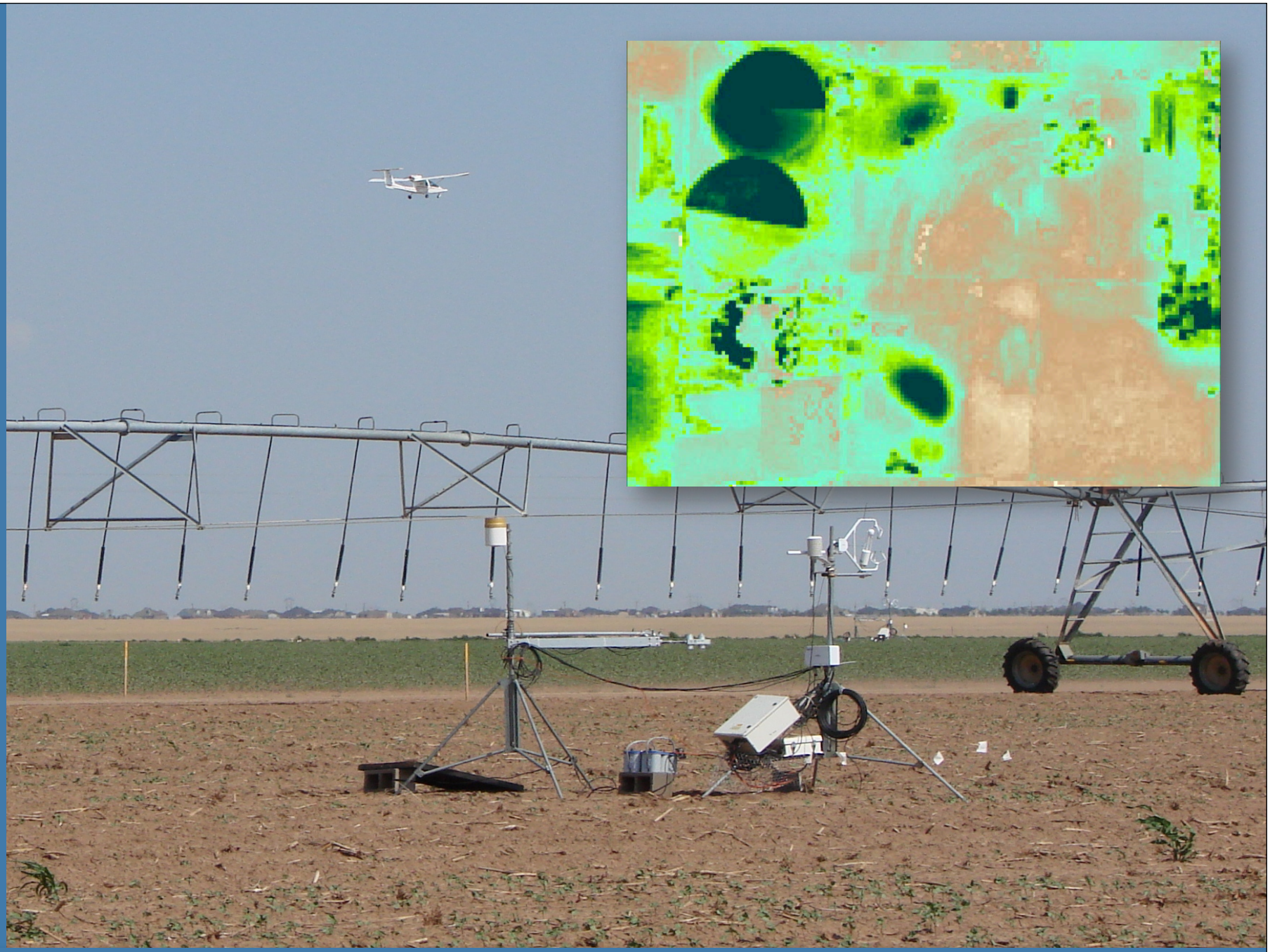
DROUGHT MONITORING

FOOD AND WATER SECURITY

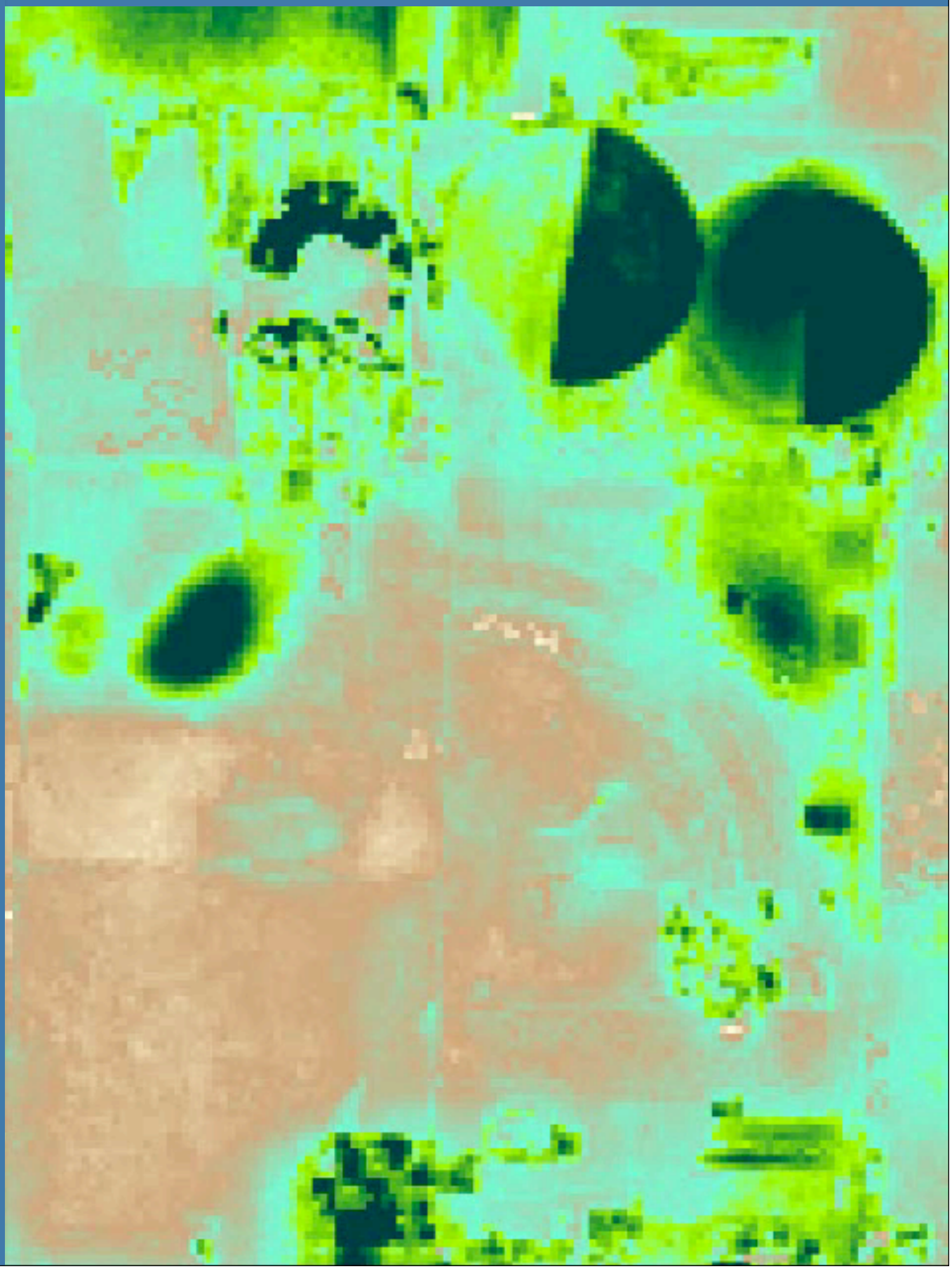
APPLICATIONS FOR SATELLITE ET

… *Water Management*

Irrigation management

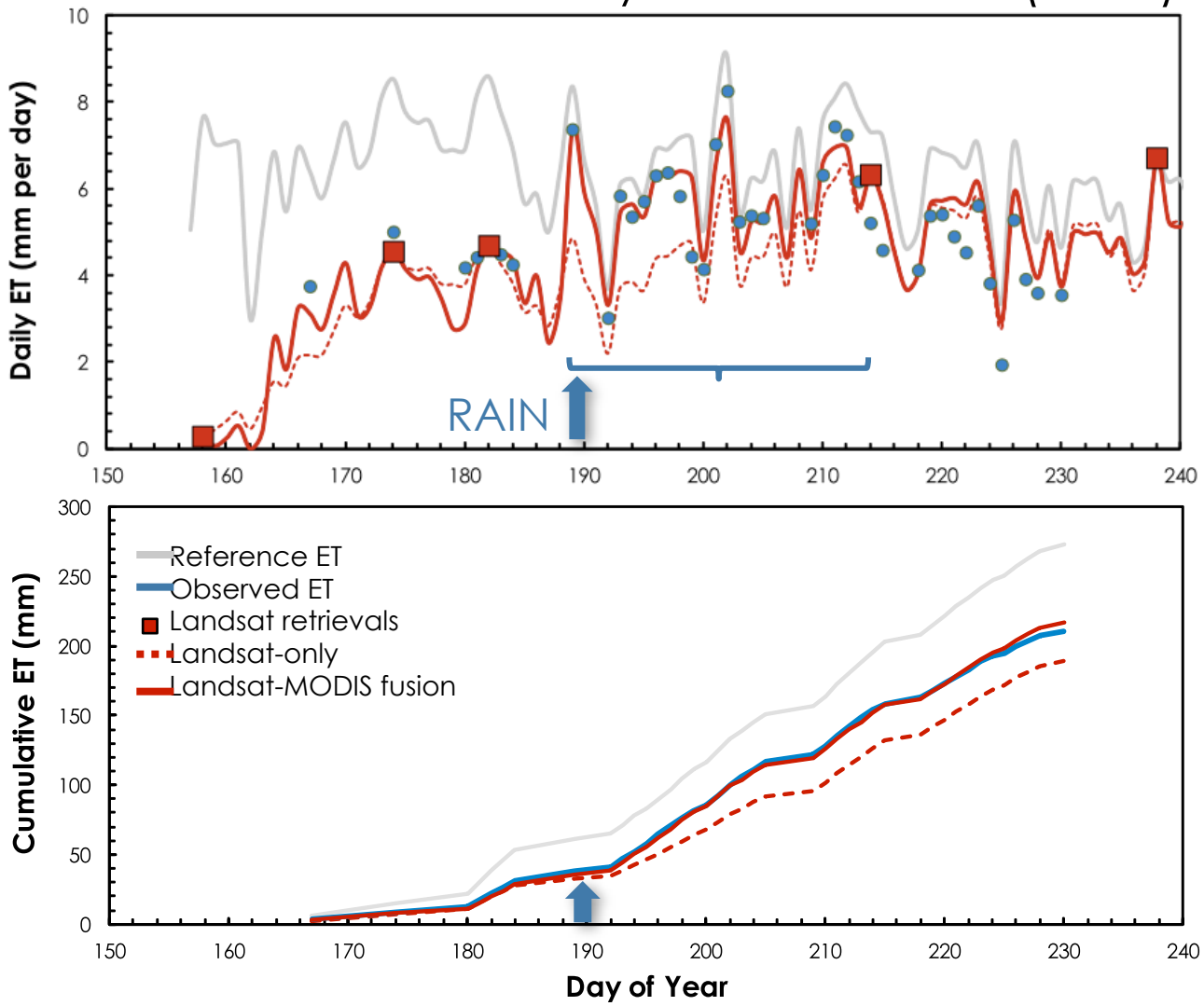


Daily ET at field scale (Landsat+MODIS)



Validation using flux tower data

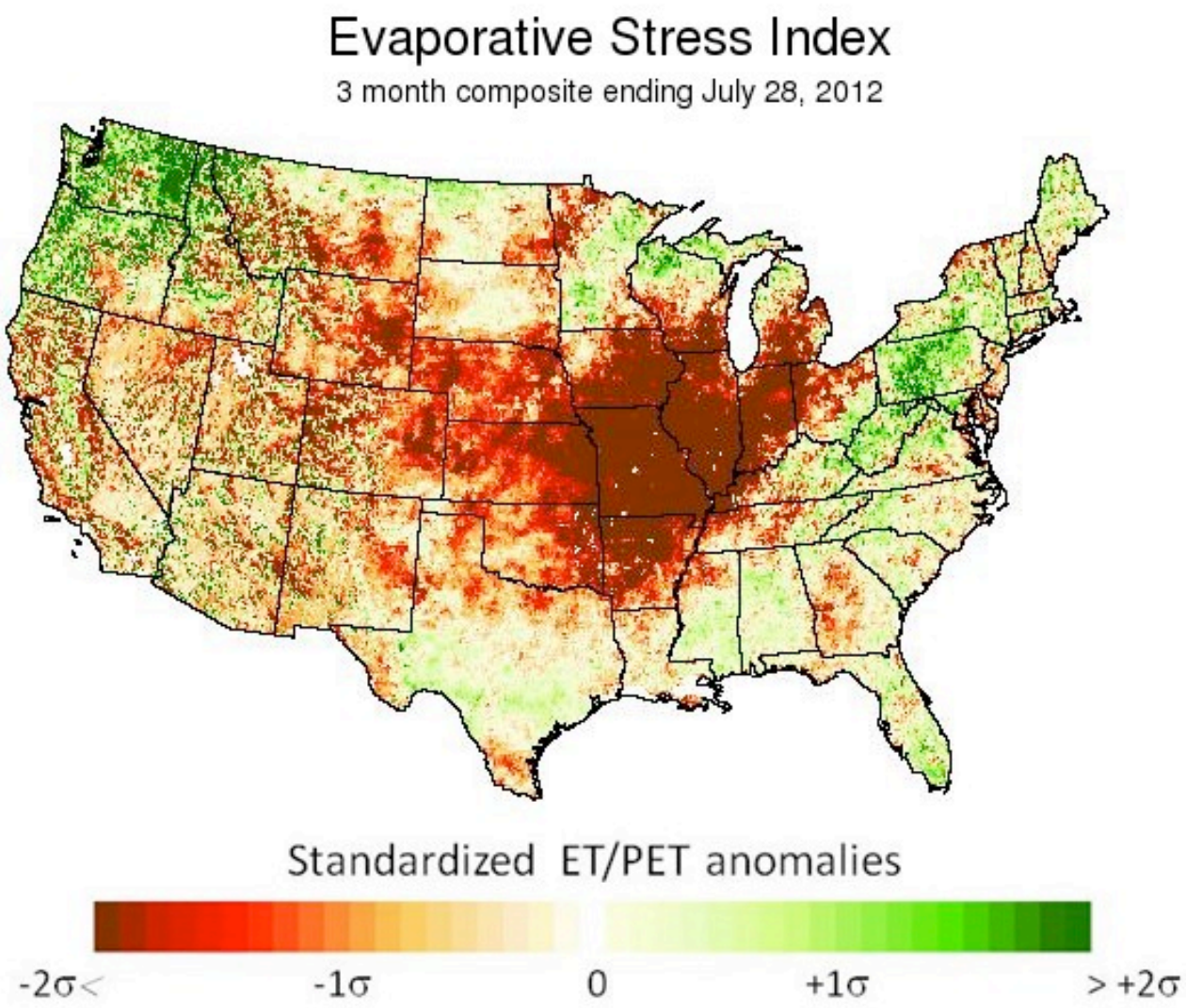
Rainfed soybean – SMEX02 (Iowa)



APPLICATIONS FOR SATELLITE ET

… Monitoring Drought

Satellite ET Drought Indicator

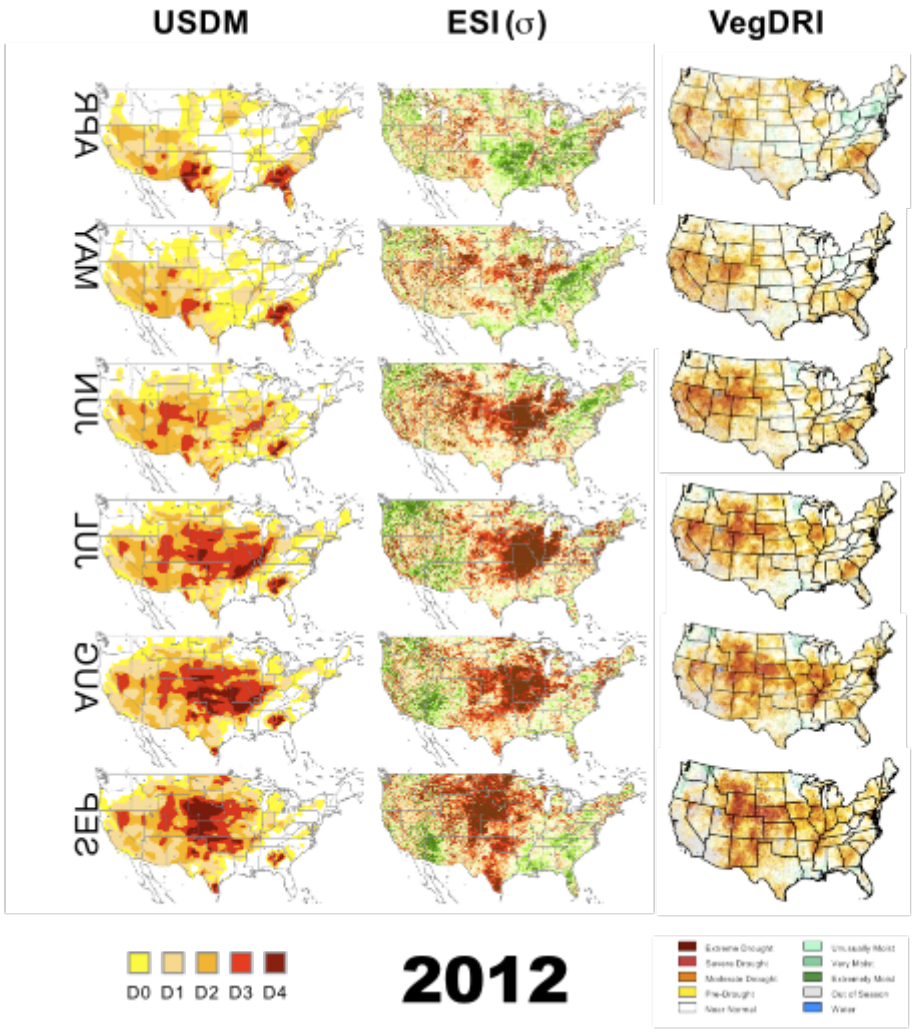


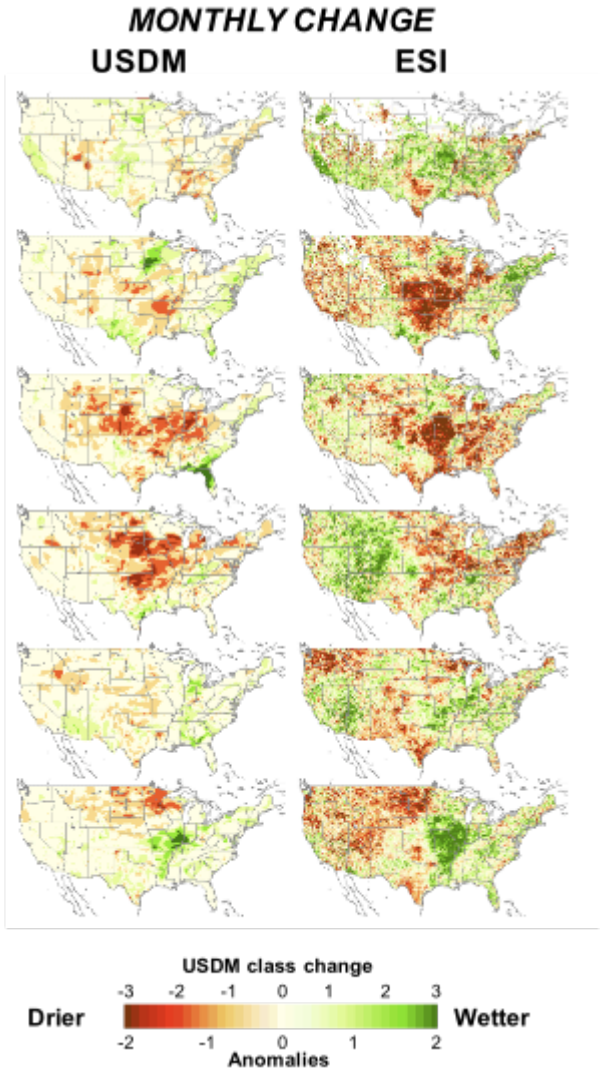
Atmosphere-Land Exchange Inverse Model (ALEXI)

(Anderson et al., 1997, 2007)

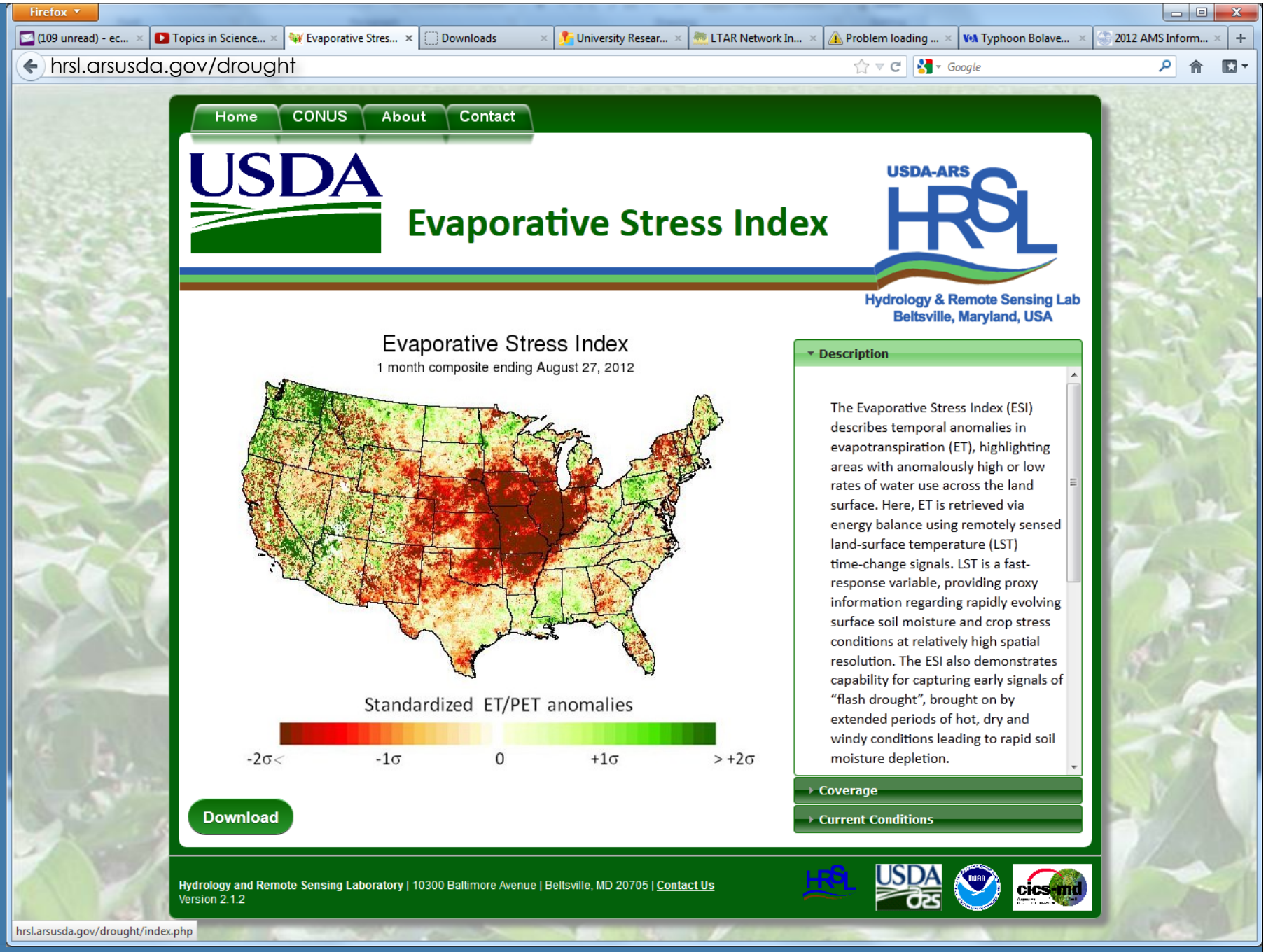
Realtime Drought Monitoring

2012 FLASH DROUGHT





Realtime Drought Monitoring



APPLICATIONS FOR SATELLITE ET

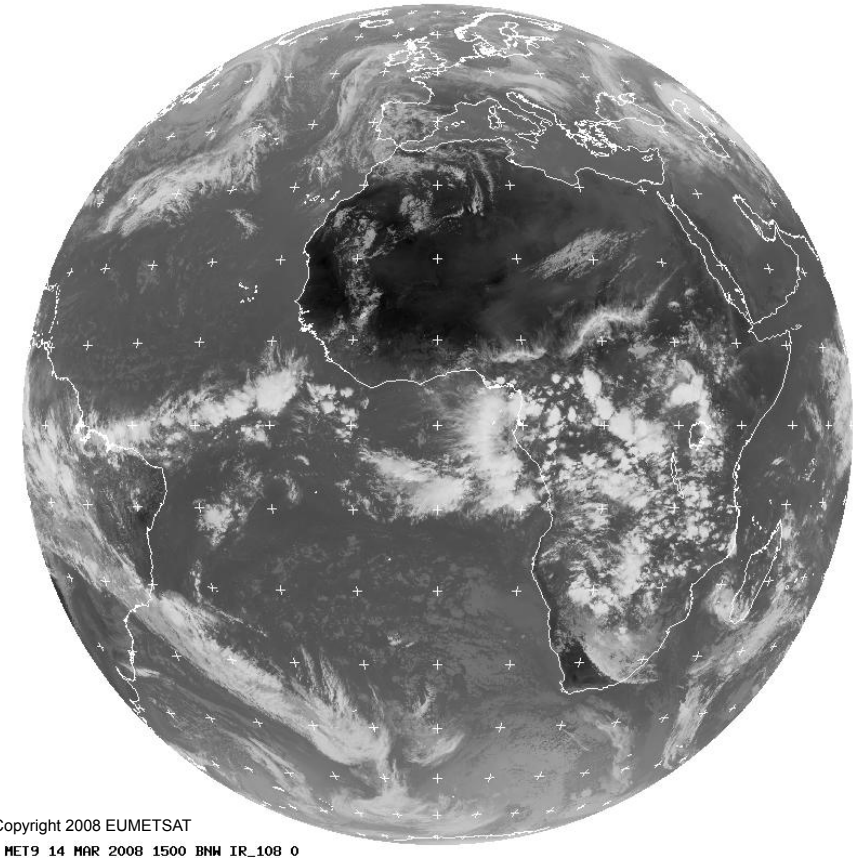
… Food and Water Security

Meteosat Coverage

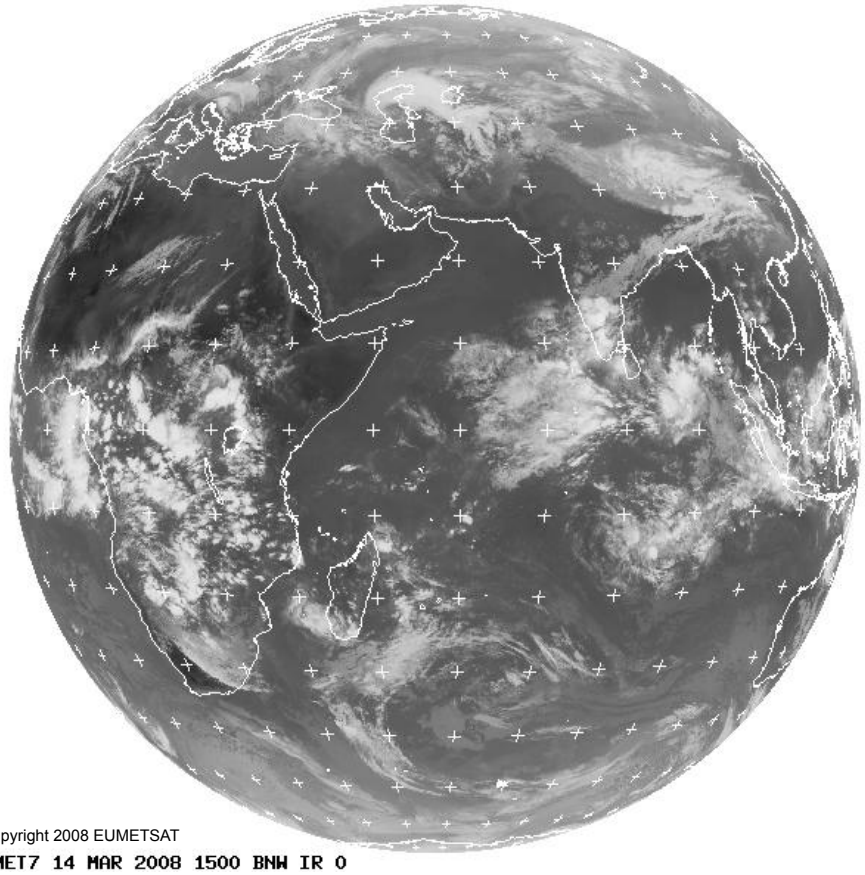
EUMETSAT

Monitoring weather and climate from space

Surveiller le temps et le climat depuis l'espace

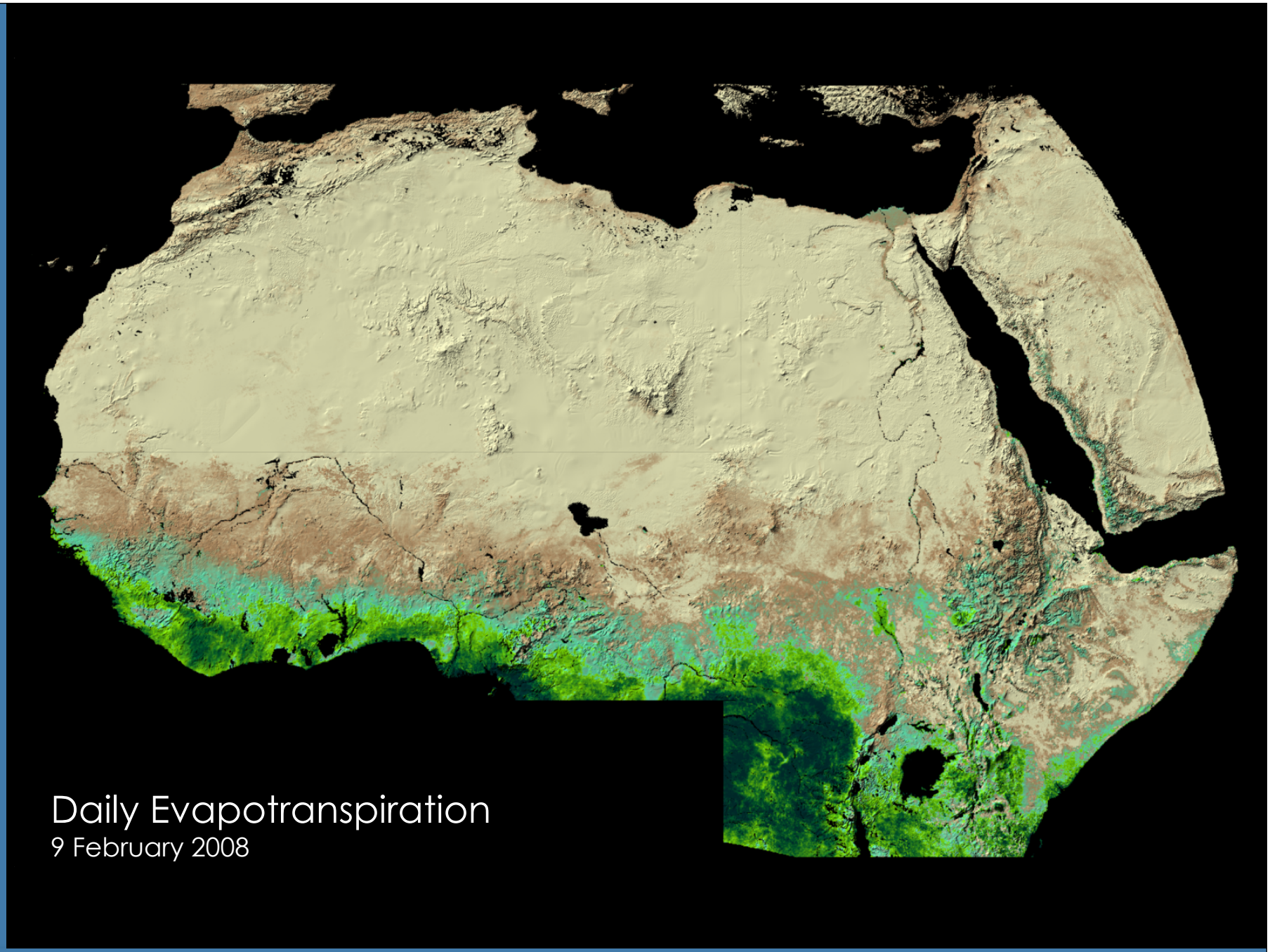


0° Operational

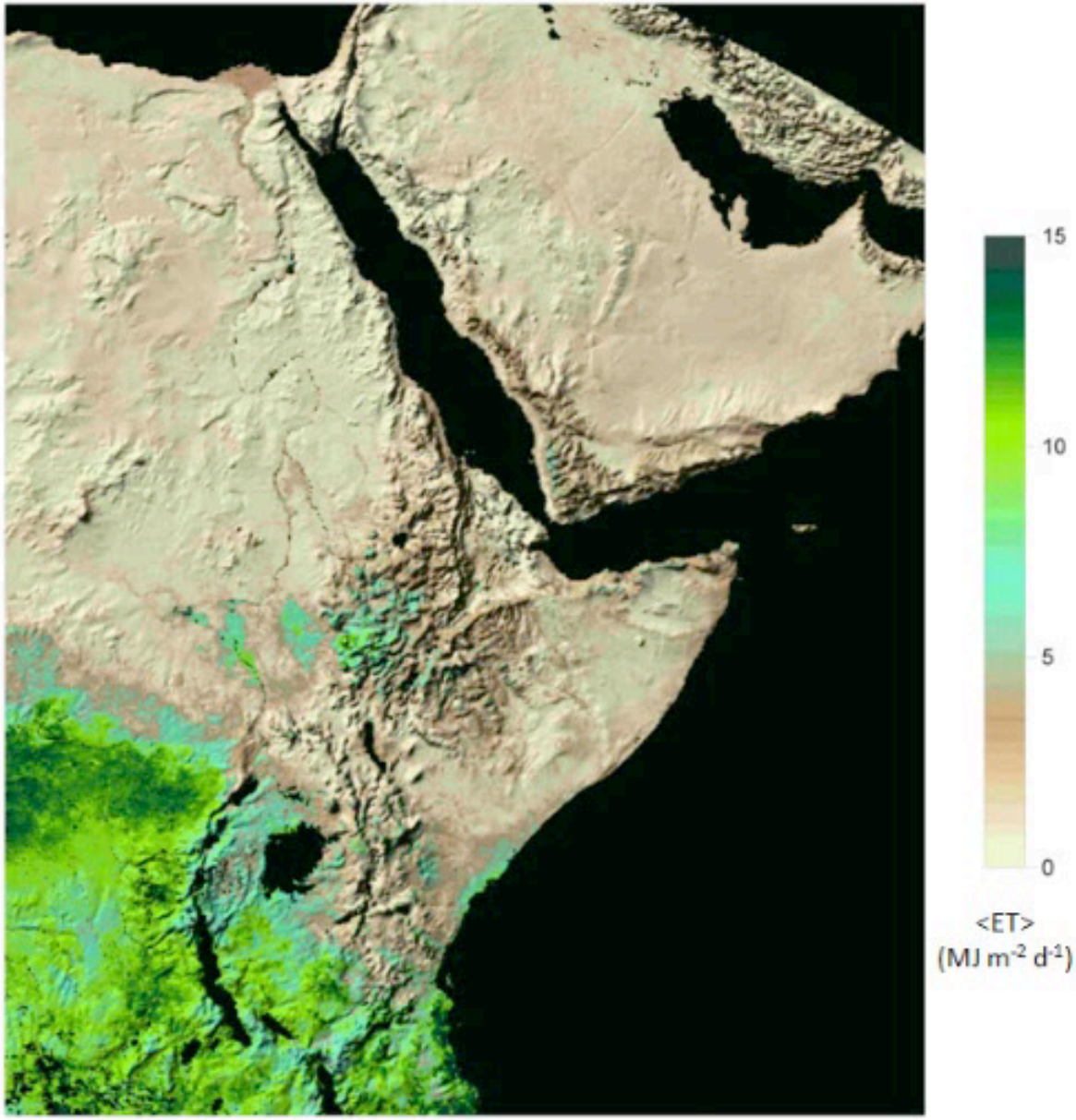


Indian Ocean

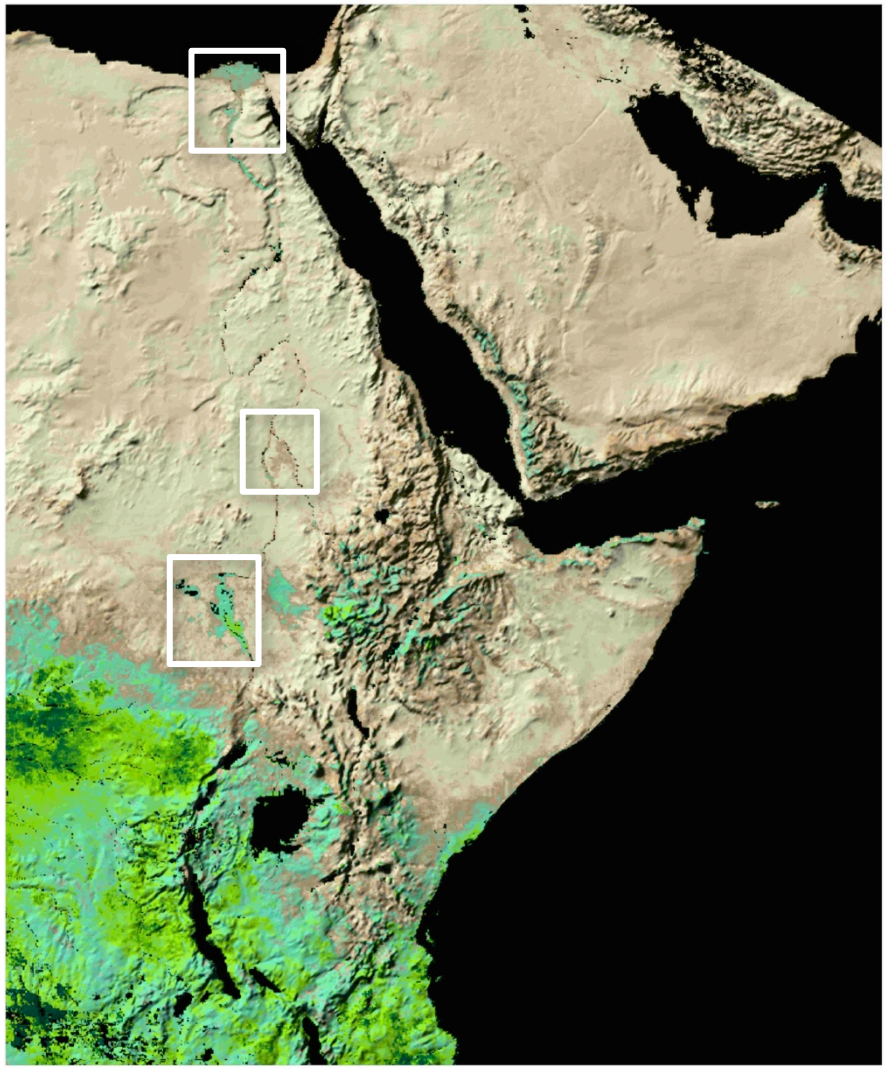
ALEXI ET over MENA Region



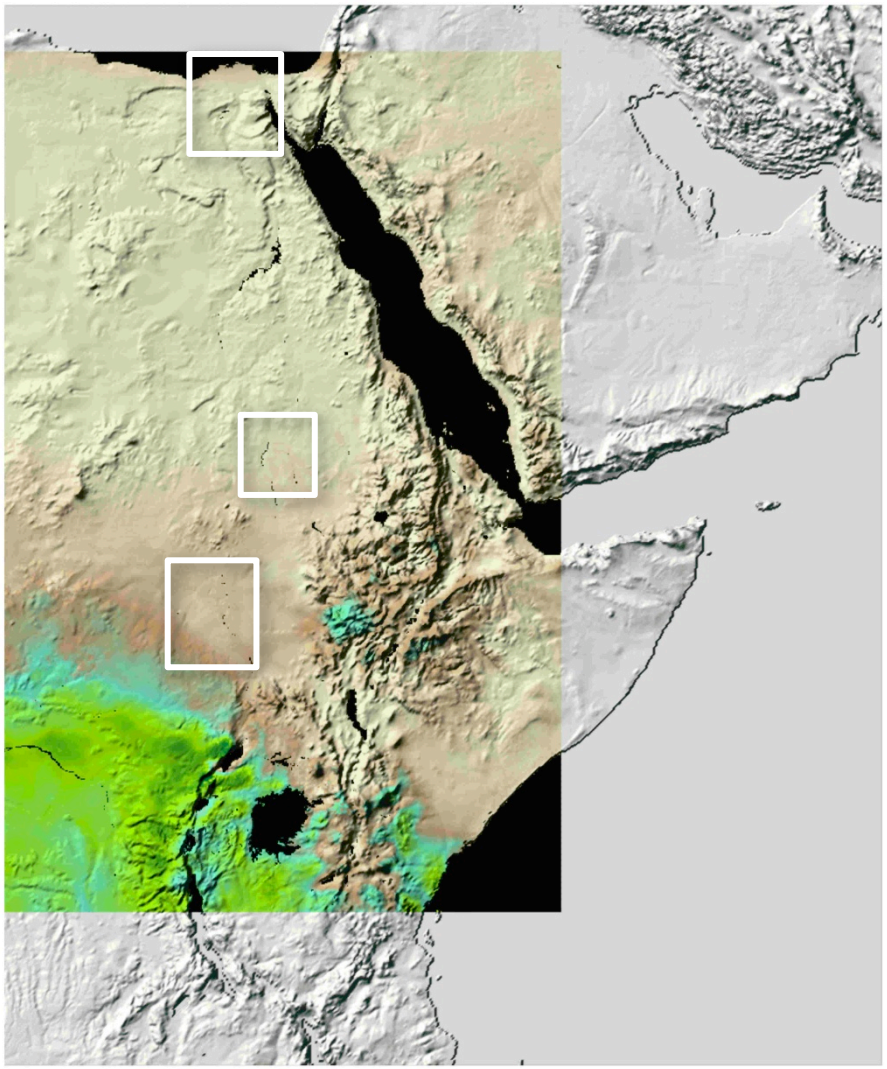
2009 JANUARY MONTHLY AVERAGE LATENT HEAT



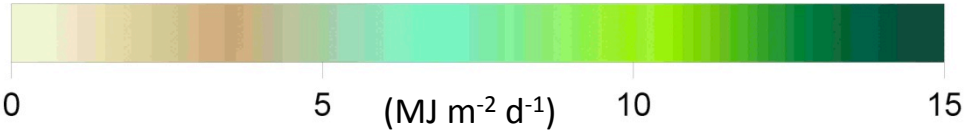
2009 FEBRUARY

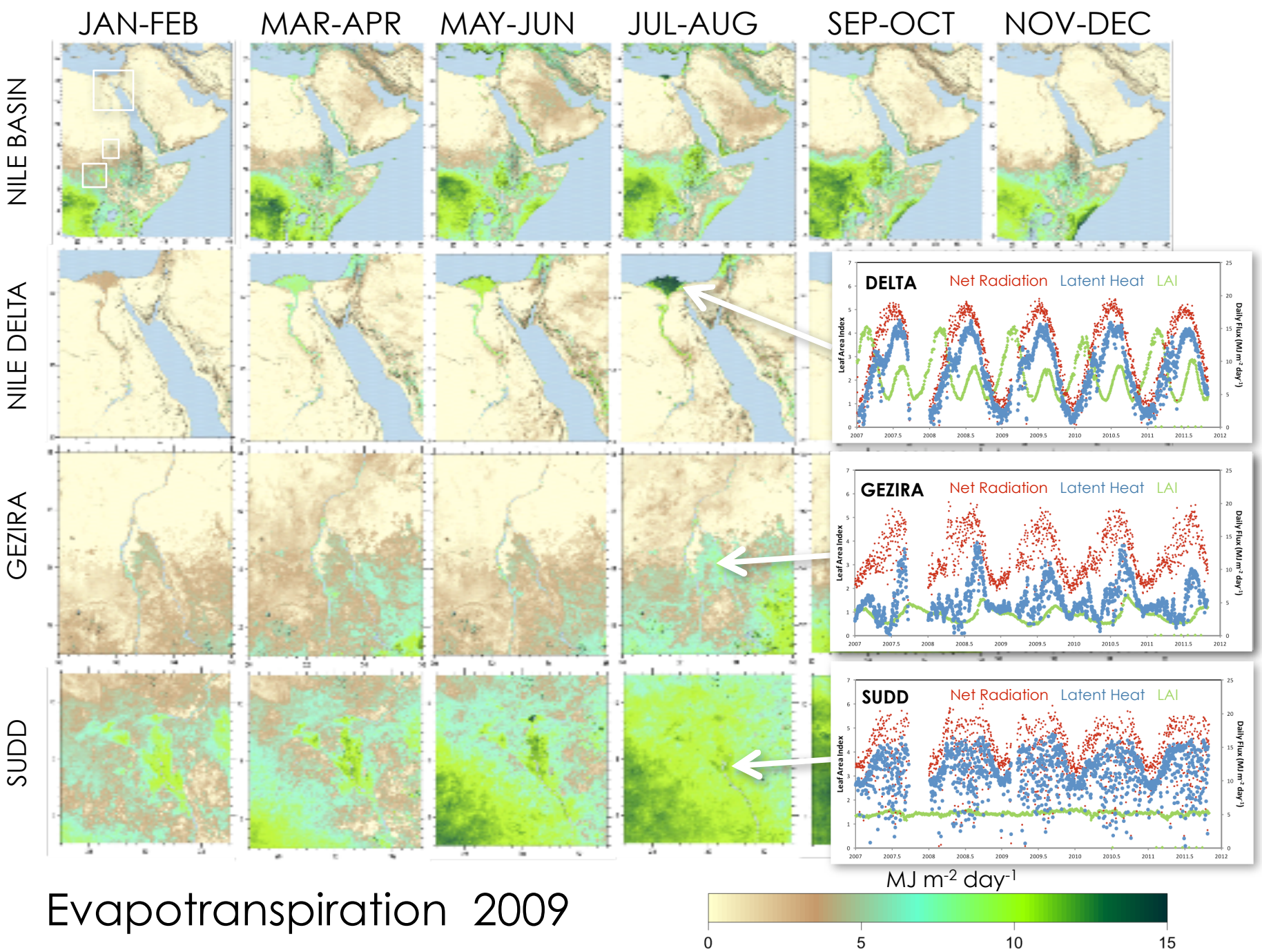


Average ALEXI ET

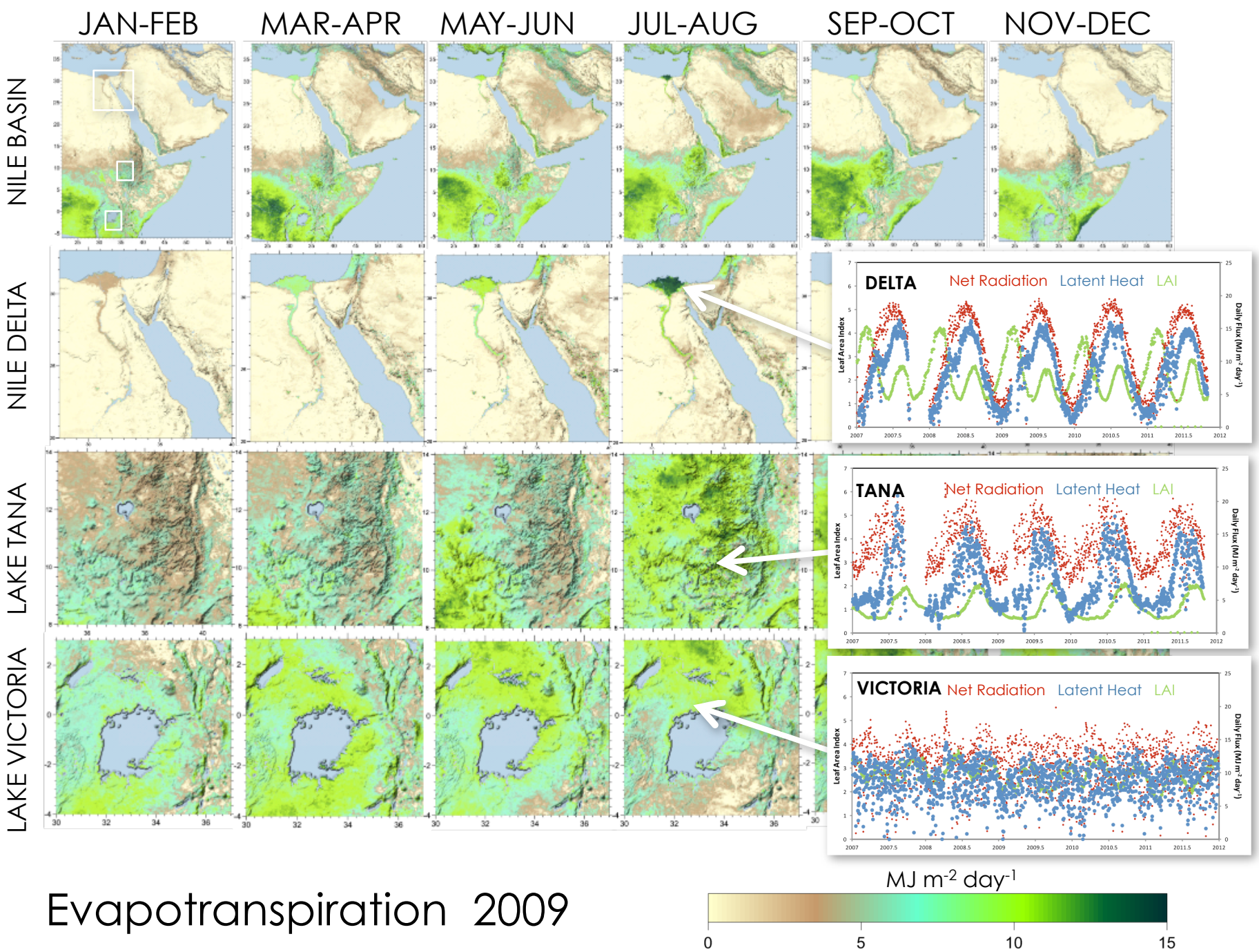


Average Noah ET



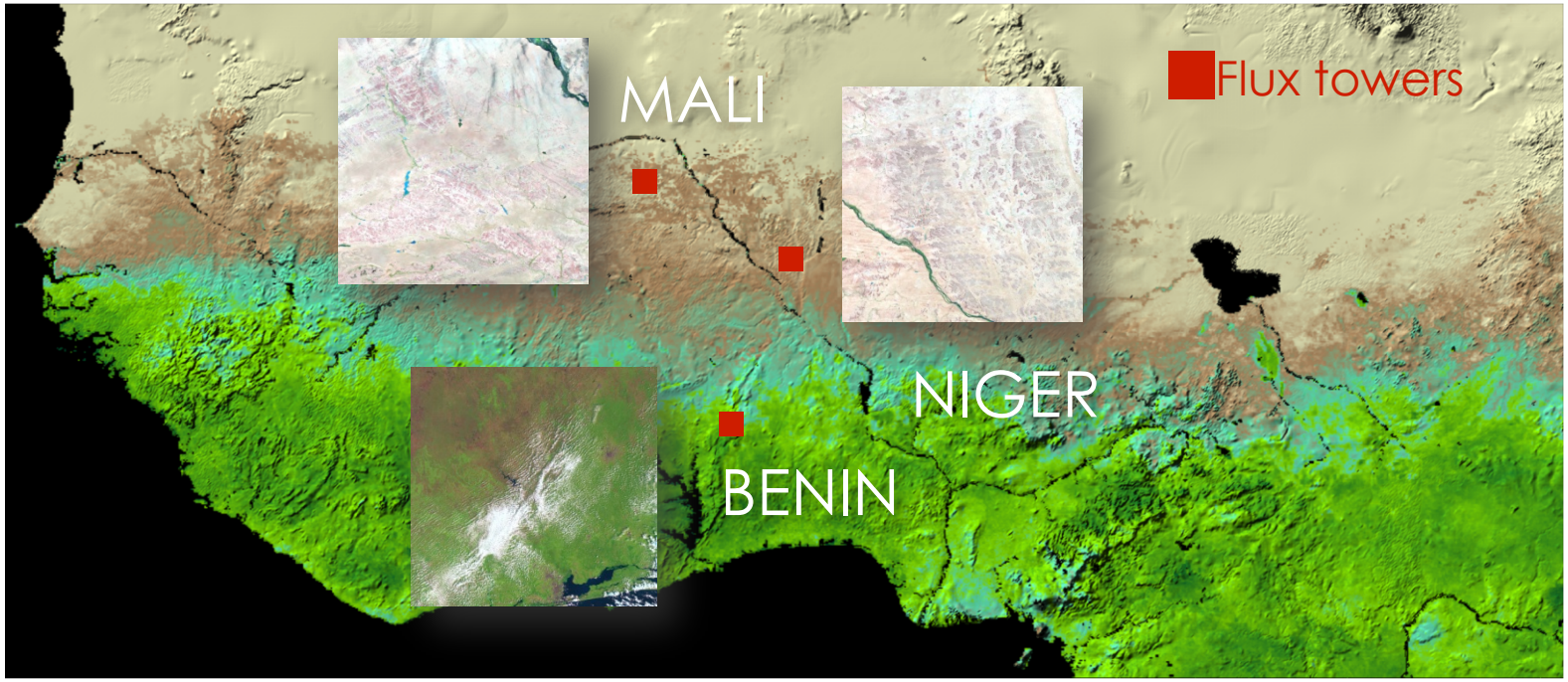


Evapotranspiration 2009

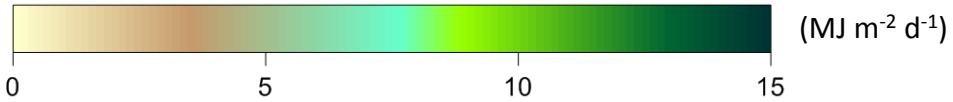


Evapotranspiration 2009

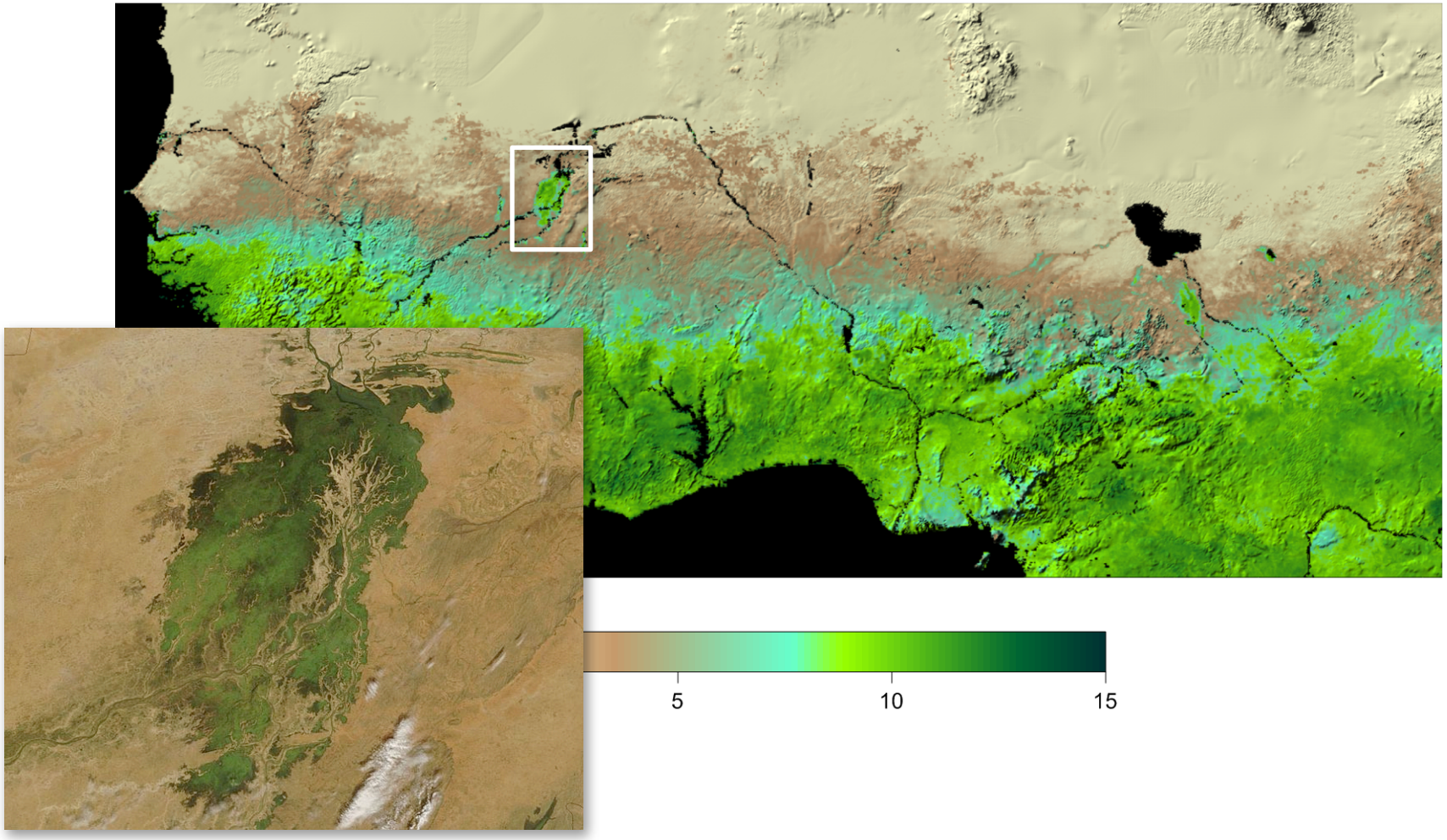
ALMIP AMMA Land Surface Model Intercomparison Project



African Monsoon Multidisciplinary Analysis (CNRM, CESBIO)



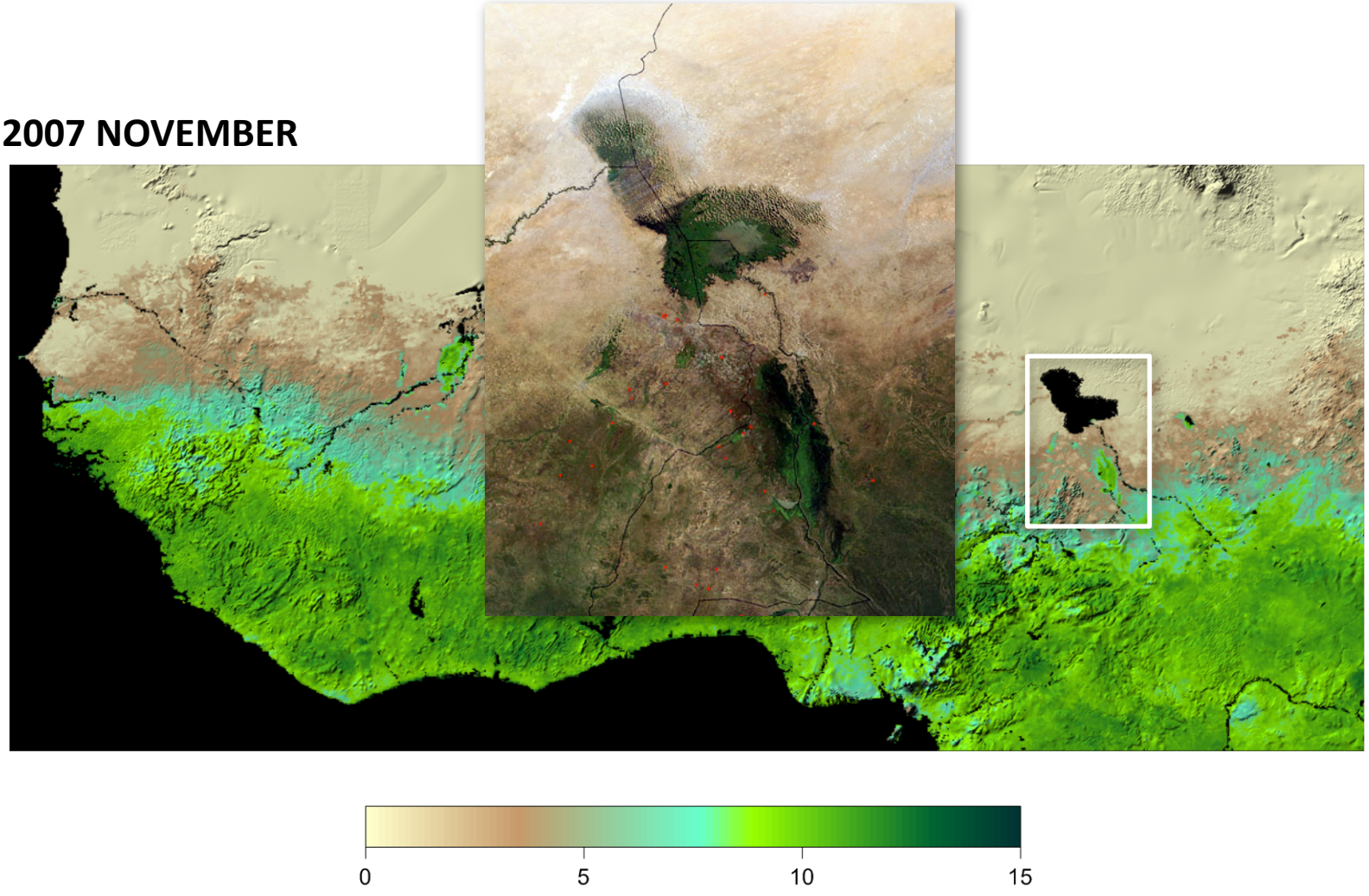
2007 NOVEMBER



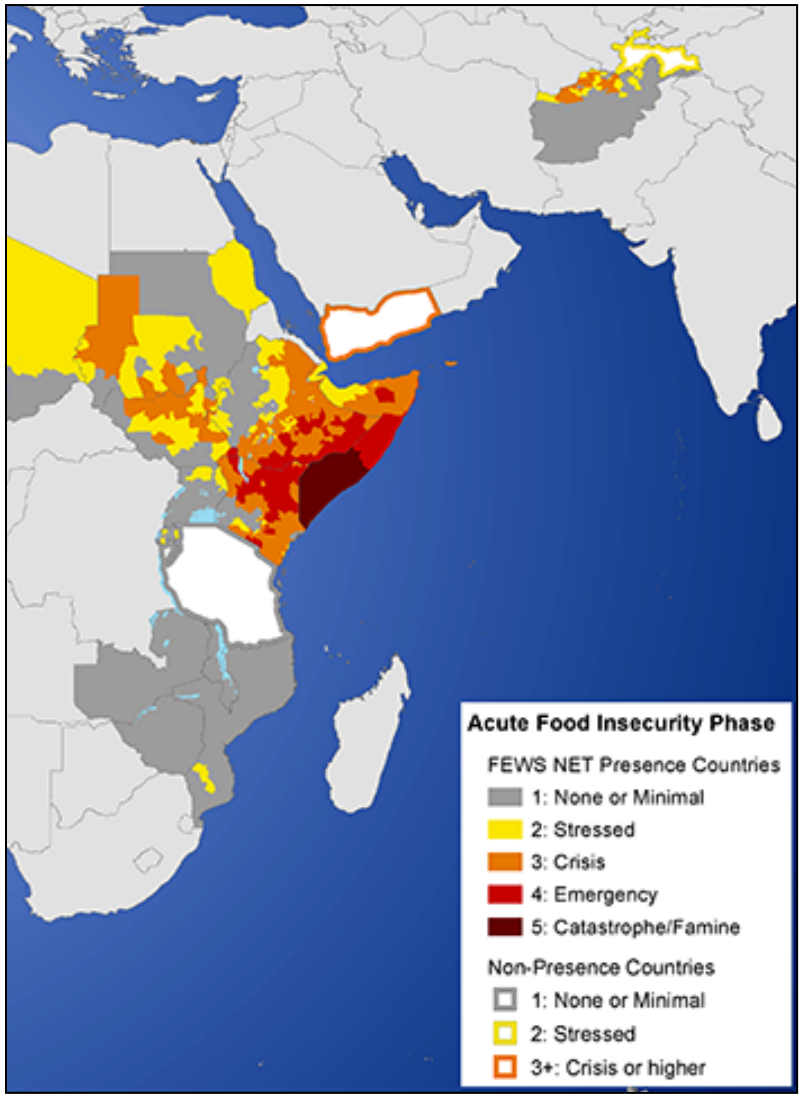
Inland Niger Delta, MODIS

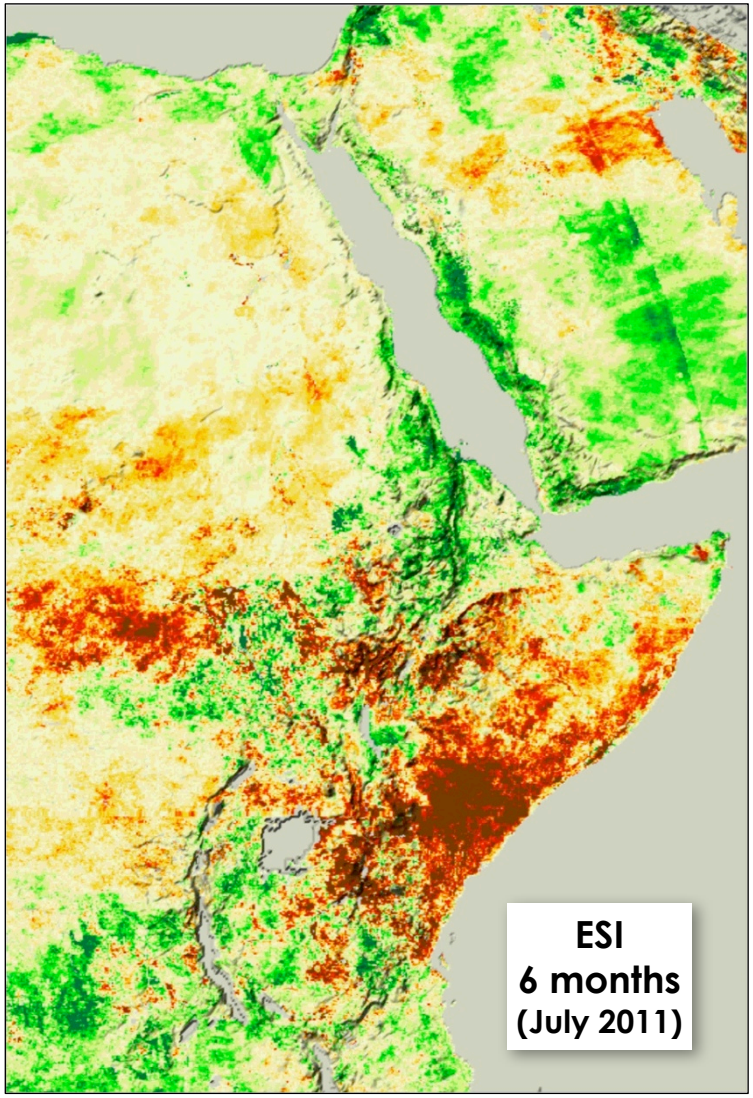
Lake Chad and Logone floodplain, MODIS

2007 NOVEMBER



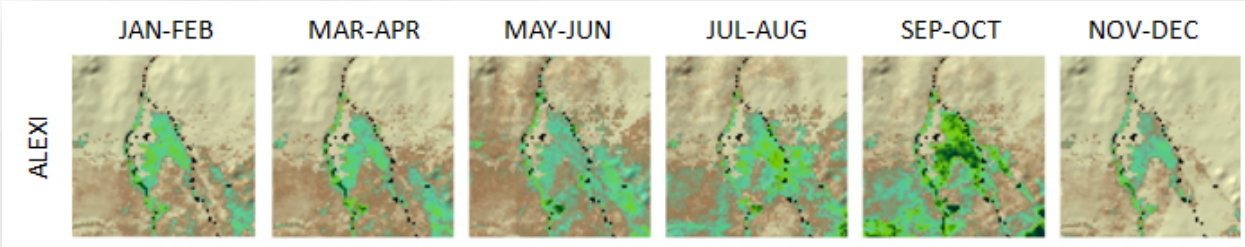
2011 Famine in Somalia



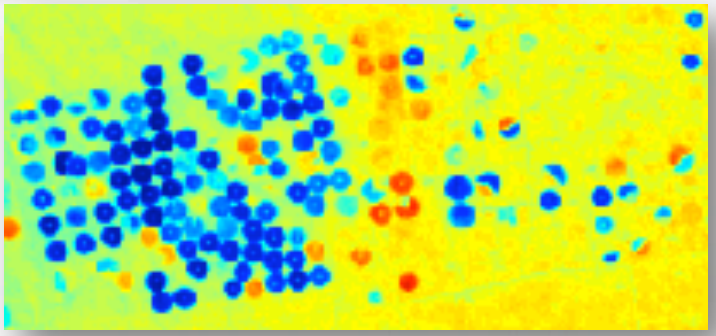


Areas for collaboration

- Evaluate regional water use (existing 3-km maps)



- Investigate patterns in water use across irrigation districts (Landsat, 30 m)



- Conduct quantitative validation at measurement sites

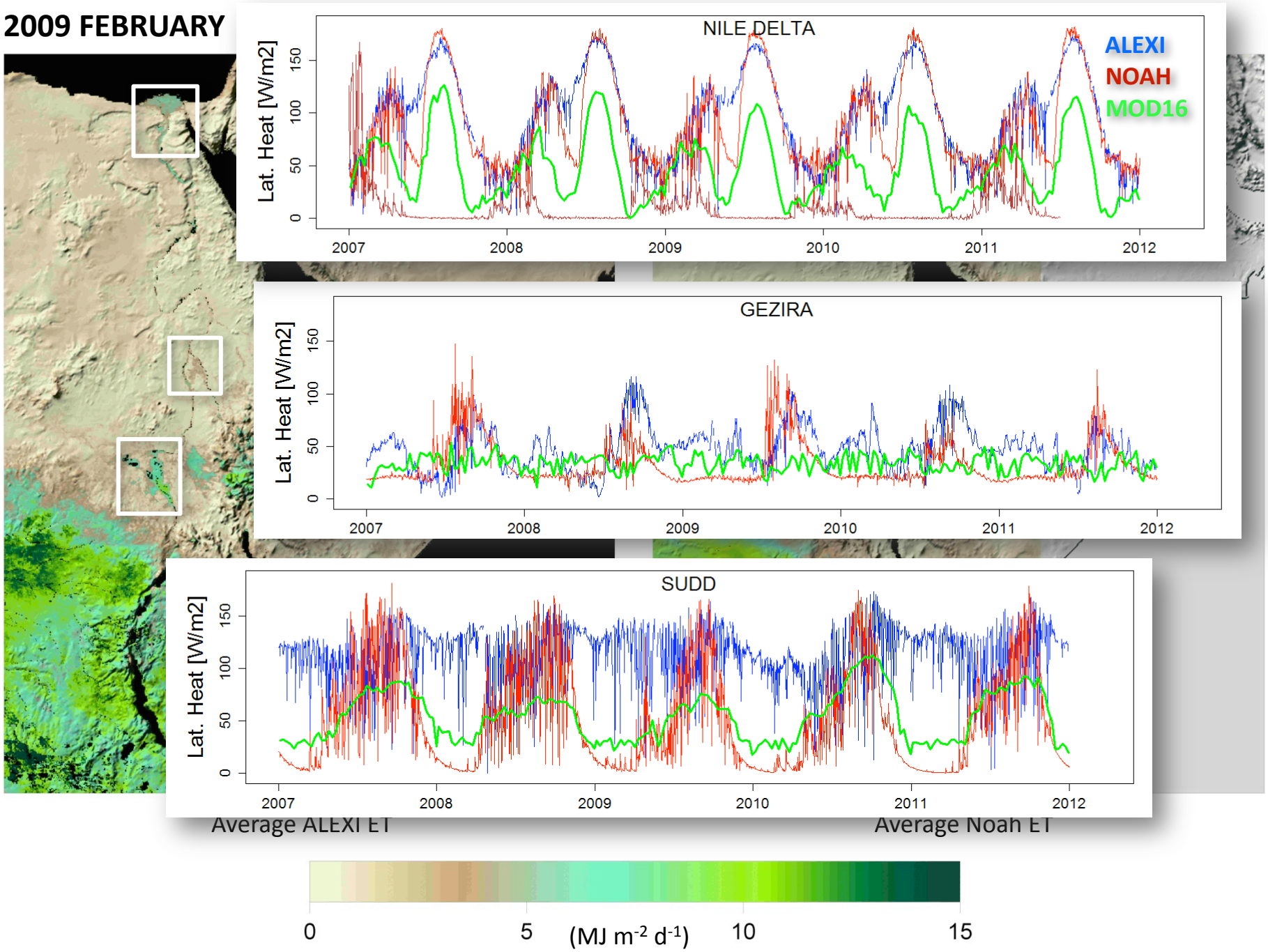
Conclusions

Satellite Evapotranspiration

- Monitoring water use at field to continental scales
- Land-surface temperature conveys early warning of vegetation stress
- Independent check on precipitation-based drought indices
- Applications in global water and food security

hrsl.arsusda.gov/drought

USDA is an equal opportunity provider and employer.


2009 FEBRUARY
NILE DELTA
ALEXI
NOAH
MOD16
Lat. Heat [W/m2]
0
50
100
150
2007
2008
2009
2010
2011
2012
GEZIRA
SUDD
Average ALEXI ET
Average Noah ET
0
5
10
15
(MJ m-2 d-1)