Mapping ET at National Scale using Multi-Satellite Imaging

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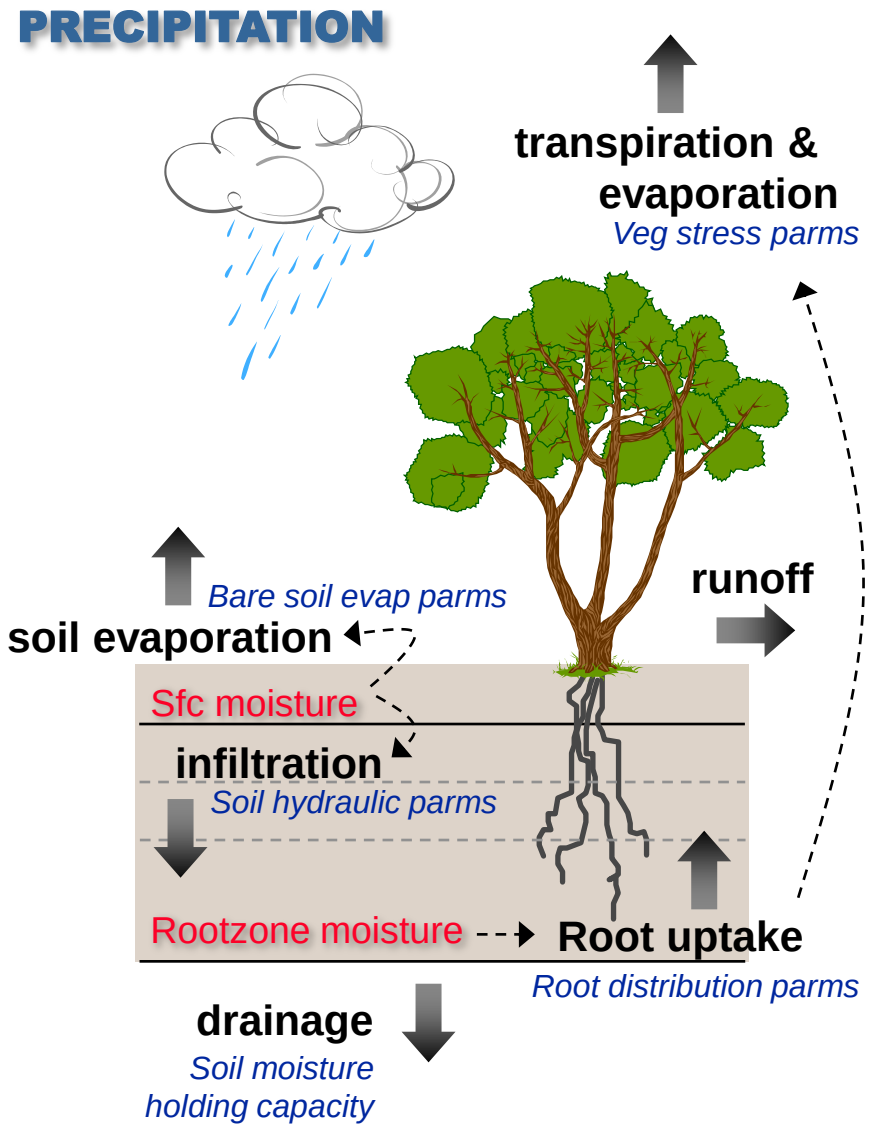
WATER ACCOUNTING AND FOOD SECURITY

- Monitoring changes in water use with changing climate, land-use and population
- Improved hydrologic monitoring (flood, drought, runoff) to better cope with extremes
- Improved accounting of current water use and crop water productivity (crop per drop)
- Crop stress detection and yield estimation

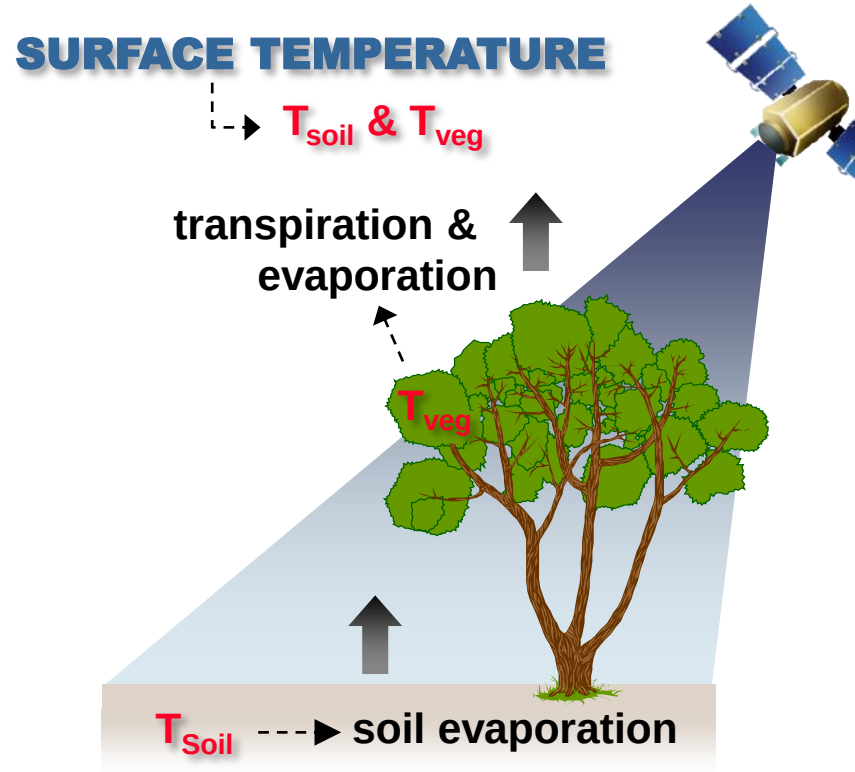
We can't manage what we can't measure …

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)

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

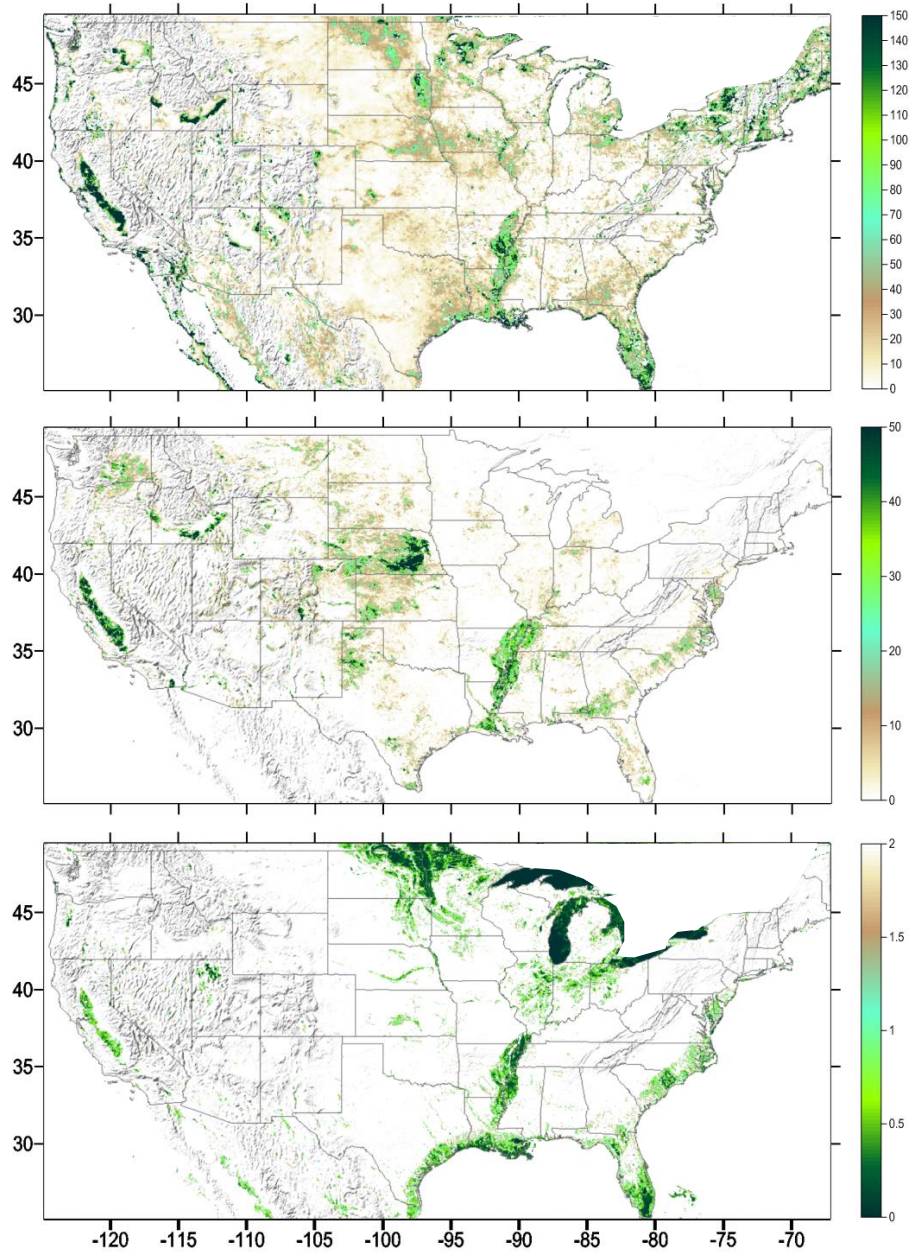
(Green indicates energy balance ET is persistently wetter than expected based on local water balance)

Differences are primarily related to:

% Irrigation

Depth to water table (m)

(as well as density of subpixel water bodies)

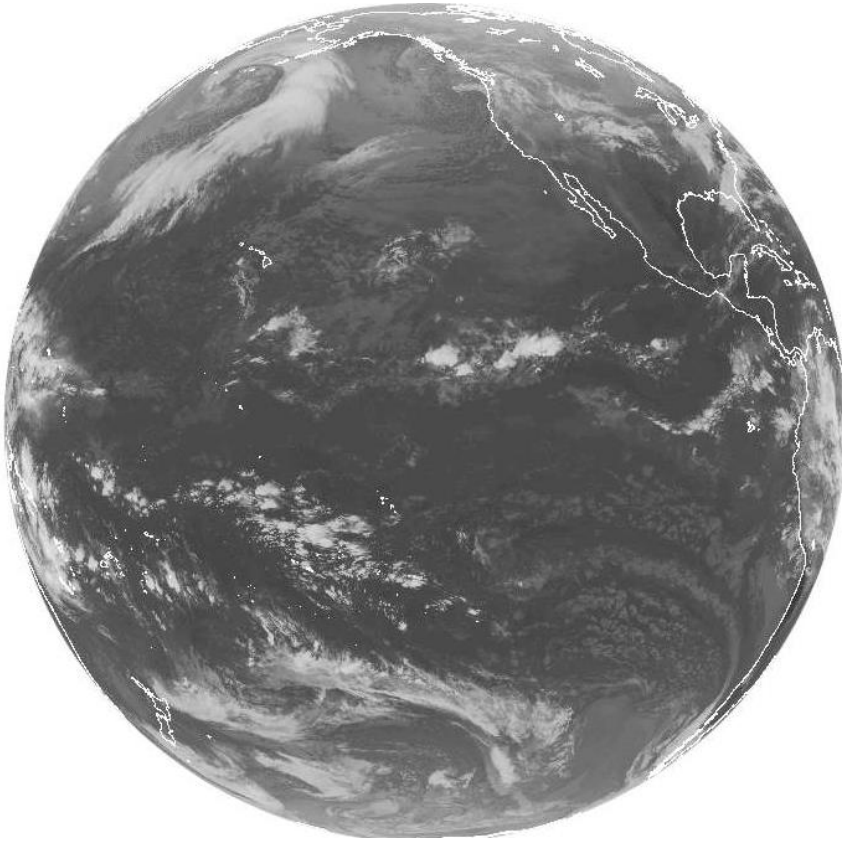


Hain, et al. (2014)

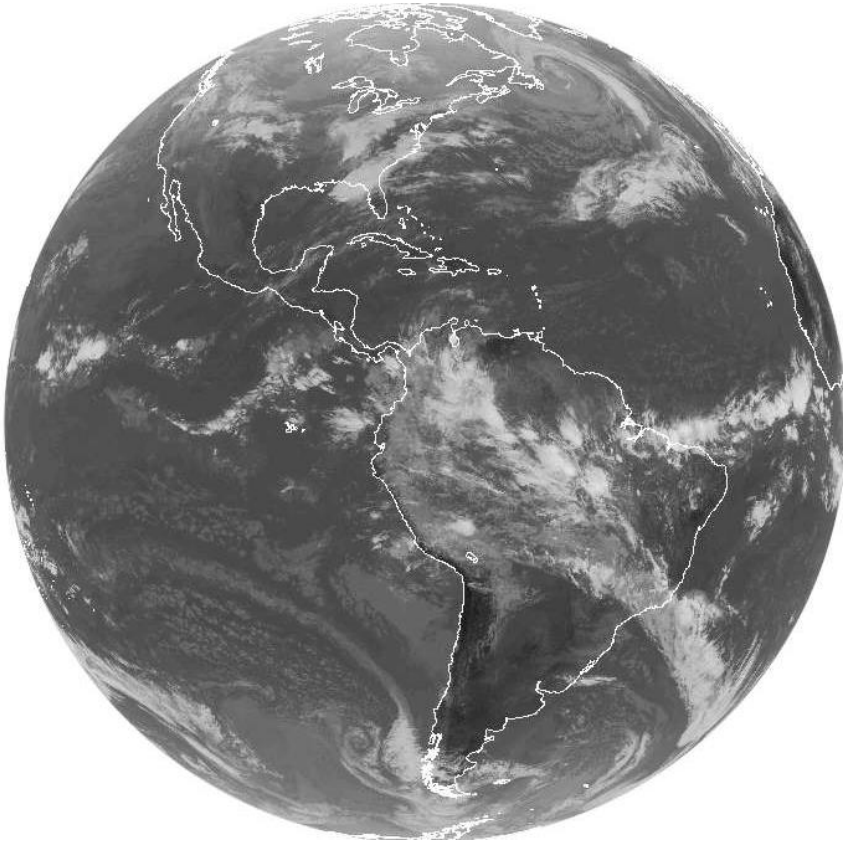
GOES coverage (15-minute images)

Geostationary Operational Environmental Satellites

NOAA NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
UNITED STATES DEPARTMENT OF COMMERCE

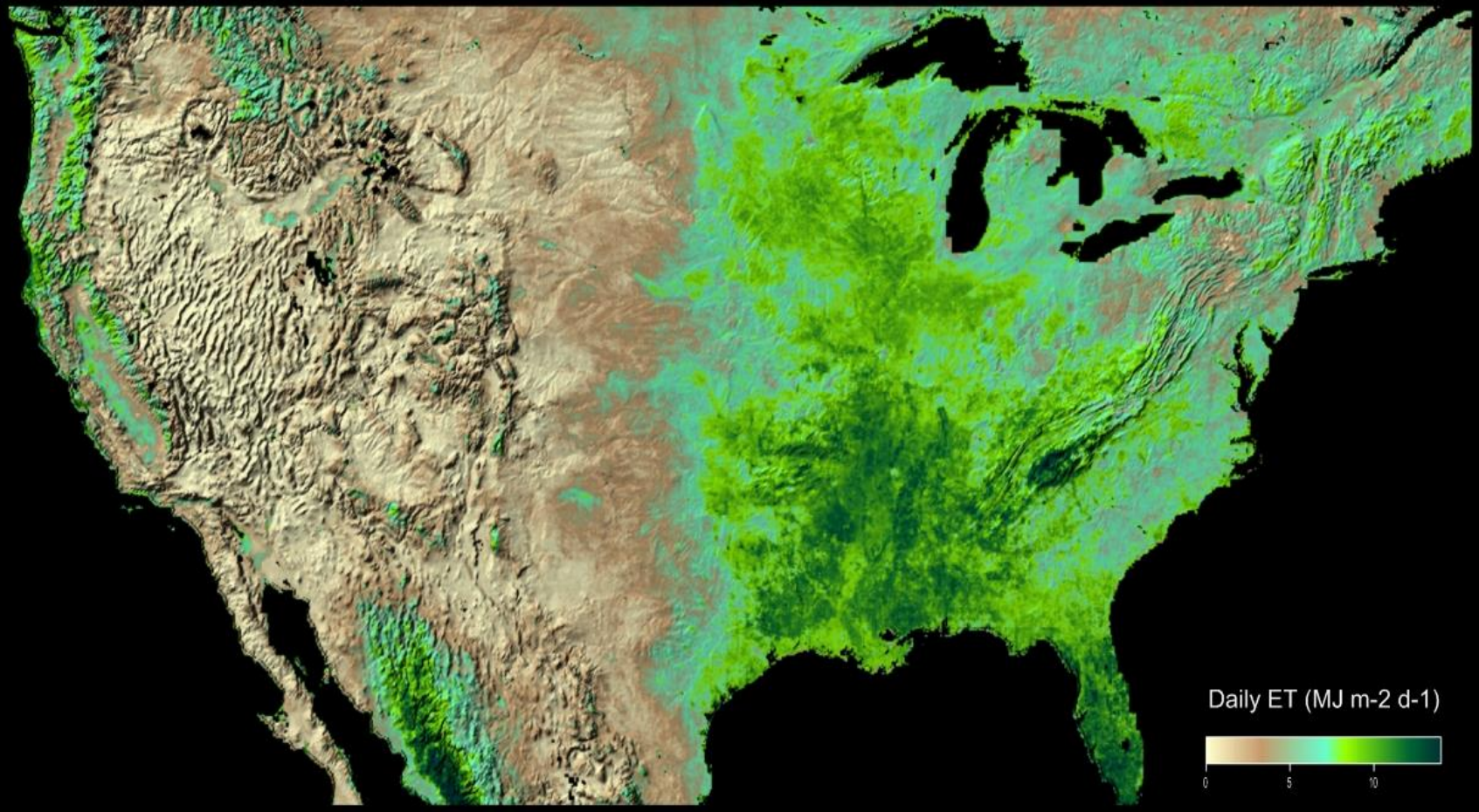


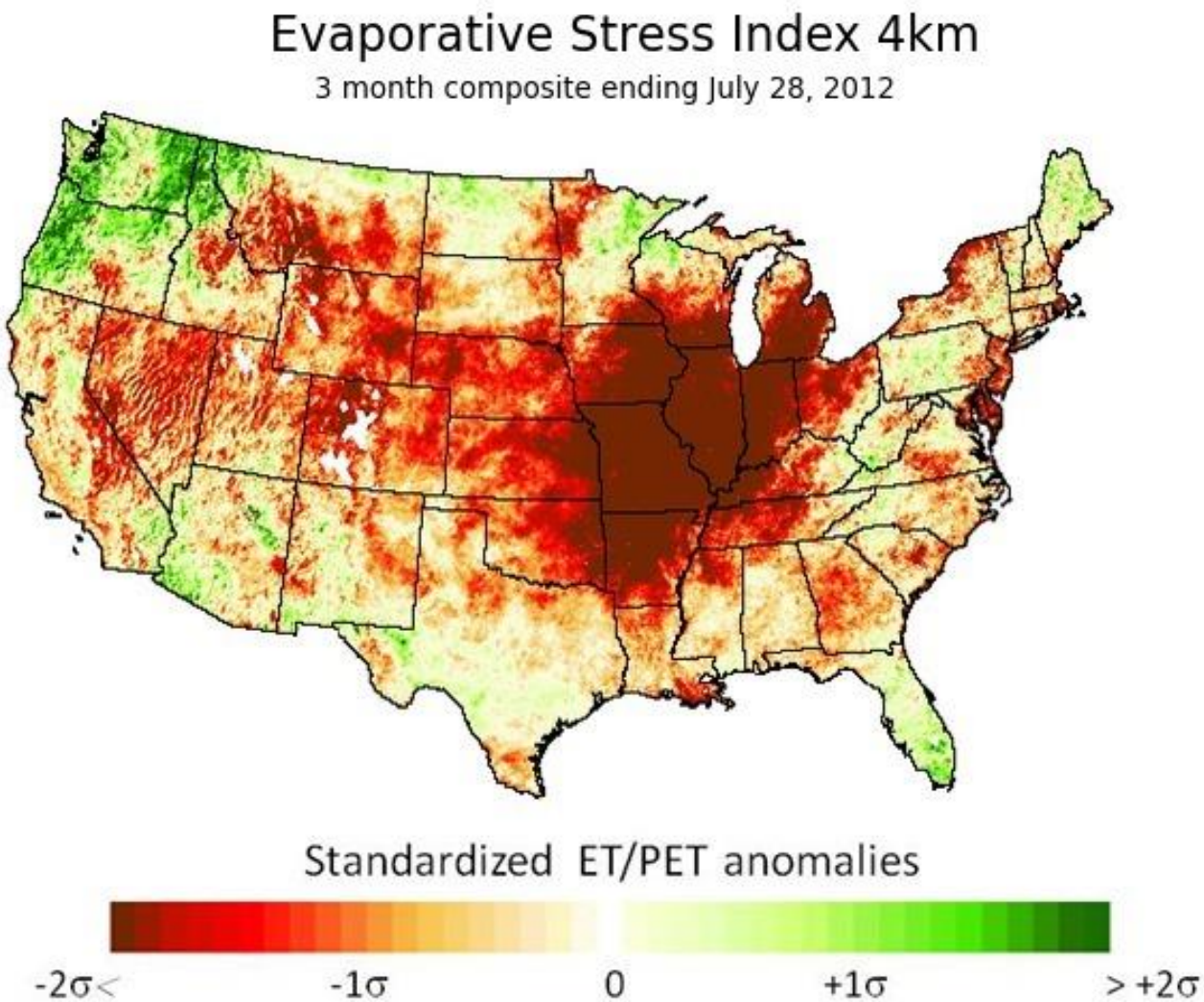
GOES – West
(Pacific)



GOES – East
(Atlantic)

4km Daily Evapotranspiration AUG 2002

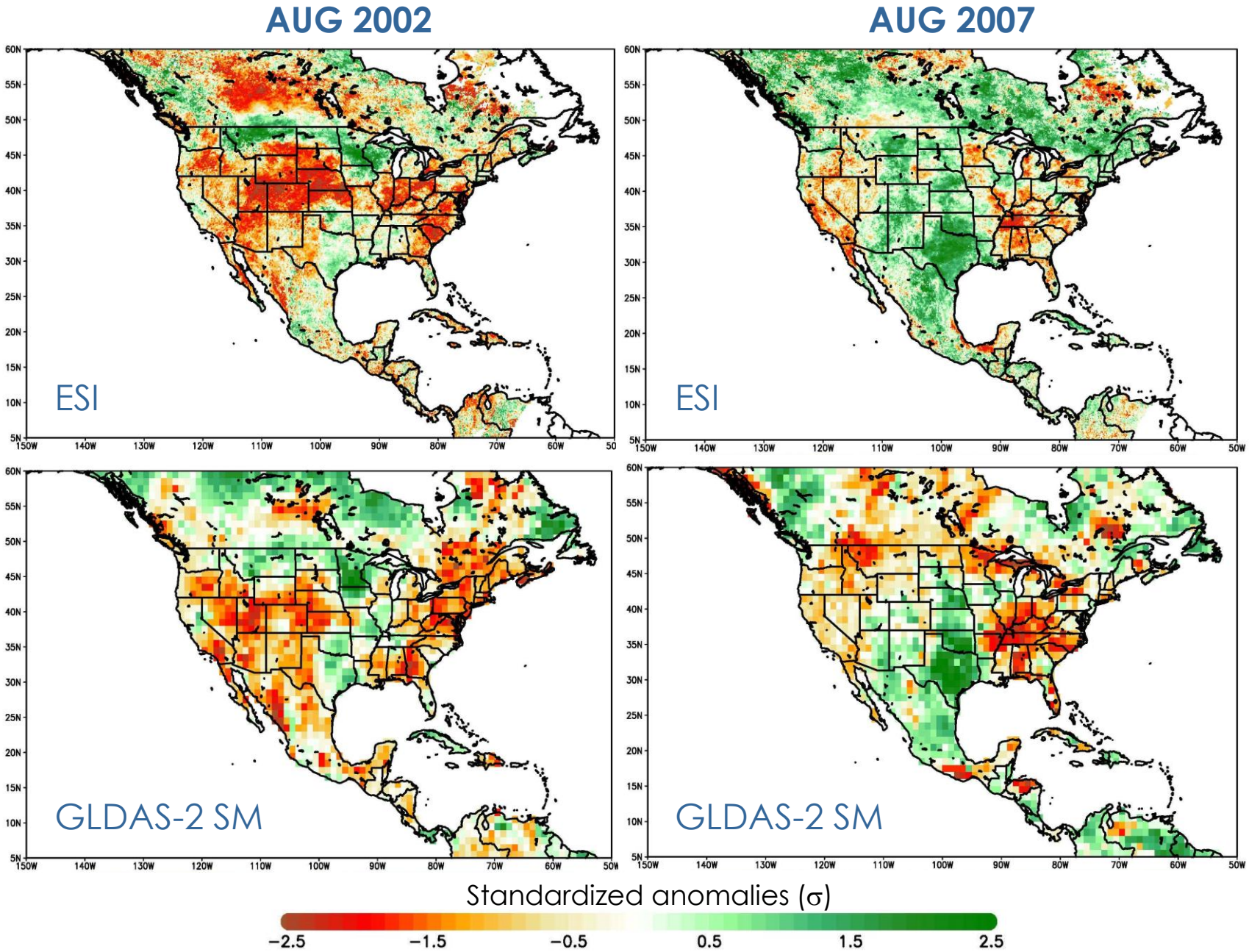




Atmosphere-Land Exchange Inverse Model (ALEXI)

(Anderson et al., 1997, 2007)

North American ESI (GET-D)

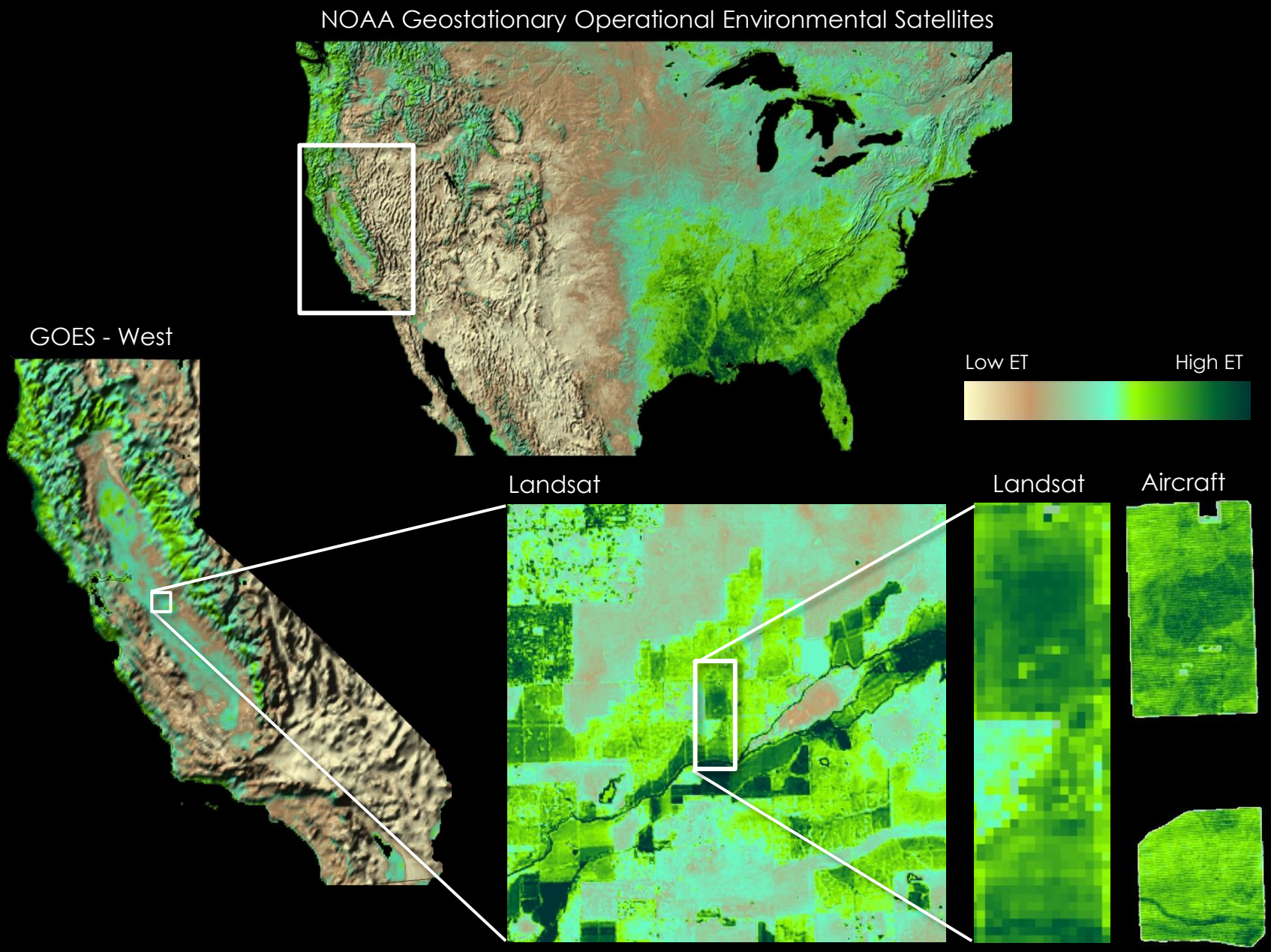


GET-D APPLICATIONS (N. AMERICA)

NOAA (NESDIS/NCEP/CPC/CPO)

- Independent evaluation of NCEP Noah landsurface model ET and soil moisture
- Input to N. American Drought Briefing, N. American Drought Monitor, NIDIS website (drought.gov), Agri-Food Canada
- Assimilation into numerical weather prediction models to improve short-term weather forecasts

Multi-sensor evapotranspiration



GET-D APPLICATIONS (N. AMERICA)

USDA (ARS/NASS/FAS/FS)

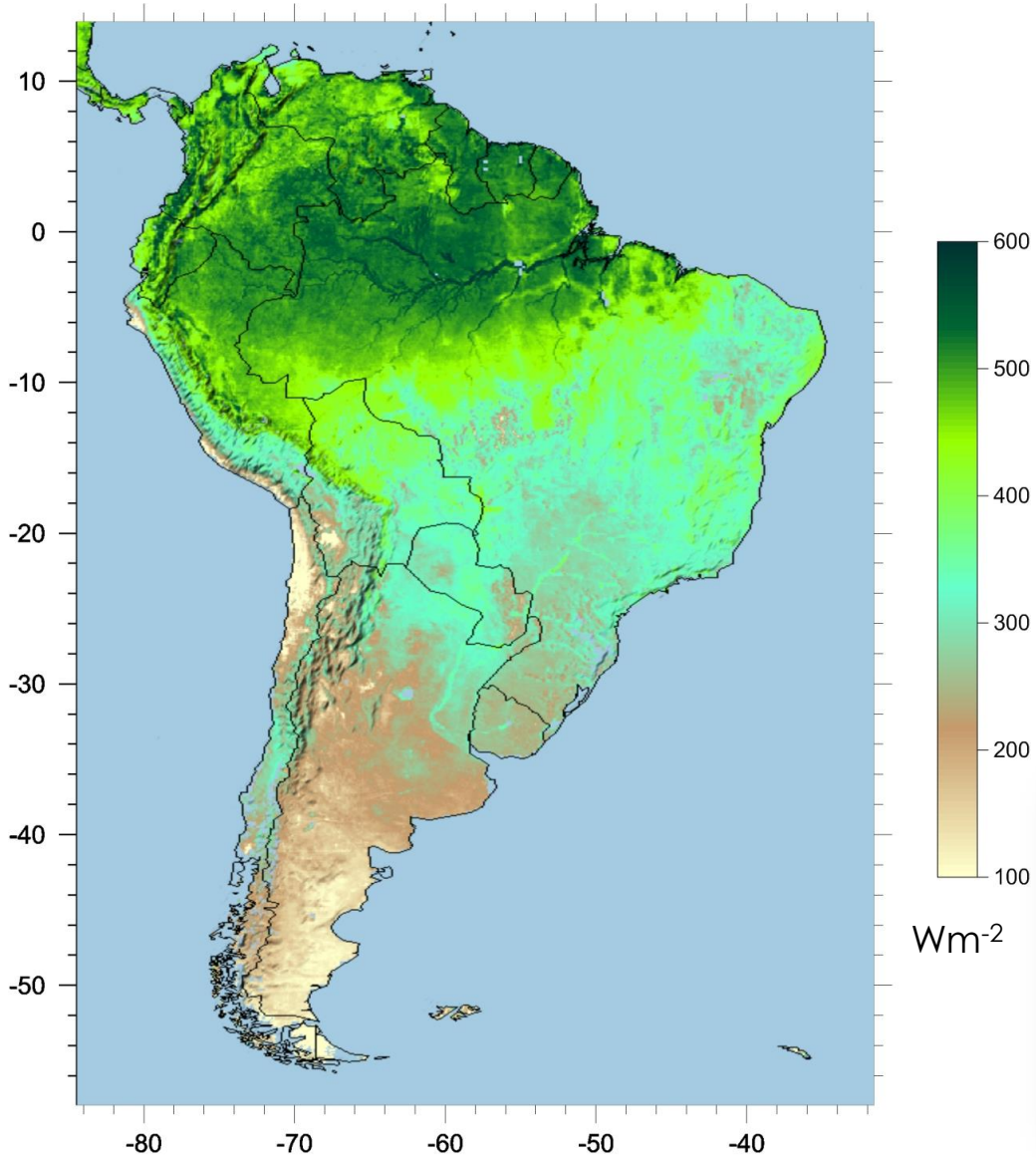
- Watershed-scale water balance in agricultural landscapes
- Impacts of irrigation and agricultural drainage on regional hydrology
- Plot-scale water-use, water-yield and stress dynamics (using Landsat for spatial disaggregation)
- Early crop stress detection and yield forecasting
- Identification of groundwater-dependent ecosystems

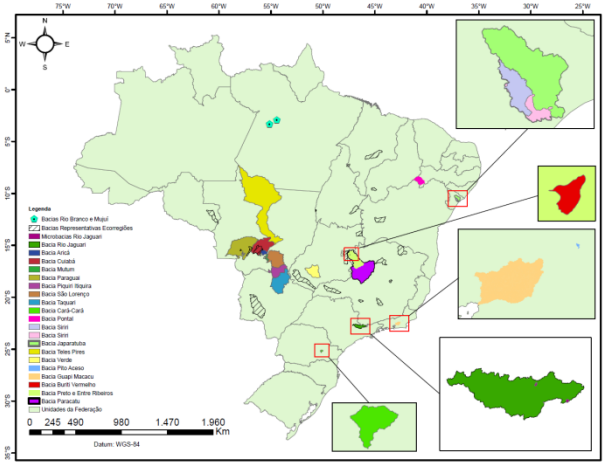
GLOBAL APPLICATIONS FOR SATELLITE ET

… South America/Brazil

Land-use impacts on water use

August-October composite of
clear-sky midday latent heat flux for 2013 (10 km)





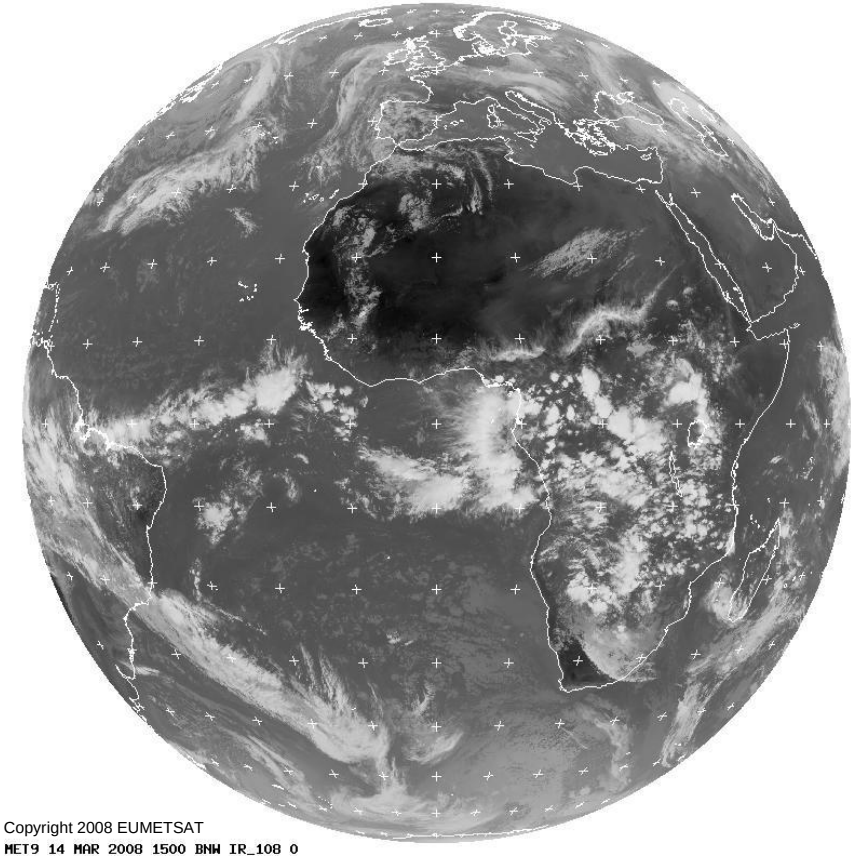
GLOBAL APPLICATIONS FOR SATELLITE ET

… *Africa/MENA*

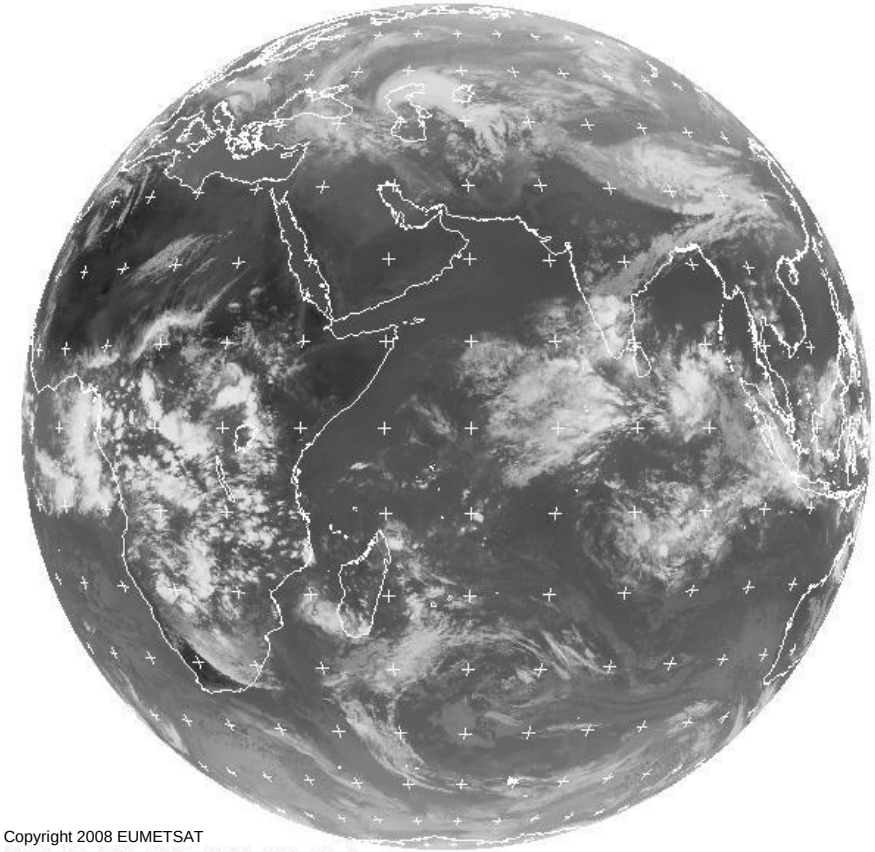
Meteosat Coverage

EUMETSAT

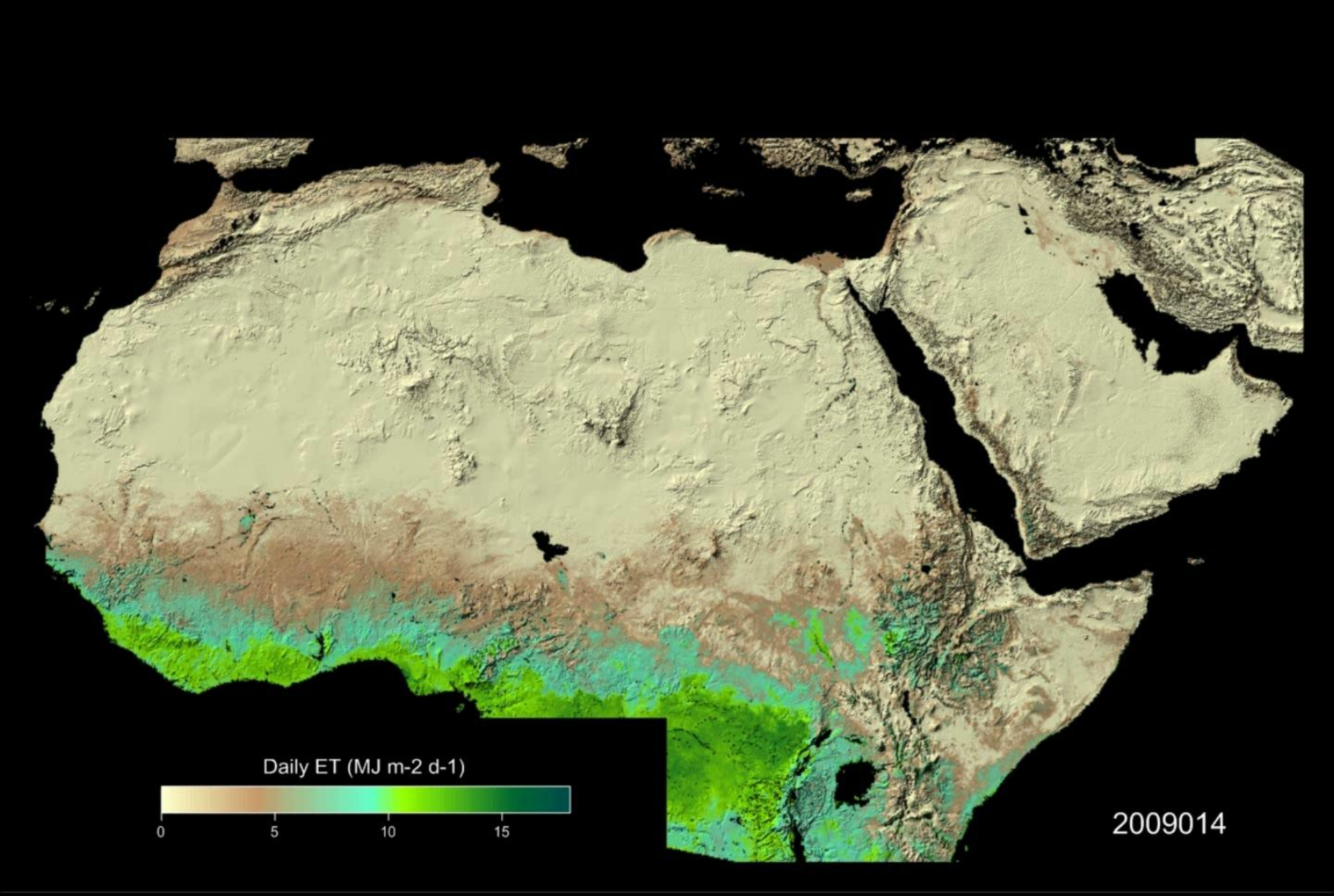
Monitoring weather and climate from space
Surveiller le temps et le climat depuis l'espace



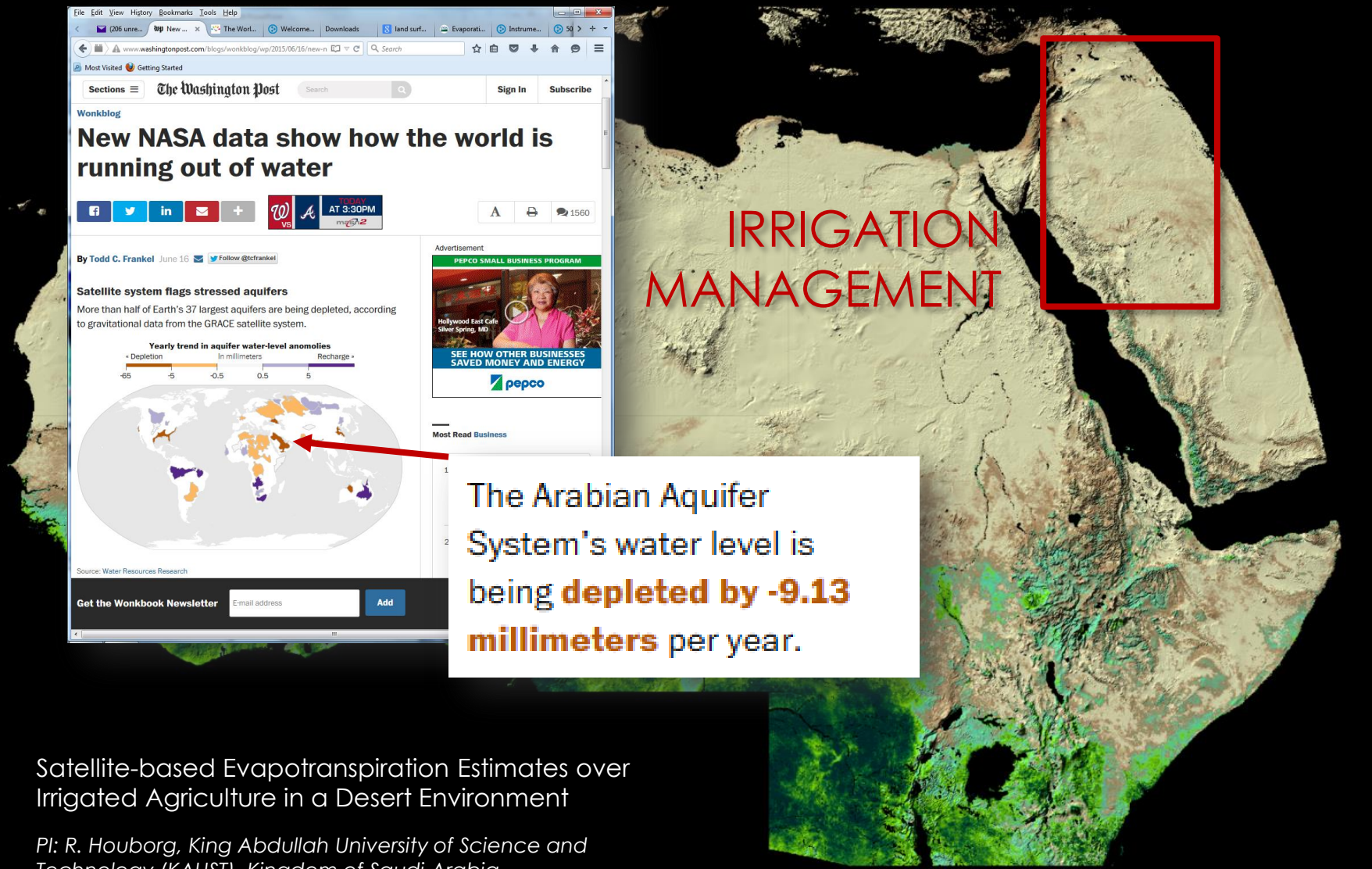
0° Operational



Indian Ocean


Daily ET (MJ m-2 d-1)
0
5
10
15
2009014

Groundwater extraction

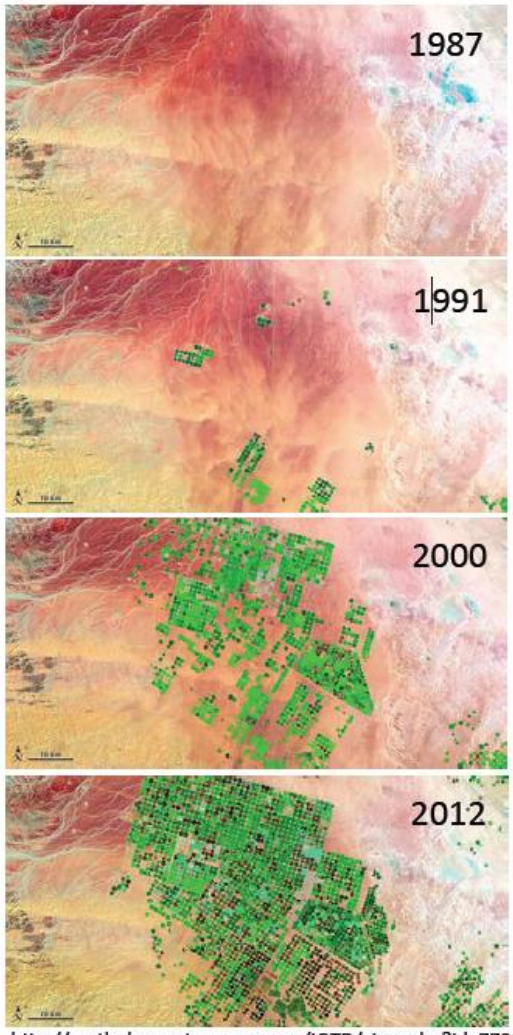


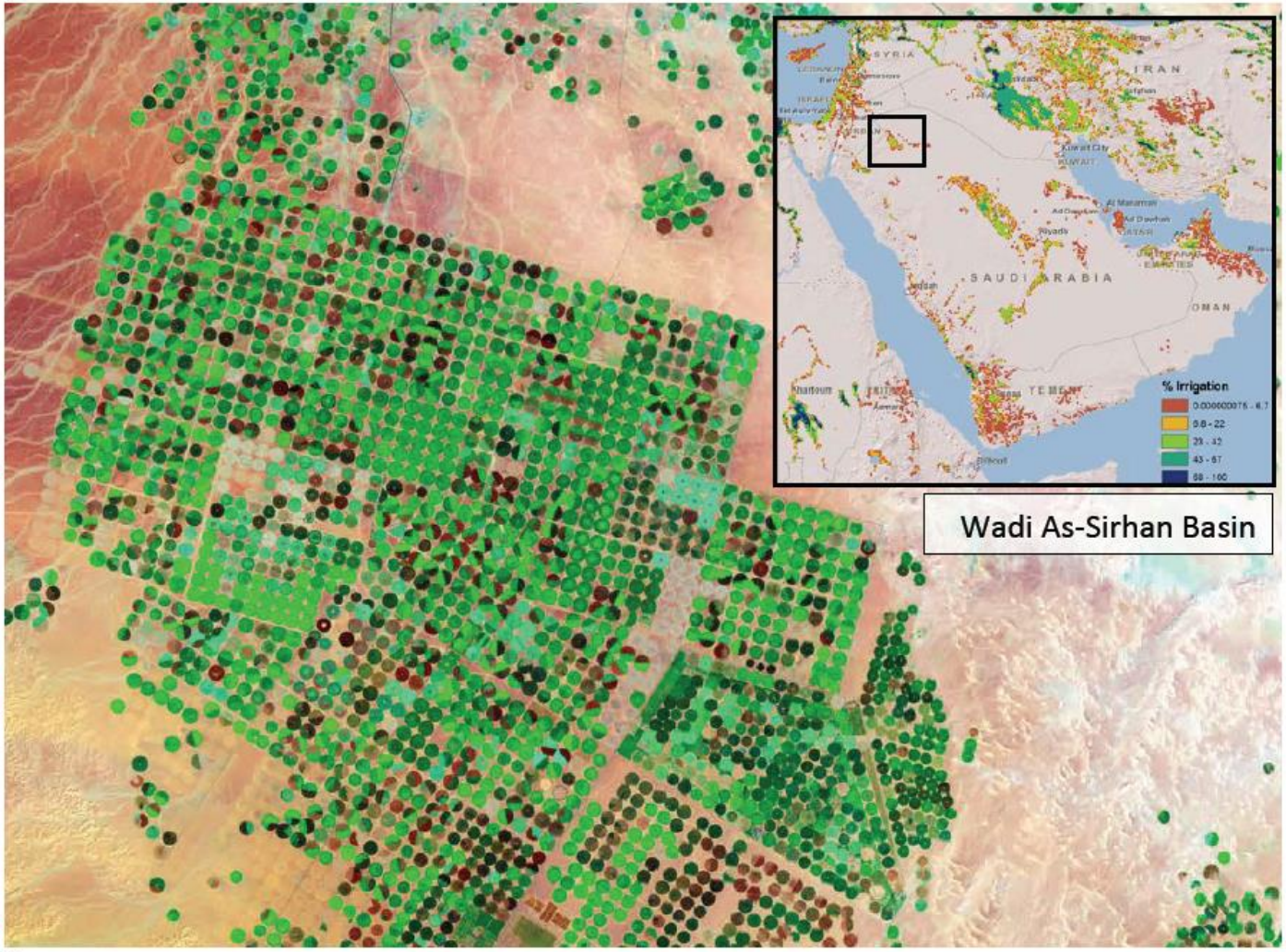
The Arabian Aquifer System's water level is being **depleted by -9.13 millimeters** per year.

Satellite-based Evapotranspiration Estimates over Irrigated Agriculture in a Desert Environment

PI: R. Houborg, King Abdullah University of Science and Technology (KAUST), Kingdom of Saudi Arabia

EXPANSION of IRRIGATION





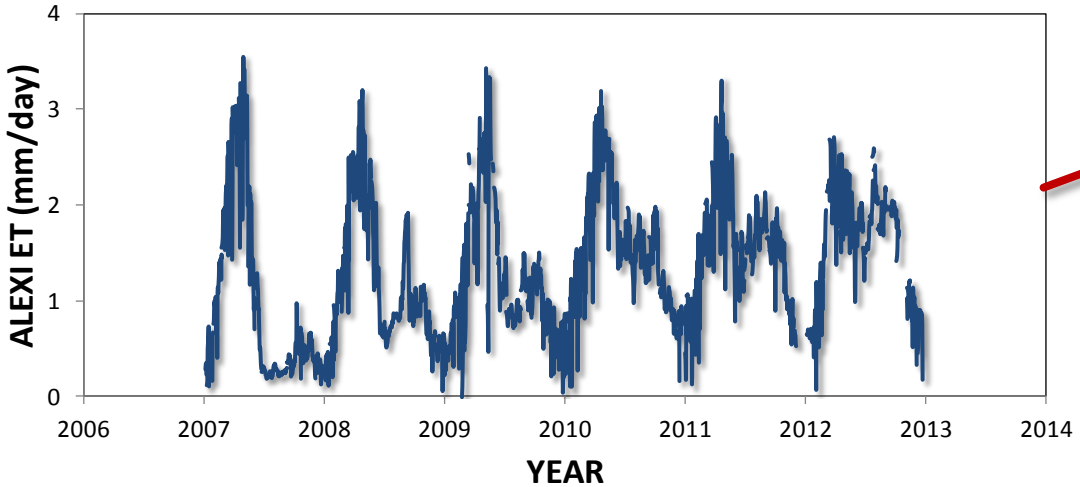
http://earthobservatory.nasa.gov/IOTD/view.php?id=77900

Landsats 4,5,7

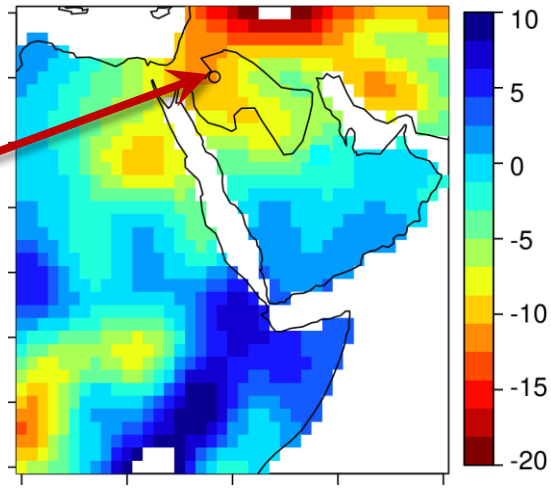
Visible, near IR bands: vegetation amount
Thermal band: water use

Water use by irrigation

ALEXI ET – AL JOWF IRRIGATION SITE

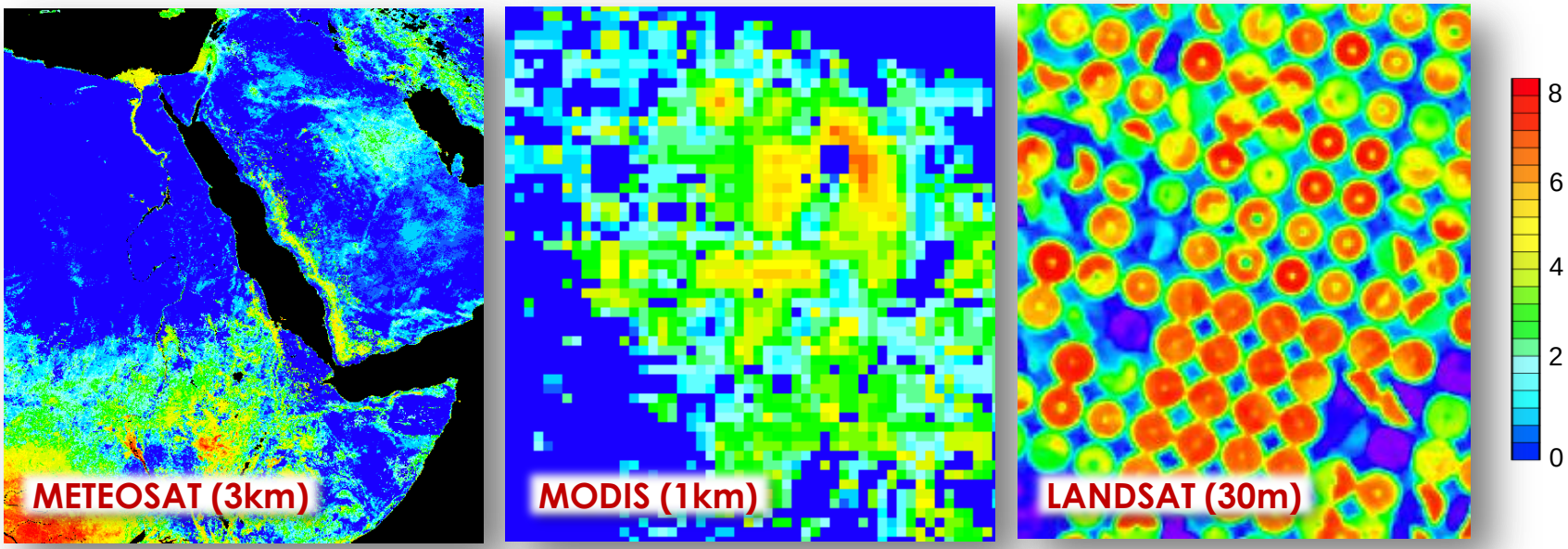


GROUNDWATER DEPLETION TRENDS

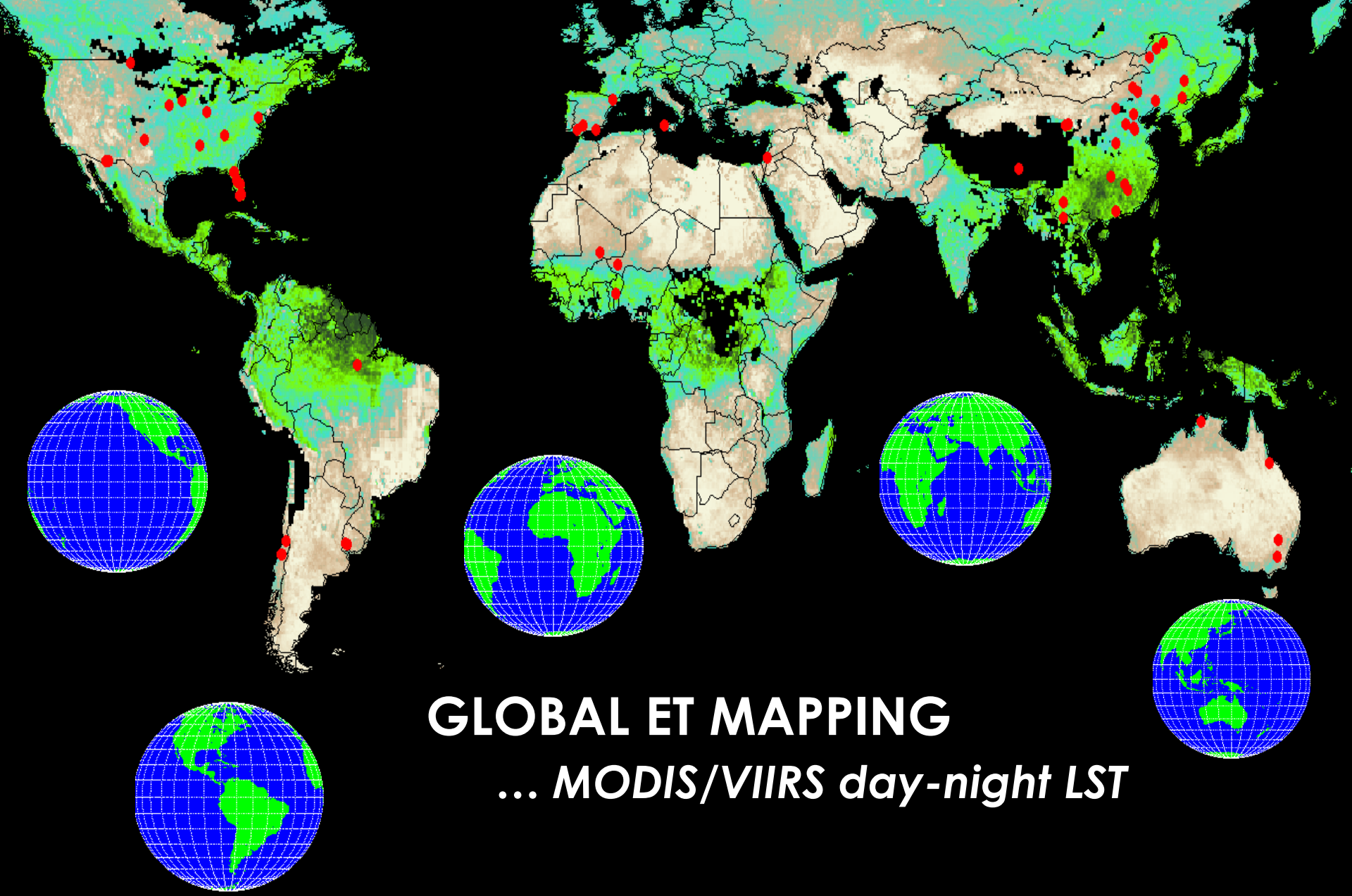


(GRACE, mm/yr)

MULTI-SCALE ET MAPPING (mm/day)



Houborg et al., 4th International Symposium of RAQRS, Valencia, Spain, Sept. 2014

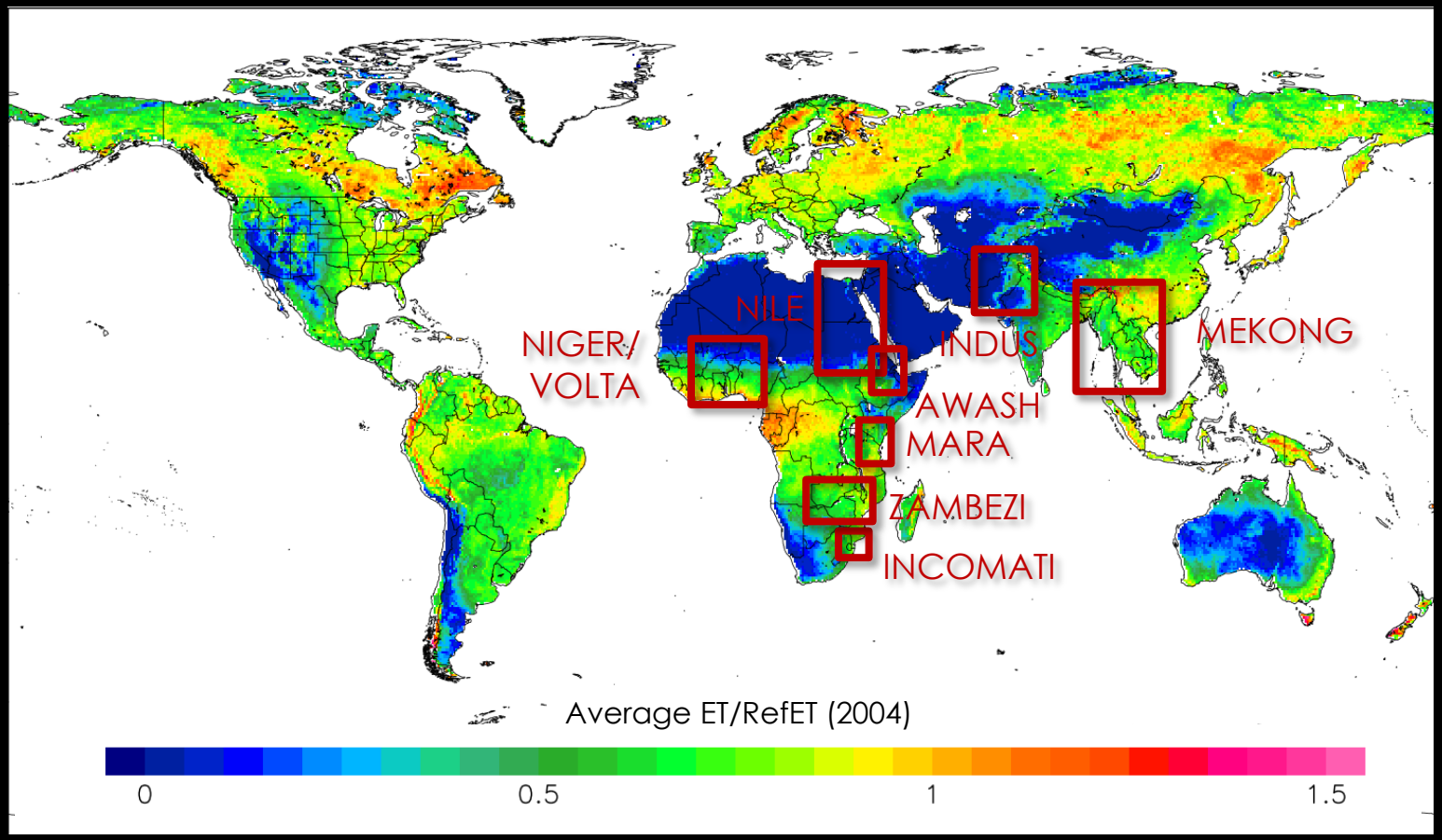


GLOBAL ET MAPPING

… MODIS/VIIRS day-night LST

Global basin water accounting

ALEXI: MODIS – Day/night temperature difference method (Hain)



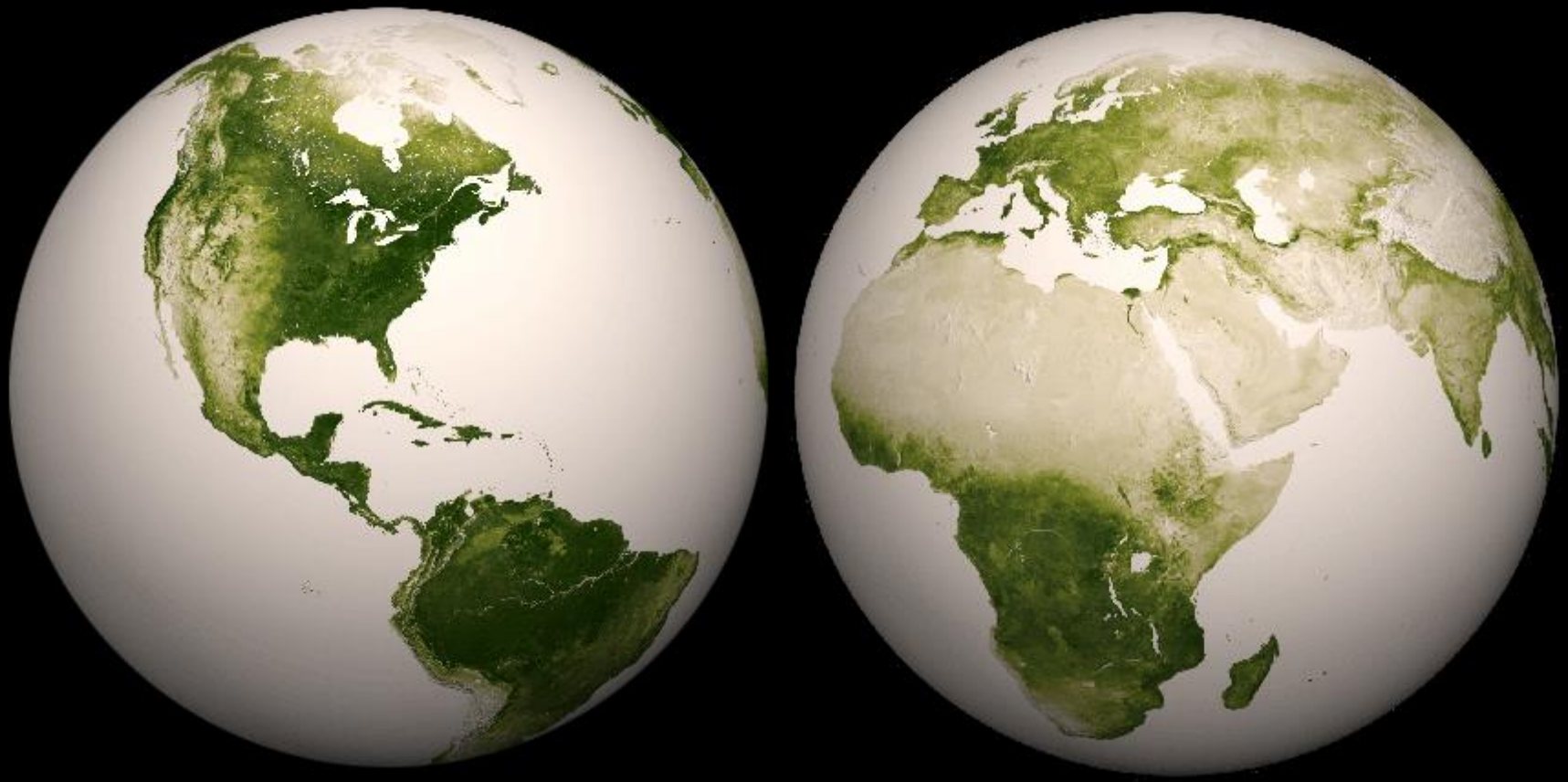
Water Accounting+ : Independent Estimates of Water Flows, Stocks, Consumption and Services

Partners: CGIAR, UNESCO-IHE, IWMI, FAO, Daugherty Water for Food Institute

VIIRS - NPP Coverage

Suomi-NPP

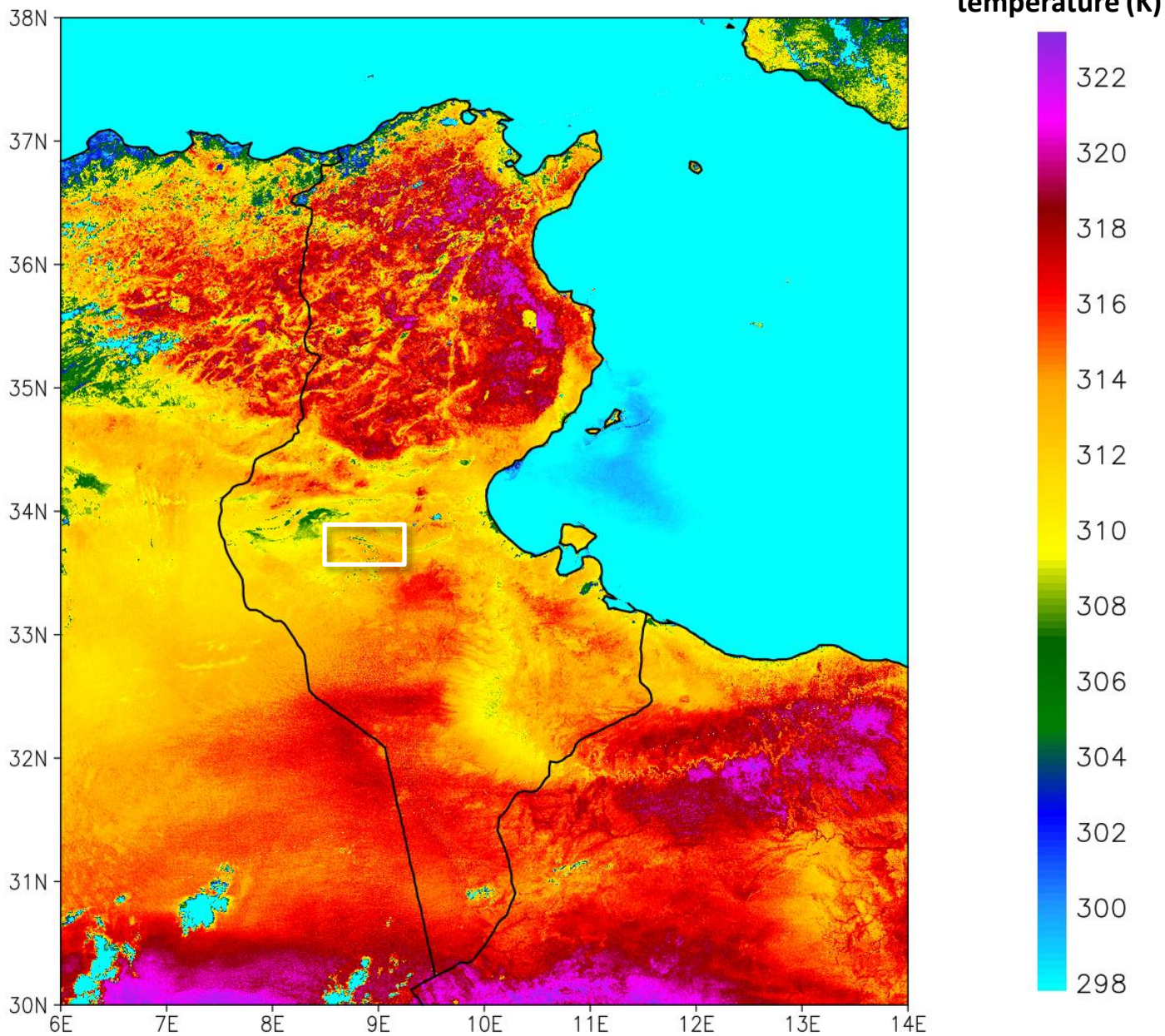
National Polar-orbiting Partnership



~ Daily global revisit, thermal resolution 375 and 750 m

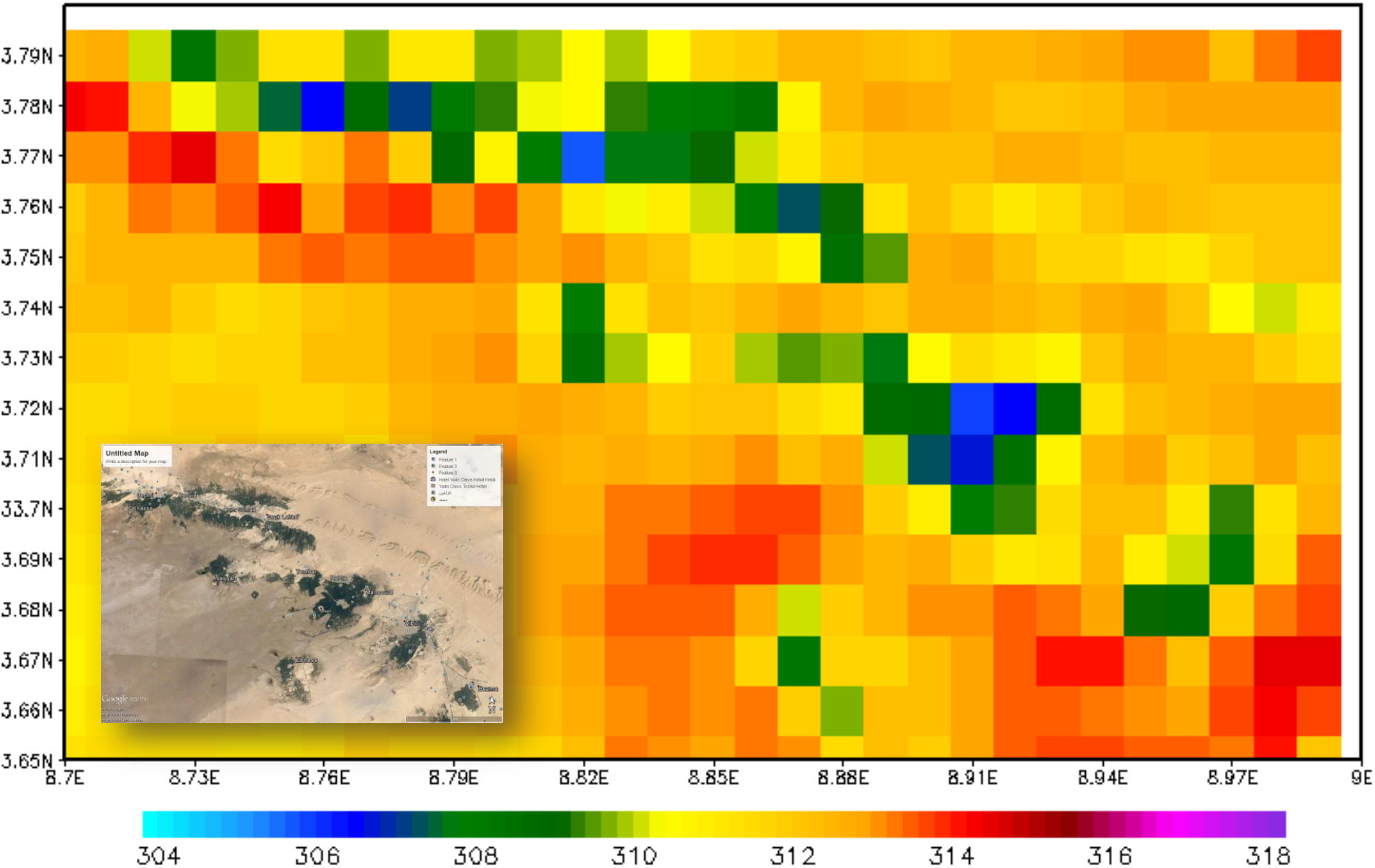
375 m resolution

VIIRS (Visible Infrared Imaging Radiometer Suite)



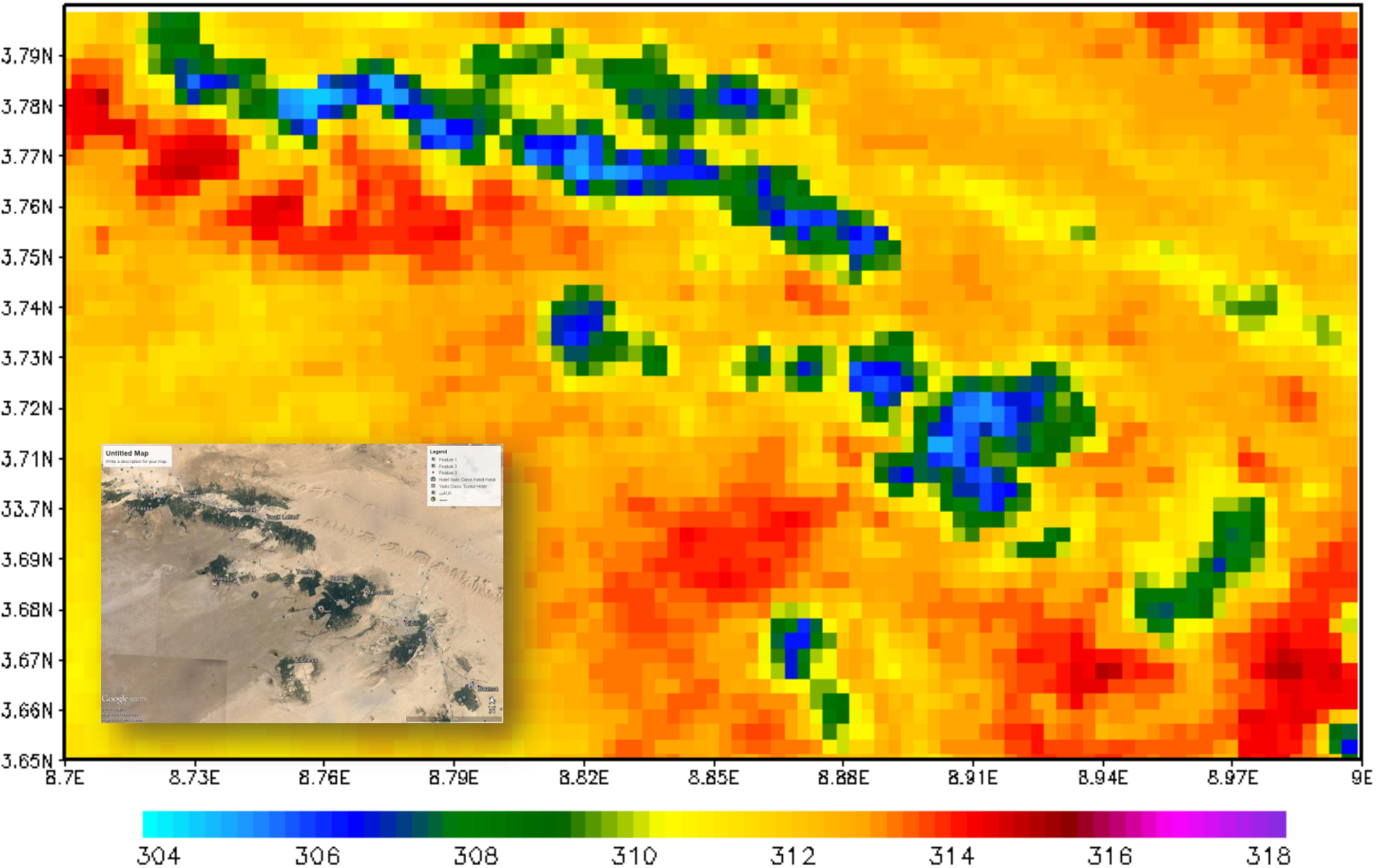
1 km resolution

MODIS (Moderate Resolution Imaging Spectroradiometer)

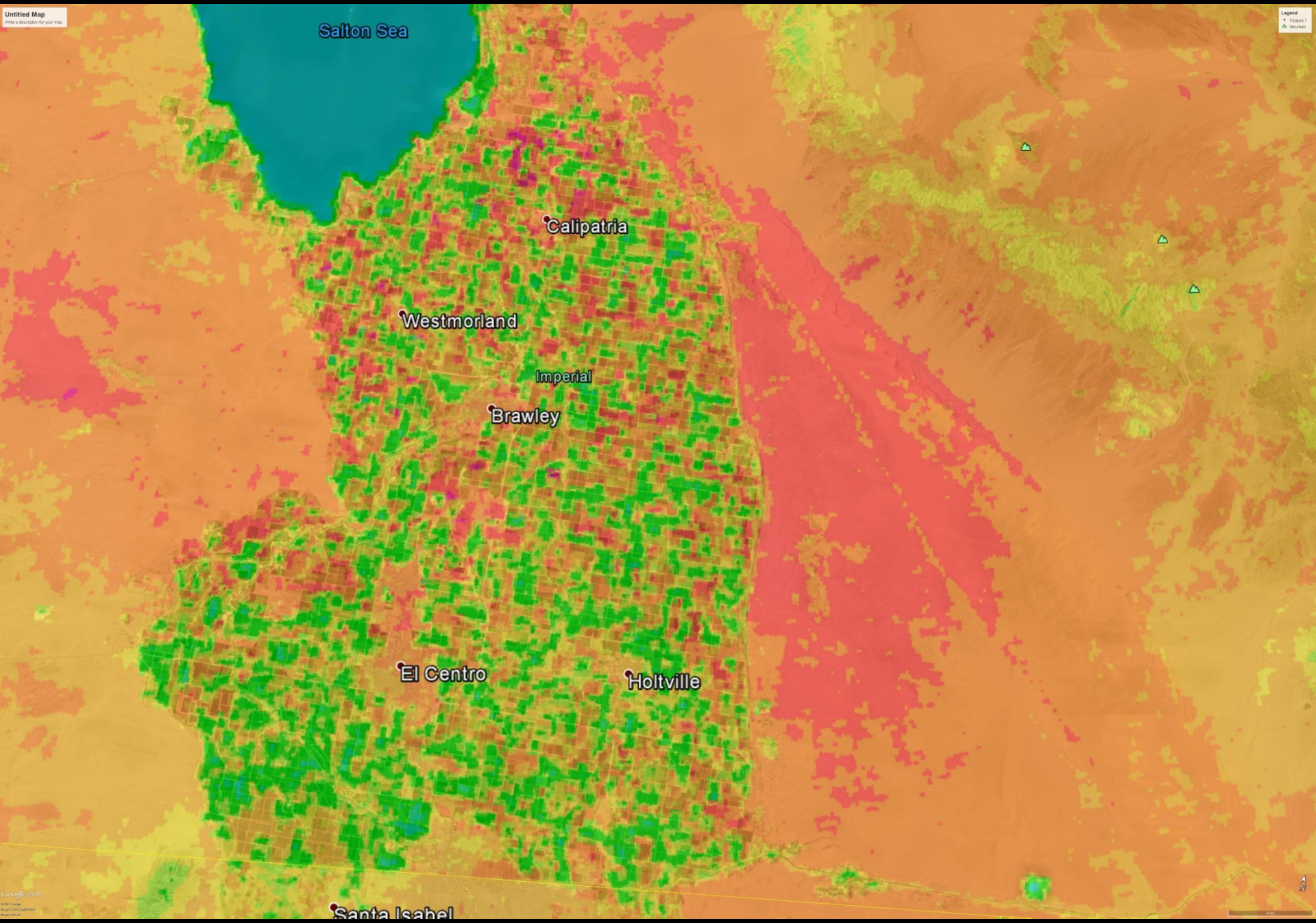


375 m resolution

VIIRS (Visible Infrared Imaging Radiometer Suite)



Untitled Map
Write a description for your map.
Legend
Feature 1
Mountain
Salton Sea
Calipatria
Westmorland
Imperial
Brawley
El Centro
Holtville
Santa Isabel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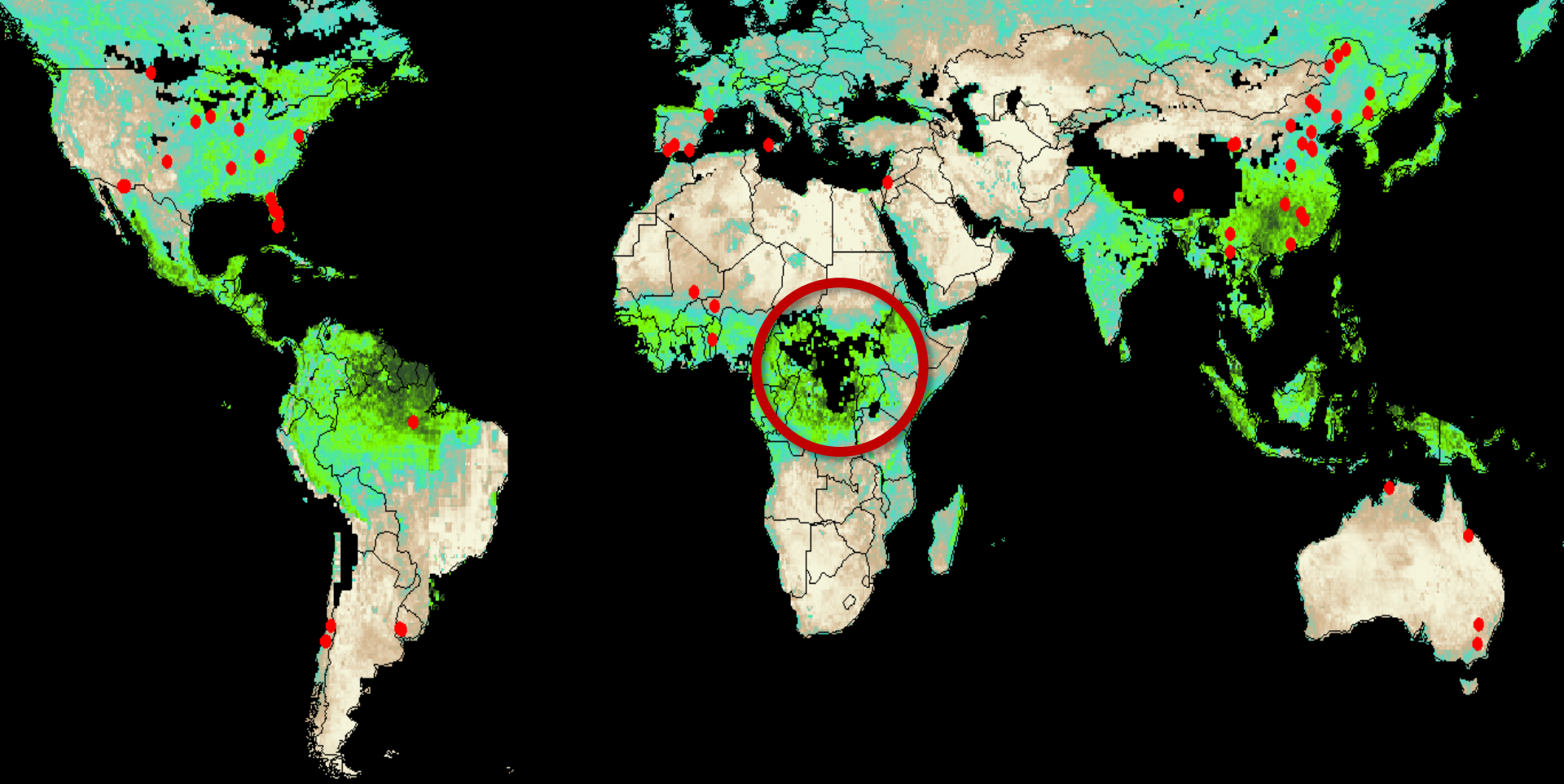


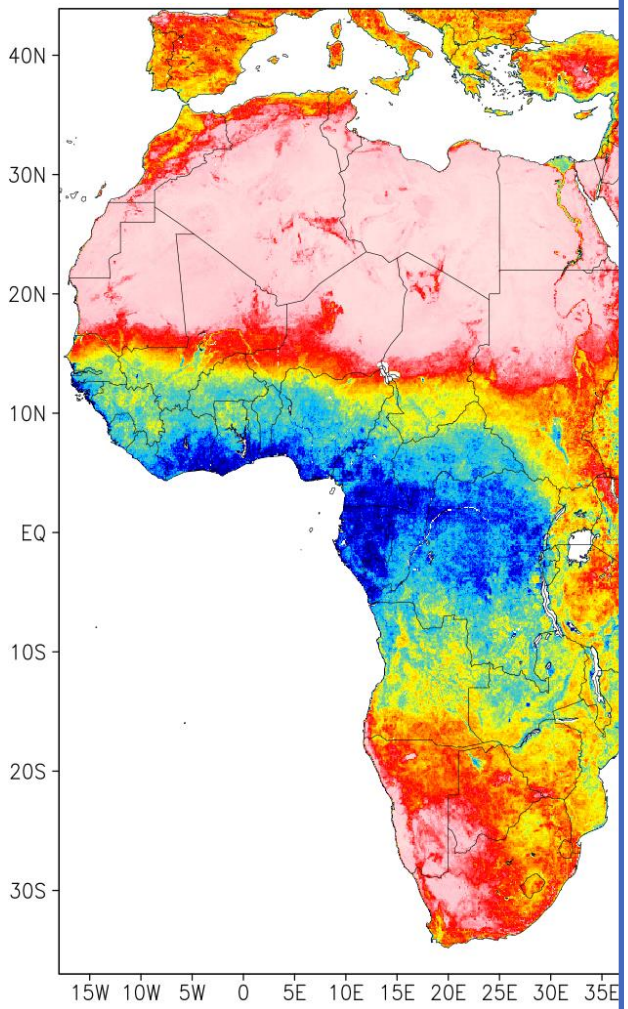
GLOBAL ET MAPPING

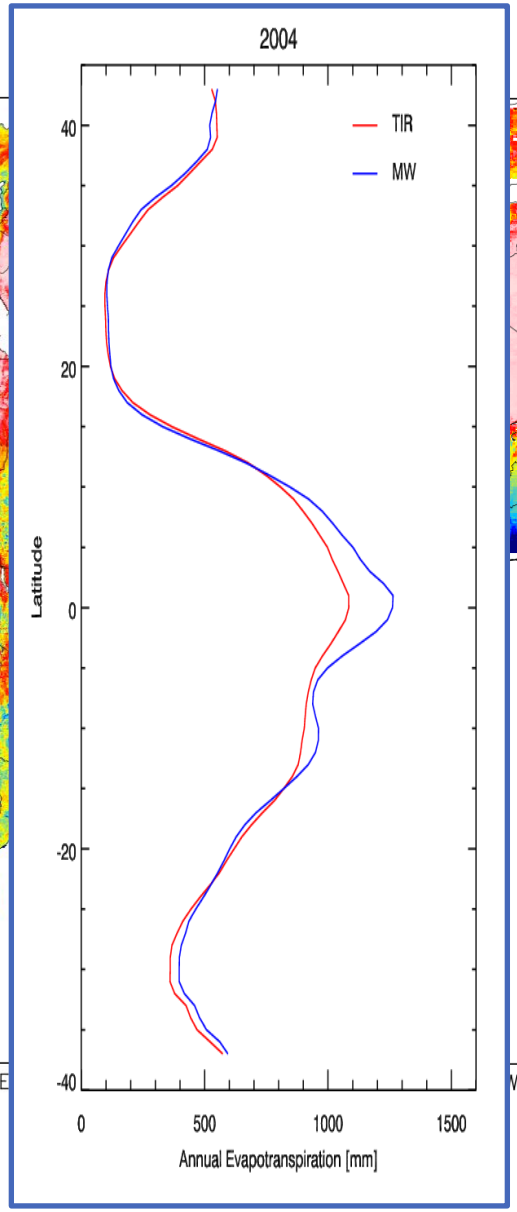
… cloud gapfilling with Ka-band LST

Cumulative Clear-Sky Evapotranspiration (2004)

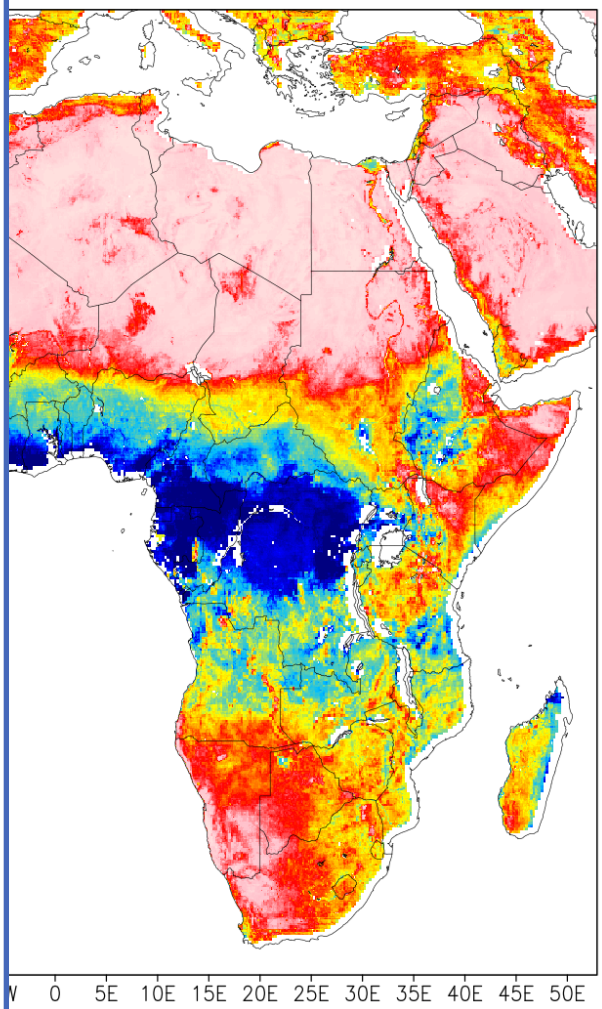
ALEXI-TIR vs. ALEXI-MW

TIR-ALEXI





MW-ALEXI



Holmes, 2015

Conclusions

Satellite Evapotranspiration

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

hrsl.arsusda.gov/drought

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