Evapotranspiration Estimation with ASTER & MASTER over the Jornada Experiment Range, New Mexico, USA

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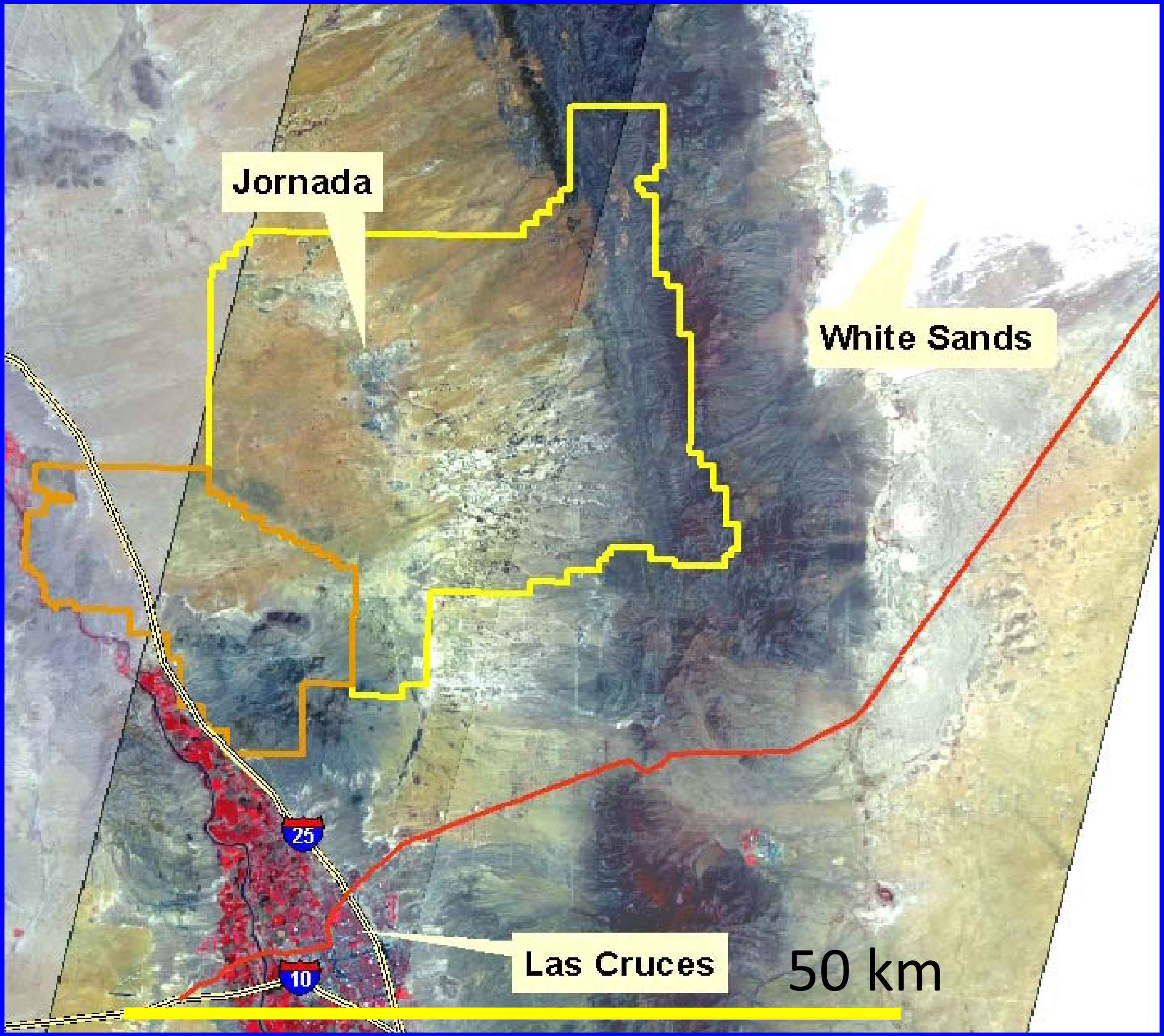
ASTER Composite over Jornada 2001-2003



Moderate/High Resolution TIR Data at Jornada

- ASTER
  - 2001 to 2003: 27 `clear' sky scenes; 90 m resolution
  - 200+ scenes 2000 to 2009, including nighttime
- MASTER
  - 68 lines from 1999 to 2008; 7-15 m resolution

Evapotranspiration Estimation

- Fractional vegetation cover
- Land surface temperature
- Land cover type & plant height
- Near-surface meteorology

Evapotranspiration Estimation with a Two-Source approach

$$R_n - G = H + LE$$

Sensible Heat (H)

$$\mathrm{H_{soil}} = \rho c_p \frac{\mathrm{T_{soil}} - \mathrm{T_{air}}}{\mathrm{r_{soil}} + \mathrm{r_{aero}}}$$

$$\mathrm{r_{soil}} = \frac{1}{\mathrm{a} + \mathrm{bU_{soil}}}$$

Latent Heat (LE)

$$\lambda \mathrm{E_{canopy}} = \alpha\, \mathrm{f_{green}} \frac{\Delta}{\Delta + \gamma} \mathrm{R_{canopy}}$$

Composite Temperature

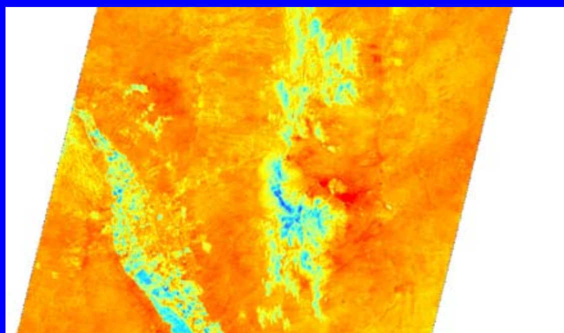
$$T^4_{comp} = f*T^4_{Veg} + (1-f)*T^4_{Soil}$$

-Better parameterization of soil-canopy energy interactions than single-source

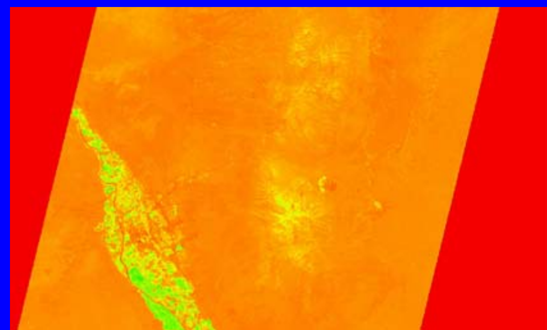
-Detection of crop stress

Remote Sensing of Instantaneous Evapotranspiration

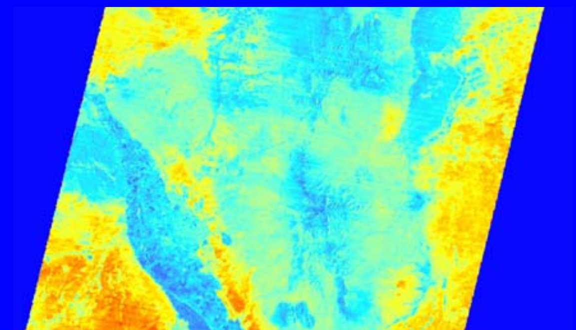
LST



NDVI



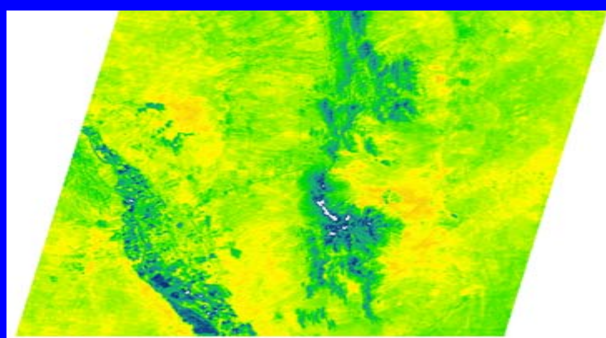
Emissivity



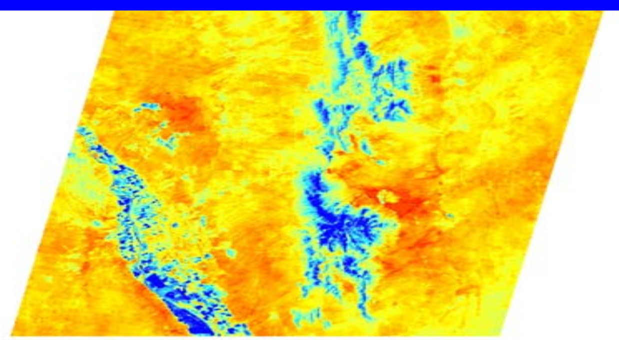
+Land Use
+Meteorology+…

ASTER
6 Oct 2002

H

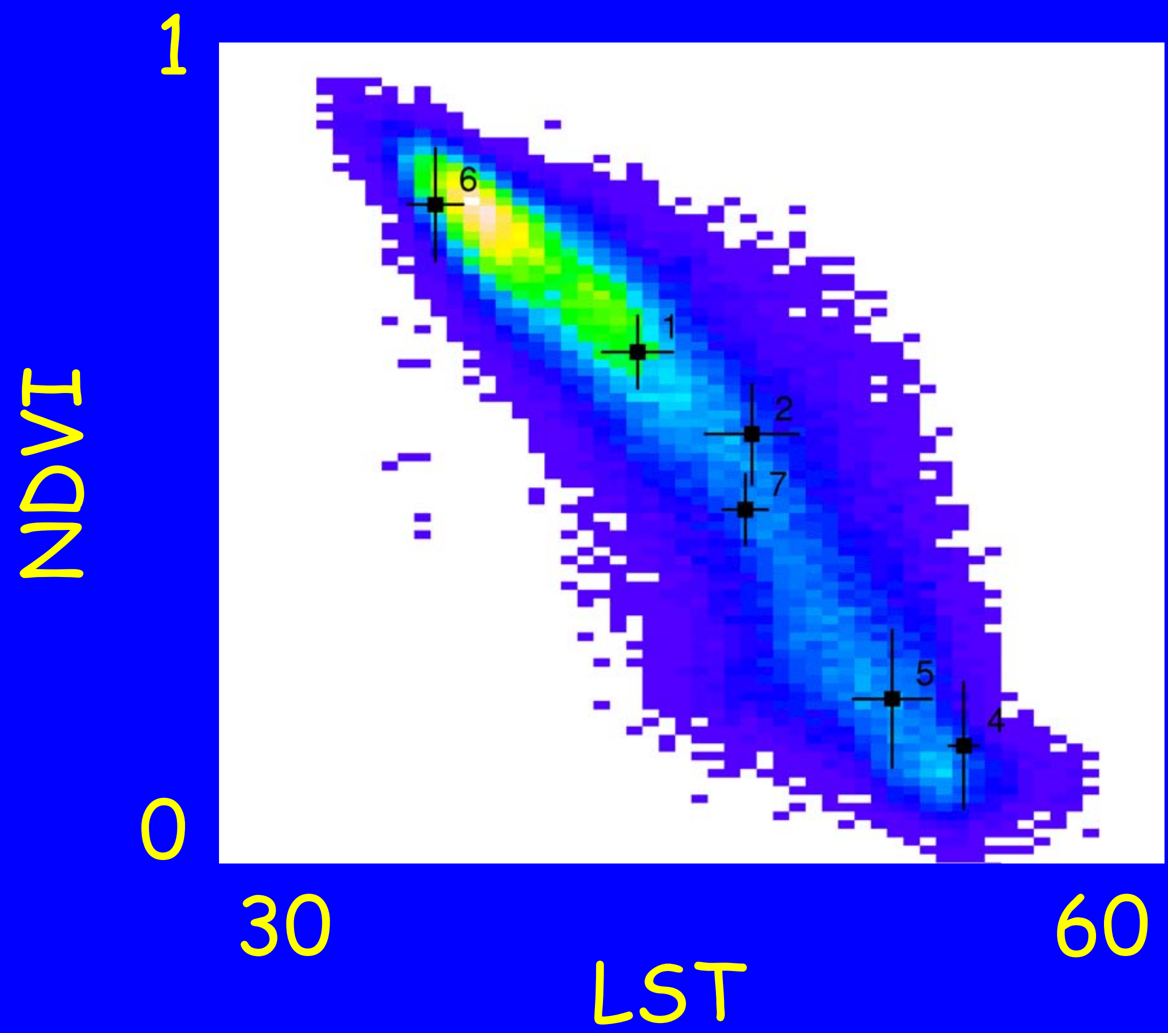


LE

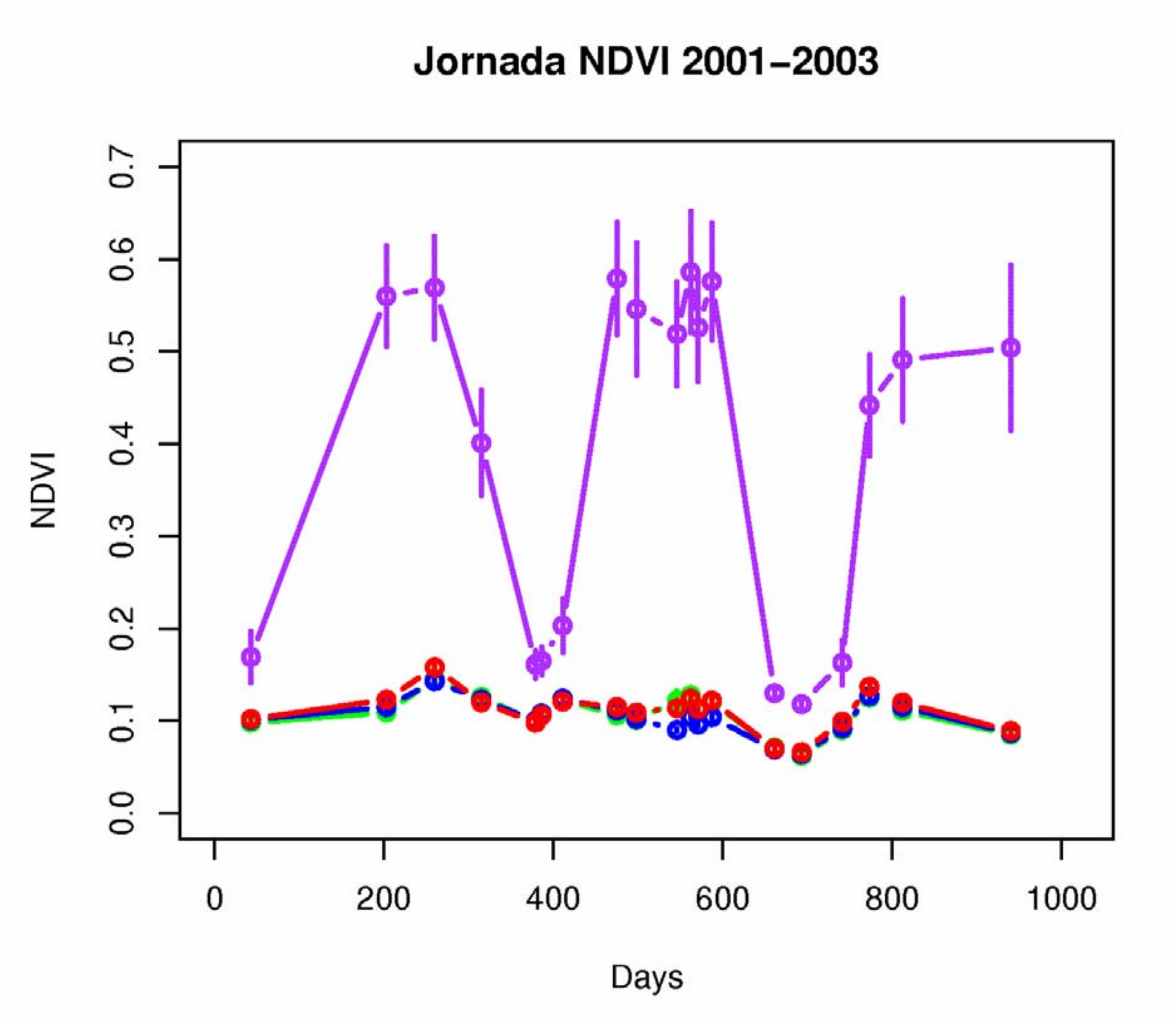


ET Estimation with TIR Needed to detect water stress

NDVI vs. Temperature inverse relationship
NDVI does not explain all variability of surface fluxes.
i.e.Penman-Monteith ET insufficient.



NDVI for Jornada & Rio Grande 2001-2003



Effect of Emissivity on Land Surface Temperature

Errors in estimated emissivity can result in LST retrieval errors of 2-3 C

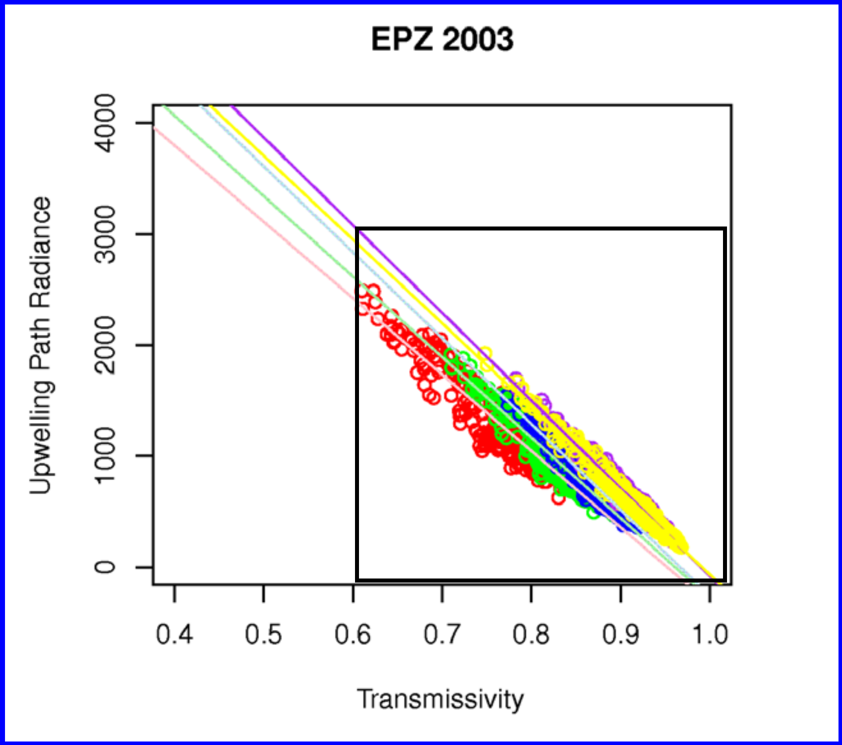
Depending upon resistance term, these errors can exceed 50 W/m^2

$$H = \rho c_p \frac{\Delta T}{r_a}$$

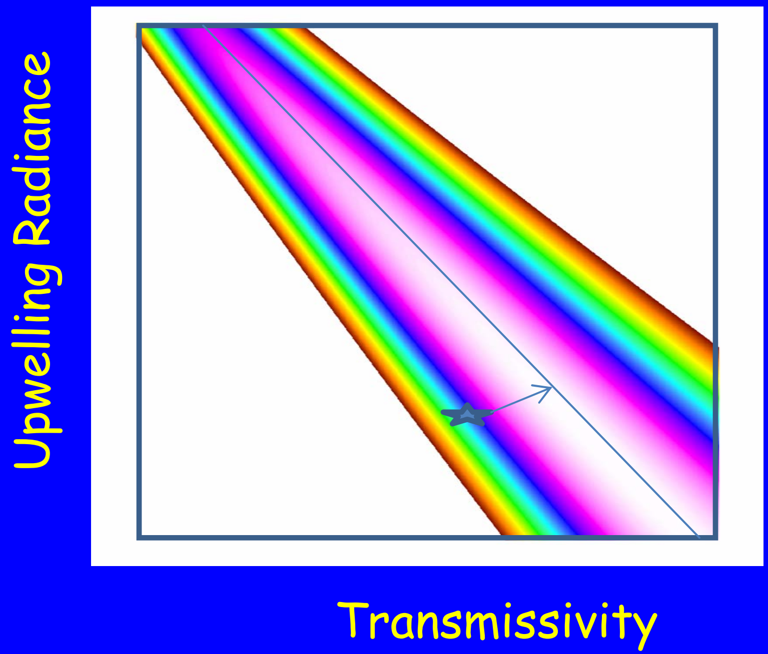
Graybody Temperature Optimization

- Initialize LST computation using profile-based τ, L↑, L↓
- Import regression data for L↑ vs. T
- Minimize multispectral LST deviations

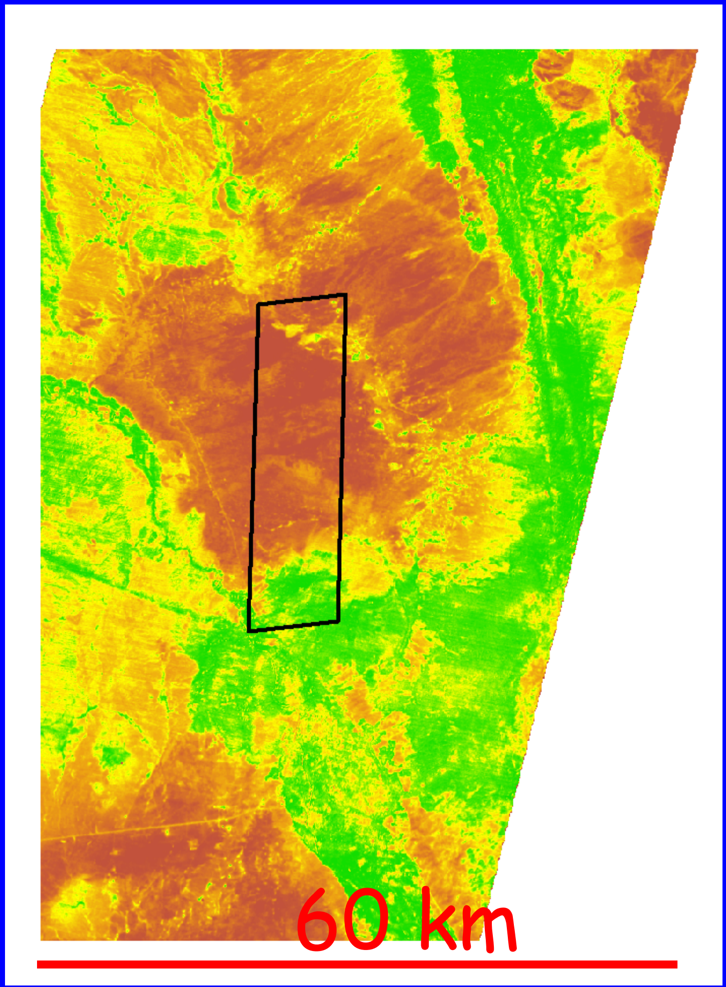
Linear regression



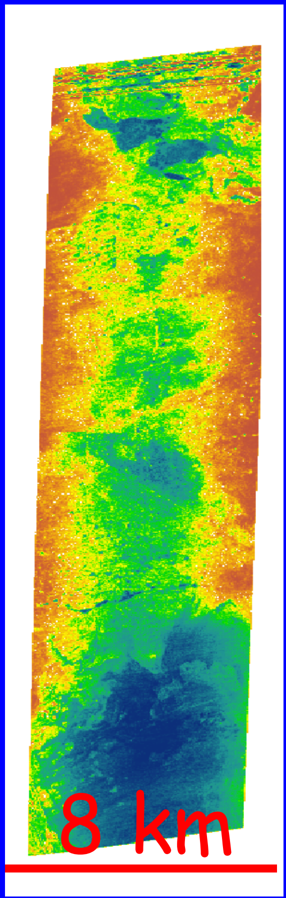
LST Estimation Error



Jornada Emissivities
6 October 2002



ASTER (90 m)



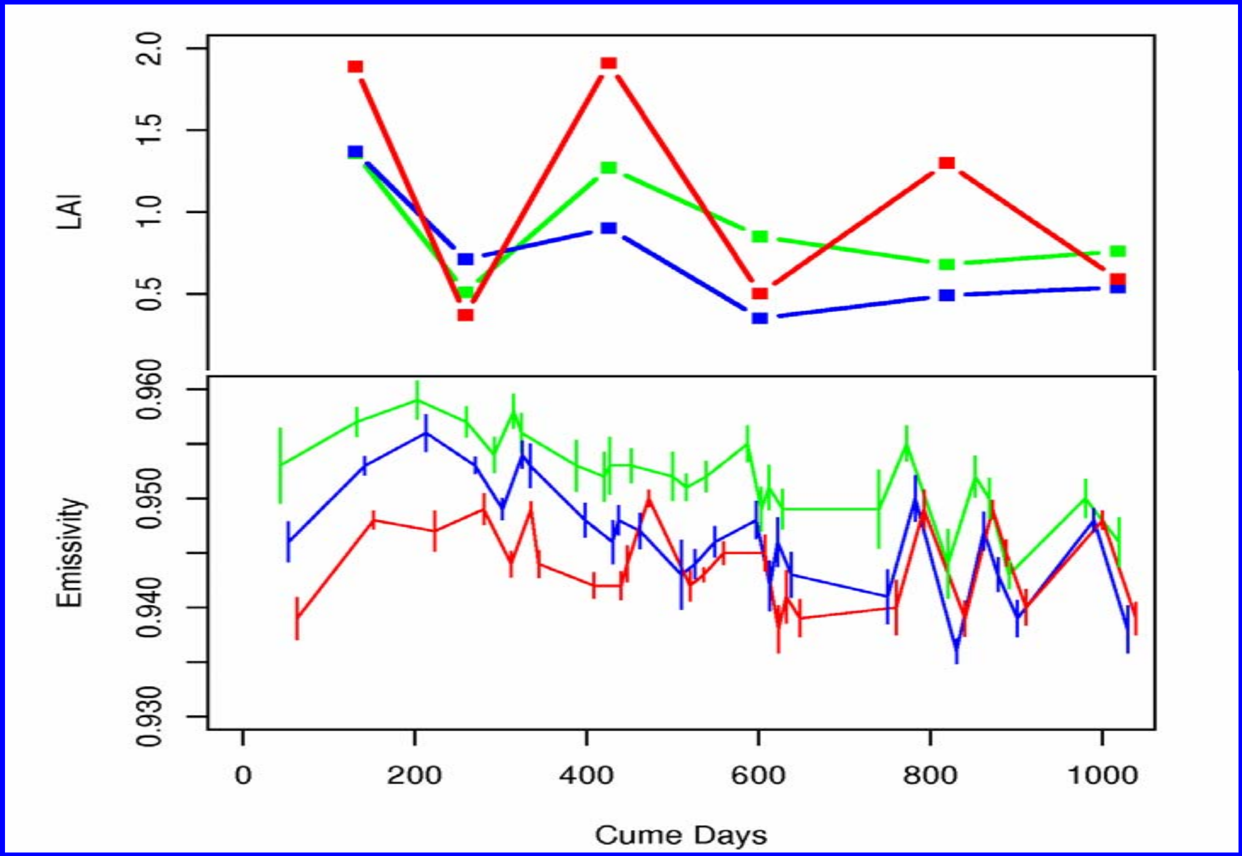
MASTER (5 m)

Effect of Emissivity upon Land Cover Classification

Can determine estimation of surface resistance

- -Distinguish between bare soil and senescent vegetation
- -Better estimation of canopy geometry & canopy height $z_m = h/8$
- -Improve estimation of r_a and r_s

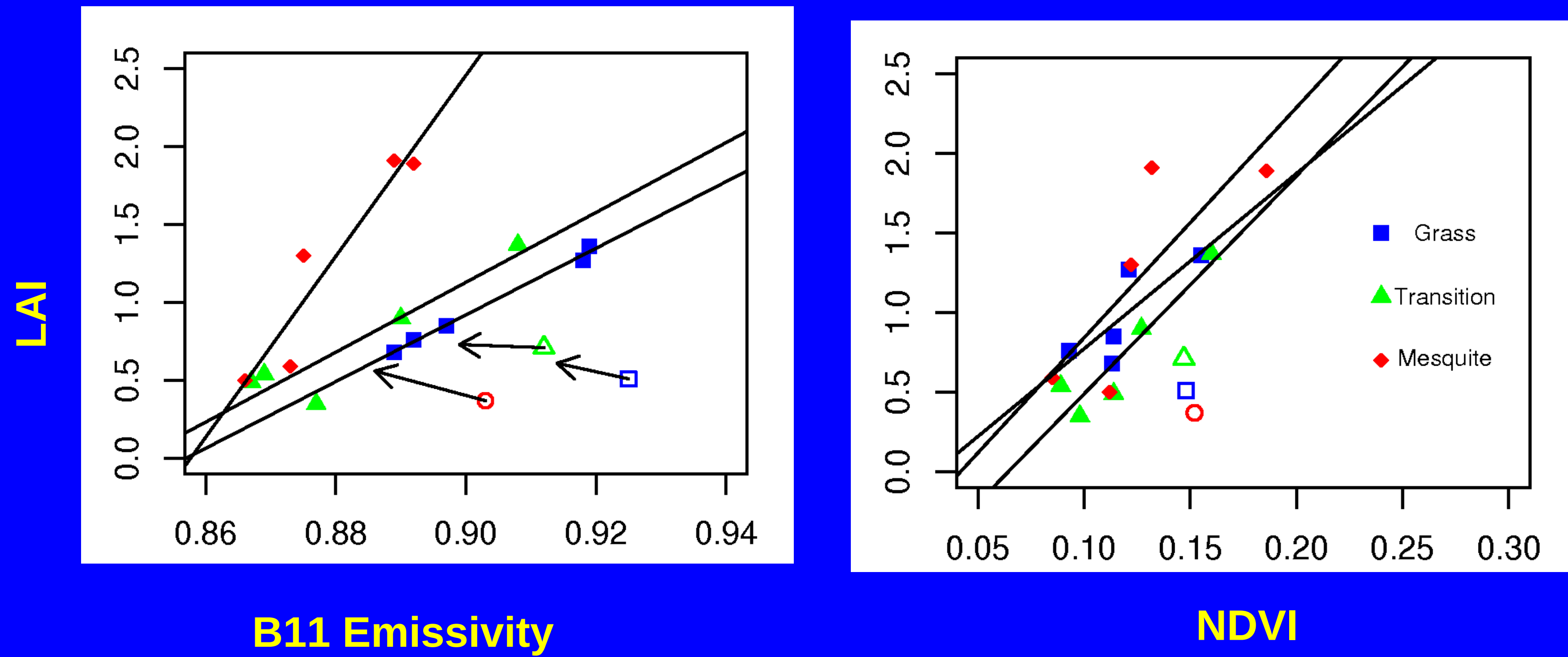
Change Verification: LAI & Emissivity 2001-2003



LAI

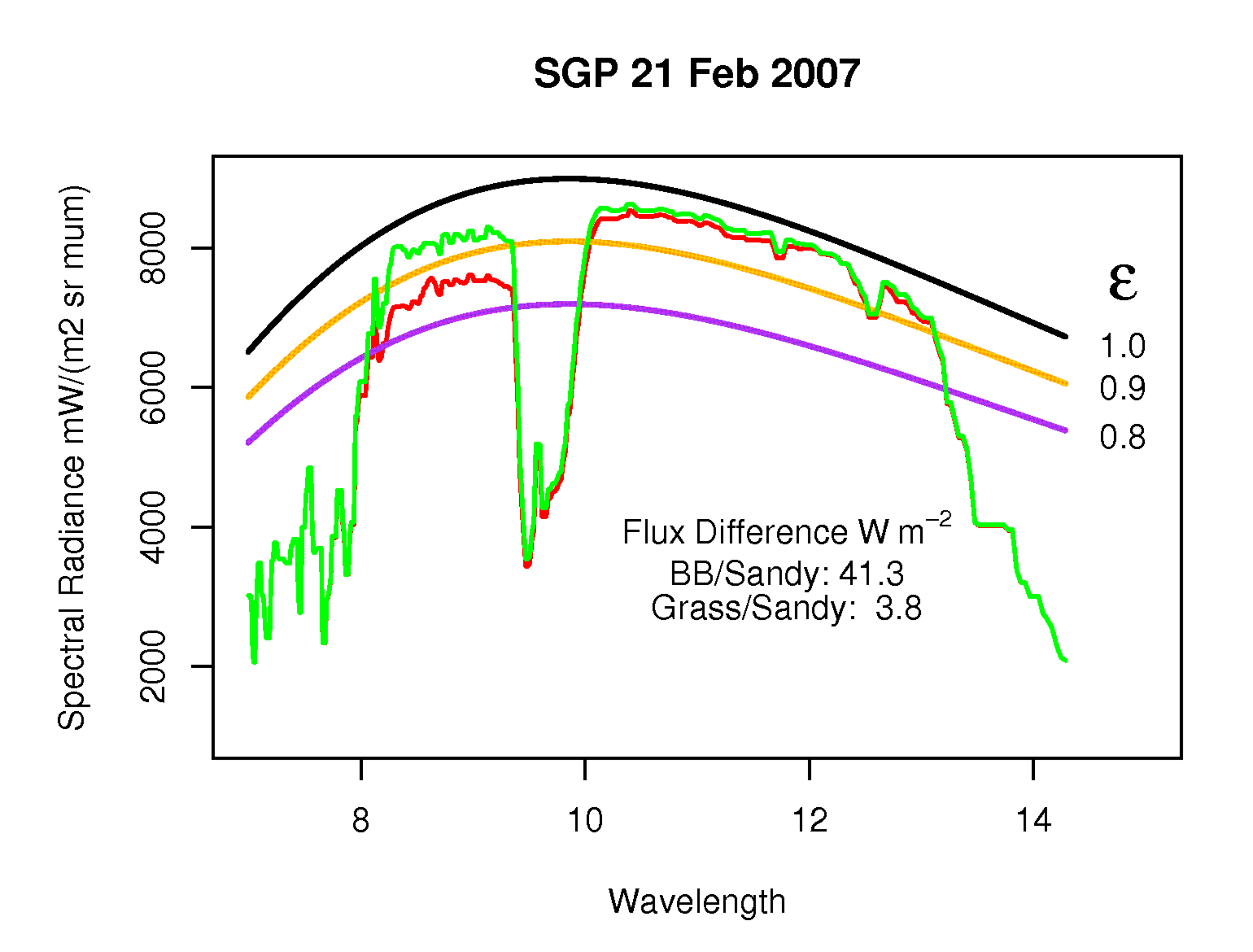
Emissivity

Land Cover Estimation from Emissivity & NDVI

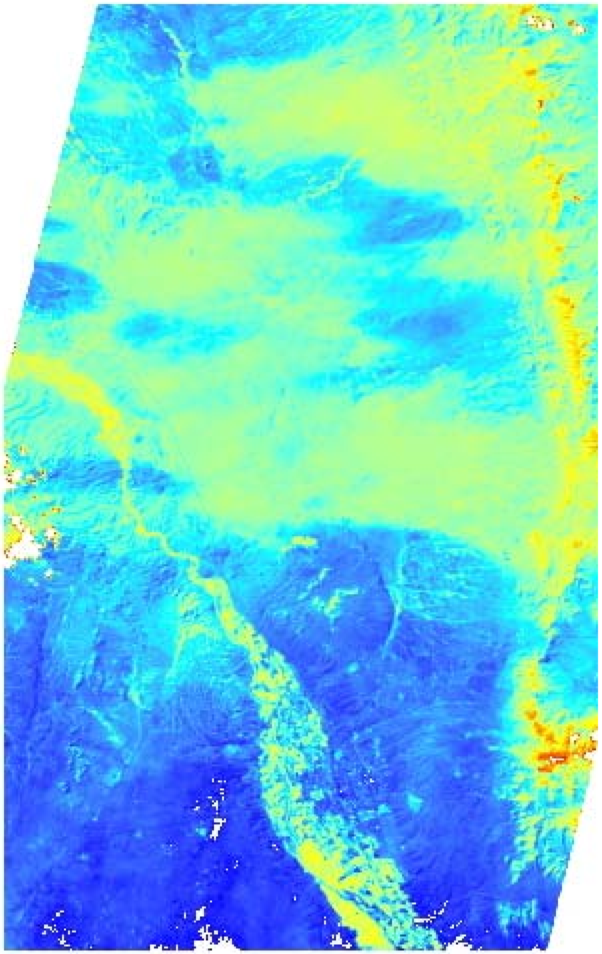


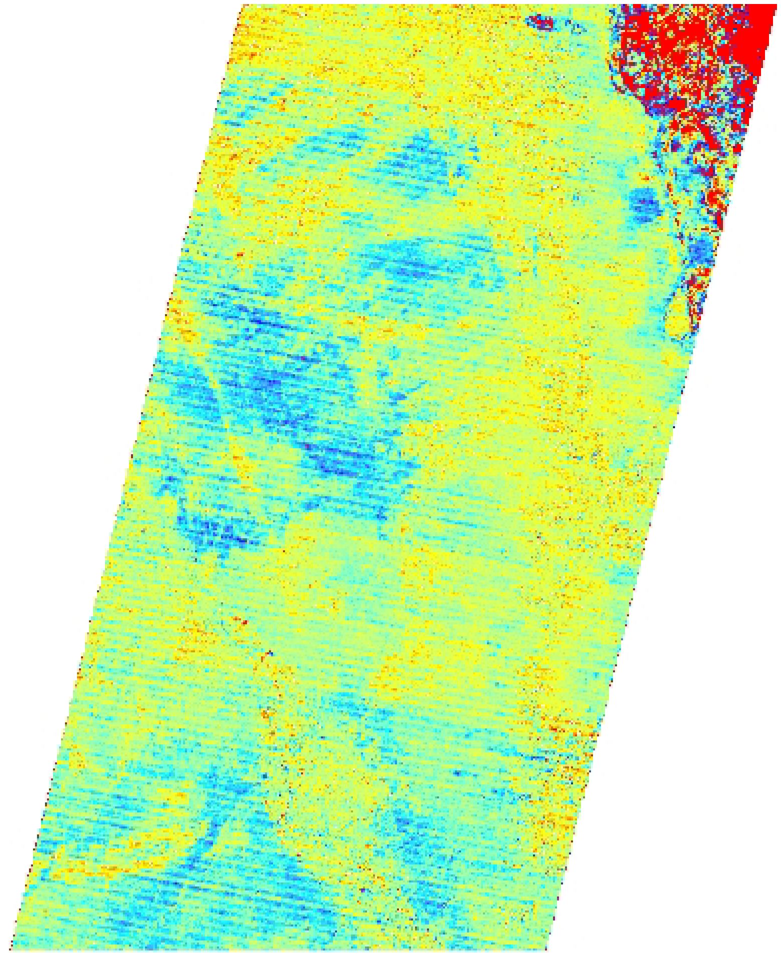
Site	Emissivity	NDVI
Grass	0.99	0.52
Transition	0.81	0.81
Mesquite	0.86	0.50

Effect of Emissivity on Net Longwave Flux



Rainfall Effect on LST & Emissivity





LST

ASTER B11 emissivity

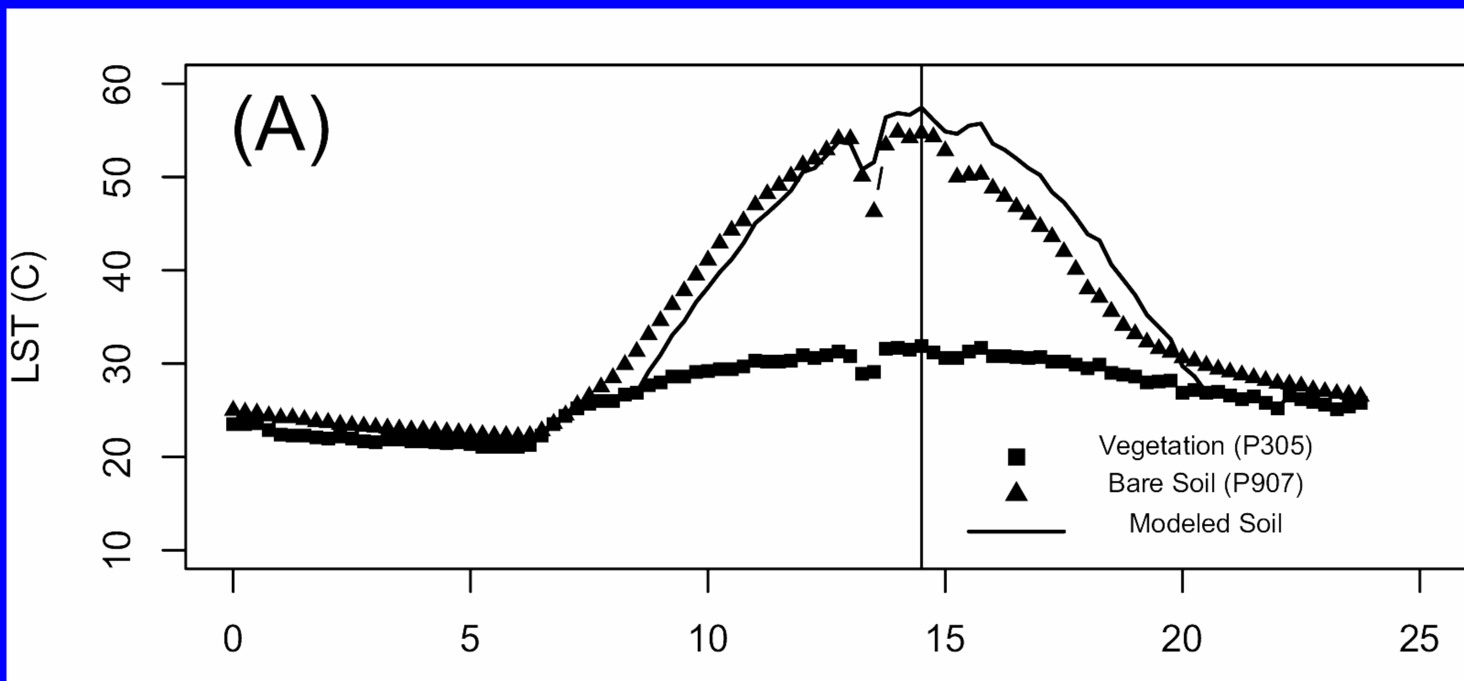
Benefits of HyspIRI for Evapotranspiration Studies

- Observational Achievements:

-Improved temperature over Landsat
-Emissivity change assessment
-Moderate spatial resolution
-Greatly improved temporal resolution

Soil Temperature Modeling: Disaggregation from Canopy Temperatures

$$T_{Soil} = T_{Veg} \times \left(1 + \left(k - 1\right)\right) \times \sin\left[\frac{\pi}{12} \times \left(t - 6 - \phi\right)\right]$$



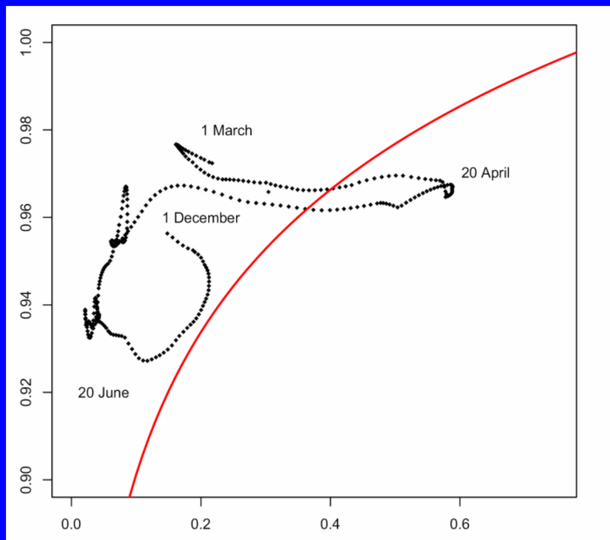
Expectations

- Greatly improved temporal estimation of ET with more frequent LST observations
- Continuation of ASTER legacy for spatial and spectral sampling
- High potential for improved land cover classification & plant height estimation using hyperspectral observations
- Continued need for SVAT models to provide ET time series

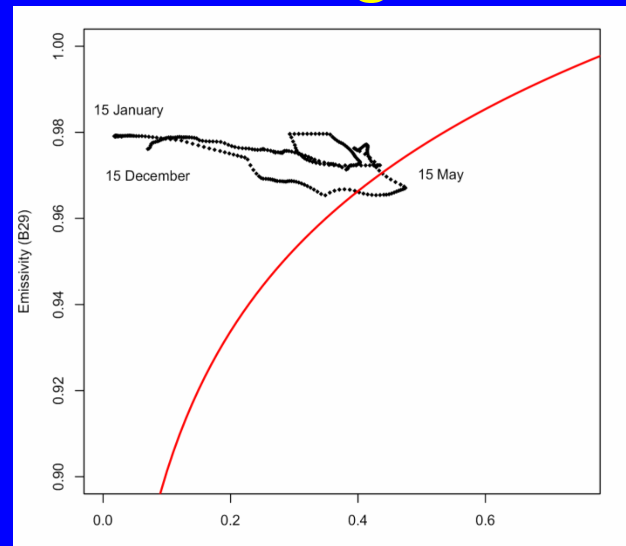
Winter Wheat

Grazingland

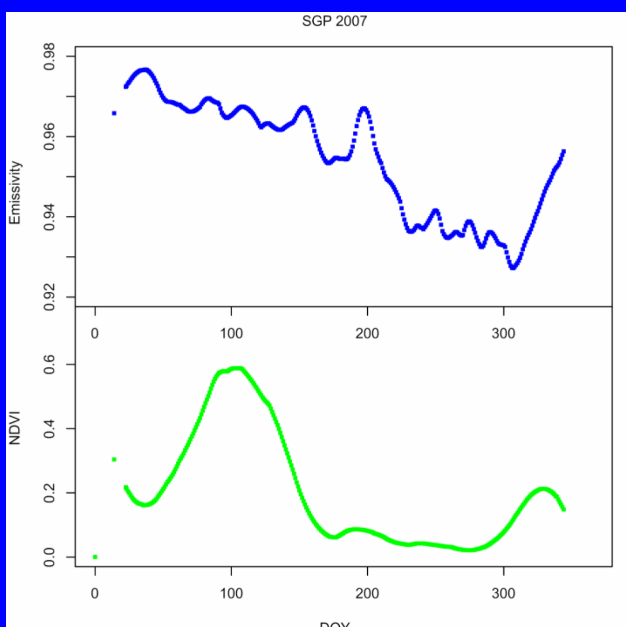
Emissivity

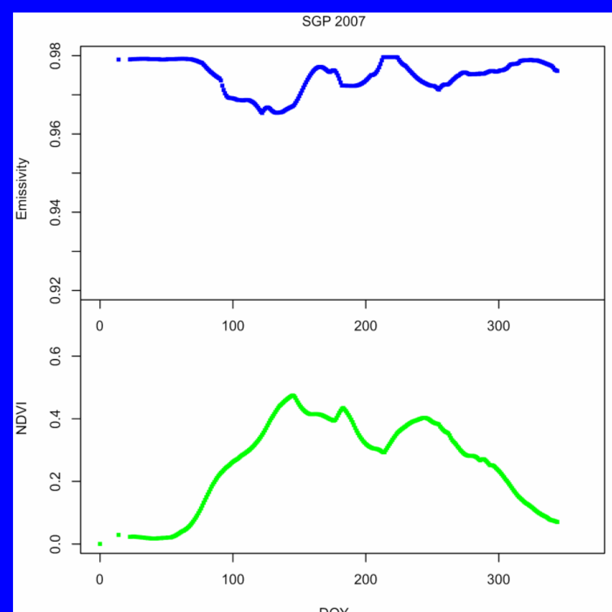


NDVI



NDVI





Surface Energy Balance ASTER
El Reno, Oklahoma
4 Sep 2000

Sensible Heat

Latent Heat