REMOTE SENSING OF MONTHLY EVAPOTRANSPIRATION USING DATA FUSION NEAR DISNEY WILDERNESS PRESERVE

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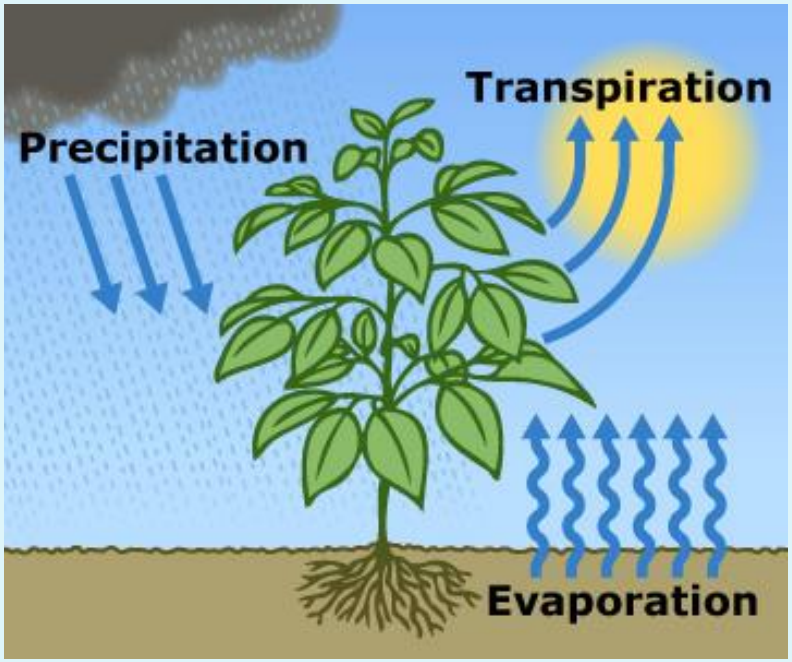
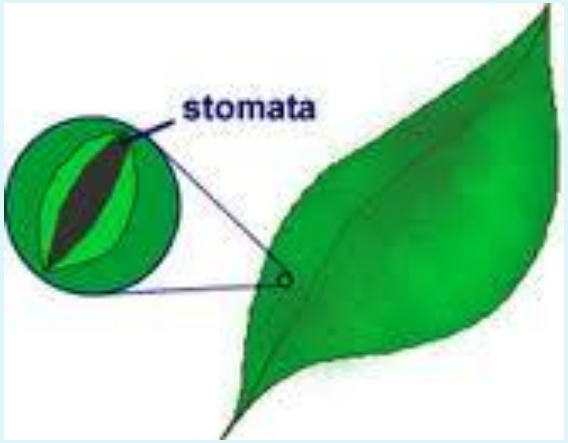
What is Evapotranspiration?

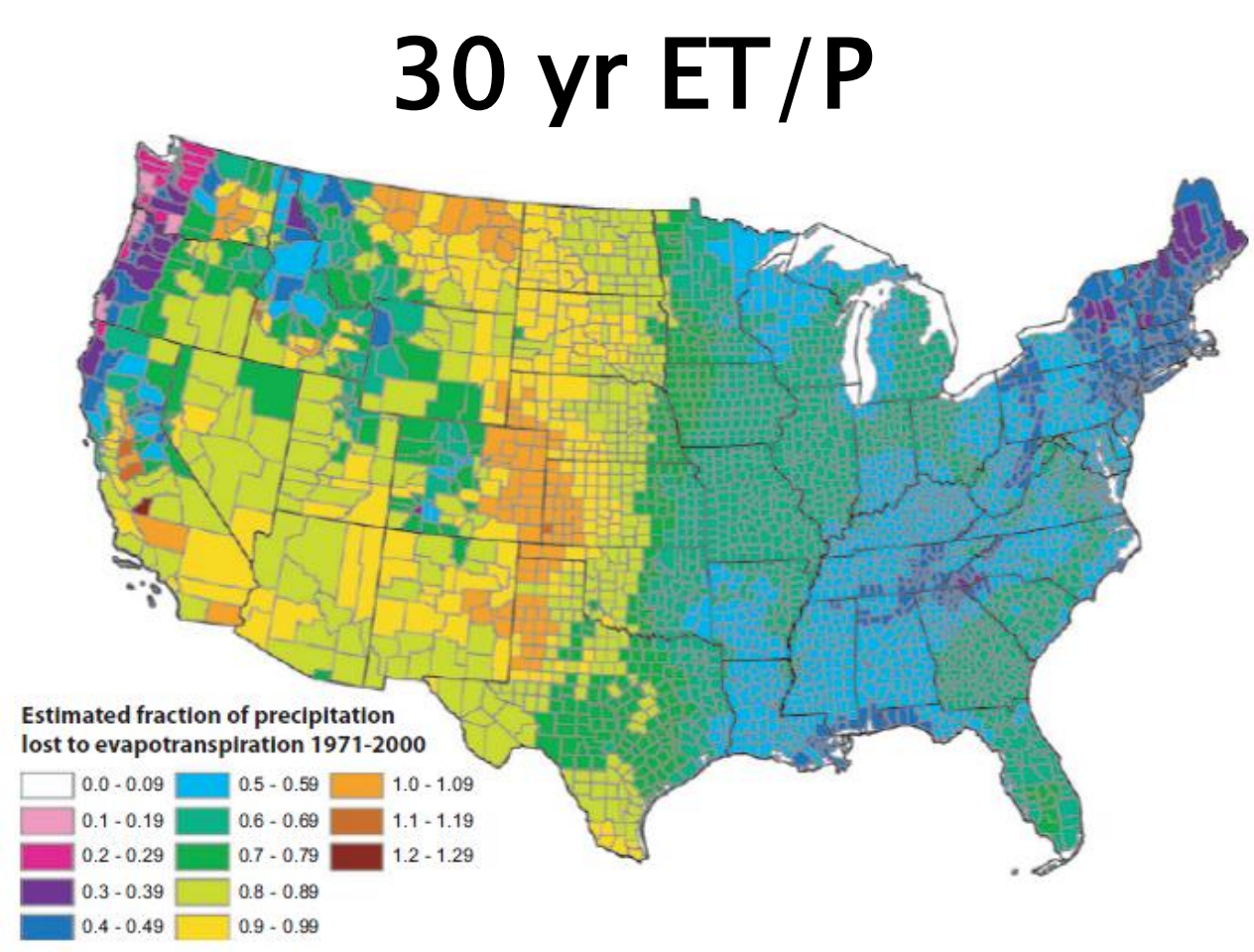
- **Evapotranspiration (ET)**: Combination of Evaporation and Plant Transpiration
- **Transpiration**: Release of vapor from stomata





ET vs. Precipitation

Florida has Intermediate ET/P



Energy Balance

$$\lambda ET = EF\ A$$

- A = Available Energy (Radiation)
- EF = Evaporative Fraction of Energy

Divide Problem Between Finding:

- **1) Energy**
- **2) EF**

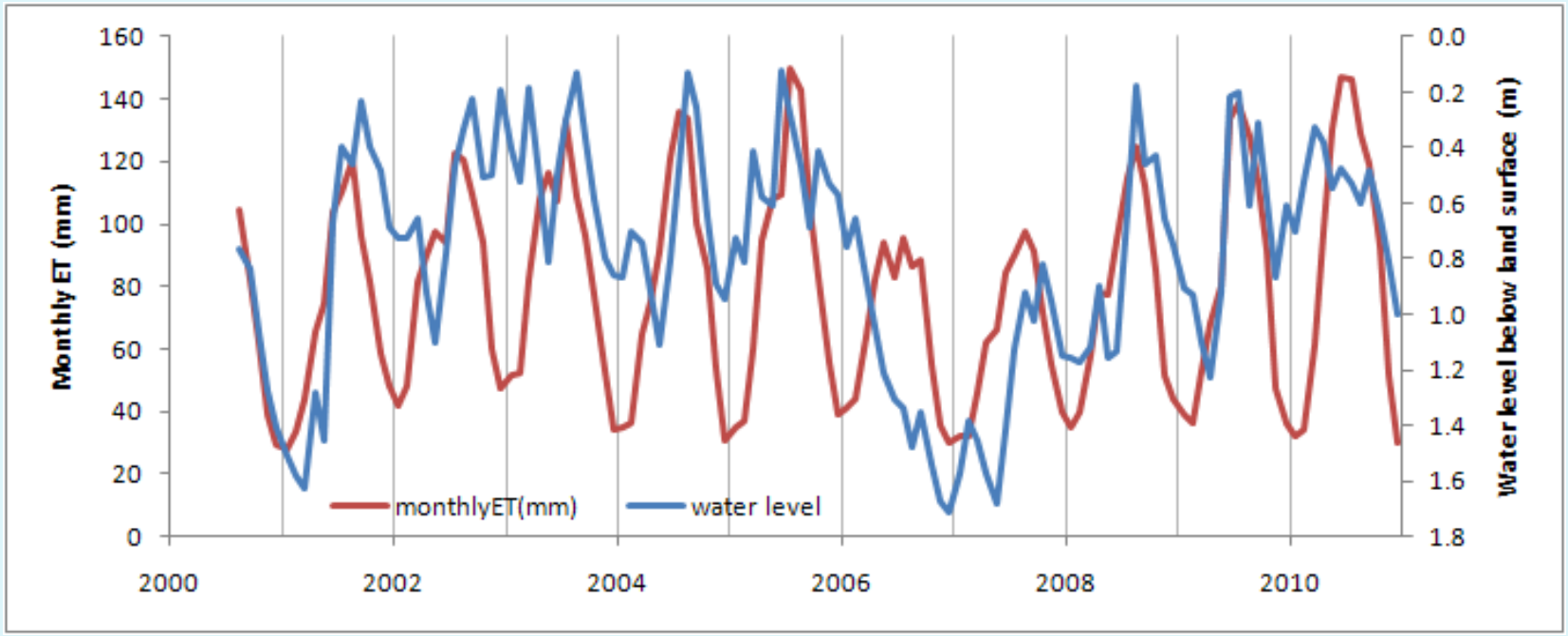
Disney Wilderness Preserve

- Mostly Grass
- Shallow Water Table

Chosen Because It Has Flux Towers

Flux Tower Monthly ET

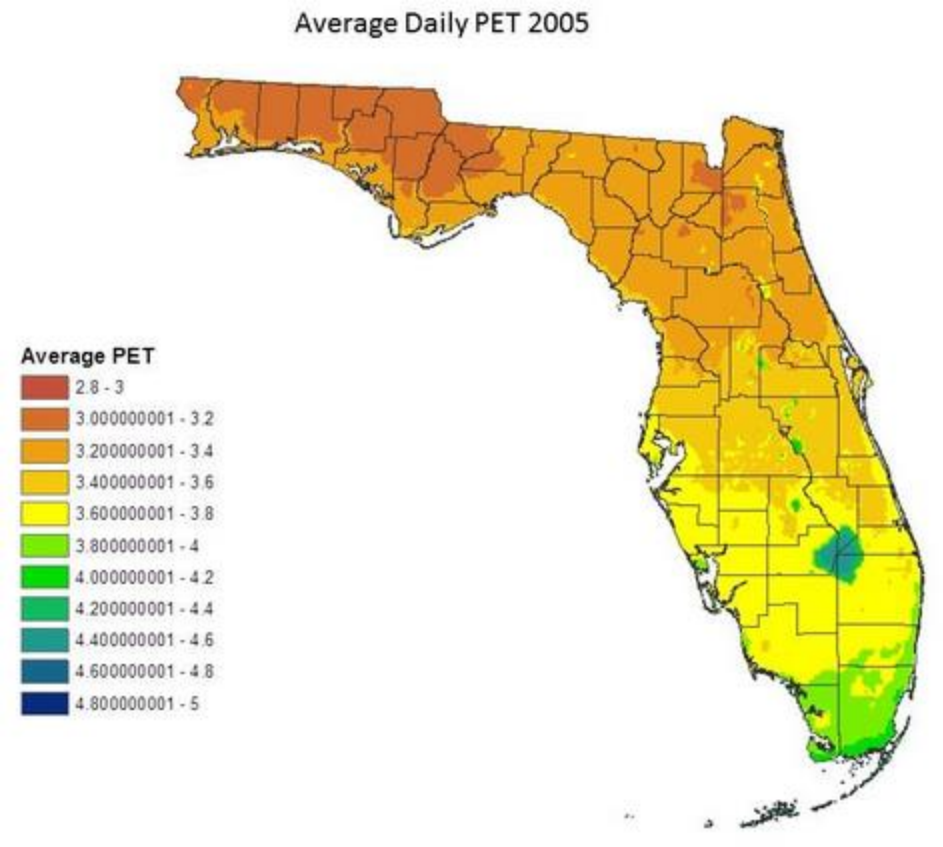
- 2000–2011: USGS measured ET via **Eddy Covariance Method**
- 2006–2007: Very Dry Years



OBJECTIVE

- Use Remote Sensing to Estimate **Monthly ET** Over Multi Year Period
- Validate Against Flux Tower

USGS PET Maps



from: https://eros.usgs.gov/doi-remote-sensing-activities

- USGS has produced 2 km maps from **GOES/FAWN**

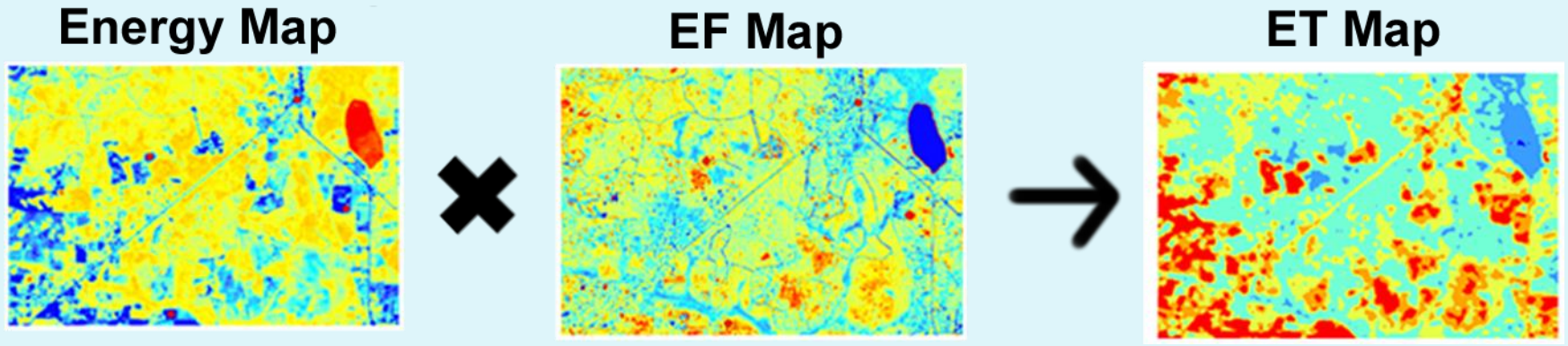
Available Energy (Accounts for **CLOUDS**)
→ "Potential" ET

- Not "Actual" ET
  Depends on Water/Vegetation Availability

Actual ET

- Produce “Actual” ET maps

- Produce EF maps using **LANDSAT**
  -> multiply by USGS Daily Available Energy



MODIS Operational ET Product

MOD 16: Global Actual ET (1 km)

- Complex Model -> Assumes Many Parameters
- 11 Sets of Parameters for **Only** 11 Biome Types
- Will These Work For Our Study Area?

Thermal Remote Sensing

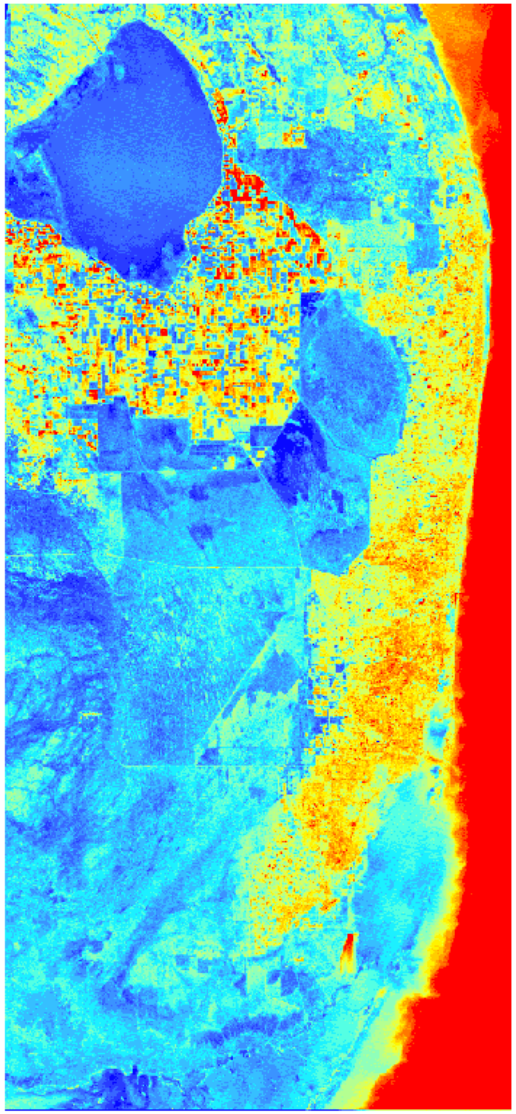
- ET Strongly Related To Surface **Temperature**

- Use Residual Method:

$$ET = A - H$$

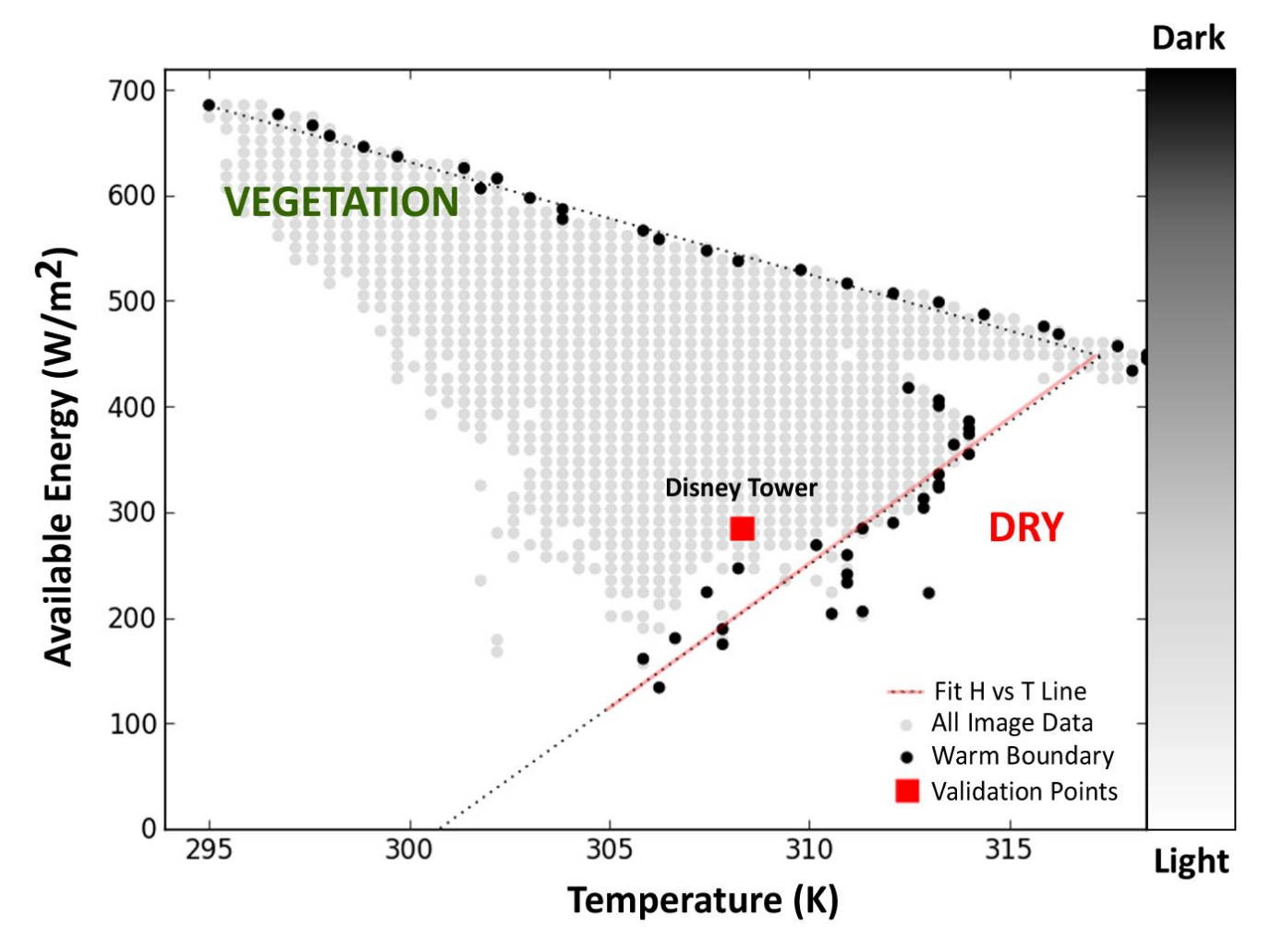
$$H = a + b\,T_s$$

- Find **a, b** via **Calibration**



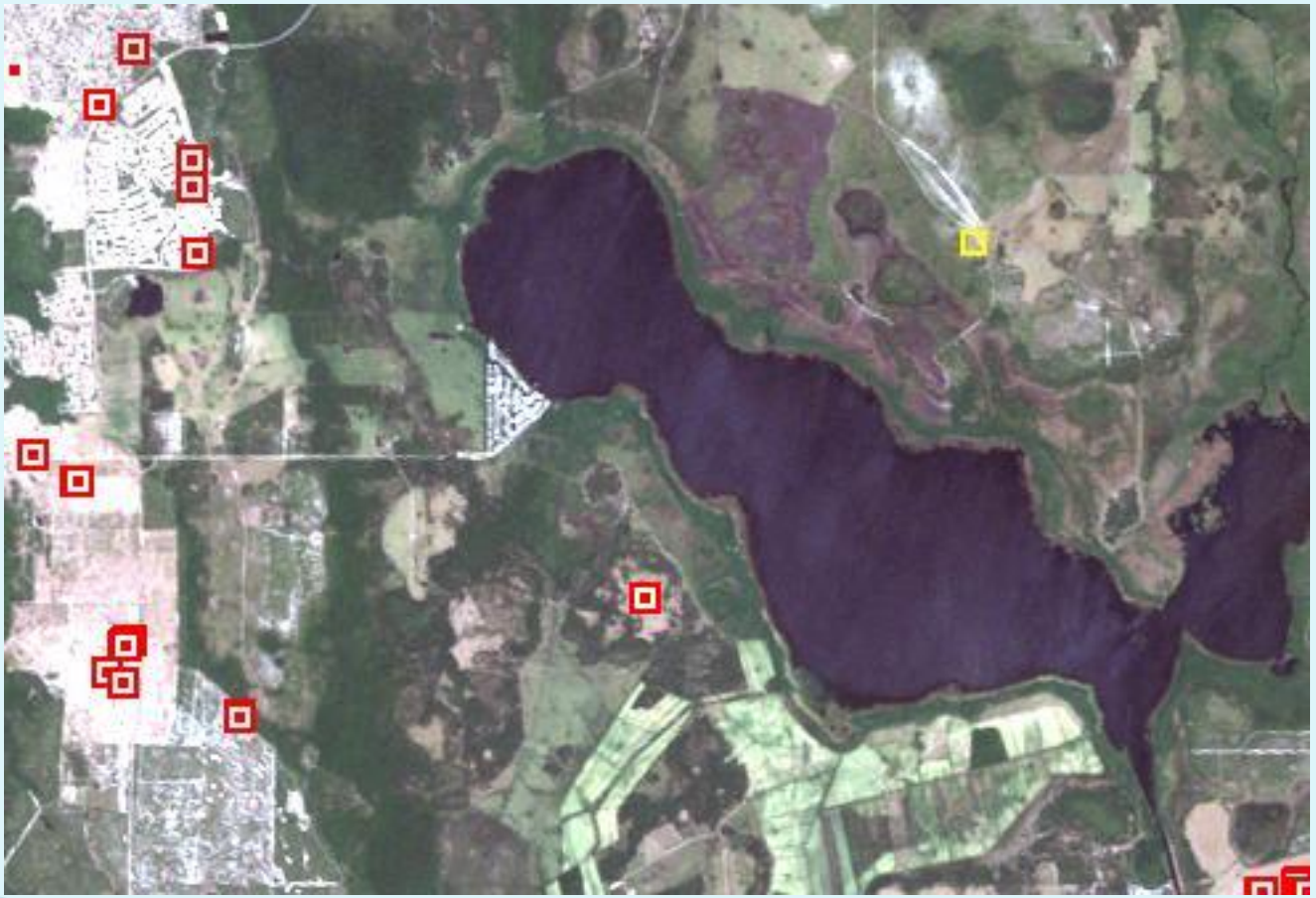
Automated Calibration

- Performed for **LANDSAT**



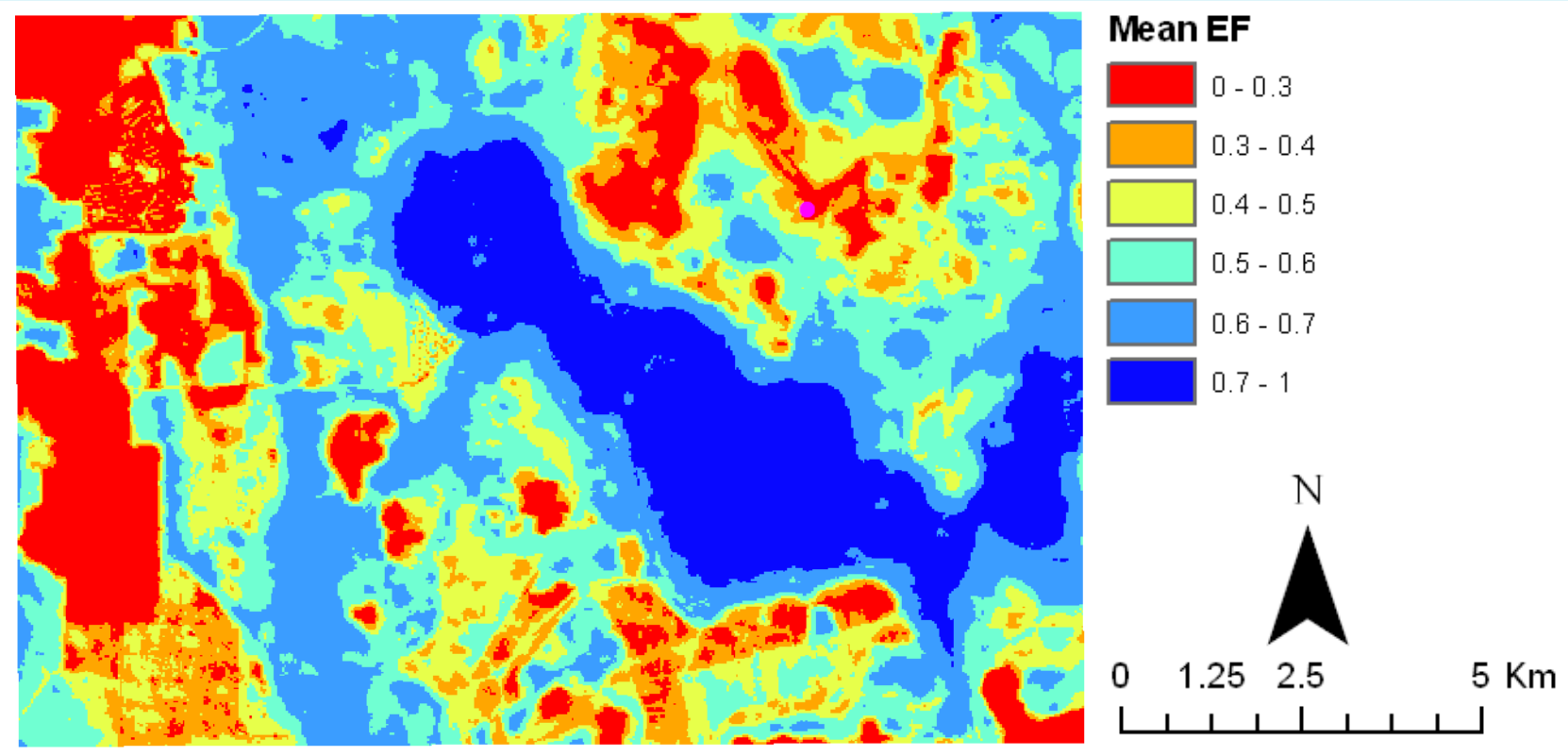
Dry Pixels

- Performed for Every Image



EF Maps

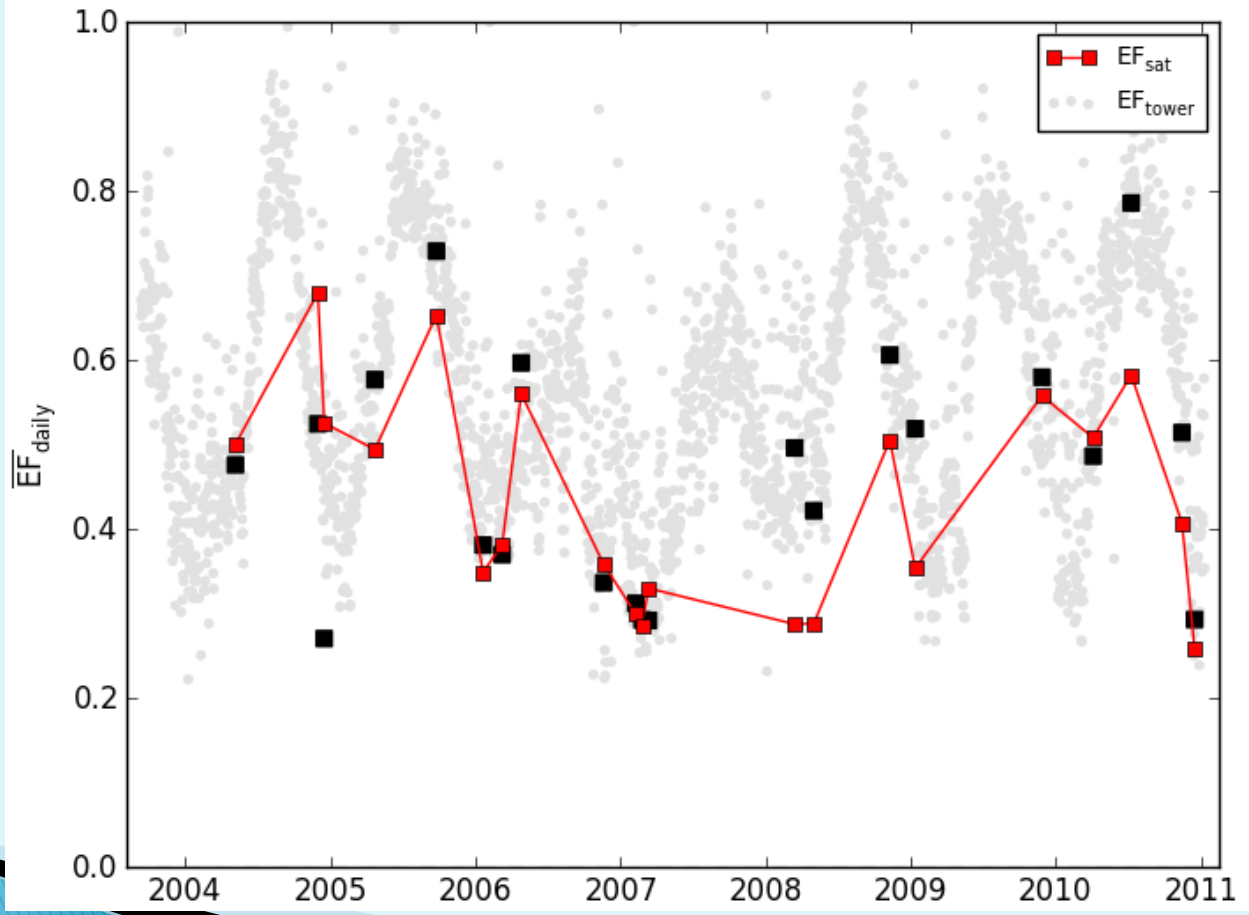
April 2008



Linearly Interpolated EF

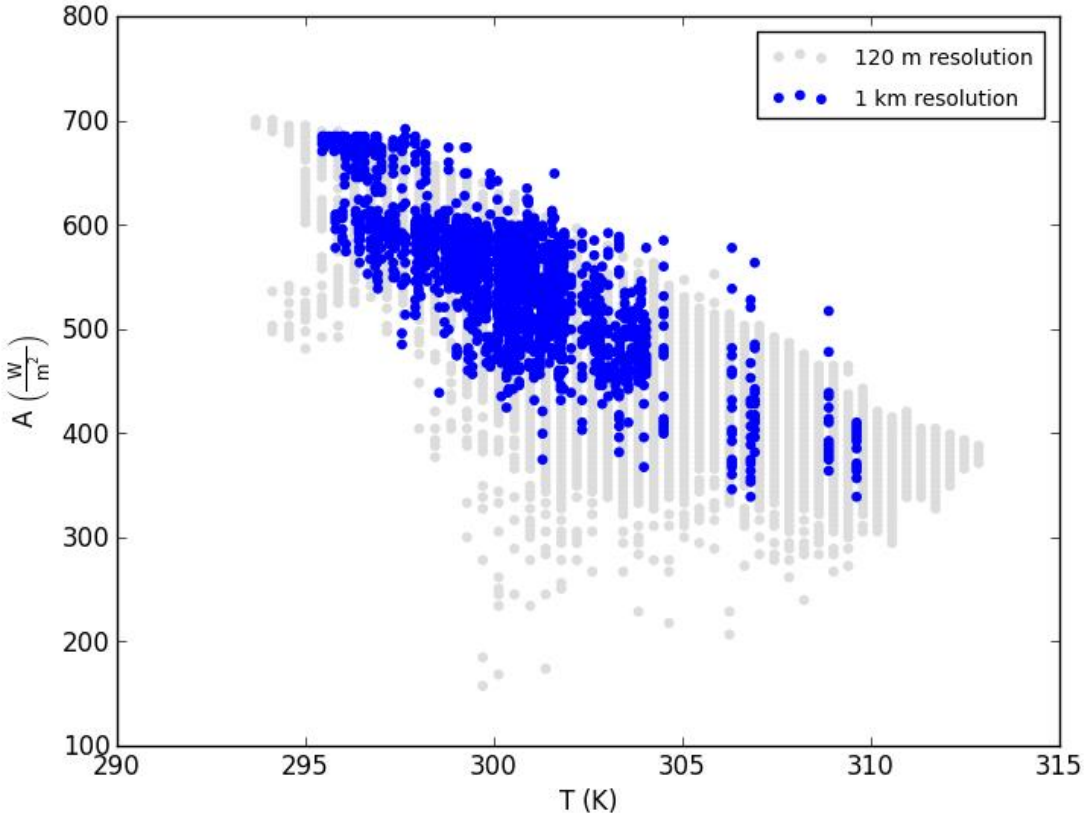
LANDSAT

16 Day Return + Clouds = Poor Temporal Resolution



MODIS TOO COARSE

- **MODIS** has Daily Return
- But Dry Pixels Don't Exist at this Resolution



Need LANDSAT

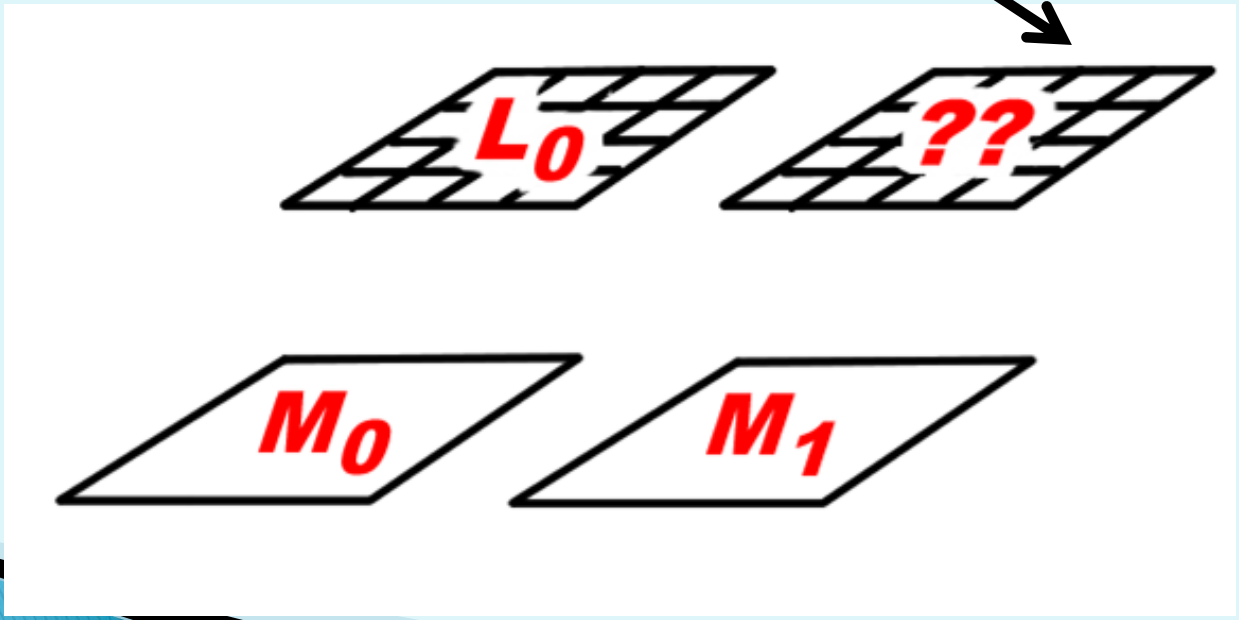
(120 m)

Solution? Data Fusion

- Combine LANDSAT and MODIS
- Use LANDSAT “Pattern” and MODIS “Change”

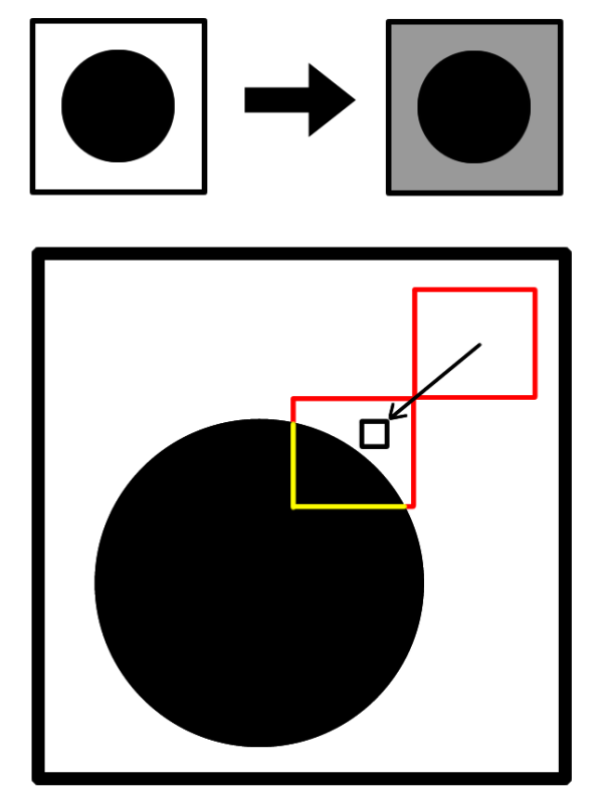
$$\Delta M = M_1 - M_0$$

$$L_1 = L_0 + \Delta M$$

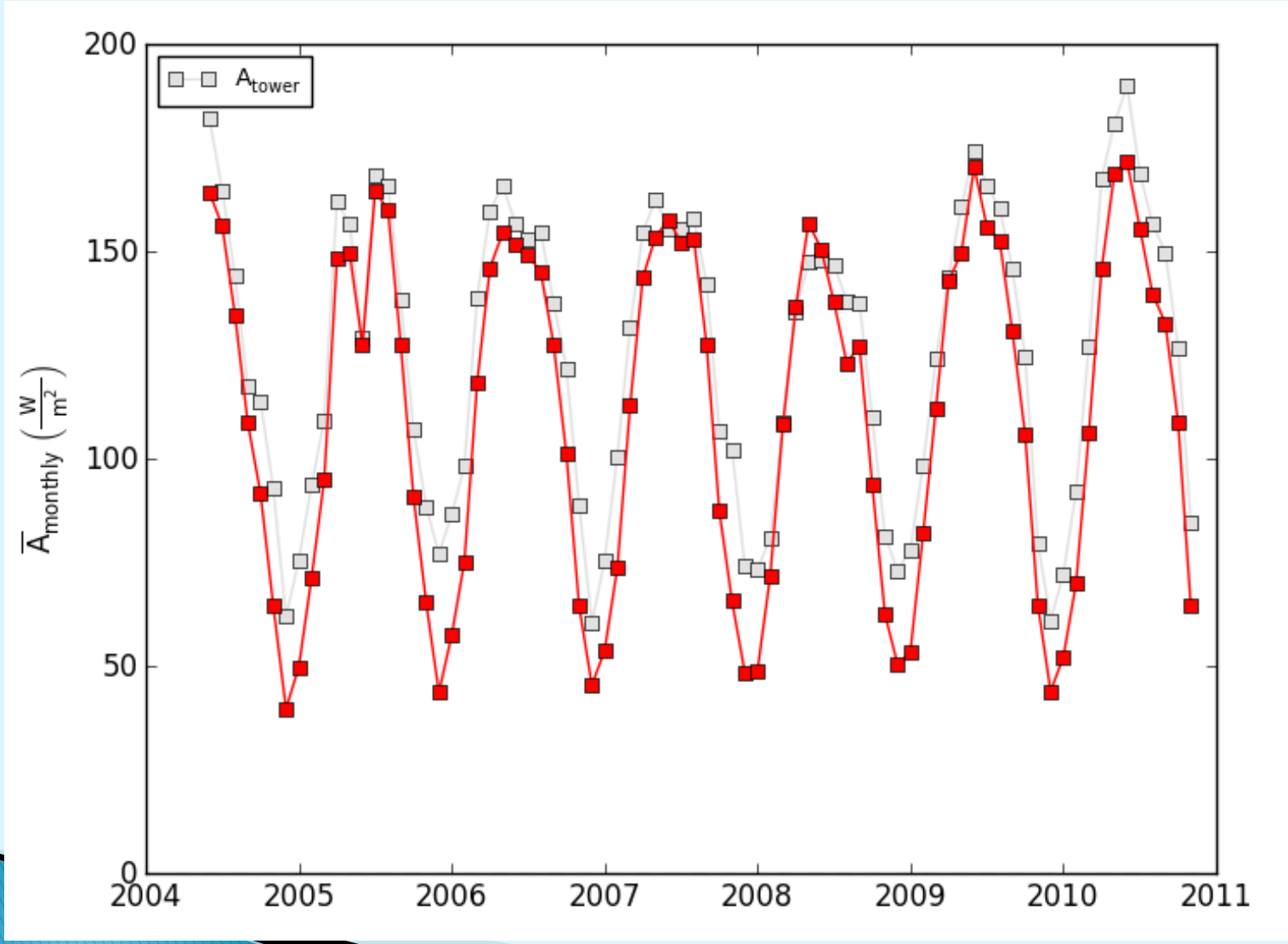


Similarity Fusion

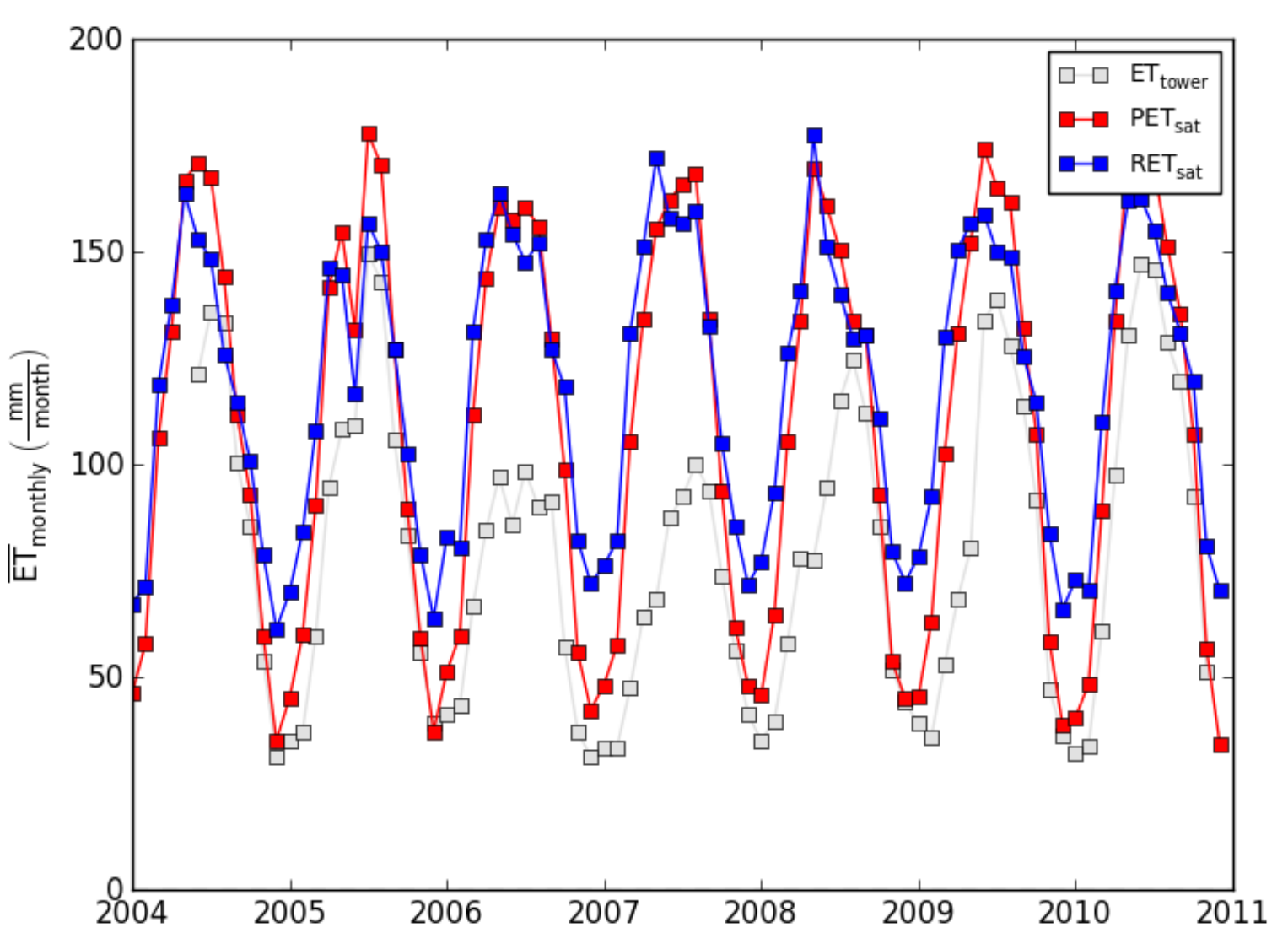
- Find MODIS Block with Most Similar ET
- Use Temp Change (ΔM) from this Block



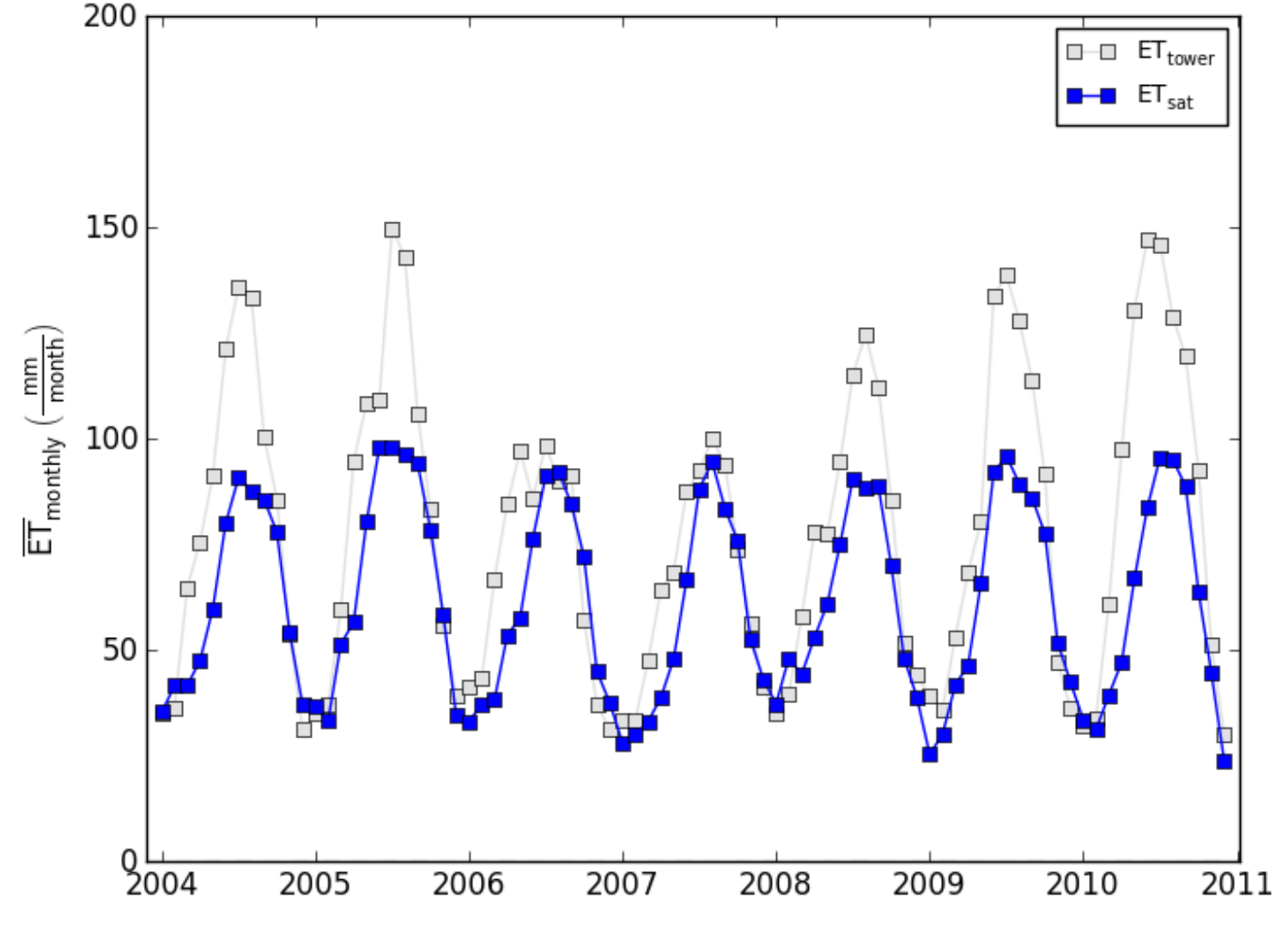
USGS Energy


200
150
100
50
0
2004
2005
2006
2007
2008
2009
2010
2011
A_tower
$\overline{A}_{monthly}\left(\frac{W}{m^2}\right)$

USGS PET/RET


200
150
100
50
0
2004
2005
2006
2007
2008
2009
2010
2011
$\overline{ET}_{monthly}\left(\frac{mm}{month}\right)$
ET_{tower}
PET_{sat}
RET_{sat}

MOD16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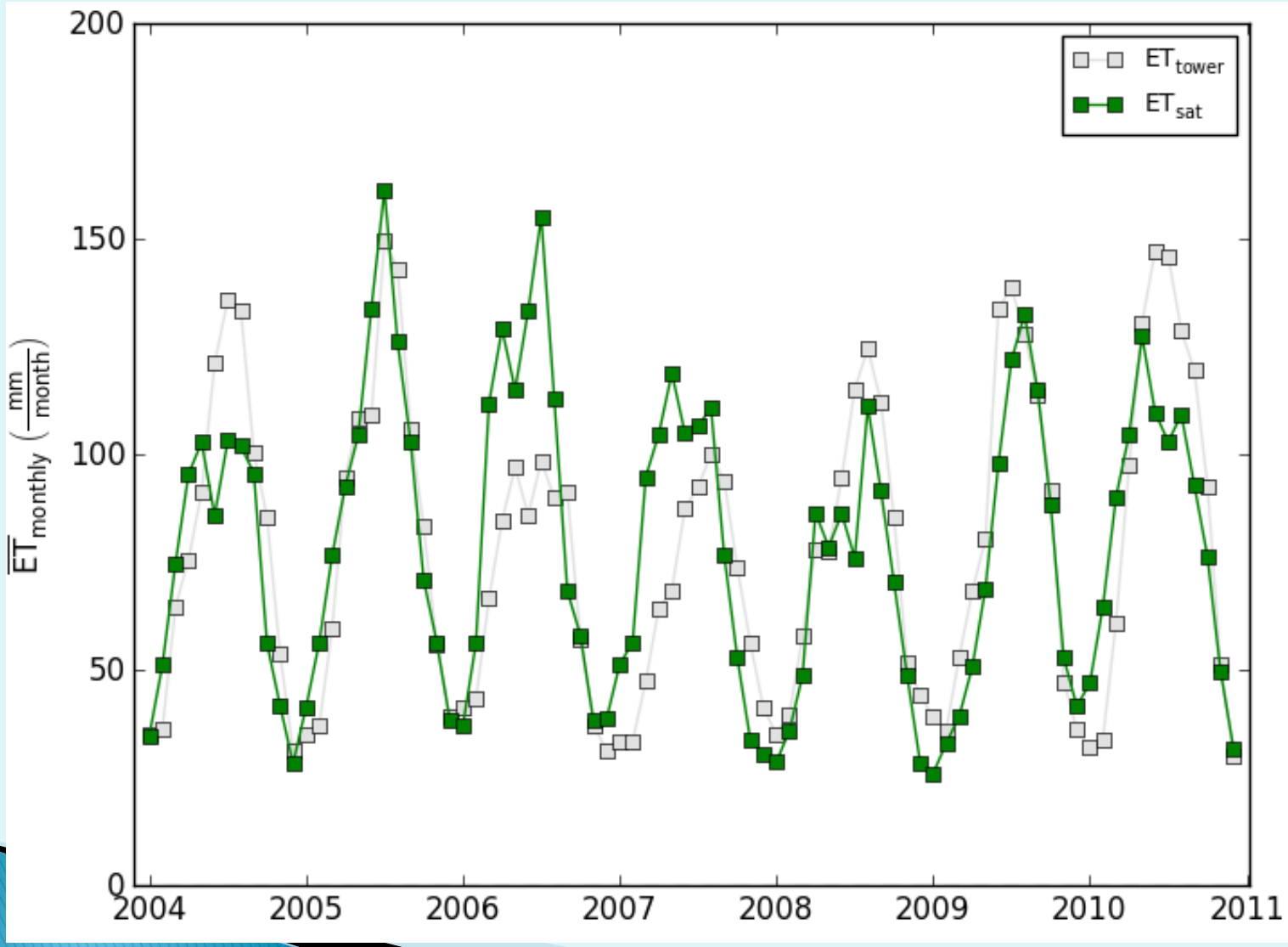
$\overline{ET}_{monthly}\left(\frac{mm}{month}\right)$
ET_{tower}
ET_{sat}

FUSION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Bias/MAE Errors

- PET/RET has Positive Bias
- MOD16 has Negative Bias
- Fusion has Small Bias But MAE Similar to MOD16

Method	Bias (mm/month)	MAE (mm/month)	Bias/ET (%)	MAE/ET (%)
PET	31.19	31.23	40	40
RET	40.3	40.48	51.7	51.9
MOD16	-16.65	18.41	-21.3	23.6
Diss. Linear	-25.15	25.2	-31.5	31.6
Diss. Fusion	0.49	16.74	0.6	21.5

QUESTIONS