Satellite spectral, spatial, temporal, phenologic sensitivities in upscaling fluxes

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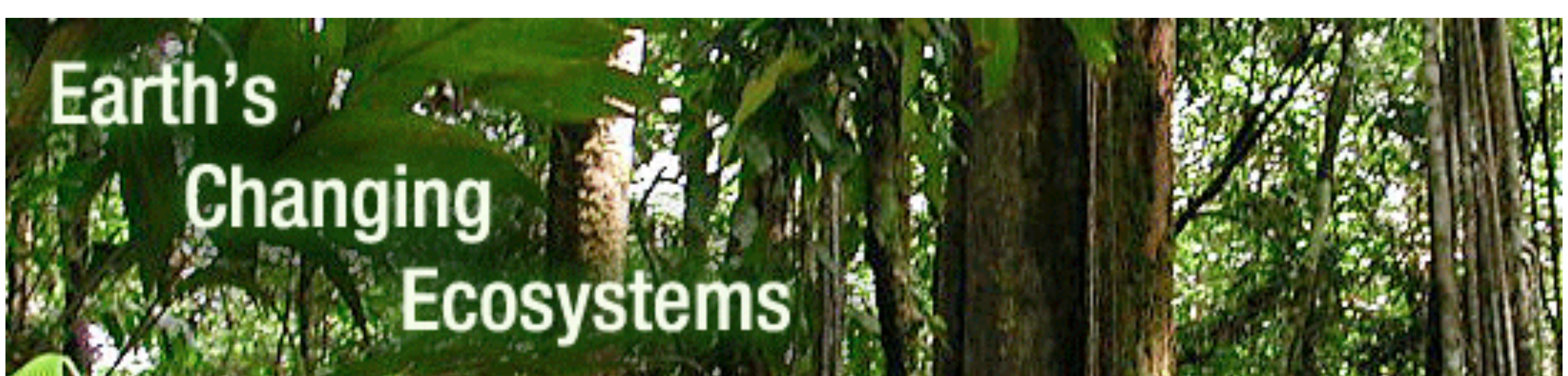


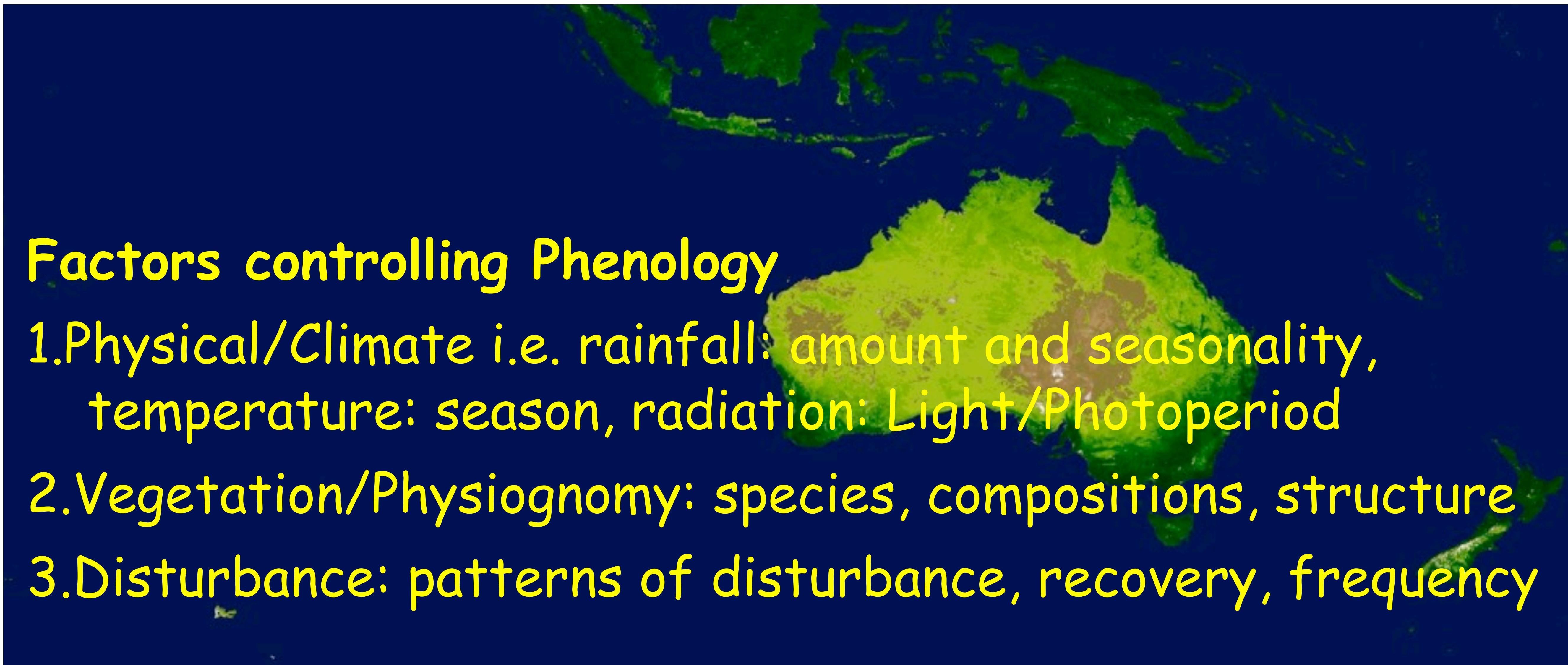
OzFlux Perth, Australia June 14 2011

UTS:C3
PLANT FUNCTIONAL BIOLOGY & CLIMATE CHANGE CLUSTER

MODIS

Ecosystem Seasonality from Space

- Seasonal variations depict a canopies **<u>integrated response</u>** to environmental change and, in turn, influence local biogeochemical processes, photosynthesis, water cycling, soil moisture depletion, and canopy physiology



Factors controlling Phenology

1. Physical/Climate i.e. rainfall: amount and seasonality, temperature: season, radiation: Light/Photoperiod
2. Vegetation/Physiognomy: species, compositions, structure
3. Disturbance: patterns of disturbance, recovery, frequency

Savanna Biome (structure and functioning)

- Tropical savannas are key components of the global carbon and water cycles and understanding their functioning is critical to understanding ecosystem feedbacks to global climate.

- Savannas are highly varied in their composition, structure and function consisting of seasonally variable contributions of C3 overstorey and C4 understorey (e.g. grass may account 20% ET and 50% GPP in wet season).

- By observing broad scale vegetation responses to climatic variability, remote sensing offers powerful insights into the patterns and processes underlying savanna behaviour.

- However, seasonal variations in satellite data need to be sufficiently accurate to ensure confidence in interpreting vegetation responses to inter- annual climatic variation and to aid in constraining models of carbon and water fluxes.

Objectives

- Analyse high MODIS and EC tower flux data across a tropical savanna aridity gradient in northern Australia. (*controlled by Indo-Australian Monsoon*).

- Integrate tower fluxes of GPP and ET with several key MODIS vegetation products across a range of spatio-temporal footprints.

- Investigate satellite product sensitivities to *seasonal* variability in rainfall and tower fluxes across the aridity gradient.

- Investigate sensitivity of MODIS data to detect *inter-annual* patterns in tower fluxes.

North Australian Tropical Transect

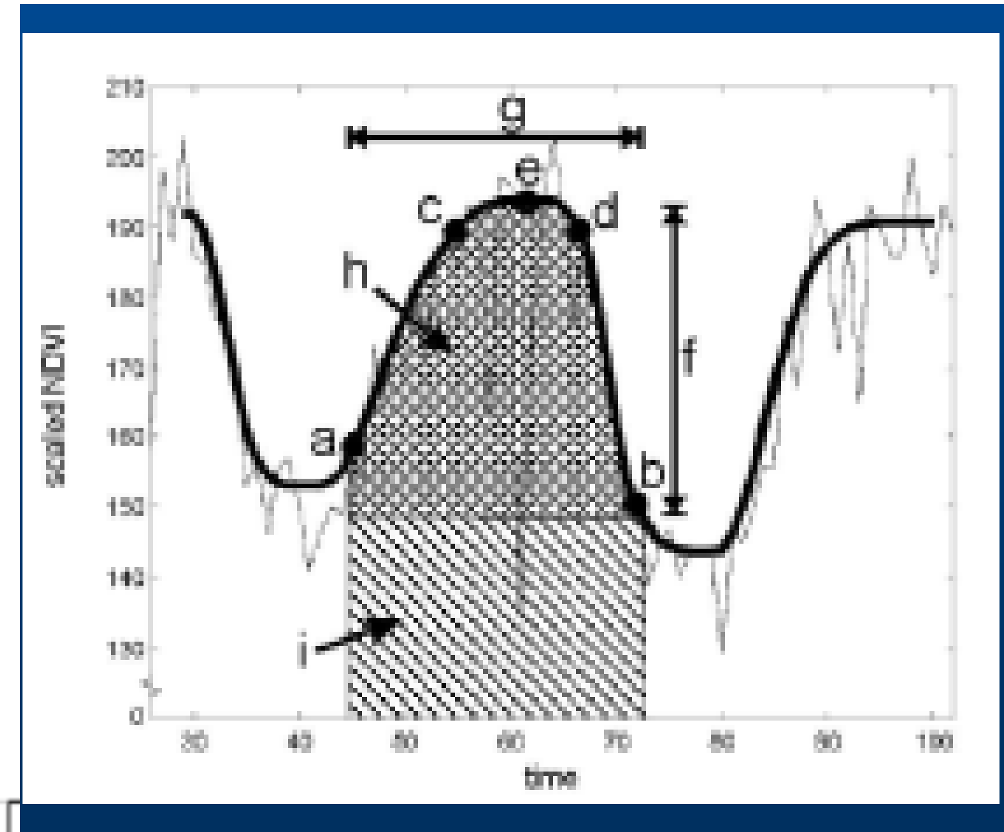
NATT transect
aridity gradient
annual rainfall 580-1760mm

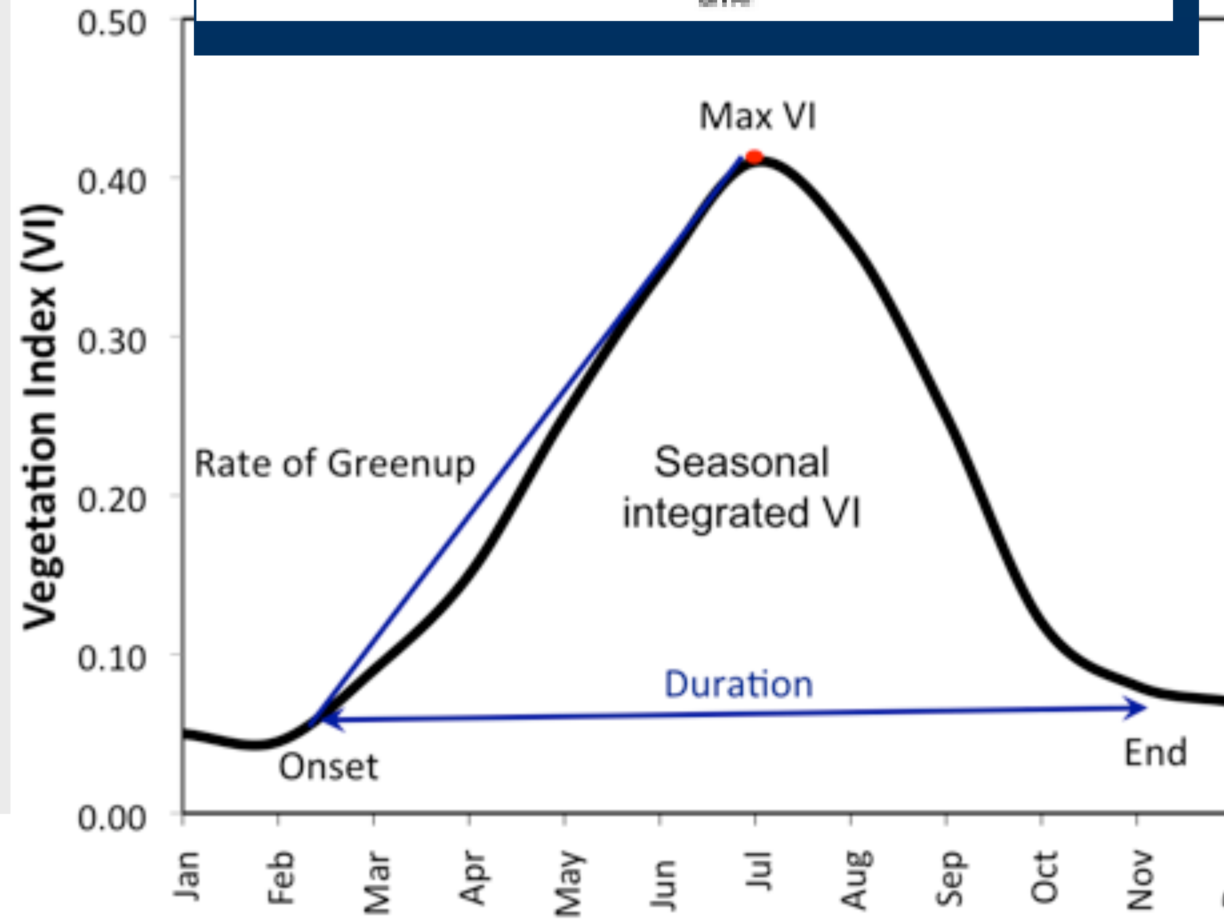
(Wet tropical savanna)

According to the 'Resource optimization paradigm', plants tend to adjust their foliage density over time periods of days to weeks, to match the level of photosynthesis that can be supported by the environment [Field et al. 1995].

Data & Methods

- 5 years of daily flux measurements from Howard Springs site (La Thuille dataset) were averaged to 8d and 16d intervals to match MODIS
- MODIS EVI, NDVI at 16d/250m; 8d/500m; and 16d/ 0.05^0 were analysed from 2000-2010 (MOD13Q1, MOD09A1, MOD13C1)
- MODIS EVI data QA filtered to remove clouds, mixed clouds, high aerosol, aerosol climatology, and strong view angle effects (>30^0)
- Timesat software used to gap fill (Savitzky-Golay filter function) (Jönsson and Eklundh, 2004)
- Acceptable QA data of varying window sizes were averaged for tower flux comparisons
- Timesat software also used for phenology metrics (SOS, POS, EOS, LOS, integrals)

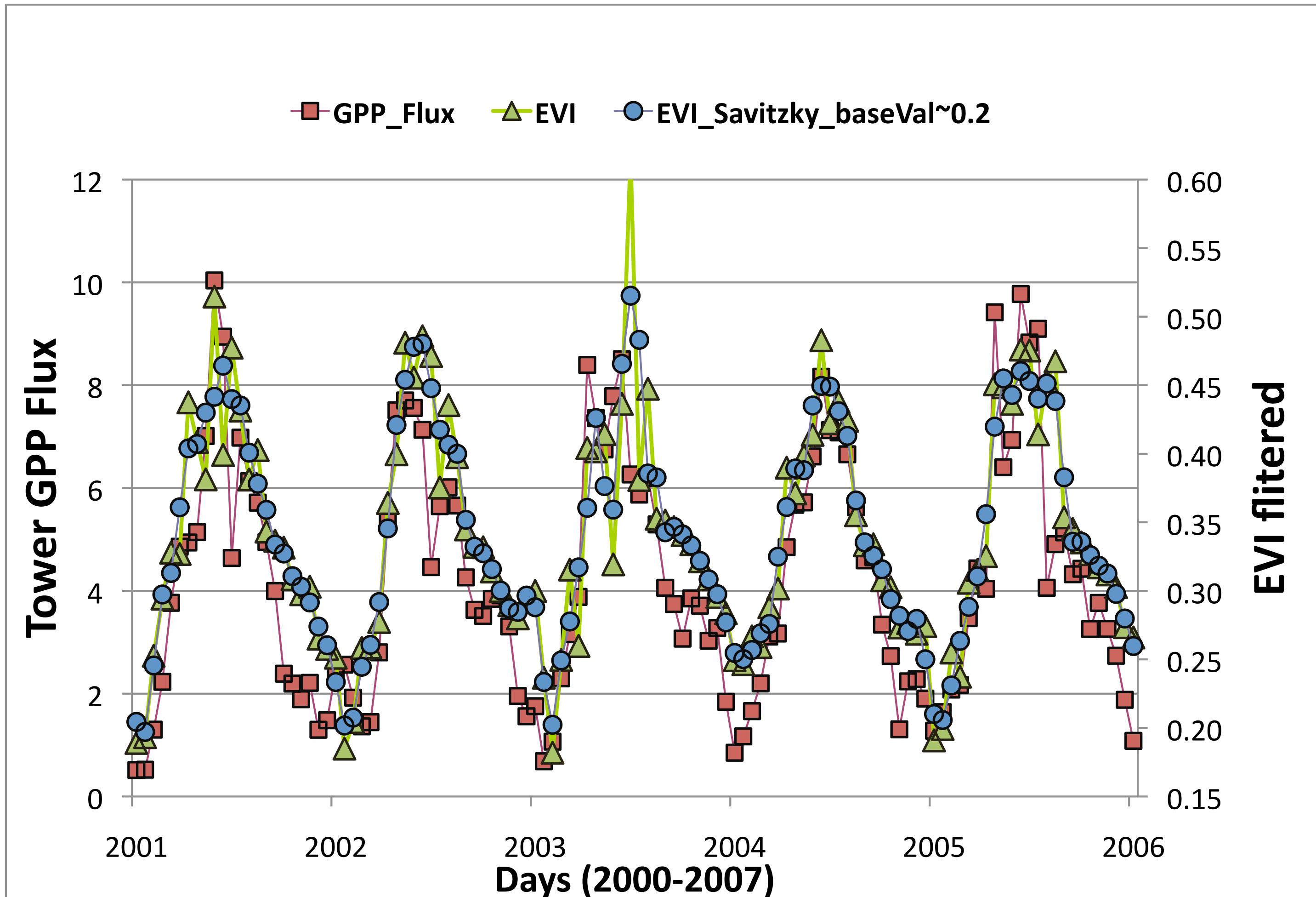


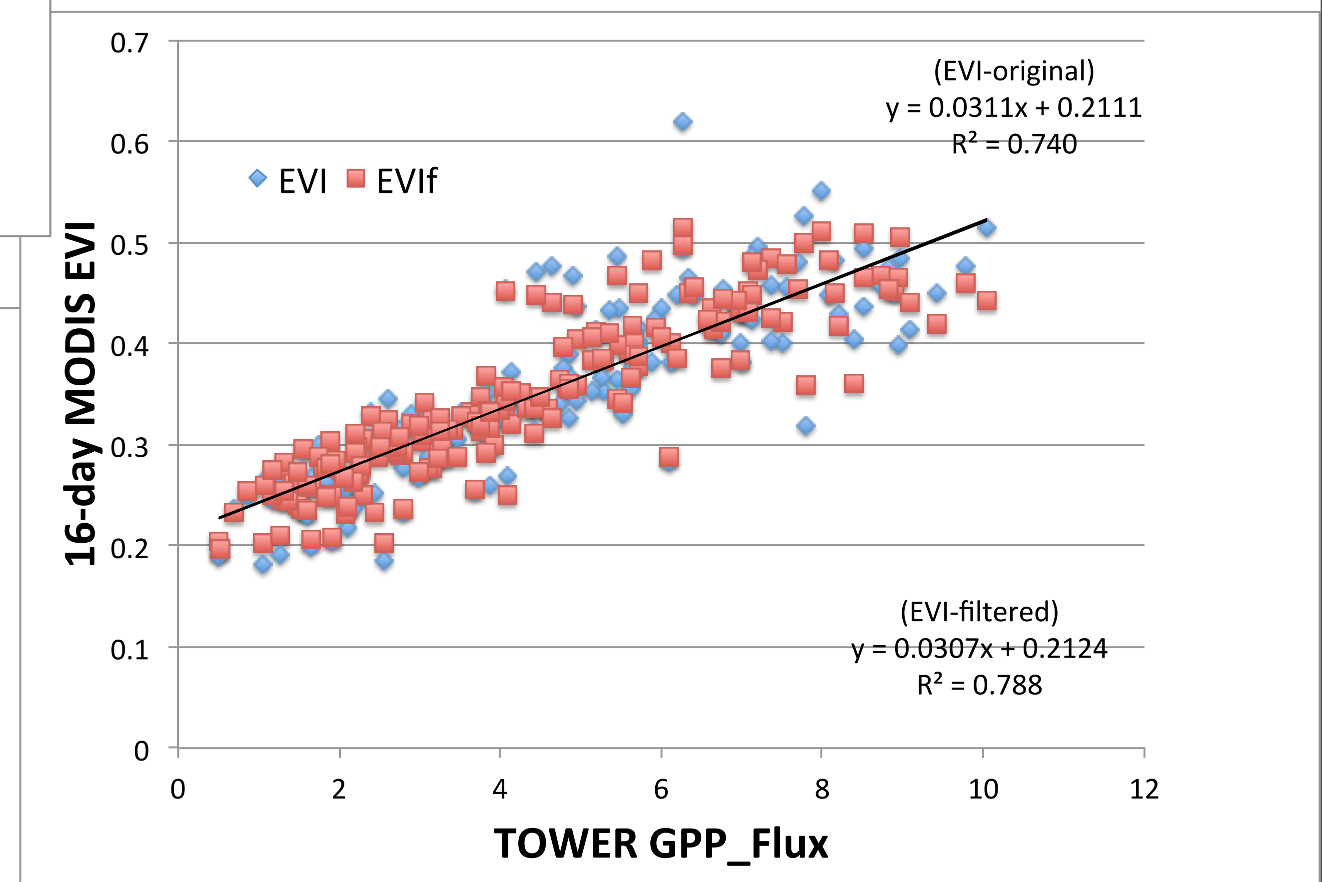


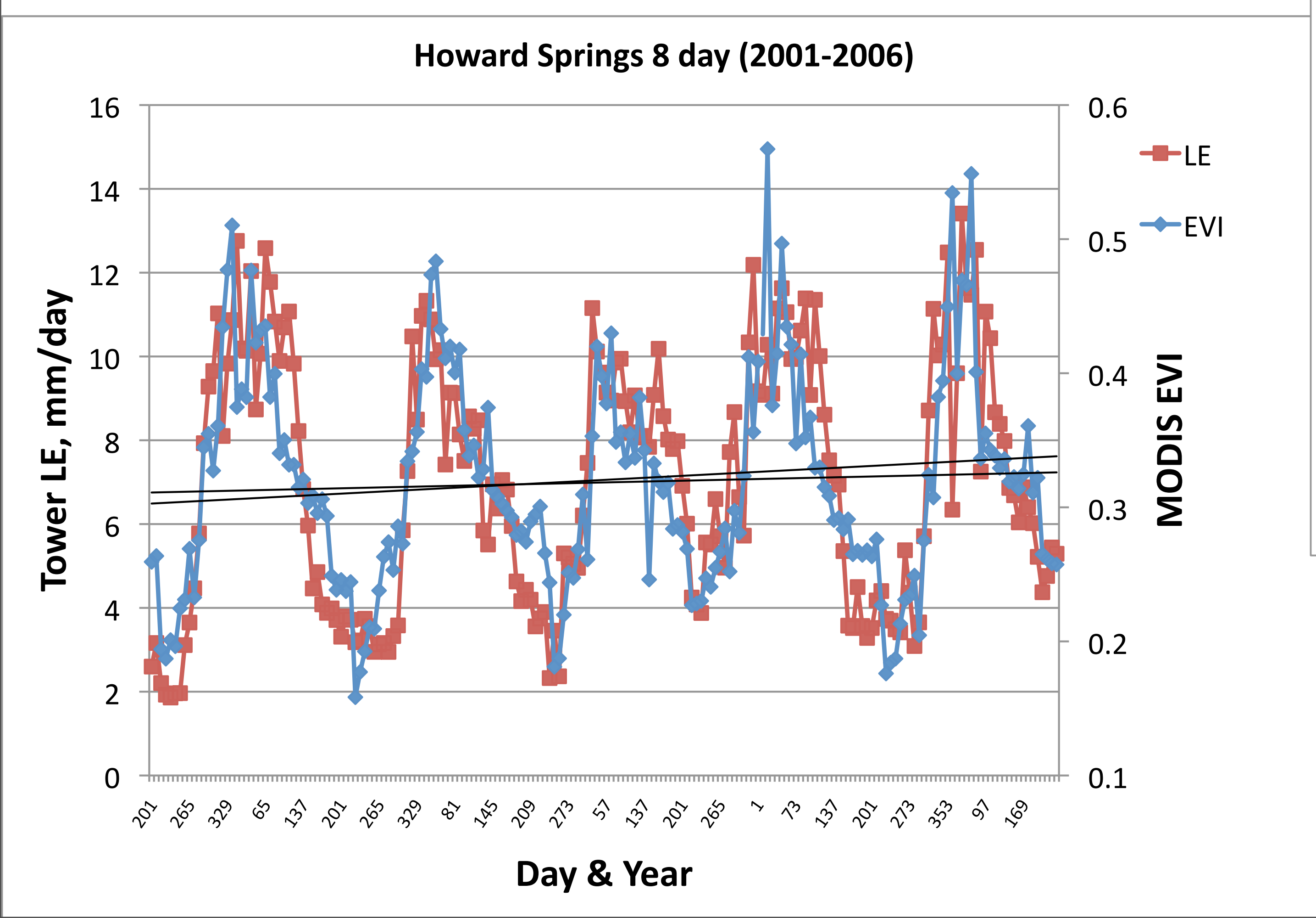
WorldView2 June 2010 image over Howard Springs site

MODIS 7x7 km and 3x3 km windows

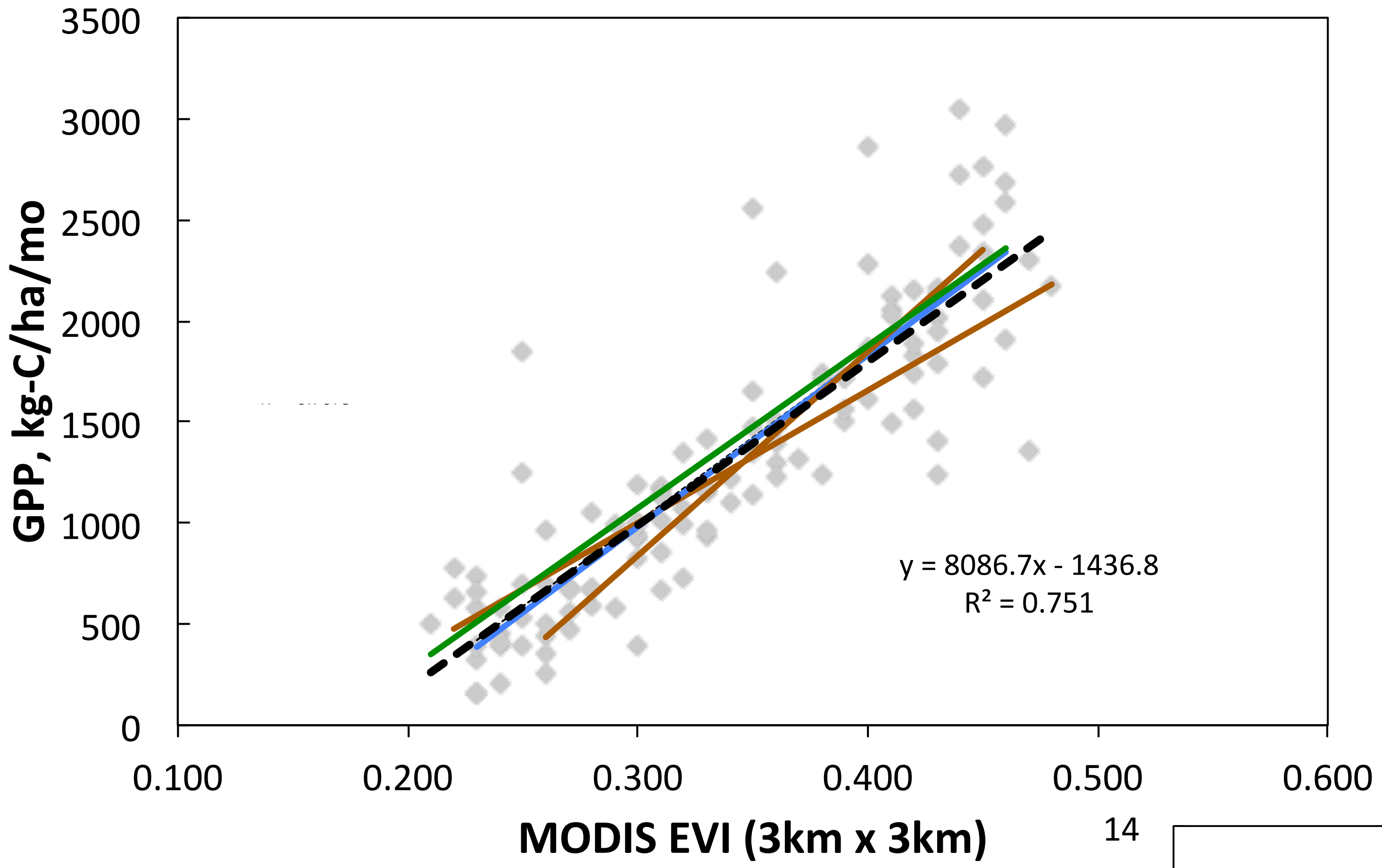
Howard Springs tower flux and MODIS EVI comparisons (*Timesat filtered*)

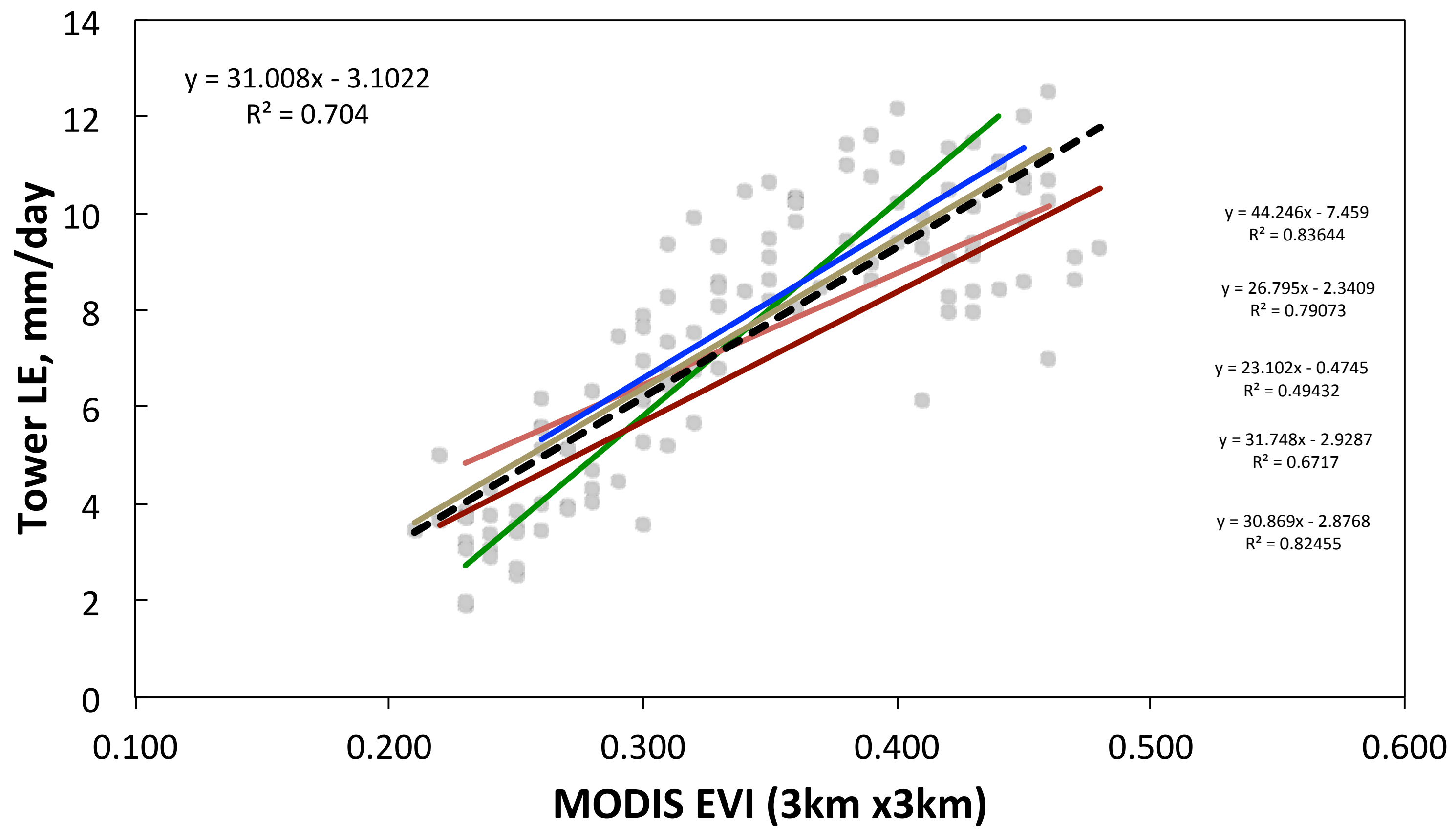




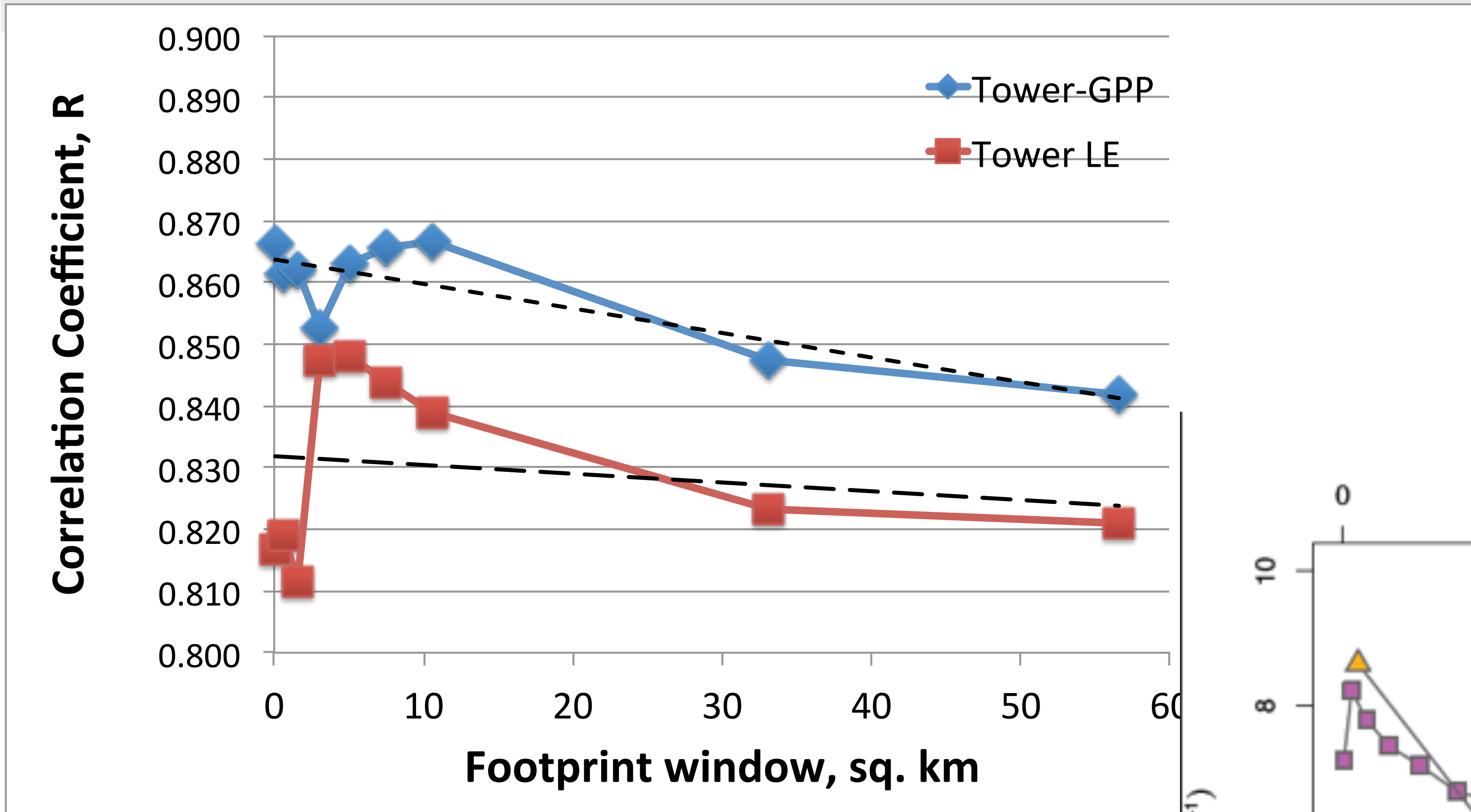


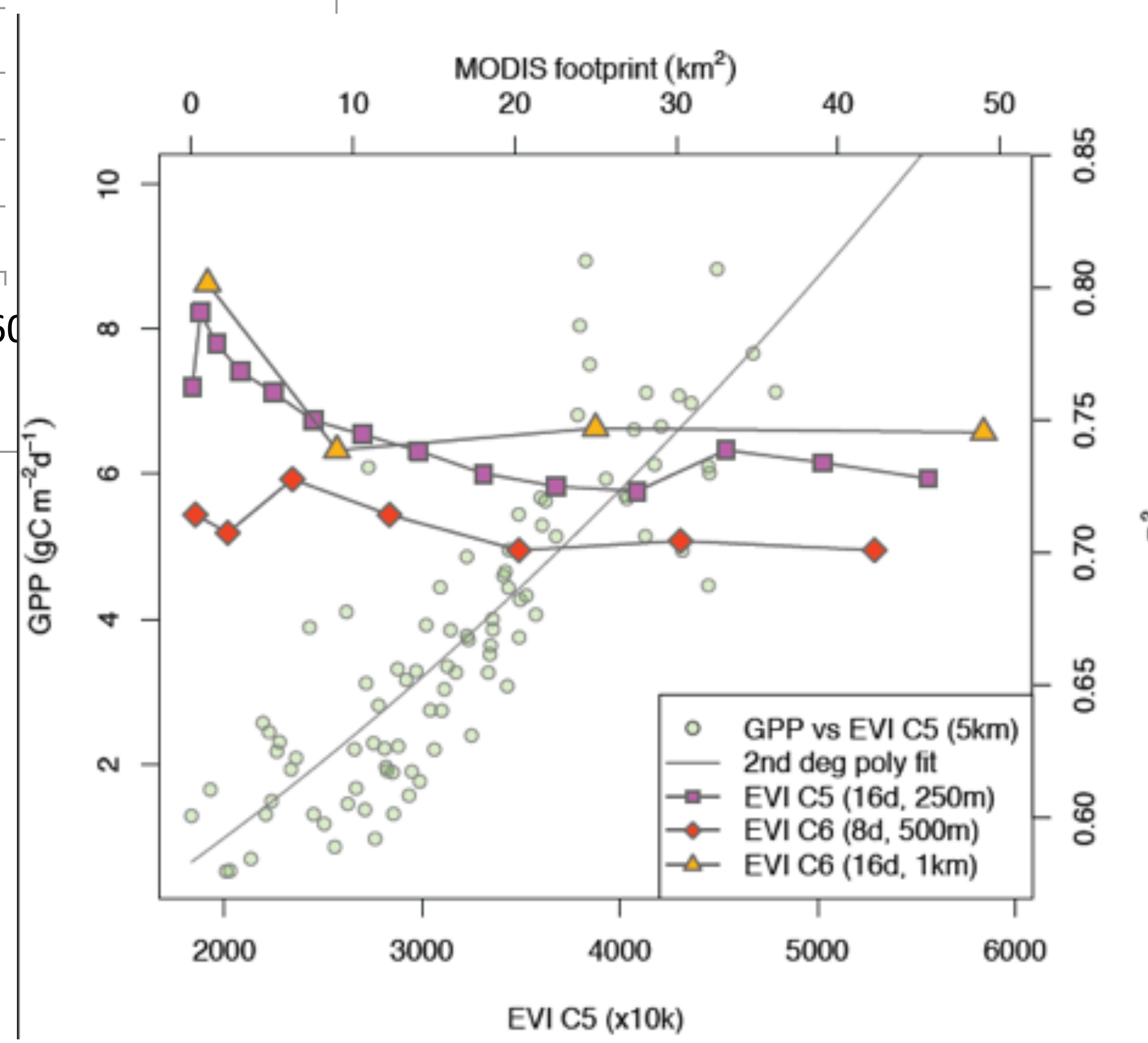
Tower GPP/ LE and MODIS EVI for individual hydrologic years (Jul 1- Jun 30)





Footprint analyses of MODIS EVI and Tower GPP

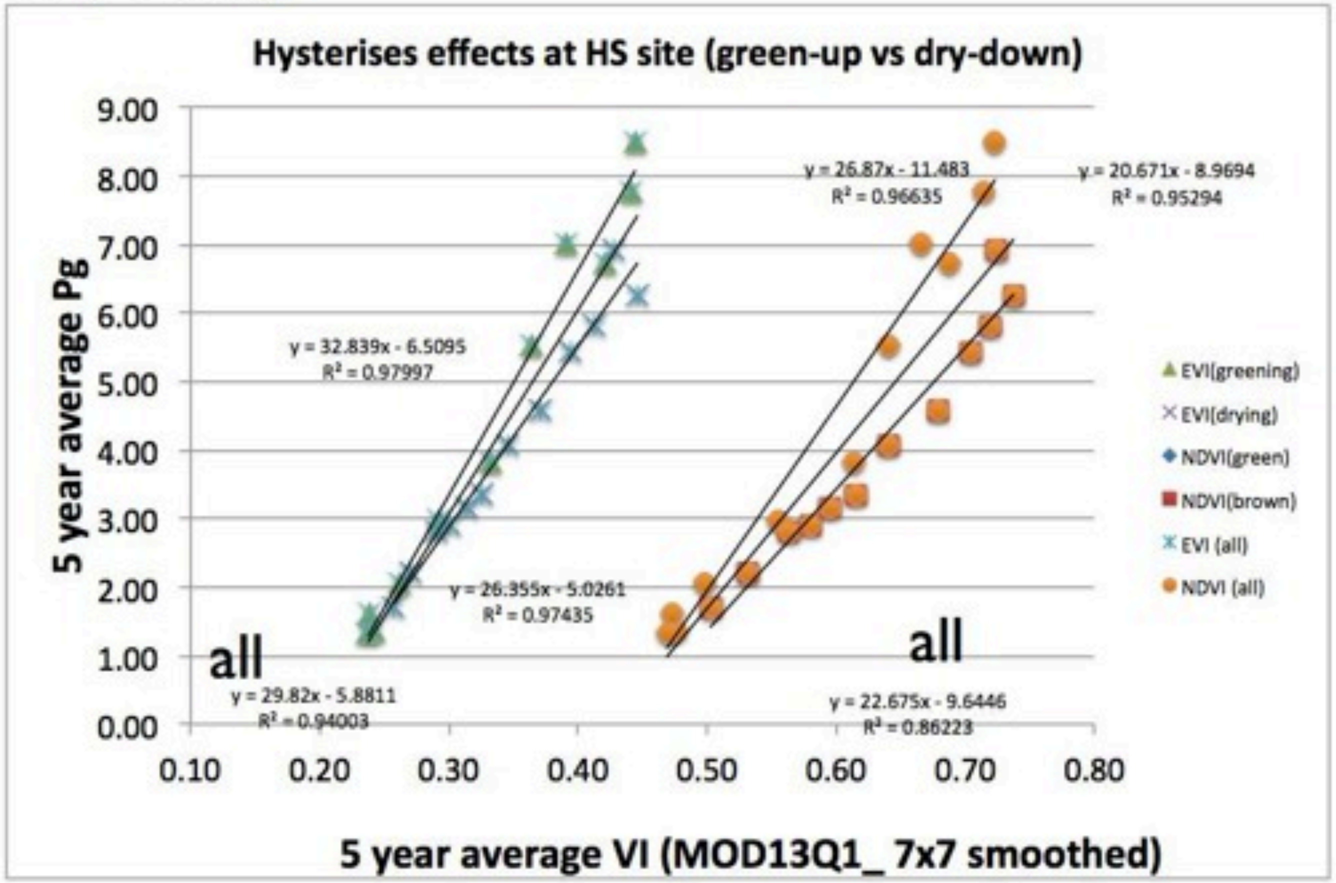




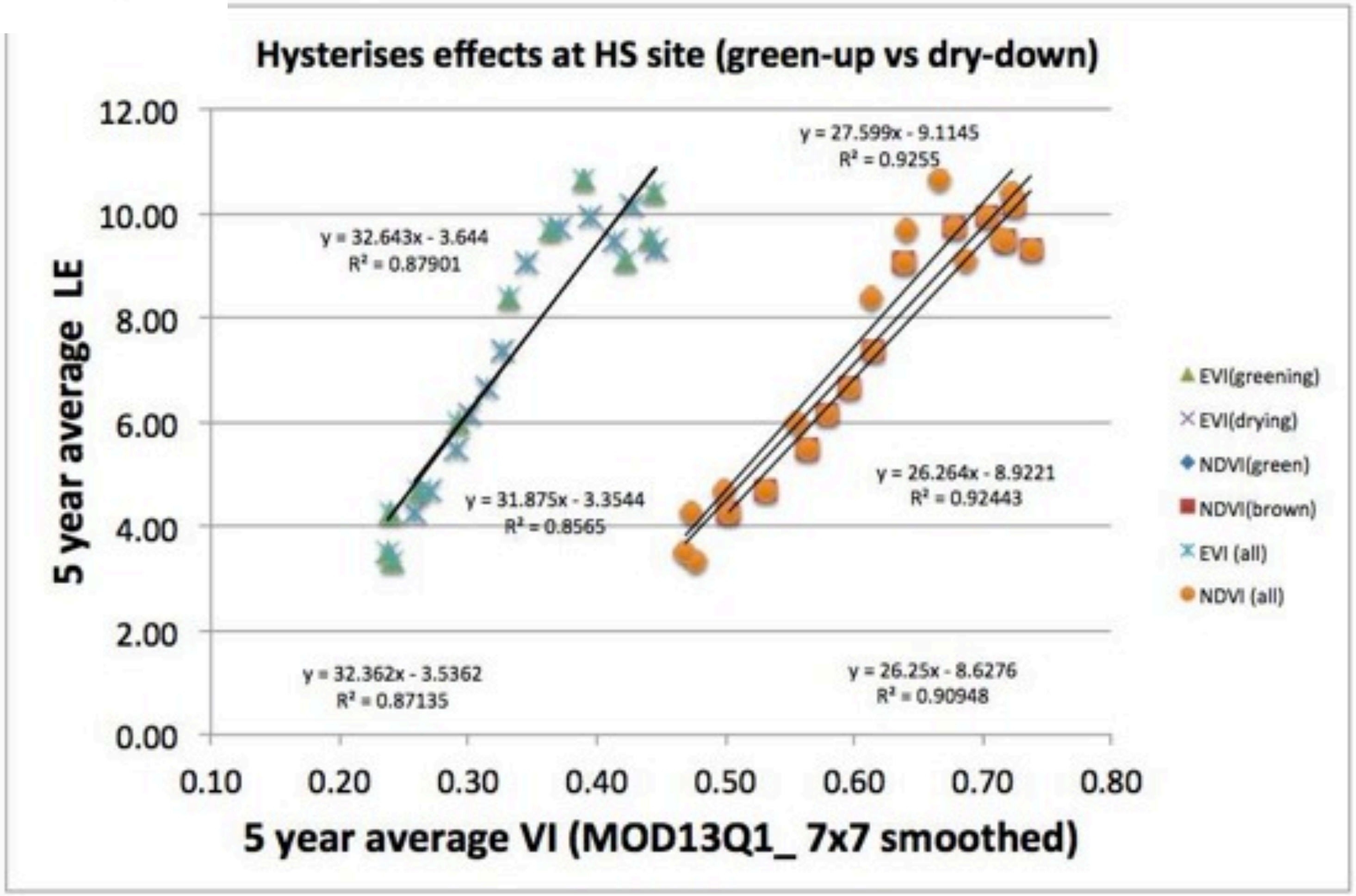
- There is decreasing sensitivity of tower-satellite relationships with window size,
- It is not possible to say if decreased MOD09 sensitivity is due to 8-day intervals or more cloudy MOD09 data.

greening (left)
all (center)

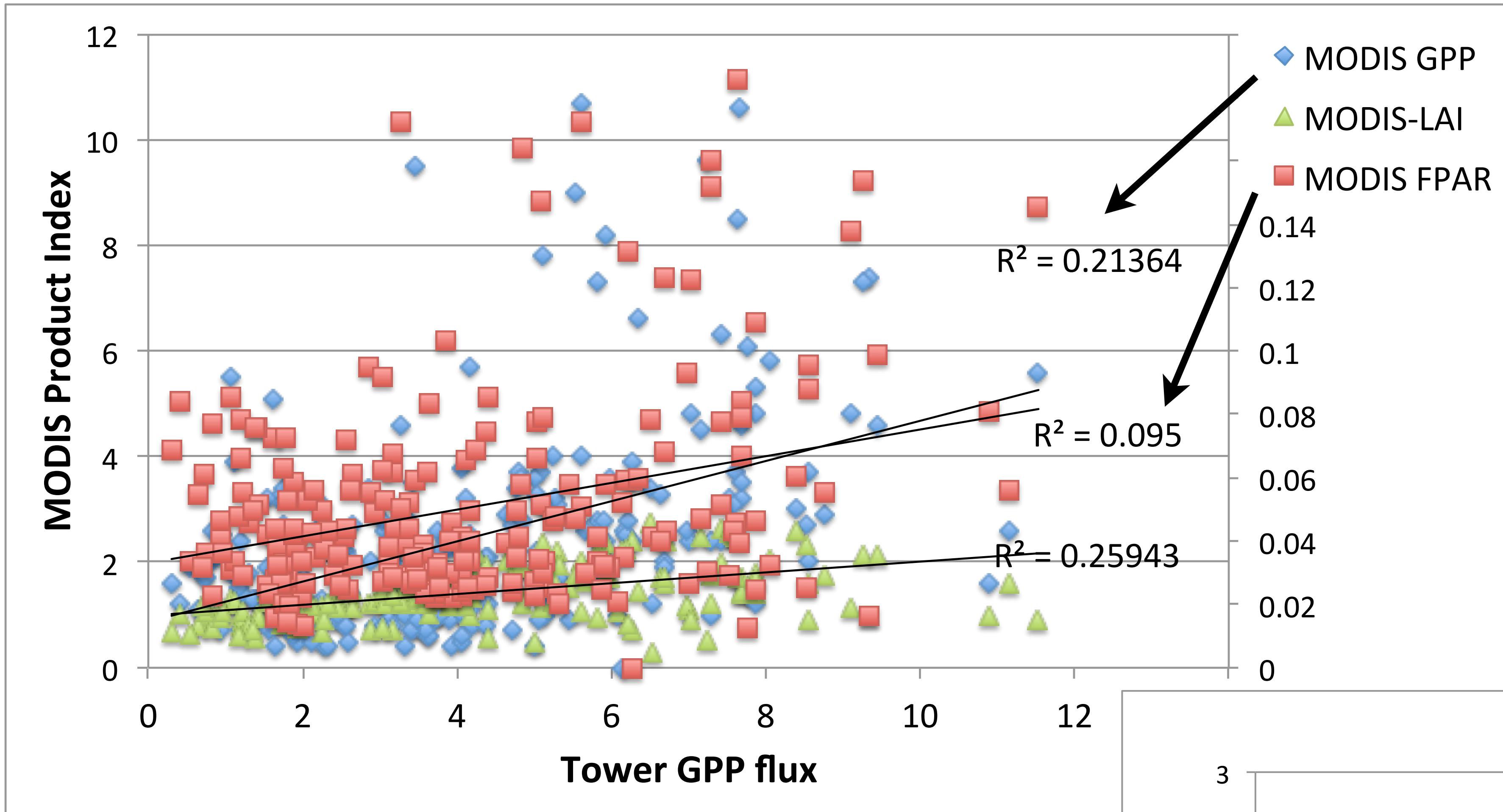
Hysteresis

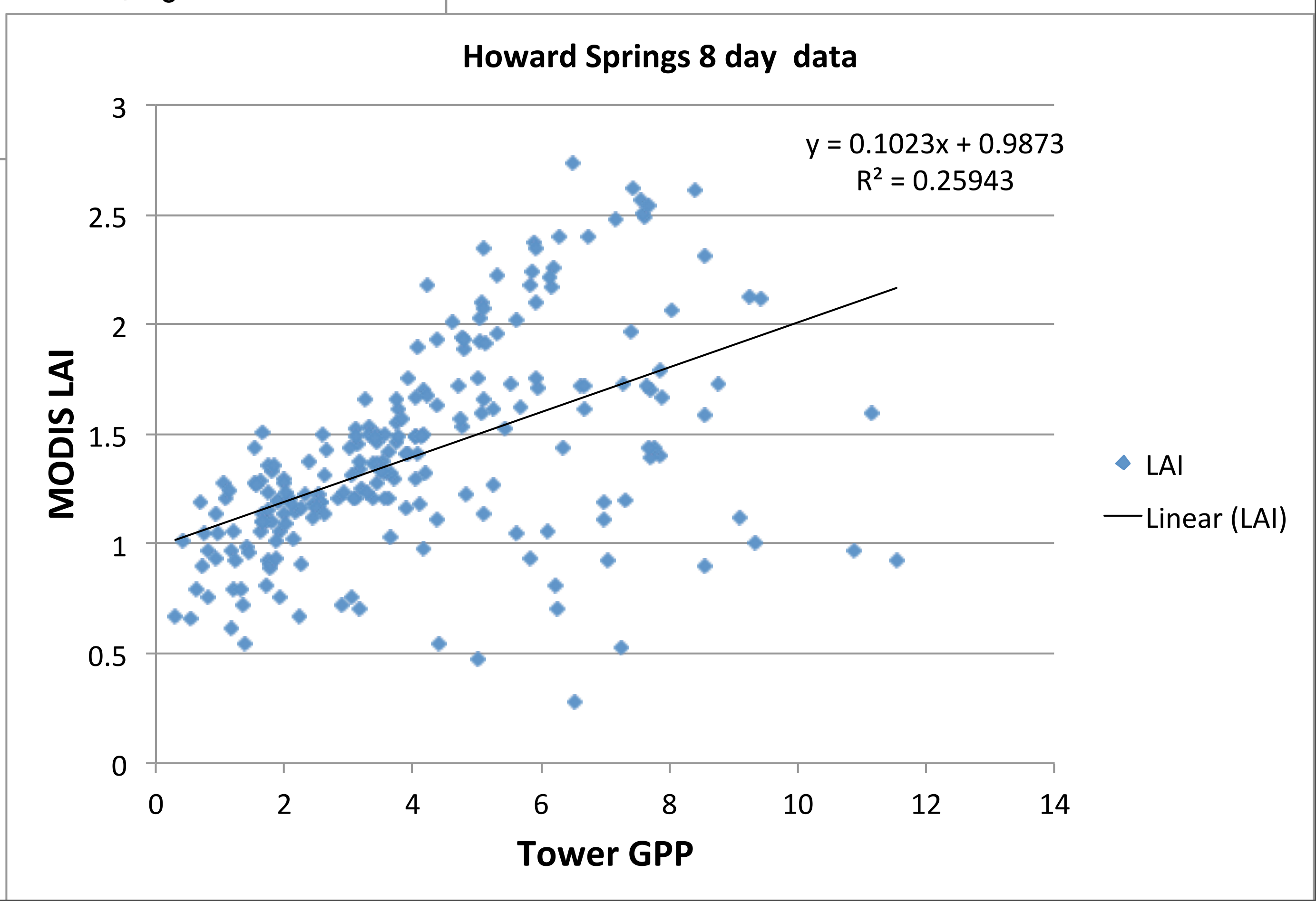


Hysteresis & LE



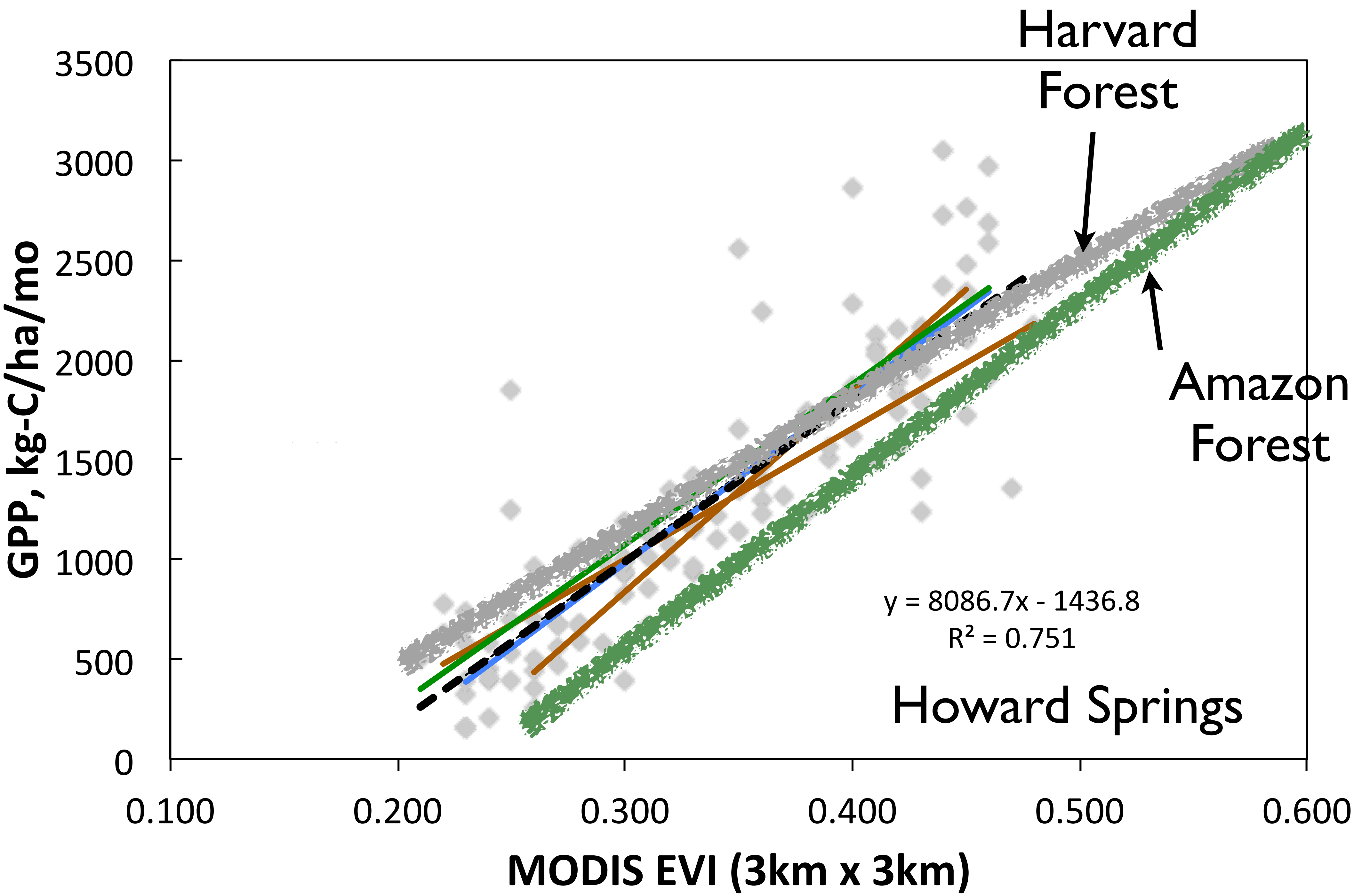
MODIS LAI/FPAR/ GPP



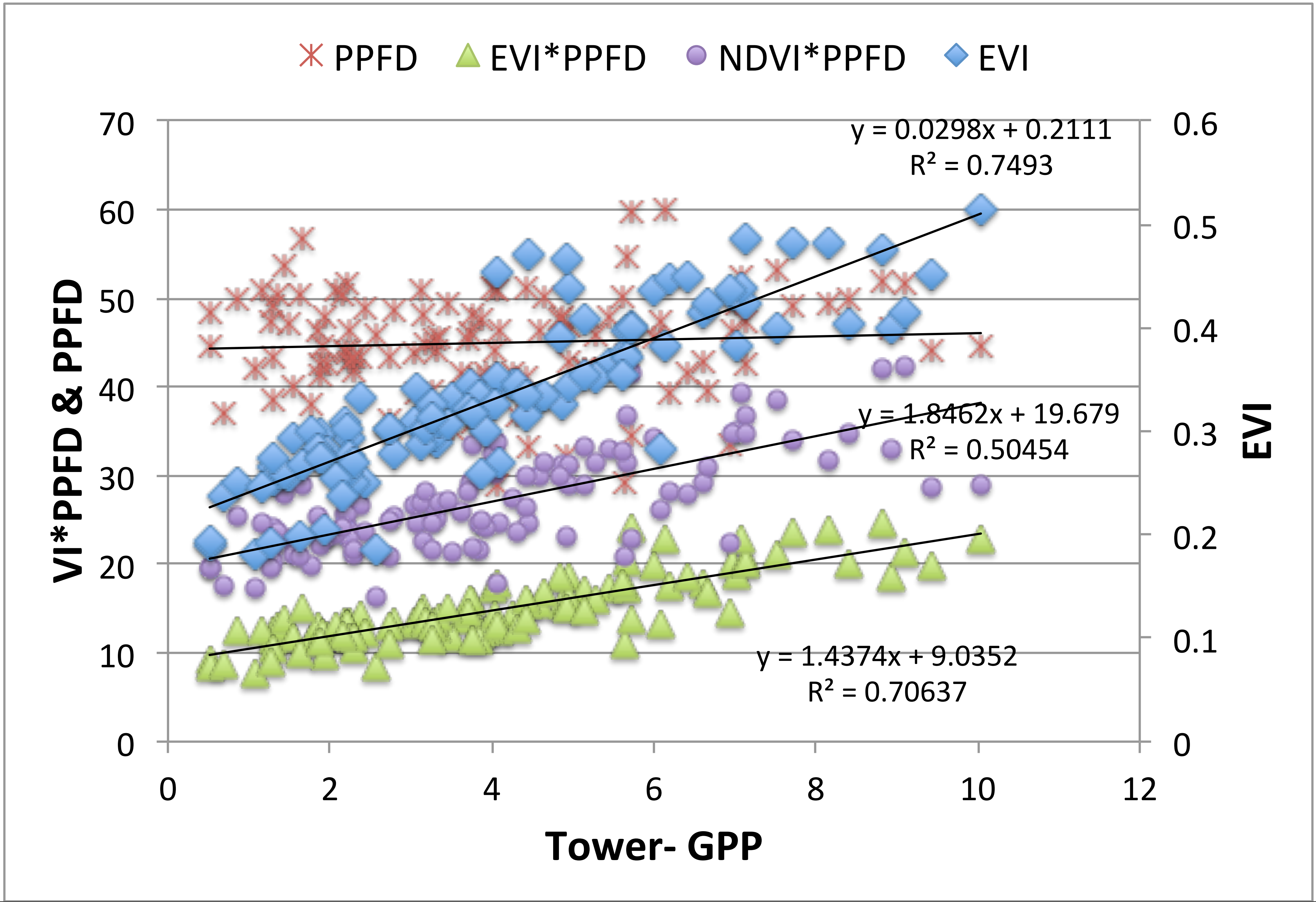


Poorer regressions overall, however, these 3 products are at 8 day temporal resolution.

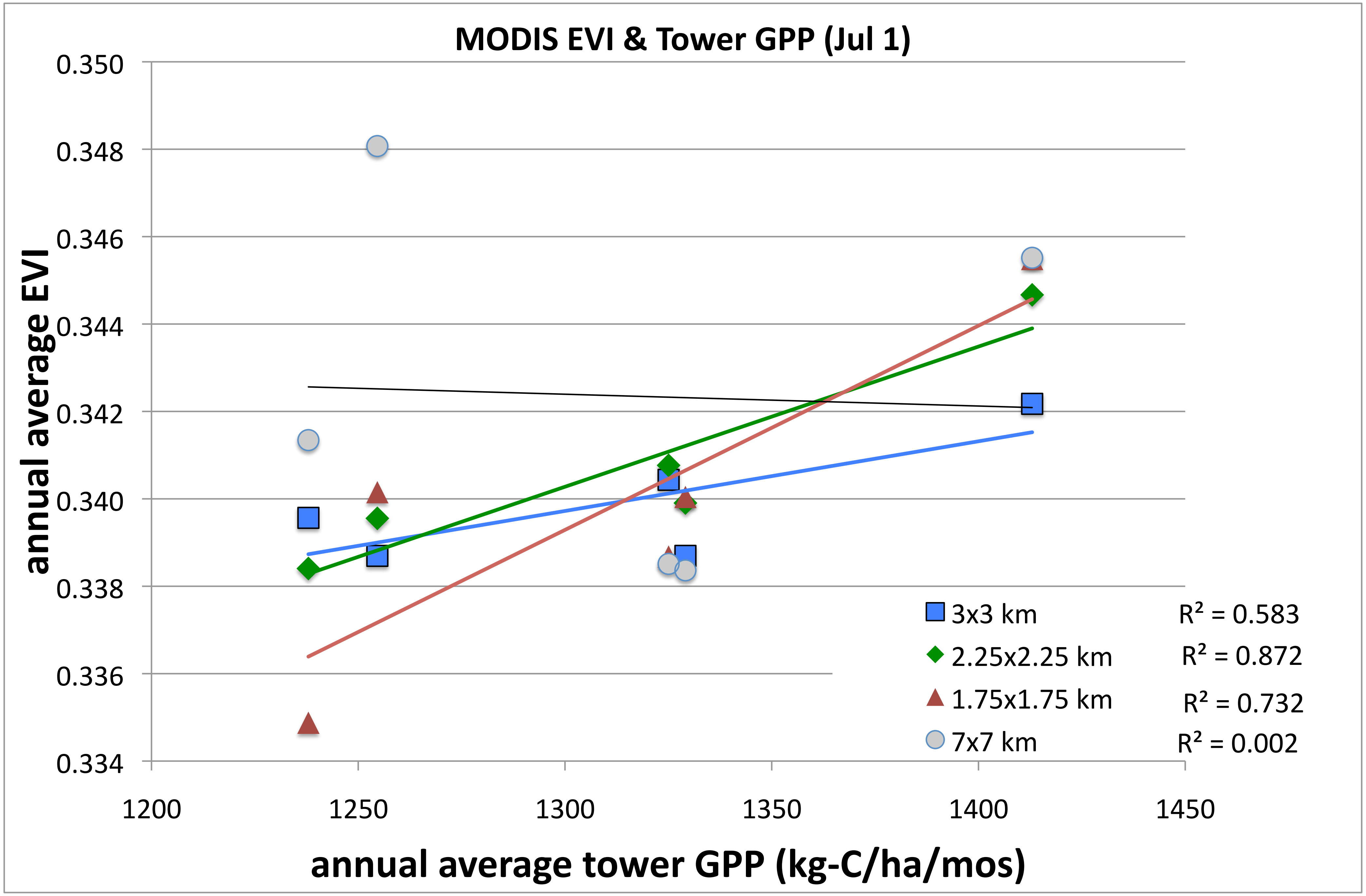
Multiple-site Tower GPP and MODIS EVI



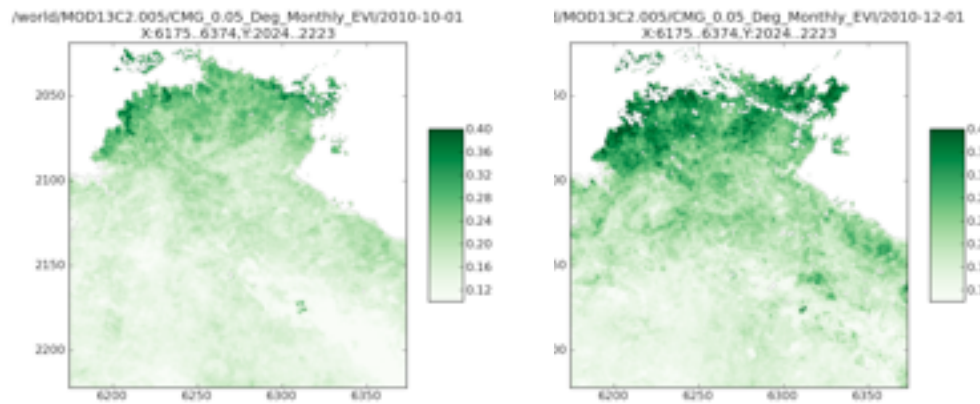
Role of solar radiation and light use efficiency models

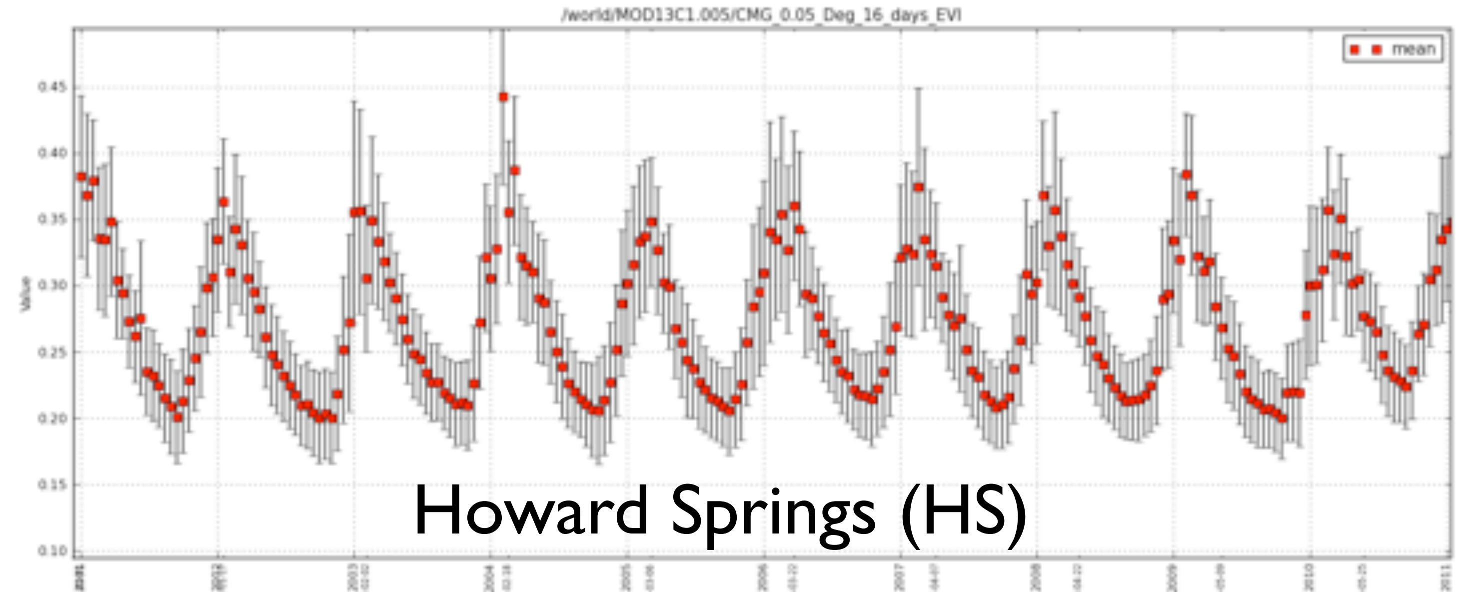


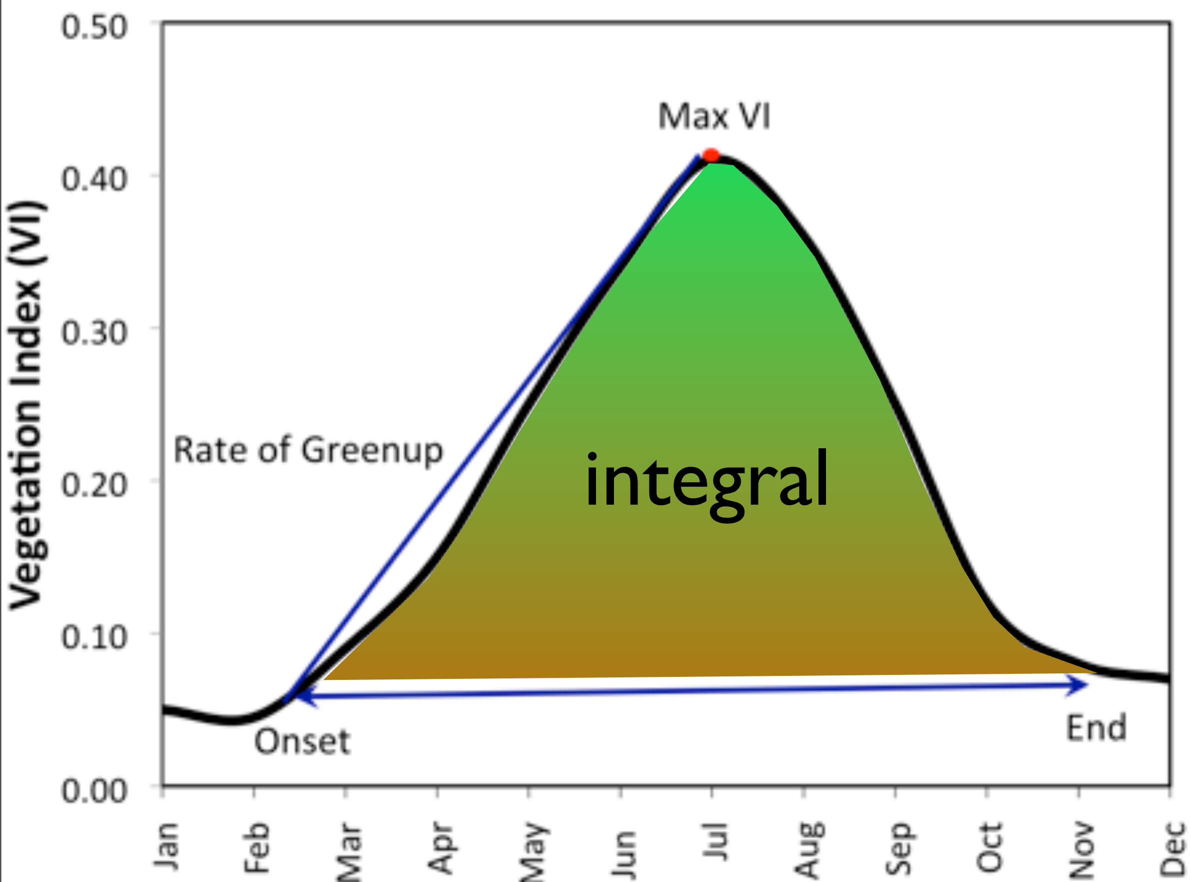
interannual variations *(very sensitive to footprint matching)*



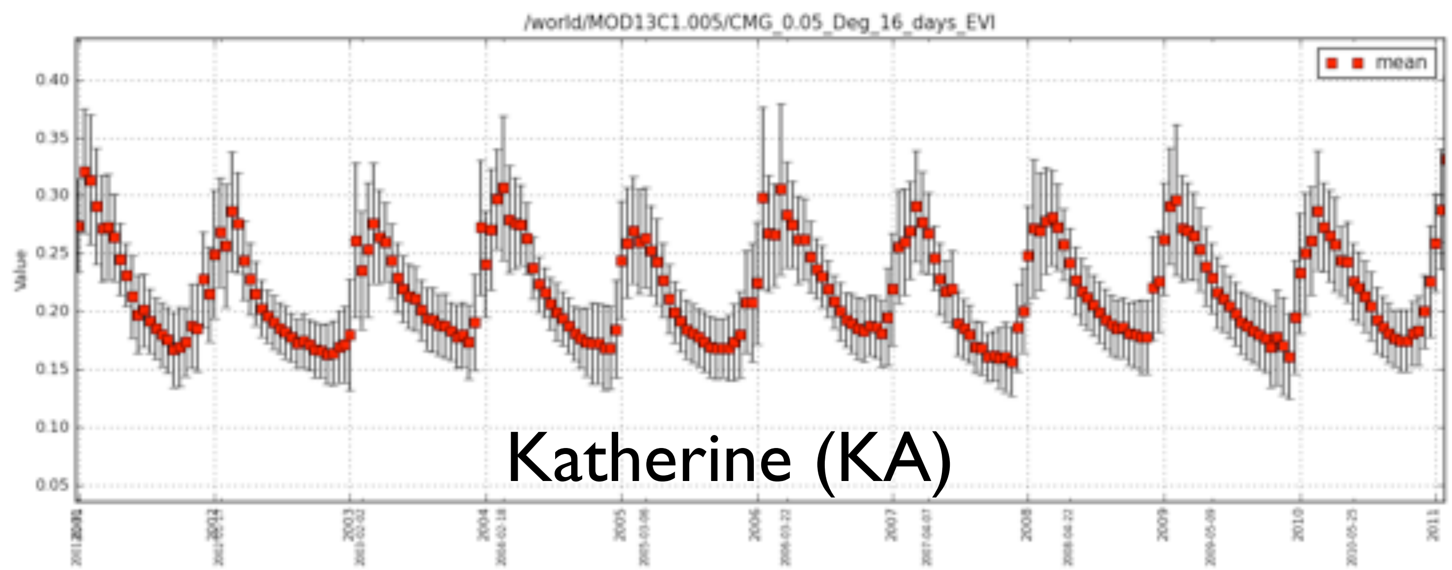
Examples of EVI seasonal/ annual time series along NATT aridity transect

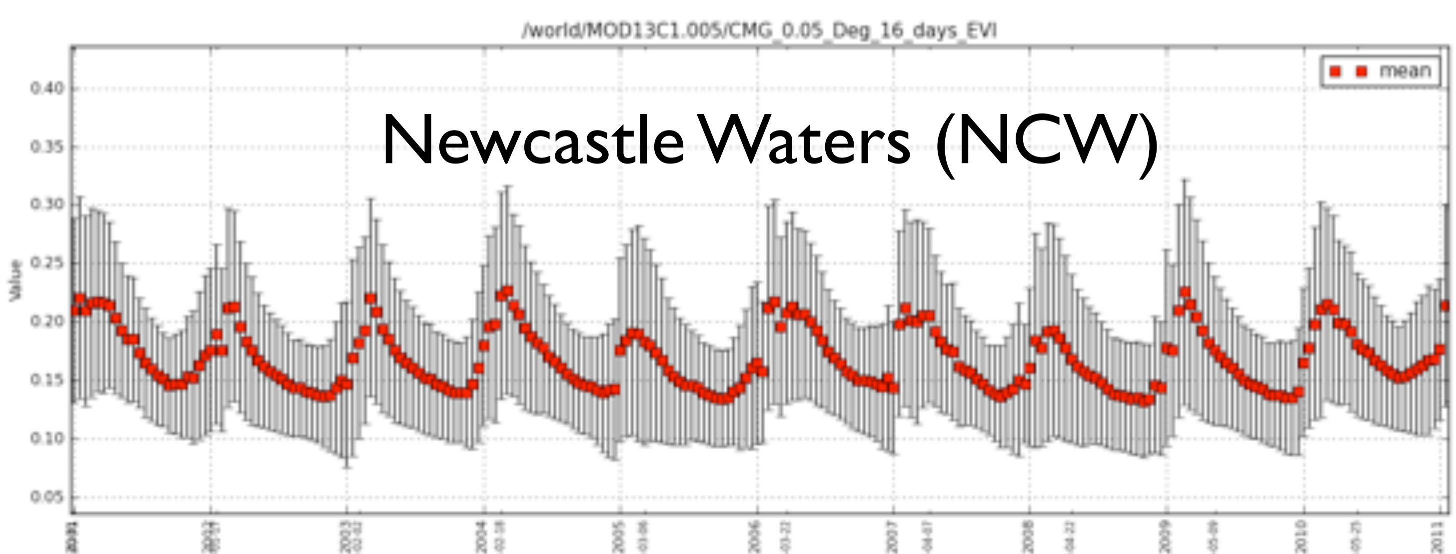






metrics retrieval

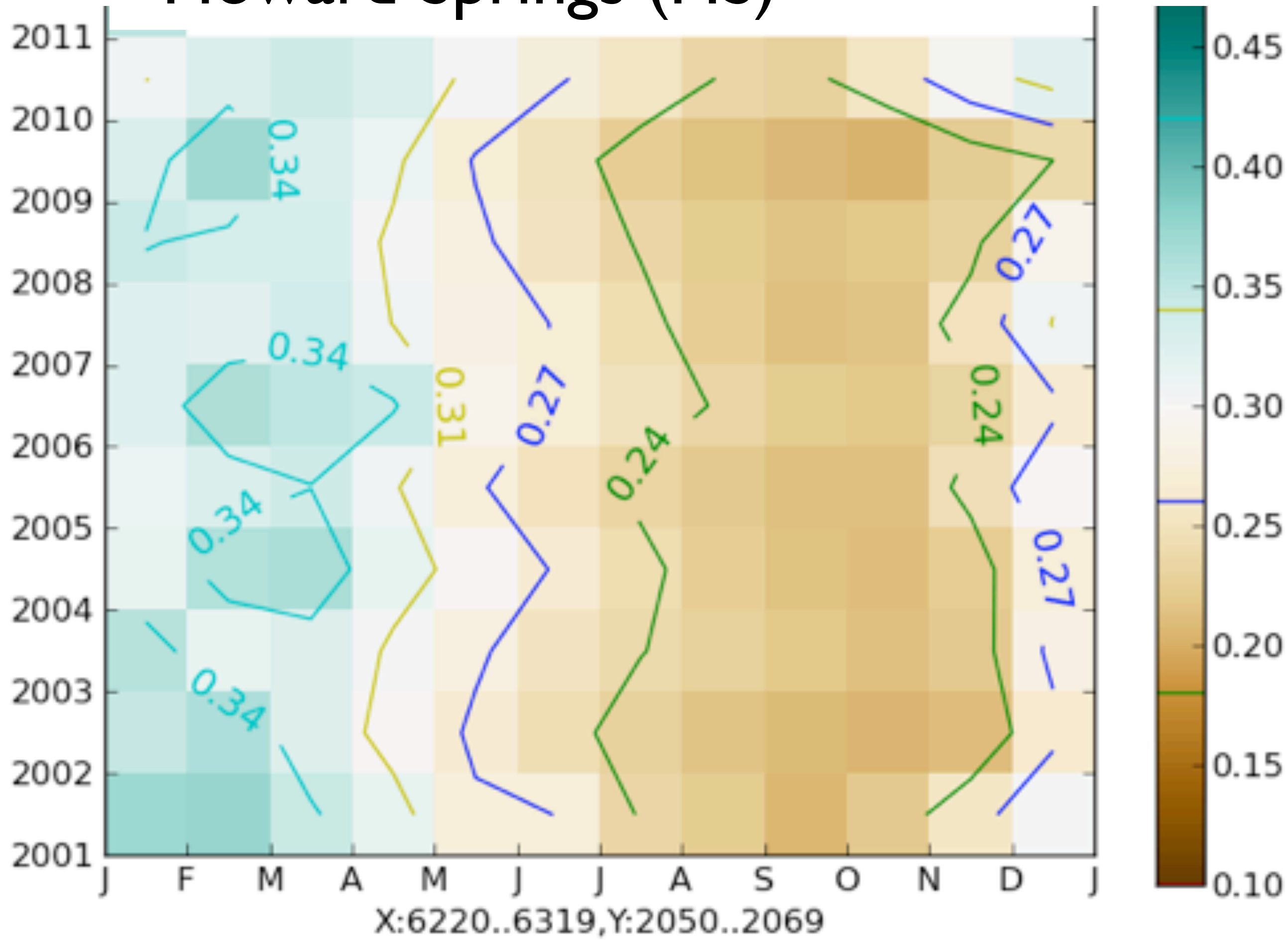




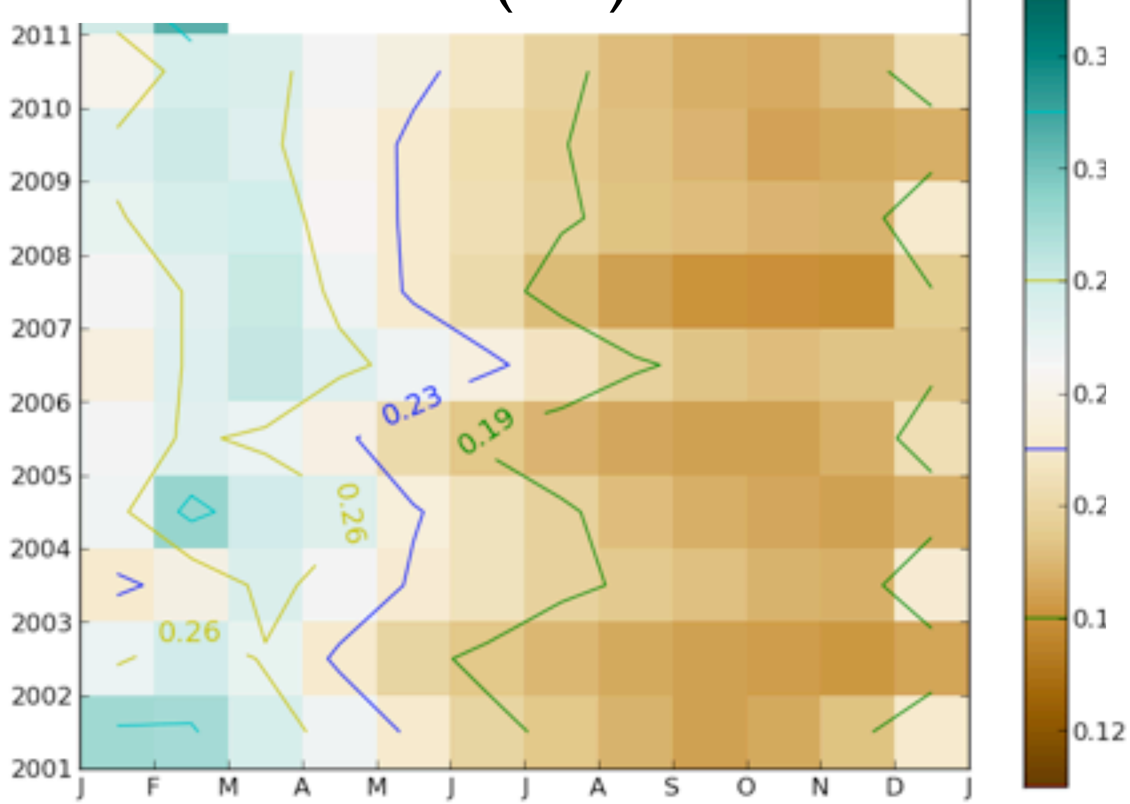
Seasonal- annual contour plots

**variability in phenology timing events increase from north to south*

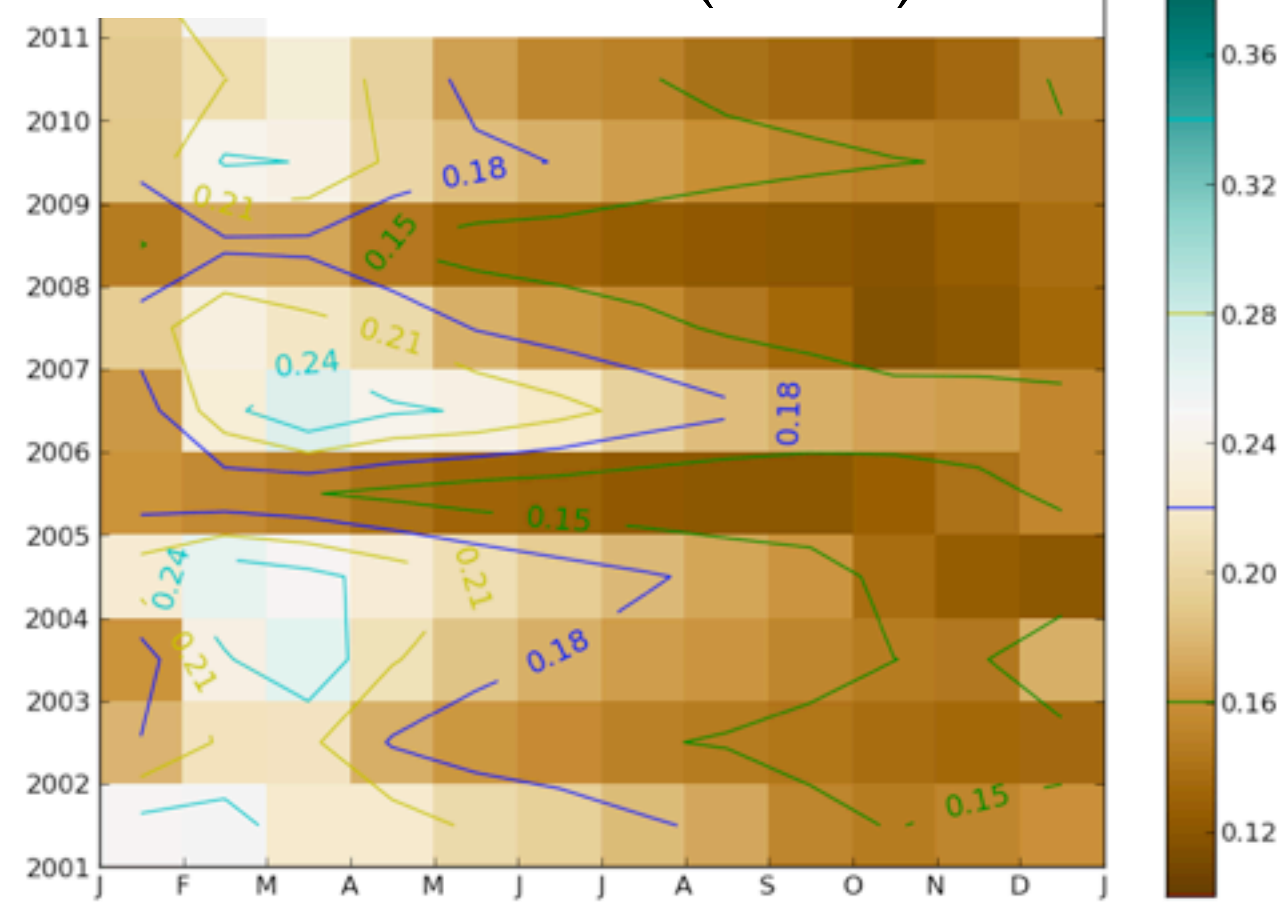
Howard Springs (HS)



Katherine (KA)



Newcastle Waters (NCW)



Conclusions

- In general, MODIS EVI tracked tower-Flux measurements fairly well, both seasonally and interannually, and without the need for meteorological data inputs nor LUE estimations.
- Although inter-annual integrals of Tower and MODIS were correlated, other phenology metrics (LOS and SOS) did not agree.
- Further spatial extension analyses needed, however similarity in EVI * tower-GPP relationships with other sites appear promising for future regional-scale extensions.
- More detailed analyses needed on temporal footprint matching of high frequency fluxes with low frequency satellite data and how this varies across canopy phenology stages,
- Next is to partition savanna functional classes, particularly the woody and herbaceous layers.
- This illustrates the power of integrating remote sensing and ground data. -the consistency between the independent satellite and tower-derived observations lends confidence to both findings.

Thank you