Phenology Cues in Tropical Dry Forests

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What do we know?

•Well… Very little to start with (although 47% of the tropics are tdfs).

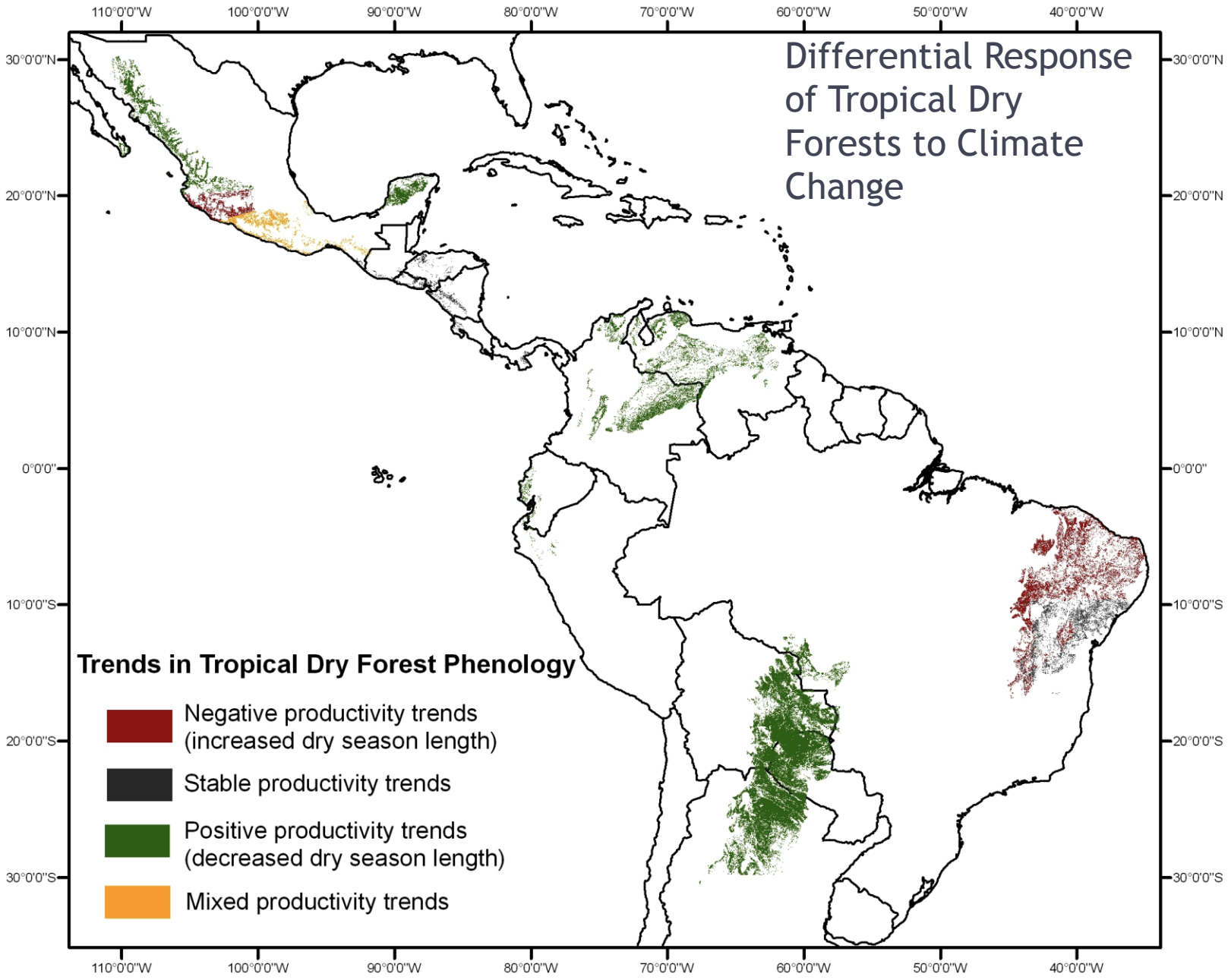
•Dry forests lag on long term studies aimed to understand their response to climate change. In fact, dry forest lag on a ratio of 1:300 scientific papers when compared with tropical rainforests.

•Ecological studies in dry forestes are systematic in two regions: Chamela-Cuixmala biosphere reserve, Mexico; and Santa Rosa National Park; Costa Rica.

•Tropical Forests are not considered part of any global networks aimed to link climate change observations and models to phenological response; nor are part of long term monitoring efforts.

• Tropical dry forests present well define phenological signals allowing for unique opportunities to evaluate their response to climate change and specially drought effects.

Differential Response of Tropical Dry Forests to Climate Change

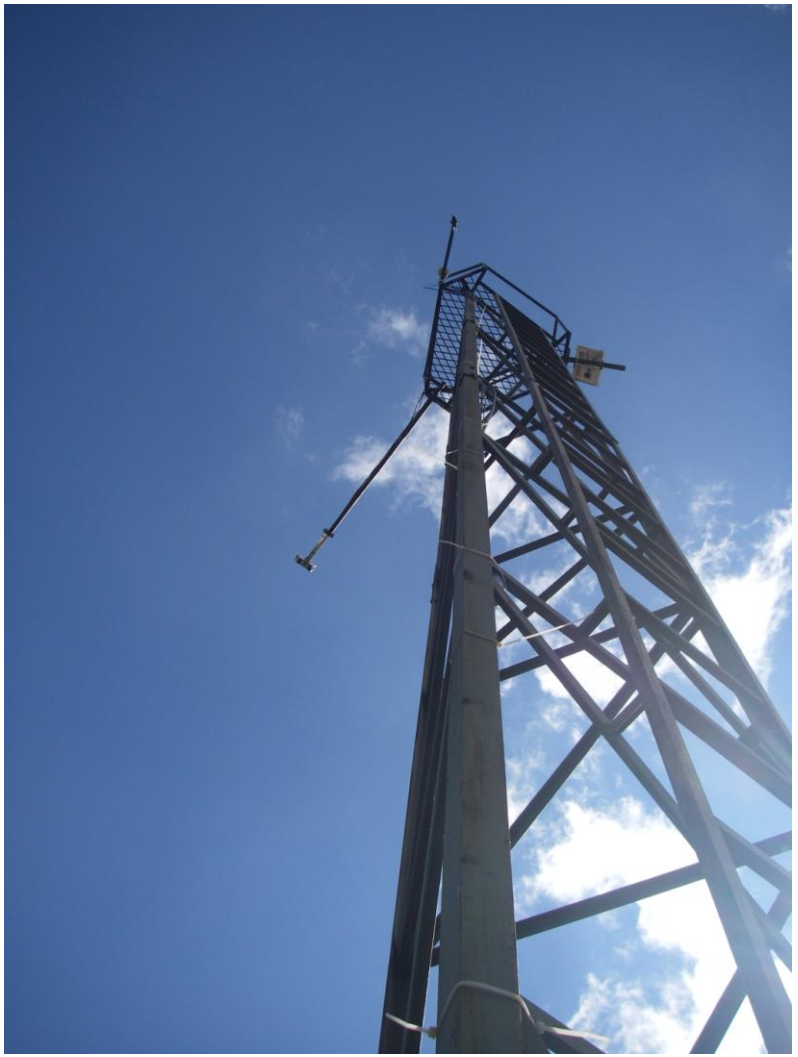


Enviro-Net Project

- **Seven Sites**
  - Argentina, Brazil (3), Canada, Costa Rica, Mexico
- **36 Deployments**
  - 14 Wired Phenology Towers
    - logger & 4-8 sensors
  - 12 Wired Ground Deployments
    - logger & 3-8 sensors
  - 2 Wireless Phenology Towers
    - logger, node & 6 sensors
  - 8 Wireless Ground Deployments
    - logger, 5-10 node, 15-50 sensors

Wireless Optical Phenology Systems (WOPS®)

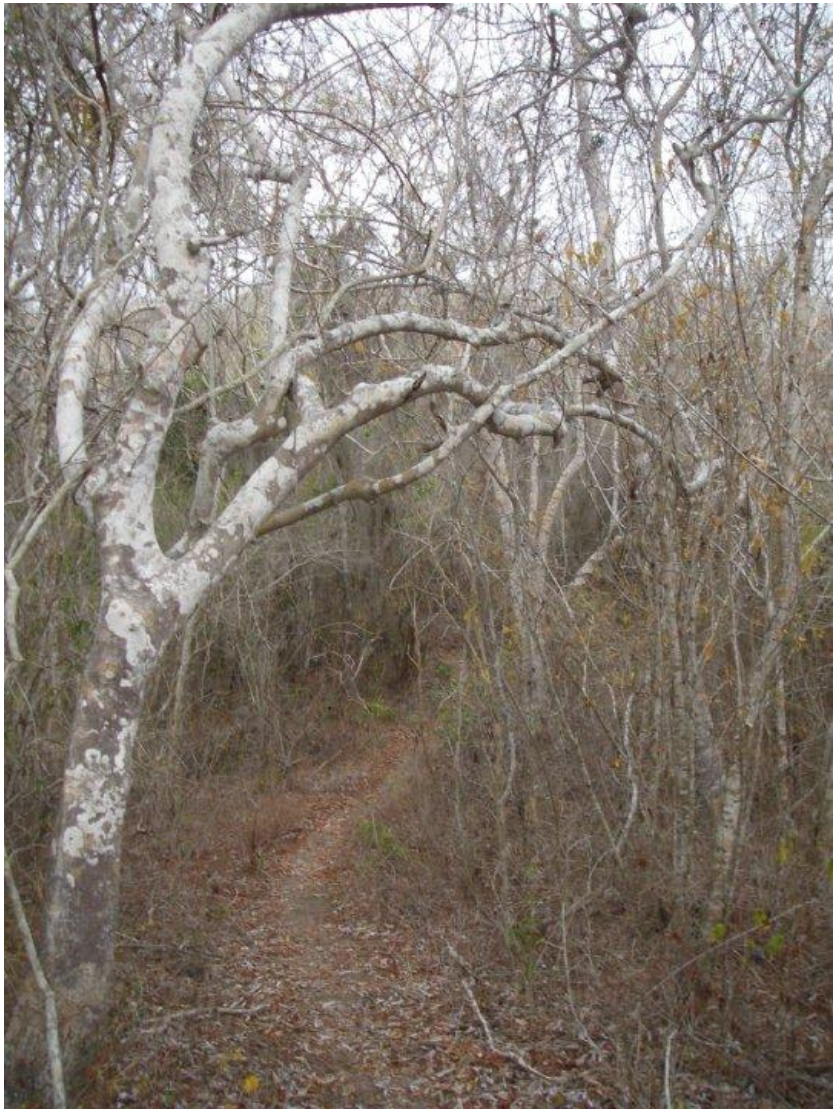
- 5-10m above canopy (5-20m total height)
- Physical Variables Measured:
  - Air/soil temperature
  - Air/soil humidity
  - Solar Radiation
  - Photosynthetically Active Radiation (PAR)
- Derived Variables:
  - Vegetation Indexes
  - APAR, fAPAR
  - Vapour Pressure Deficit
  - Carbon and water fluxes



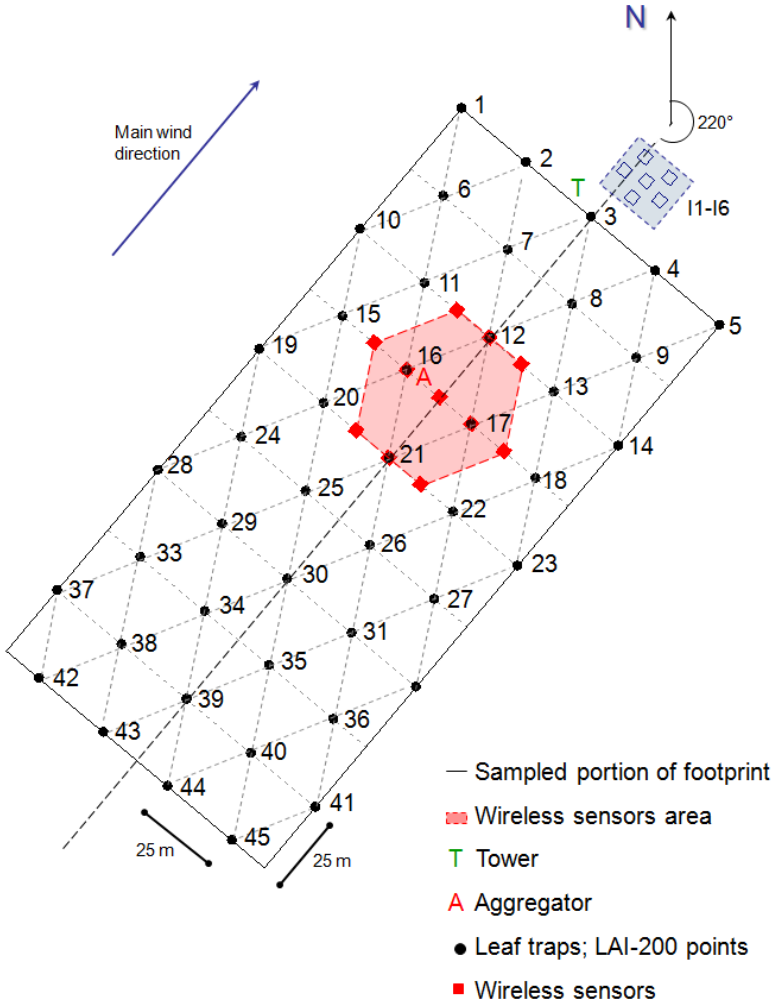
Wireless Ground Deployments Nodes:

- Current deployments (2007-2010): 5 – 20 nodes per deployment
- Planned deployments (2011-2014): up to 100 nodes per deployment

Chamela, Mexico Sampling Design

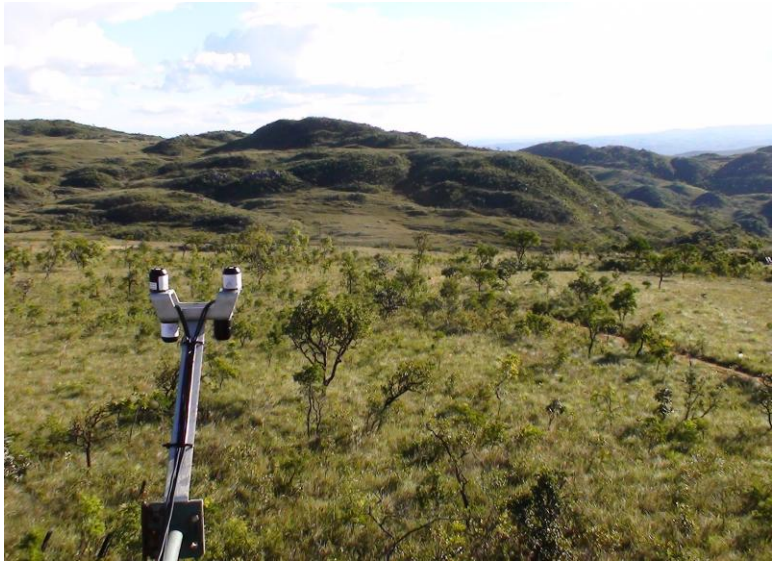


Localization of litterfall traps, LAI-2000 measurement points and wireless PAR sensors within the flux tower footprint at the Chamela Biological Station.



Serra do Cipo, Minas Gerais, Brazil

Mata Seca State Park, Minas Gerais, Brazil



- Data management within Wireless Sensor Networks (WSNs), e.g., algorithms for in-network query processing
- Exploiting the (potential) synergy between networking issues and data management within WSNs, e.g., logical topology and packet scheduling oriented by query semantics
- Indexing of spatio-temporal data and time-series with a focus on re-using sound and industrially tested technologies, e.g., B^+-trees
- Data mining, web data and social network analysis

Time Span:

Format Dates as YYYY-MM-DD

Start: 2008-03-22 10 : 30

End: 2010-11-09 10 : 30

Time Filter:

☑ Enable Time Filter

Only gather readings that are between the hours below:

Start Hour: 16 : 00

End Hour: 20 : 00

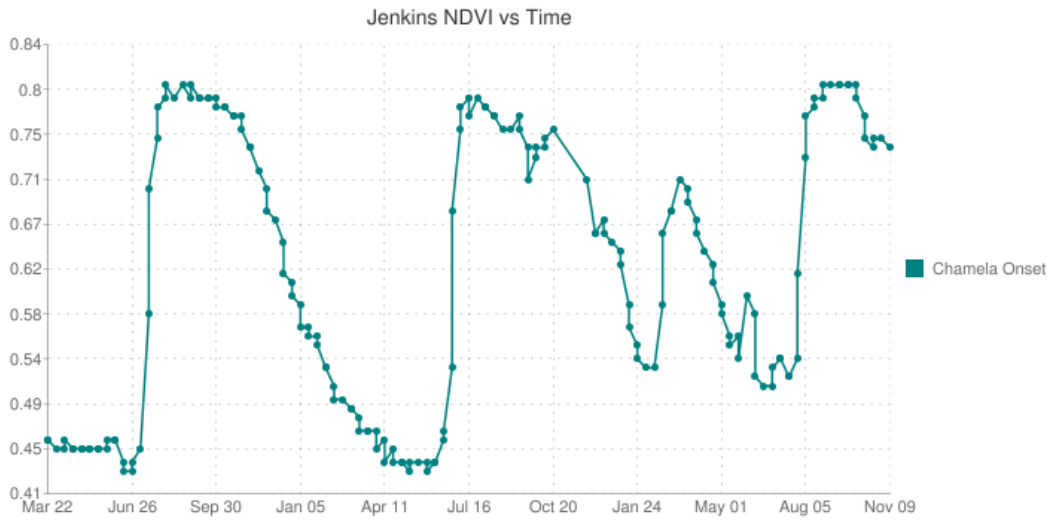
Value Filter:

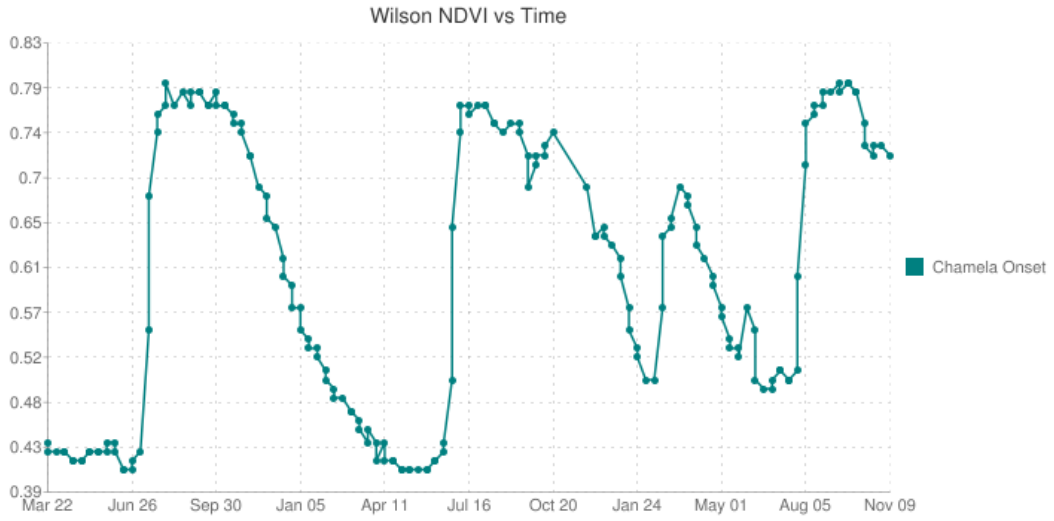
☑ Enable Value Filter

Limit the range of values for PAR Incoming.

	Min:	**Max:**
PAR incoming	900	3000

Graph!





Cluster: MS-CC4 Understory

Daily Averaging: On / Off

Remove Erroneous Data: On / Off

Nodes: 57776

Uncheck All

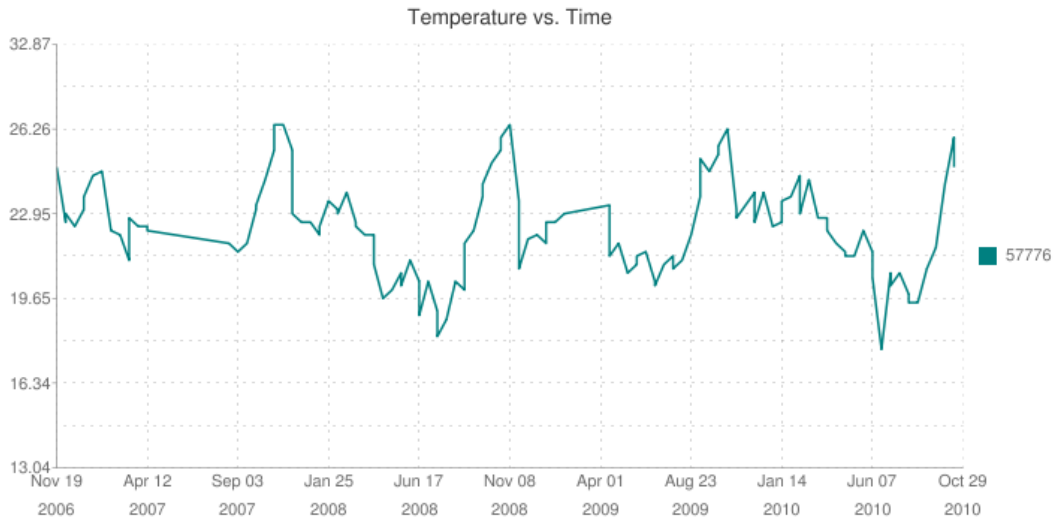
Sensors: Soil Moisture, PAR, Temperature, Humidity, Rainfall

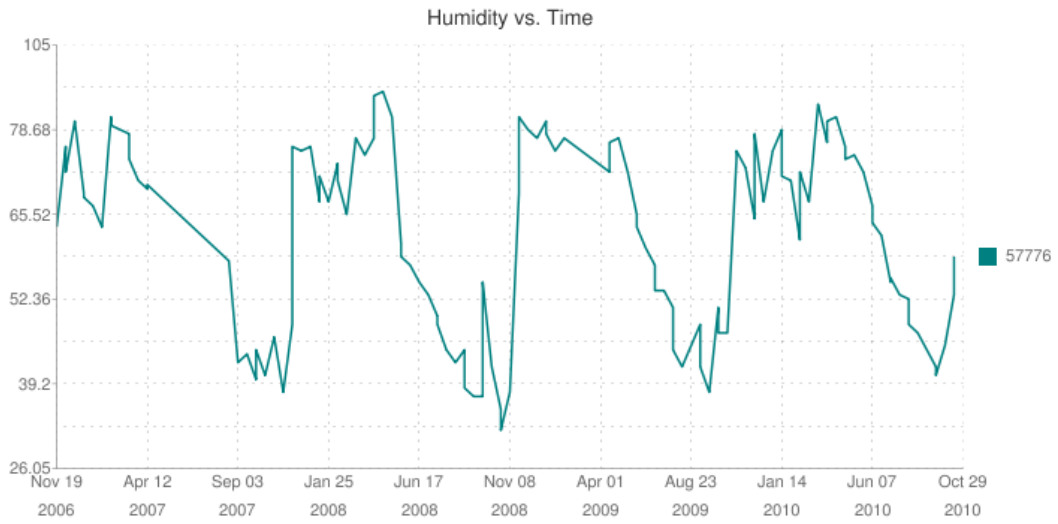
Time span: (YYYY-MM-DD)

Start: 2006-11-19 11 : 40

End: 2010-10-29 11 : 40

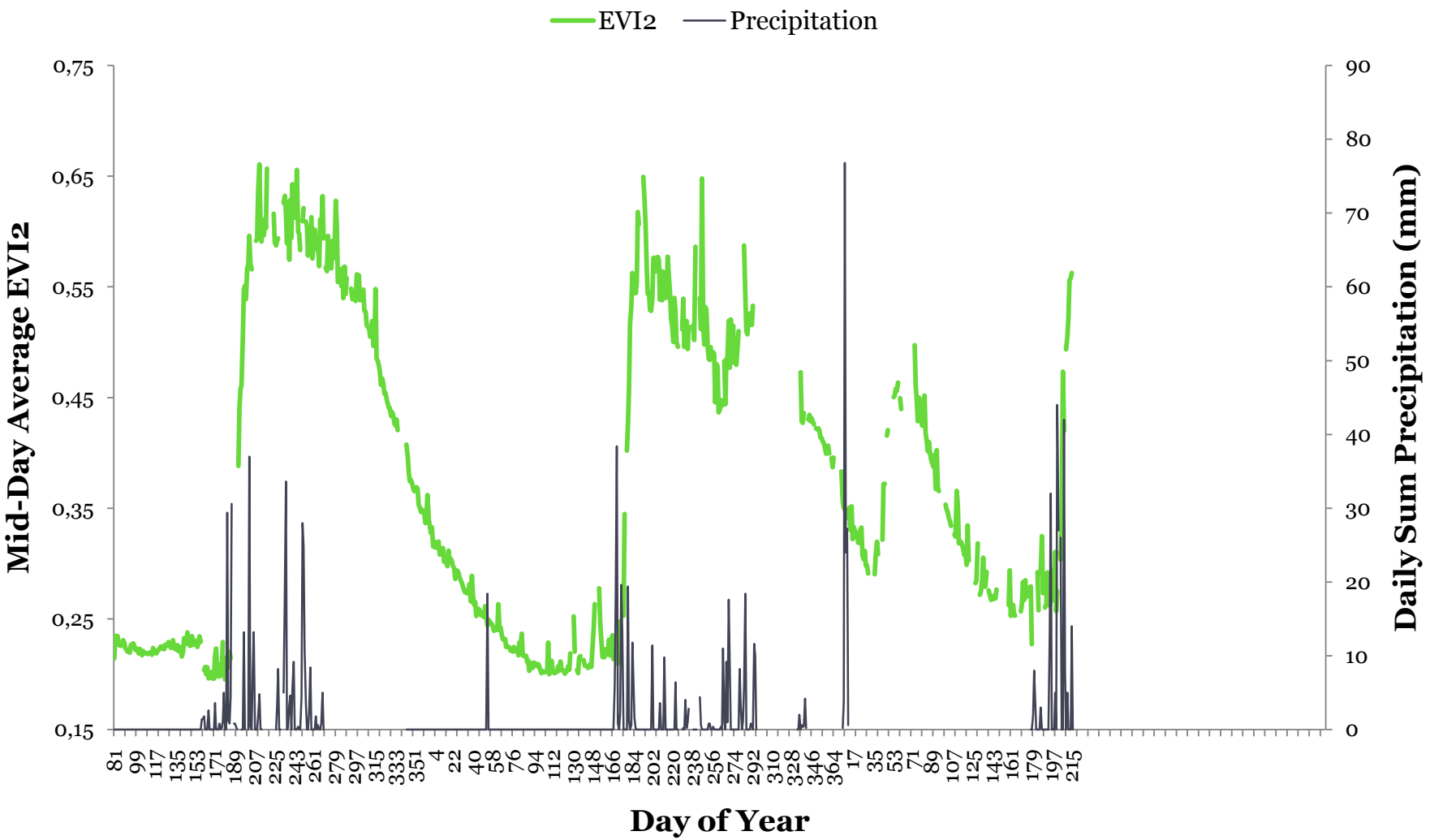
Graph!





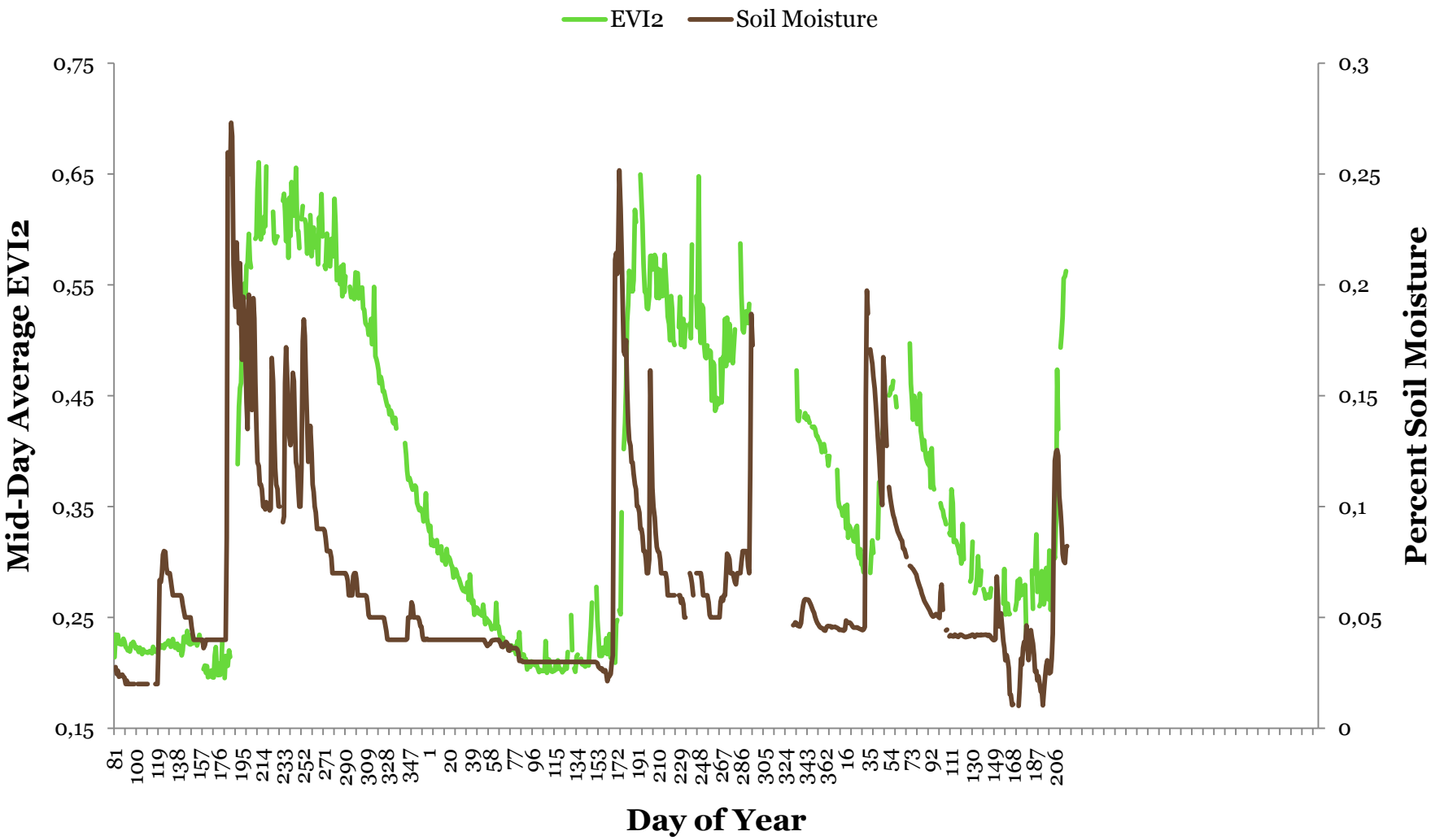
Chamela: Phenology Cues

Precipitation



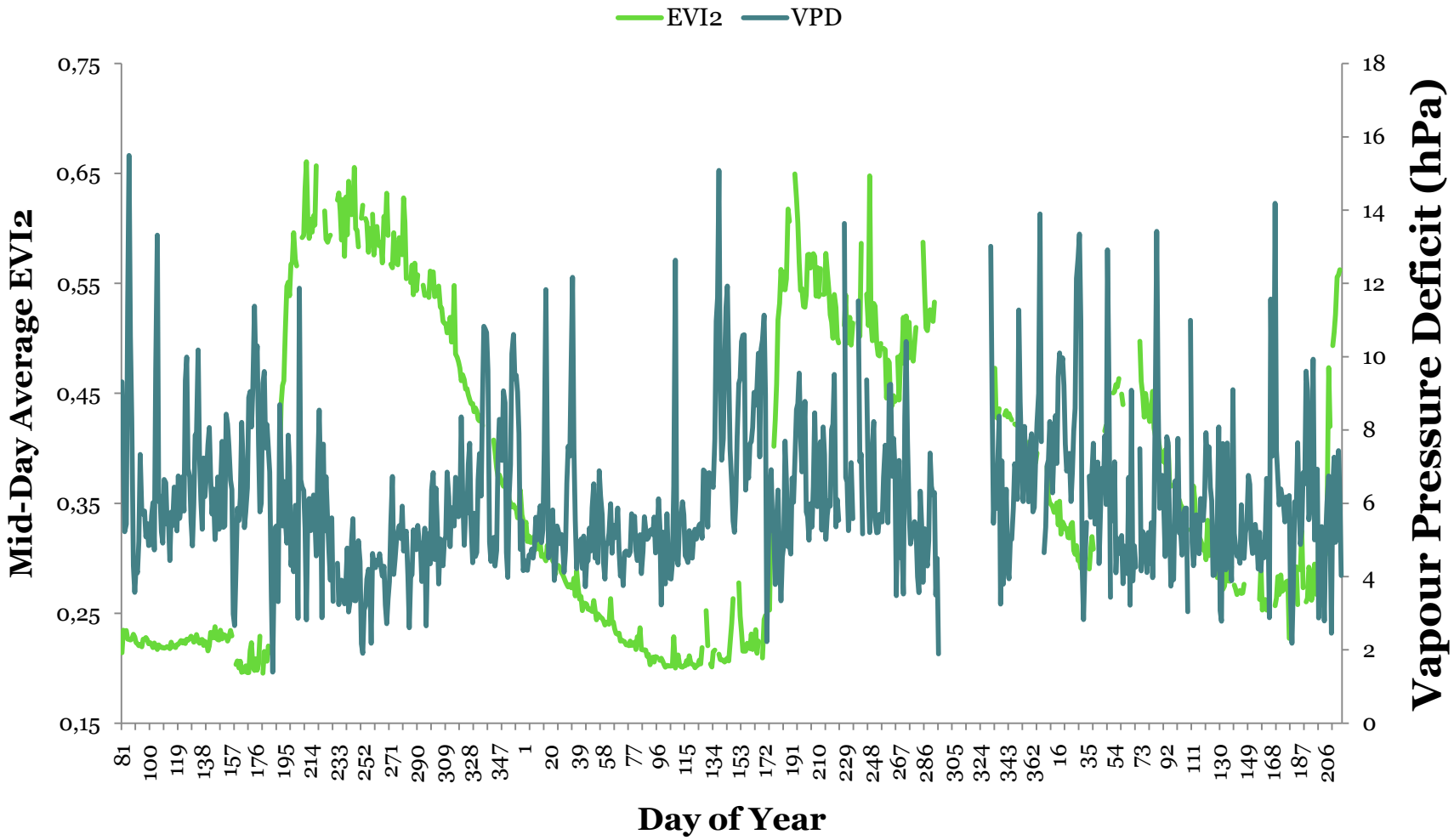
Chamela: Phenology Cues

Soil Moisture

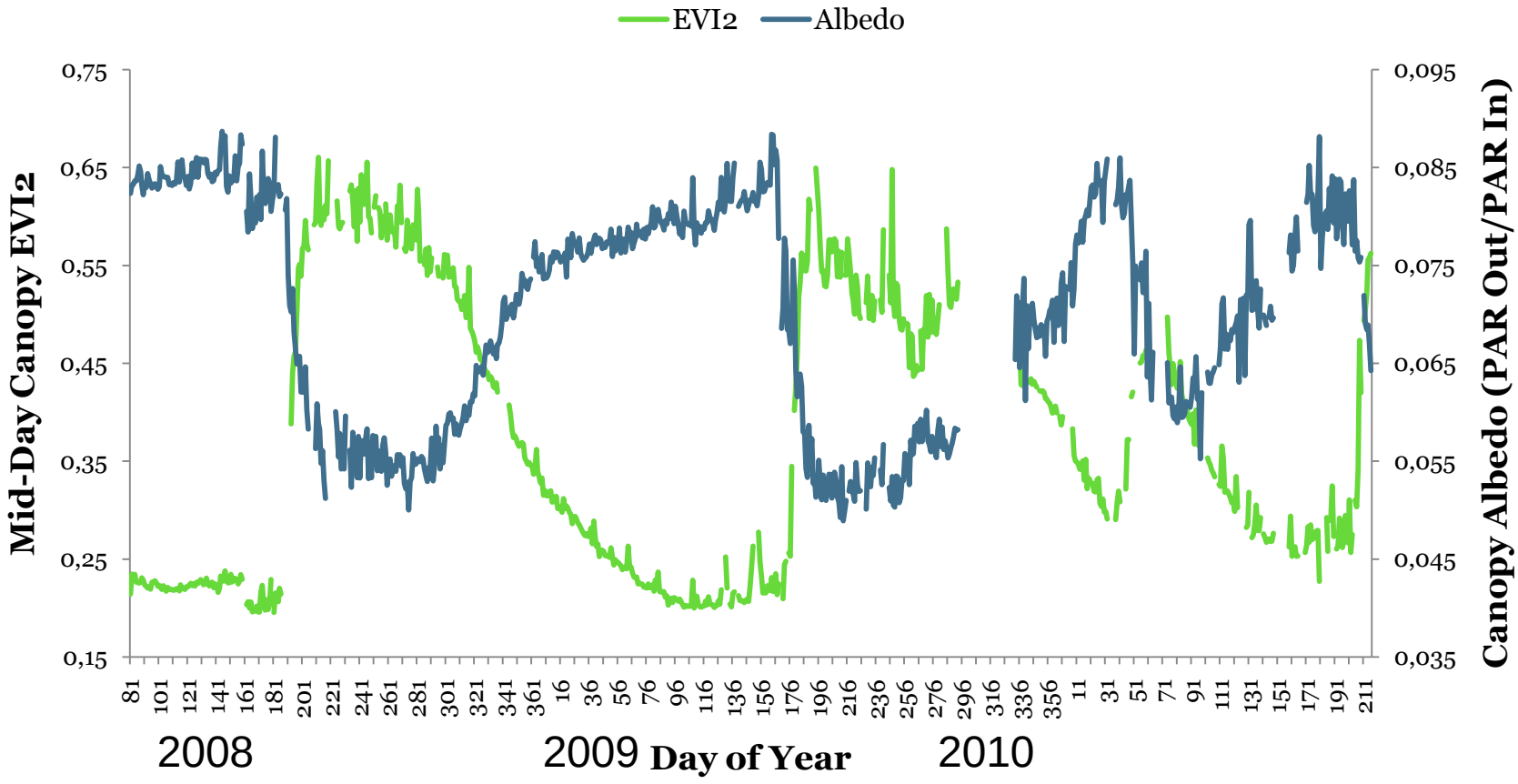


Chamela: Phenology Cues

Vapour Pressure Deficit

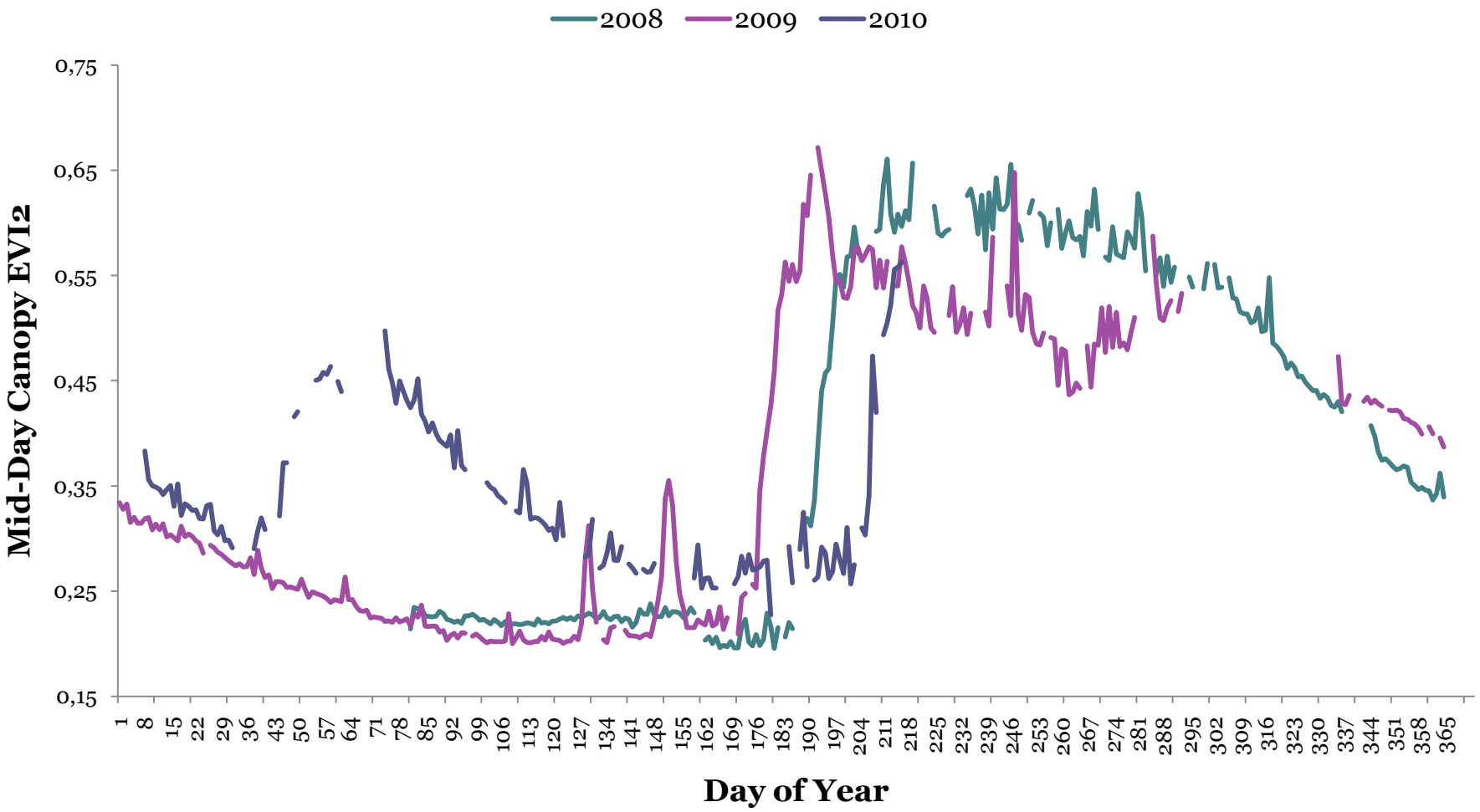


Chamela, Mexico
Albedo Shifts

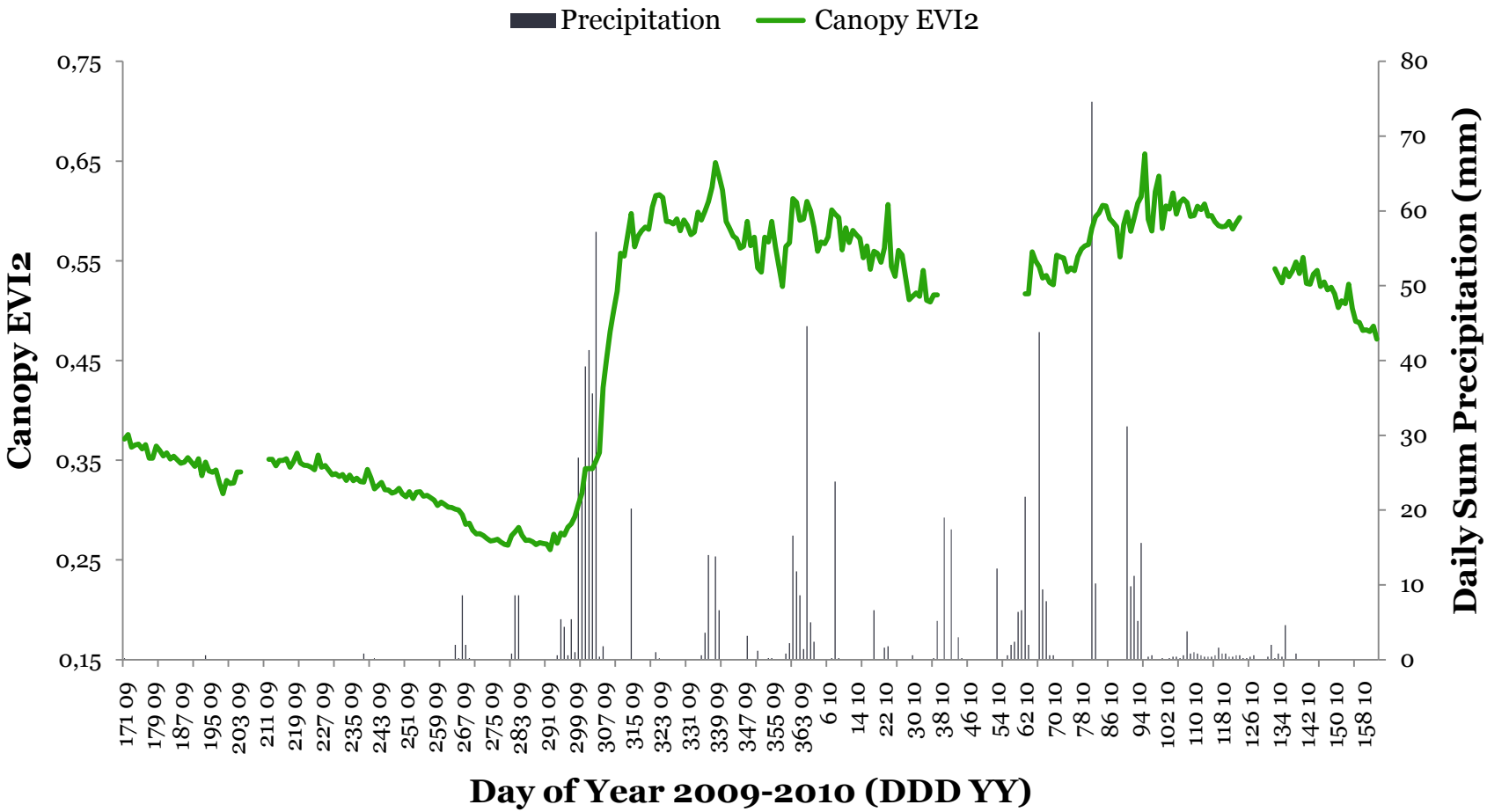


Chamela: Phenology Cues

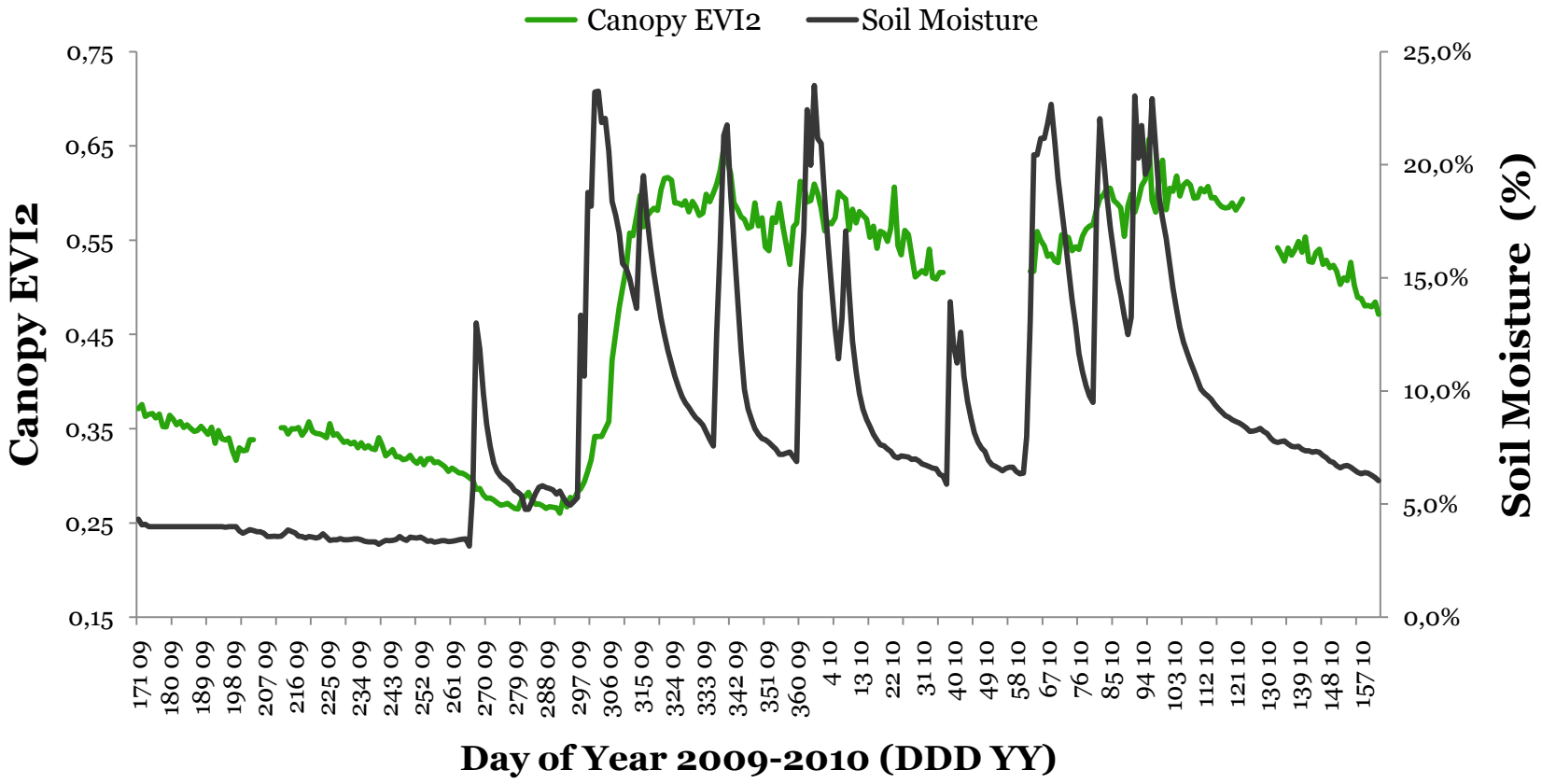
Phenology Shifts



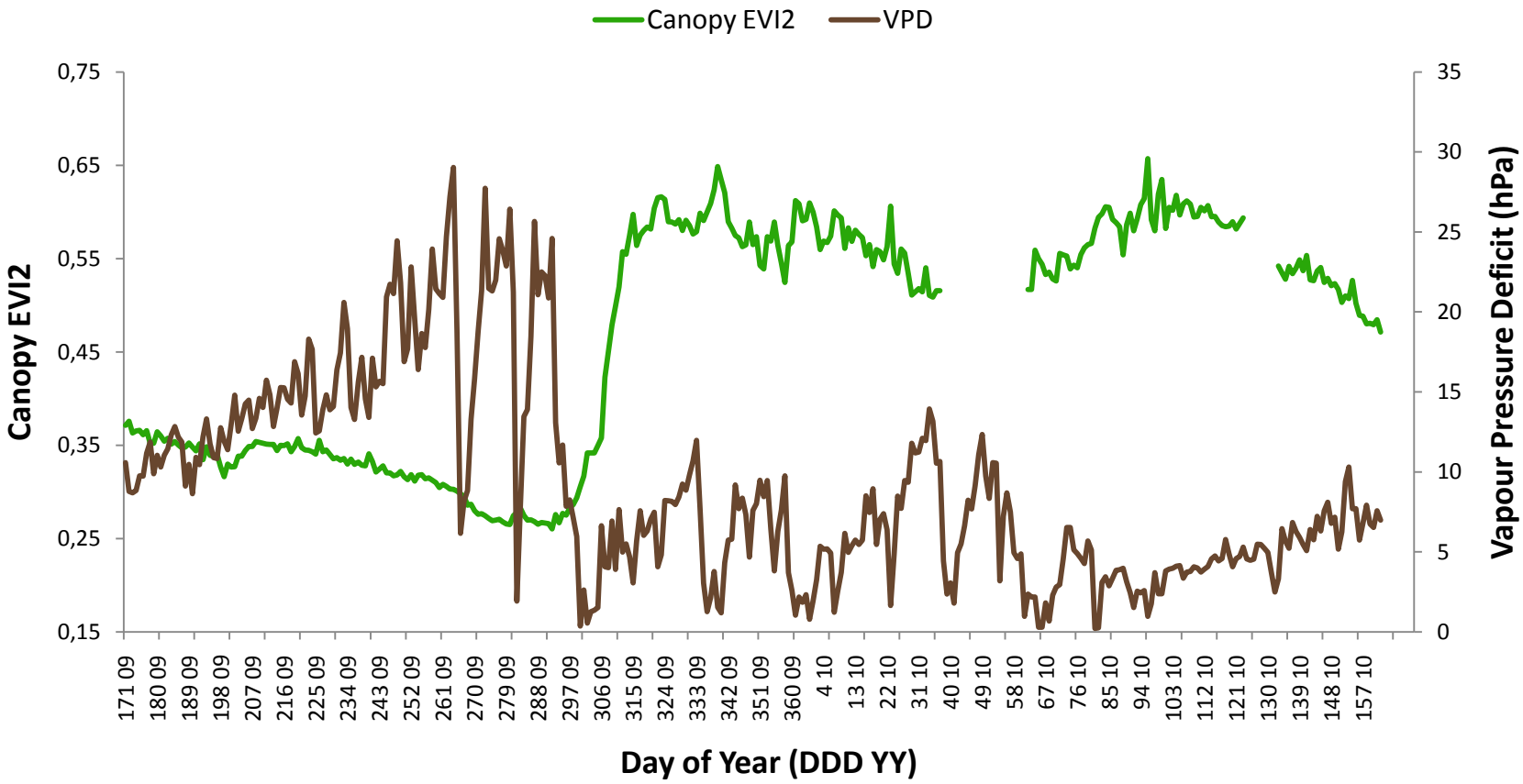
Mata Seca, Minas Gerais, Brazil Precipitation



Mata Seca, Minas Gerais, Brazil
Soil Moisture

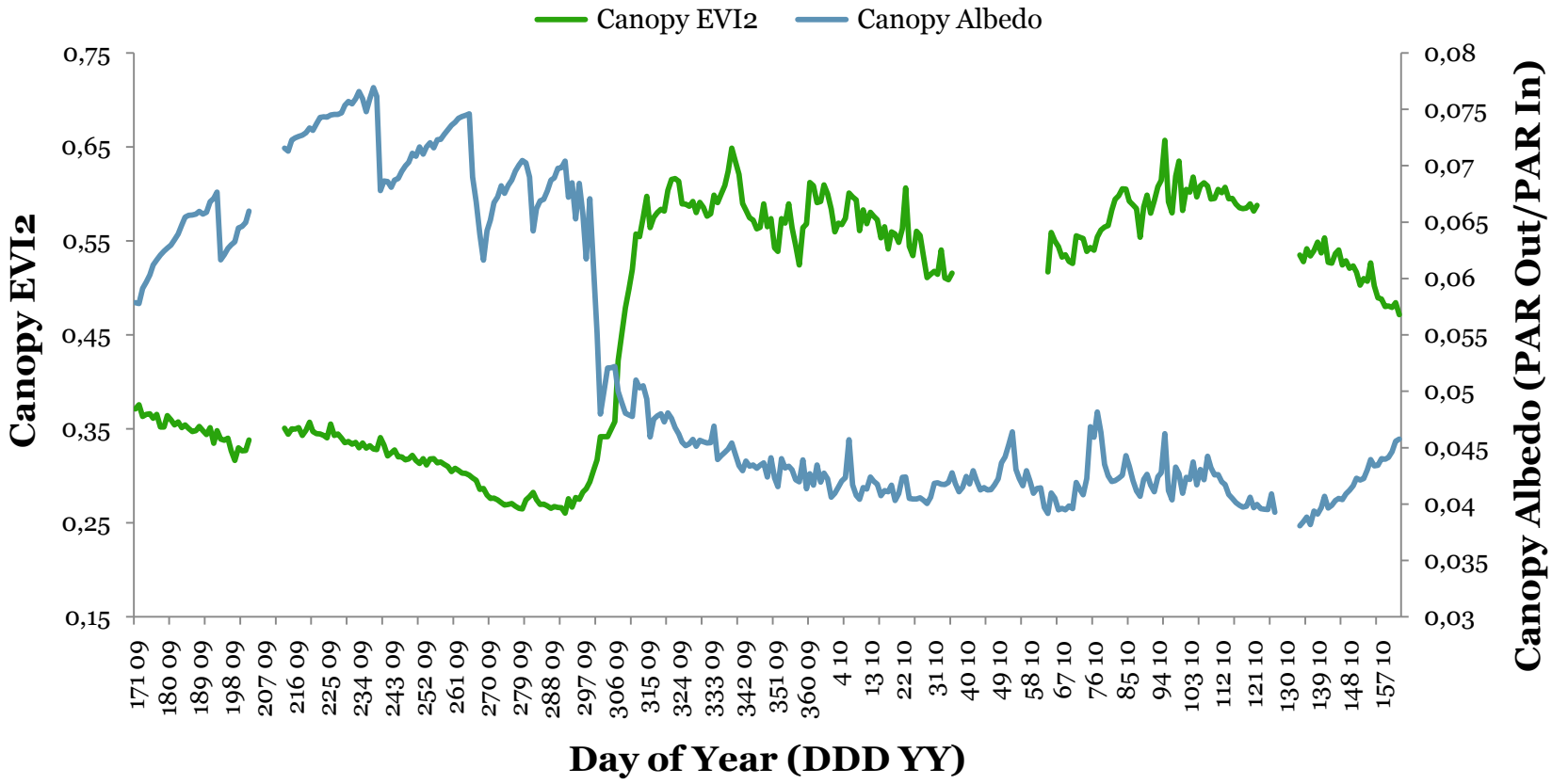


Mata Seca, Minas Gerais, Brazil
Vapour Pressure Deficit



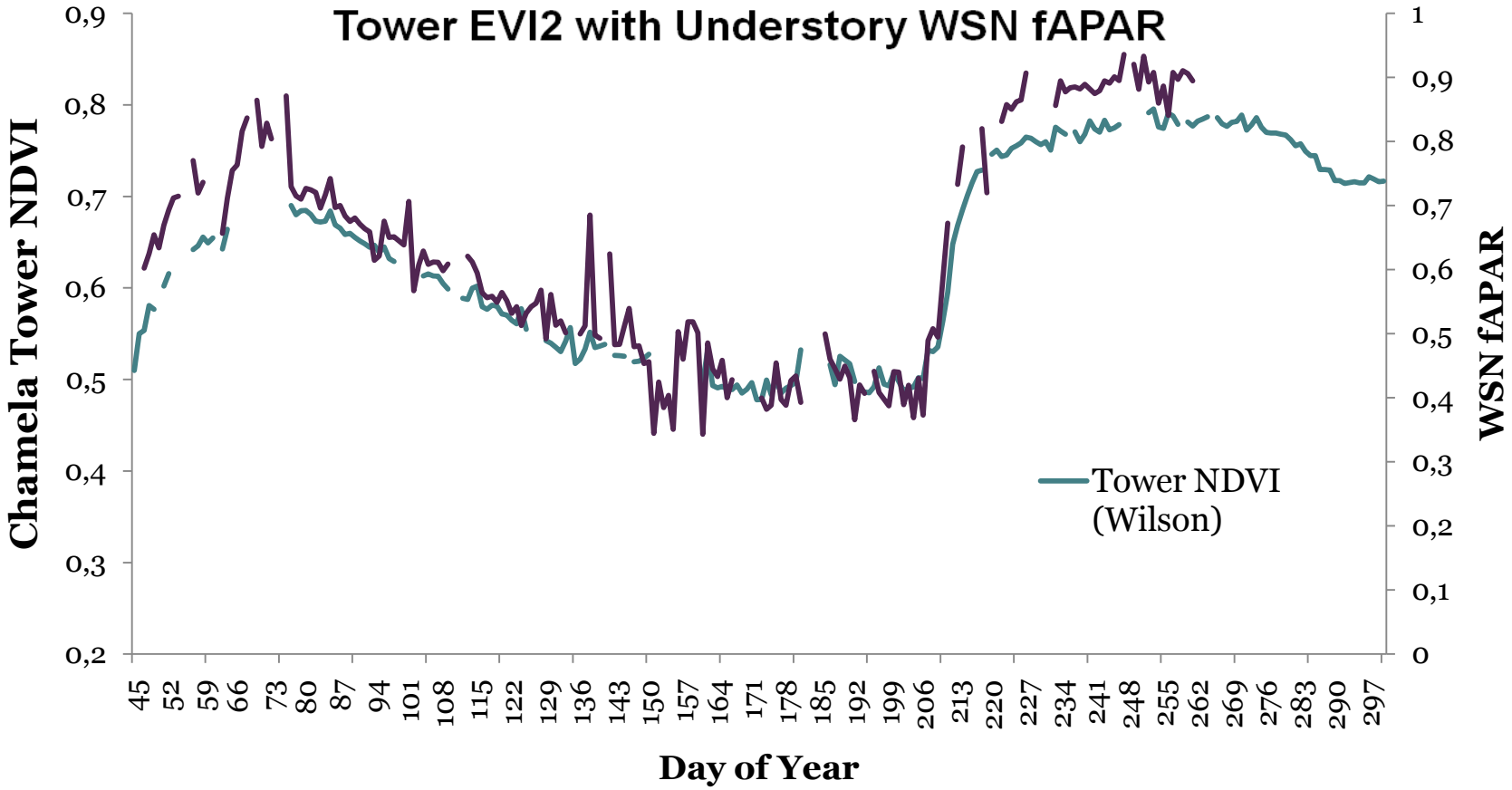
VPD has strong implications for plant physiology and is the earliest micro-climatic cue for leaf flush at this site

Mata Seca, Minas Gerais, Brazil
Alberdo Shifts

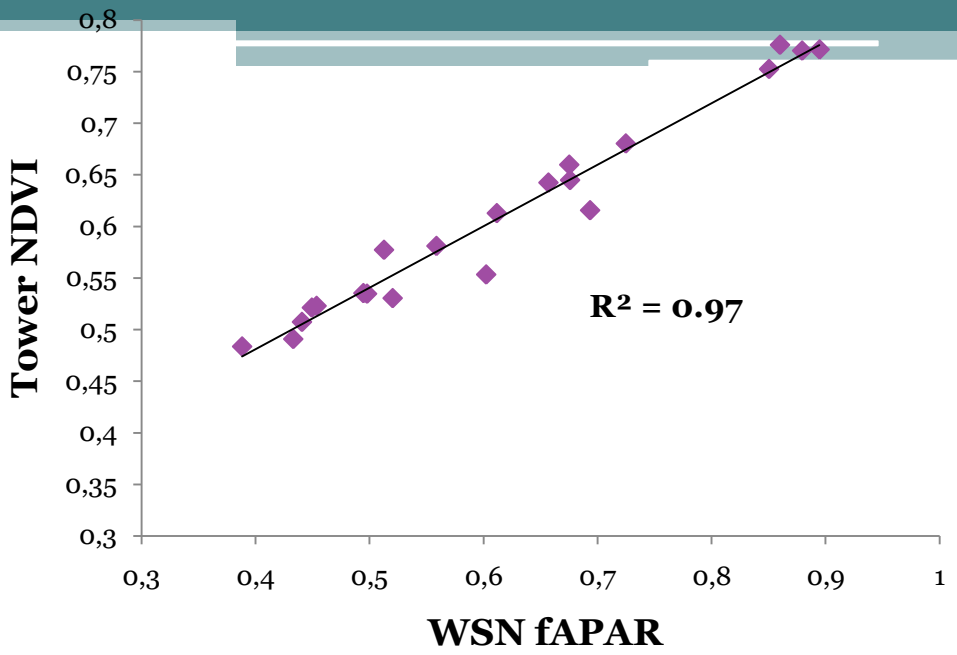


Important implications for phenological remote sensing

This Year's Leaf Flush in Chamela

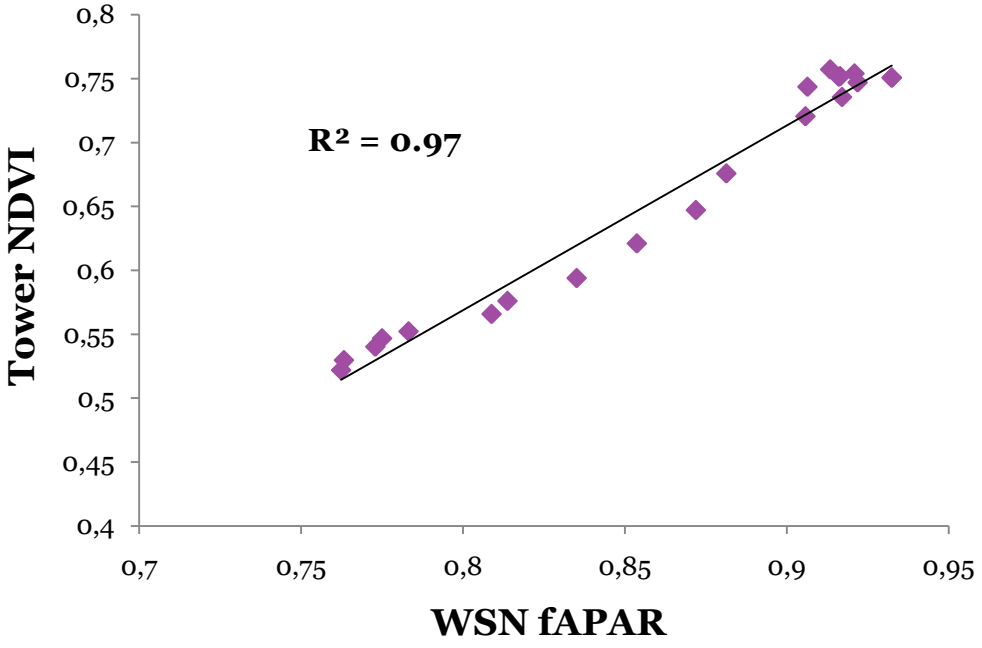


Chamela, Mexico
Primary TDF



WSN fAPAR and Tower NDVI have a strong linear relationship

Mata Seca, Brazil
(Intermediate stage TDF)



Conclusion

- WSN for environmental monitoring are providing important information on cues controlling phenological processes in tropical dry forests.
- Not all dry forests follow the common “soil moisture” model, other sites indicate less dependence on this variable.
- New data analysis and visualization tools are necessary to handle MASSIVE amounts of information specially on real time transmissions.

Biodiversity and Ecosystems Services

Gracias, Obrigado, Thank You!