Precipitation and vegetation phenology: comparison of remotely sensed greenness in the Santa Rita Mountains

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Background

- Remotely sensed time-series data can be used to assess spatial and temporal patterns of life-cycle, or phenology, in vegetation communities in response to climate drivers.
- Phenological metrics characterizing vegetation dynamics could be useful for
  - modeling of vegetation-climate interactions
  - local studies where field-based methods are prohibitive
  - land cover change research

Objectives

•Derive phenological metrics from satellite-derived Normalized Difference Vegetation Index (NDVI) and Enhanced Vegetation Index (EVI) time-series data with Timesat software for rain gauges around the Santa Rita Experimental Range:

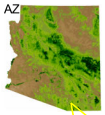
- •Season start
- •Season peak
- •Season end
- •Base NDVI
- •Peak NDVI
- •Length
- •Amplitude
- •Green-up rate
- •Senescence rate
- •Small Integral
- •Large Integral

•Examine the temporal relationships between precipitation and vegetation response in and around the SRER.

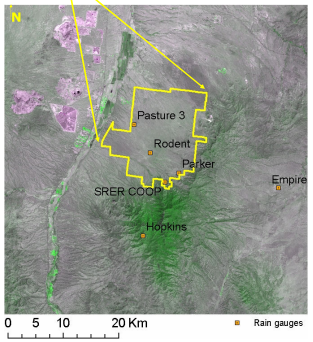
Study Area

•Six rain gauges in and around the Santa Rita Experimental Range, within six different vegetation communities:

Parker	Creosote
Pasture 3	Mesquite upland scrub
Rodent	Palo verde desert scrub
SRER Coop station	Oak encinal
Empire	Desert grassland
Hopkins	Ponderosa pine forest




Ponderosa pine forest




Paloverde desert scrub


Desert Grassland

Data extraction

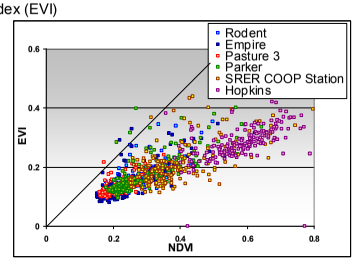
•Time-series greenness datasets were extracted for 6 rain gauges from 2000 into 2007:

- •Monthly **ground-based** precipitation measurements
- •**MODIS** (Moderate Resolution Imaging Spectroradiometer) Normalized Difference Vegetation Index (NDVI) and Enhanced Vegetation Index (EVI)
  - 250 m spatial resolution
  - 23-period-per-year (16-day composite)

NDVI and EVI

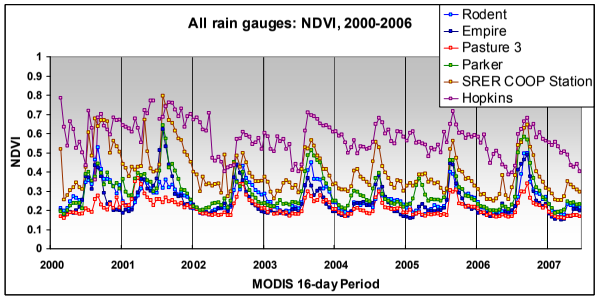
$$NDVI = \frac{(\rho_{NIR} - \rho_{red})}{(\rho_{NIR} + \rho_{red})}$$

$$EVI = \frac{2.5(\rho_{NIR} - \rho_{red})}{(\rho_{NIR} + 6.0\rho_{red} - 7.5\rho_{blue} + 1)}$$



•NDVI is more sensitive than EVI with lower vegetation cover

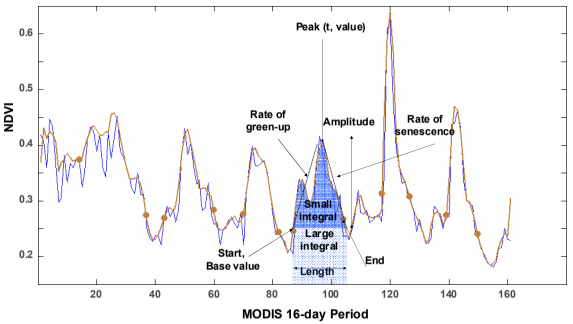
•Both data sets revealed the difference in vegetation community as evidenced by the clusters of values in the regression (right); this can also be seen in the time series (below).



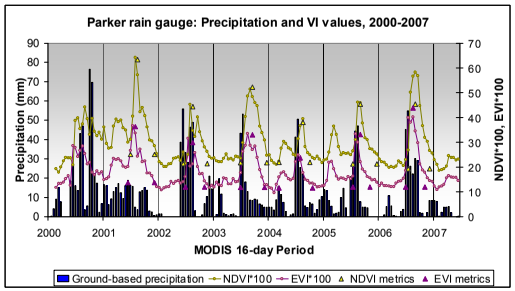
Pheno-metrics Extraction

•**Timesat** phenology software was used to extract metrics from VI data for (Jonsson and Eklundh 2004).

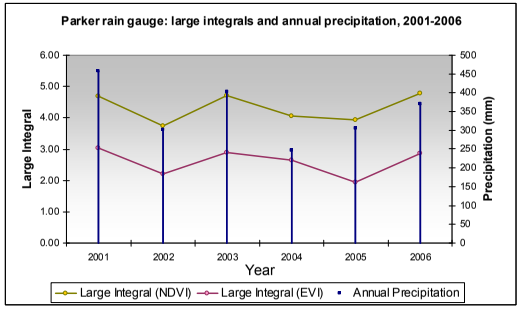
- •We used the Savitsky-Golay curve-fitting algorithm.
- •Thresholds for model sensitivity, seasonality, and data outliers
- •seasons 2001-2006



Precipitation and Phenology: Parker rain gauge



Greenness response to precipitation is seen in all rain gauges, through peaks in NDVI and EVI. Timesat base, peak, and season start, peak and end, also correspond to precipitation, for both VIs.



Seasonal integrated NDVI, or the large integral metric, was shown to correspond to annual precipitation.

Discussion and Next Steps

- Rain gauges around the Santa Rita Experimental Range in a variety of vegetation communities experience heterogeneous precipitation events.
- EVI and NDVI have different magnitudes but similar trends.
- Pheno-metrics derived from both MODIS NDVI and EVI time-series data responded to drought and precipitation events.
- *In-situ* observations are also needed to validate our findings:
  - Climate
  - Phenology
  - Vegetation type
- Pheno-metrics could assist in diagnosing disturbance-induced drought effects, classifying vegetation, and forecasting land cover change.