DMESS,
Nov 18, 2017, New Orleans

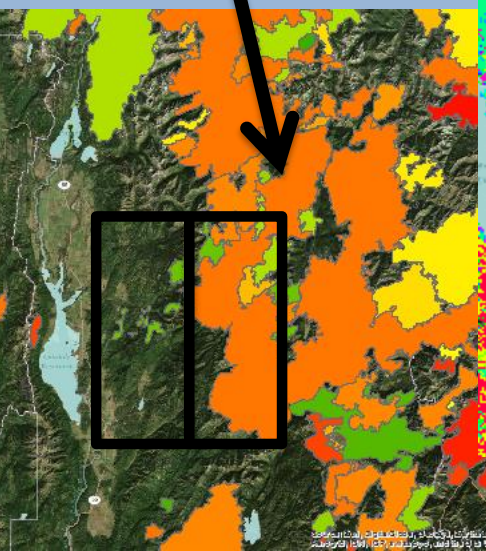
Quantifying seasonal patterns in disparate environmental variables using the PolarMetrics R package

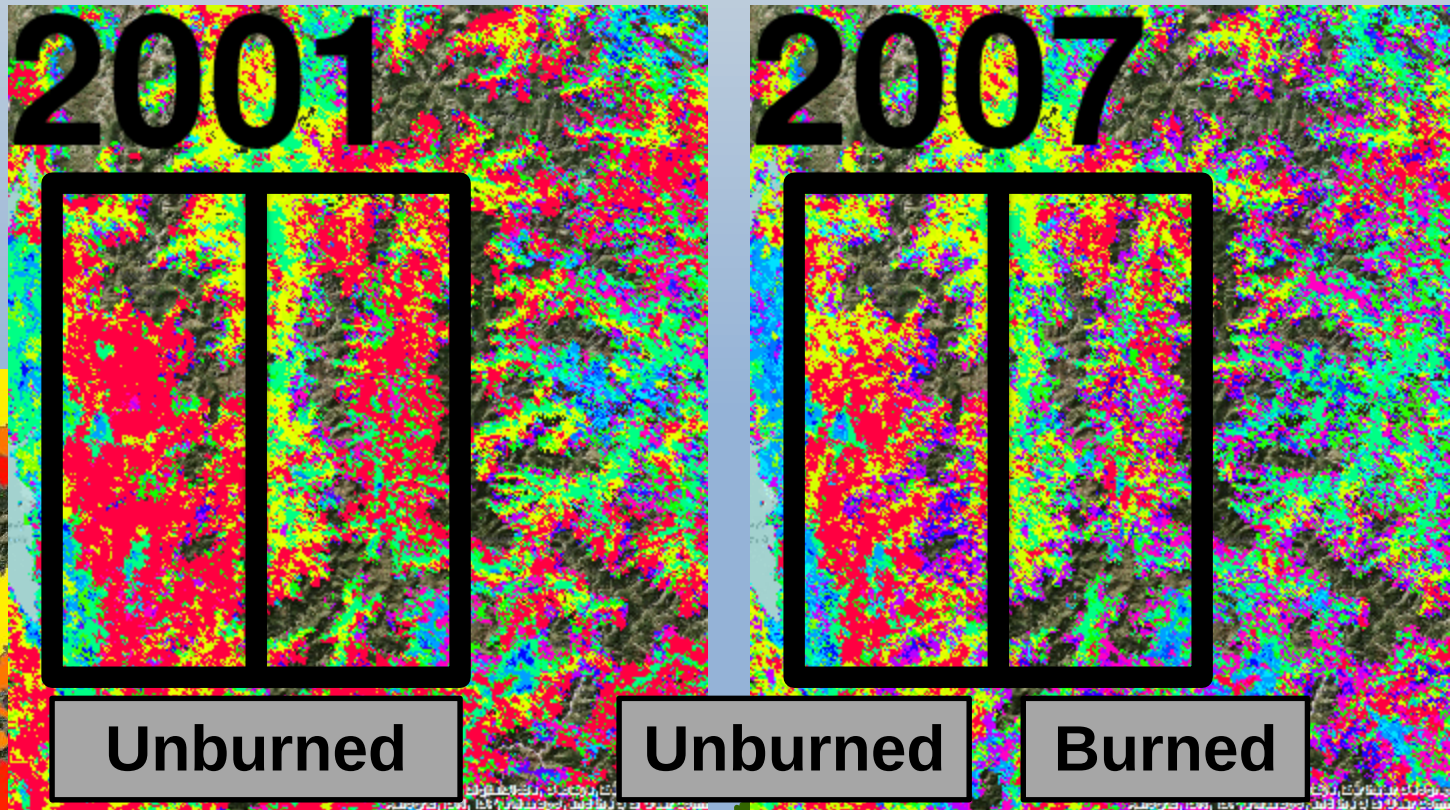
Bjorn J. Brooks

USDA Forest Service,
Eastern Forest Environmental Threat Assessment Center

Broader research that I won't talk about: Clustered phenologies & landscape dynamics

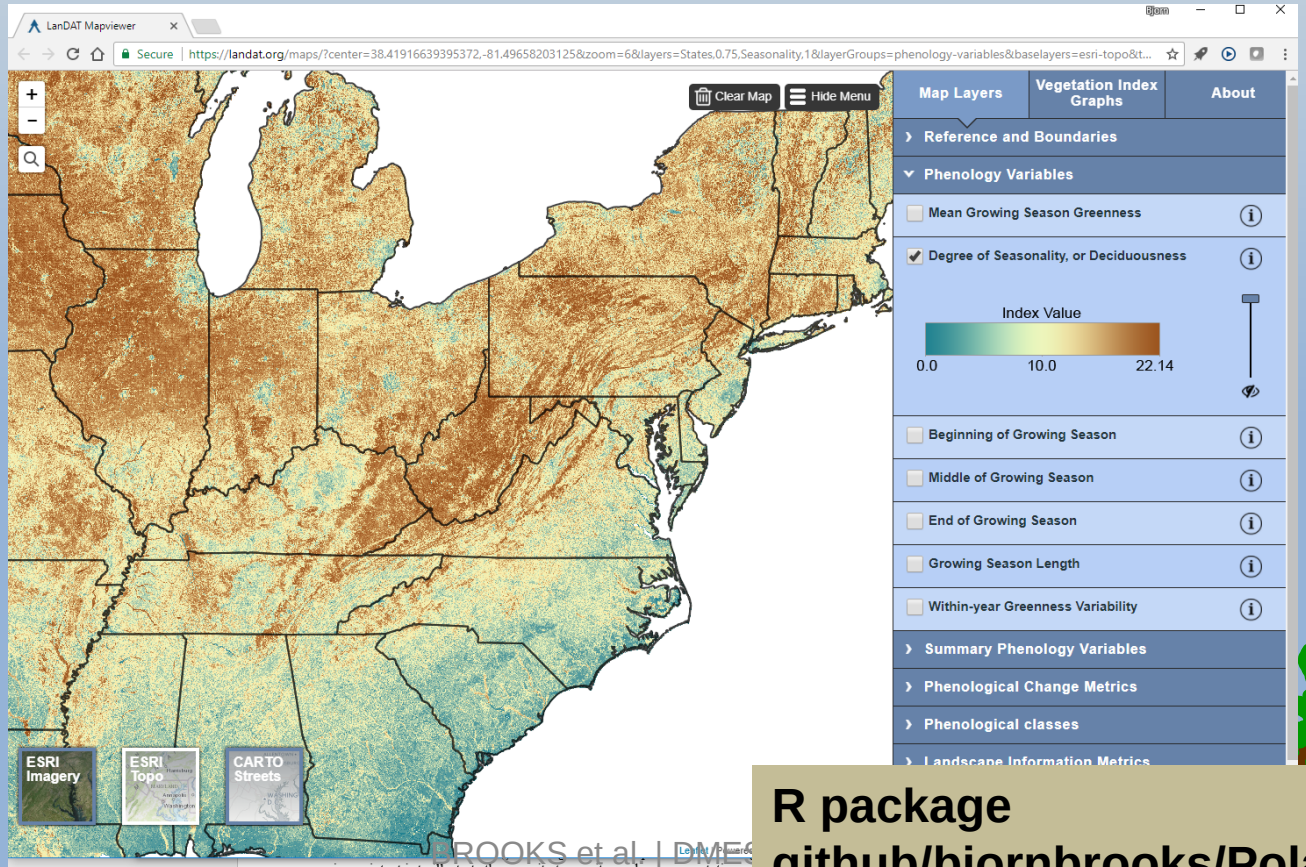
Cascade Complex fire (2007), Idaho





Polar Metrics Maps

landat.org/maps



R package
github/bjornbrooks/PolarMetrics

Where these Polar Measures Are in Use

Landscape analysis

Appalachian Landscape Conservation Cooperative

Policy directives

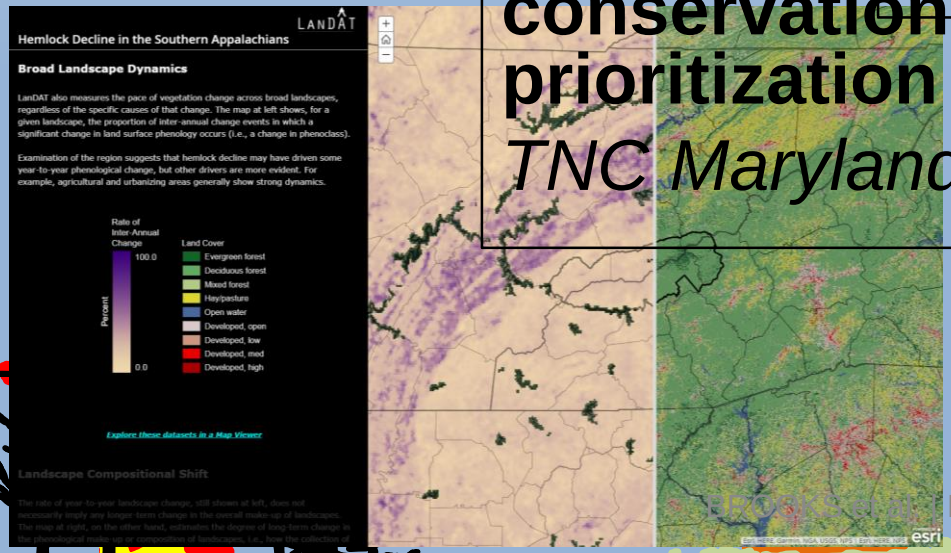
National Cohesive Wildland Fire Management Strategy

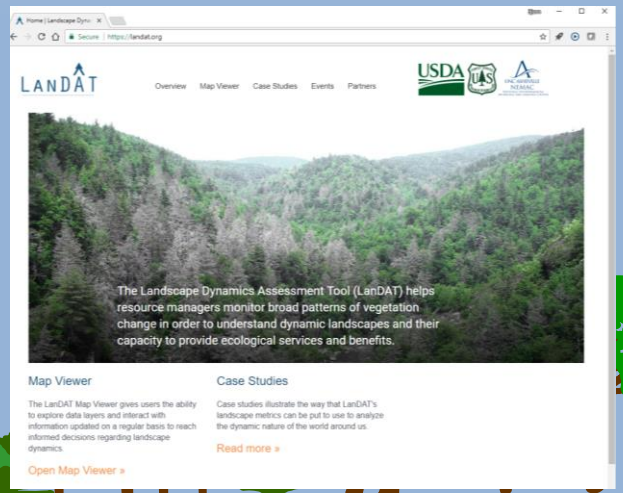
Forest revision planning

Texas NF

Land conservation prioritization

TNC Maryland





BROOKS et al., DiVES-S, 2017

How Seasonal Patterns are Represented

Time series values

Year	Jan 3	Jan 11	Jan 19	…
1995	0.57	0.58	0.57	
1996	0.61	0.60	0.61	
1997	0.58	0.54	0.55	
…				

Polar (phenology) values

Year	Mid Ssn DOY	Length of Ssn	Seasonality (vec. mag.)	…
1995	112	210	0.76	
1996	111	209	0.76	
1997	109	221	0.76	
1998	101	213	0.79	
…				

A History of Extracting Circular Statistics from Environmental Data

Phenological Research pp 339-359 | Cite as

Applications of Circular Statistics in Plant Phenology: a Case Studies Approach

Authors | Authors and affiliations

L. Patricia C. Morellato, L.F. Alberti, Irene L. Hudson

Chapter
First Online: 14 September 2009

16 Citations | 47 Readers | 1.7k Downloads

Abstract

Phenology is the study of recurring biological events
statistics is an area of statistics not very much used b
the biological sciences, and indeed not much visited,
Nevertheless, the connection between the evaluation
analysis of directional data have converged in several
an outstanding tool by which to better understand pl
to assess applications for circular statistics in plant p
data analysis in general. We do not discuss the mathe
actual and potential applications to plant phenology.
levels of application: from generating circular phenol
hypotheses, say, for the existence of certain a priori s
particular value and application when flowering onse
in an annual cycle and importantly in southern clima

Geophysical Research Letters

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Research Letter

Peak tornado activity is occurring earlier in the heart of "Tornado Alley"

John A. Long, Paul C. Stoy

First published: 10 September 2014 Full publication history

View issue TOC
Volume 41, Issue 17
16 September 2014
Pages 6259–6264

Remote Sens. **2010**, *2*(3), 697-716; doi:10.3390/rs2030697

Open Access Article

Land-Cover Phenologies and Their Relation to Climatic Variables in an Anthropogenically Impacted Mediterranean Coastal Area

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* Author to whom correspondence should be addressed.

*Received: 31 December 2009 / Revised: 11 February 201
March 2010*

(This article belongs to the Special Issue Ecological Statu

View Full-Text | Download PDF [402 KB, uploaded

Abstract

Mediterranean coastal areas are experiencing rapid lan
degradation and extreme climatic events. Vegetation in
vegetation phenological variations. This study quantitati
temporal changes for Mediterranean land-covers from
relation with climate. A time series from 2001 to 2007 o
composite (MOD13Q1) was analyzed to extract anomalie
components (by the Fourier Transform). Vegetation pher
covers for an area in south Alicante (Spain) providing
phenology associated to those land-covers. Time series
anomaly detection techniques and the Fourier Transfo

USDA United States Department of Agriculture
Forest Service
Rocky Mountain Research Station
General Technical Report RMRS-GTR-41
November 1999

Ground Sample Data for the Conterminous U.S. Land Cover Characteristics Database

Robert Burgan
Colin Hardy
Donald Ohlen
Gene Fosnight
Robert Treder

Advanced Review

Circular data

Alan Lee*

The special nature of circular data means that conventional methods suitable for the analysis of linear data do not apply. In this article, we survey a range of methods that have been developed over the last 50 years to handle the special characteristics of data consisting of angular measurements. We discuss summary statistics and graphical methods, methods for the analysis of single and multiple samples of circular data, circular correlation, regression methods, and time series. We discuss the standard probability models on which these analyses are based, and give several examples of the application of these methods. A reasonably comprehensive bibliography is provided. © 2010 John Wiley & Sons, Inc. *WIREs Comp Stat* 2010 2 477–486 DOI: 10.1002/wics.98

Keywords: circular data; circular probability models; circular confidence intervals; circular correlation; regression models for a circular response

Environ Ecol Stat (2006) 13:311-324
DOI 10.1007/s10651-004-0014-5

ORIGINAL ARTICLE

Measures of preferred direction for environmental and ecological circular data

B. Sango Otieno · Christine M. Anderson-Cook

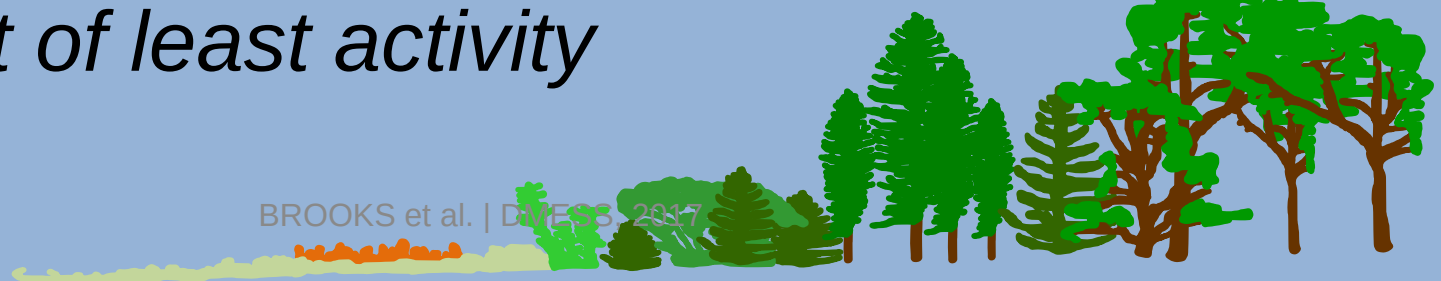
Received: November 2003 / Revised: June 2004
© Springer Science+Business Media, LLC 2006

Abstract Circular or angular variables indicating direction or cyclical time can be of great interest to scientists studying ecology, biology or environmental issues. A common problem of interest in circular data is estimating a preferred direction and its corresponding distribution. This problem is complicated by the so-called "wrap-around effect" on the circle, which exists because there is no natural minimum or maximum. The usual statistics employed for linear data are inappropriate for directional data, as they do not account for its circular nature. Three choices for summarizing the preferred direction (the sample circular mean, sample circular median and a circular analog of the Hodges–Lehmann estimator) are discussed, with examples from environmental and ecological applications. Similar to the linear data case, the relative emphases of different methods sometimes yield different measures of preferred direction in the presence of outliers or lack of symmetry in the original data.

Data Mining Benefits

What benefits can polar transformation offer?

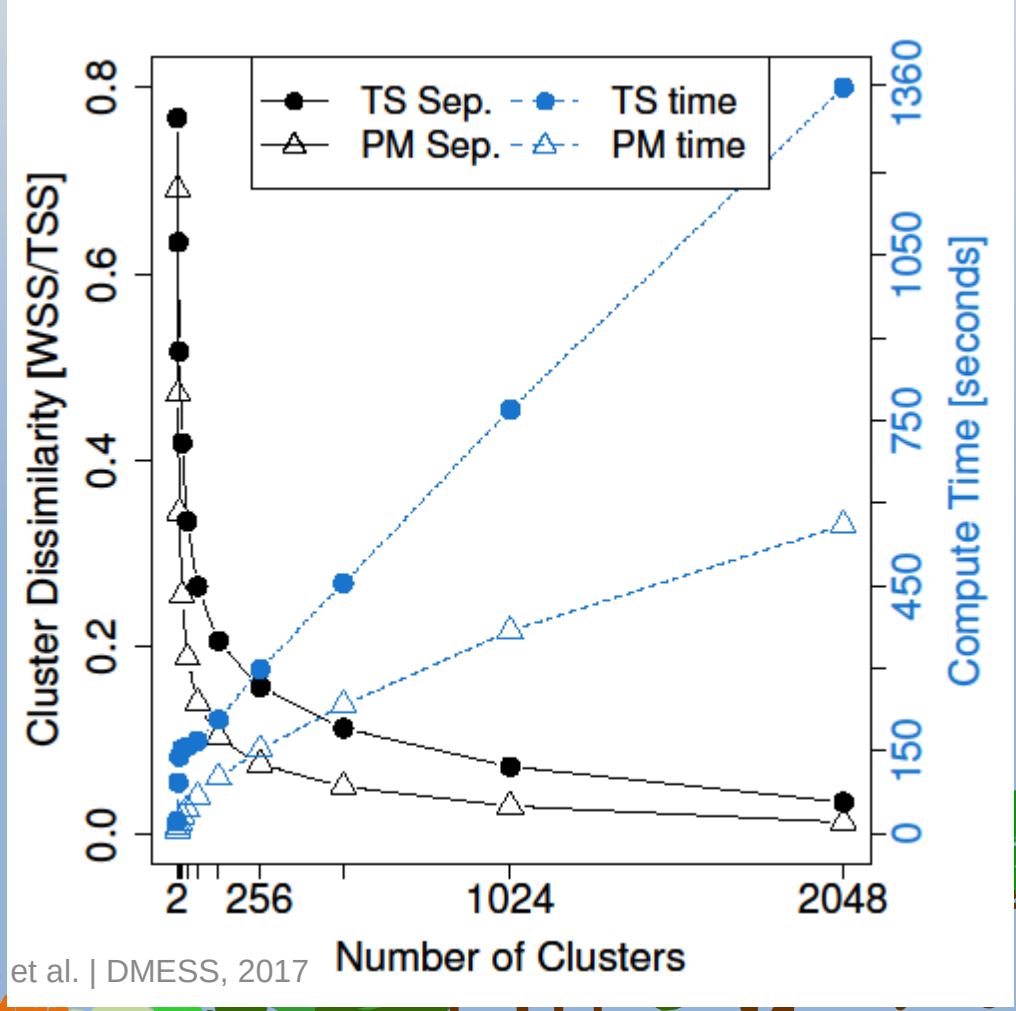
- Smaller data set size
- *Extraction of intuitive measures of change*
- *Visual enhancement of changes in timing*
- *Comparability of different sensor data*
- *Choice of calendar year or a year centered on point of least activity*



Data Mining Benefits

Smaller data set size

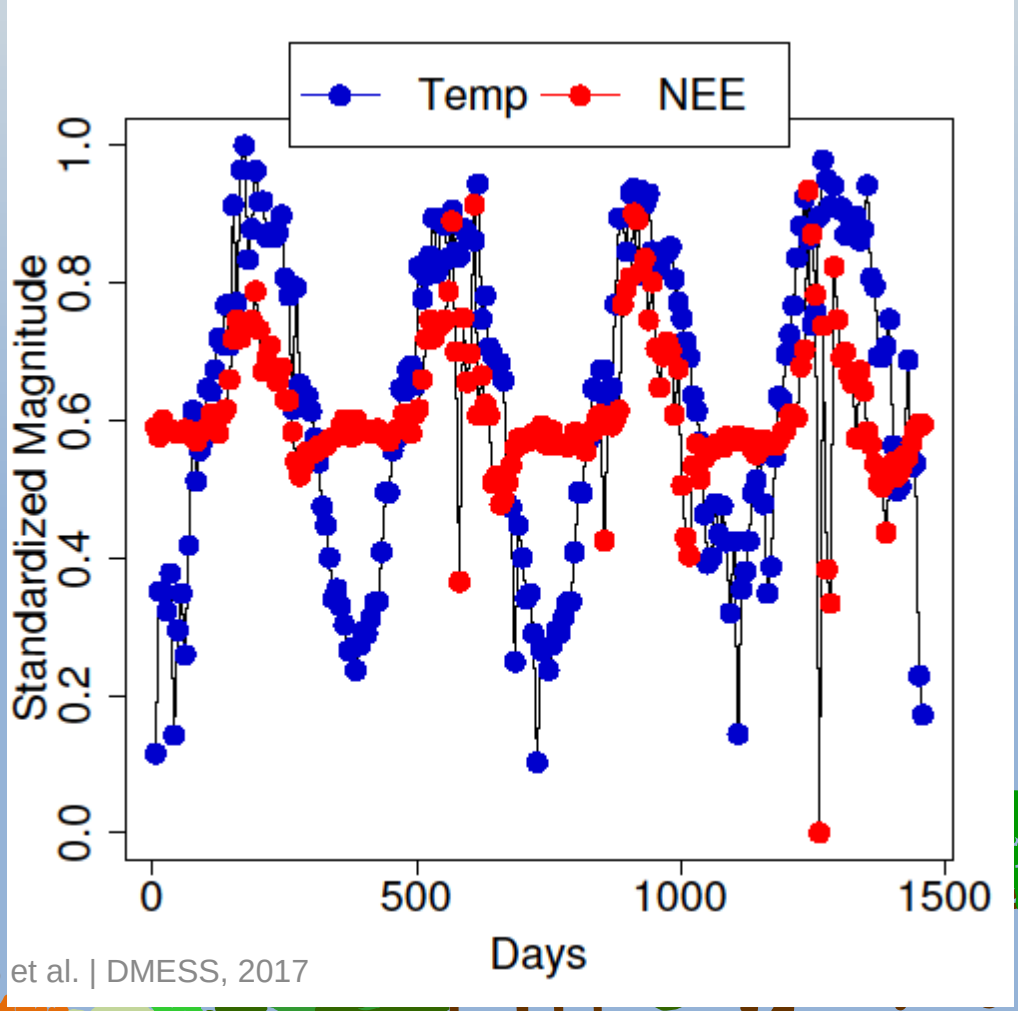
Faster computing for subsequent analysis



BROOKS et al. | DMESS, 2017

Extracting Polar Measures

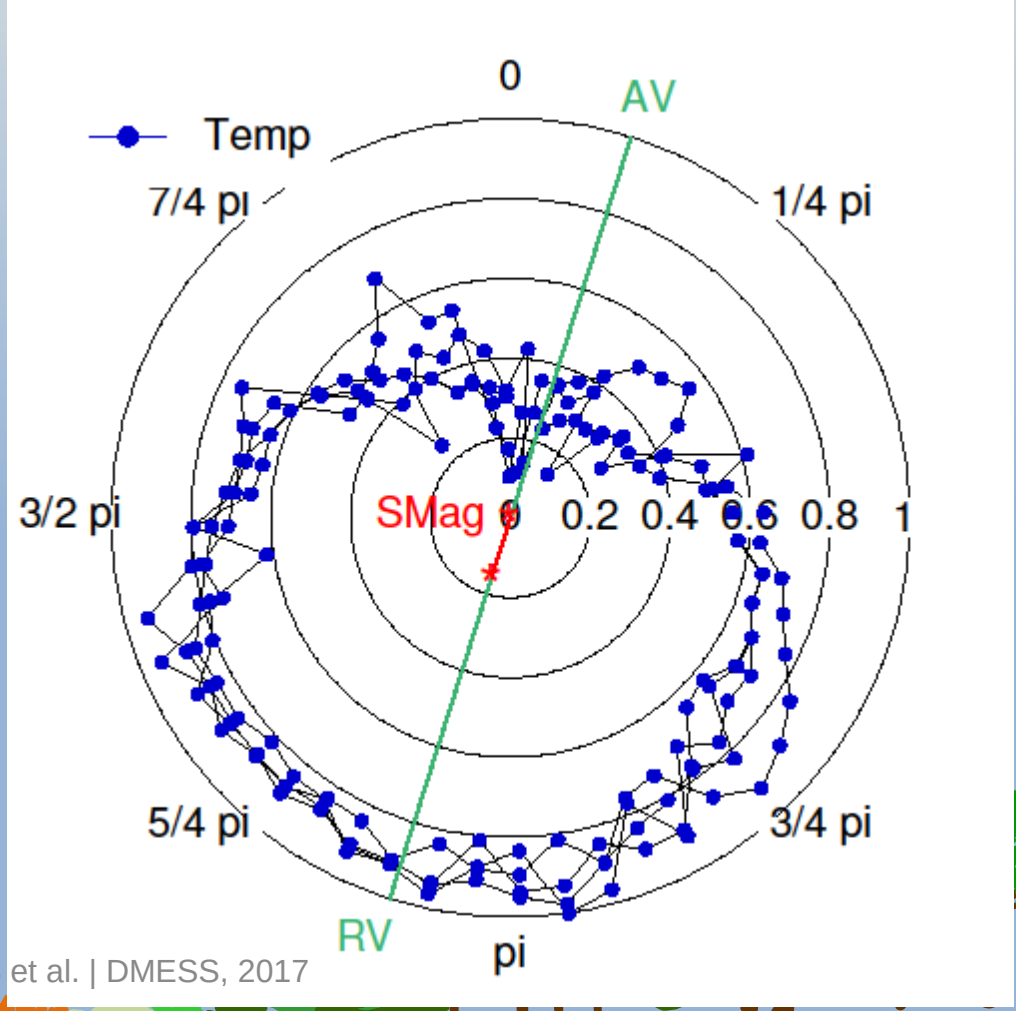
PolarMetrics R package calculates circular statistics for any uniformly sampled time series



BROOKS et al. | DMESS, 2017

Extracting Polar Measures

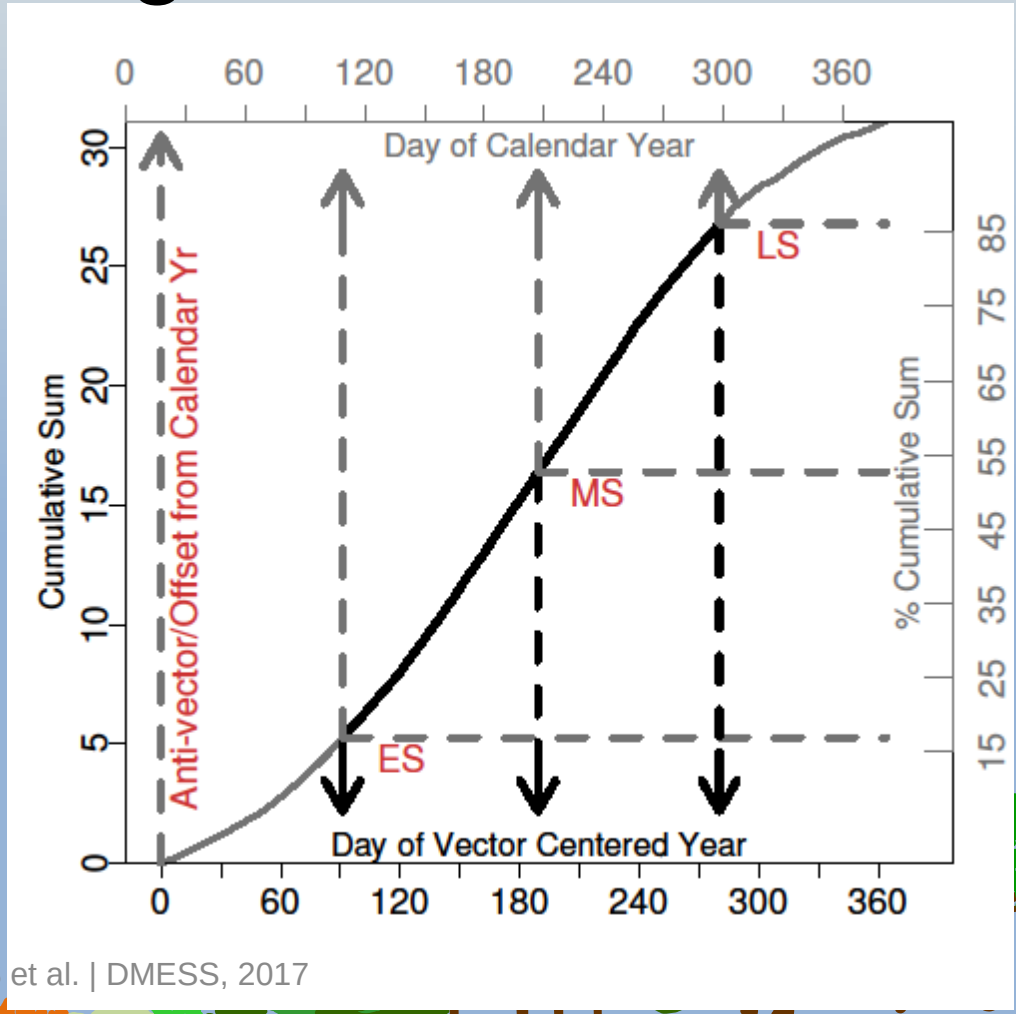
```
Procedure 4
# Transform first variable into
# its component vectors
vecs =
  calc_metrics(lef.7dy$TA,
  yr_type="cal_yr", spc=52,
  lcut=0.15, hcut=0.85,
  return.vecs=TRUE)$vectors
# Repeat calculation and return
# overall avg vecs (RV and AV)
avg_vecs =
  calc_metrics(lef.7dy$TA,
  yr_type="cal_yr", spc=52,
  lcut=0.15, hcut=0.85,
  return.vecs=TRUE)$avg.vectors
```



Dividing the Series & Extracting Metrics

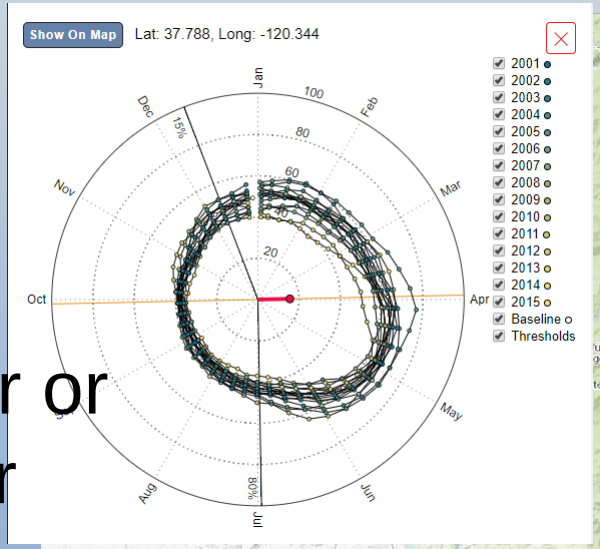
Dividing the time series into regular cycles that begin & end at the point of least activity (anti-vector).

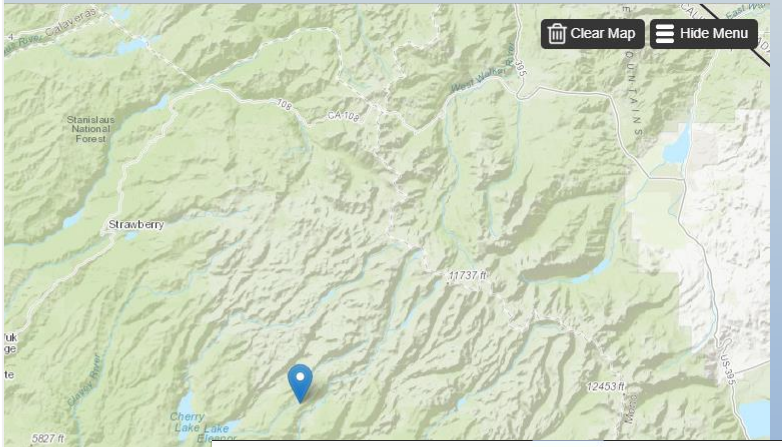
This makes it possible to examine differences in seasonality corresponding to empirically defined years.

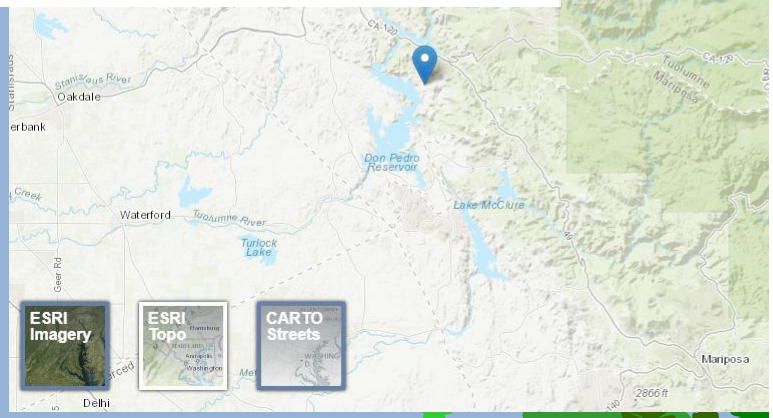


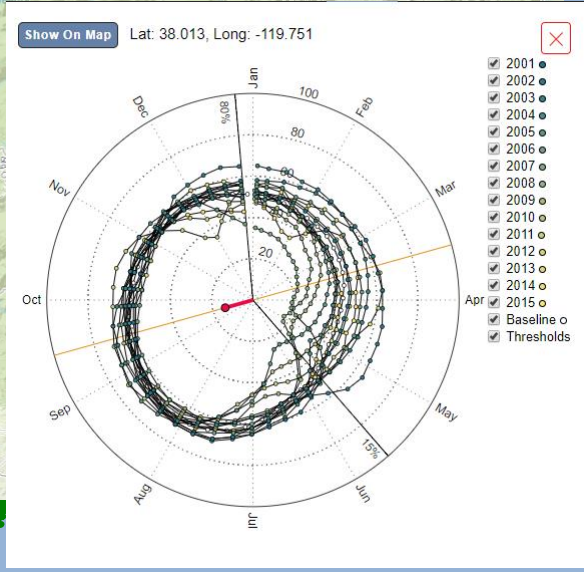
Dividing the Series & Extracting Metrics

- Timing measures
  - Calendar yr or empirical yr
- Magnitude measures



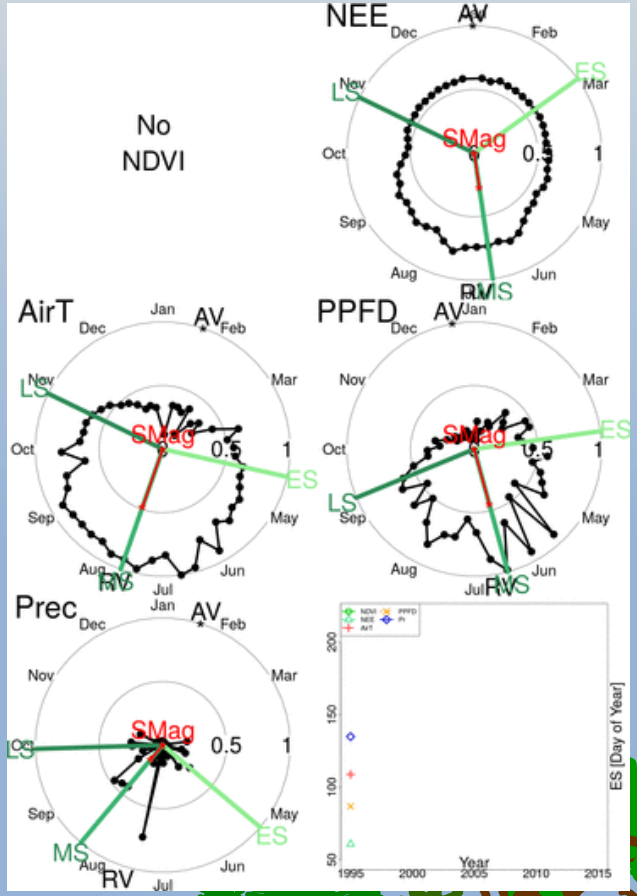






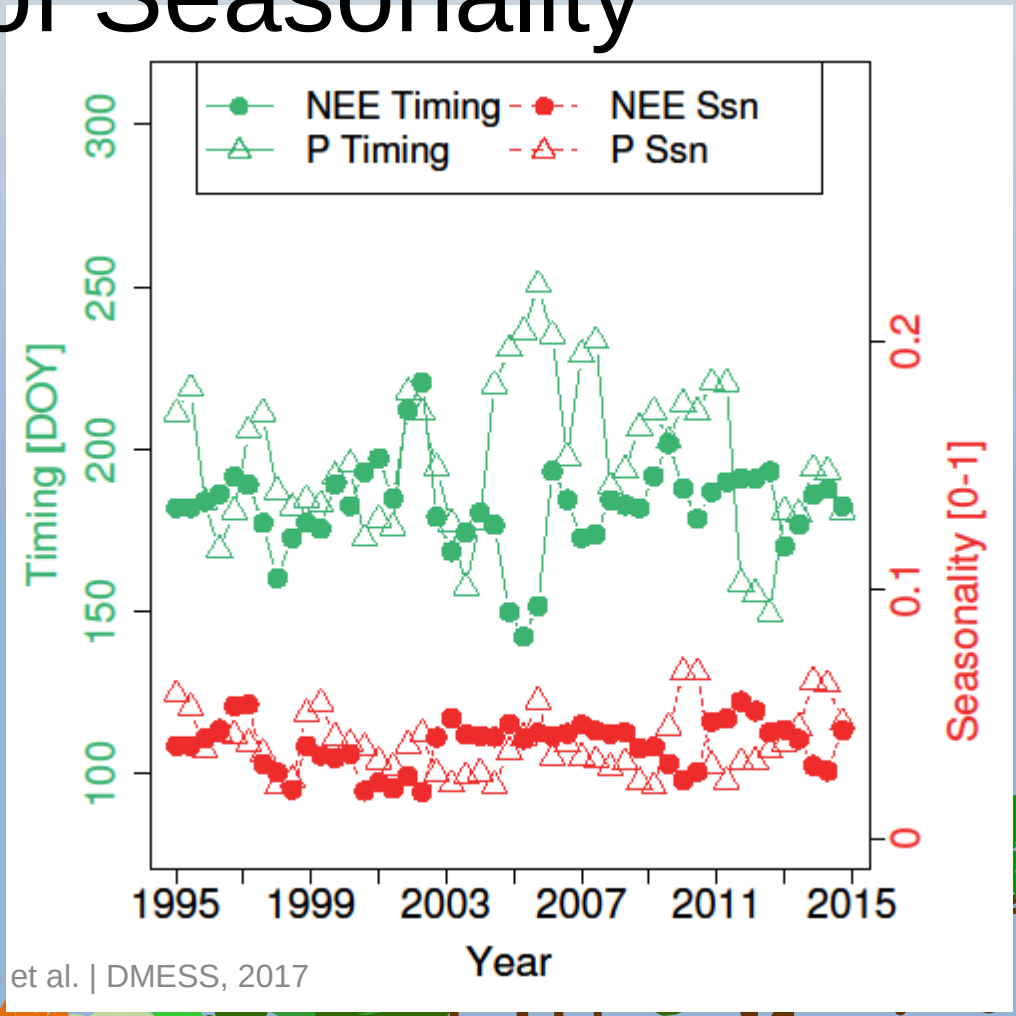
Capacity for Comparison of Disparate Environmental Variables

- Comparability across sensors
- Comparable on calendar year or empirically defined year
  - Empirical year suitable for comparison across elevational, latitudinal gradients



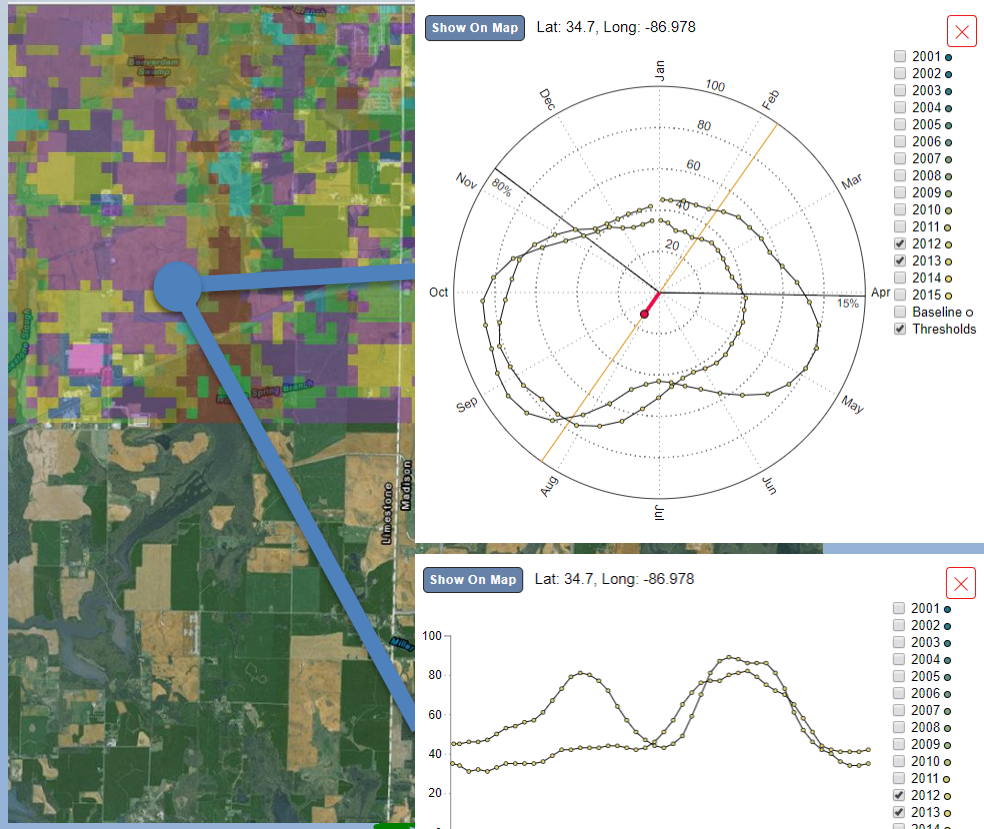
Example Applications: Nonstationarity in Facets of Seasonality

Departures from horizontal reflect shifts, trends, oscillations

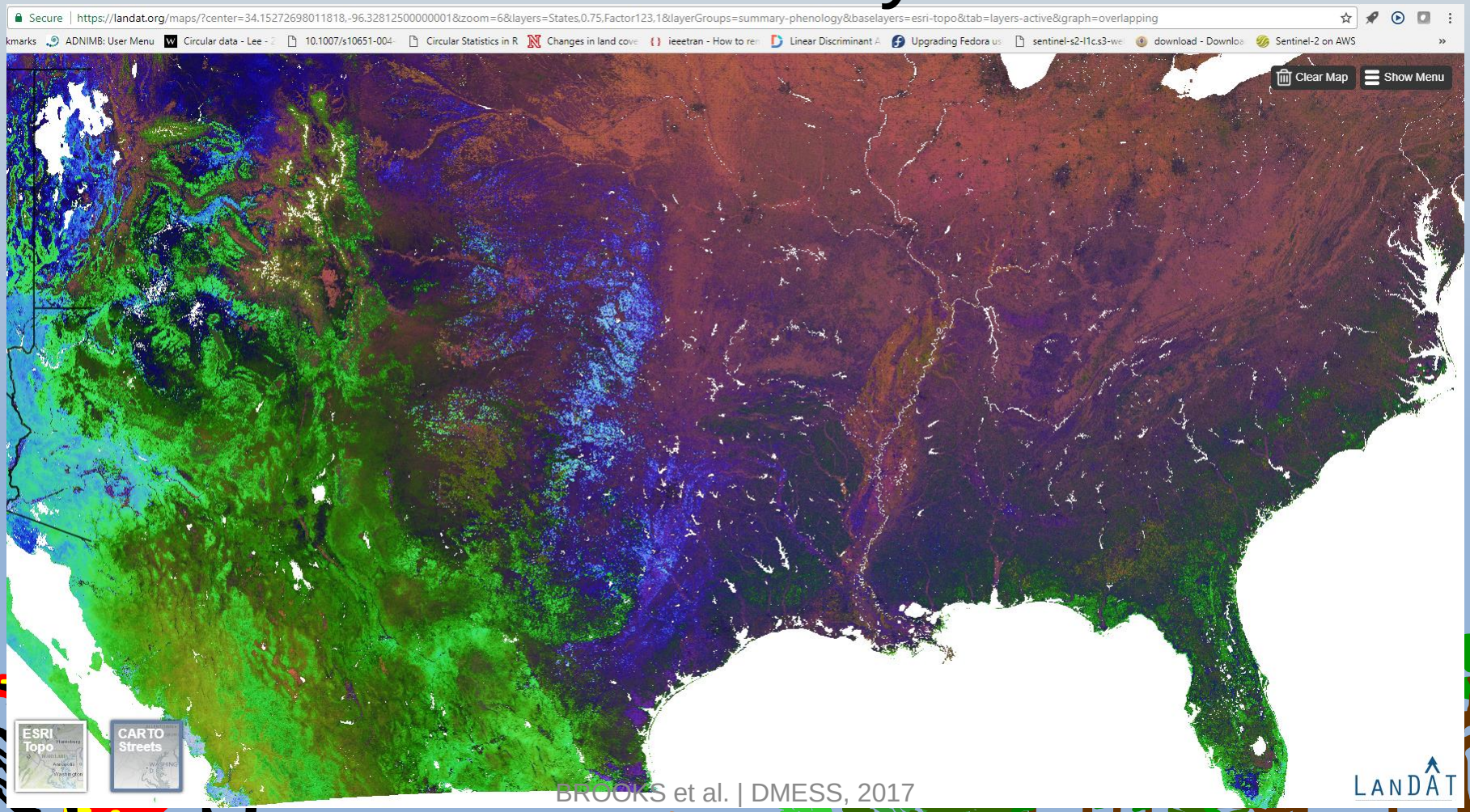


Further Applications: Discriminant Functions of LC Types

Polar measures lend themselves to novel analyses that better describe the controls on land cover type



Further Applications: Exploratory Factor Analysis



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Wrap-up

The PolarMetrics R package was developed as a set of open source generalizable tools that replicate our initial data processing steps of environmental time series.

PolarMetrics is generalizable and simple, but offers significant analytical benefits:

1. Functions are flexible, simple yet describe facets of seasonality through intuitive measures
2. No matter the input the output consist of standardized measures of seasonal profile
3. Filtering/Focusing on certain parts of the year

DMESS,
Nov 18, 2017, New Orleans

Thank You

Bjorn J. Brooks, Ankur Desai,
Danny Lee, Lars Pomara
and William W. Hargrove

Quantifying seasonal patterns in disparate environmental variables using the PolarMetrics R package