

# The phenologies of a Great Smoky Mountain

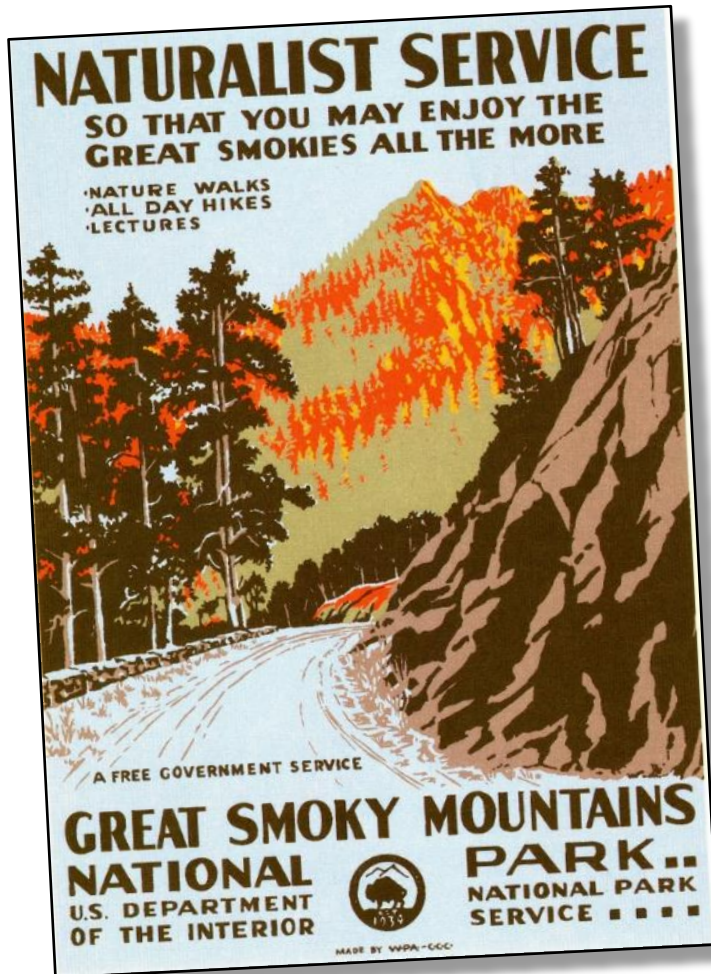
US-IALE Annual Meeting  
Baltimore, MD  
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William Hargrove  
William Christie



# Why is vegetational phenology important?



*Phenological values include spring flowering, wildlife, and fall foliage: these are sensitive to seasonal variation.*

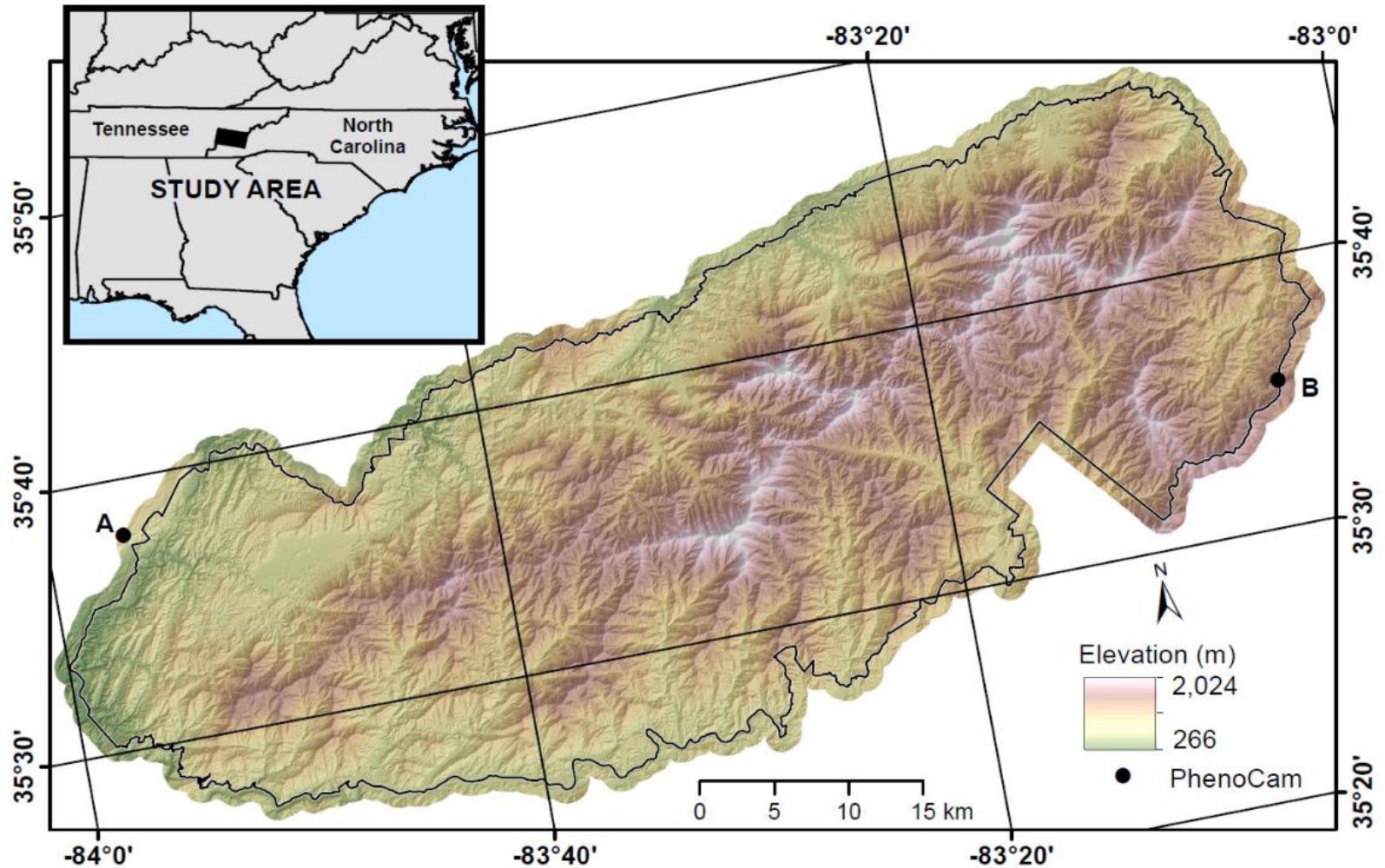


*Climate-mediated phenology impacts disturbances dynamics and growing season productivity.*

## Research questions

- What is the fundamental nature of the Park's *land surface phenology* (LSP) gradients?
- How and why does spring and autumn LSP vary from year to year?
- What do observations tell us about our ability to monitor LSP and its response to climate change?

# Great Smoky Mountains National Park

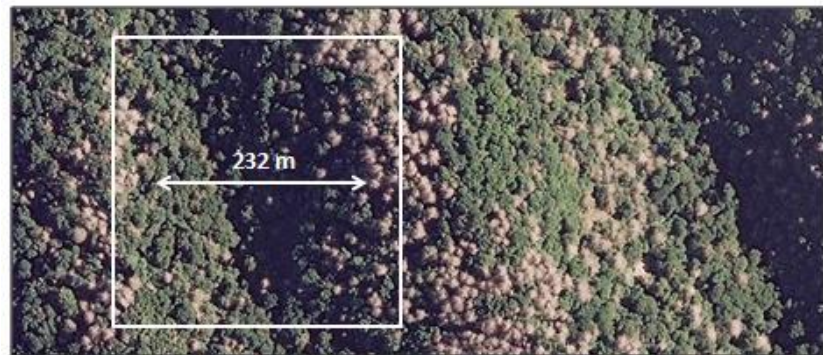
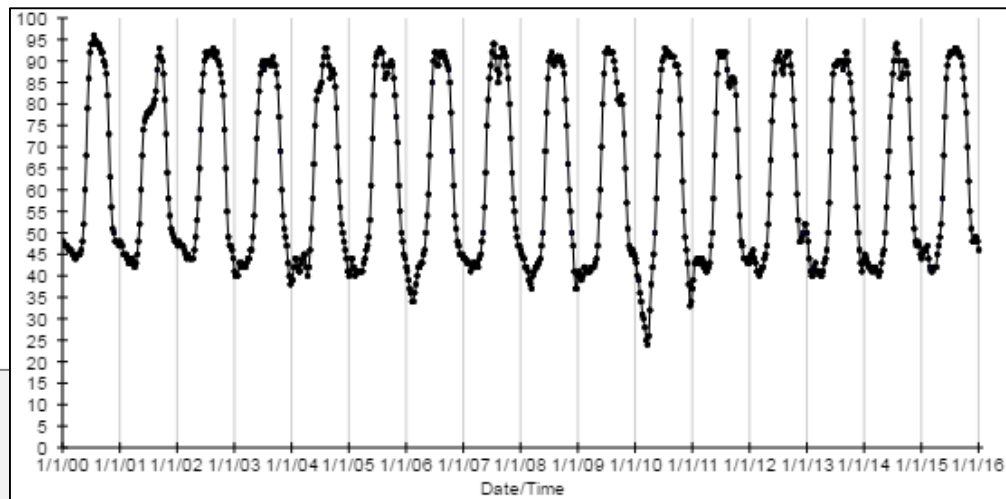




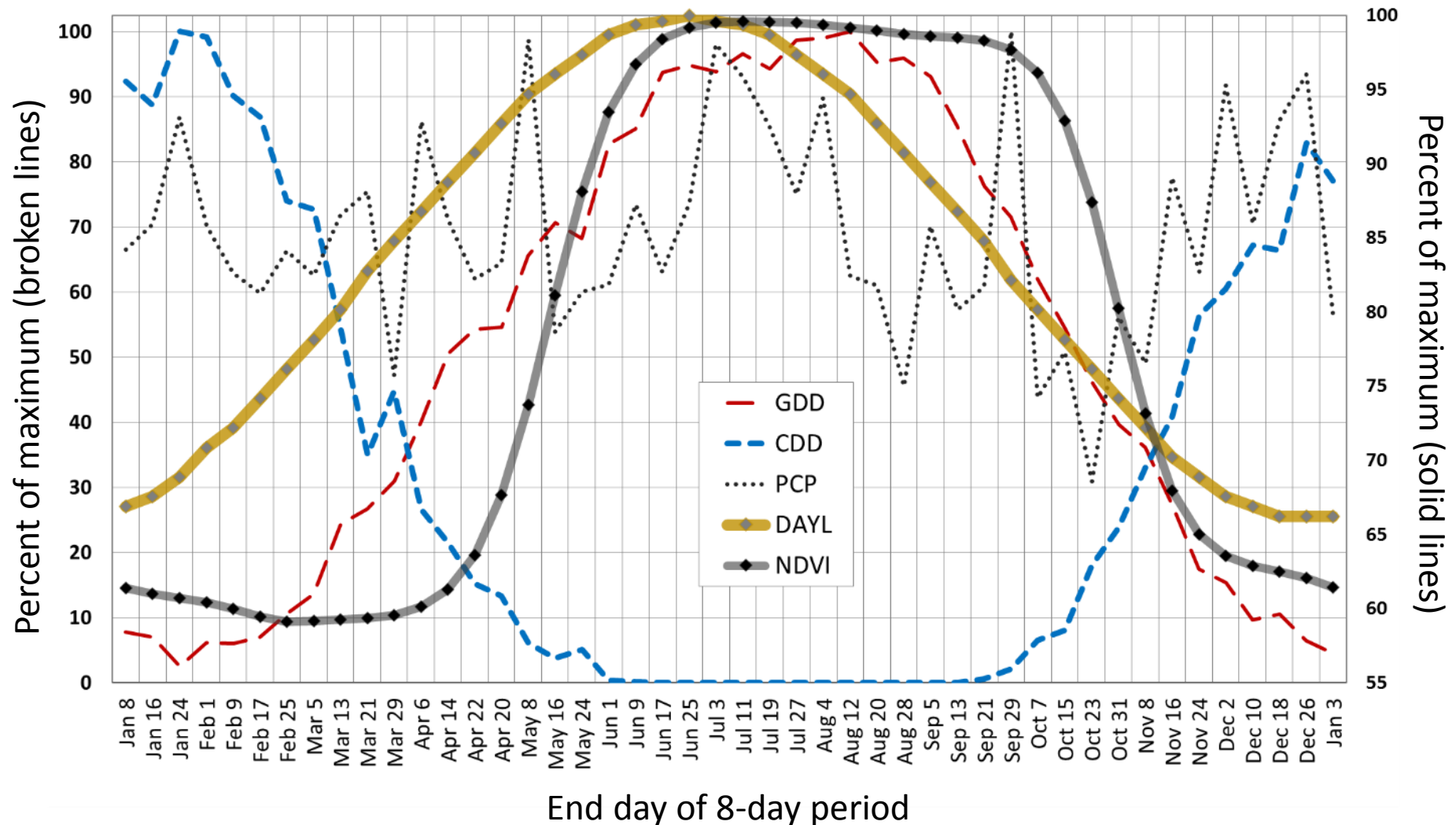
# The *ForWarn* dataset



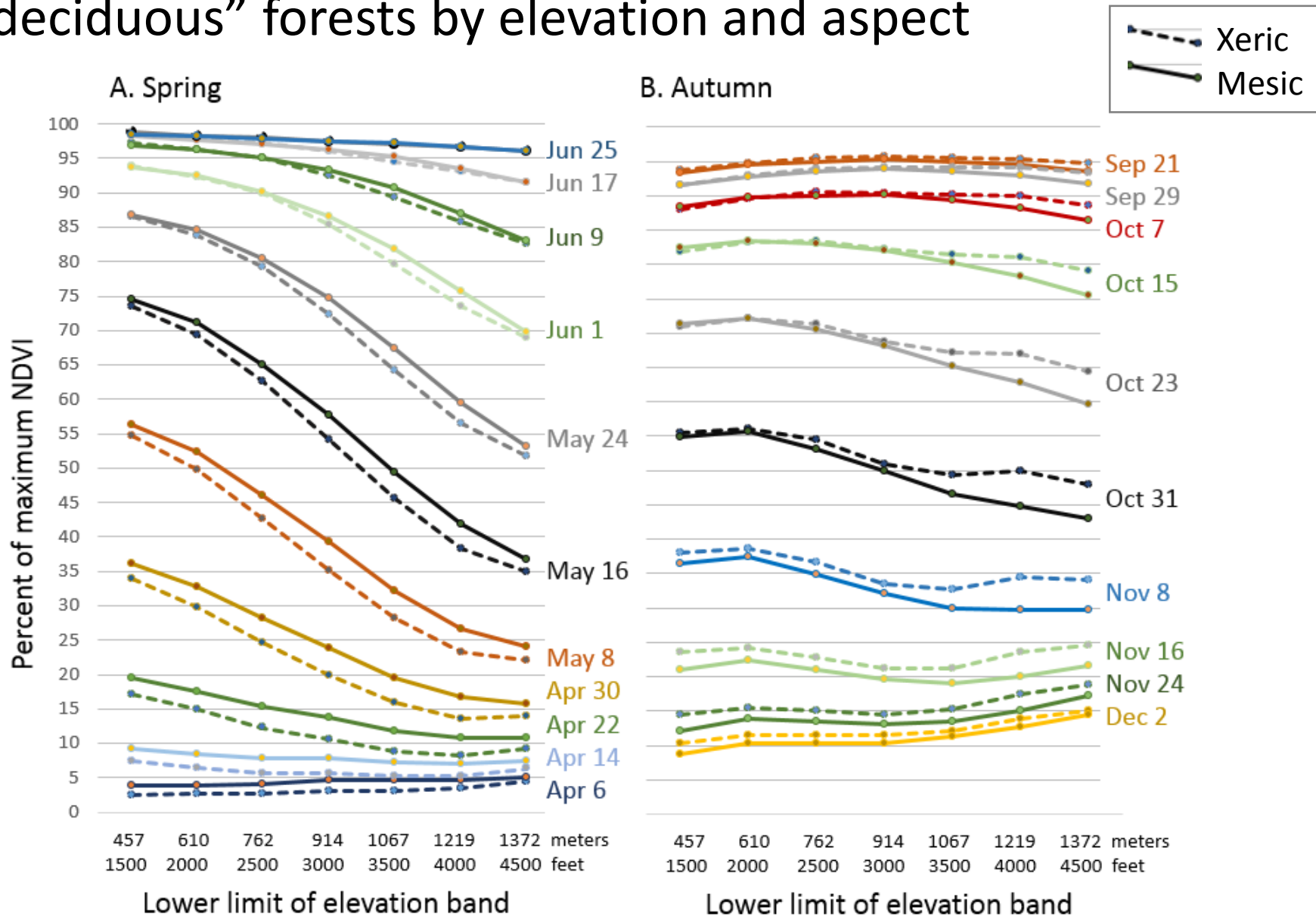
- From MODIS satellite streams (Terra and Aqua satellites)
- Highly processed to remove clouds and other image quality issues (max value compositing)
- 232m spatial resolution (13.4 ac.)
- 8-day time steps (46 periods per year)
- Uses NDVI (the Normalized Difference Vegetation Index)
- Data online at ORNL's DAAC and viewable at [forwarn.forestthreats.org](http://forwarn.forestthreats.org)



# The seasonal timing of deciduous forest phenology (NDVI), daylength, temperature, precipitation across GRSM National Park



# Long-term mean phenological behavior of “pure deciduous” forests by elevation and aspect





**April 20, 2015**

**Tulip poplar**

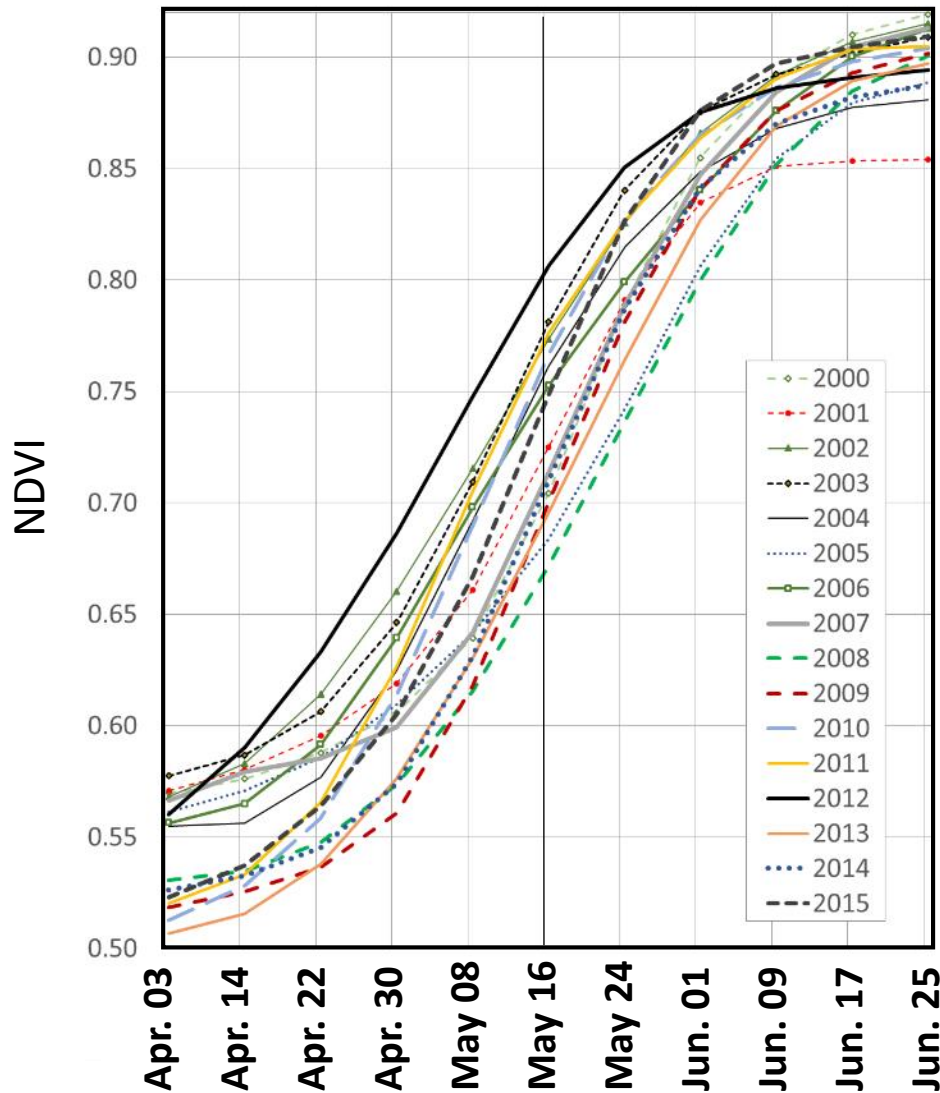
**White oak**



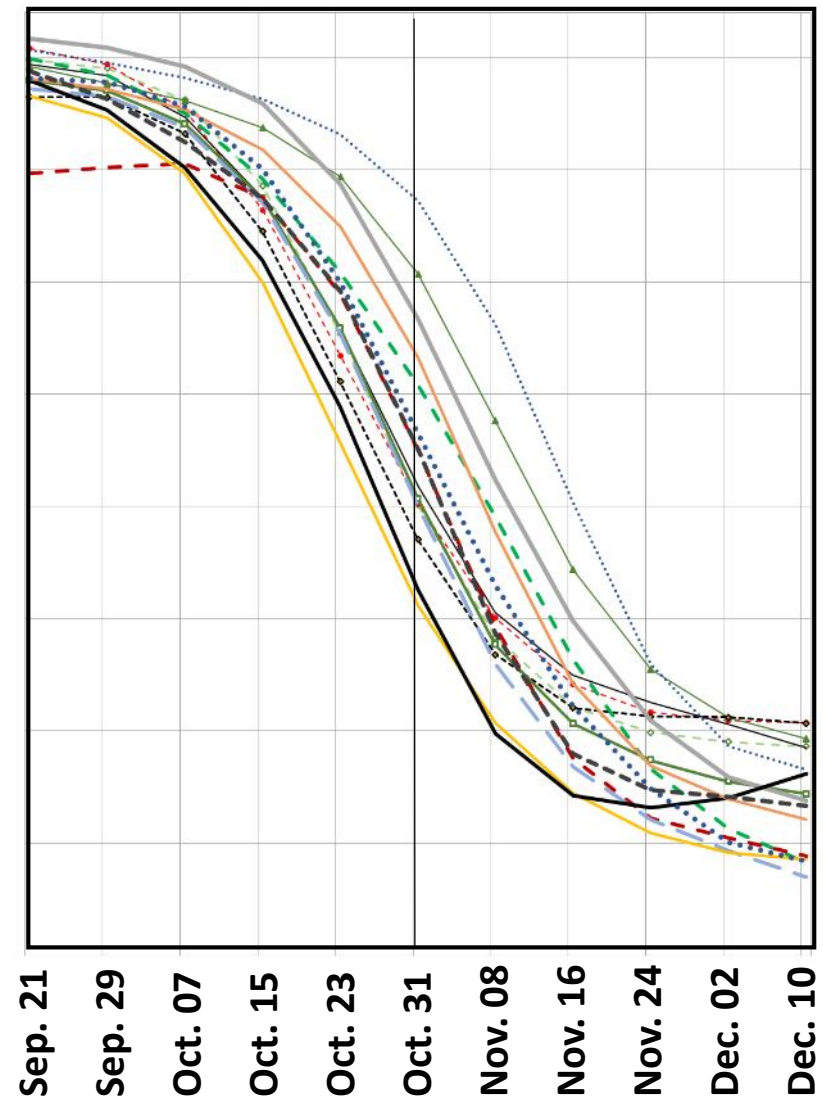


# Phenological variation of “pure deciduous” forests of GRSM below 5000 ft. from MODIS NDVI, 2000-2015

A. Spring

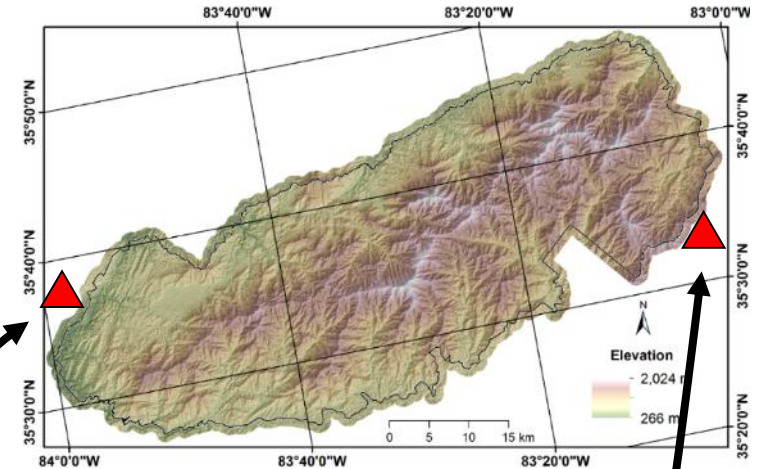
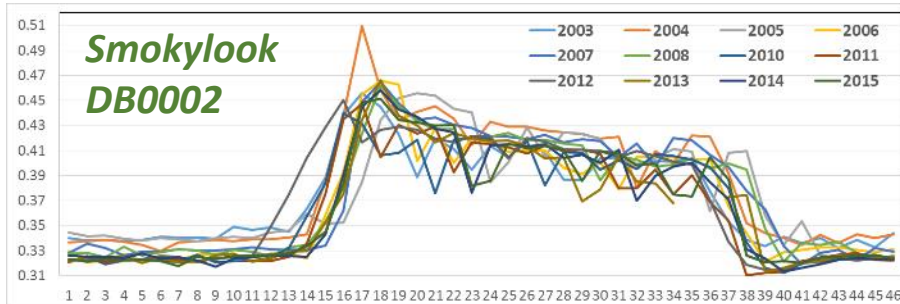


B. Autumn



# Comparison of MODIS NDVI with other data: The PhenoCam Network's green chromatic coordinate (gcc)

<https://phenocam.sr.unh.edu/webcam/>



## Smokylook PhenoCam

Elevation 801m (2628 ft.)  
2003-8, 2010-15



## Smokypurchase PhenoCam

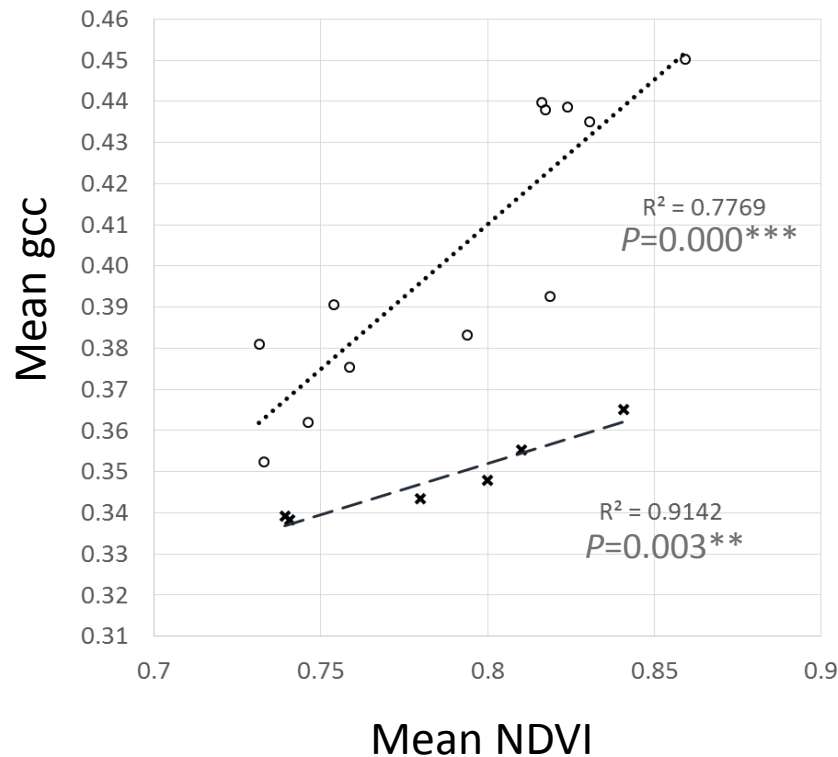
Elevation 1550m (5085 ft.)  
2008-2015



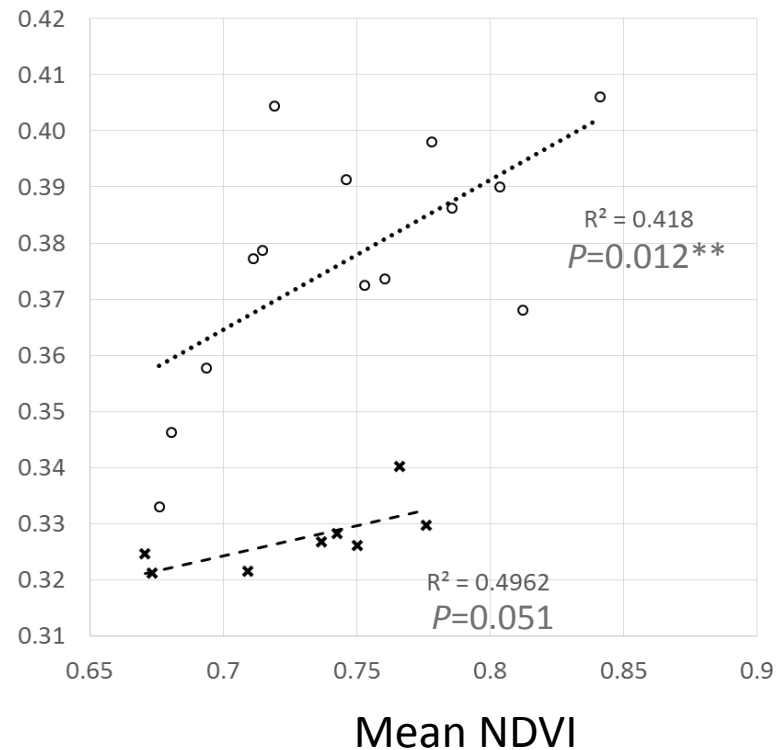


# Comparison of MODIS-NDVI (100m elev. bands) and PhenoCam green chromatic coordinate (gcc)

A. Spring

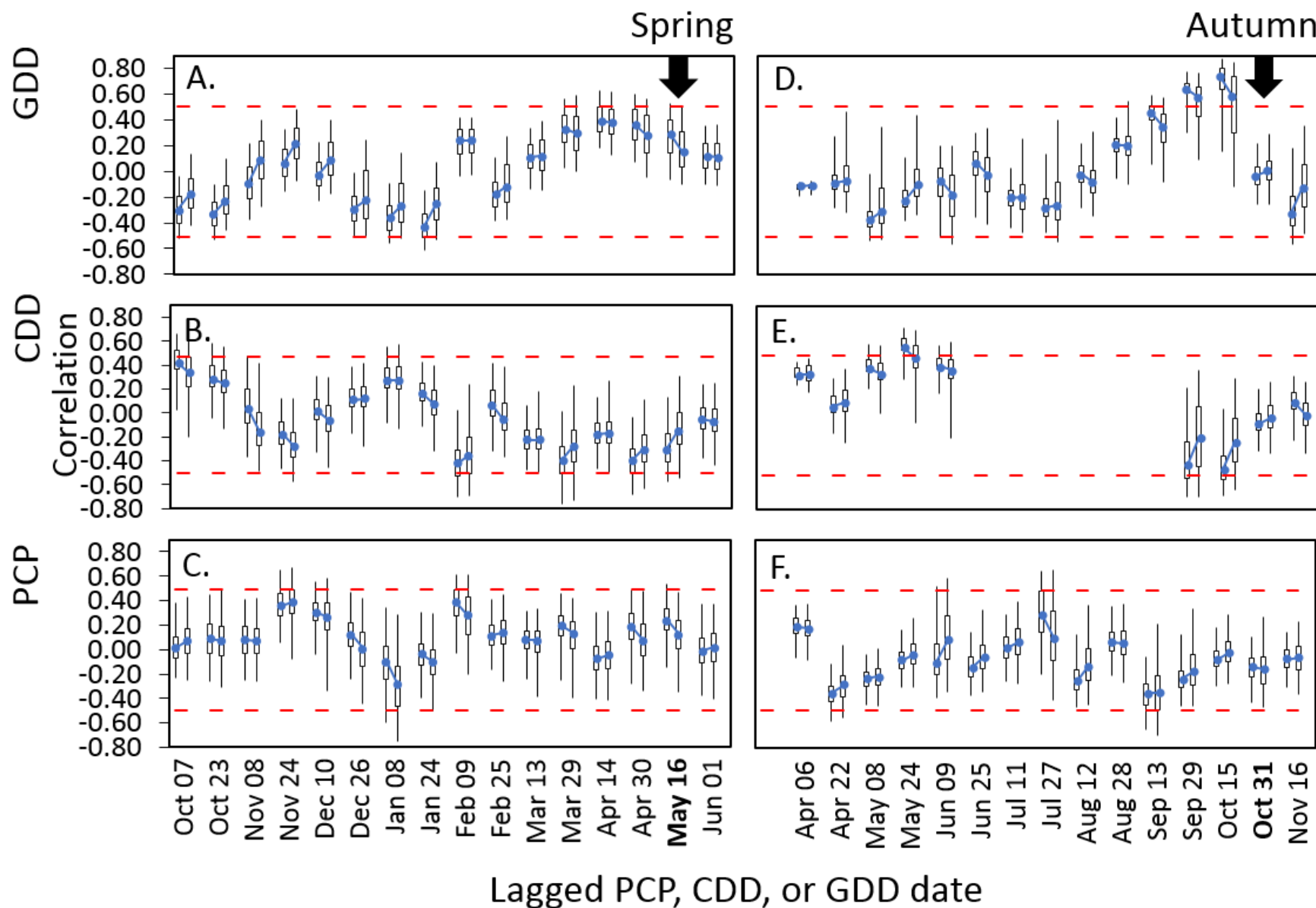


B. Autumn



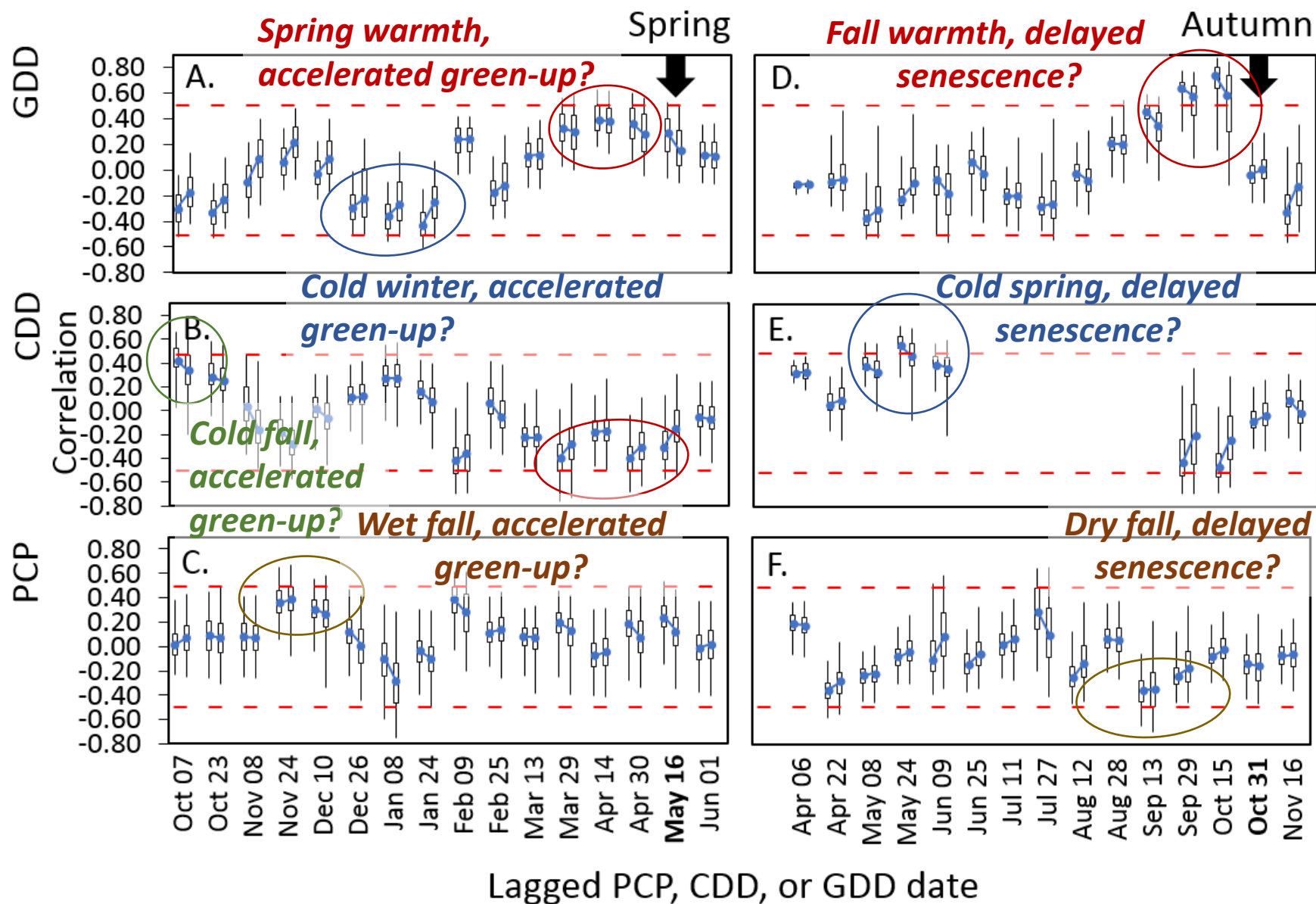
..... Smokylook (801m, 2628 ft.)  
- - - - Smokypurchase (1550m, 5085 ft.)

# Lagged correlations of Spring and Autumn NDVI with antecedent 24-day weather for deciduous and mixed/evergreen forests

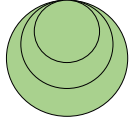




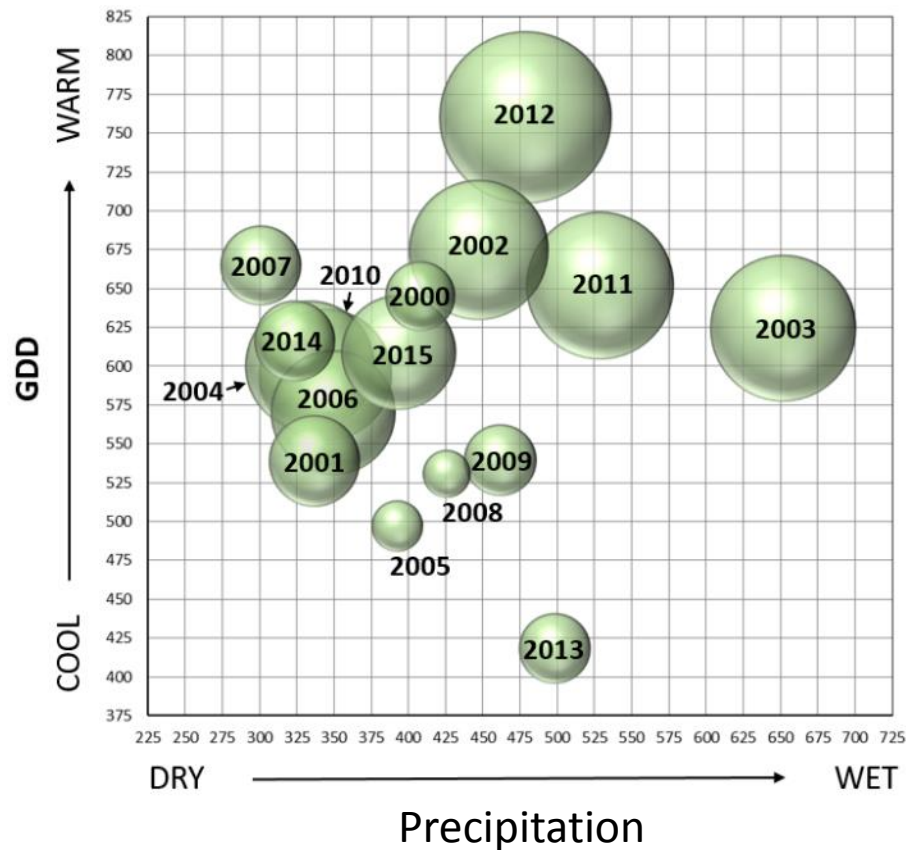
# Lagged correlations of Spring and Autumn NDVI with antecedent 24-day weather for deciduous and mixed/evergreen forests



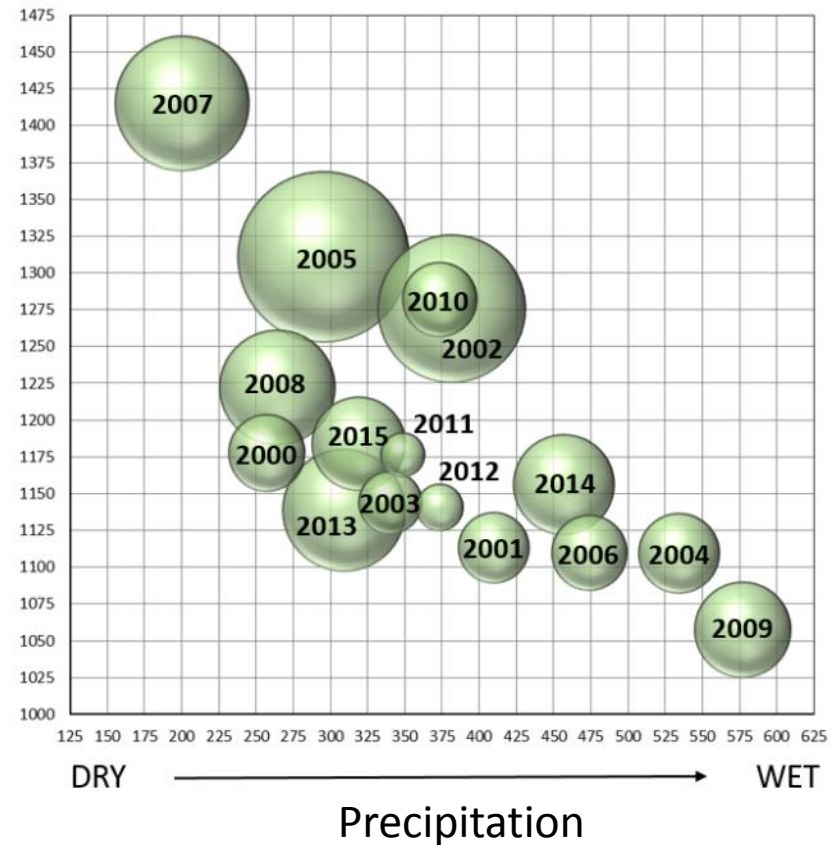
# Effects of Cumulative Growing Degree Days and Precipitation (over 88 days) on Spring and Autumn NDVI

 Diameter denotes relative state of green-up (NDVI)

A. Spring (May 16 period)

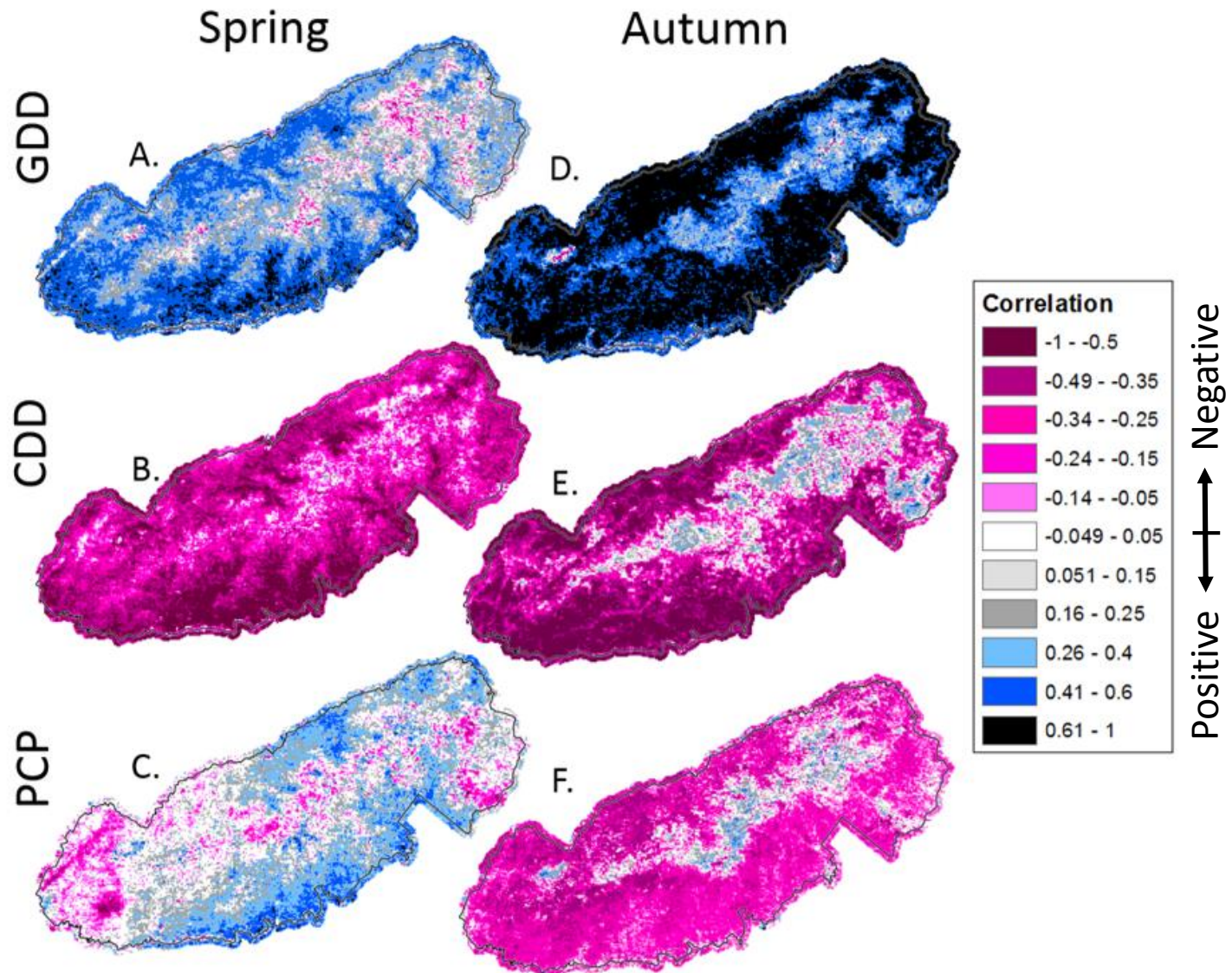


B. Autumn (Oct. 31 period)

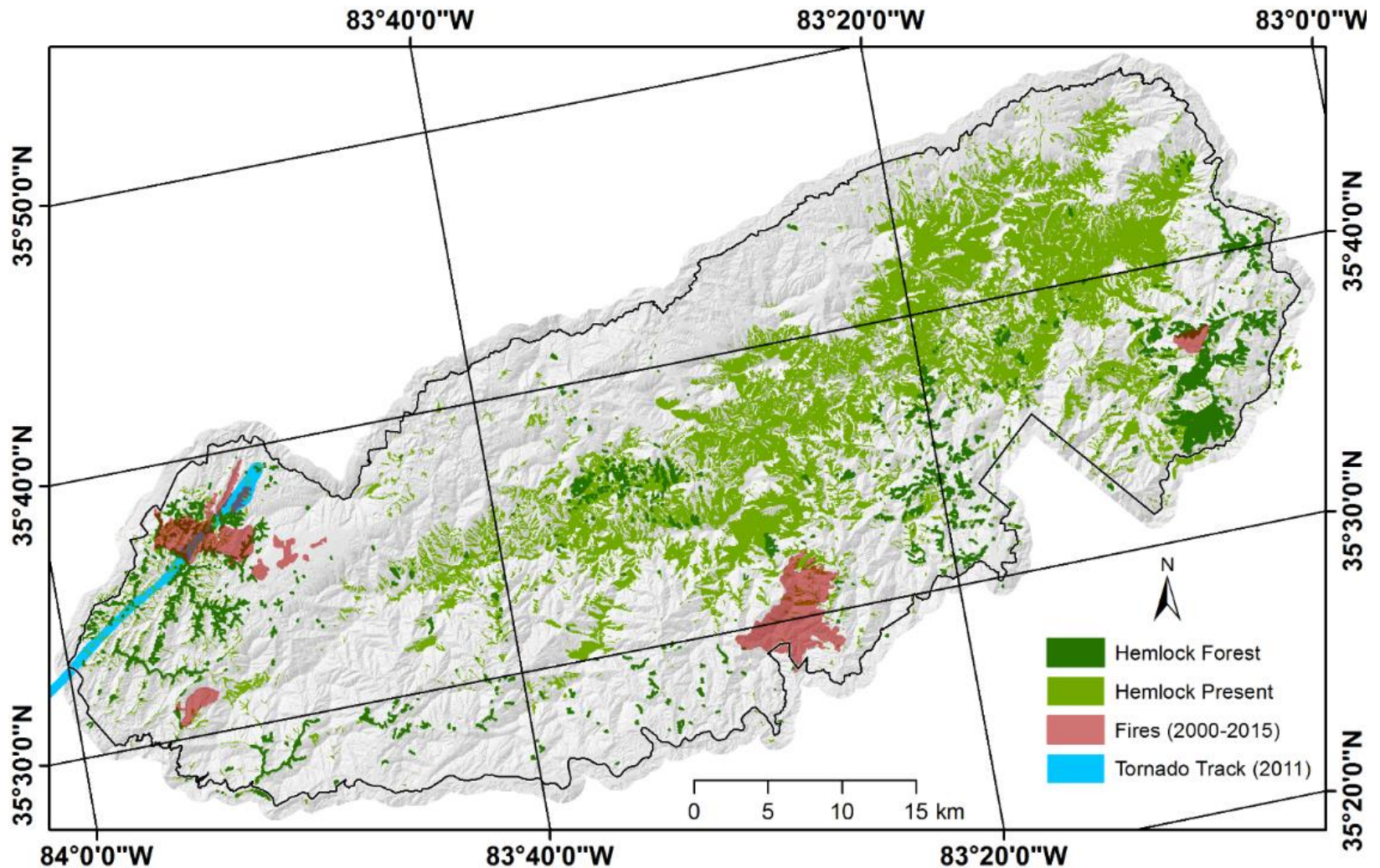




# Mapped correlations of Spring and Autumn NDVI with lagged weather

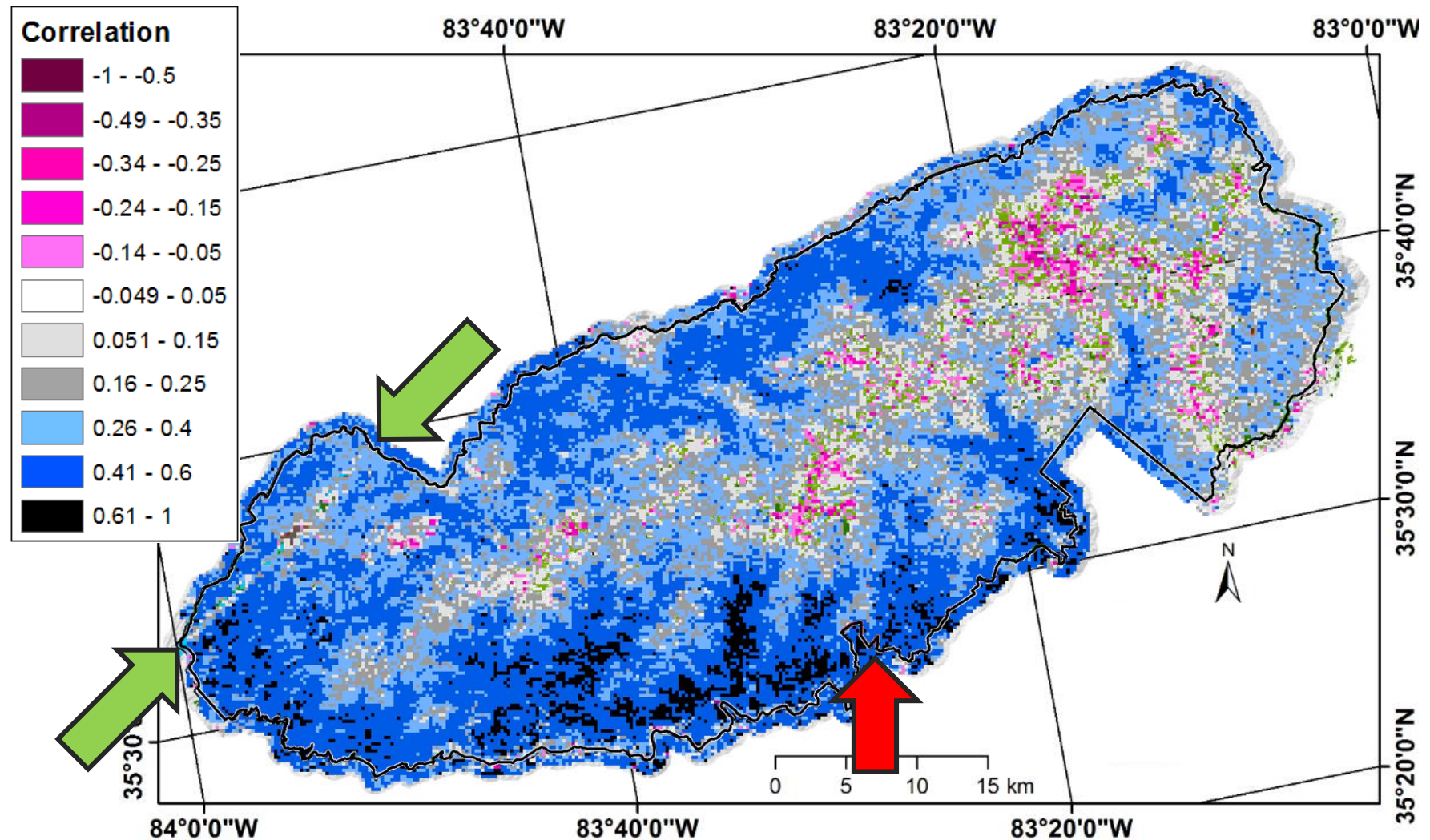


# Areas of Disturbance within GRSM National Park, 2000-2015





# Mapped correlations of Spring NDVI with antecedent growing degree days, 2000-2015





# Summary of results

- Elevation is the primary driver of Land Surface Phenology (LSP) for the Park, with a secondary, though important influence of aspect and vegetation type.
- Satellite-based measures of LSP capture how spring timing can vary as it progresses, and that green-up and brown-down have varied by about 2.5 weeks over these 16 years.
- Warm-wet spring weather accelerates green-up, while warm-dry or average fall weather delays senescence, with potential cross seasonal lags in both seasons.
- Disturbances can confound our ability to monitor LSP, but we can deal with this problem through aggressive use of ancillary data filtering.



Thanks!

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Norman, S.P., Hargrove, W.W., Christie, W.M. *In review*. Spring and autumn phenological variability across environmental gradients of Great Smoky Mountains National Park, USA