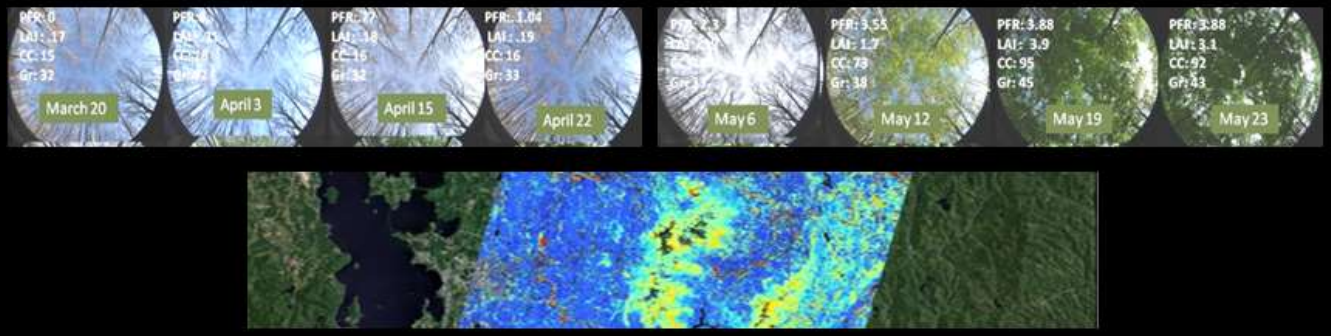
Remote Sensing of Spring Phenology

trends and patterns in Vermont's forests



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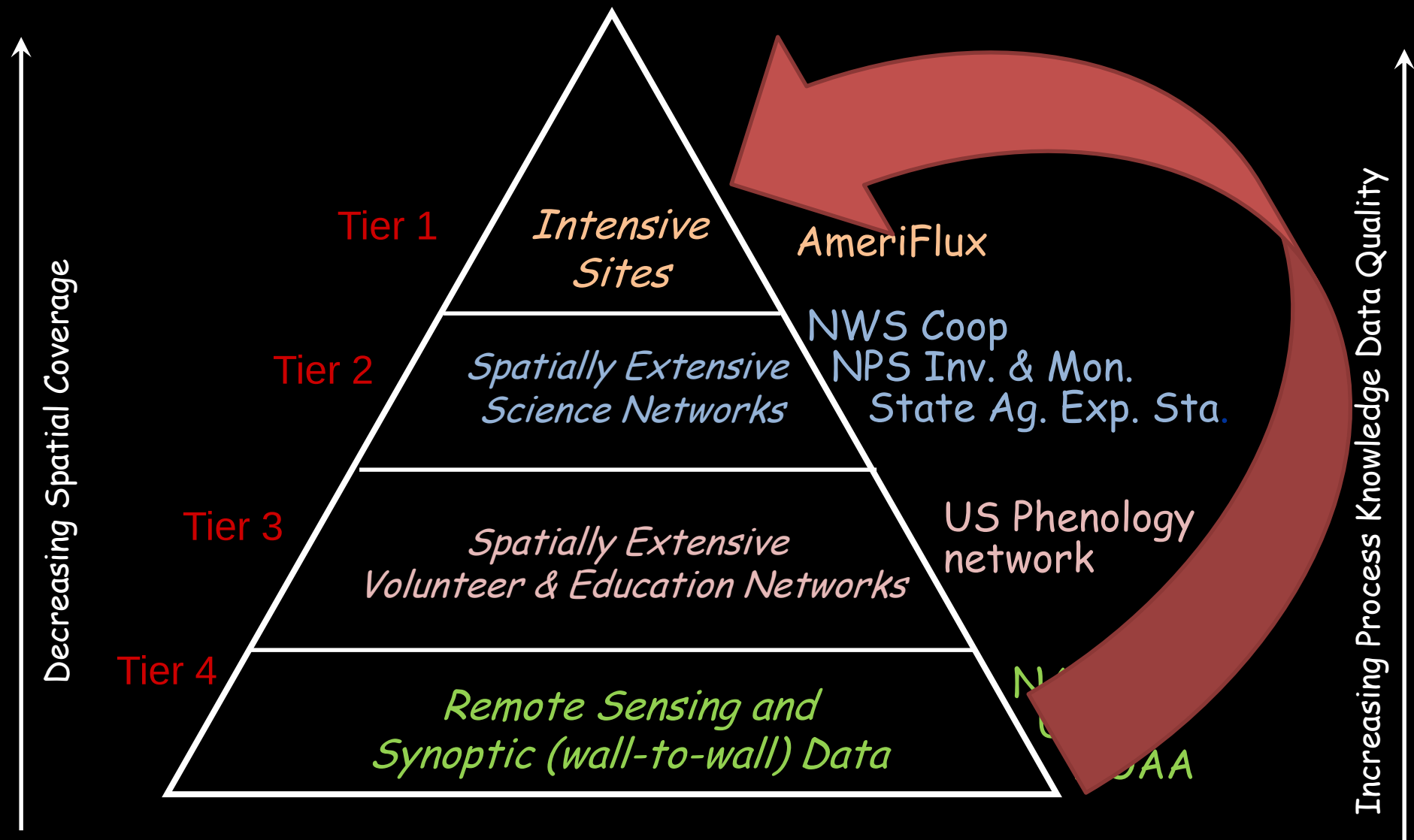
Rubenstein School of Environment and natural Resources

USFS Northern Research Station

Northern RESEARCH STATION USDA Forest Service

Scales of Phenology



George R. Kish U.S. Geological Survey

Remote Sensing of Spring Phenology

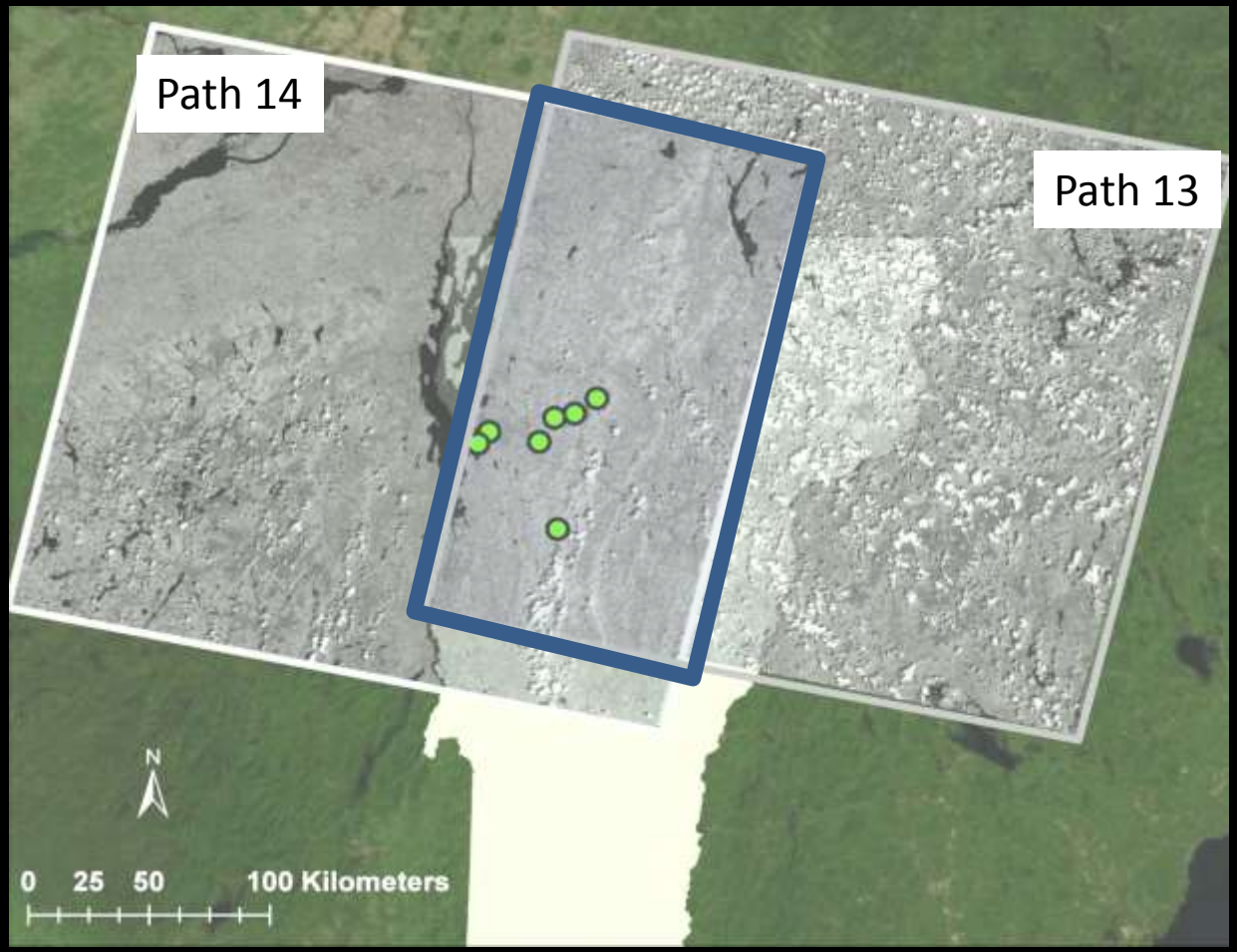
Best Vegetation Index: Enhanced Vegetation Index (EVI)
Best curve fit: 5 parameter sigmoid (Zhang 2000)
Best threshold: EVI = 0.3
Ground truth link: Full leaf out
QAQC: min 5 dates, including March baseline, July max, no more than 32 days between dates, significant χ^2 fit

Project Objectives

Apply this Landsat based technique to as many years as possible ……..

1. Examine temporal trends and
2. Spatial patterns in those trends

Study Area


Path 14
Path 13
N
0 25 50 100 Kilometers

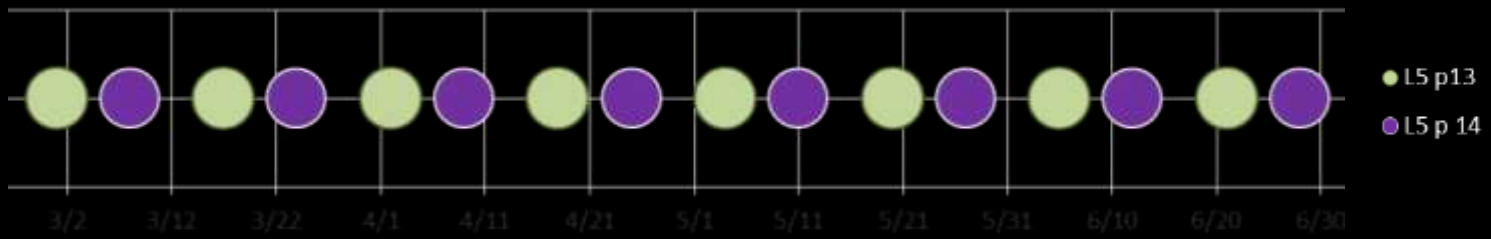
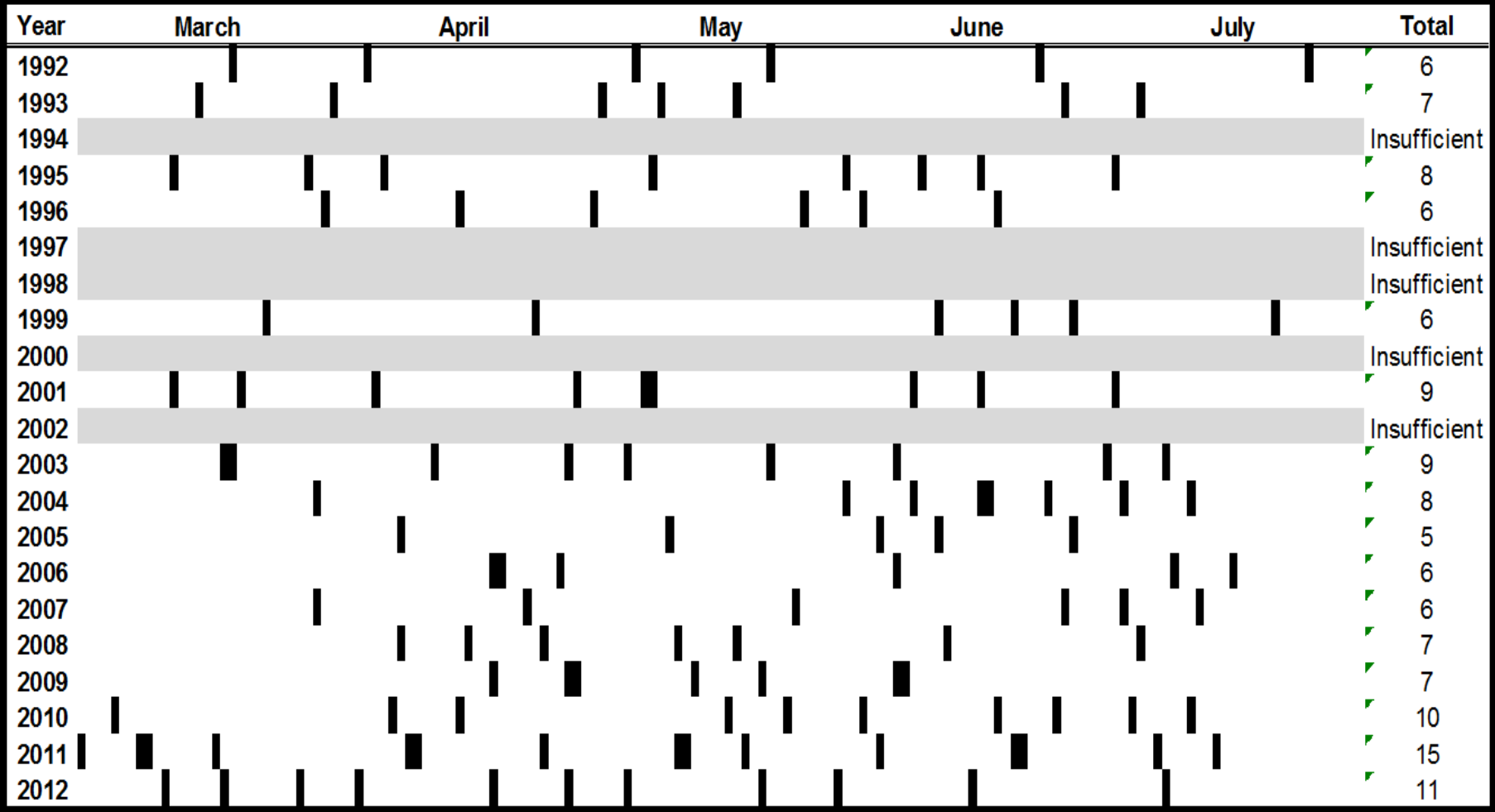
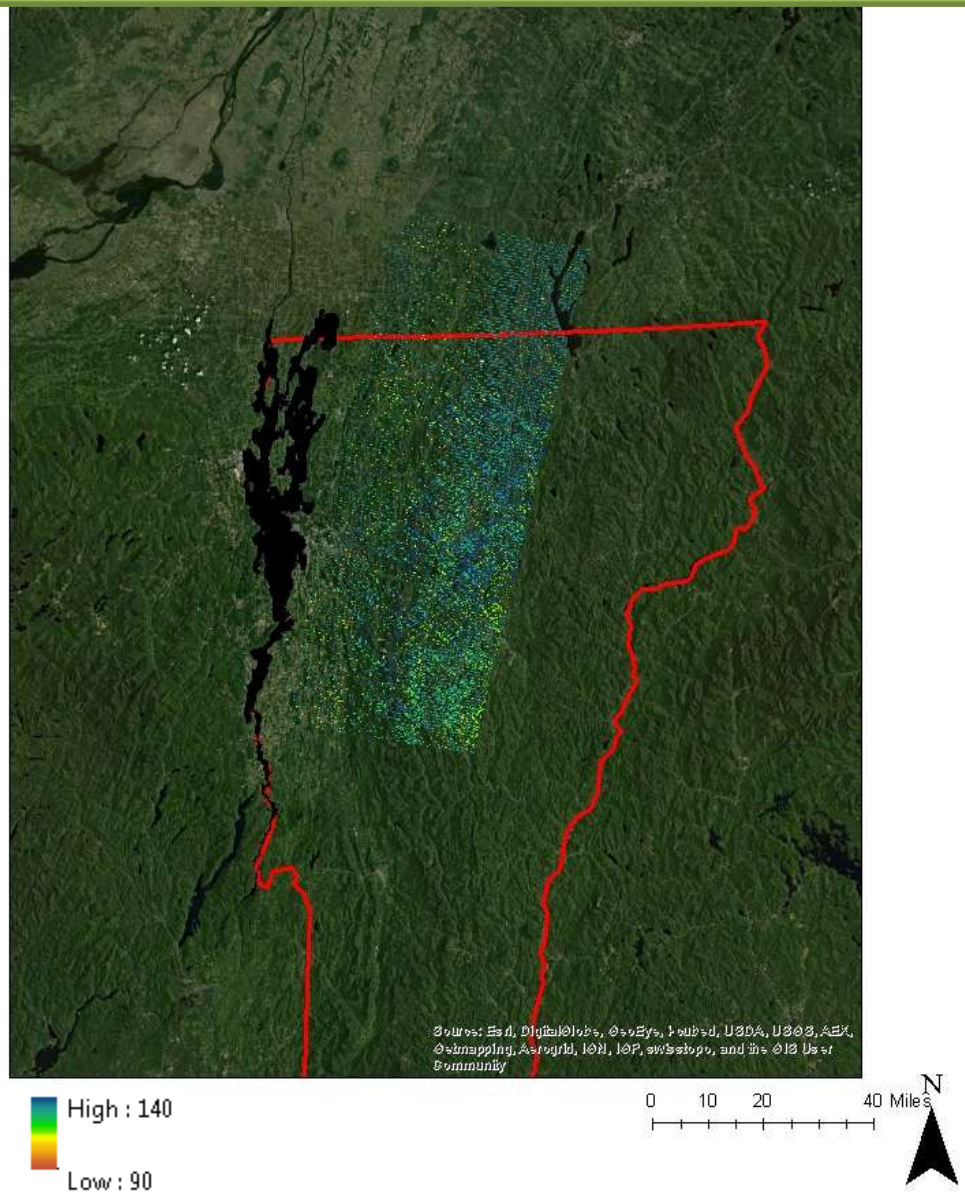

3/2
3/12
3/22
4/1
4/11
4/21
5/1
5/11
5/21
5/31
6/10
6/20
6/30
L5 p13
L5 p 14

Image Availability



Landsat Predicted SOS



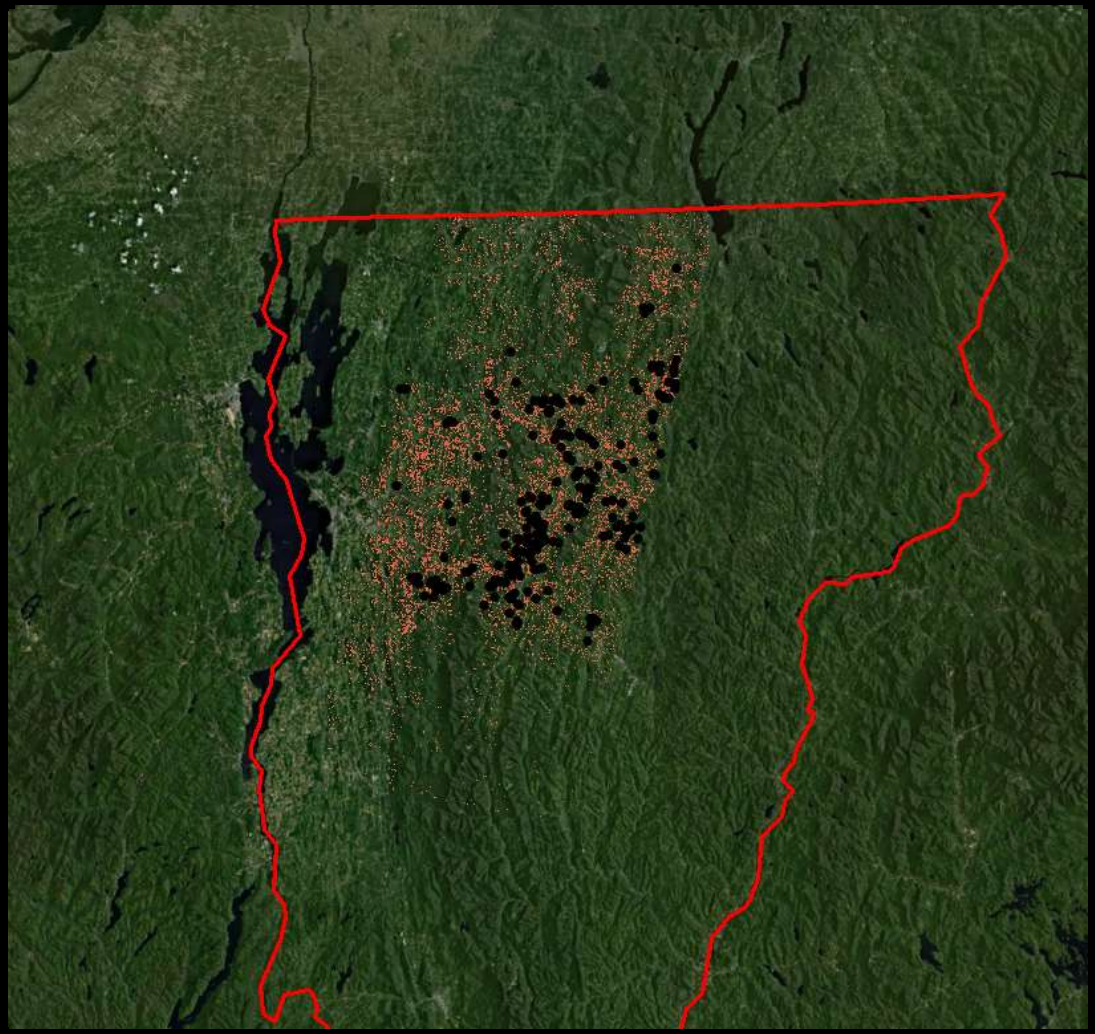
Comparing “apples to apples”

Data Set

Random pixels
Classified as
northern hardwood
With at least 10 years of data

Including Data for:

- 1992
- 1995
- 1999
- 2000
- 2003
- 2004
- 2007
- 2008
- 2009
- 2010

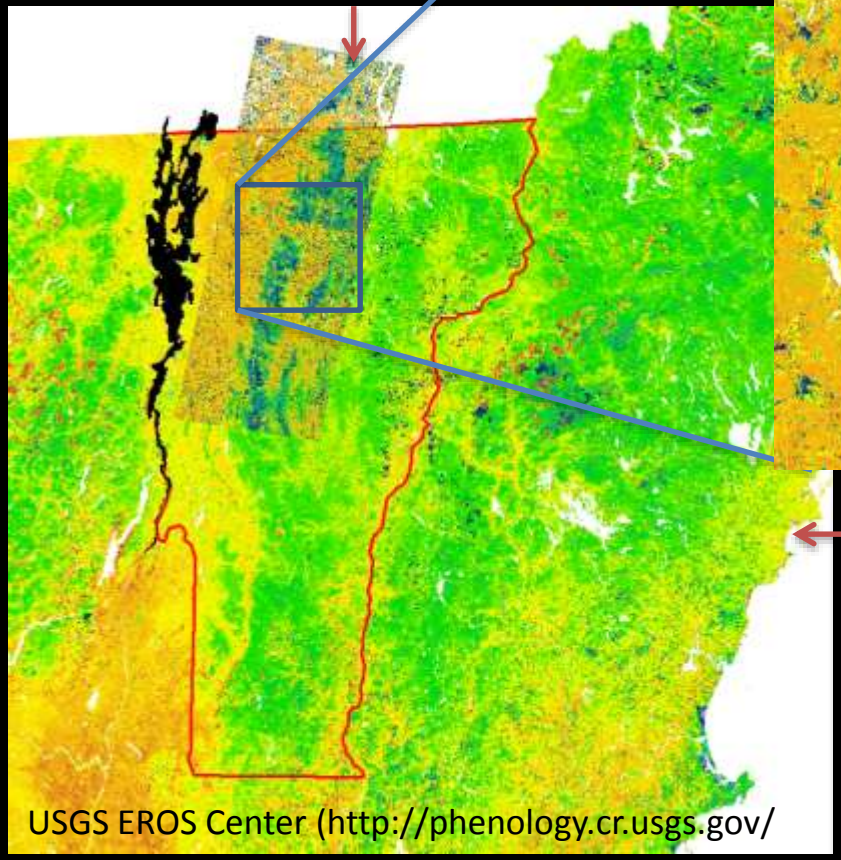


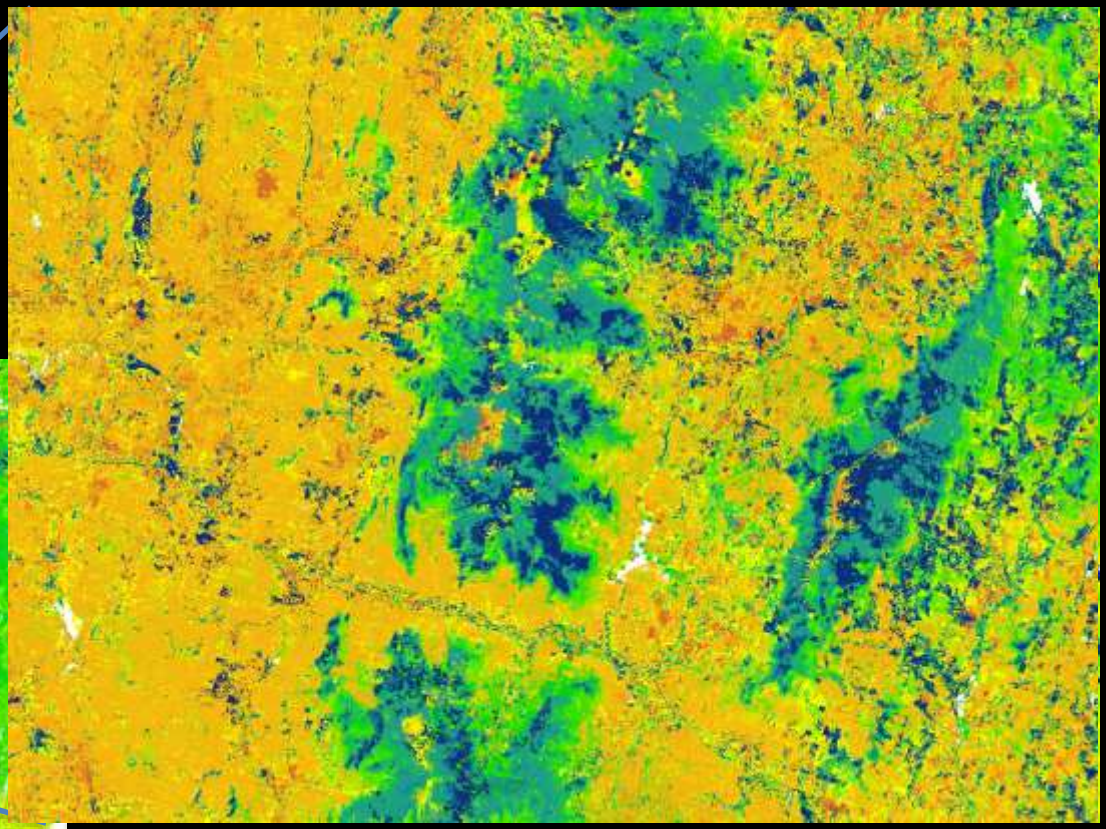
Scales of Phenology

Landsat "White" DOY

Pros: Accuracy Tested
Ecologically meaningful
30m resolution
20+ year archive

Cons: Spotty data coverage
Sensitive to missing dates



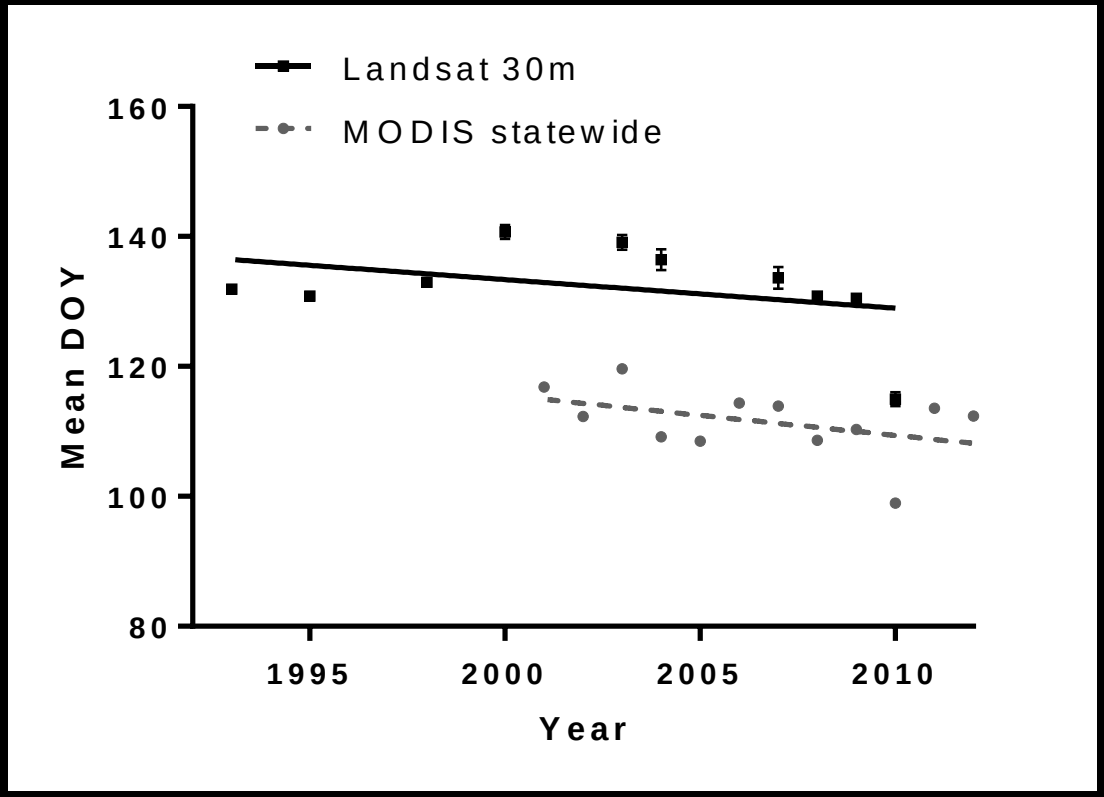


MODIS NDVI "SOST"

Pros: Complete coverage every year

Cons: Yearly coverage to 2001
250m resolution
no link to field metric
No accuracy assessment

Phenology Trends



Mean CHANGE in start of spring:

Landsat (N = 260)

(20 year partial assessment)

Slope = -0.40

P < 0.0001

73% of all pixels demonstrate a negative trend (earlier spring)

MODIS (N = 1000 statewide)

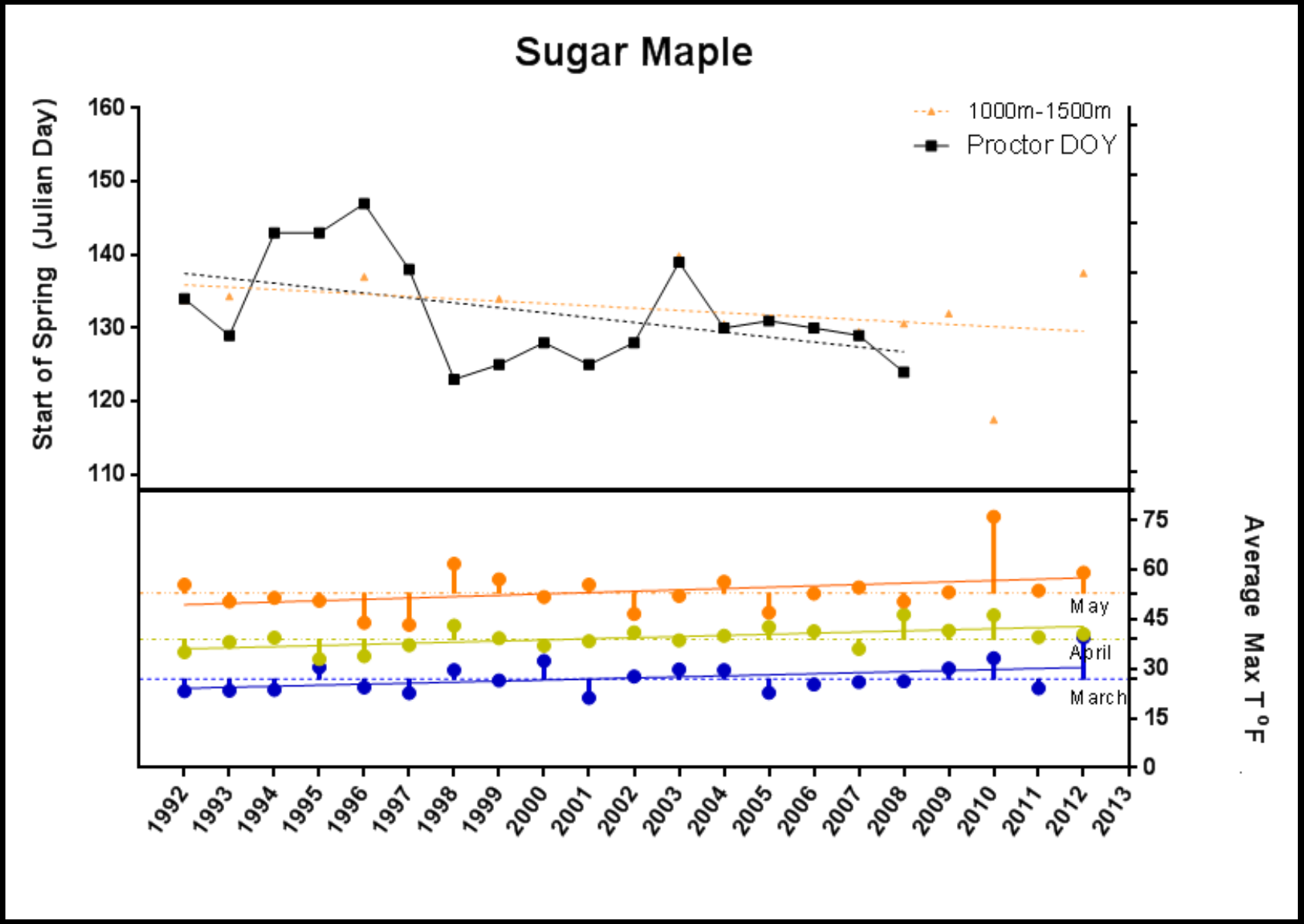
(11 year full assessment)

Slope = -0.63

P < 0.0001

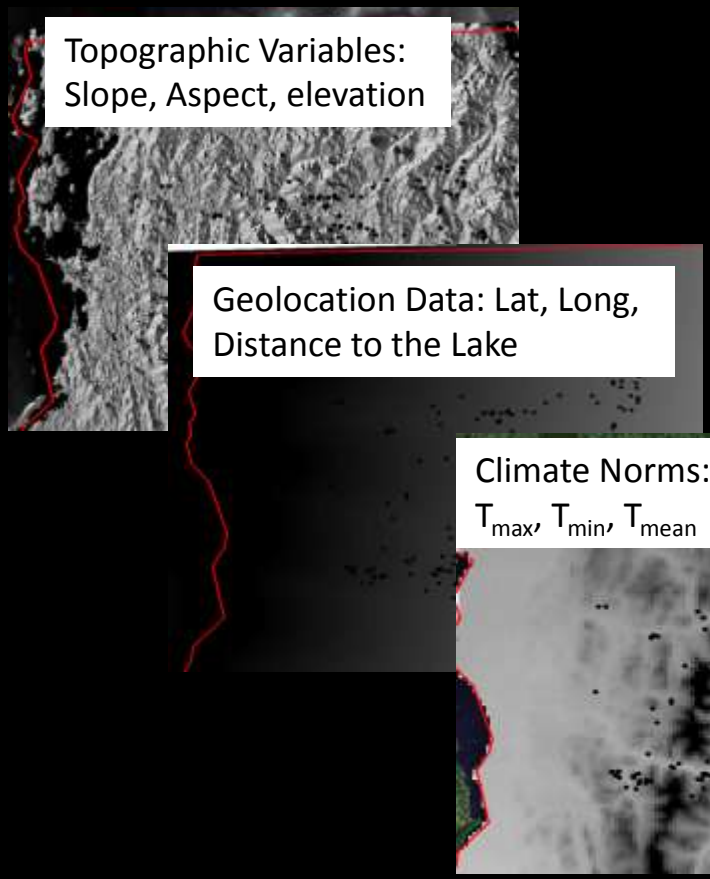
74% of all pixels demonstrate a negative trend (earlier spring)

Phenology Trends

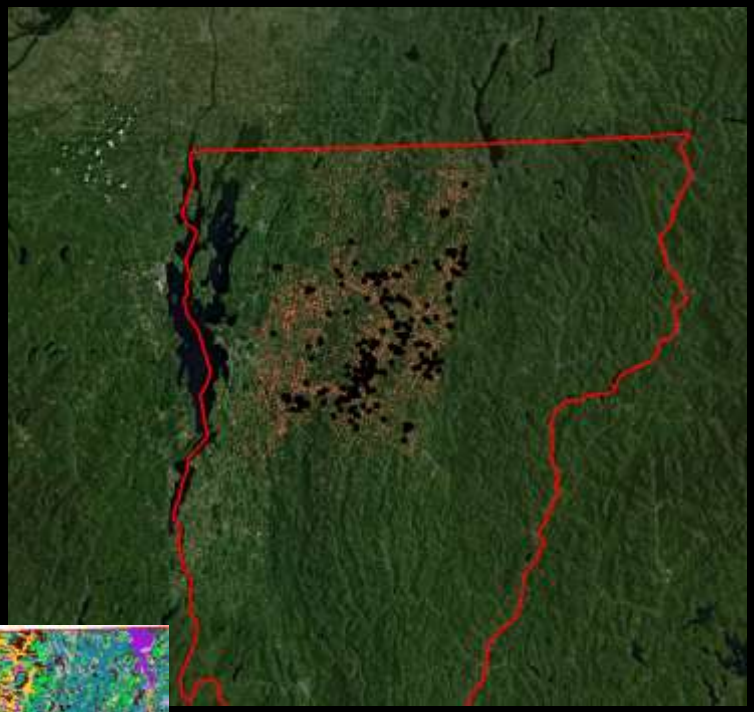


Changing Phenology Patterns

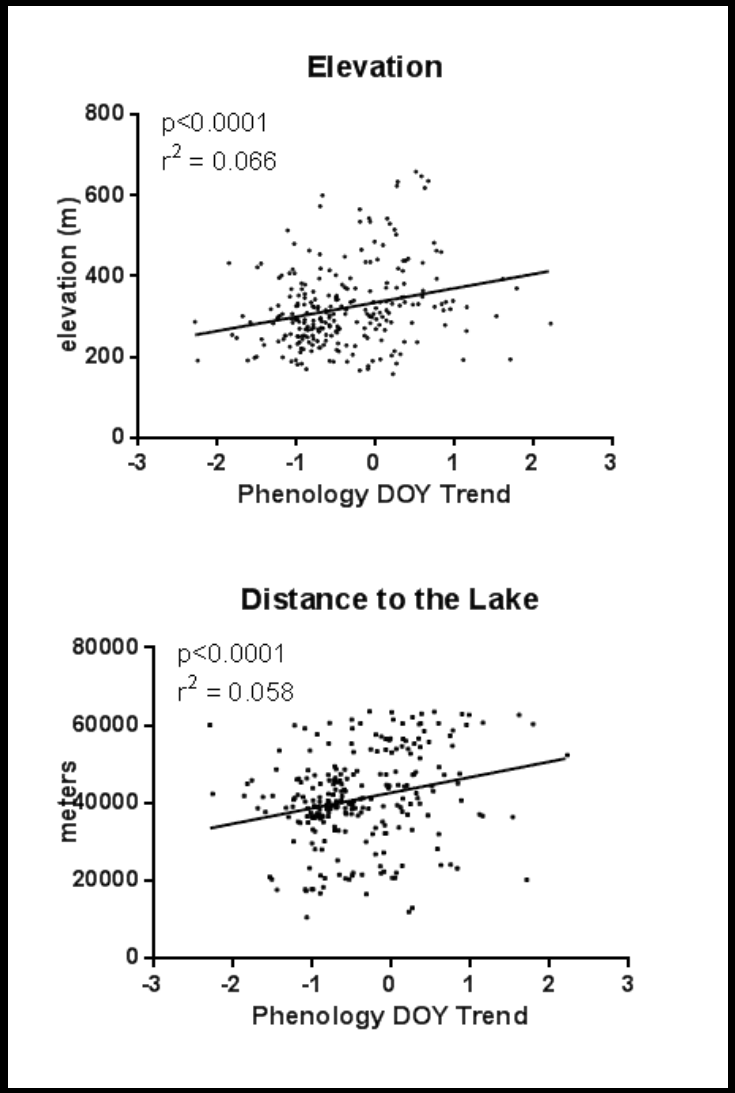
Static Environmental Variables

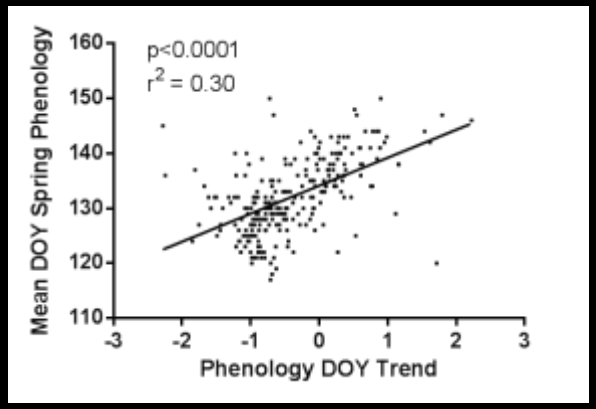


Random points with key years

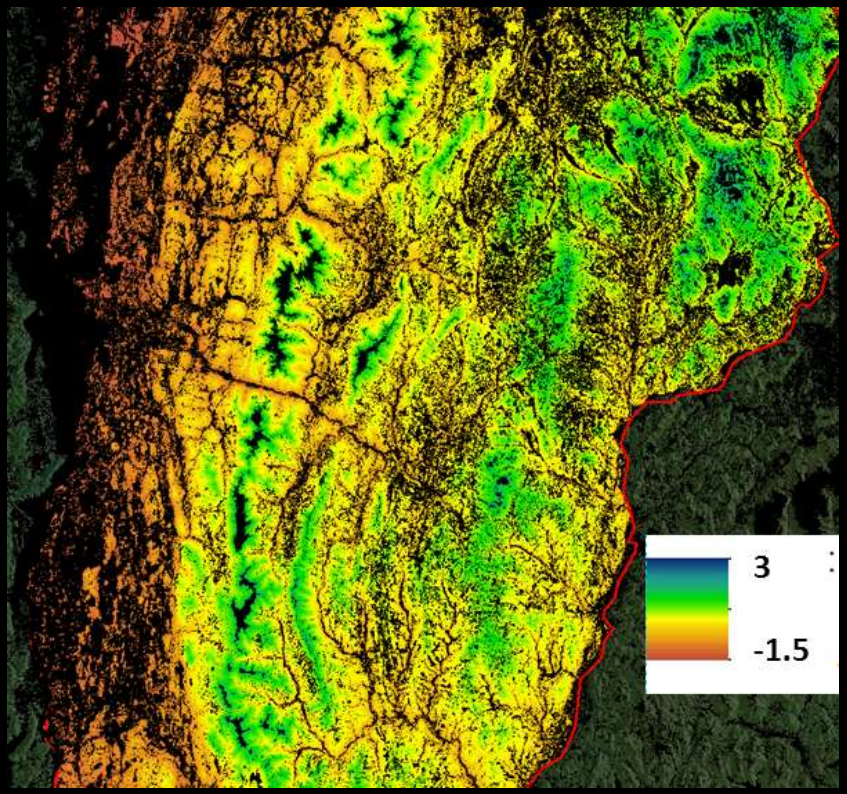


Landsat Changing Phenology Patterns

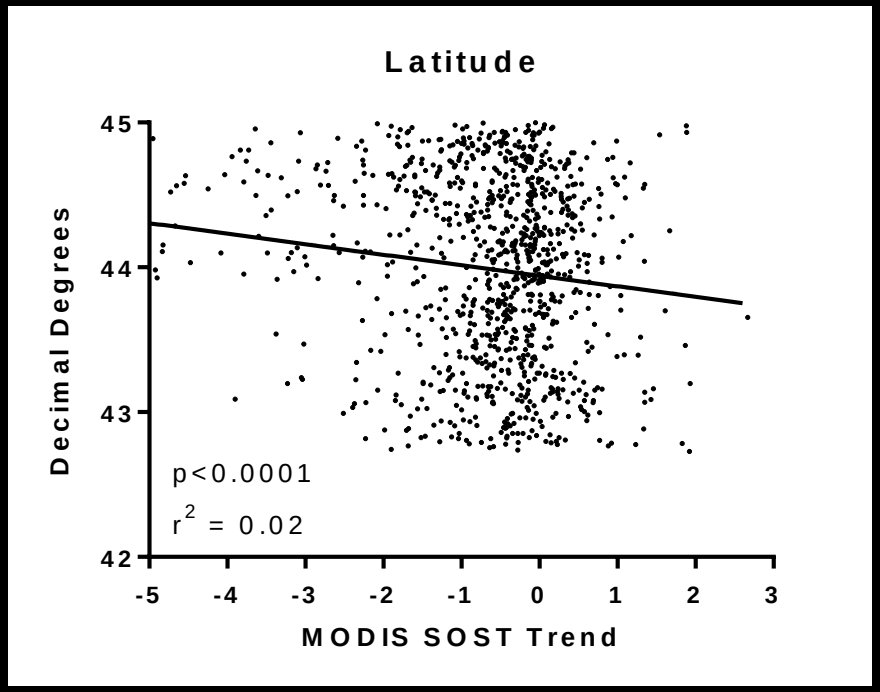




Elevation
Lake Distance
Soil “Forest Value”



MODIS Changing Phenology Patterns



Higher latitudes are associated with earlier spring

No other environmental variables were significant

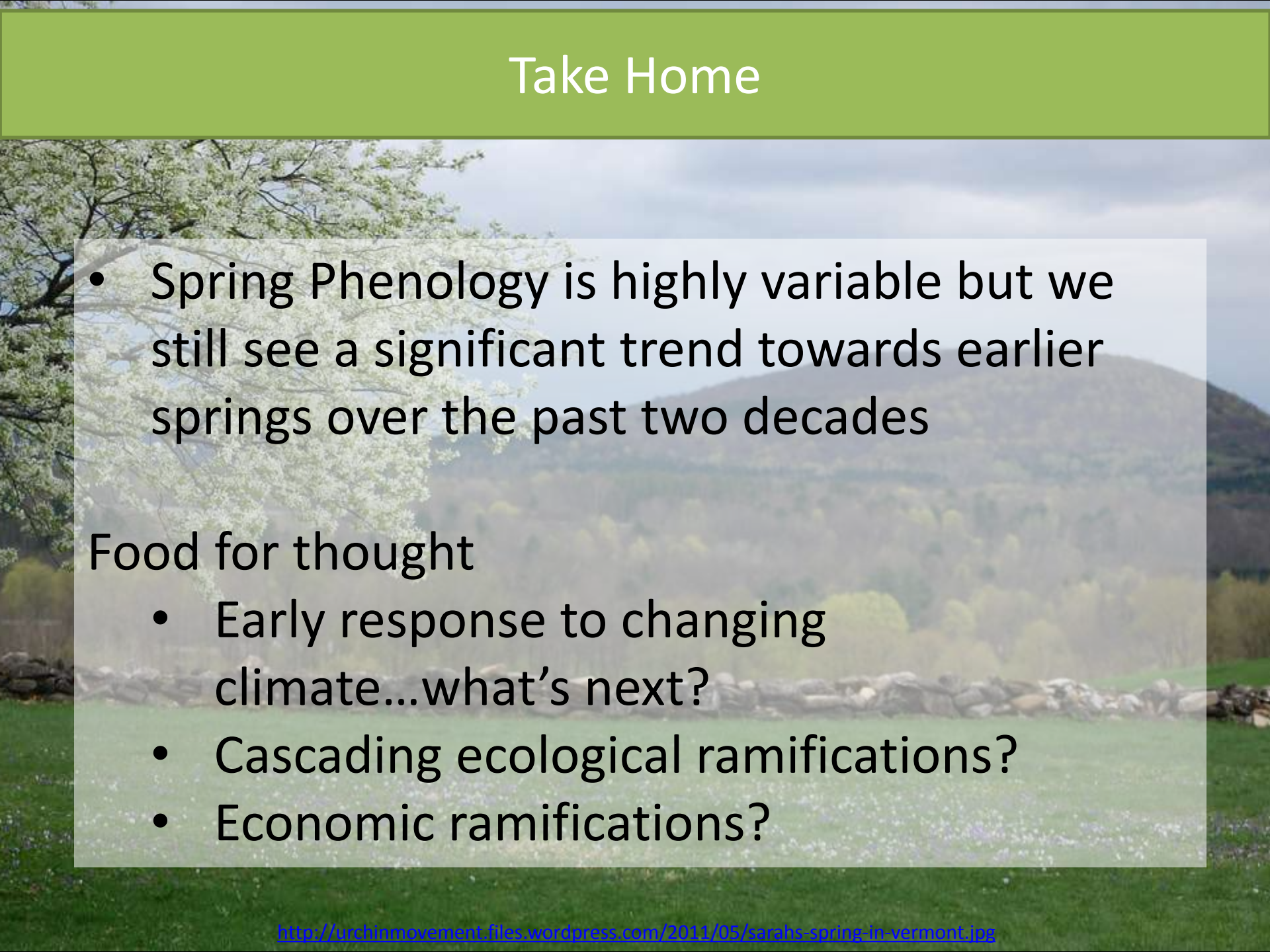
250m resolution may not adequately capture static environmental conditions for this type of analysis.

Take Home

- Spring Phenology is highly variable but we still see a significant trend towards earlier springs over the past two decades

Food for thought

- Early response to changing climate…what's next?
- Cascading ecological ramifications?
- Economic ramifications?



http://urchinmovement.files.wordpress.com/2011/05/sarahs-spring-in-vermont.jpg

Acknowledgements

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Vermont Monitoring Cooperative

Forests, Parks & Recreation Vermont

Northern Research Station
USDA Forest Service