

Mapping Forest Dynamics in the Southern Appalachians Using Landsat Imagery



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March 12, 2014 ♦ 12:20 pm ♦ PBB 160



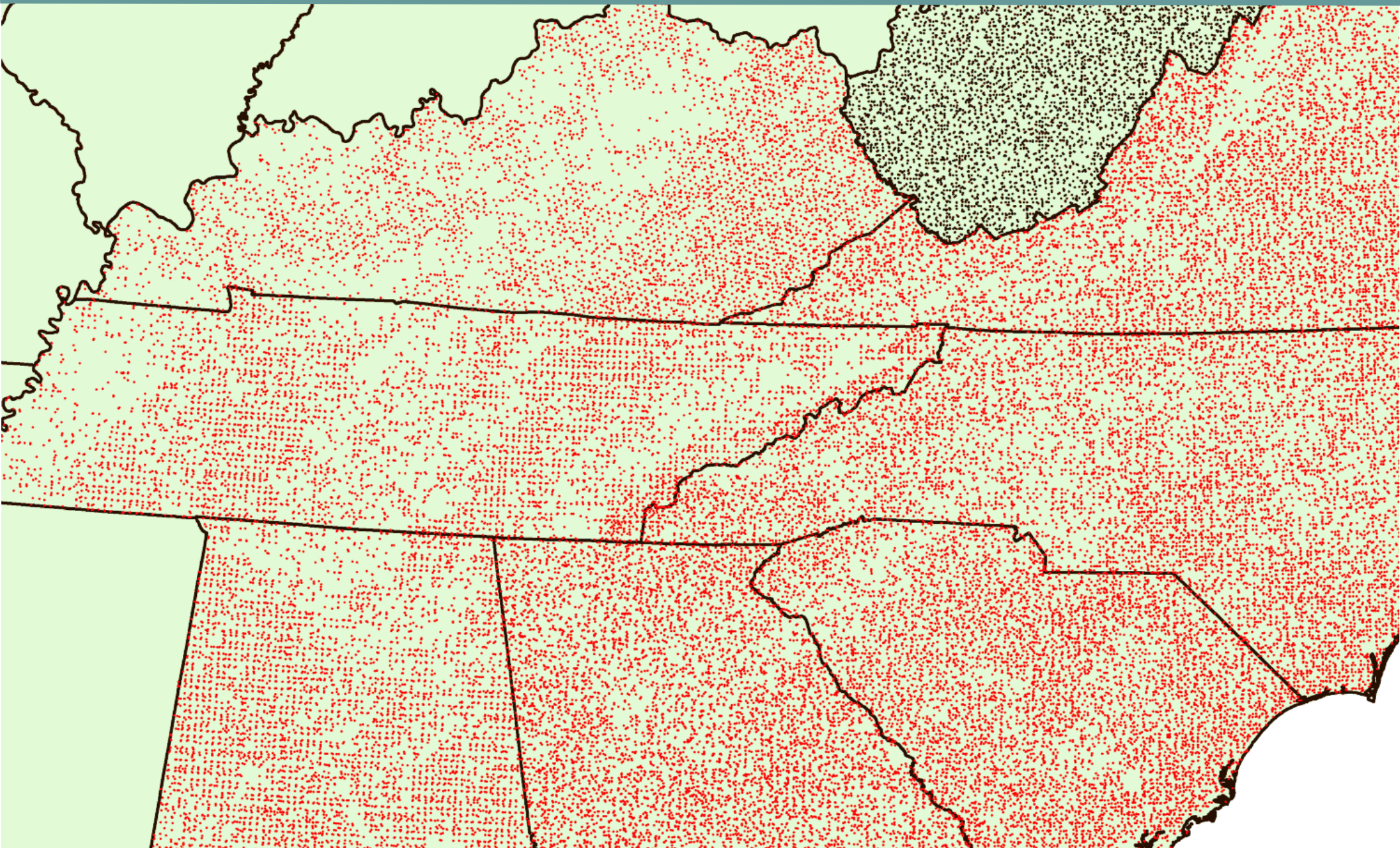
Stochastic disturbances like **fire, disease, and **insect** outbreaks create variation in forest mortality (Dale *et al.* 2001), leading to **instability** in **carbon sinks** over **large spatial scales** (Coomes *et al.* 2012)**

Mortality and **disturbance** are some of the **least represented** parts of terrestrial ecosystem models (Medvigy & Moorcroft 2012; Smith *et al.* 2012).

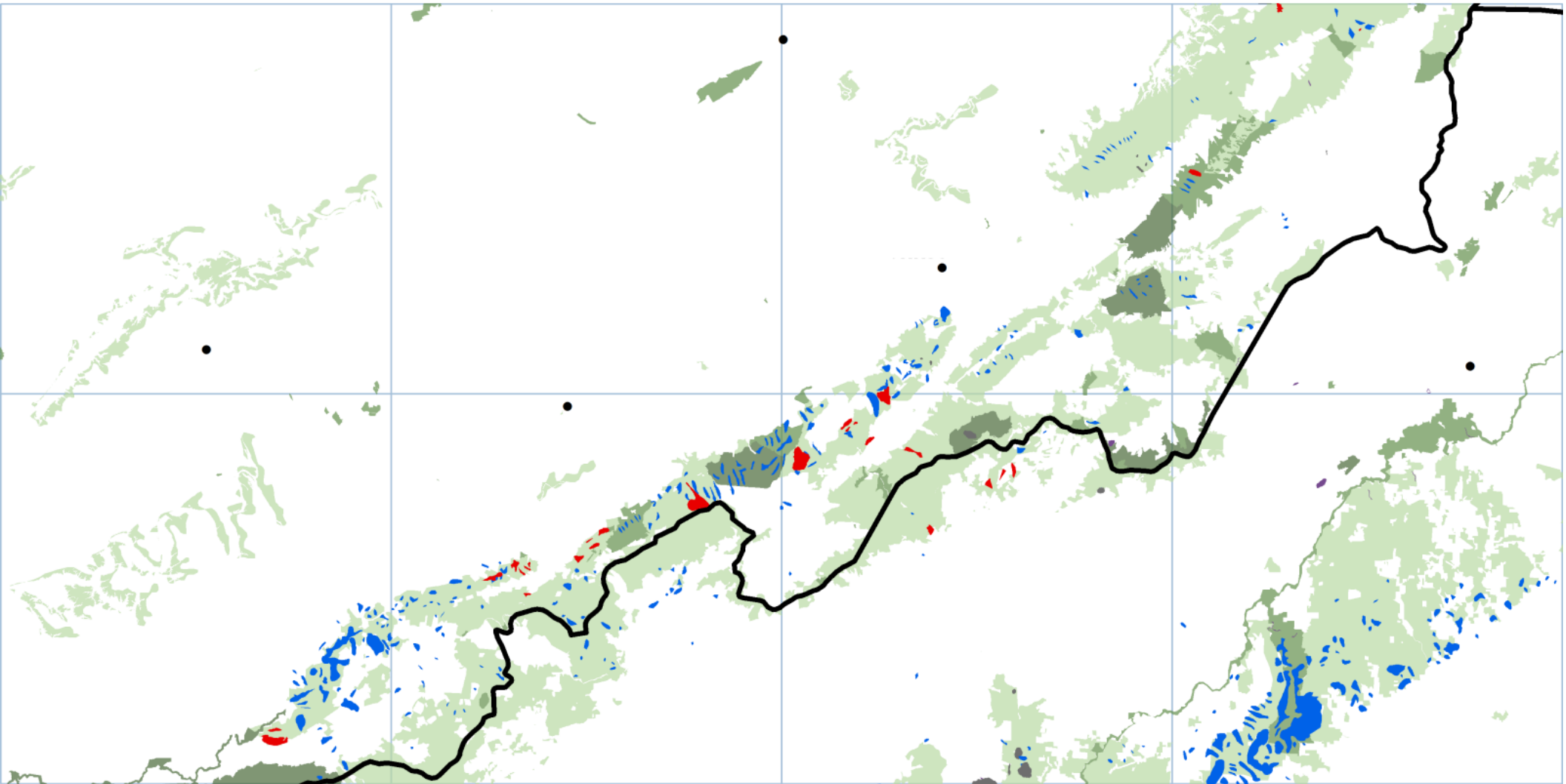
Carbon Cycle Models Need

- **Forest change estimates with high spatial and temporal resolution**
- **Estimates of disturbance severity, extent, & causal agent**
- **Length of recovery time and role of disturbance history**

Forest Inventory & Analysis



Aerial Insect and Disease Survey



9/24/2004



Image © 2014 DigitalGlobe

Google earth

Tour Guide

1997

Imagery Date: 9/24/2004 36°15'45.63" N 82°21'21.03" W elev 2990 ft eye alt 13915 ft

9/24/2004



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Tour Guide

1997

Imagery Date: 9/24/2004 36°15'45.63" N 82°21'21.03" W elev 2990 ft eye alt 13915 ft

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Tour Guide

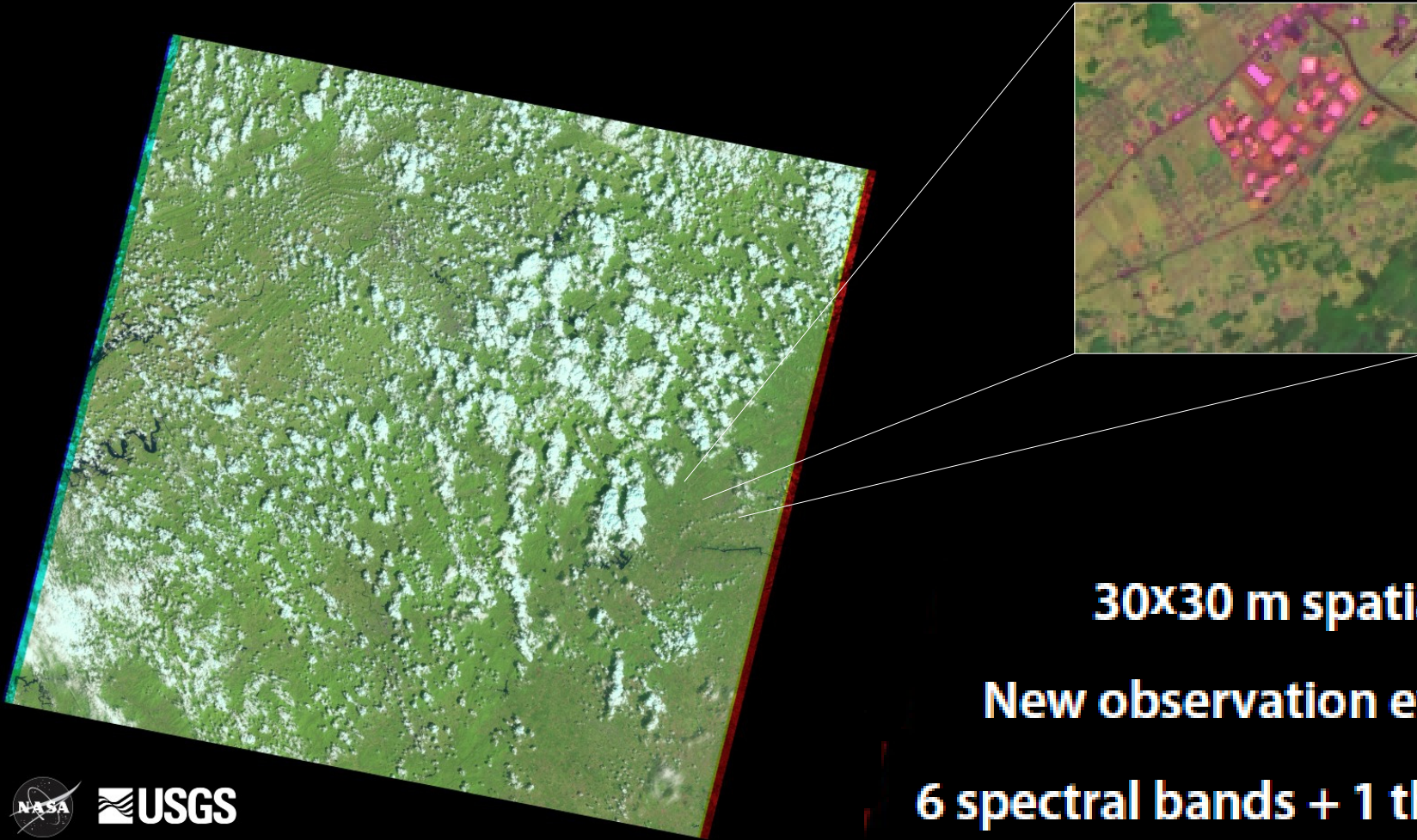
1997

Imagery Date: 9/24/2004 36°15'45.63" N 82°21'21.03" W elev 2990 ft eye alt 13915 ft

Vegetation Regeneration and Disturbance Estimation through Time

- Uses Landsat spectral data
- **Masks** clouds and shadows
- Generates weighted summertime composites for **each year 1984-2013**
- Uses vegetation index (like NDVI)
- **Find** disturbances, determine **when** they occur, and what the **causal agent** is.

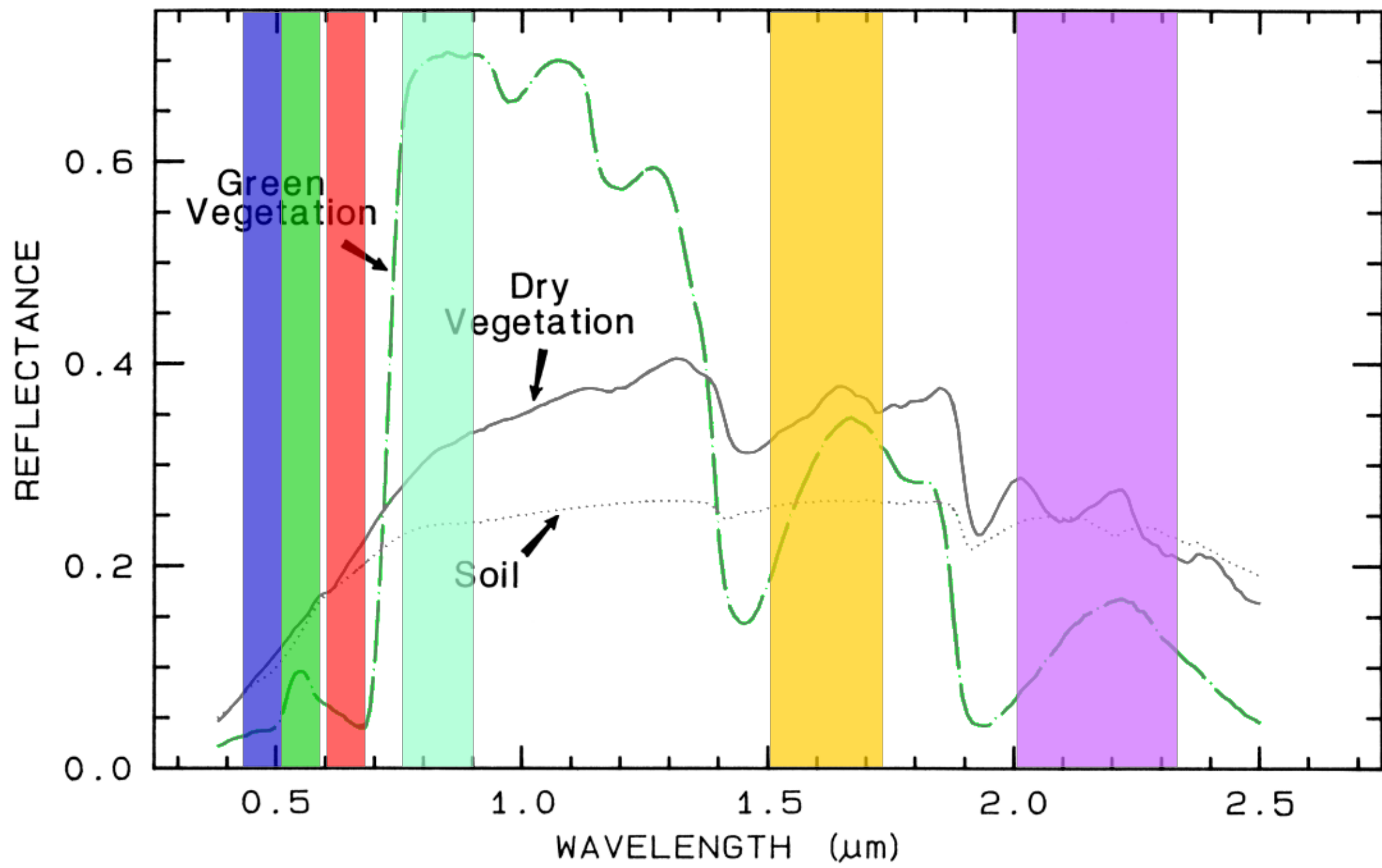
Landsat Thematic Mapper

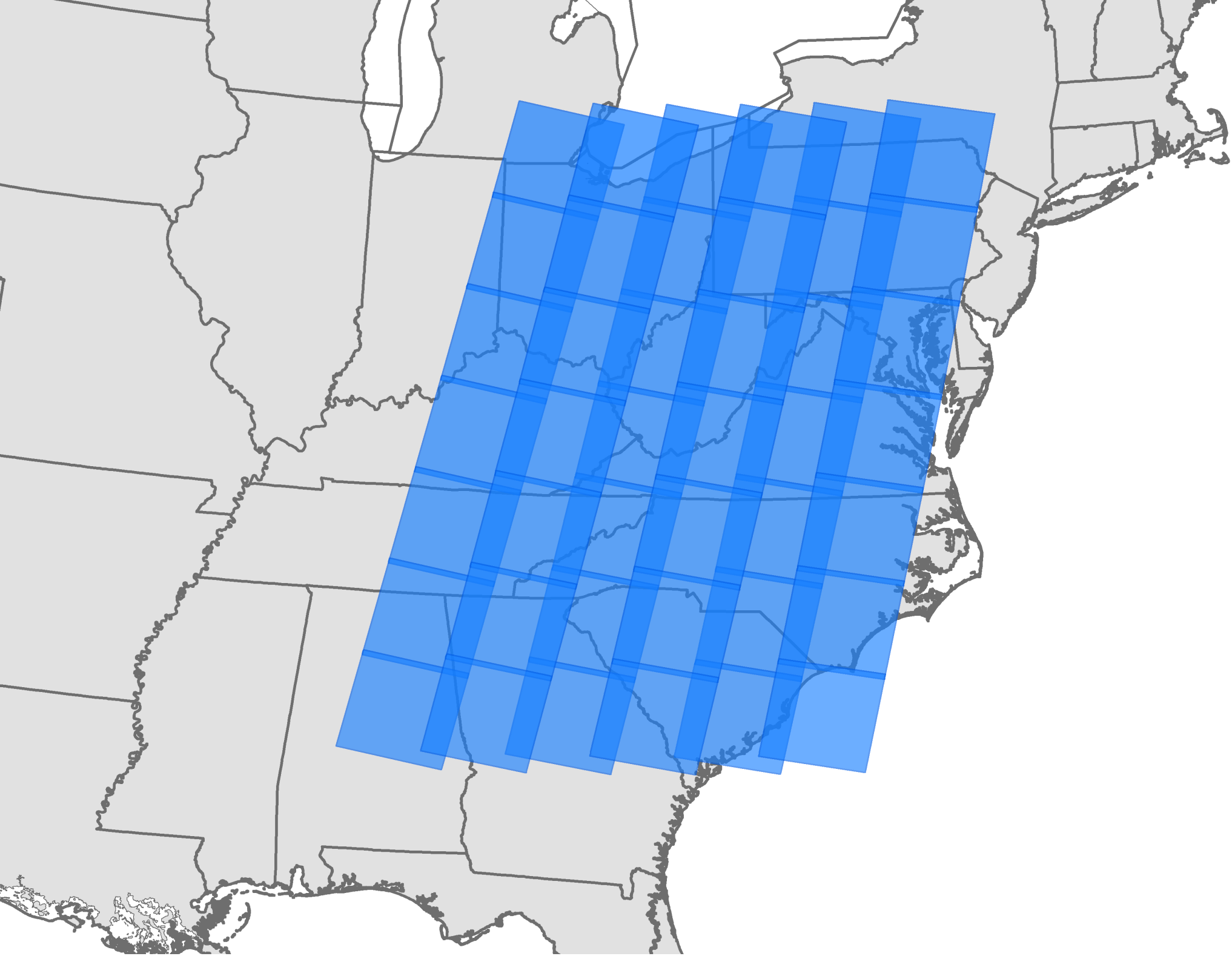


30x30 m spatial resolution

New observation every 16 days

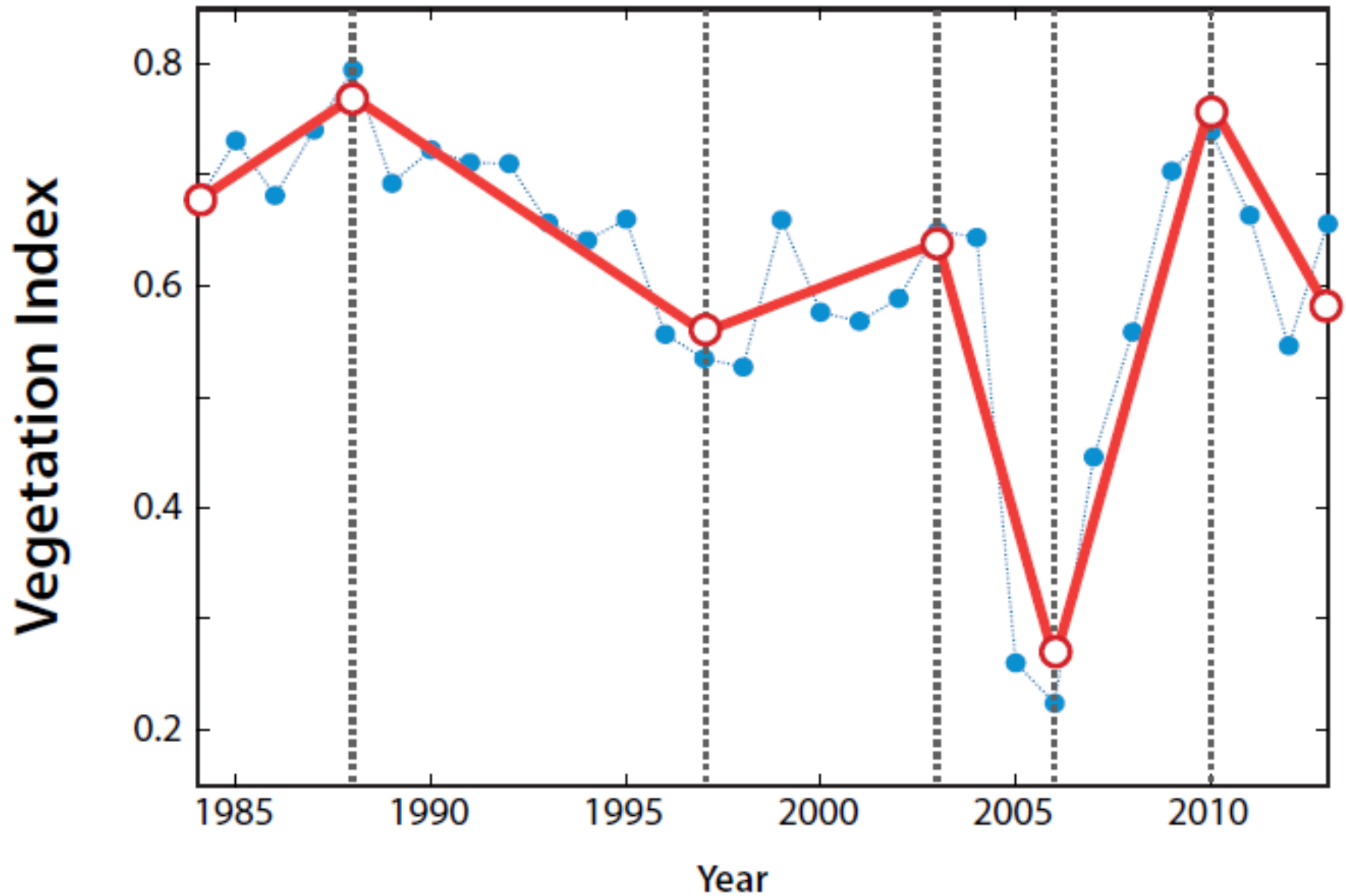
6 spectral bands + 1 thermal band



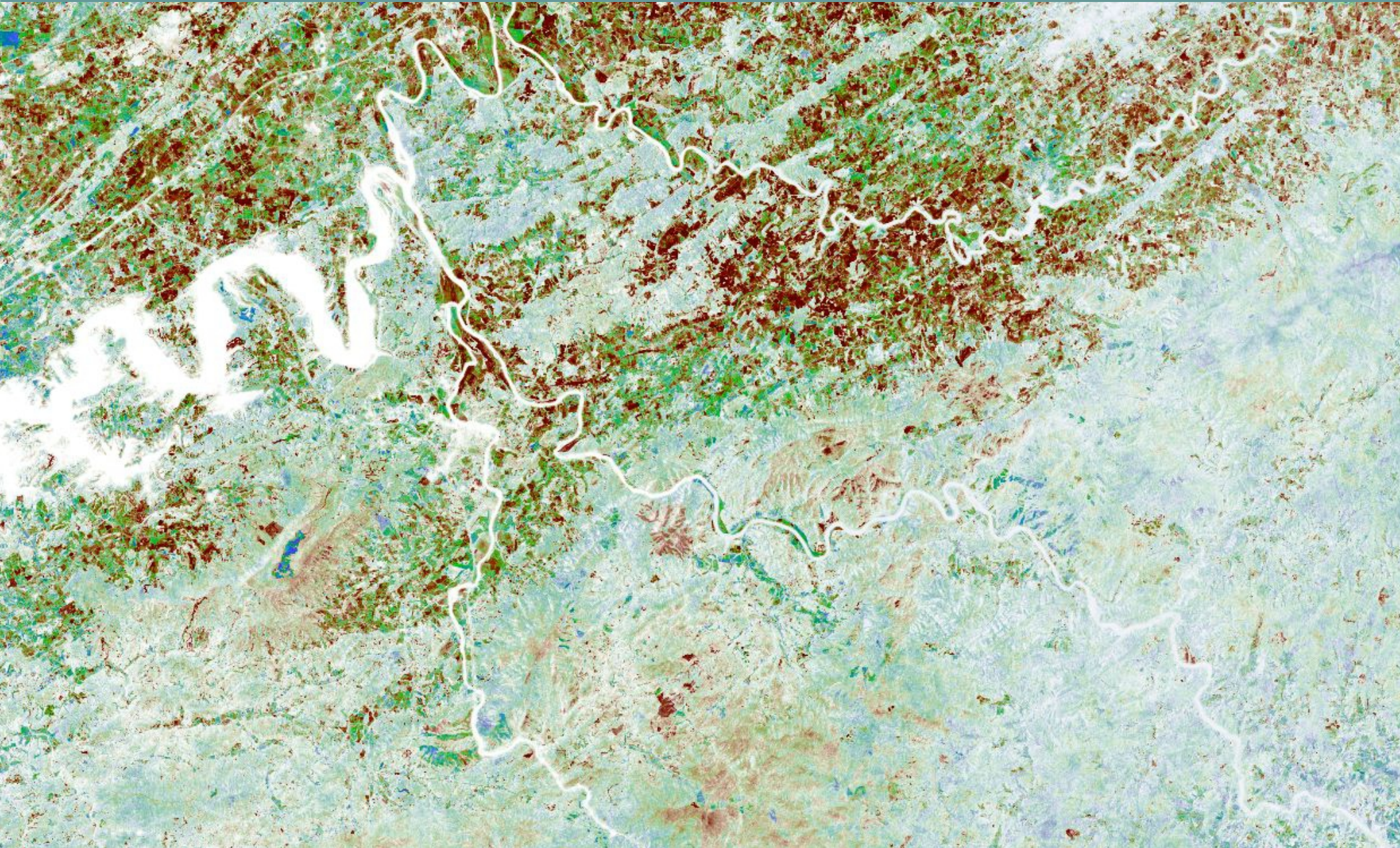




A forest pixel through time



Changescape



Research Objectives

(1) Ground-truth VeRDET

How accurate is the map?

Can VeRDET correctly identify years when land cover change occurs?

(2) Generate dataset of disturbance agents

Methods



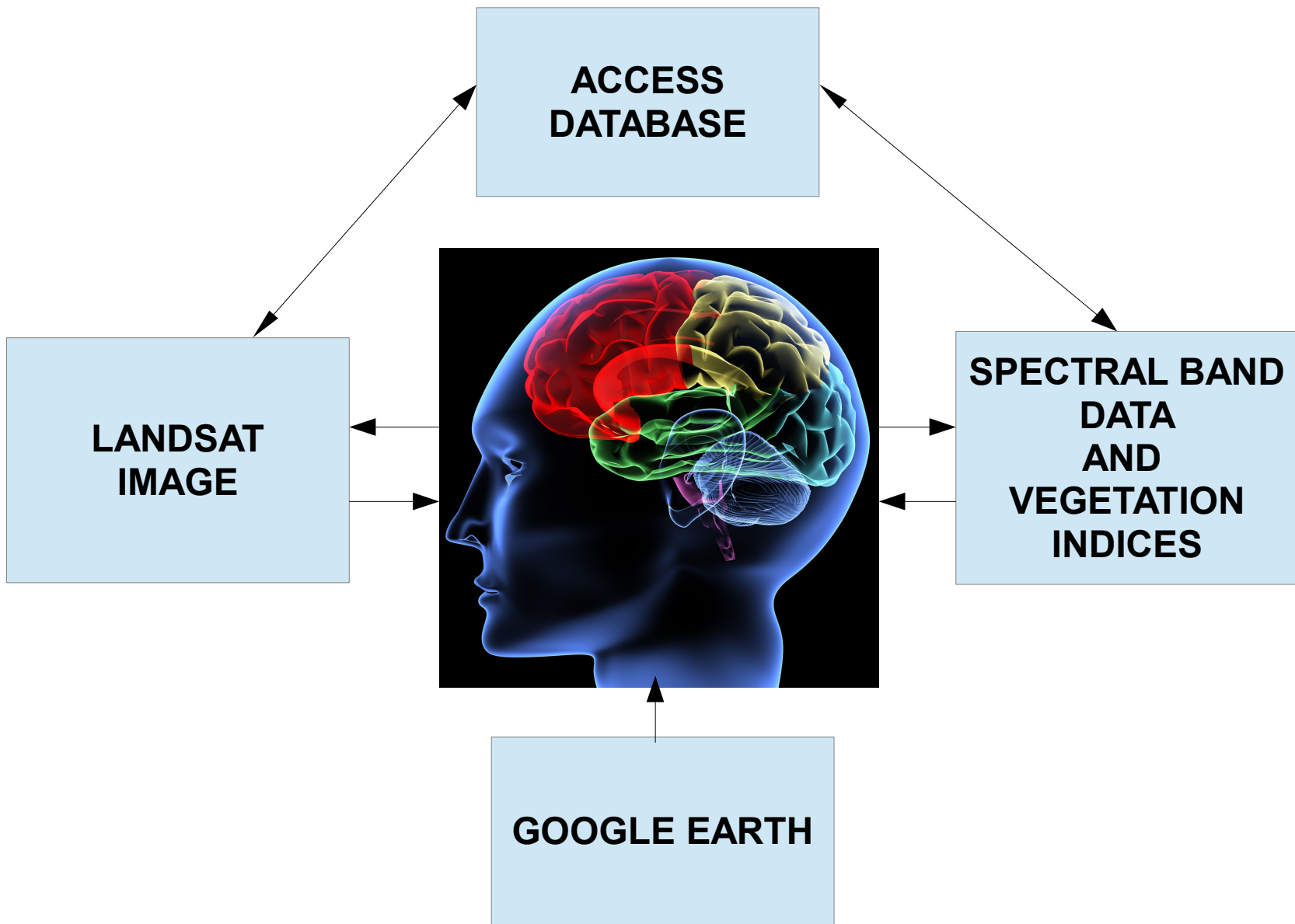
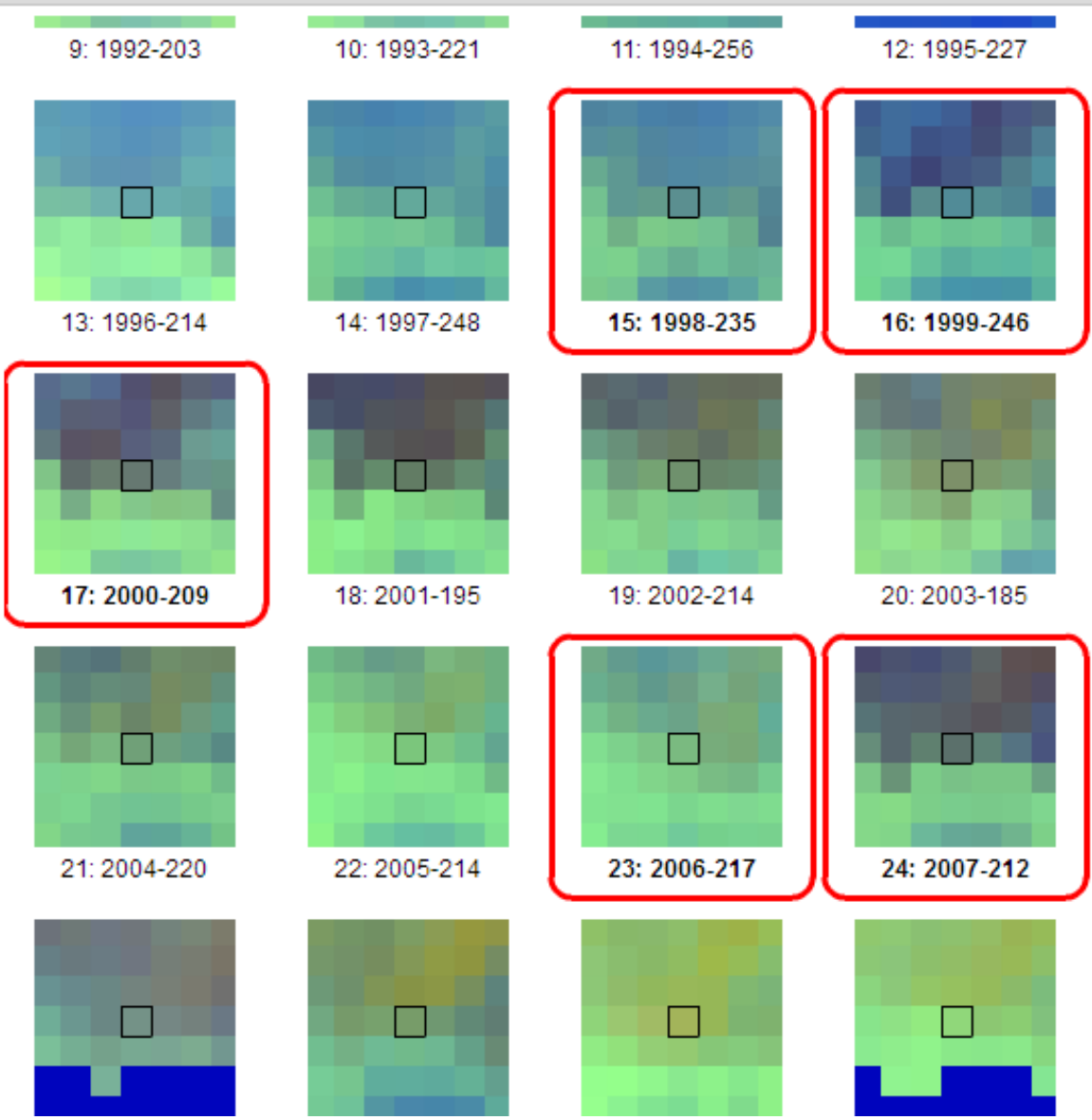


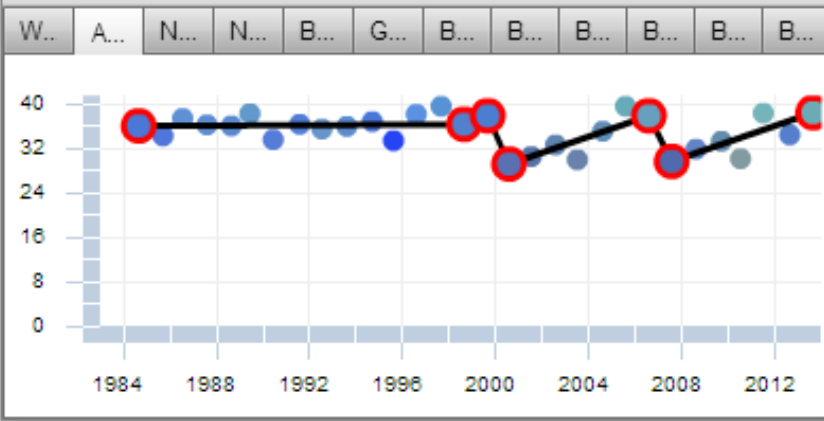
Figure adapted from Cohen, Yang & Kennedy 2010

Image Chip: Plot 103 Target Day: 215

History Chip QA Vertex Only



Trajectory Overlay



Segments Vertices

Start	End	Change Process	Ephemeral
1984-245	1998-235	Stable	<input type="checkbox"/>
1998-235	1999-246	Other disturbance	<input type="checkbox"/>
1999-246	2000-209	Disturbance	<input type="checkbox"/>

Comments Wetland Graphic example

- Uncertainty
- Vertex
 - Disturbance
 - Causal Agent
 - Land Use
 - Land Use Change

Insects

Navigation and history controls including a clock icon, search icons, a home icon, and a close icon. A timeline slider shows the current date as 9/18/2007, with a range from 1997 to 2012.

Map navigation controls including a north arrow, a compass, a street view pegman, and a vertical zoom slider.



Image USDA Farm Service Agency

Google earth

6/30/2011



Image © 2014 DigitalGlobe

Google earth

⤴ Tour Guide



1997 Imagery Date: 6/30/2011

36°06'34.15" N 82°31'41.11" W

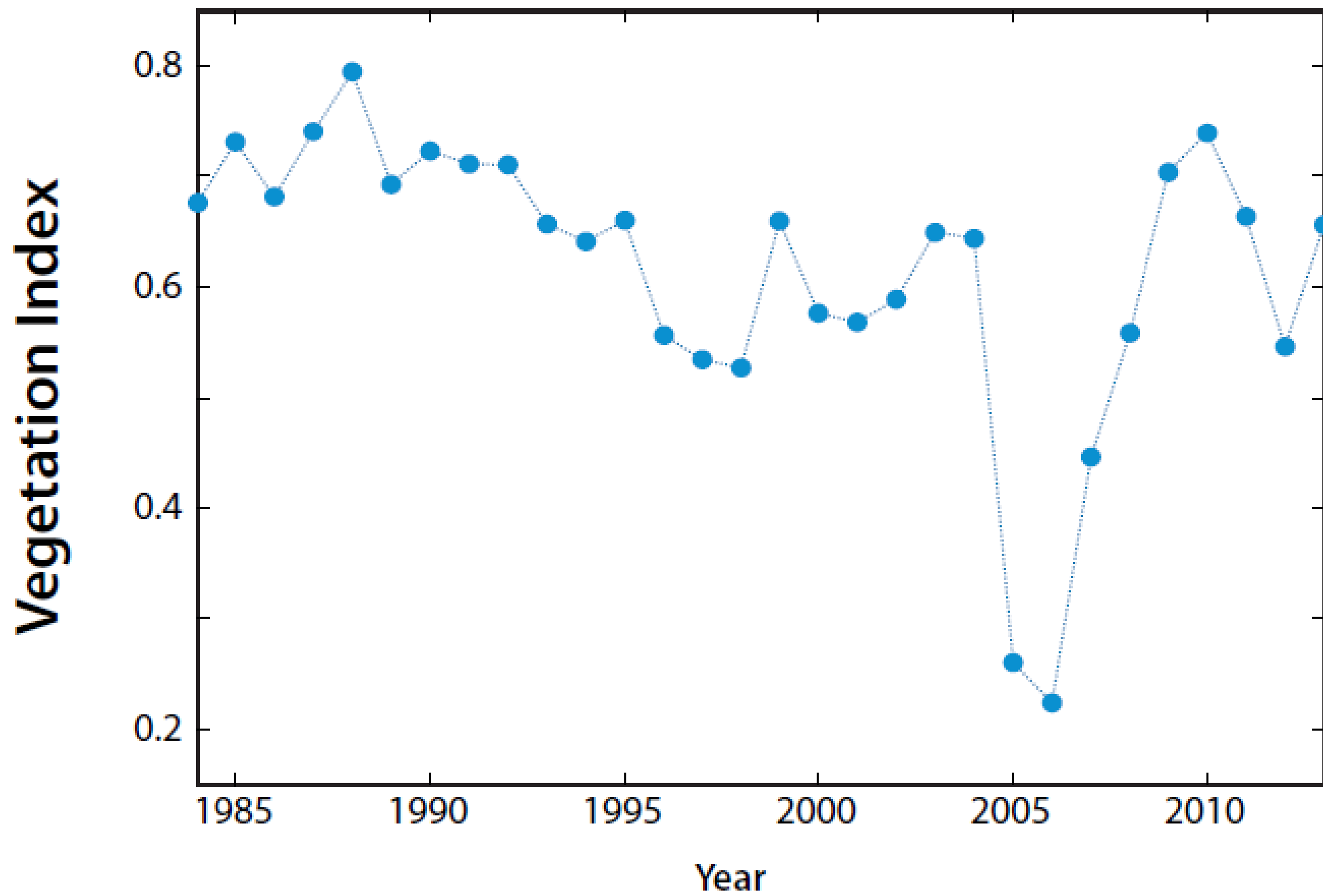
elev 2783 ft

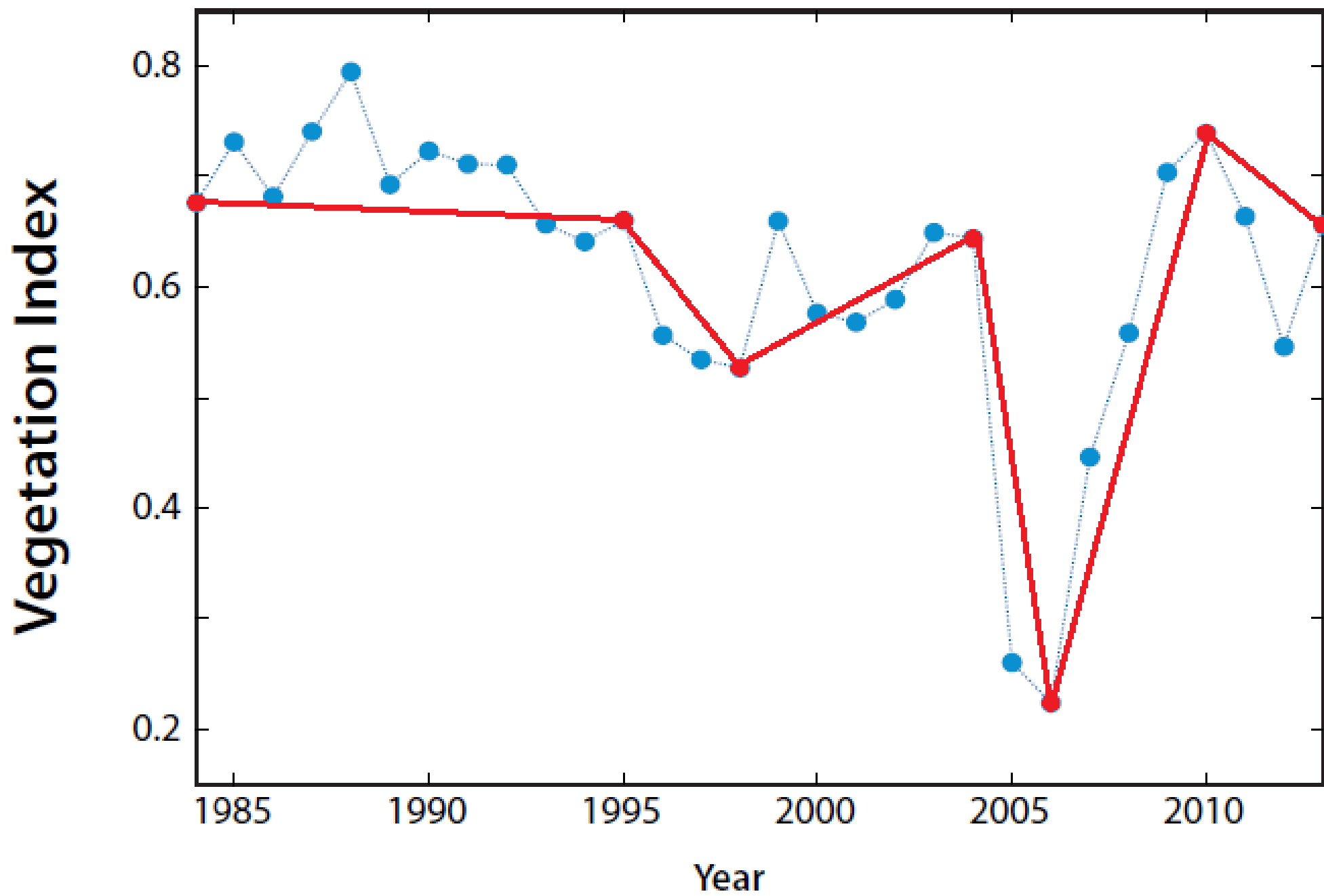
eye alt 6077 ft

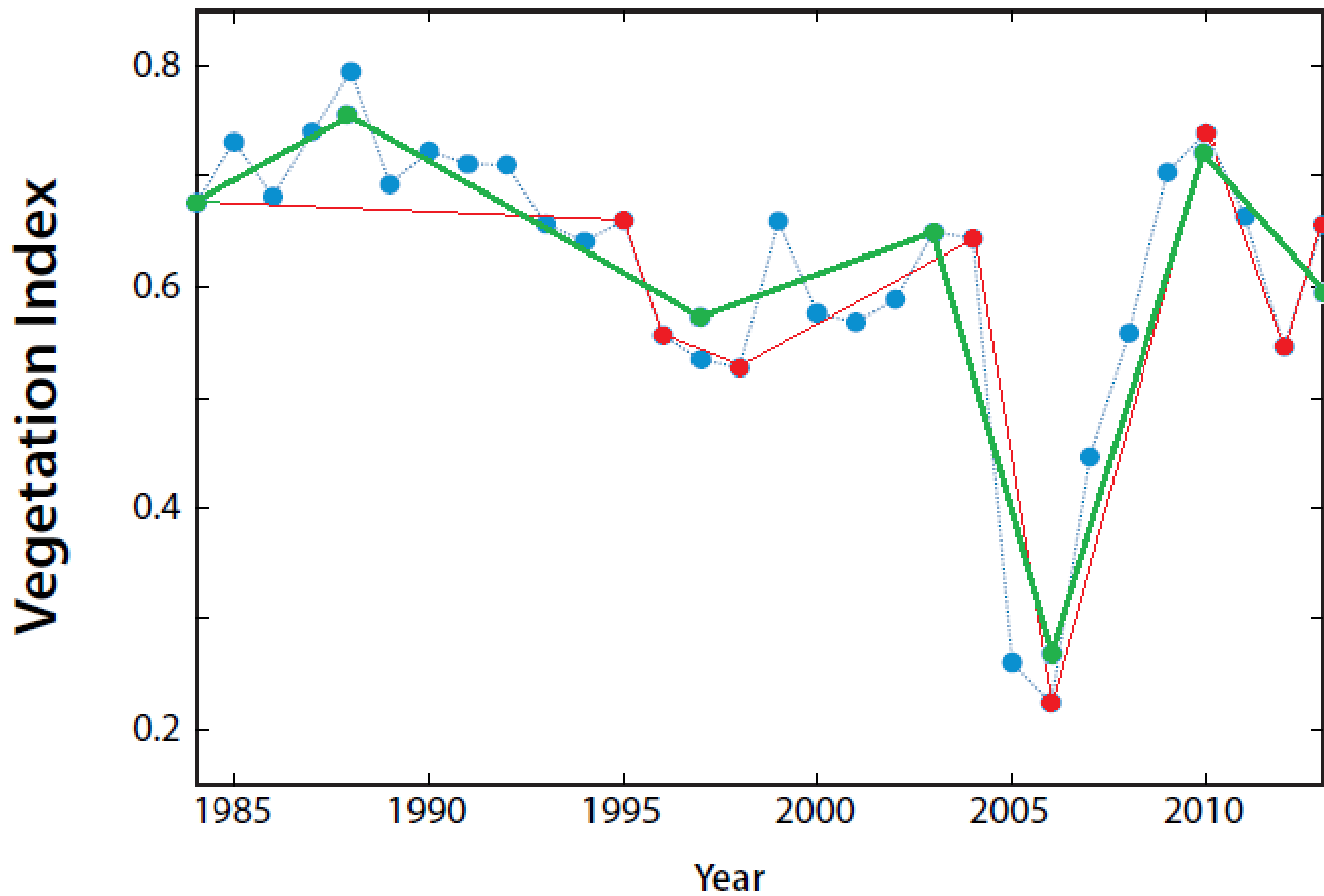


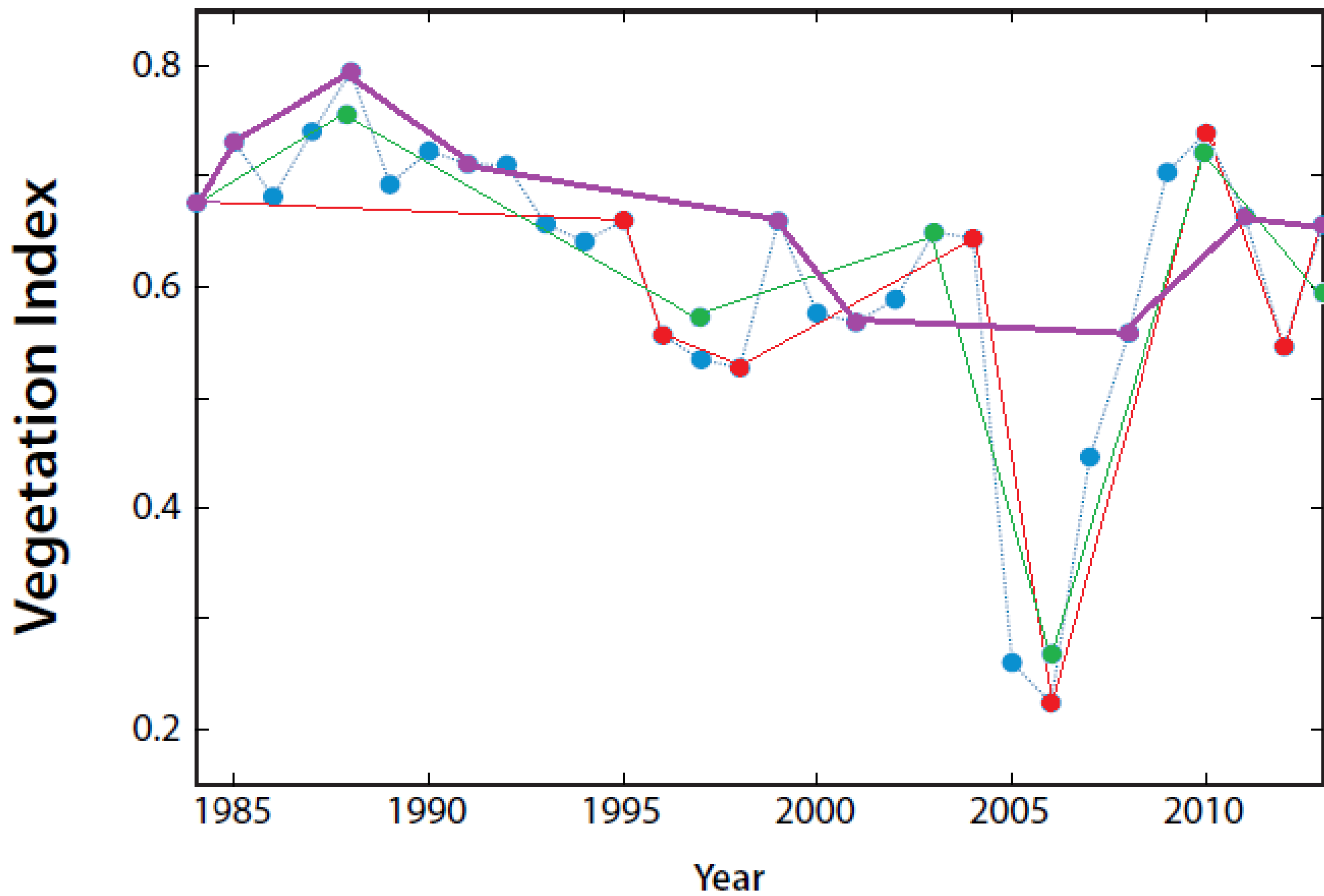
Data Analysis

- **310 stratified pixels**
- **Agreement between TimeSync and VeRDET for **times** of disturbance/recovery events**

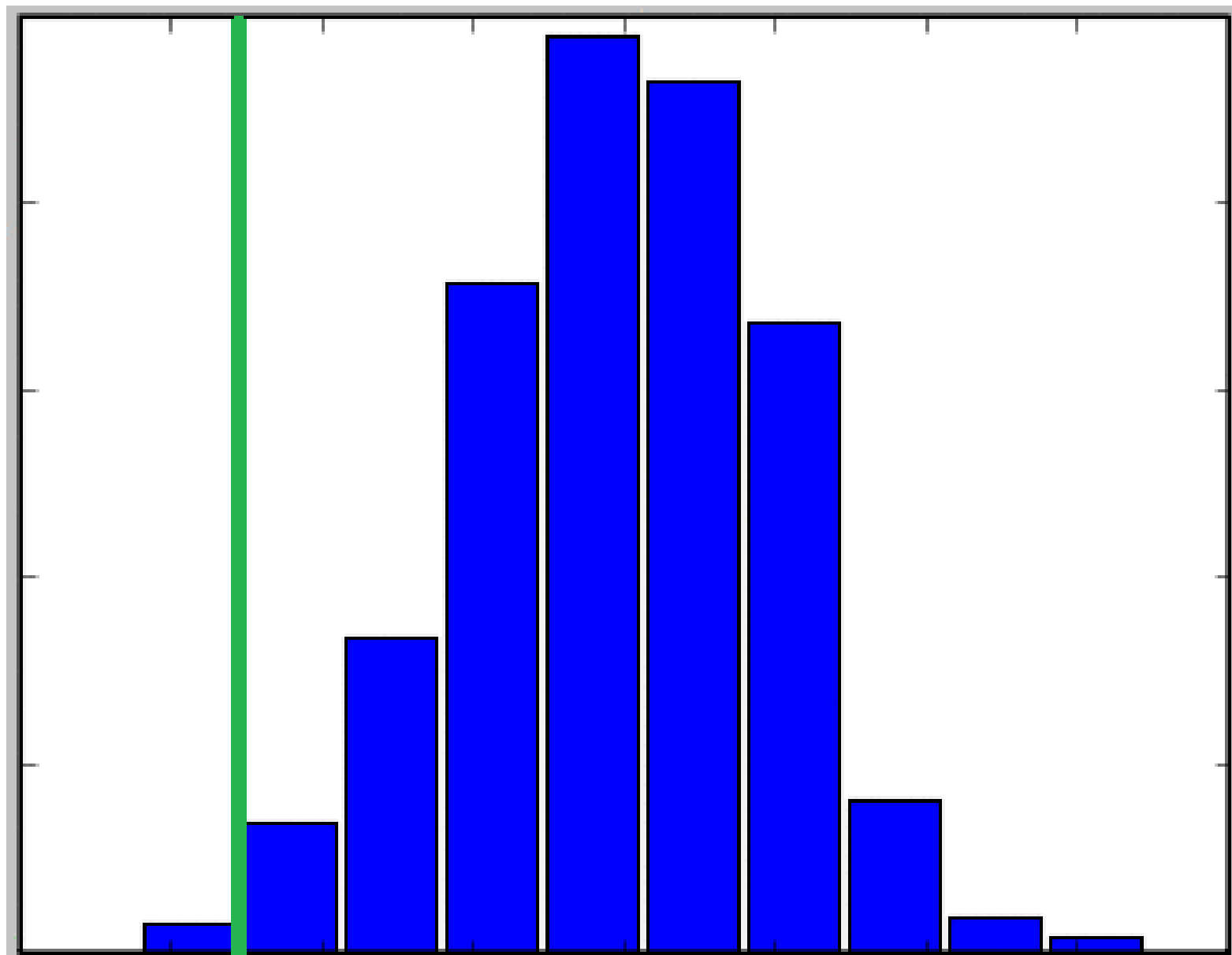








of Trends



0

Error

Large

Results



VeRDET

Vertex **No Vertex**

TimeSync

Vertex

32

55

87

No Vertex

64

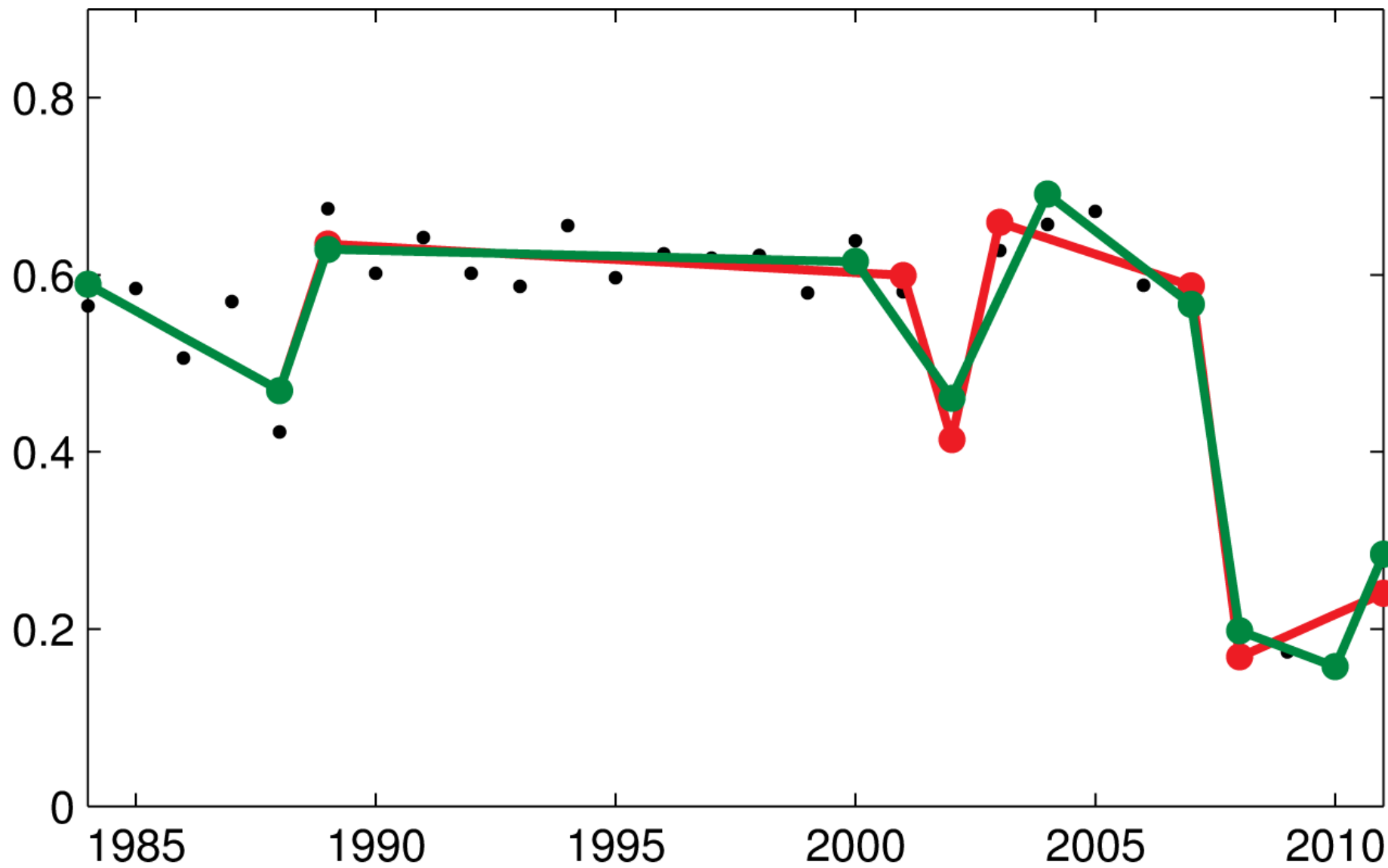
3177

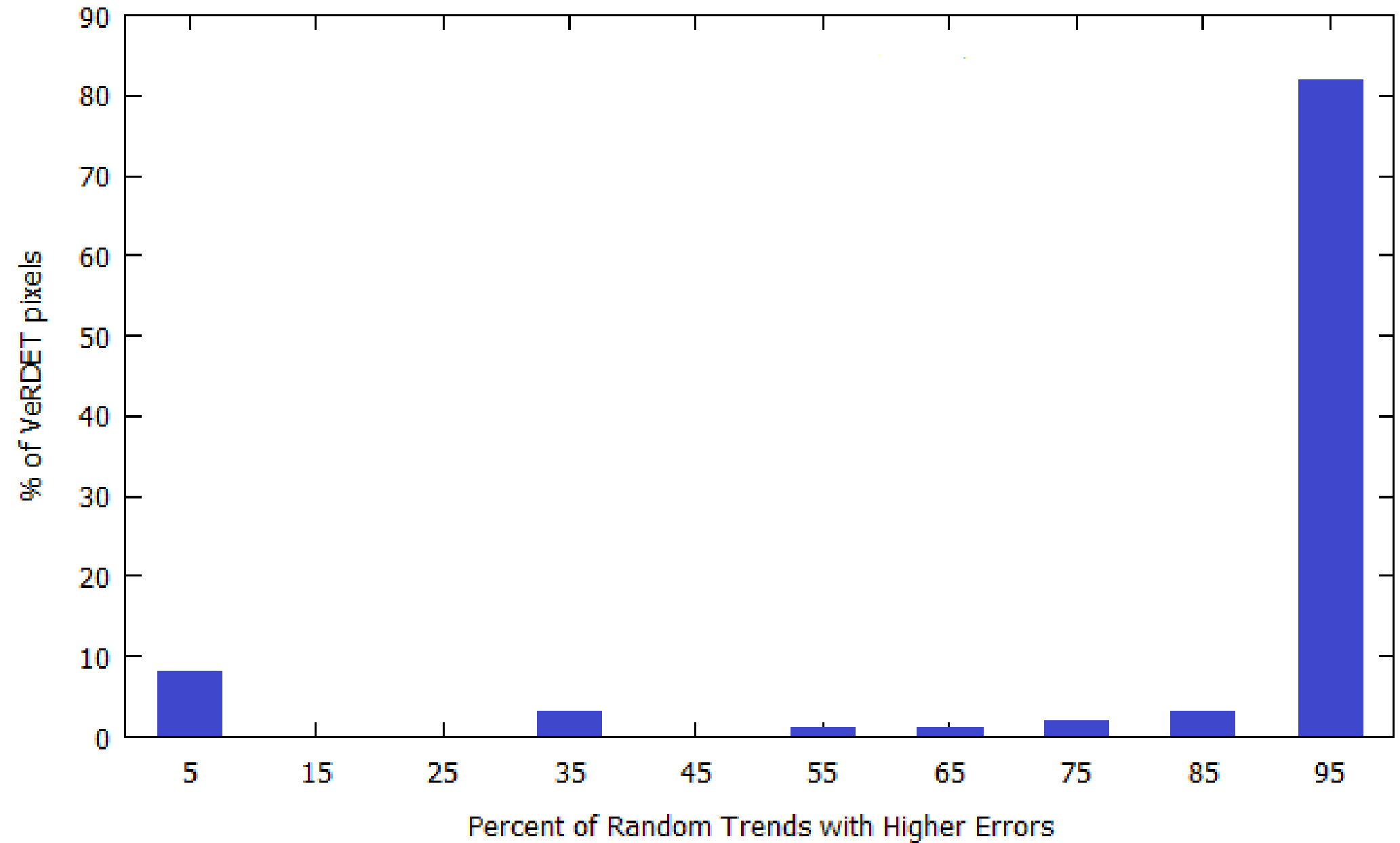
3232

96

3241

	Vertex	32	55
TimeSync	No Vertex	64	3177
		96	3241





Summary of Results

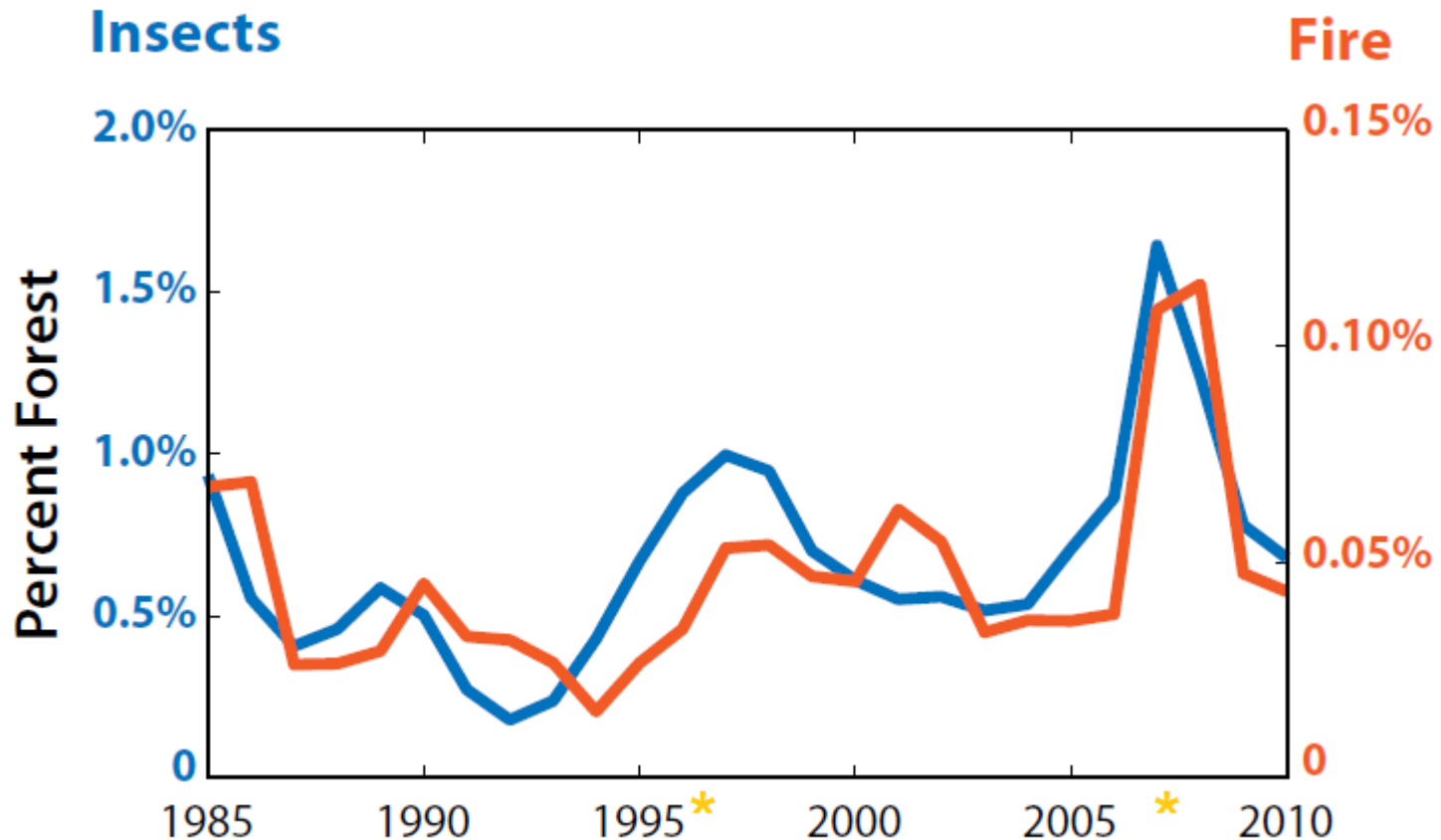
- **VeRDET finds more low intensity disturbances**
 - Human operator has a hard time picking between “noise” and smaller stress events
 - De-noising algorithm may need fine tuned
 - Agrees with Cohen *et al.* 2010
- **VeRDET tends to pick earlier dates of disturbance**
- **VeRDET is a good automated method of tracking land cover changes through time**

Discussion

- **Are disturbances becoming more frequent in eastern forests?**
 - **Vanderwel *et al.* 2013: Uses FIA data--No**
 - **Williams et al 2013: Uses Landsat--Yes**

Discussion

- We see a coupling of insect and drought and fires (Simard *et al.* 2011, Lynch 2006)



Discussion

- **Data from this study is going to help parametrize a continental scale C model.**
- **Compare disturbance regimes across protected areas.**

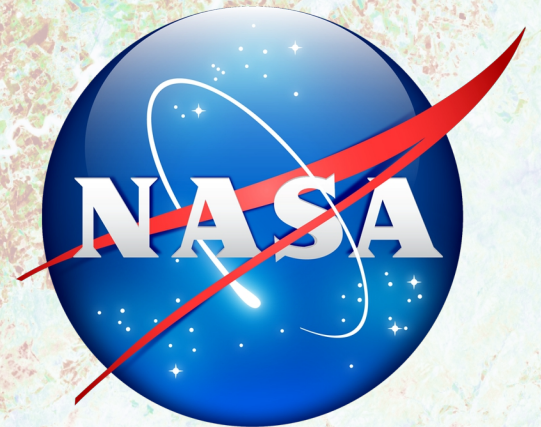
Acknowledgments



Dr. Dan Hayes



Joe Hughes



Dr. Warren Cohen



References

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References

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- *HWA and SPB disturbance images courtesy of the US Forest Service.*

8/2010

N



Image USDA Farm Service Agency

Google earth

⤴ Tour Guide



1991 Imagery Date: 4/9/2010 36°04'46.56" N 83°04'01.44" W elev 1259 ft eye alt 4540 ft