# *CHARACTERIZING FOREST CHANGE –*

# *A NATIONALLY CONSISTENT DATASET FROM LANDSAT*

Karen Schleeweis, RMRS FIA, Ogden

kgschleeweis@fs.fed.us

2017 FIA User Group Meeting April 4th & 5th Madison, WI

*a vision*

*moving from individual research*

*operationalizing and producing national products*

*a vision*

*moving from individual research*

*operationalizing and producing national products*

North American Forest Dynamics Research Project (NAFD)

Science into Applications

What products ?

What role ?

What data management ?

NAFD: A 25-year History of US Forest Disturbances

# Reducing Spatial and Temporal Uncertainty in Forest Disturbance Estimates for Carbon Science

2017 FIA User Group Meeting April 4th & 5th Madison, WI

# NAFD: A 25-year History of US Forest Disturbances

from VCT

No change classes
- Persisting Nonforest
- Persisting Forest
- Water

Disturbance year classes
- Pre observation
- 1985
- 1986
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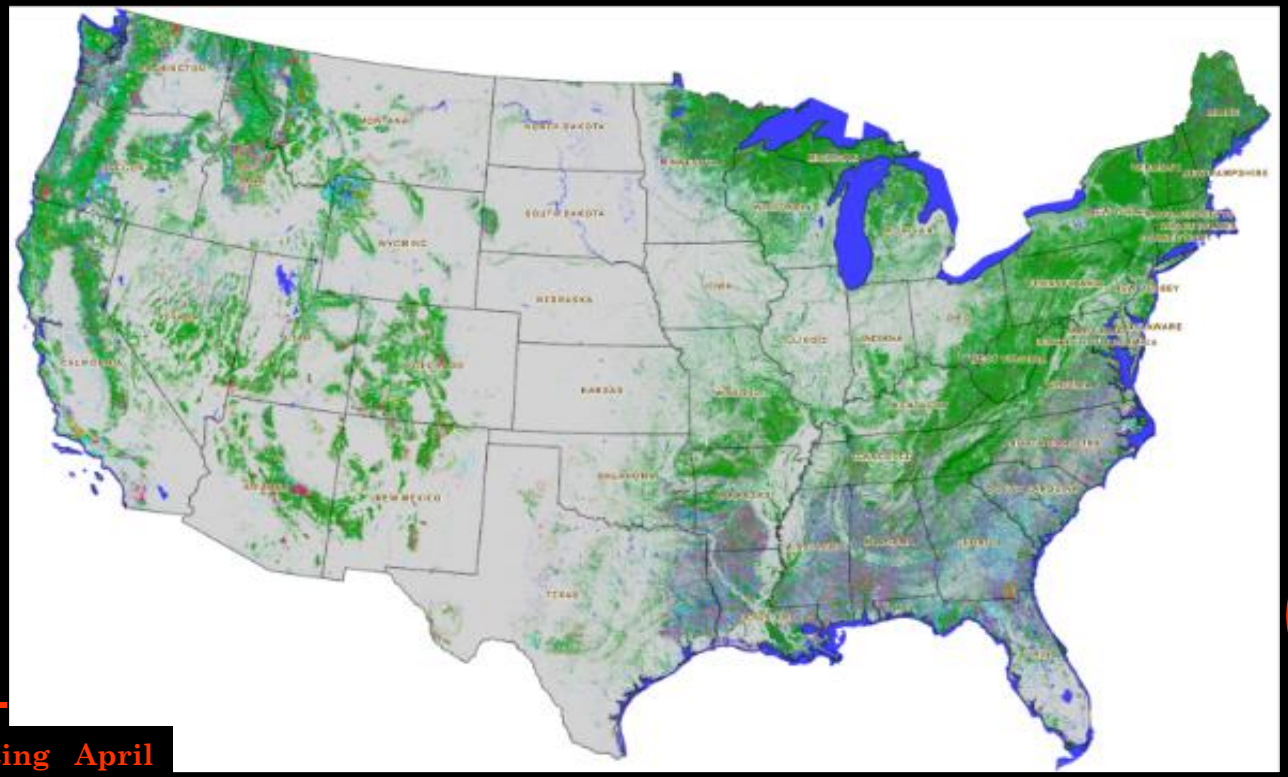

# North American Forest Dynamics-NASA Earth eXchange (NAFD-NEX) Product

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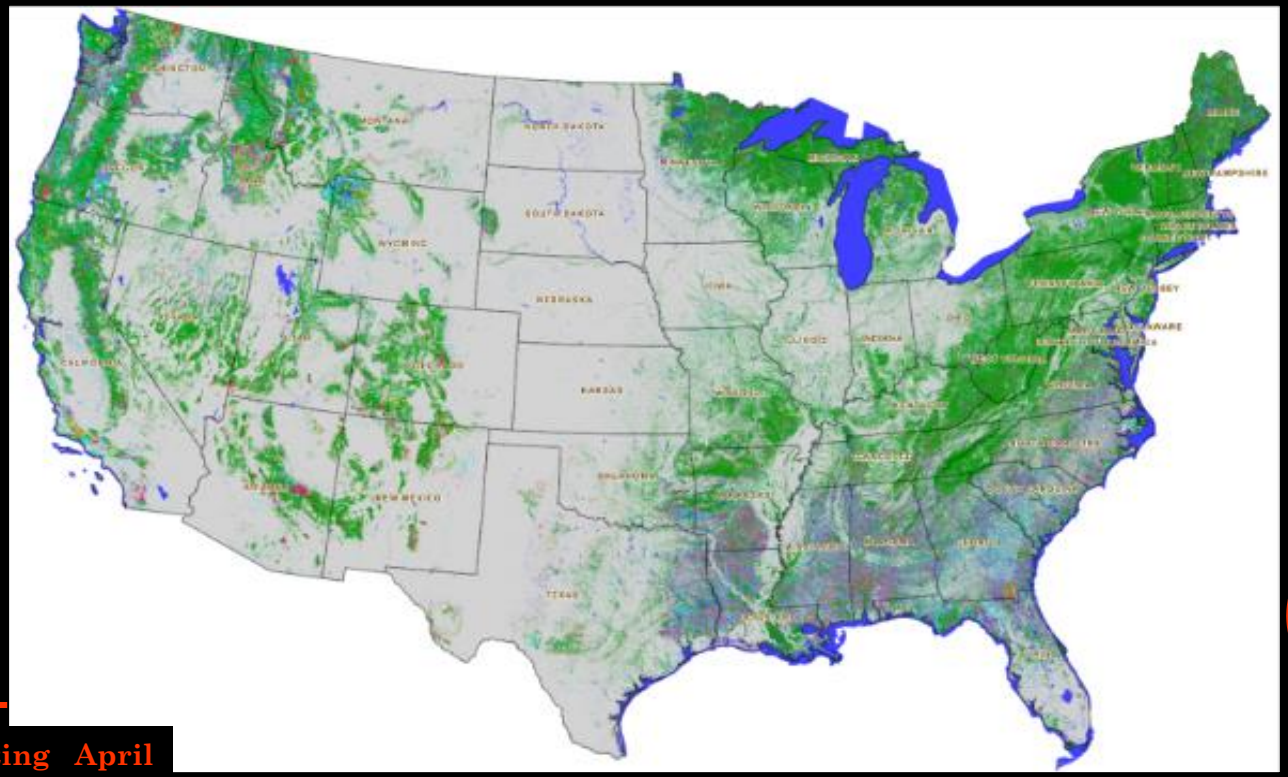
## NAFD: A 25-year History of US Forest Disturbances from VCT

Huang et al. 2010; Goward et al. 2016

Distributed at ORNL DAAC
https://daac.ornl.gov/NACP/guides/NAFDNEX_Forest_Disturbance.html



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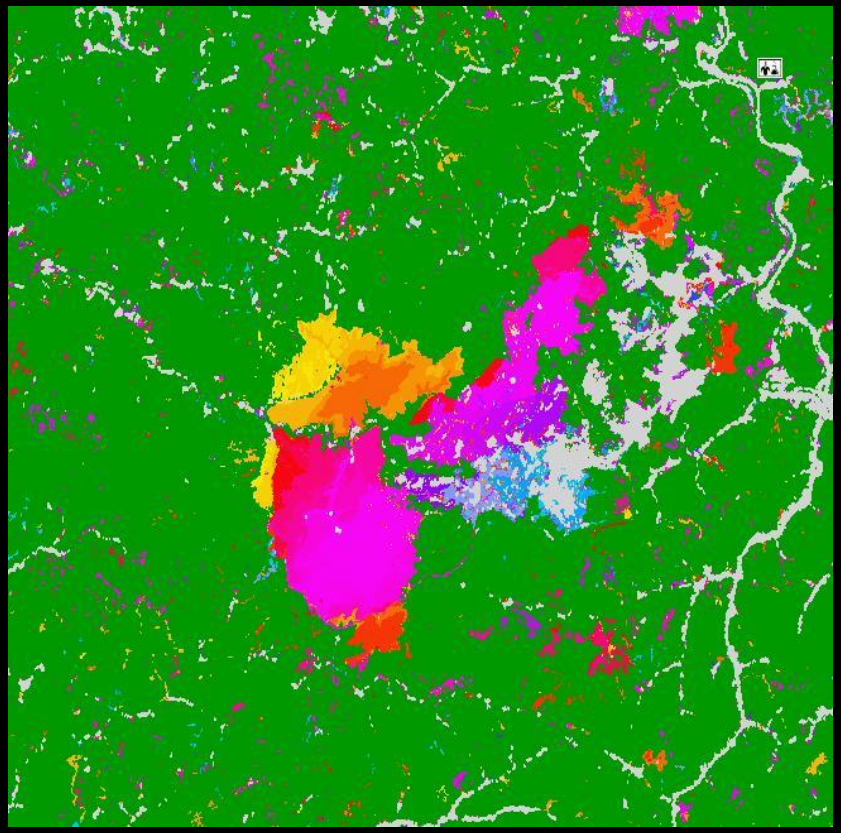

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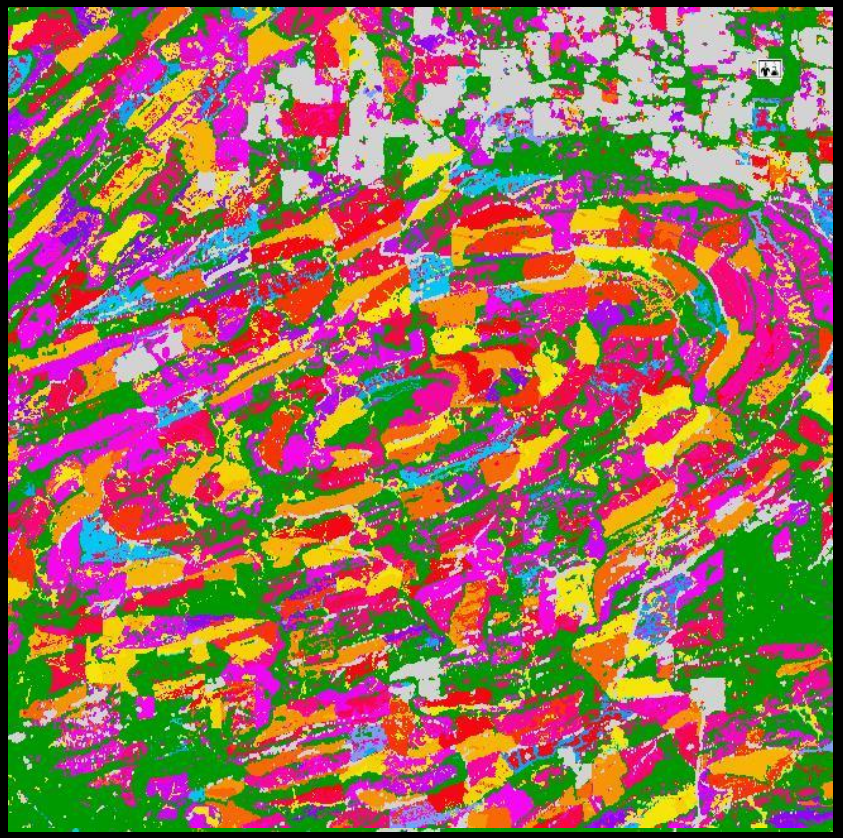

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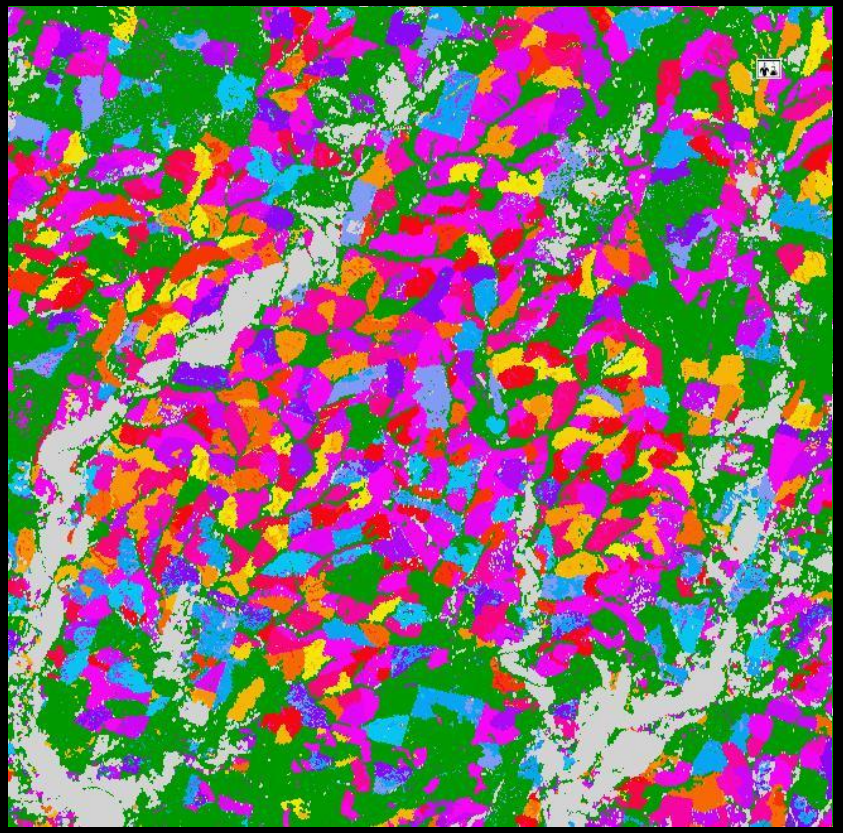

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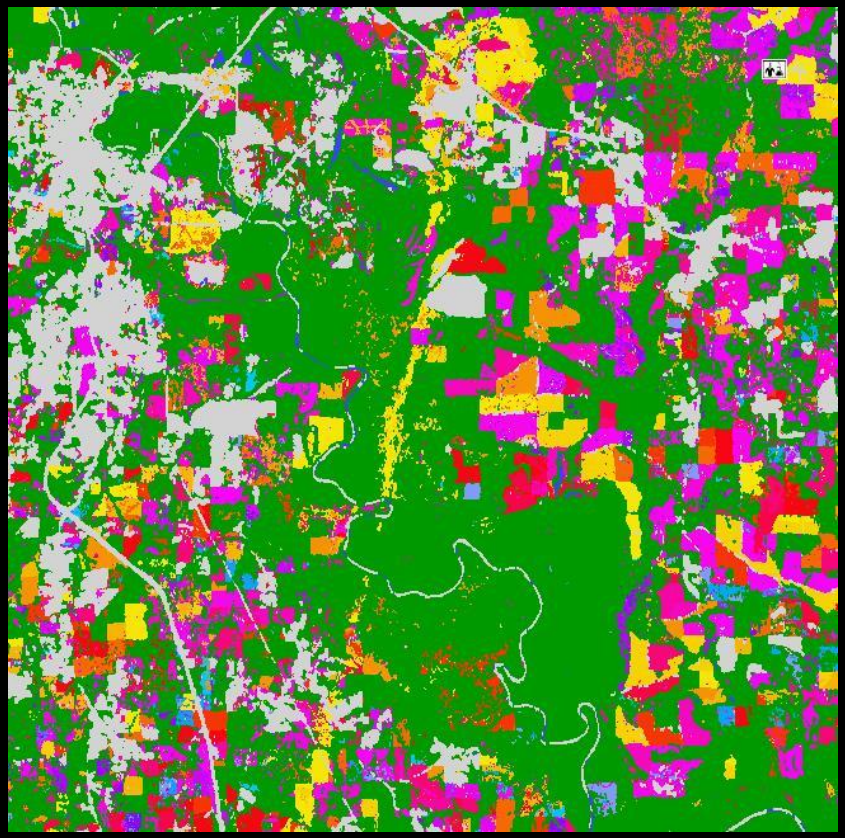

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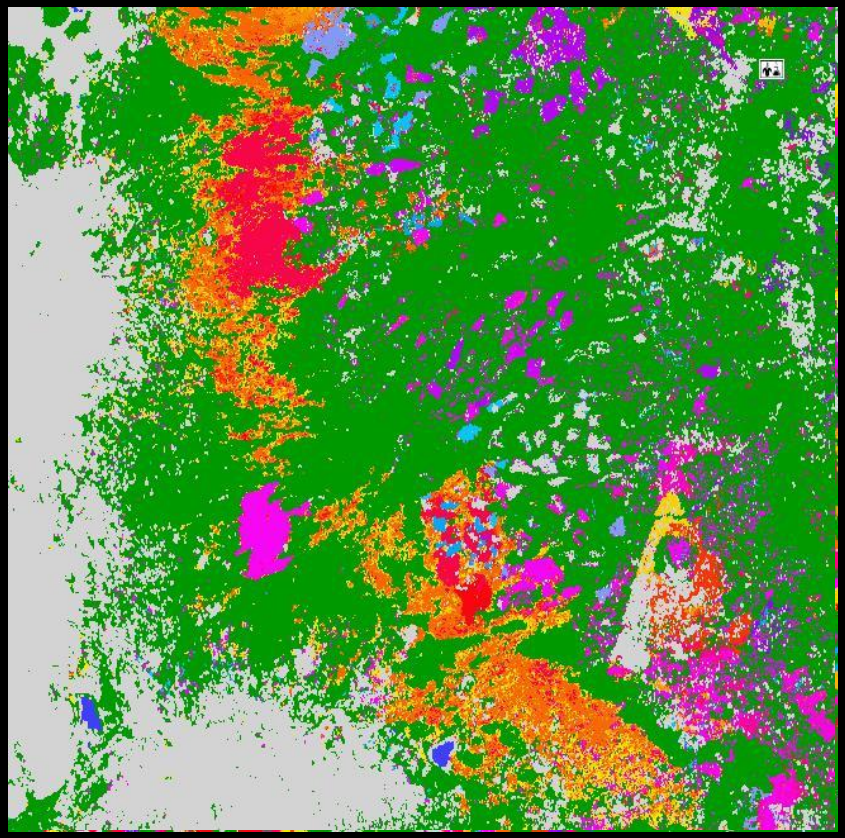

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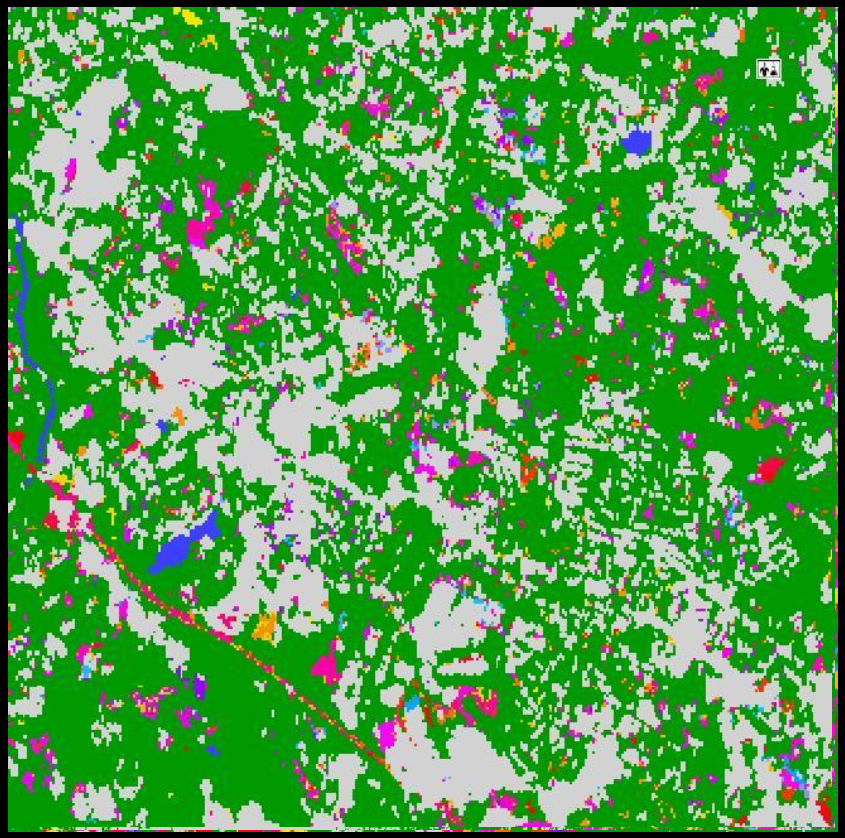

# *"Valued Collaboration"*
# *"Strengthening Connections"*

2017 FIA User Group Meeting April 4th & 5th Madison, WI

# *Mapping Forest History from Landsat*

## *North American Forest Dynamics Research Project (NAFD)*

| Space | Time Record | Project Name | yrs of funding | USFS | Ref | FIA Collaboration | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
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| | | | | | |
| | | | | | |

FIA Collaboration

- Disturbance Year Accuracy and Assessment
- Training for Biomass Trajectories

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| CONUS (434/PR) | 84-10 | NAFD-NEX | 11-14 | Mosien, Cohen, Schleeweis, Schroeder,Toney, Frescino,Freeman | Masek 2011, Schleeweis 2013, Goward 2016, Cohen 2016, Schleeweis 2016, Schroeder 2017, Zhoa ( In Review) |
| | | | | | |

FIA Collaboration

- Accuracy and Assessment (Year)
- Training Data
- Calibrate Spectral thresholds for Forest detection
- Improved Estimation of Disturbed area from FIA

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| CONUS (443/PR) | 84-16 | NAFC | 14-17 | Moisen, Schleeweis, Toney | |

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- Improved Estimation of Disturbed area from FIA

- Training Data

*a vision*

*moving from research projects*

*operationalizing and producing national products*

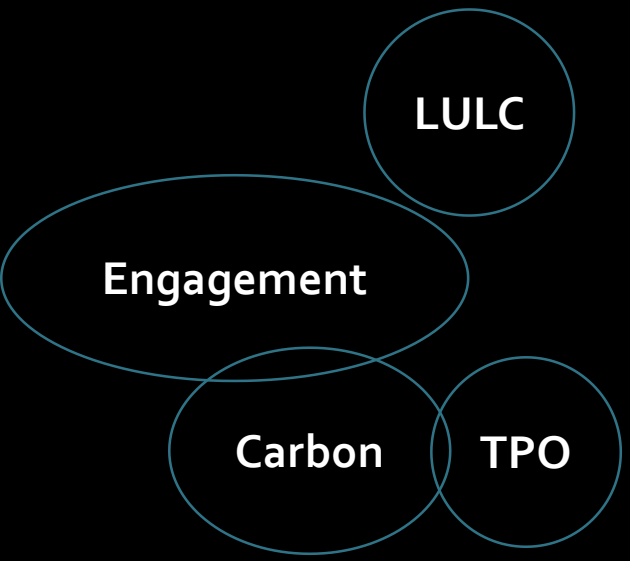
North American Forest Dynamics Research Project (NAFD)

***Science into Applications***

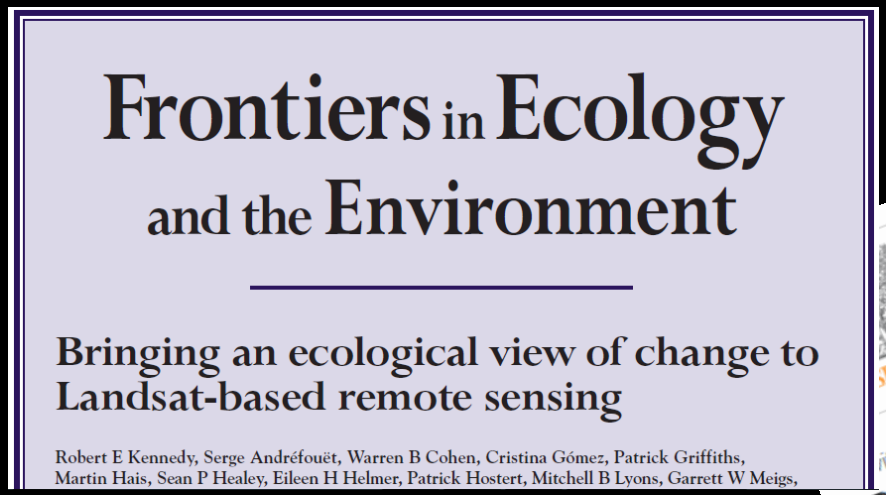
What products ?

What role ?

What data management ?




- Attribution
- Severity
- Sequence (Frequency with type)
- Regrowth
- Duration


Frontiers in Ecology and the Environment

Bringing an ecological view of change to Landsat-based remote sensing

Robert E Kennedy, Serge Andréfouët, Warren B Cohen, Cristina Gómez, Patrick Griffiths, Martin Hais, Sean P Healey, Eileen H Helmer, Patrick Hostert, Mitchell B Lyons, Garrett W Meigs,

Global and Planetary Change

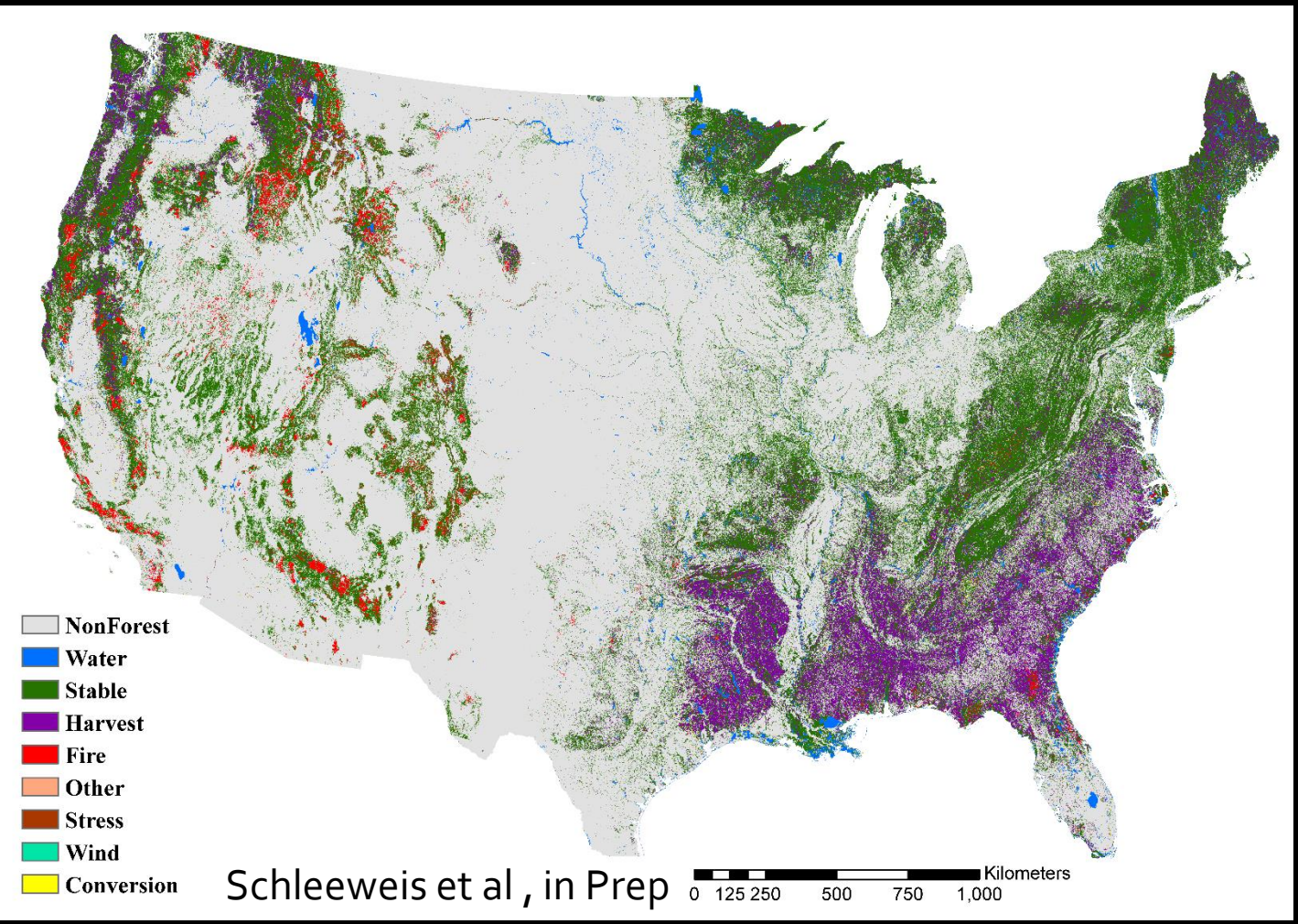
Volume 143, August 2016, Pages 66–80

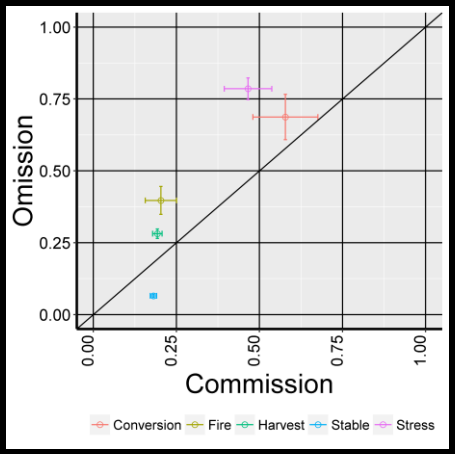
ited review article

Disturbance and the carbon balance of US forests: A quantitative review of impacts from harvests, fires, insects, and droughts

Christopher A. Williams[a], Huan Gu[a], Richard MacLean[a], Jeffrey G. Masek[b], G. James Collatz[b]

# *Mapping Disturbance Attribution*

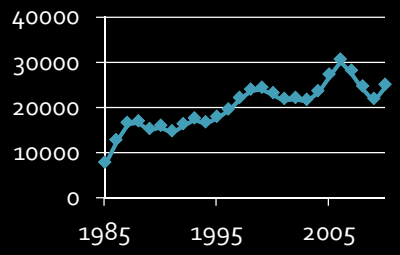



| of all Forest Land | Activity | of all Loss |
|---|---|---|
| 70.70% | Stable | |
| **21.93%** | Harvest | **74.84%** |
| 4.68% | Fire | 15.96% |
| 0.01% | Other | 0.04% |
| 2.06% | Stress | 7.01% |
| 0.00% | Wind | 0.01% |
| 0.62% | Conversion | 2.13% |

Year & Duration

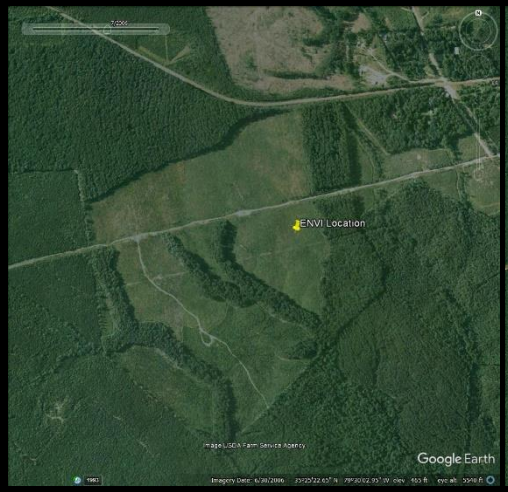
within 2 weeks



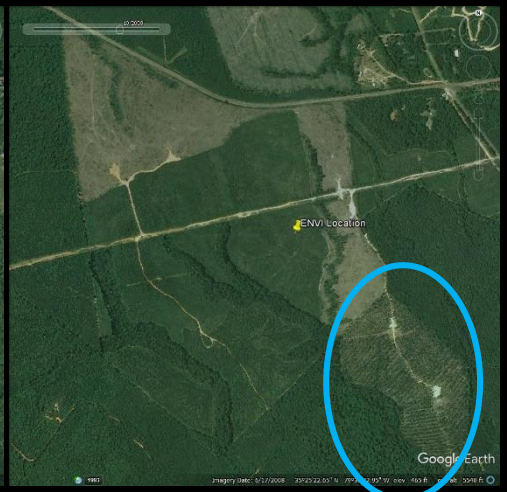
# *Mapping of Disturbance Severity (NAFD)*

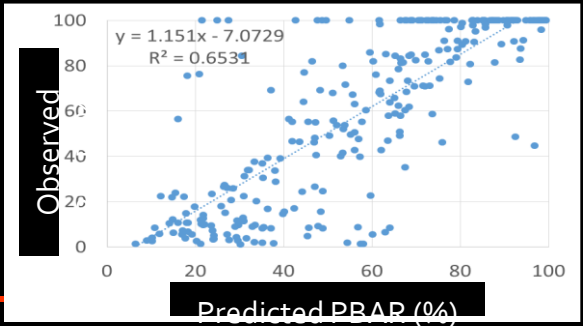
Percent basal area removal (PBAR) correlated with spectral changes
T1 to T2 using tree level dbh from plots

July 2006

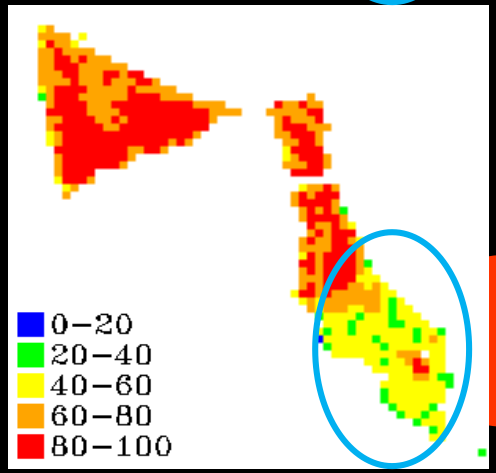



October 2008



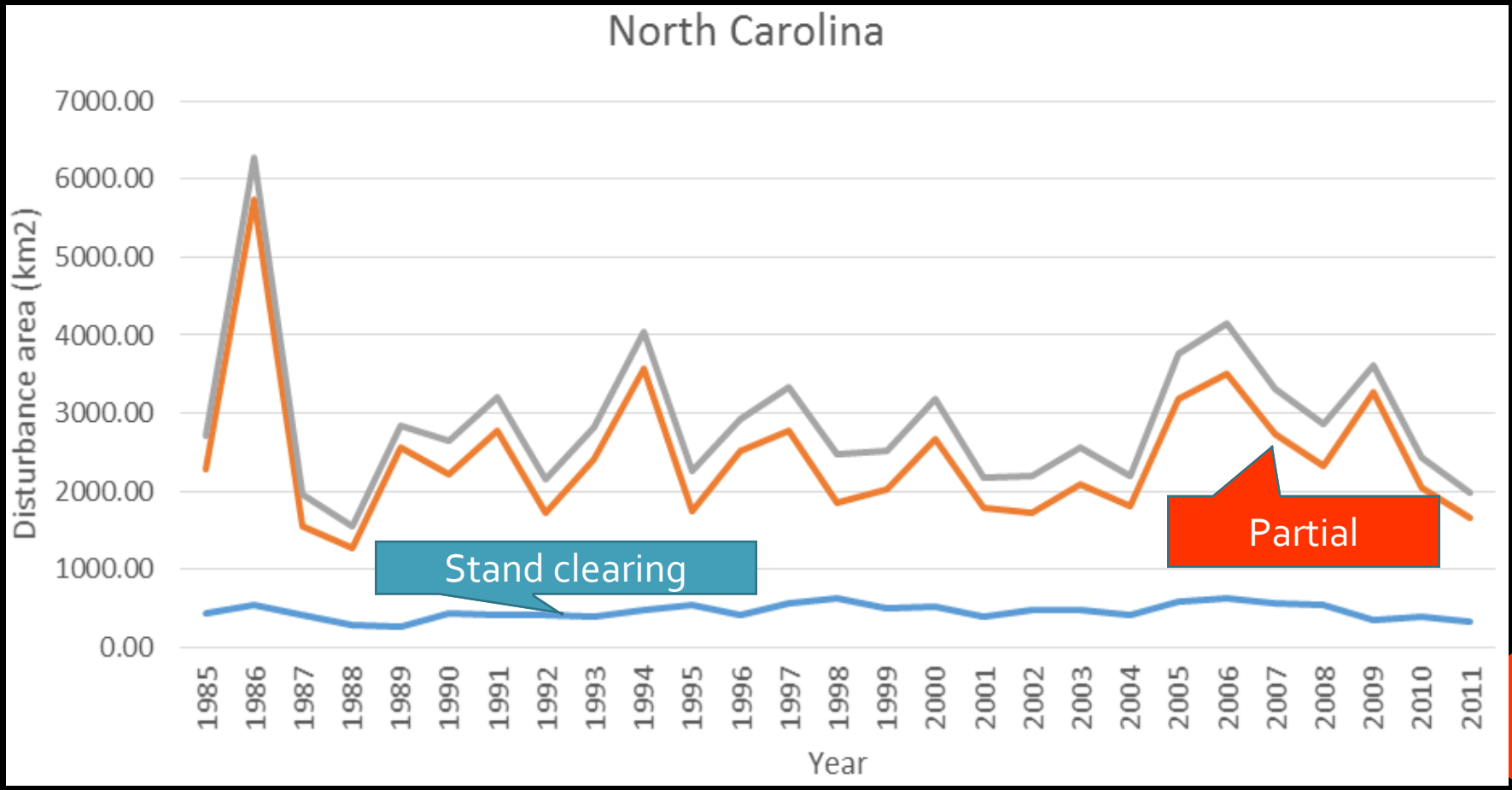




(Tao, Huang et al., in prep)

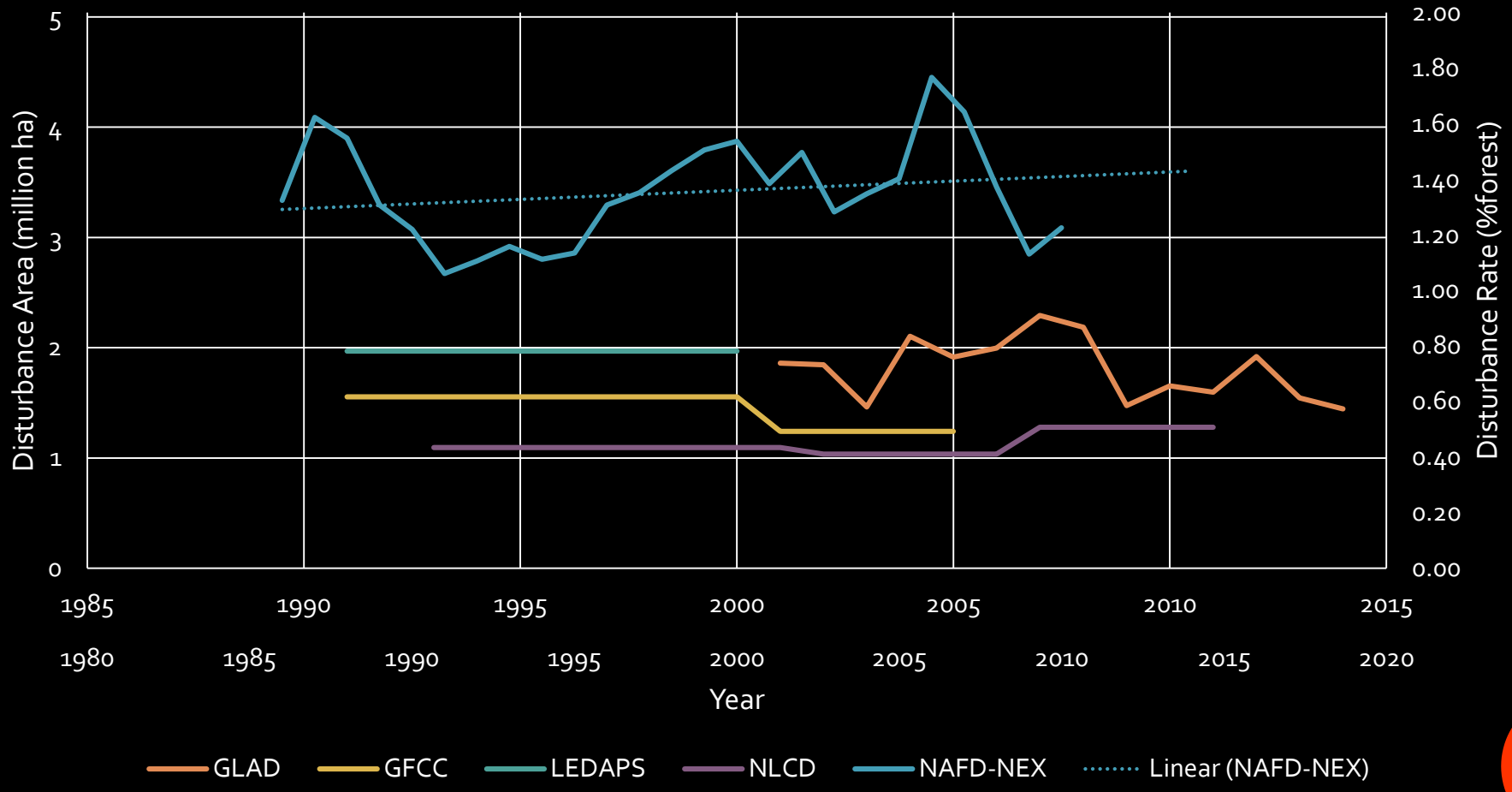



Mapped PBAR

# *Most Disturbances in NC Partial Cuts (NAFD)*



# National Disturbance Rates, CONUS

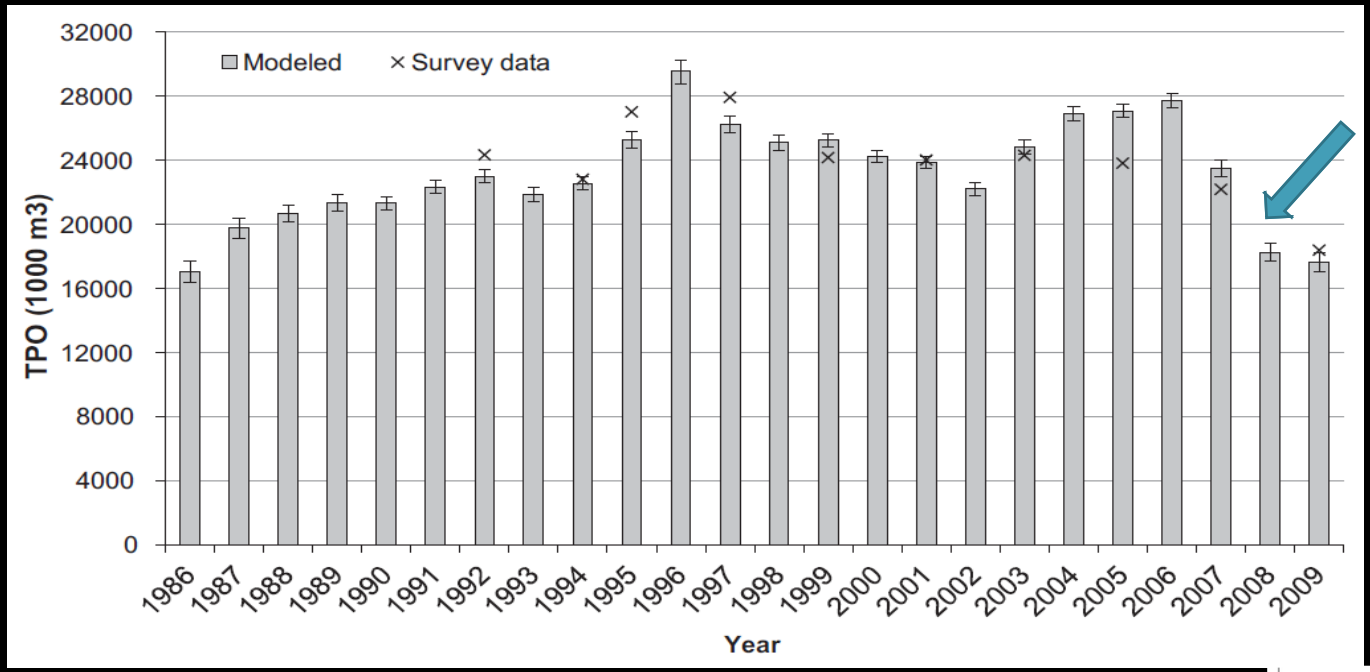





Huang et al., in Prep

# *North Carolina's Timber Harvest History Mapped Using Time Series Landsat Observations and Inventory Data*

[1] Department of Geographical Sciences, University of Maryland; [2] USDA Forest Service, Rocky Mountain Research Station; [3] NASA Ames Research Center; [4] NASA Goddard Space Flight Center

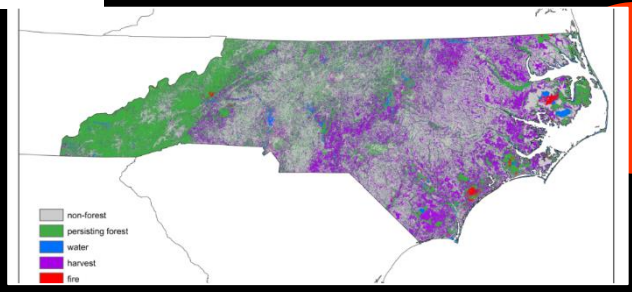



Sharp economic downturn

Average annual TPO: 23.2 million $m^3$

TPO per unit harvested forest area: ~200 $m^3$/ha

"We need area and cubic feet…"

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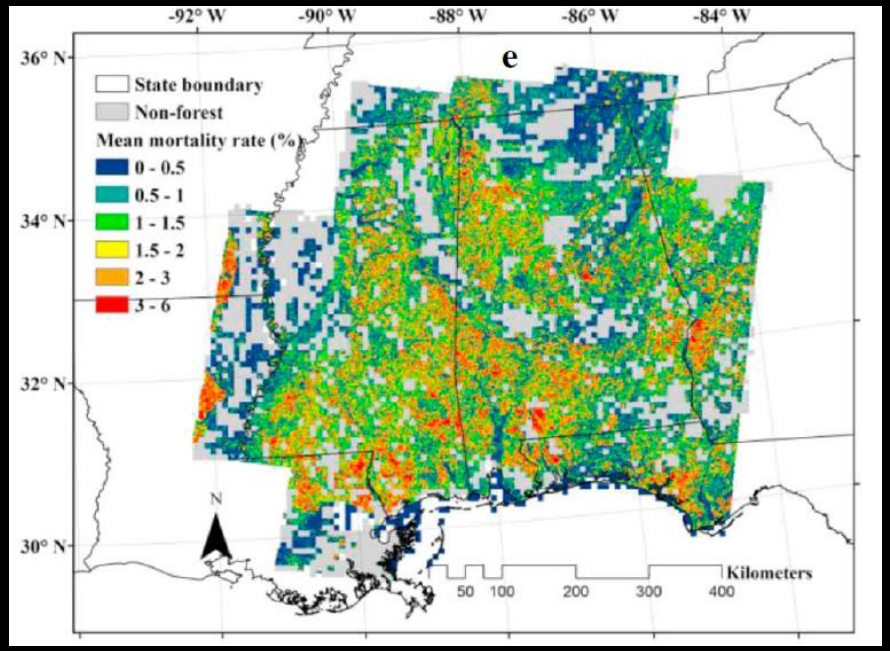
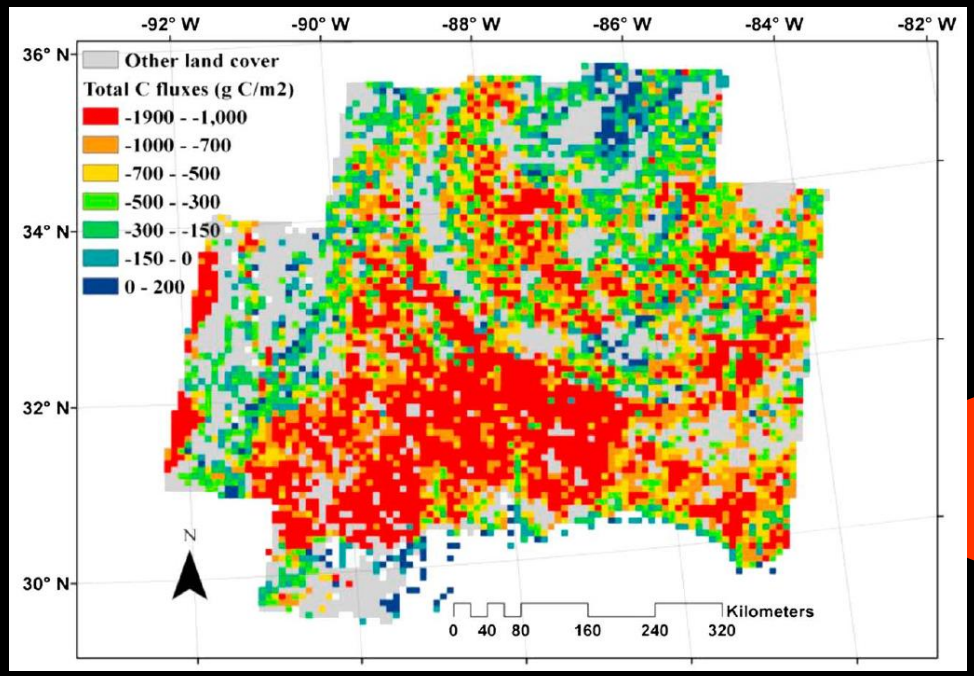
# *Use of NAFD Products for C Modeling*




NAFD Disturbance Products

Other Data Products

DLEM Model




(Chen et al. 2013)

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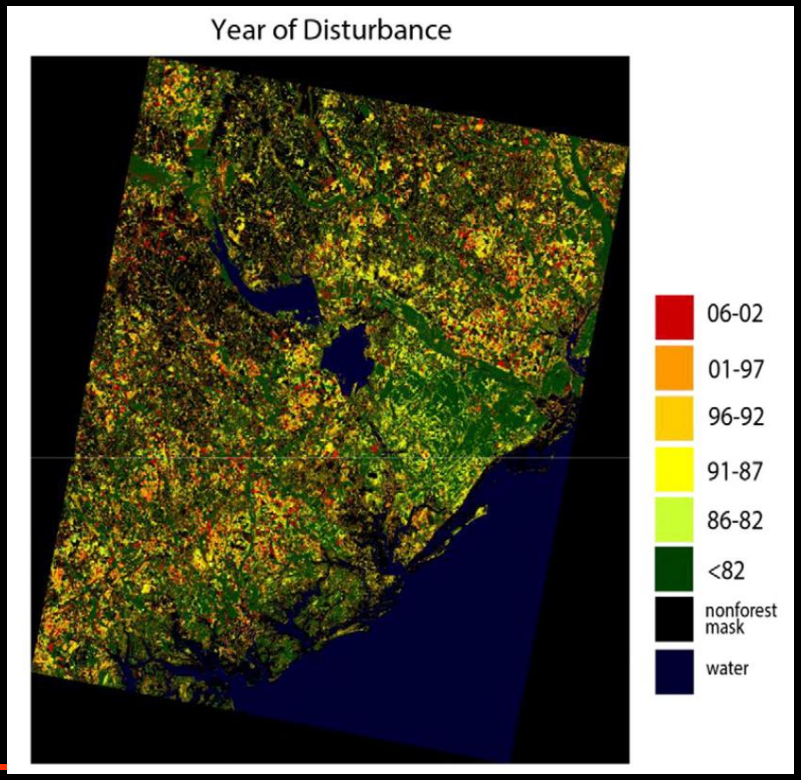
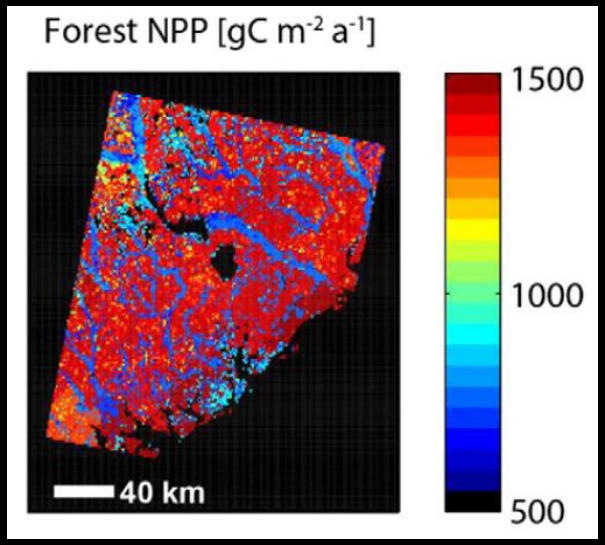
NAFD Disturbance Products

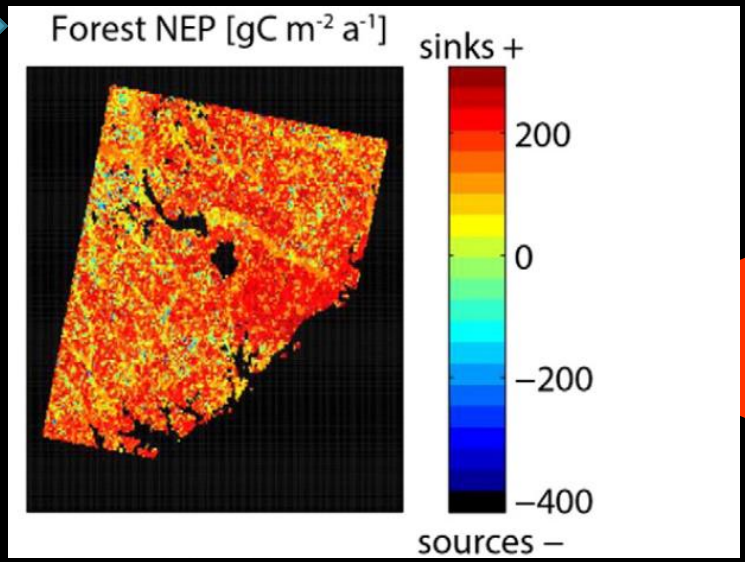



Modified CASA Model

\+

Other Data Products




(Williams et al. 2012, 2014)

# *DO YOU WANT TO USE THIS DATA?*

*kgschleeweis@fs.fed.us*

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*a vision*

*moving from research projects*

*operationalizing and producing national products*

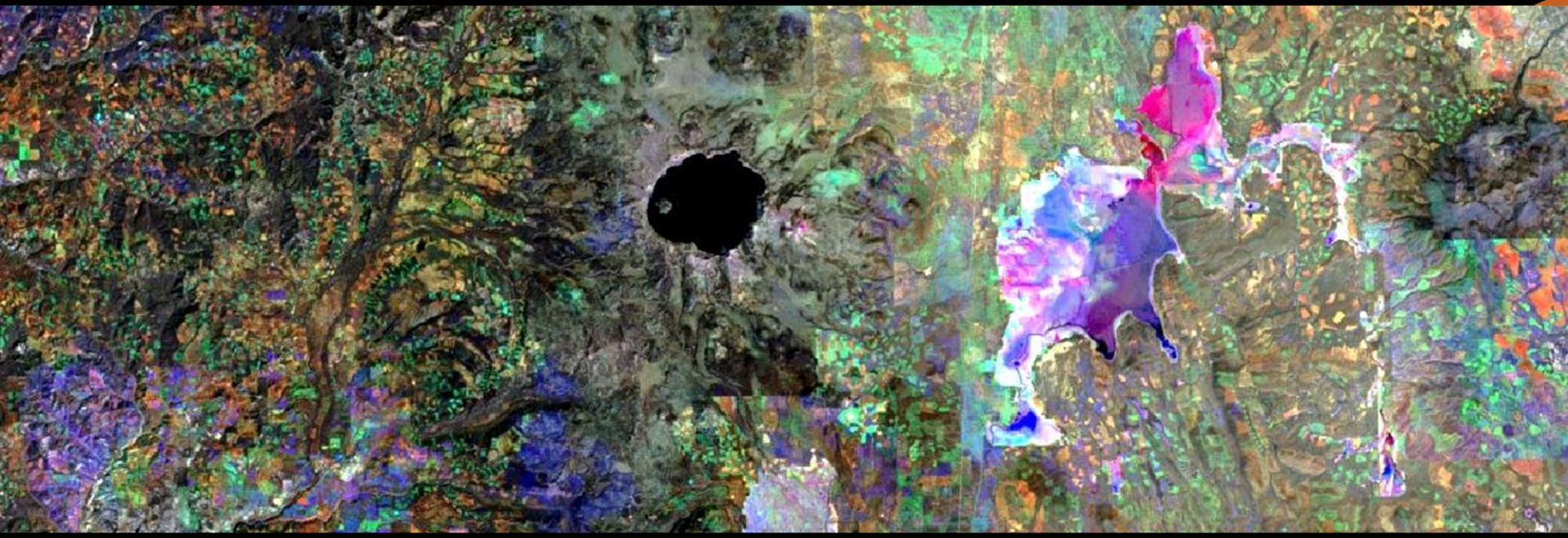
North American Forest Dynamics Research Project (NAFD)

Science into Applications

*Which products ? What is FIA's role?*

*Data management for producing and serving national products ?*

# *LANDSCAPE CHANGE MONITORING SYSTEM (LCMS):*

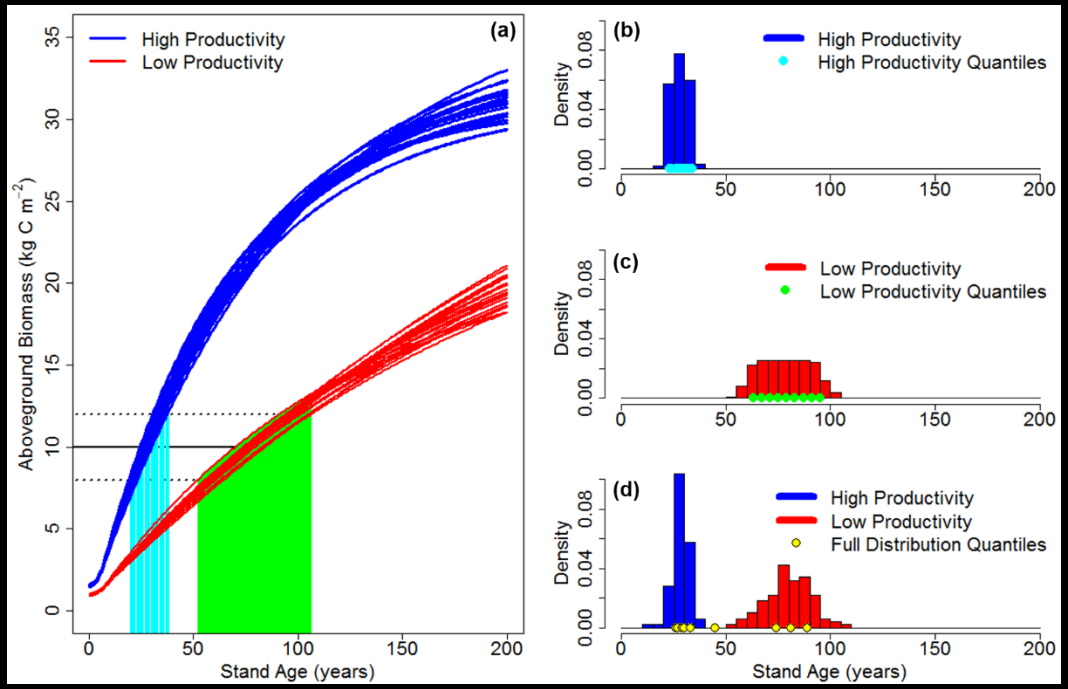


United States Department of Agriculture Forest Service (USFS)
United States Geological Survey (USGS)
USFS GeoTasc ,Boston University, University of Maryland
Oregon State University, State University of New York (SUNY)

**2017 FIA User Group Meeting April 4th & 5th Madison, WI**

# *What Products? What Role?*

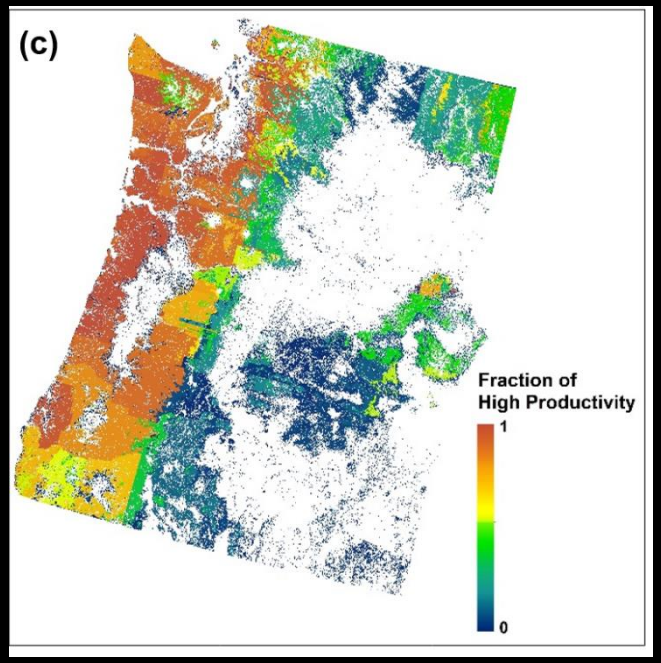
*Inferring 30m Stand Age from FIA-derived Biomass Curves*




Gu, H., Williams, C. A., Ghimire, B., Zhao, F., and Huang, C.: High-resolution mapping of time since disturbance and forest carbon flux from remote sensing and inventory data to assess harvest, fire, and beetle disturbance legacies in the Pacific Northwest, Biogeosciences, 13, 6321-6337, doi:10.5194/bg-13-6321-2016, 2016.

# *What Products? What Role?*

*Site productivity*

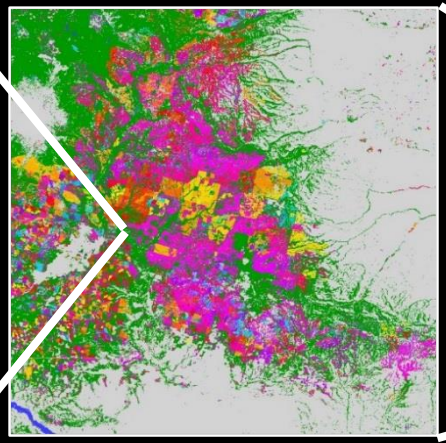


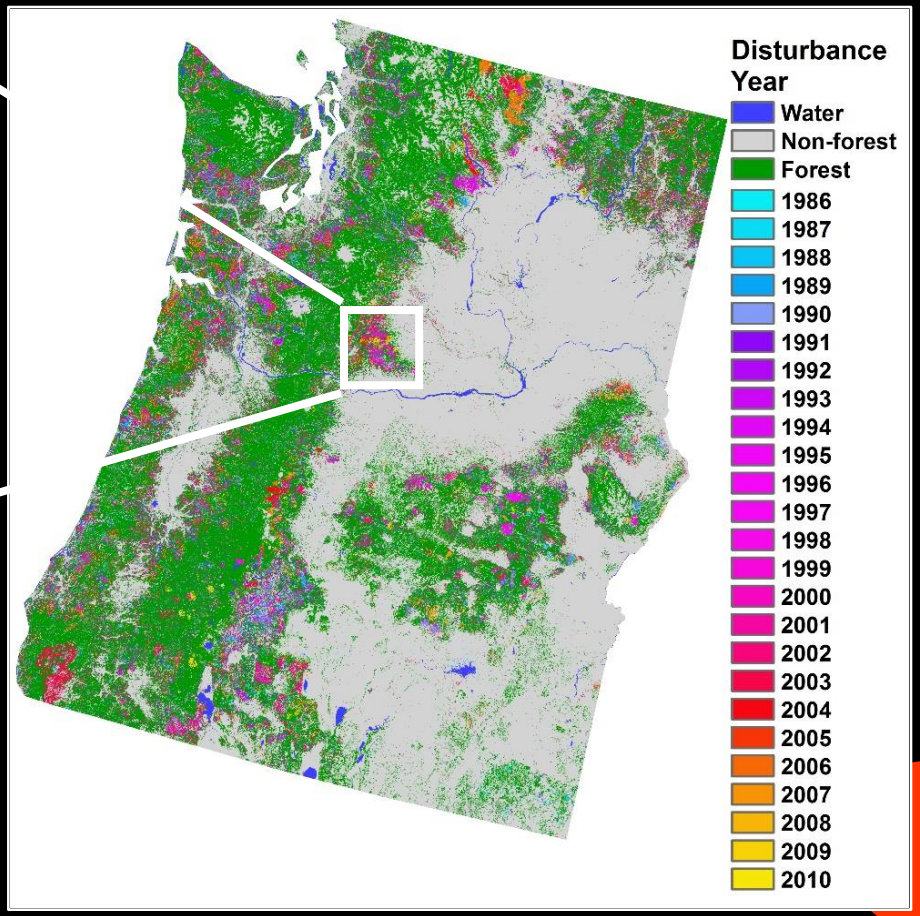

- Vetting ?
- Serving ?
- Convergence is good –
- Multiple research projects is good

CMS - Williams et al.

# *Maps from FIA-constrained Data*

**30m Pixel Attributes:**
**Pre-D Biomass**
Forest Type
**Site Productivity**
**Stand Age (Years Post-D)**
Disturbance Type
Disturbance Severity






CMS - Williams et al.

# *What Products? What Role? Path to Engagement ?*

- Nationally consistent geospatial data sets
- Which products are ready for engagement?
  - Message?
  - Serving Data
    - Internally & Externally?
- What products do you want?

LAI for hydrologists

Biomass

# *What Products? What Role? Path to Engagement ?*

*An efficient geospatial Processing Platform?*

- *Massive Raster Processing ?*
- *AGOL? Image Services*

*An efficient geospatial data gateway for users?*

- *Geospatial data clearinghouse &*
- *Raster data Warehouse…*

***R & D***

***Operational Products based on repeatable science, experimenting multiple methods***

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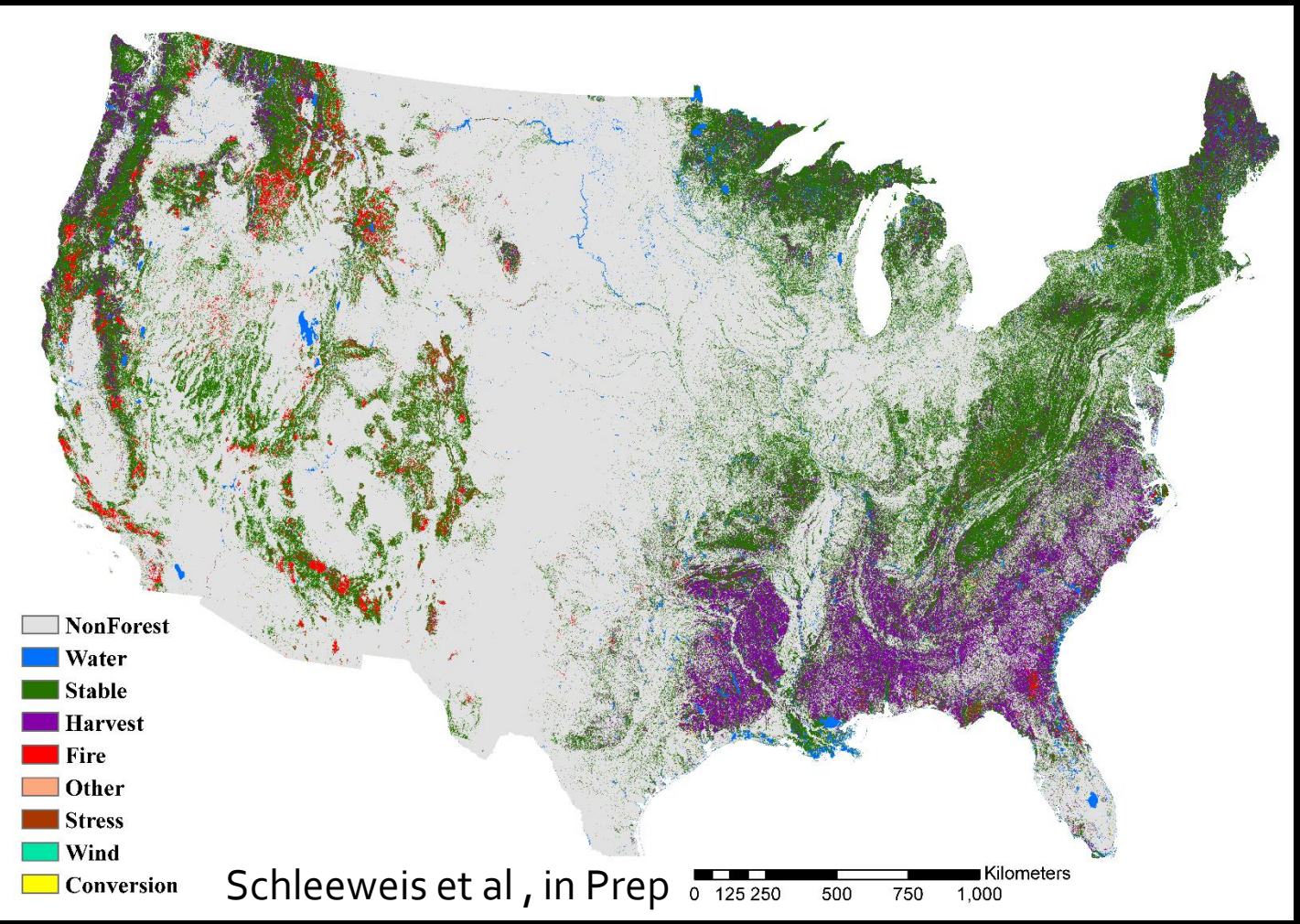



# *THANK YOU*

# *Major Landsat Based Map Products on Forest Disturbances*

| Data Set | Spatial Coverage | Temporal Characteristics | References |
|---|---|---|---|
| **Products at 5-10 year intervals** | | | |
| **LEDAPS** | US and Canada | 1990-2000 | (Masek et al. 2008) |
| **GFCC** | Global | 1990-2000<br>2000-2005 | (Sexton et al. 2013, 2015; Kim et al. 2015) |
| **NLCD** | US | 1992-2001<br>2001-2006<br>2006-2011 | (Vogelmann et al. 2001; Homer et al. 2004, 2015; Fry et al. 2011) |
| **Annual products** | | | |
| **NAFD-NEX** | CONUS | Annual, 1986-2010 | (Huang et al. 2010; Goward et al. 2016) |
| **NTEMS** | Canada | Annual, 1984-2011 | (Hermosilla et al. 2014) |
| **GLAD** | Global | Annual, 2000-2014 | (Hansen et al. 2013) |

GLAD: Global Land Analysis and Discovery, UMD

NAFD-NEX: North American Forest Dynamics-NASA Earth eXchange, UMD-AMES-GSFC-USFS

NTEMS: National Terrestrial Ecosystem Monitoring System, CFS-UBC

GFCC: Global Forest Cover Change, UMD-GSFC

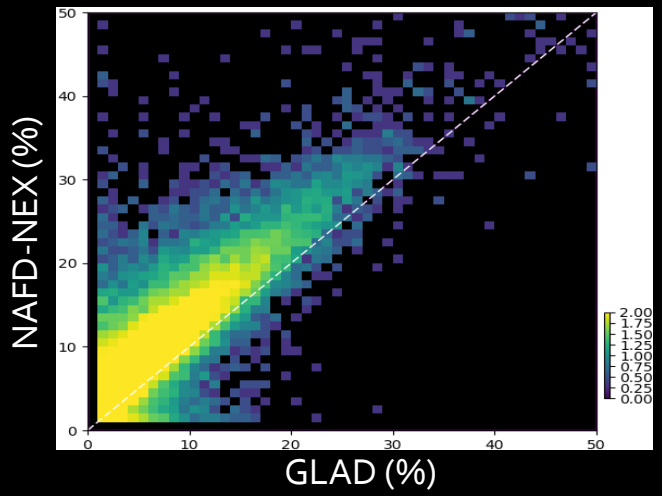
LEDAPS: Landsat Ecosystem Disturbance Adaptive Processing System, GSFC-UMD

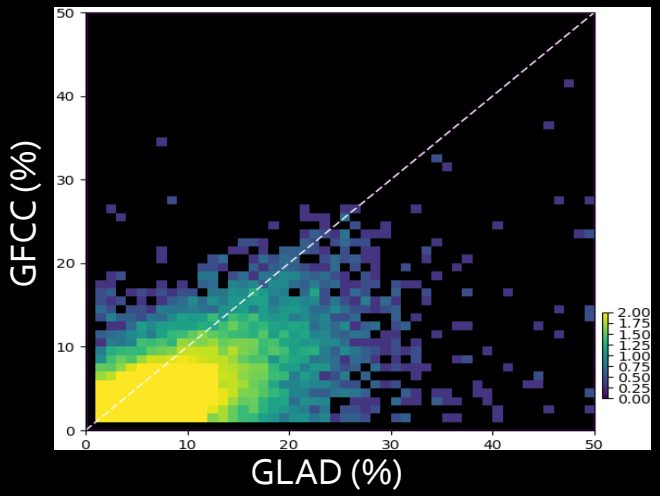
NLCD: National Land Cover Dataset, USGS-MRLC

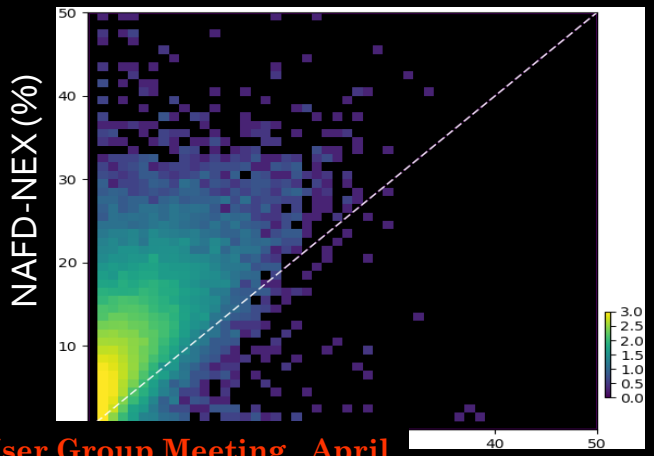


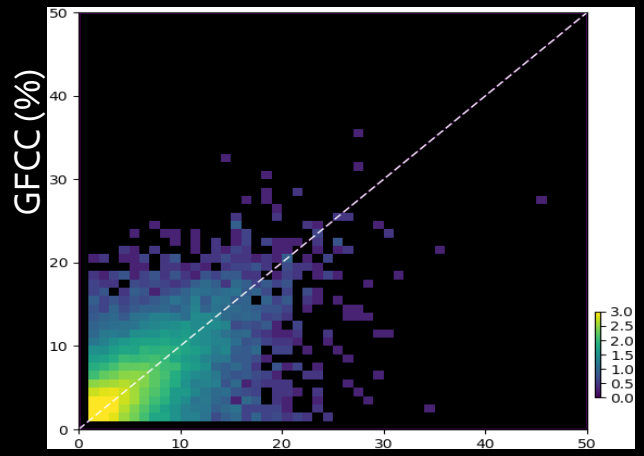
Huang et al., in Progress

# 5-km Level Disturbance Rate Comparison, CONUS, 2000-2005

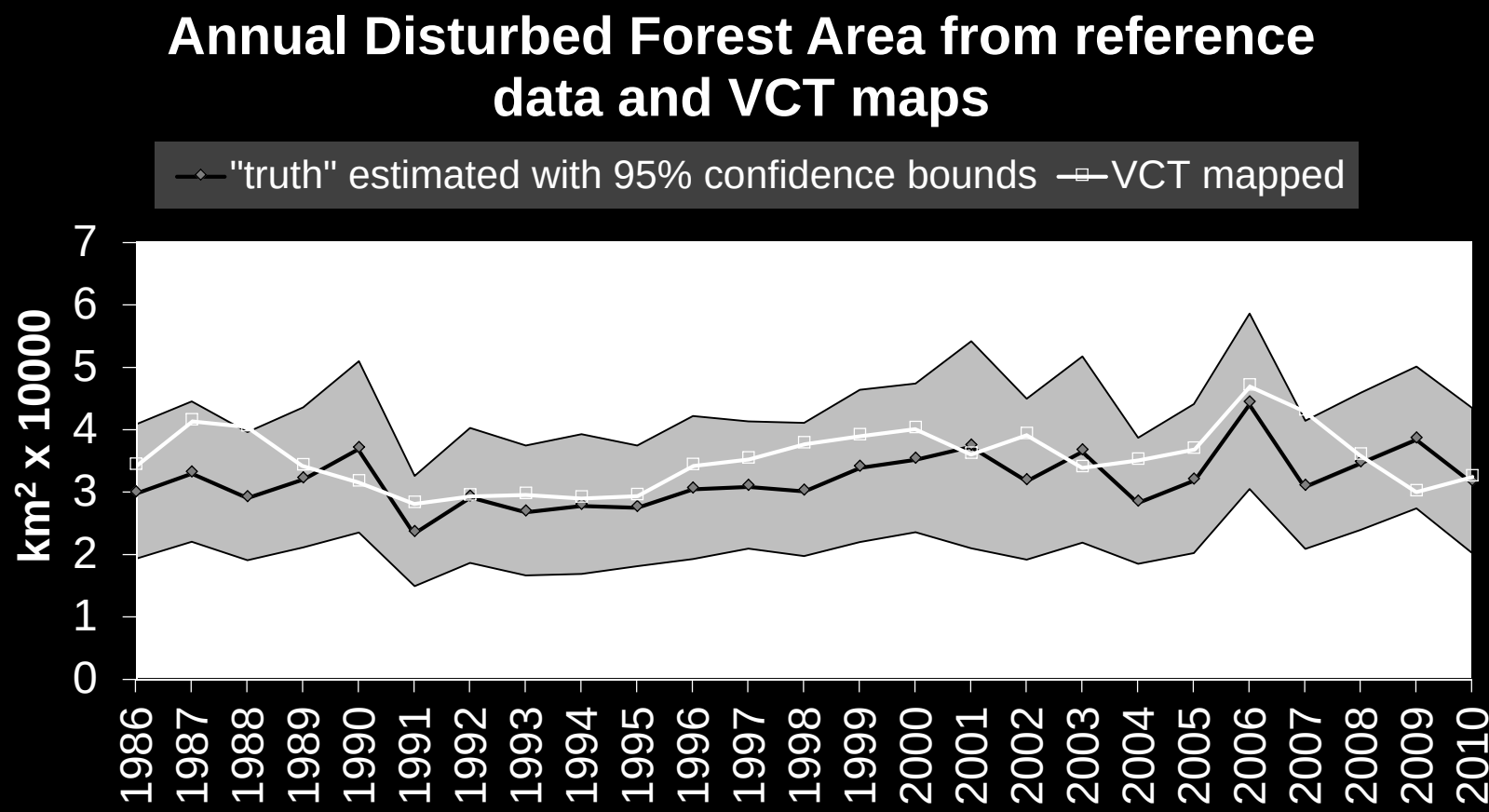


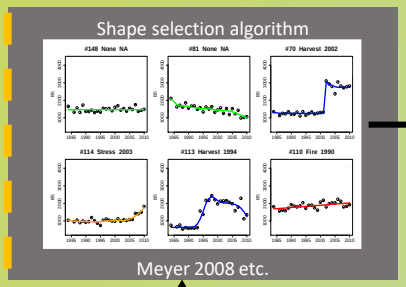



# *National Disturbance Rates, with bias from reference data*





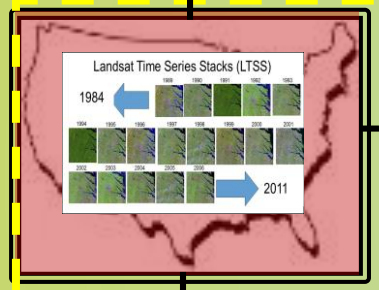

temporal "shapes" and disturbance metrics

National Predictor Data Sets

Other training data

Random Forest

National annual Maps of Forest Cover change (loss) activities (Harvest Class only)

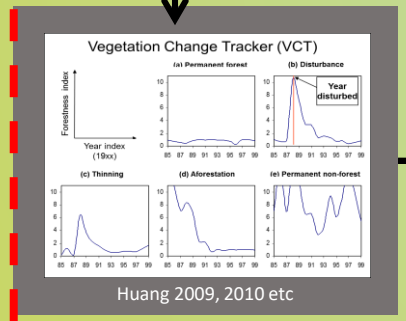



National Probabilistic training data
Cohen et al 2016

**TPO Survey Data** (training data)

Regressio n

Annual Harvest volume




Disturbance Year

Disturbance Magnitudes (spectral)

Regression Tree

Harvest intensity (basal area removal)

Basal Area Removals (training data)

**Remeasured FIA Plots**

Statistical process

Stand alone product created

RS dataset

FS dataset

Intermediate datasets

Other datasets

# Mapping Forest History from Landsat

## North American Forest Dynamics Research Project (NAFD)

| Space | Time Record | Project Name | yrs of funding | USFS | Ref | Detection | Timing | Repeat D | Regrowth | Severity | Attribution | Duration |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 3 P/R | 84-00 | NAFD pilot | 03-05 | Lister, Moisen | - | SR | E | E | I | I | - | |
| 23 P/R | 84-06 | NAFD P I | 05-08 | Moisen, Cohen, Healey, Schroeder, Powell | - | SR | E | E | I | I | - | |
| 25 P/R | 84-06 | NAFD PII | 08-11 | Moisen, Cohen, Healey, Schroeder,Powell, Nelson | Goward 2008, Stueve et al 2011, Huang et al 2011 | SR | E | E | I | I | - | |
| CONUS (434/PR) | 84-10 | NAFD-NEX | 11-14 | Mosien, Cohen, Schleeweis, Schroeder,Toney, Frescino,Freeman | Masek 2011, Schleeweis 2013, Goward 2016, Cohen 2016, Schleeweis 2016, Schroeder 2017, Zhoa ( In Review) | SR & D | E | E | I | I | (10 P/R pilot) | |
| CONUS (443/PR) | 84-16 | NAFC | 14-17 | Moisen, Schleeweis, Toney | | SR & D | E | E | E | E | E | E |

I = Implicit, E = Explicit, SR= Stand Replacing, D = Degredation