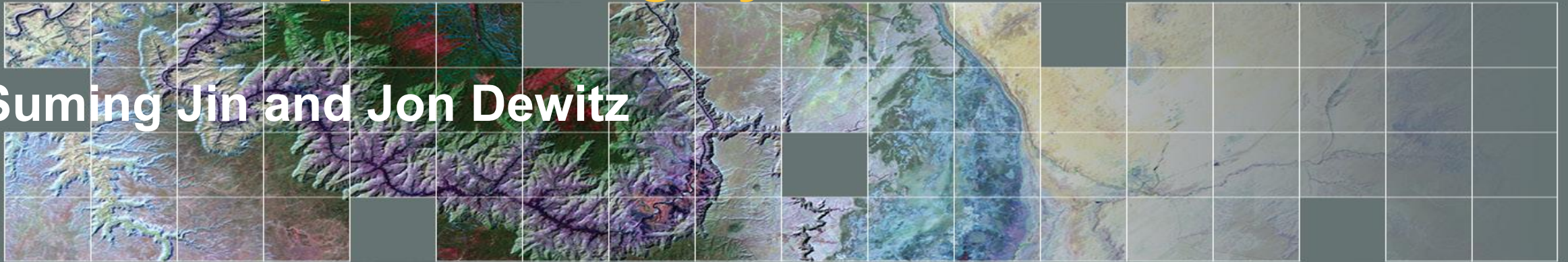


**Climate and Land Use Change**  
**Earth Resources Observation and Science (EROS) Center**

# **National Land Cover Database (NLCD): Change Detection Using CCDC Synthetic and NLCD Composite Imagery**

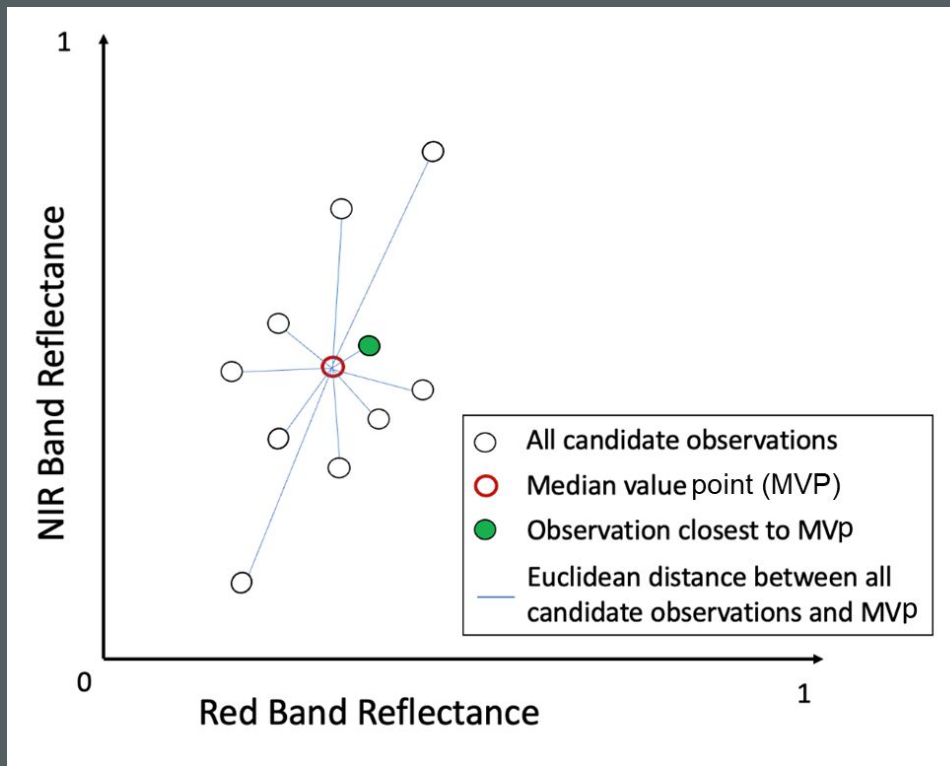
■ **Suming Jin and Jon Dewitz**



# Image Generation

- **CCDC synthetic:** Continuous Change Detection and Classification (CCDC) time series model coefficients
- **NLCD composite:** Median-value composite

Illustrative example of the median-value compositing algorithm, which selects an observation with the minimal Euclidean distance to the virtual MVP



Reference:

- Zhu, Z., Woodcock, C.E. and Olofsson, P., 2012. Continuous monitoring of forest disturbance using all available Landsat imagery. *Remote sensing of environment*, 122, pp.75-91.
- Zhu, Z., Woodcock, C.E., Holden, C., Yang, Z., 2015. Generating synthetic Landsat images based on all available Landsat data: Predicting Landsat surface reflectance at any given time. *Remote Sensing of Environment* 162, 67–83. <https://doi.org/10.1016/j.rse.2015.02.009>
- Jin, S., Dewitz, J., Danielson, P., Granneman, B., Costello, C., Zhu, Z., 2022. National Land Cover Database 2019 : A new strategy for creating clean Landsat composite images. *Journal of Remote Sensing*, Under Review.

# Comparisons between synthetic and composite images

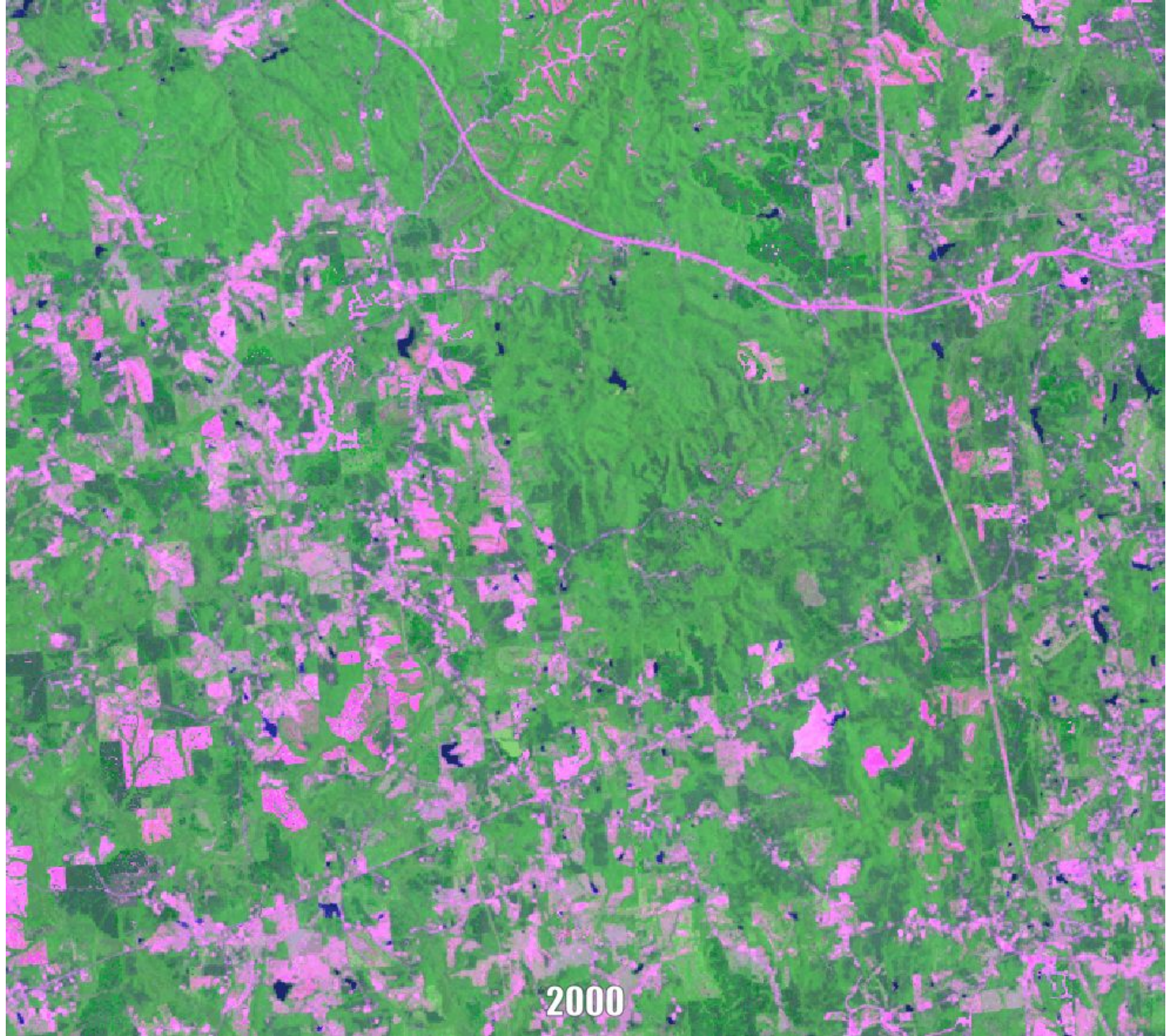
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- Long-term time series change detection
  - Short-term two date change detection
  - Land cover change detection
1. Urban change detection
  2. Forest change detection
  3. Water change detection
  4. Ice/snow change detection
  5. Agriculture change detection



# Time series of synthetic images from 2000-2020

- July 1
- Consistent
- Clean





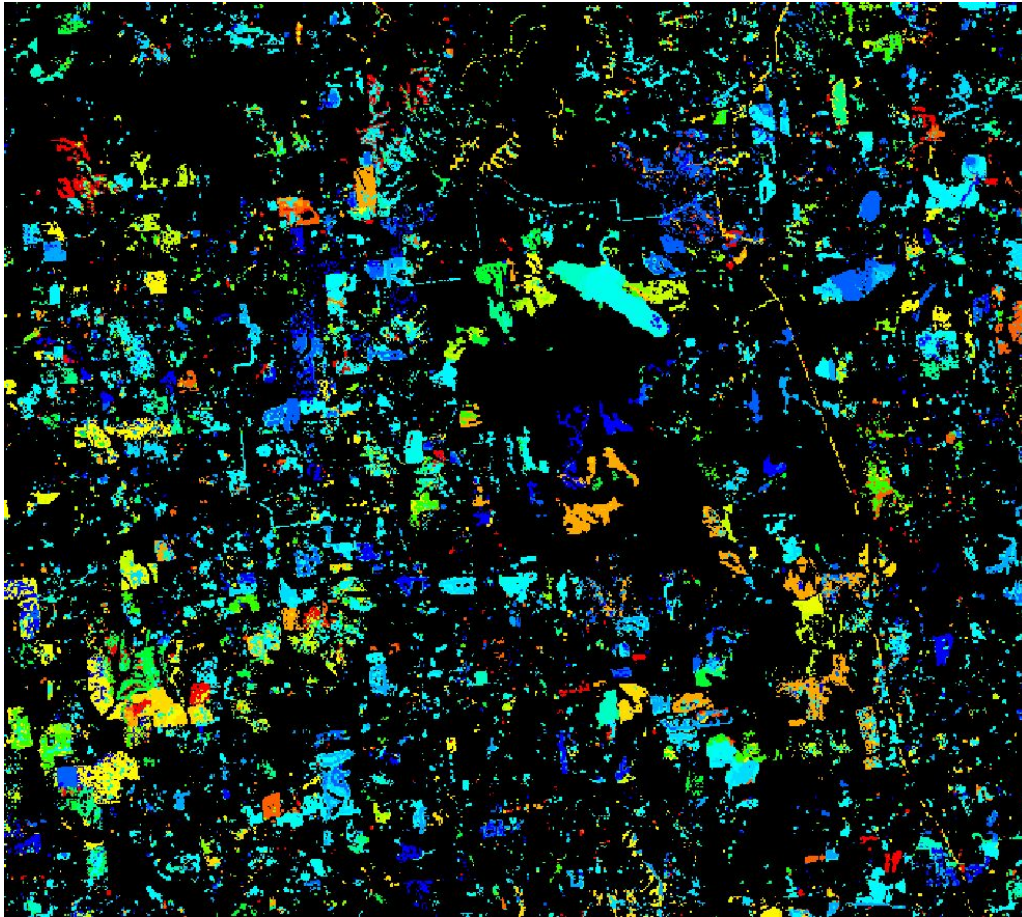
# Time series of median-compo site images from 2000-2020

- May 1- Sept. 30
- Not Consistent
- Missing value

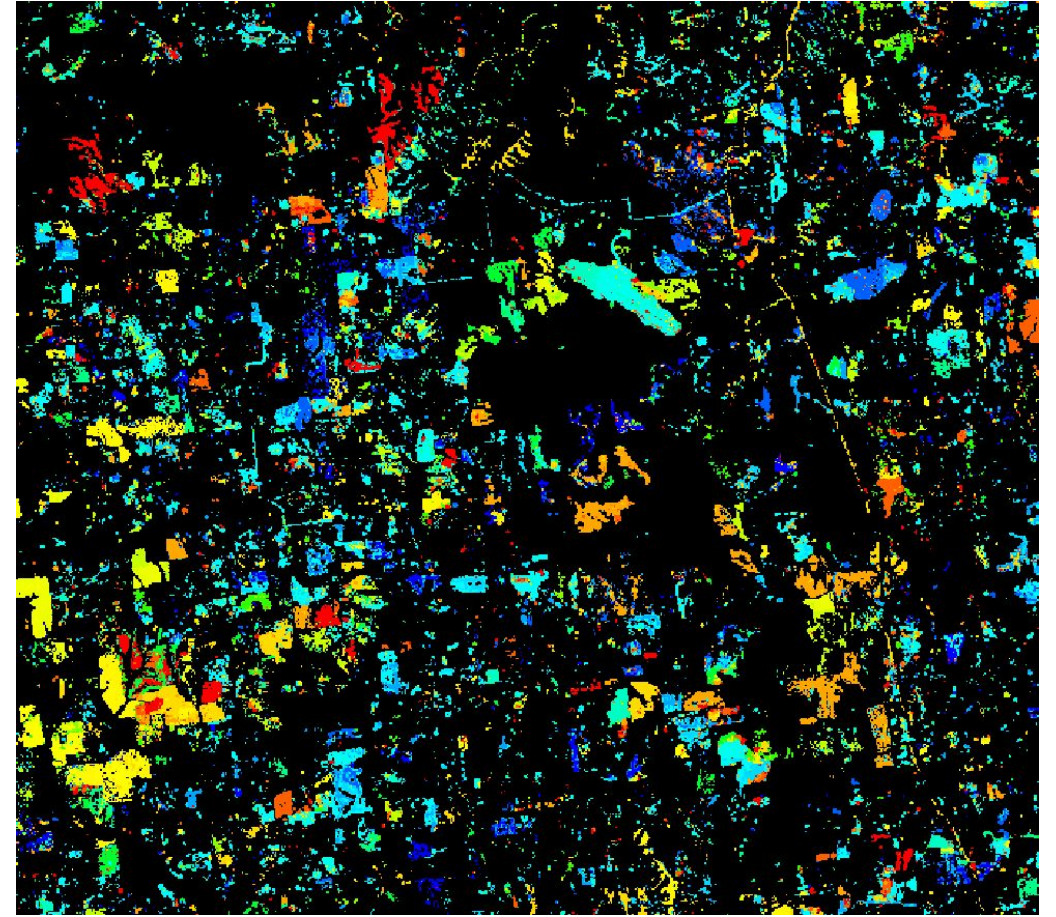
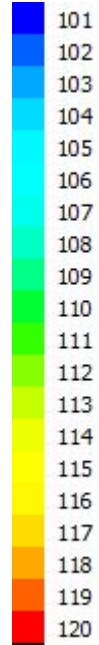




# Time series of change detection using synthetic images



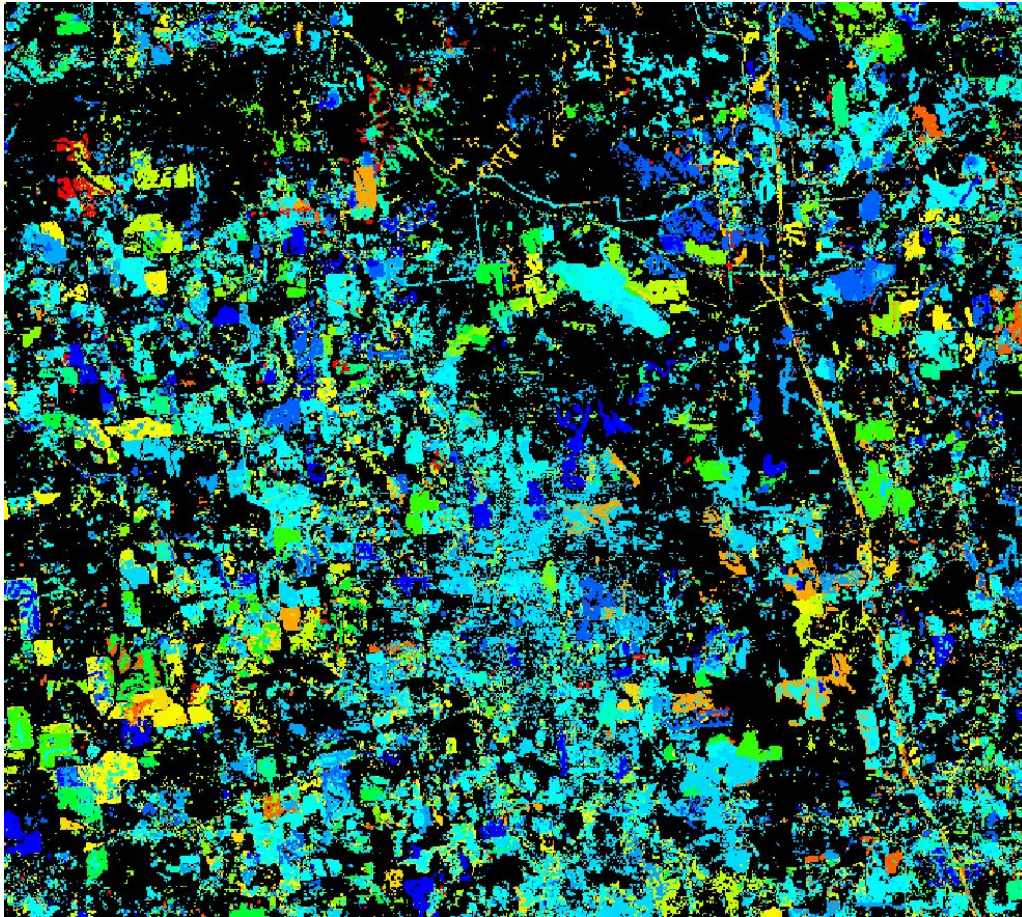
Earliest\_Disturbance\_Year\_2001\_2020



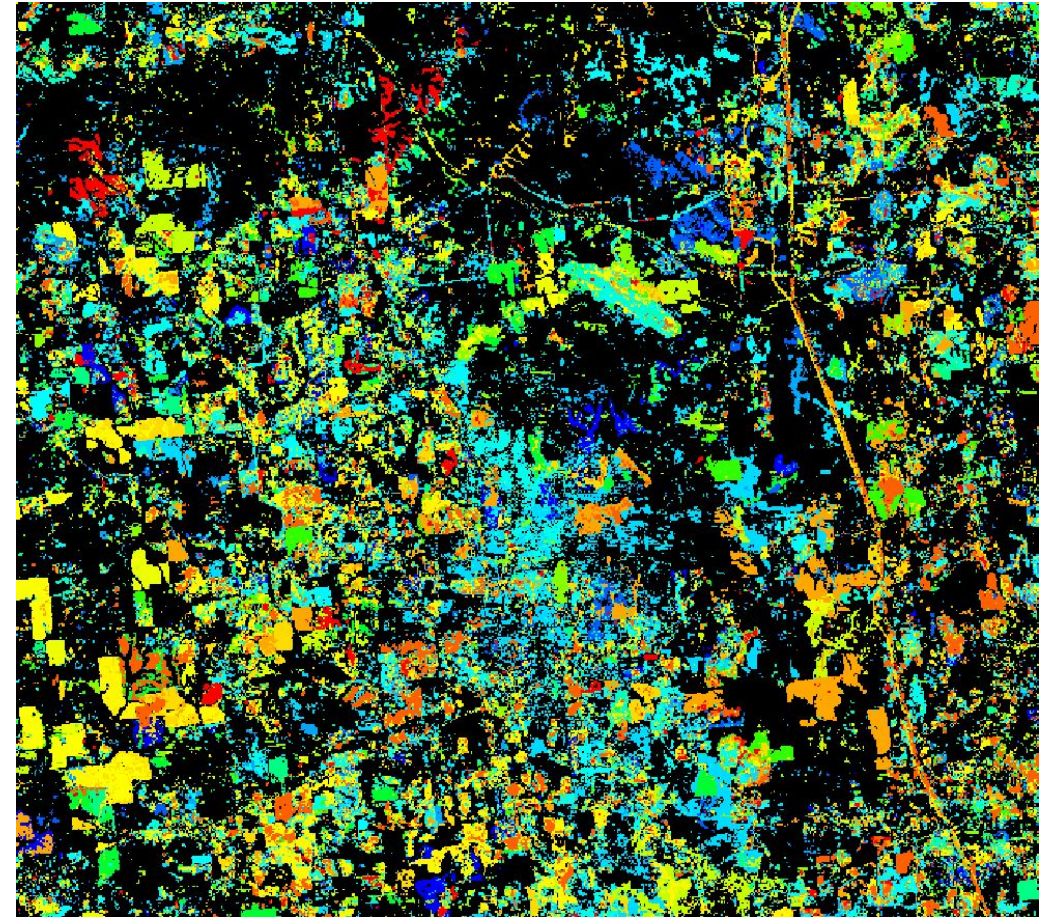
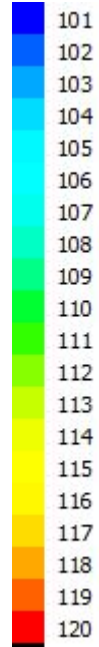
Latest\_Disturbance\_Year\_2001\_2020



# Time series of change detection using composite images



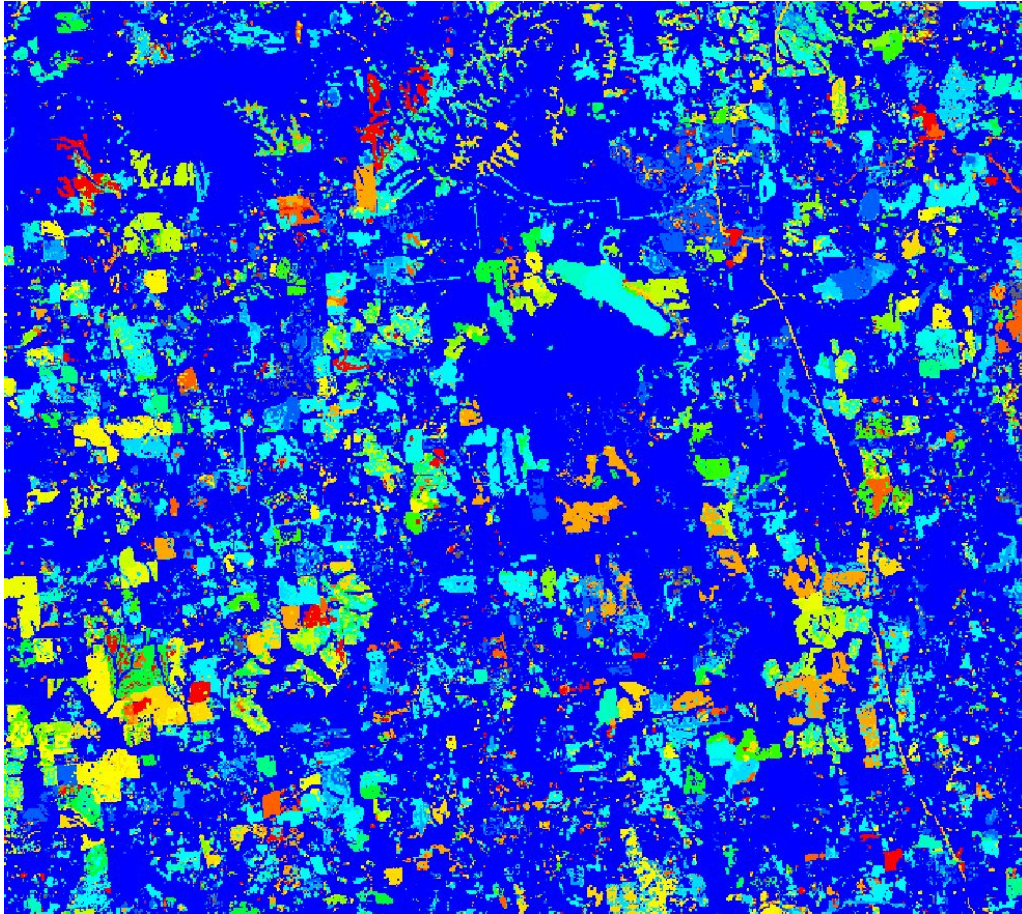
Earliest\_Disturbance\_Year\_2001\_2020



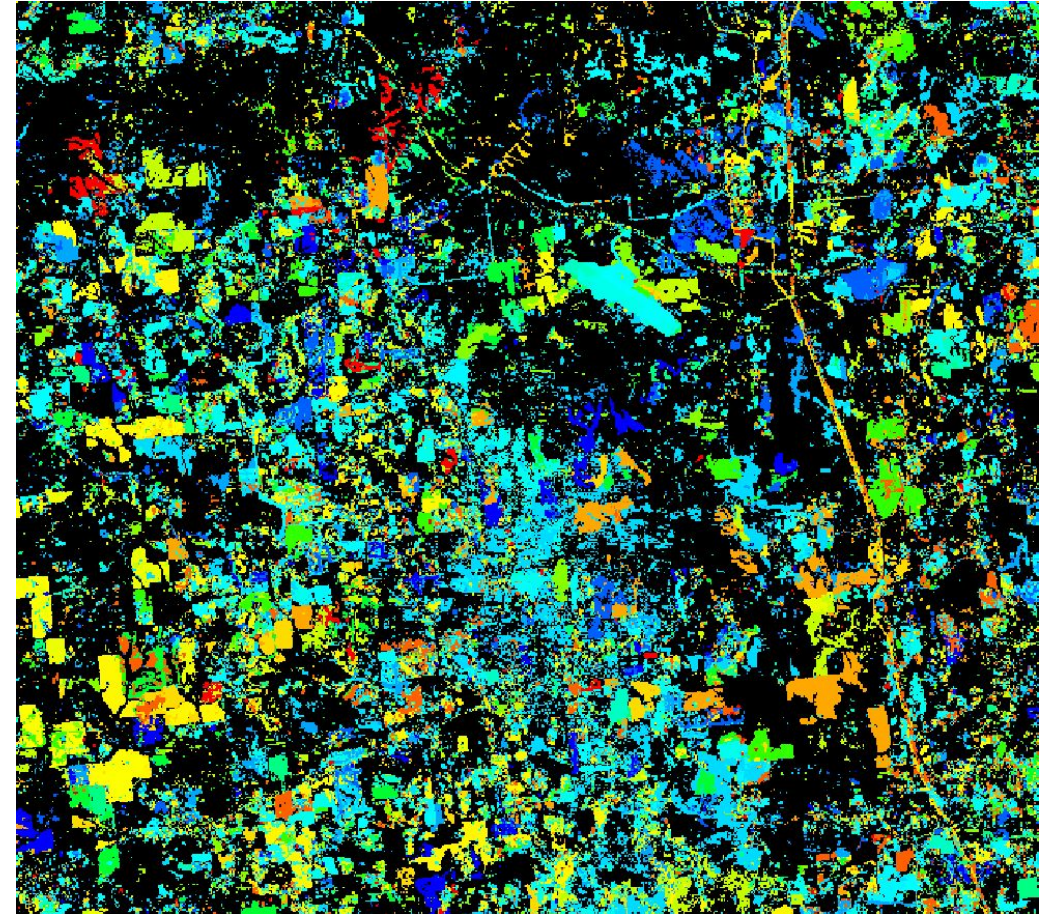
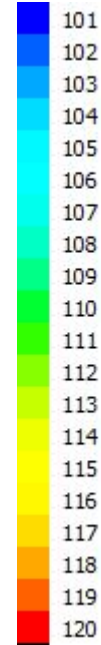
Latest\_Disturbance\_Year\_2001\_2020



# Disturbance year with maximum magnitude of 2001-2020



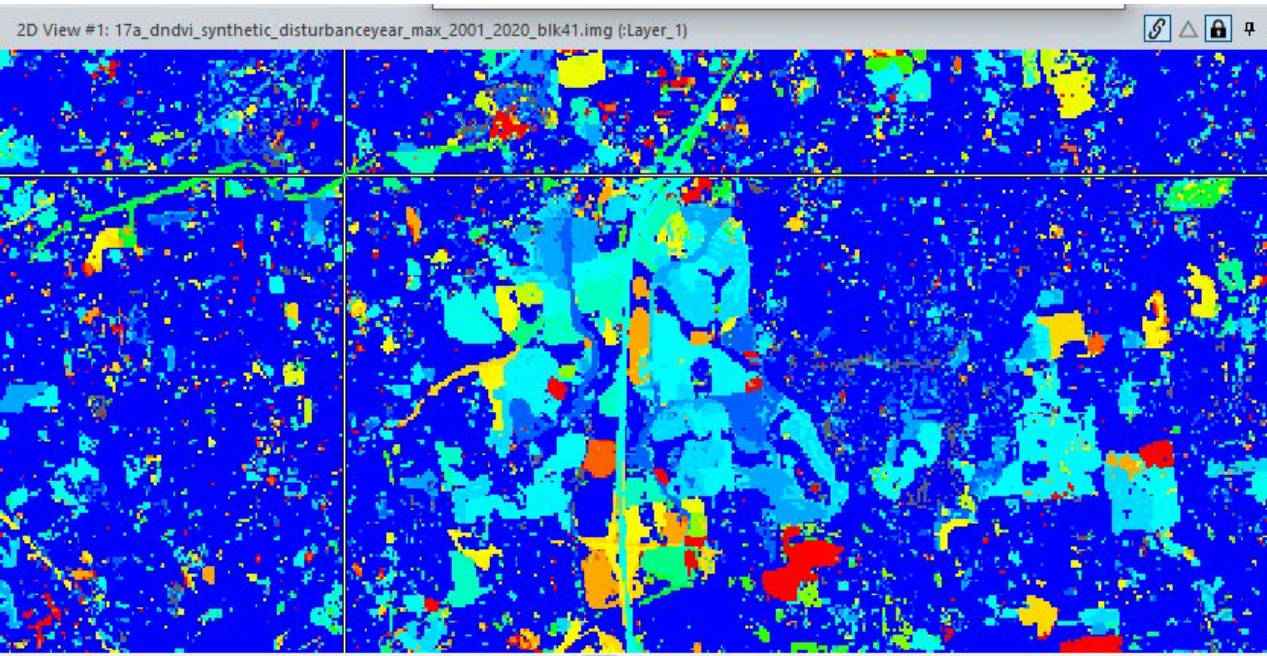
Synthetic Image



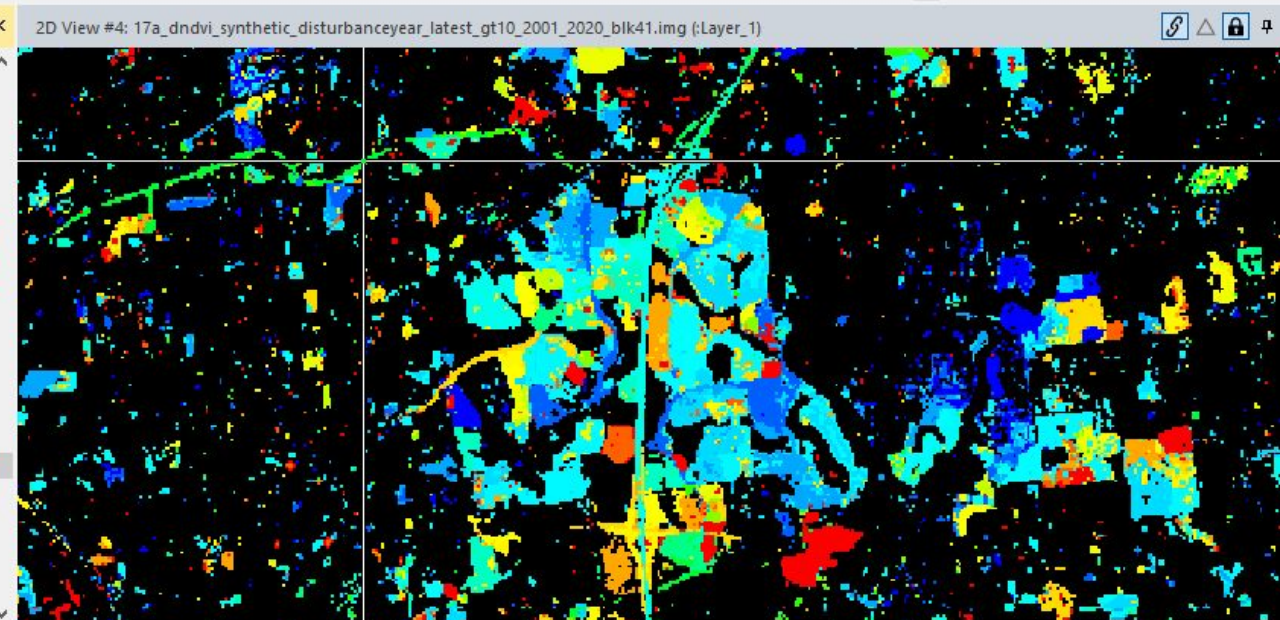
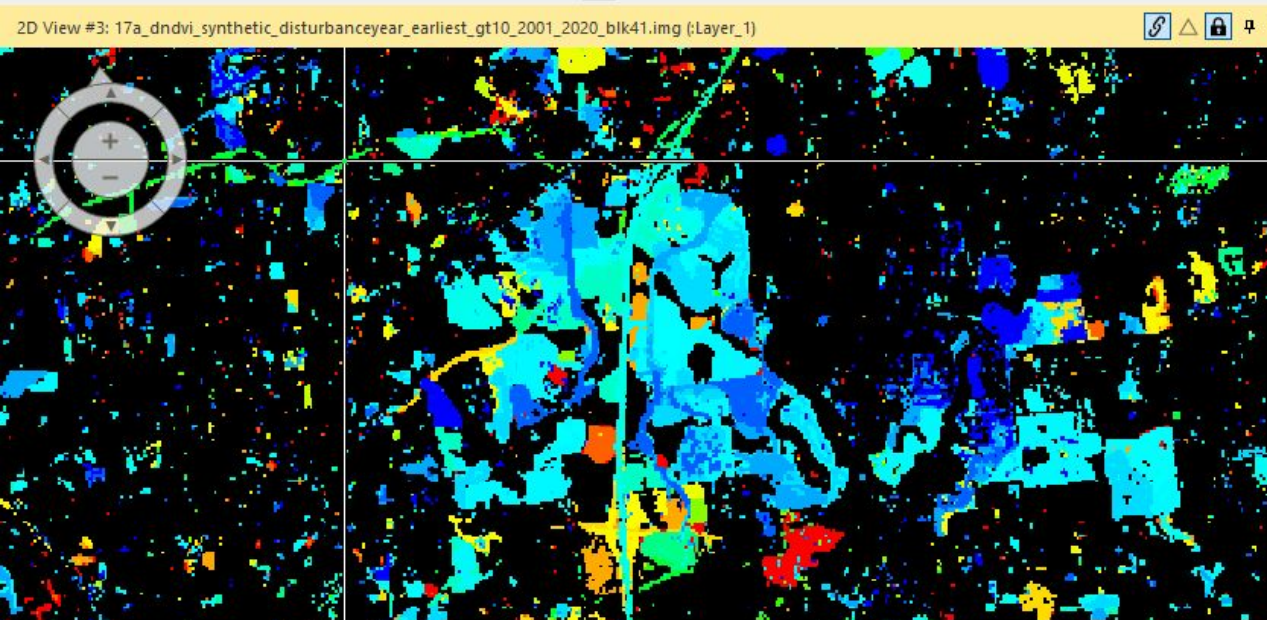
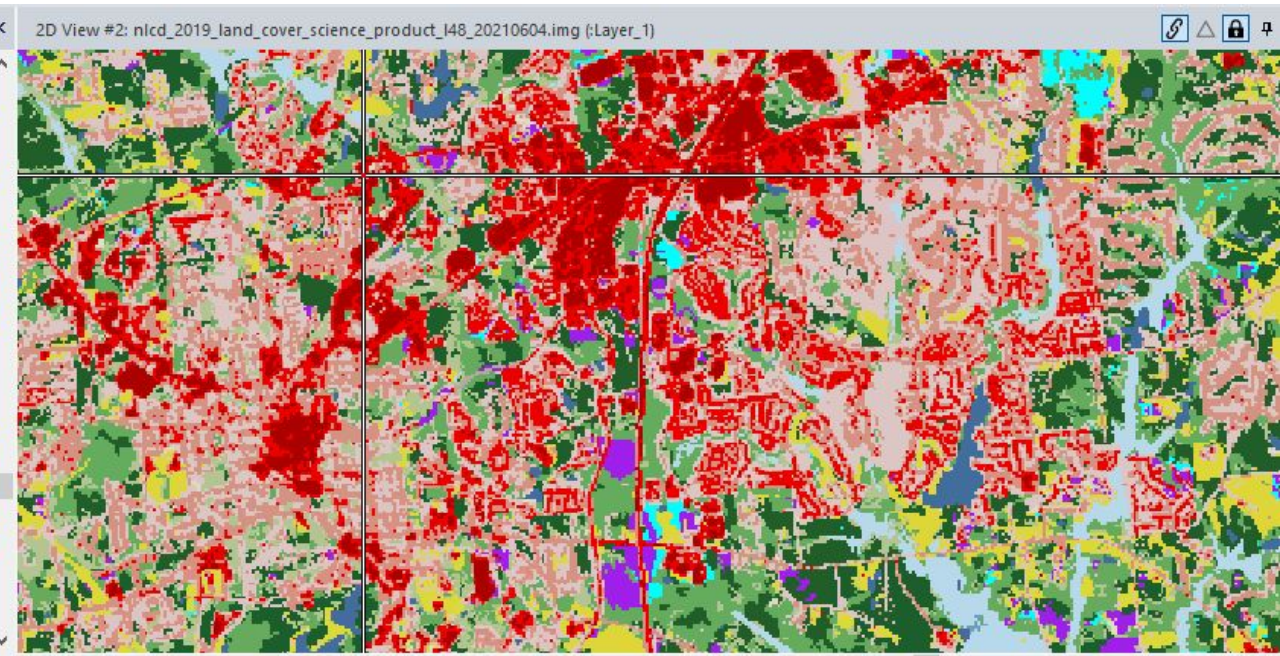
Composite image



Max\_Disturbance\_Year\_2001-2020\_Synthetic



NLCD 2019 Science Land Cover



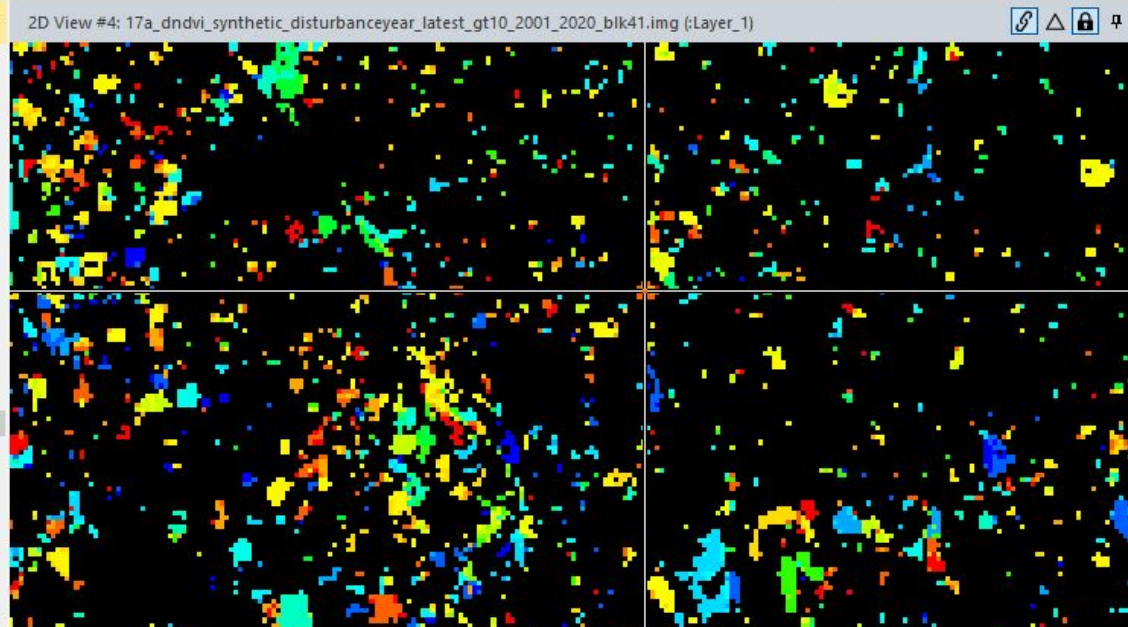
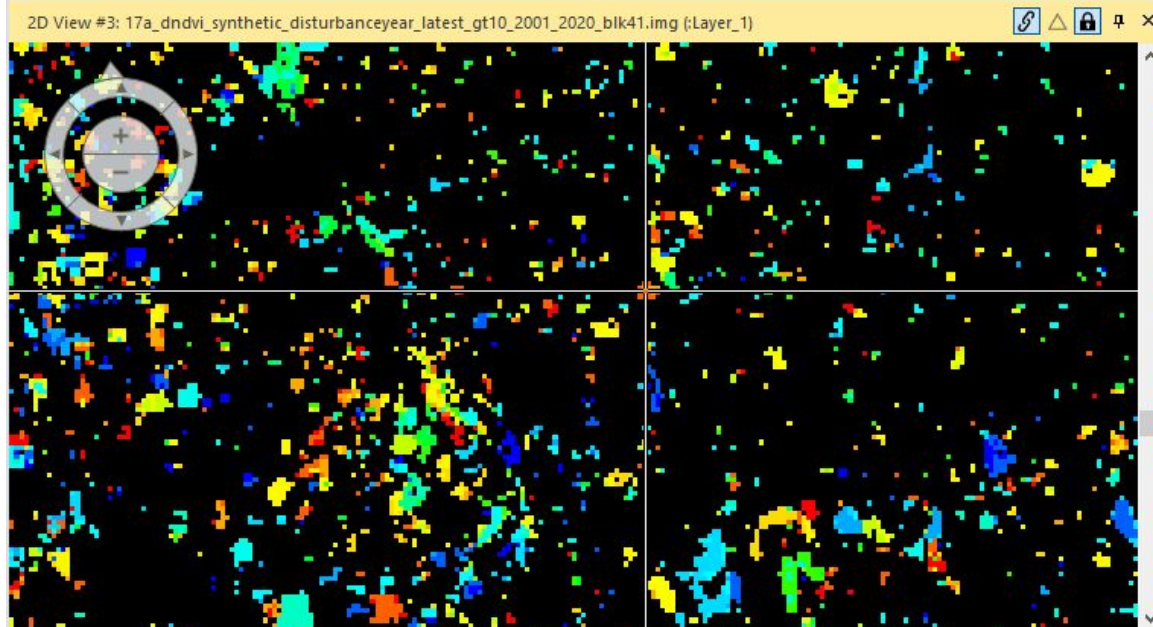
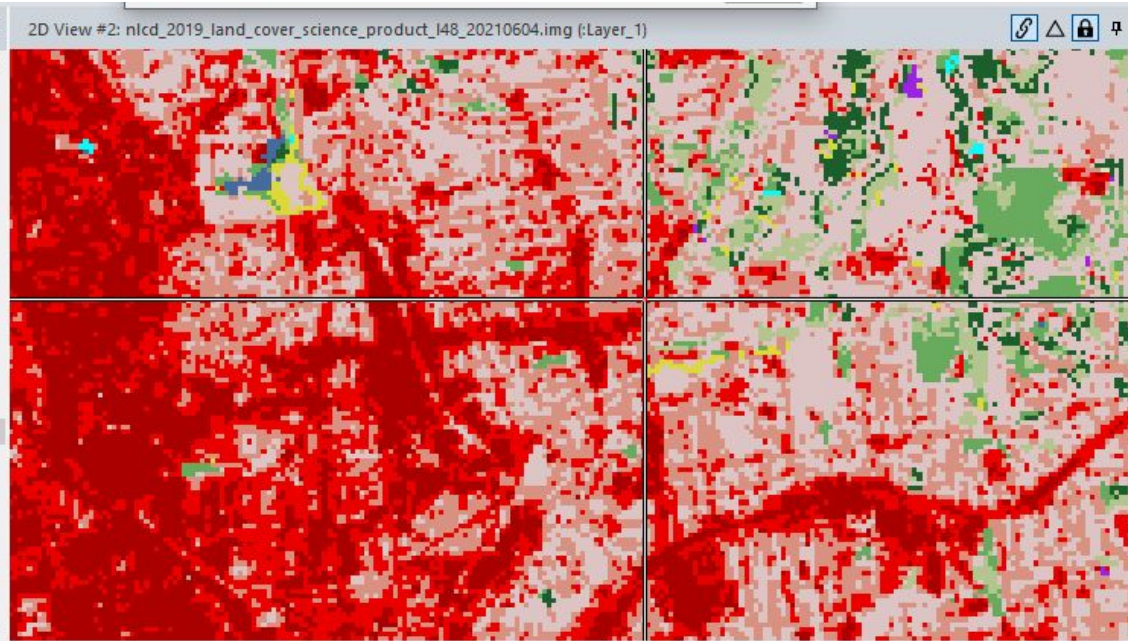
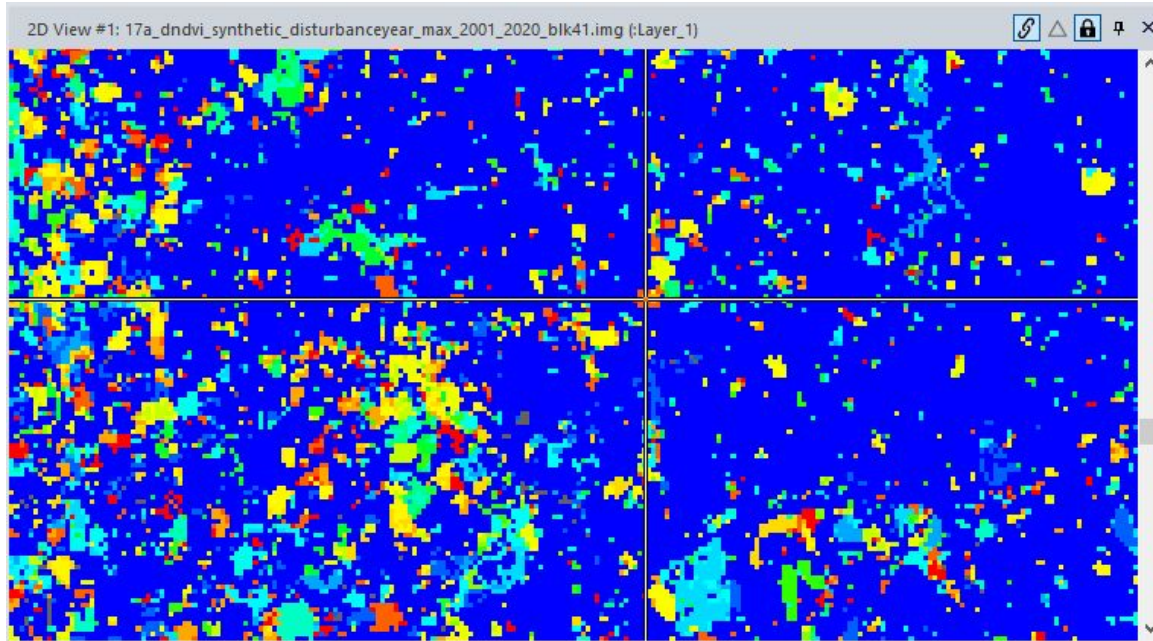
Earliest\_Disturbance\_Year\_2001\_2020\_Synthetic

Latest\_Disturbance\_Year\_2001\_2020\_Synthetic



# Max\_Disturbance\_Year\_2001-2020\_Synthetic

# NLCD 2019 Science Land Cover



Earliest\_Disturbance\_Year\_2001\_2020\_Synthetic

Latest\_Disturbance\_Year\_2001\_2020\_Synthetic



# Google Earth Images for the cursor location



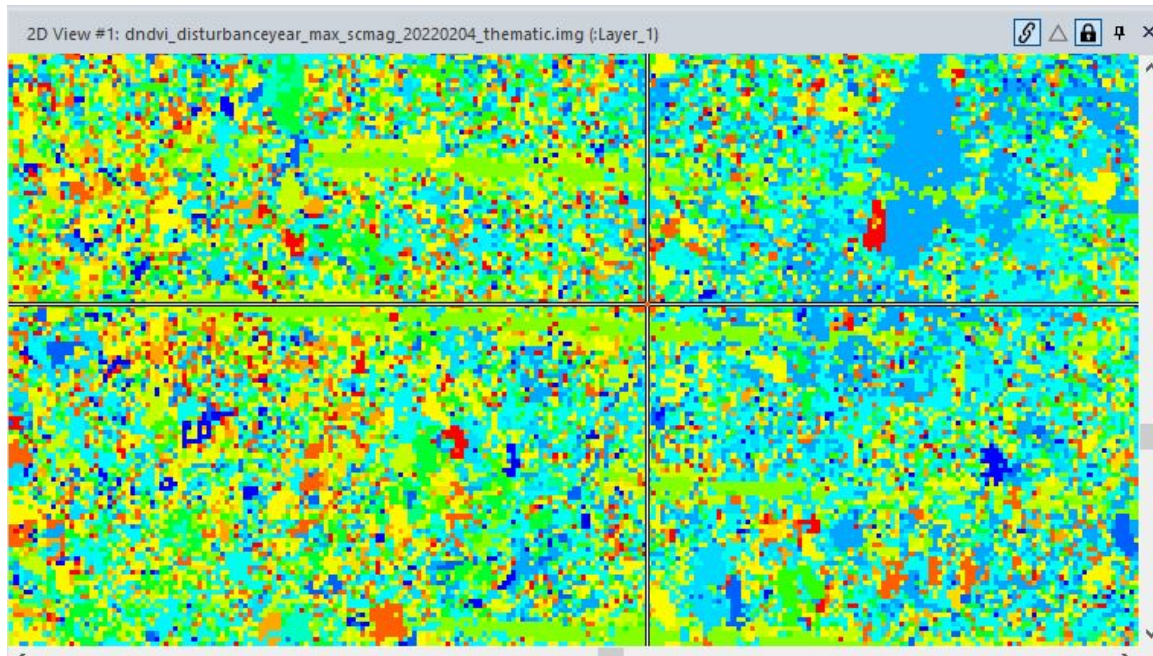
2018



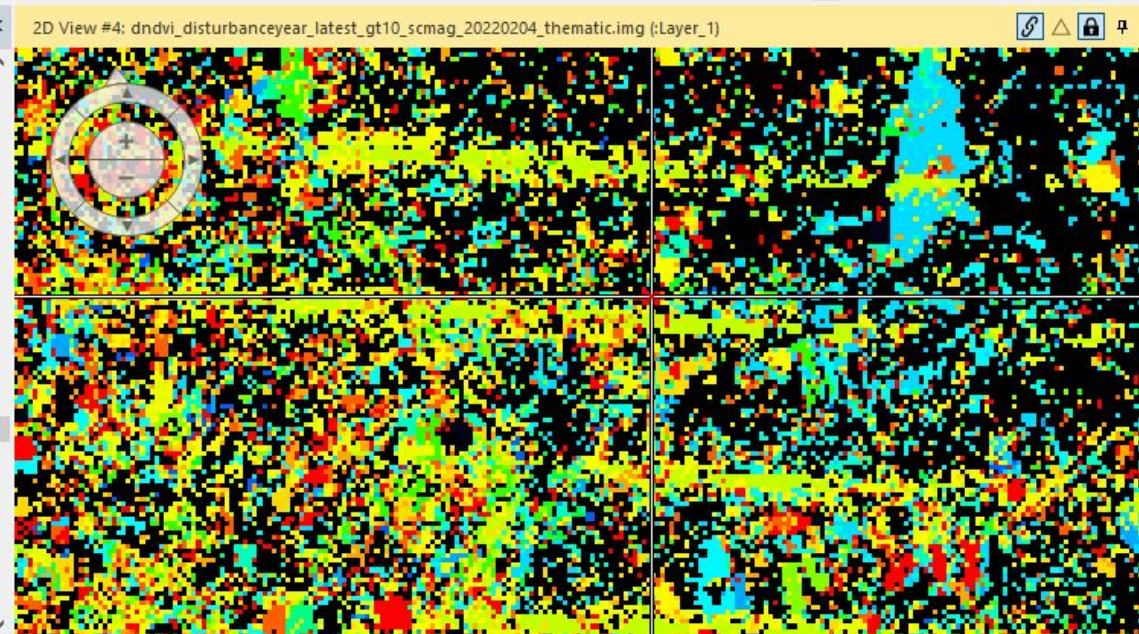
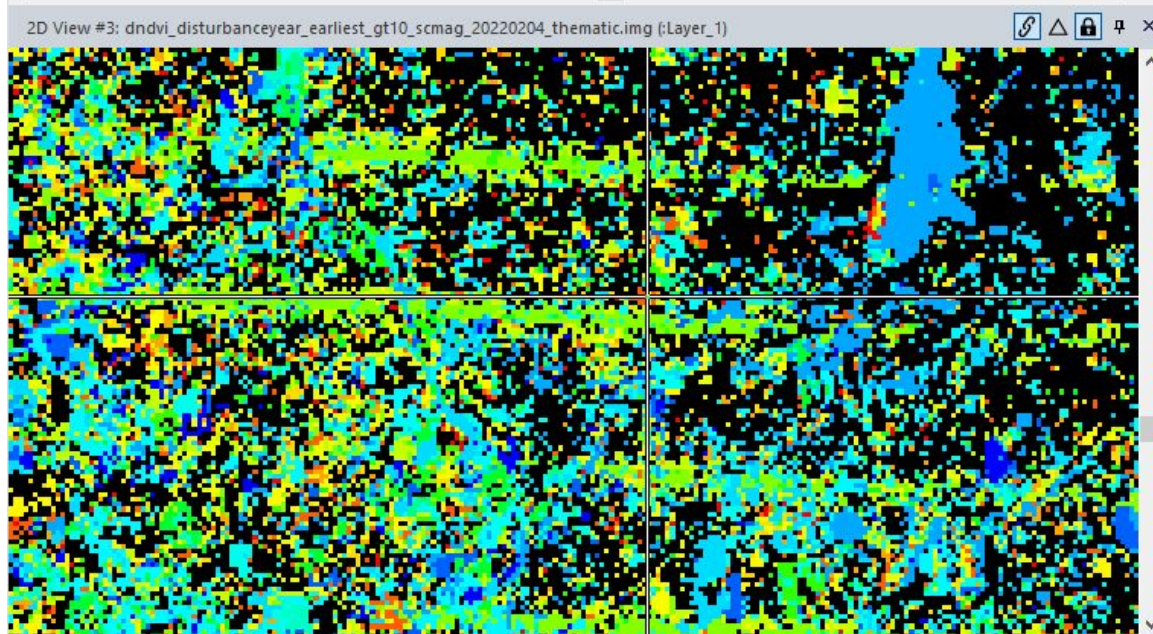
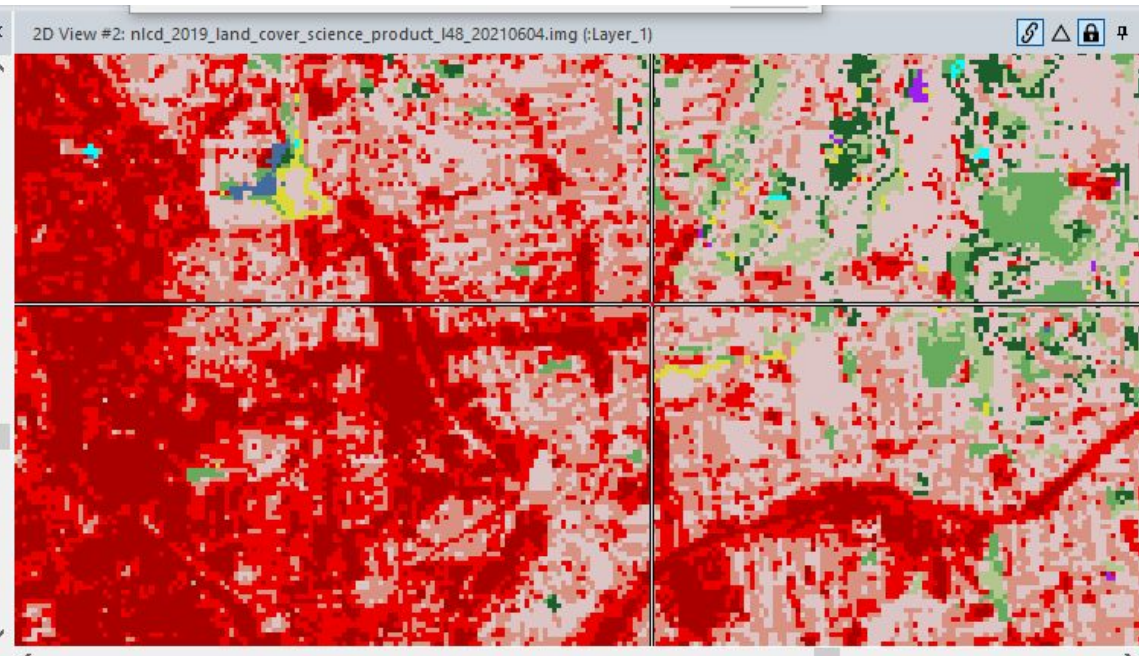
2019



Max\_Disturbance\_Year\_2001-2020\_Composite



NLCD 2019 Science Land Cover



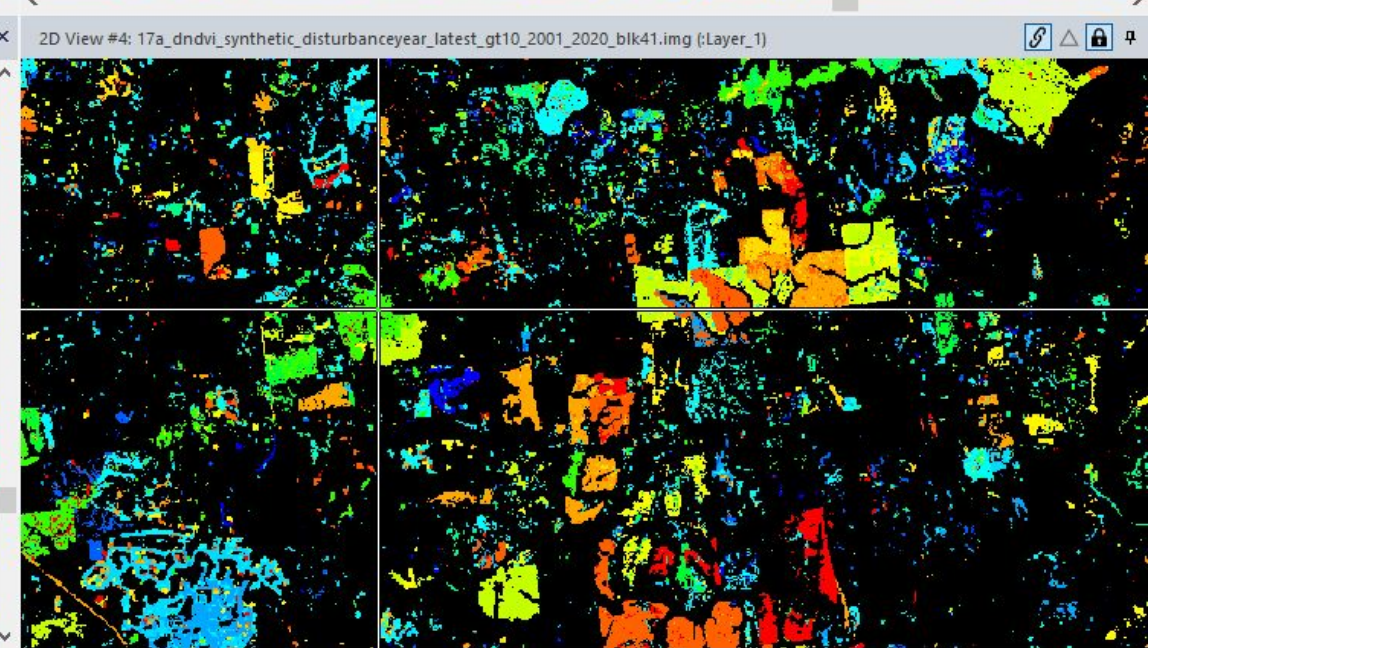
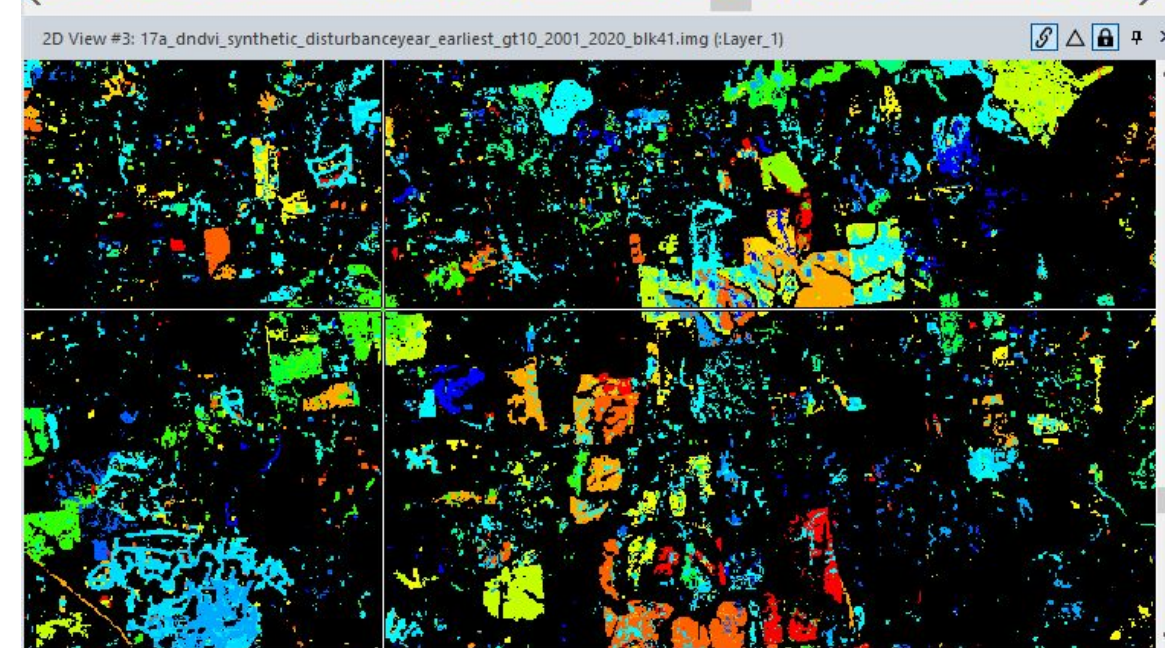
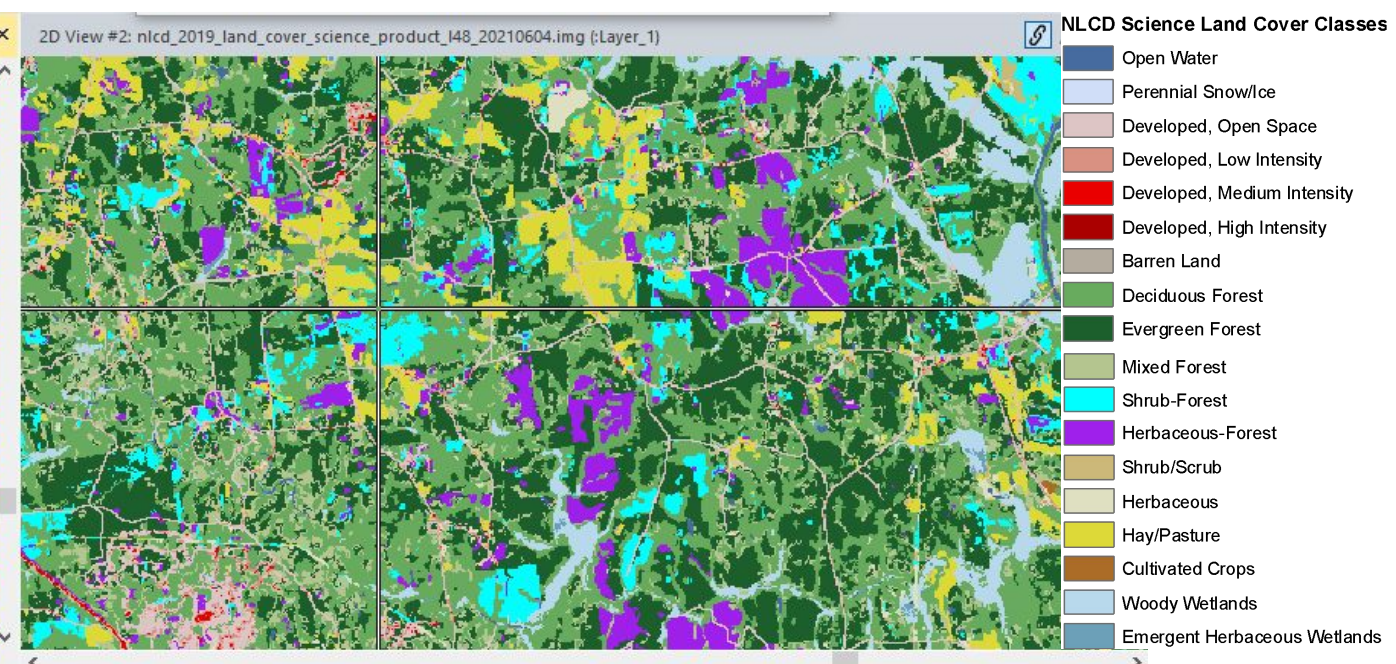
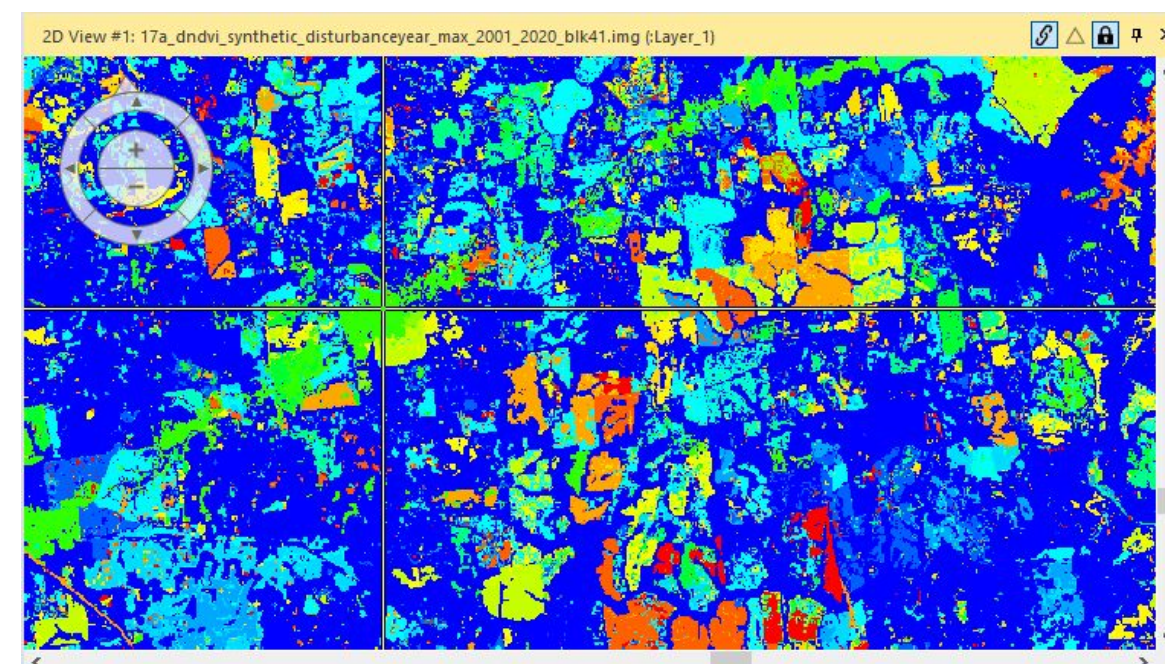
Earliest\_Disturbance\_Year\_2001\_2020\_Composite

Latest\_Disturbance\_Year\_2001\_2020\_Composite



Max\_Disturbance\_Year\_2001-2020\_Synthetic

NLCD 2019 Science Land Cover



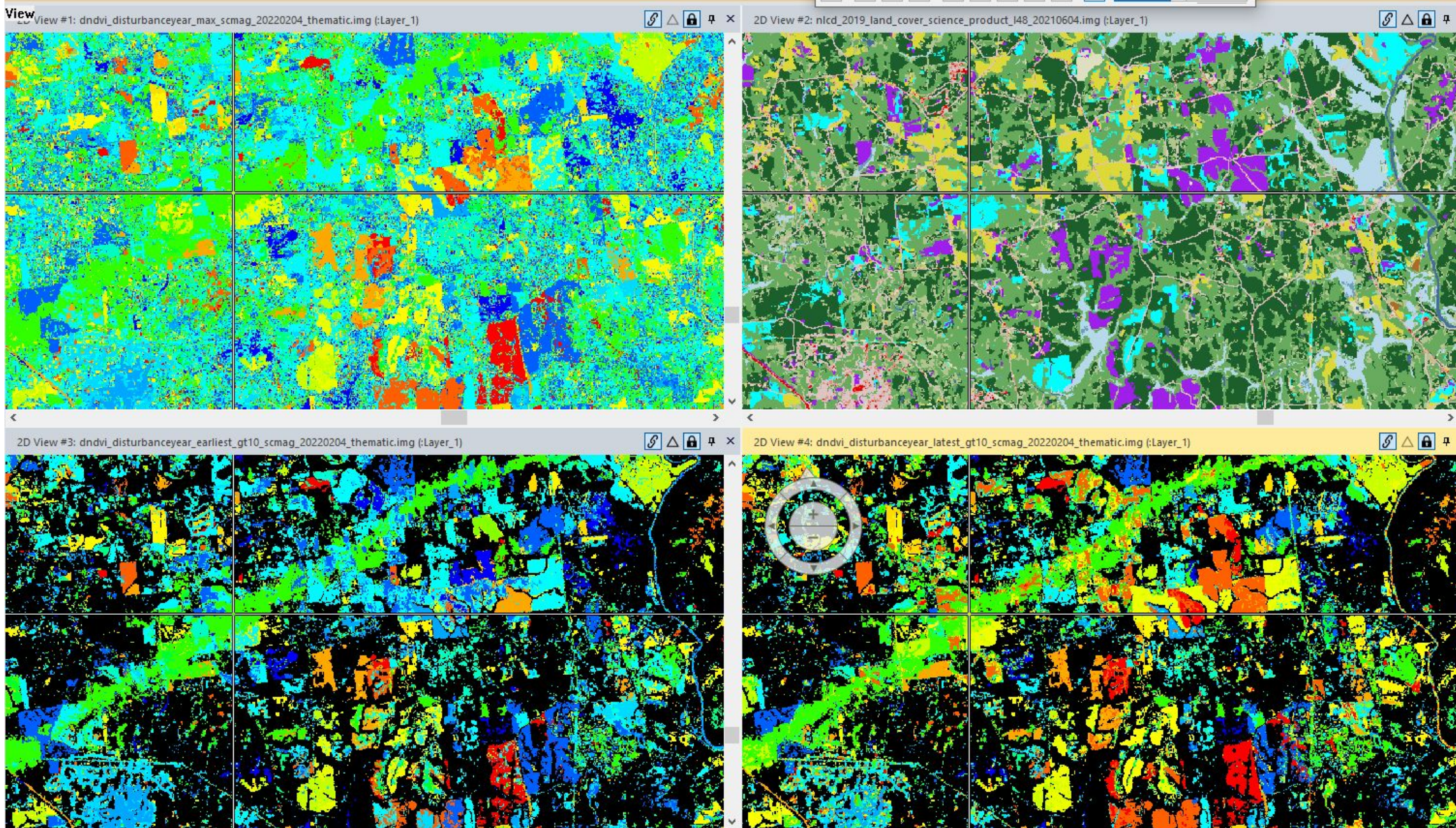
Earliest\_Disturbance\_Year\_2001\_2020\_Synthetic

Latest\_Disturbance\_Year\_2001\_2020\_Synthetic



# Max\_Disturbance\_Year\_2001-2020\_Composite

# NLCD 2019 Science Land Cover

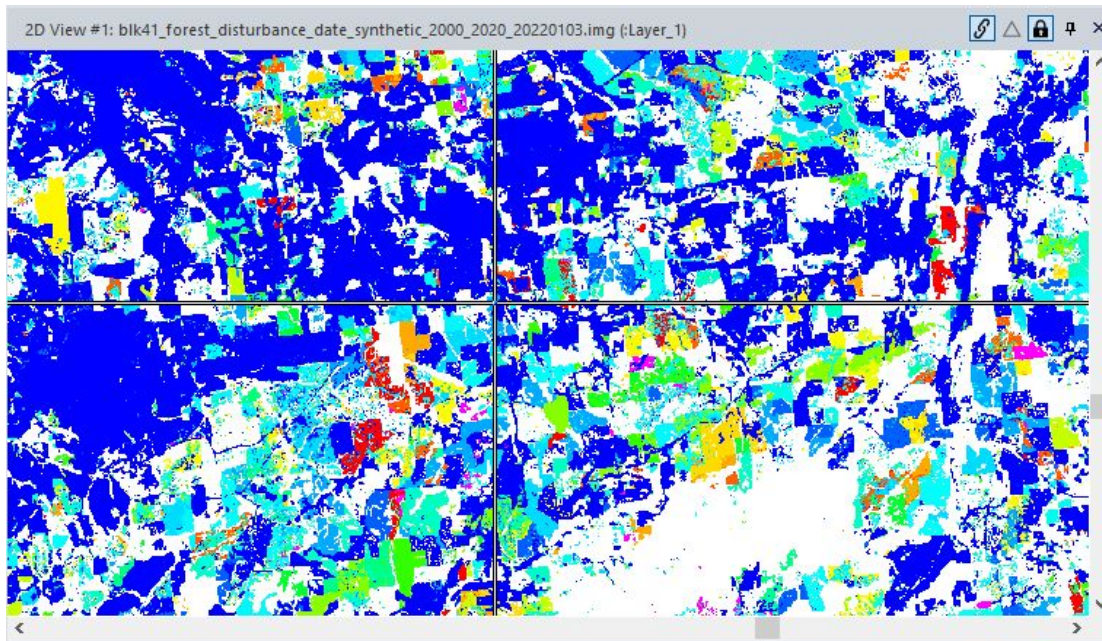


Earliest\_Disturbance\_Year\_2001\_2020\_Composite

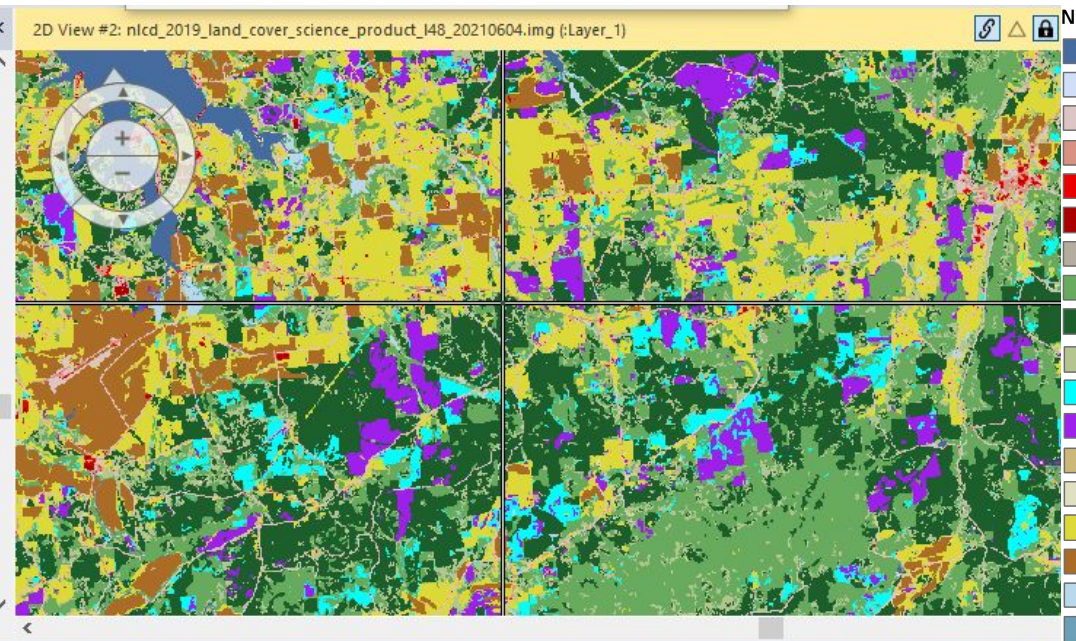
Latest\_Disturbance\_Year\_2001\_2020\_Composite



Forest\_Disturbance\_Year\_2001-2020\_Synthetic

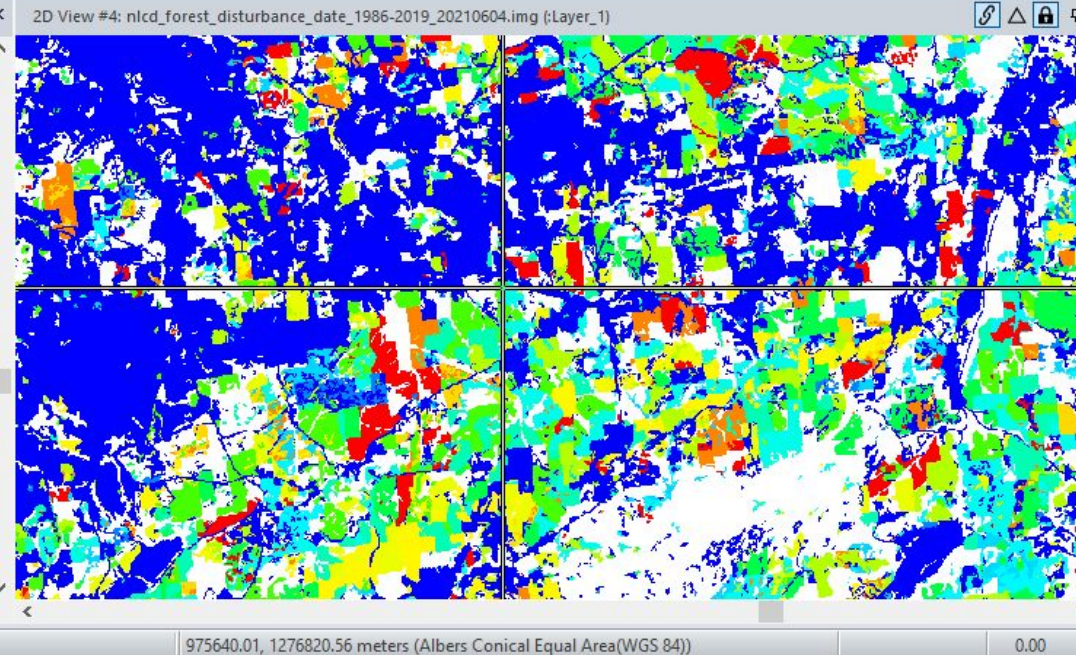
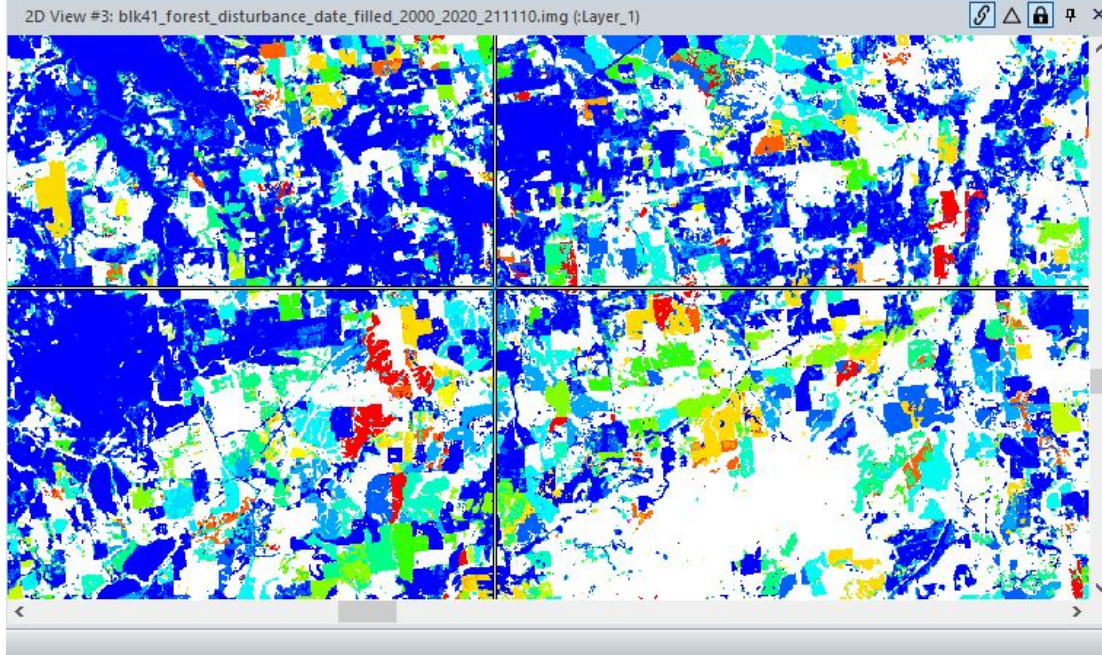


NLCD 2019 Science Land Cover



NLCD Science Land Cover Classes

- Open Water
- Perennial Snow/Ice
- Developed, Open Space
- Developed, Low Intensity
- Developed, Medium Intensity
- Developed, High Intensity
- Barren Land
- Deciduous Forest
- Evergreen Forest
- Mixed Forest
- Shrub-Forest
- Herbaceous-Forest
- Shrub/Scrub
- Herbaceous
- Hay/Pasture
- Cultivated Crops
- Woody Wetlands
- Emergent Herbaceous Wetlands



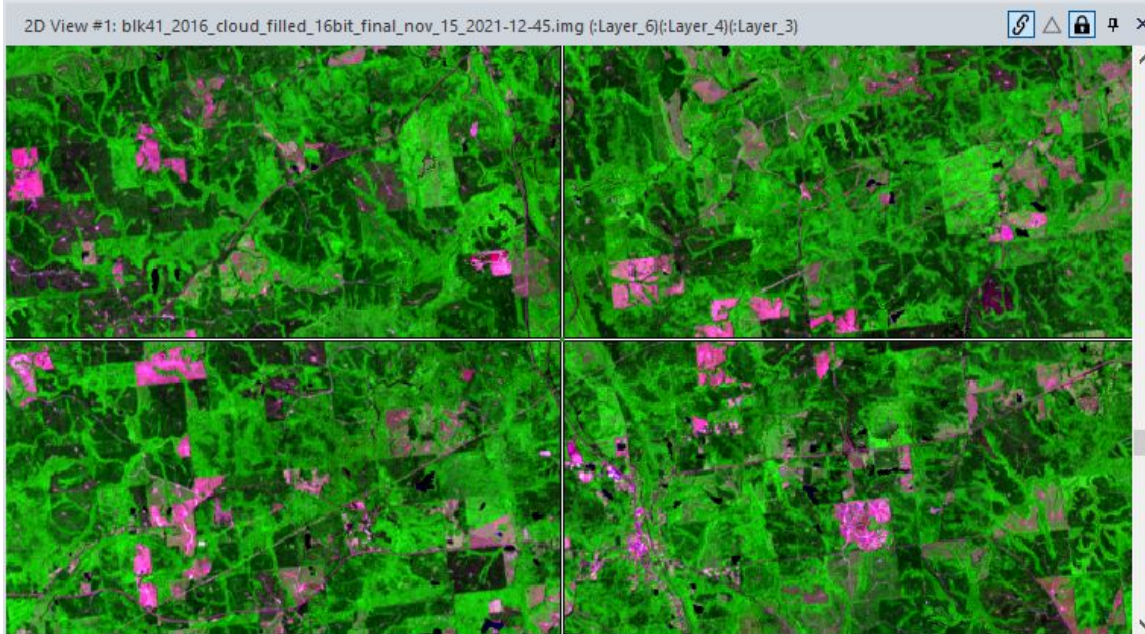
975640.01, 1276820.56 meters (Albers Conical Equal Area(WGS 84)) 0.00

Forest\_Disturbance\_Year\_2001-2020\_Composite

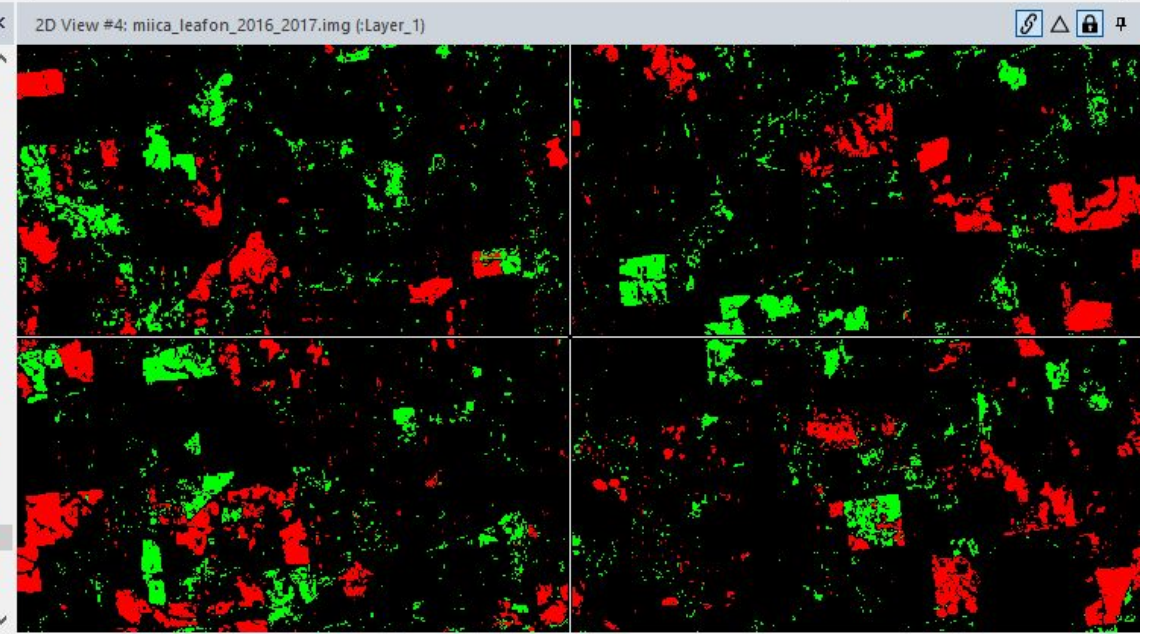
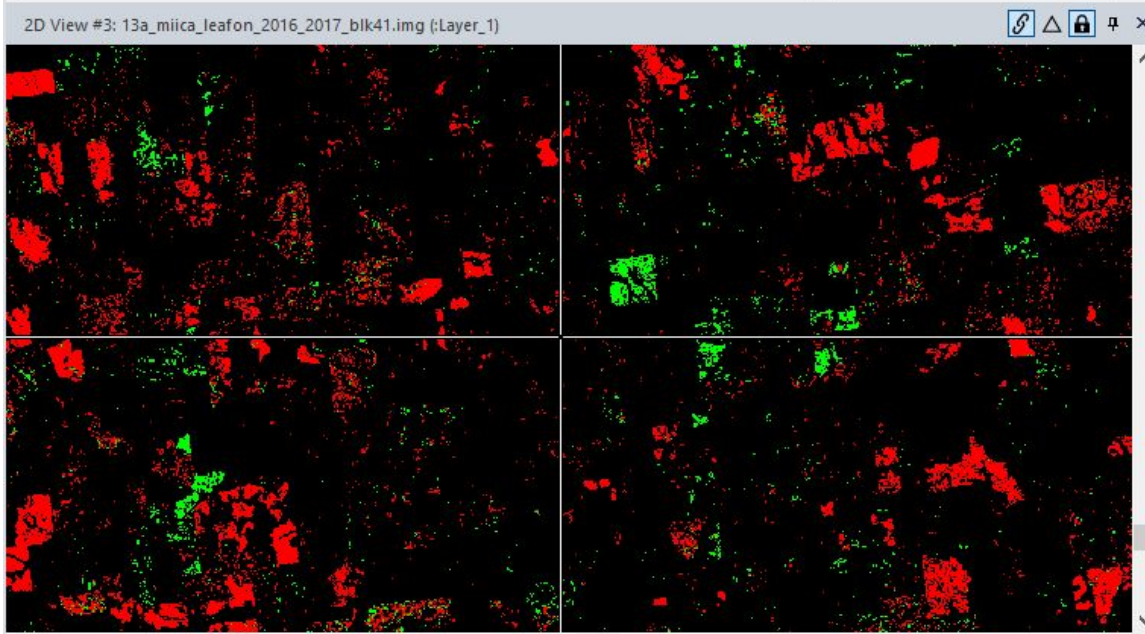
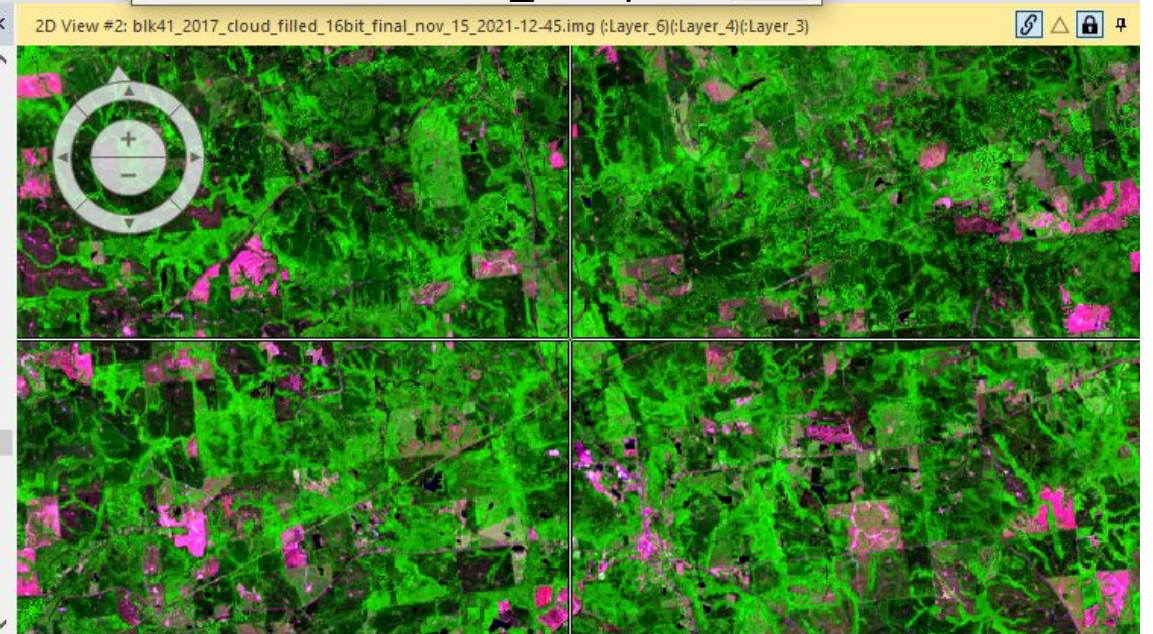
NLCD\_Forest\_Disturbance\_Year\_1986\_2019 (2-3-year interval)



# 2016\_Composite



# 2017\_Composite

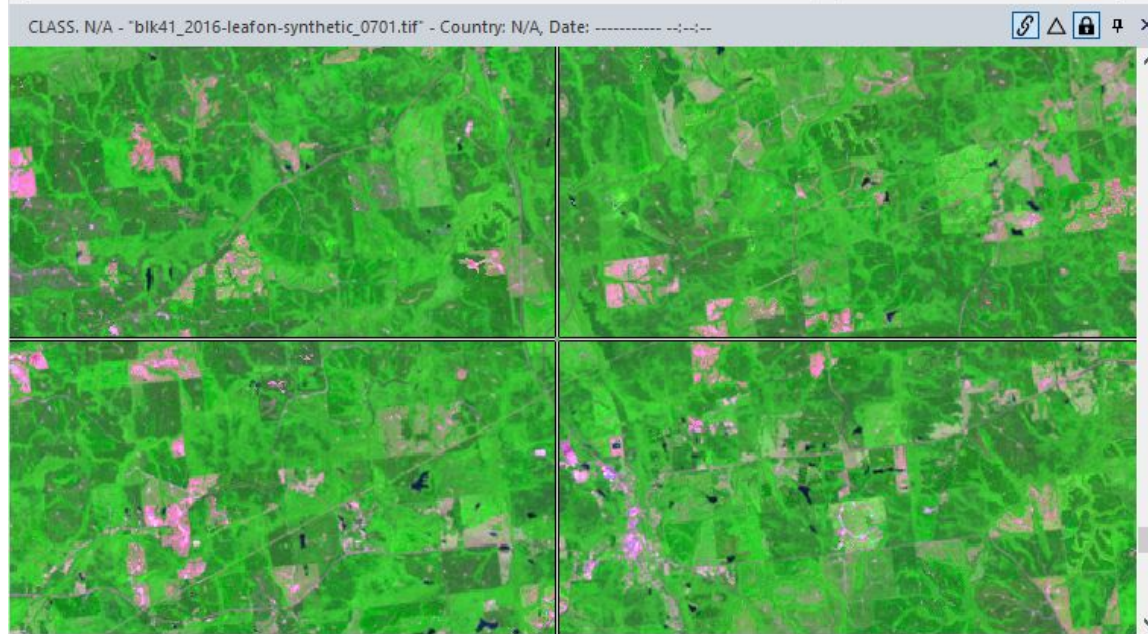
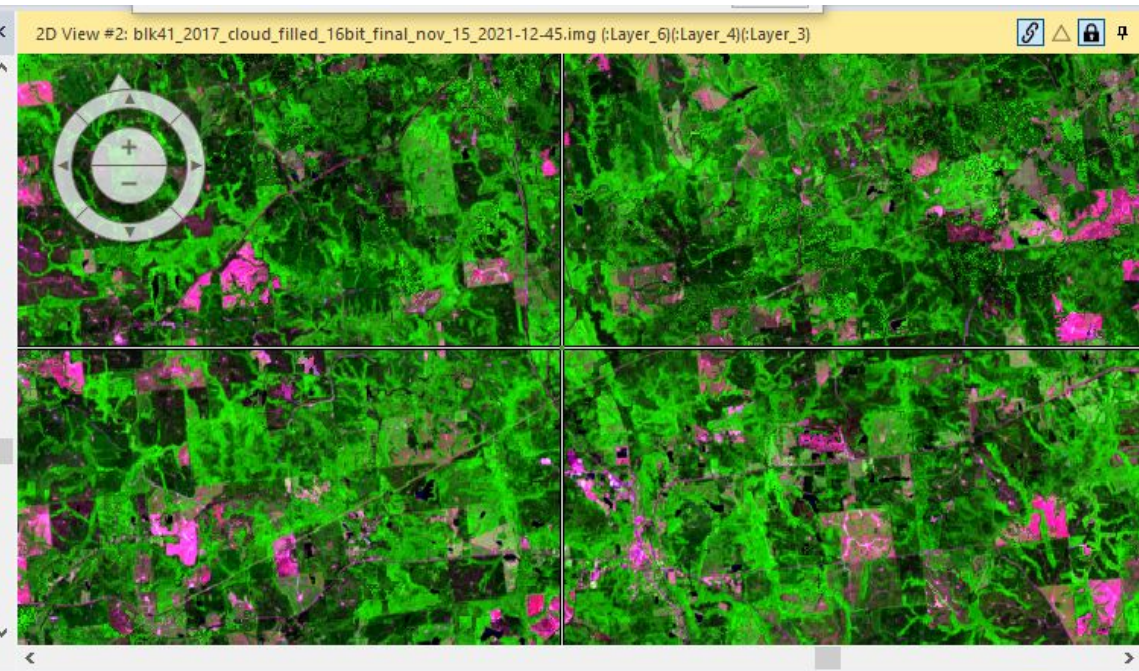


MIICA\_2016\_2017\_Synthetic

MIICA\_2016\_2017\_composite



# 2016\_Composite

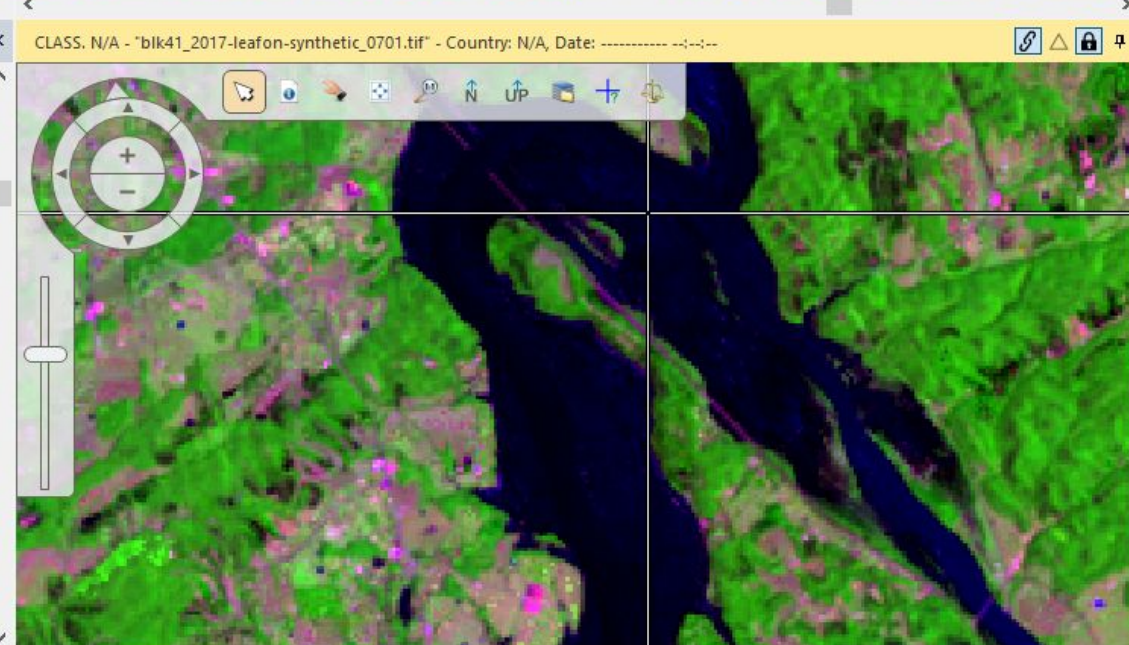
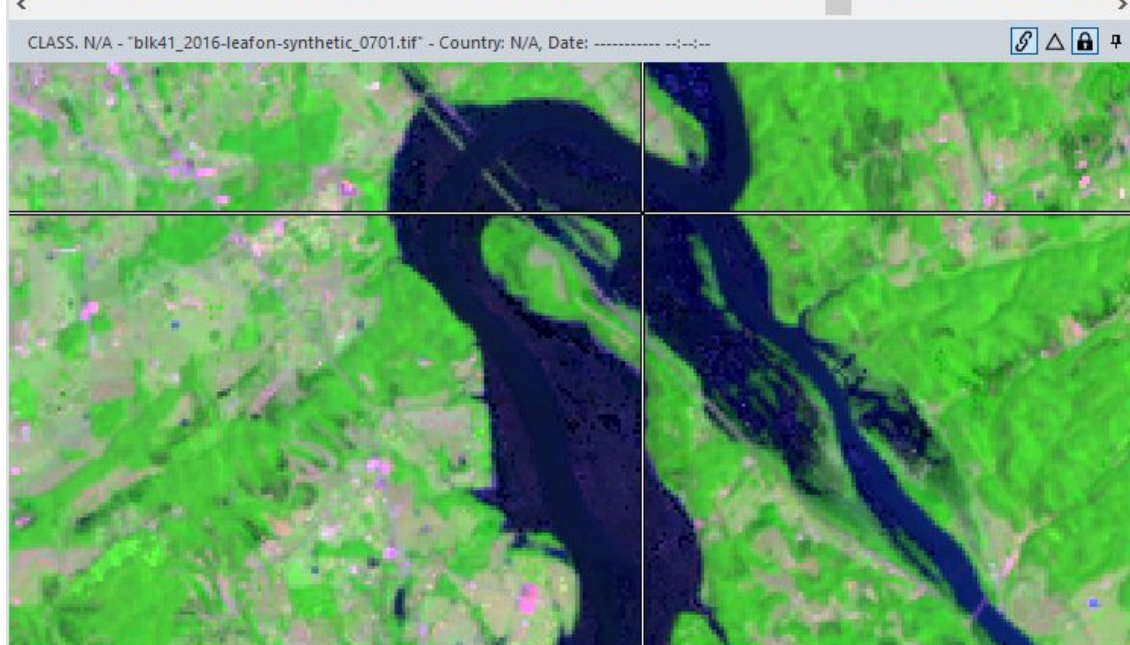
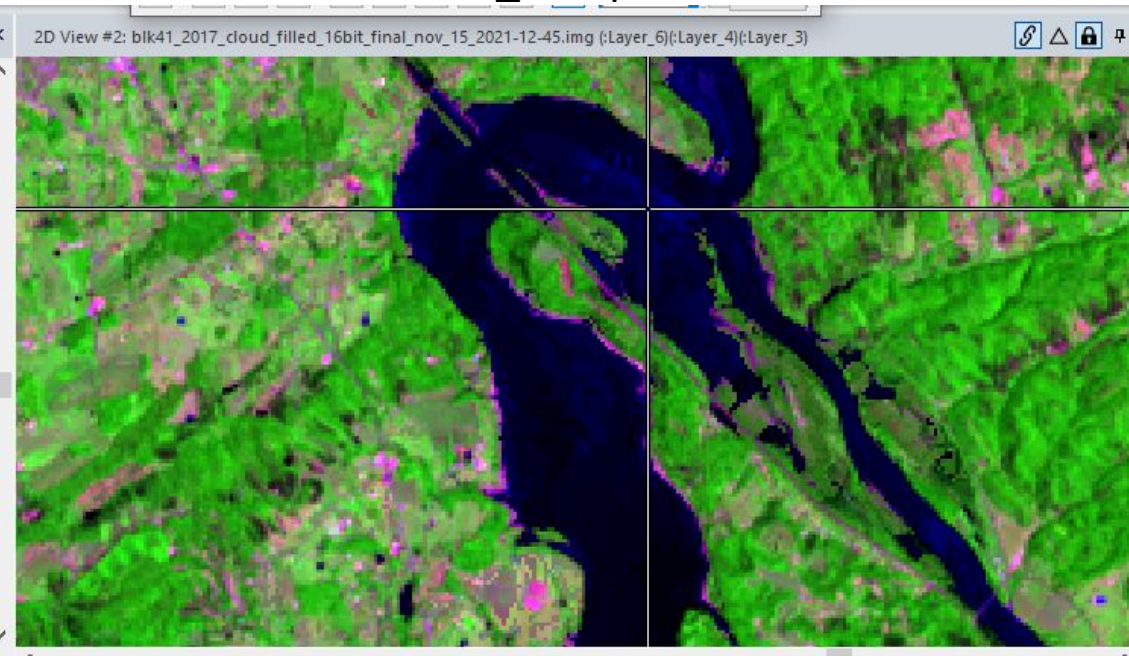
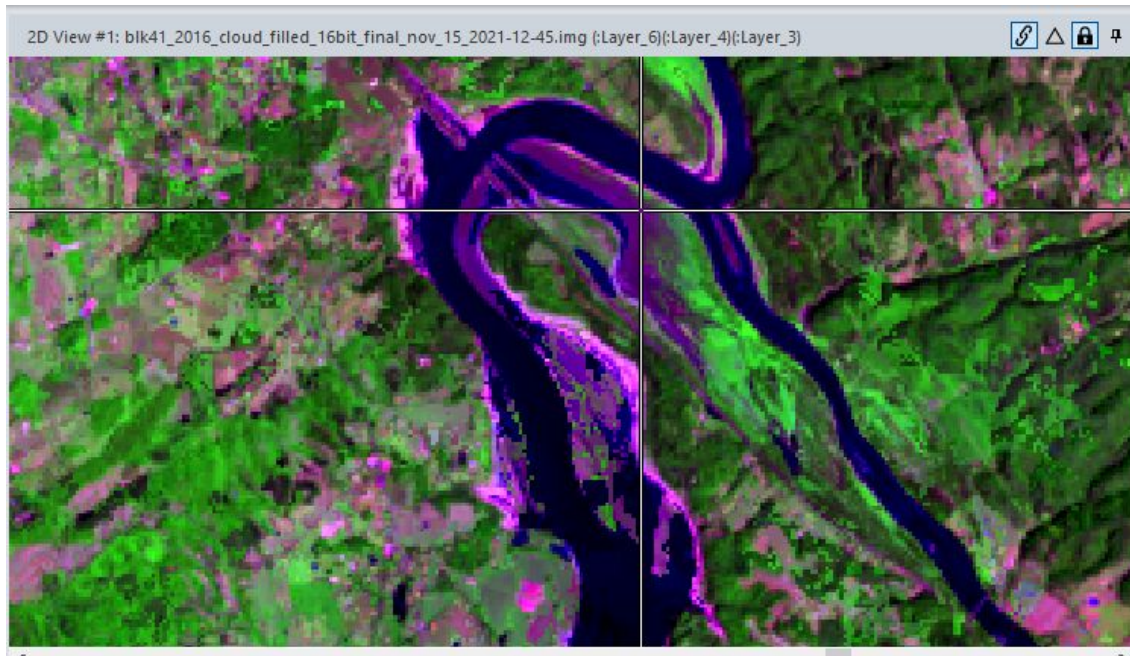


2016\_Synthetic

2017\_Synthetic



# 2016\_Composite



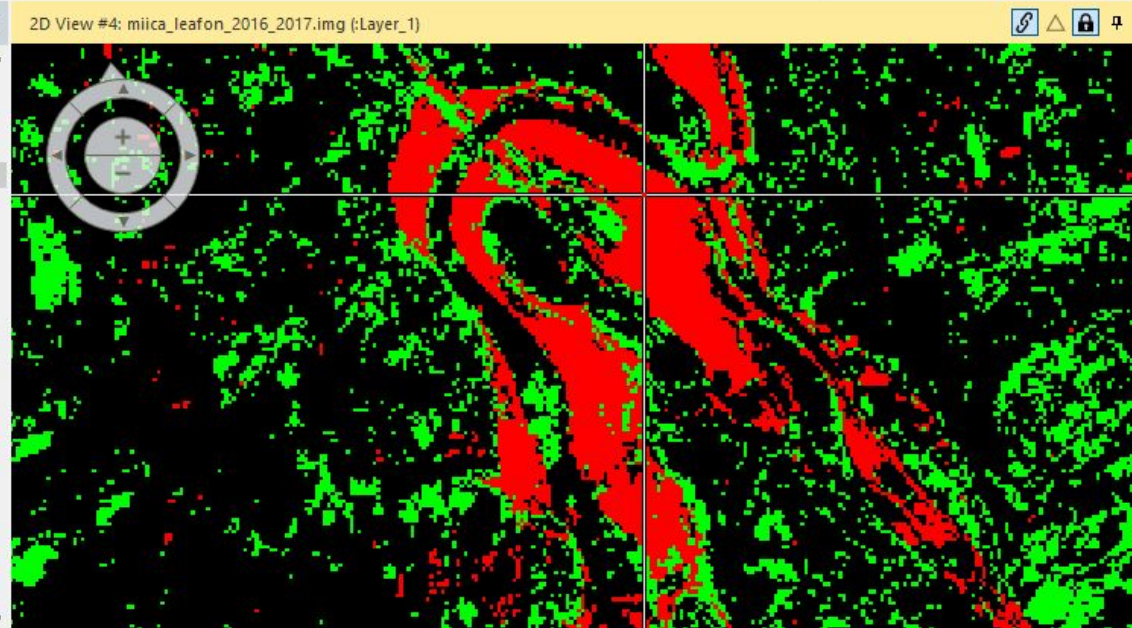
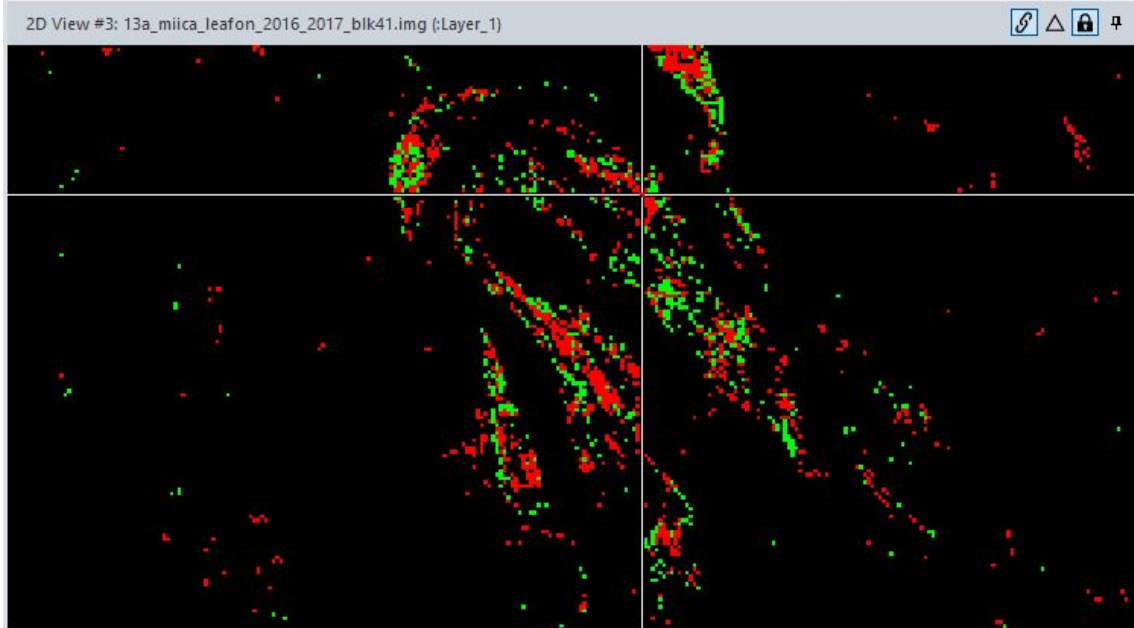
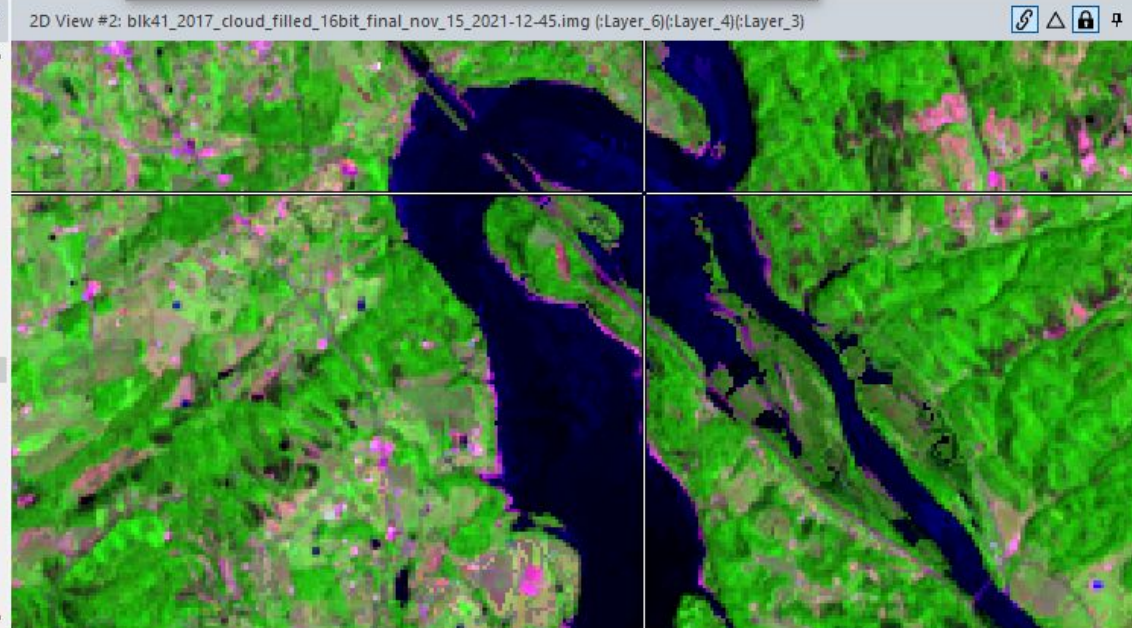
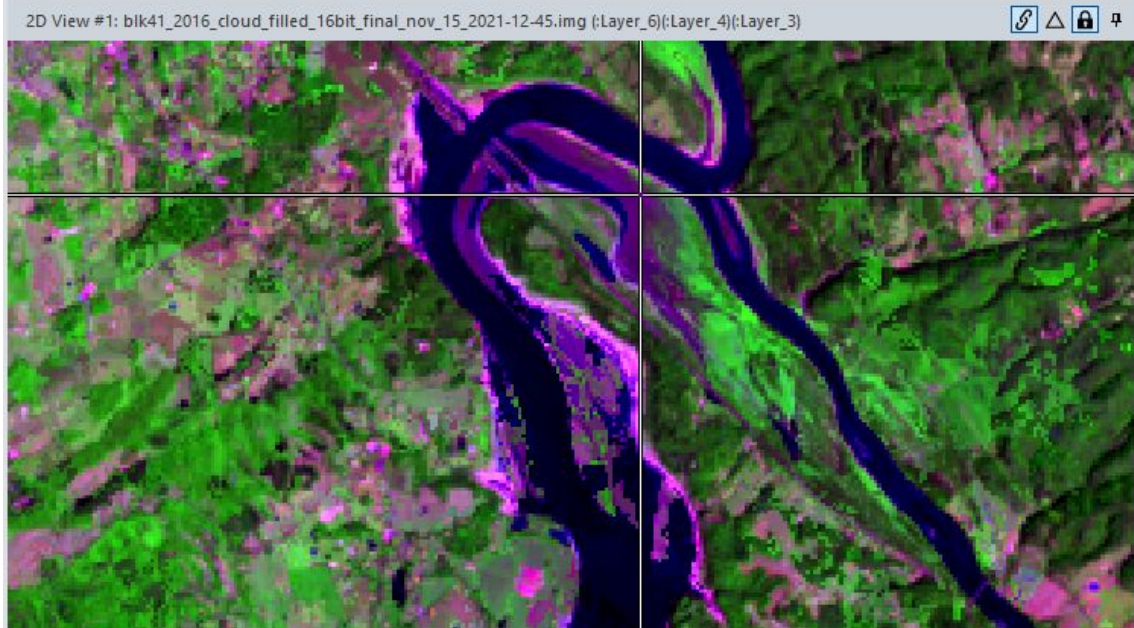
2016\_Synthetic

2017\_Synthetic



# 2016\_Composite

# 2017\_Composite



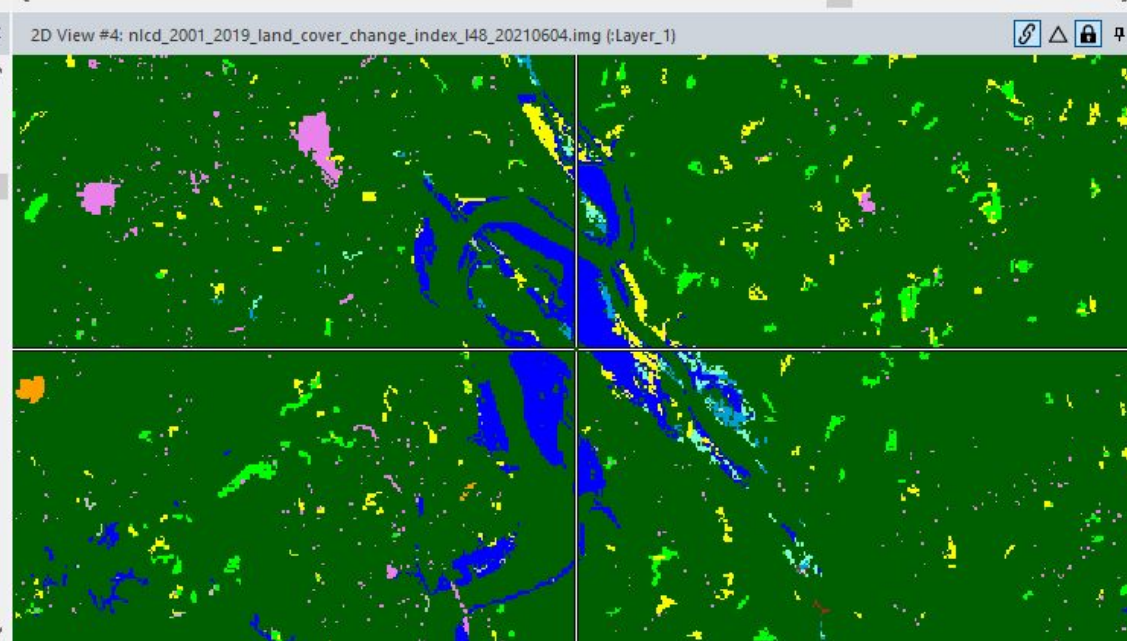
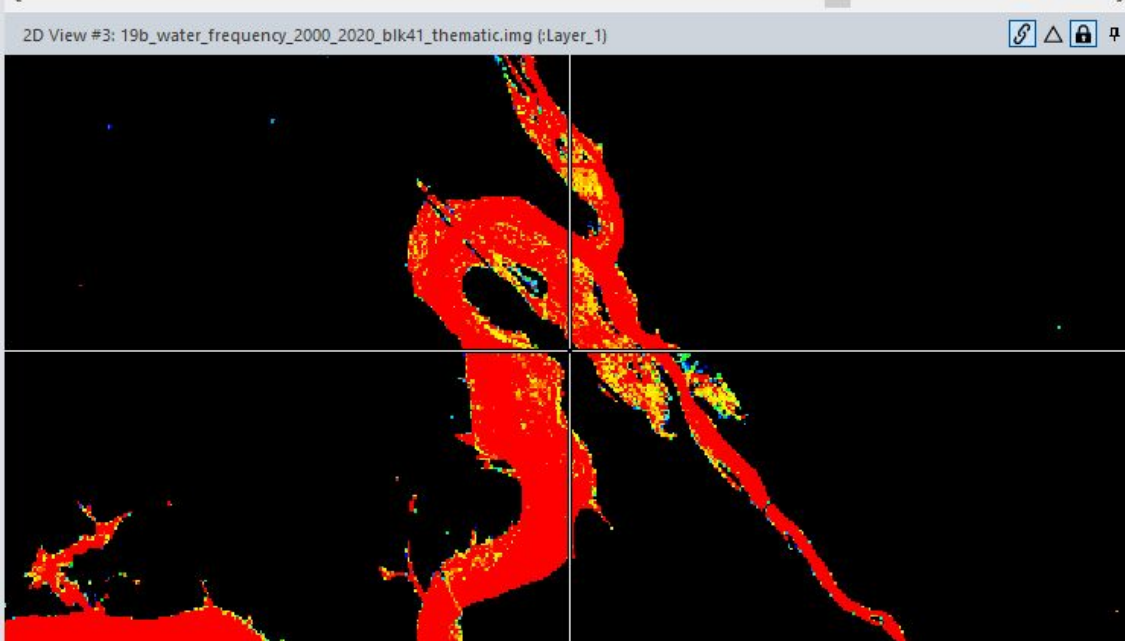
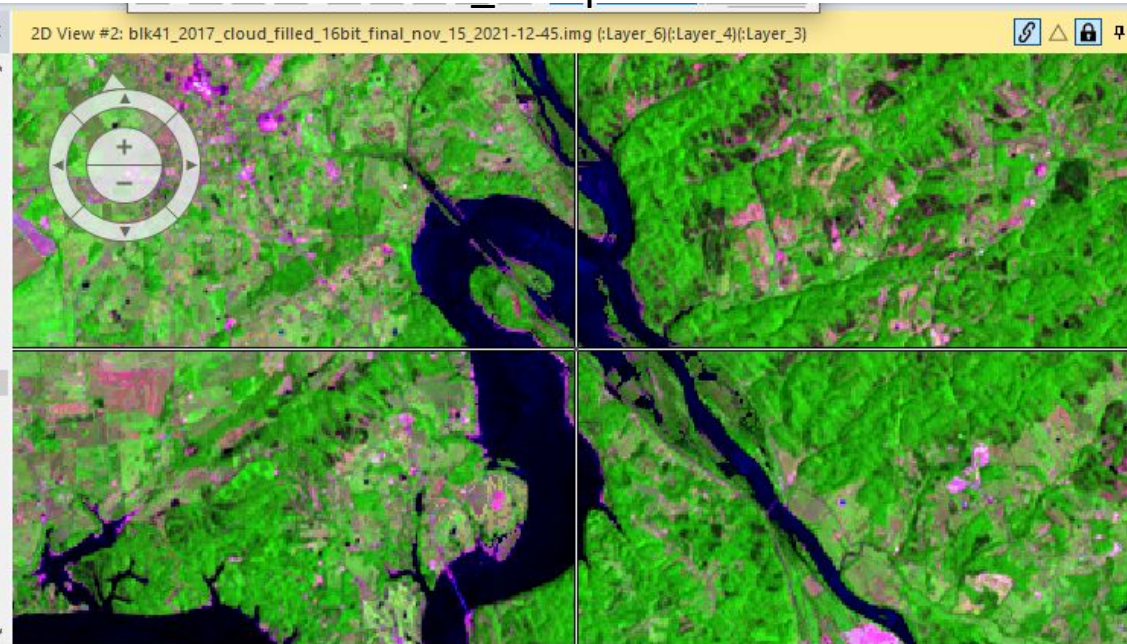
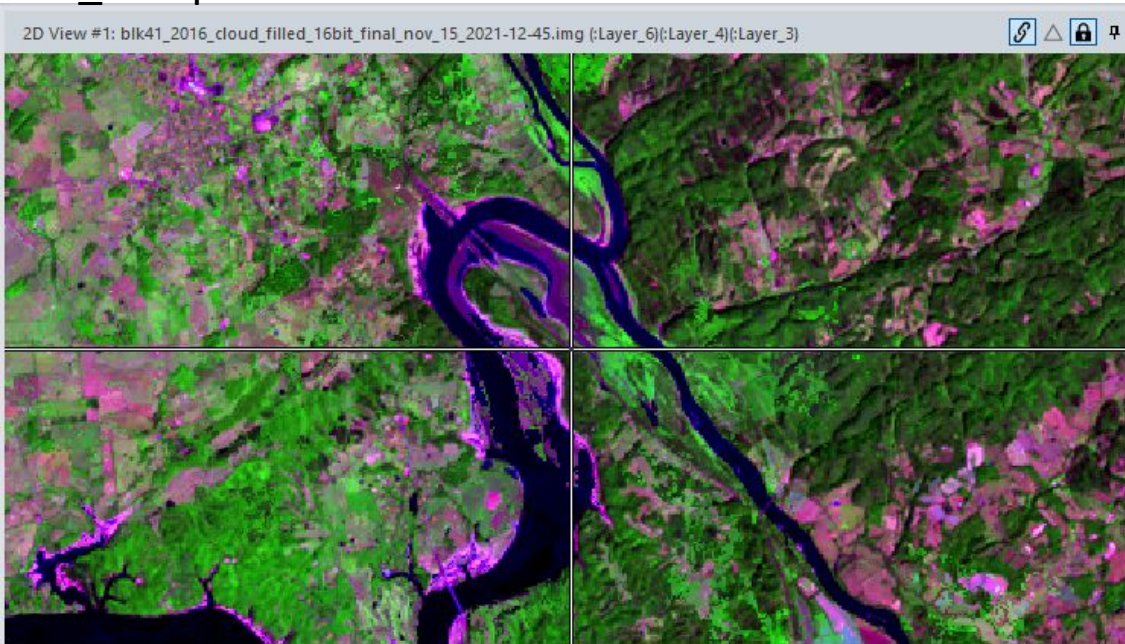
MIICA\_2016\_2017\_Synthetic

MIICA\_2016\_2017\_Composite



# 2016\_Composite

# 2017\_Composite

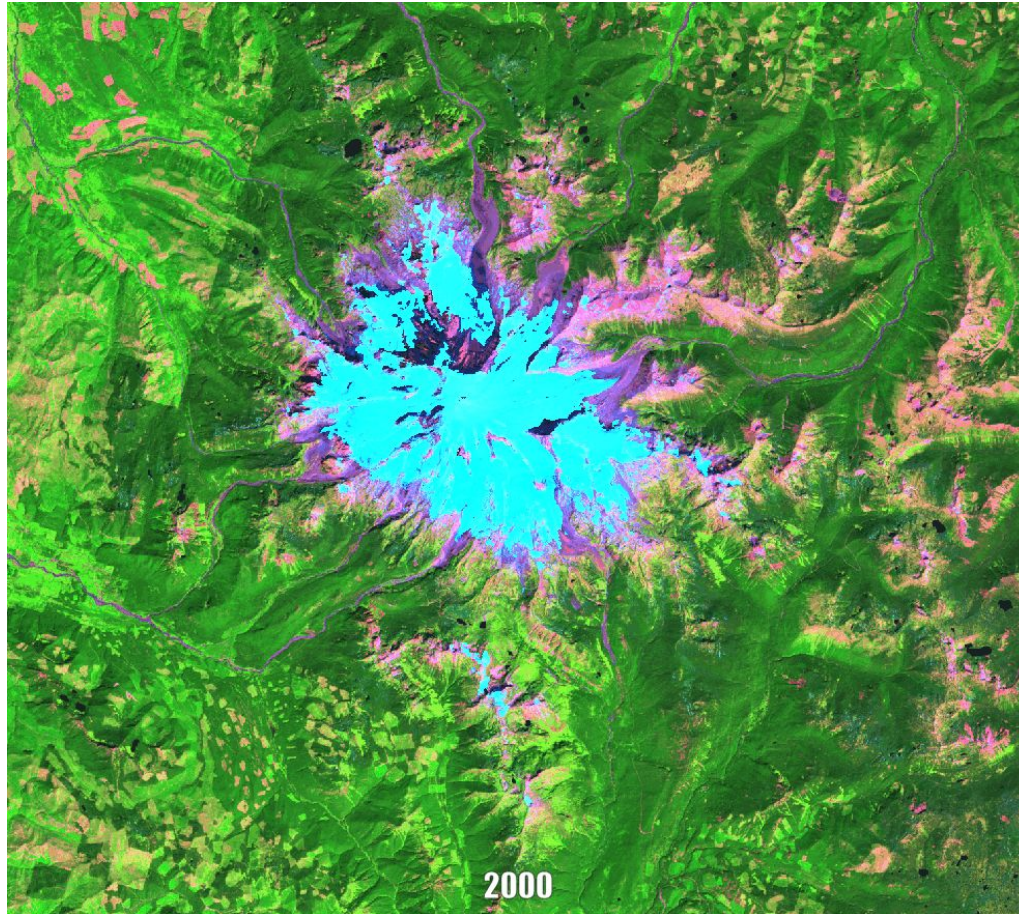


Water\_frequency\_2000\_2020\_Synthetic

NLCD\_2001\_2019\_land cover\_Change Index



# Time series of synthetic images on snow area



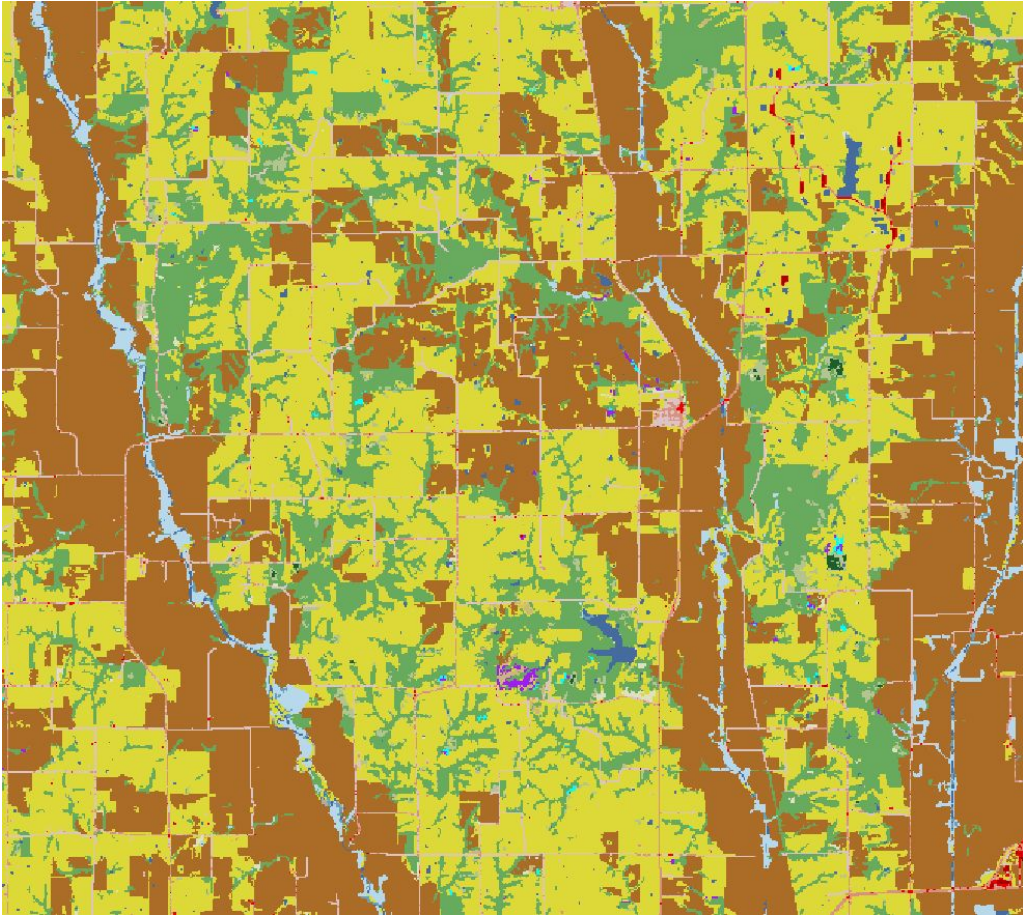
snow



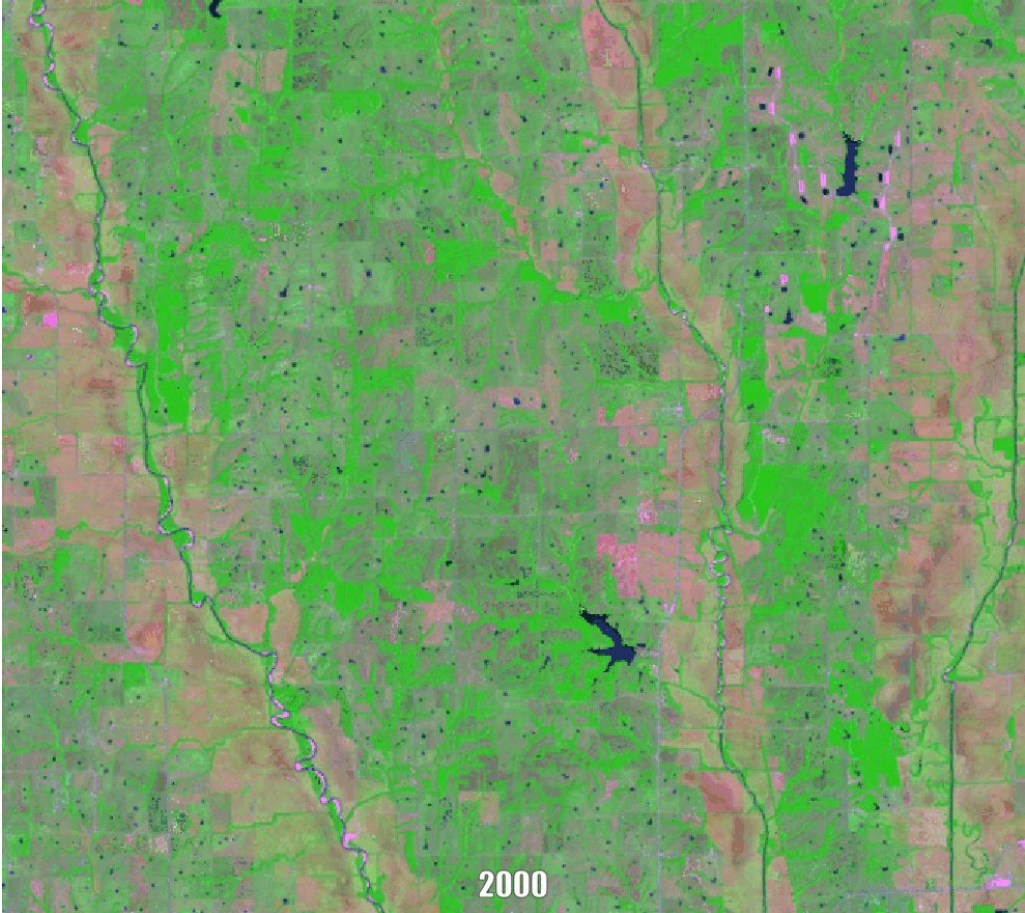
# Time series of synthetic images on agriculture

NLCD Science Land Cover Classes

- Open Water
- Perennial Snow/Ice
- Developed, Open Space
- Developed, Low Intensity
- Developed, Medium Intensity
- Developed, High Intensity
- Barren Land
- Deciduous Forest
- Evergreen Forest
- Mixed Forest
- Shrub-Forest
- Herbaceous-Forest
- Shrub/Scrub
- Herbaceous
- Hay/Pasture
- Cultivated Crops
- Woody Wetlands
- Emergent Herbaceous Wetlands



NLCD 2019



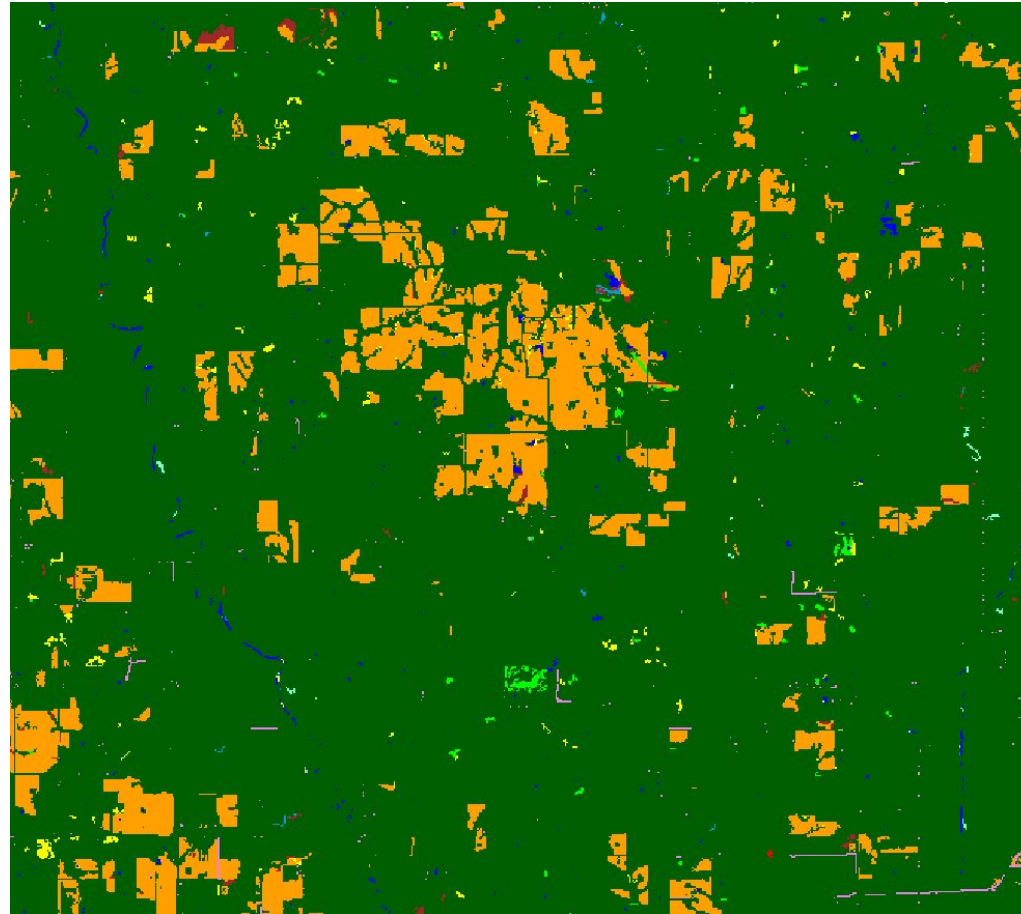
agriculture





# NLCD change index product on the agriculture

Class_Names	Color
no change	dark green
water change	blue
urban change	purple
wetland within class change	light green
herbaceous wetland change	cyan
agriculture within class change	orange
cultivated crop change	red
hay/pasture change	yellow
rangeland herbaceous and shrub change	tan
barren change	grey
forest change	bright green
woody wetland change	red
snow change	



NLCD\_2001\_2019\_land cover\_Change Index



# Summary

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- Synthetic images look clean and cloud free
- Synthetic images are very good for urban change detection with minimal commission and omission errors
- Synthetic images can capture general forest land cover change disturbance, less sensitive to gradual changes. In U.S., get less sensitive to even some clean cut in northern latitude.
- Synthetic images are poor at mapping water, agriculture change
- Synthetic images could not detect snow change
- Synthetic images have the potential to be used for base land cover mapping, e.g. water
- Composite images can be used for all land cover change detections especially ~~short-term with more commission errors, however still have residue cloud and~~ shadow, missing values, and artifacts