A Multi-temporal Digital Surface Elevation Model of the Great Lakes Basin

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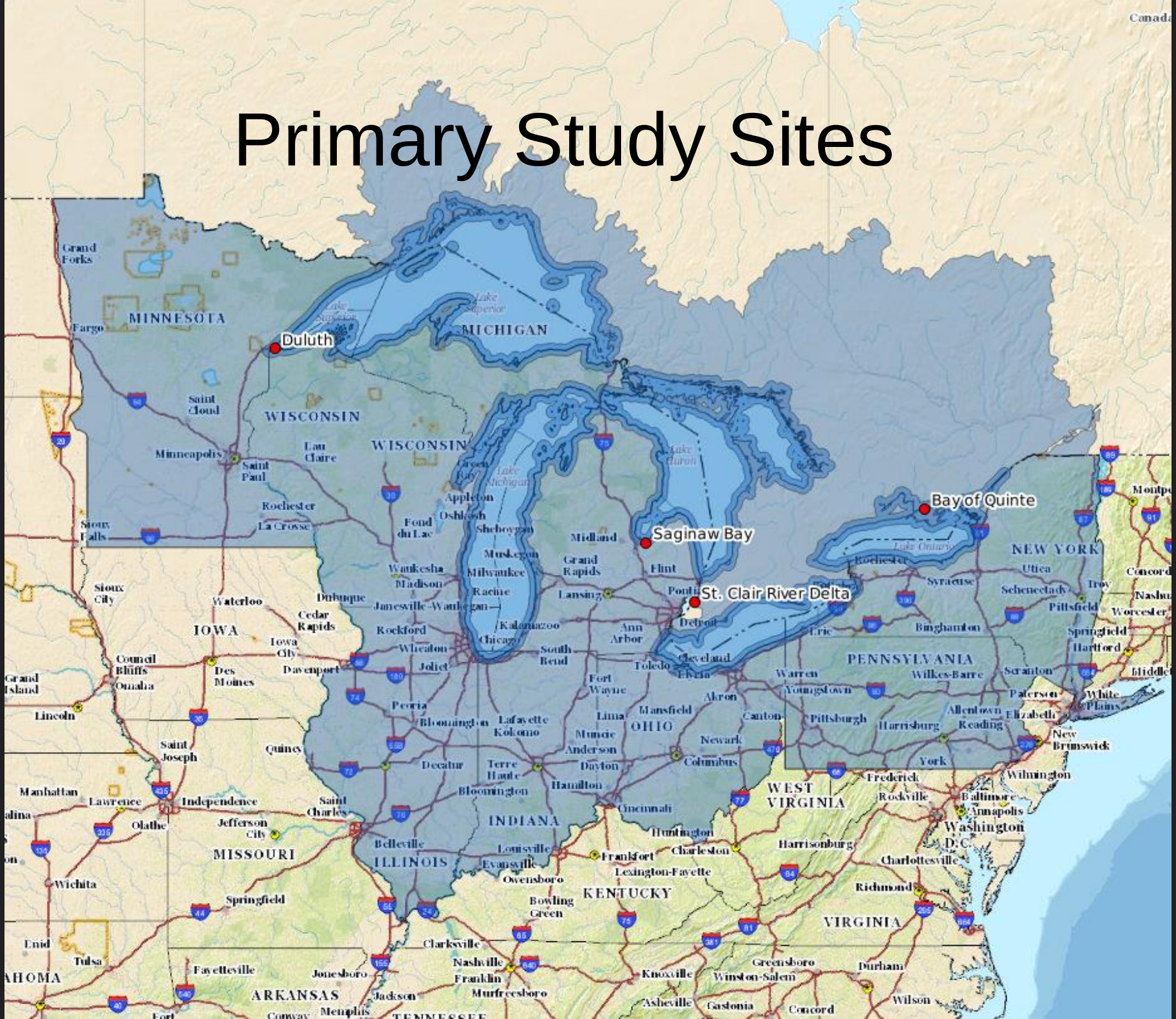
GREAT LAKES
REMOTE SENSING
pgc
NATIONAL GEOSPATIAL-INTELLIGENCE AGENCY
UNITED STATES OF AMERICA
CSA ASC
UNITED STATES
ENVIRONMENTAL PROTECTION AGENCY
U.S.
FISH & WILDLIFE
SERVICE
DEPARTMENT OF THE INTERIOR
Natural Resources Canada
Ressources naturelles Canada
Canada
Michigan Tech
Research Institute
SharedGeo
Environment and Climate Change Canada
Environnement et Changement climatique Canada

MTVEM

(Multi-Temporal Vegetation Elevation Model)

Goal: Measure surface elevation change in the Great Lakes Basin multiple times a year to detect disturbance and regeneration of vegetation as it impacts habitat.

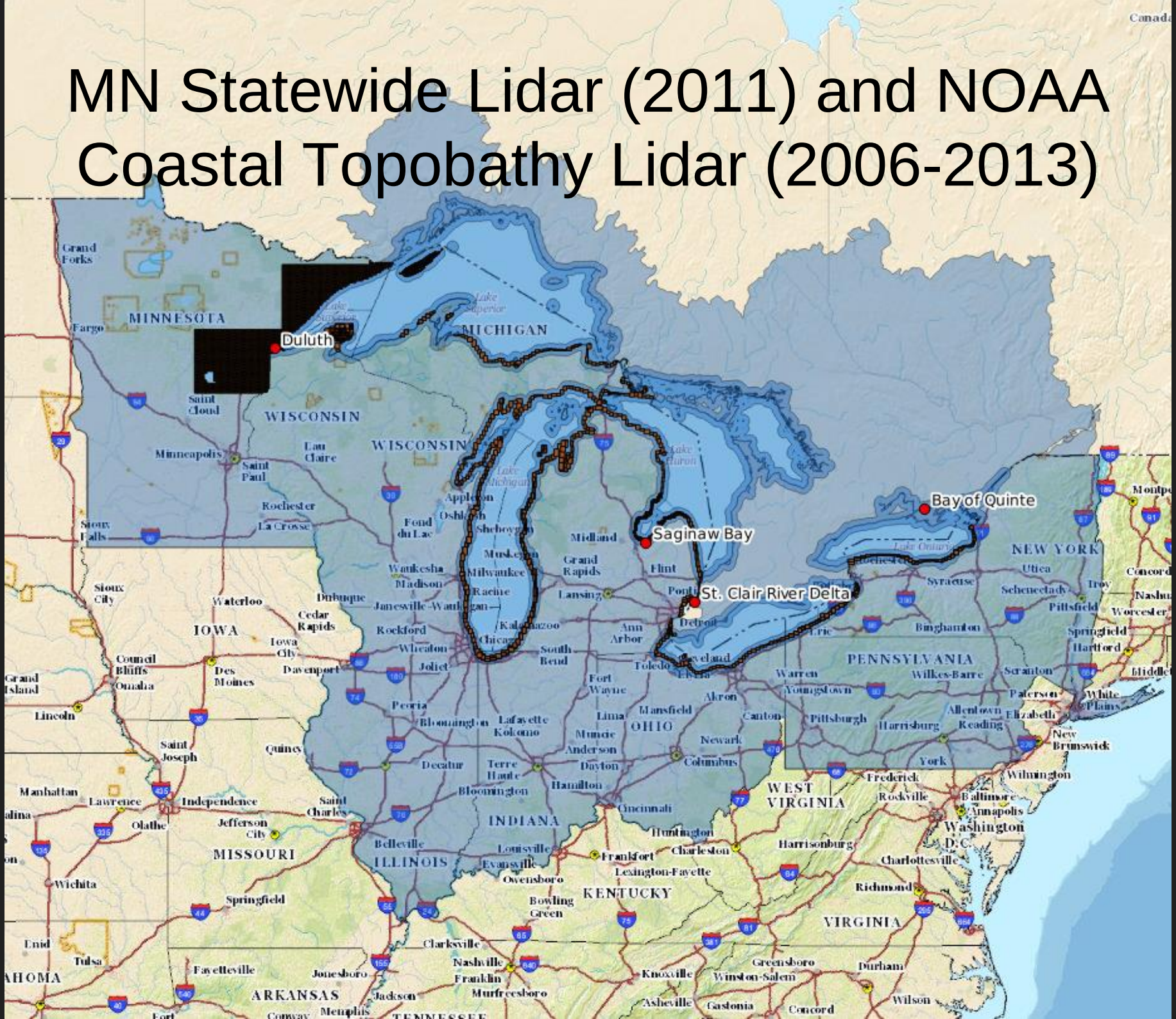
Primary Study Sites



The datasets

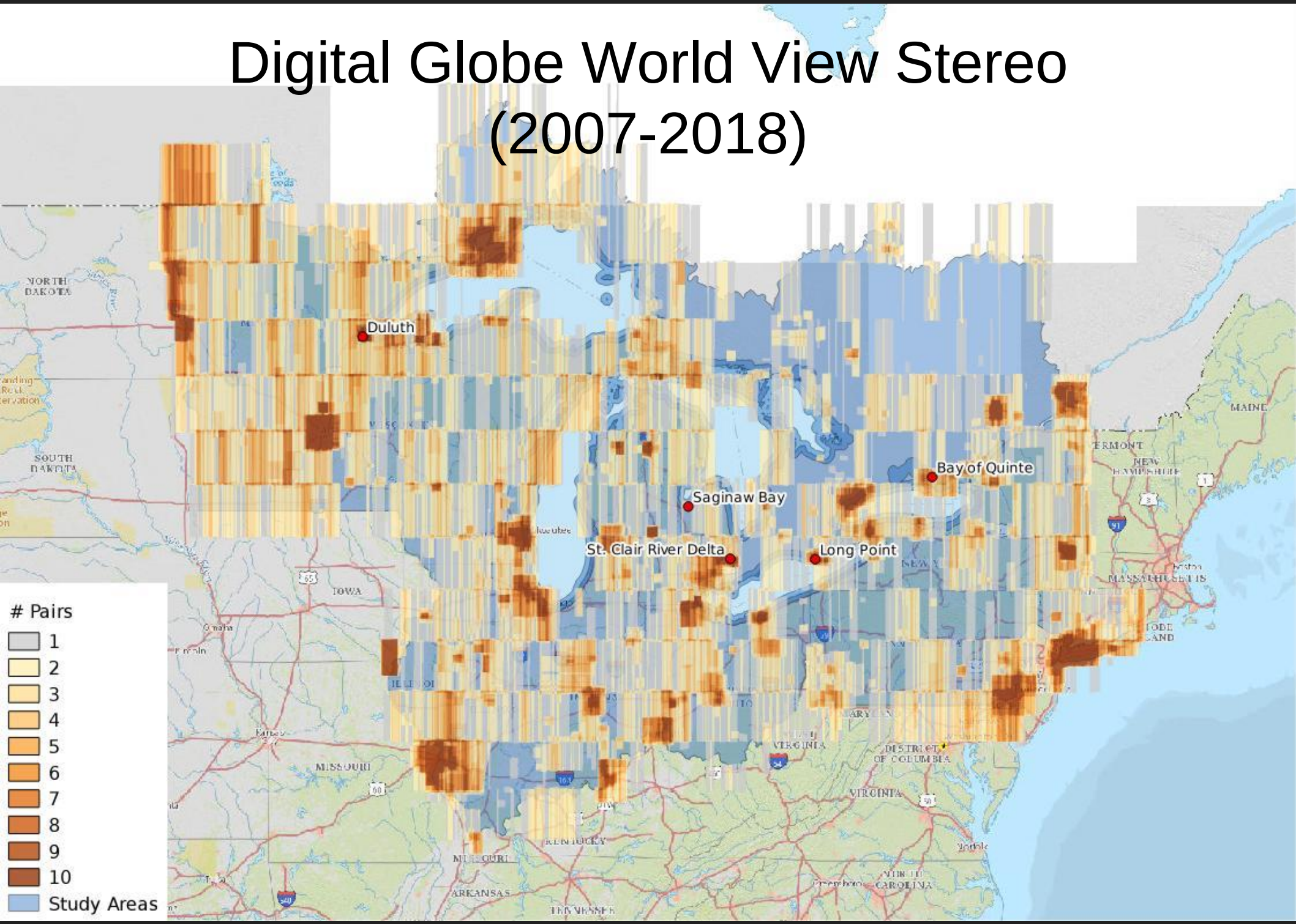
- NOAA Coastal Topobathy Lidar (2006-2013)
- MN Statewide Lidar Collect (2011)
- Border Patrol Stereo Air Photos (2008-2009)
- Digital Globe World View 1,2,3 Stereo (2007-2017)

MN Statewide Lidar (2011) and NOAA Coastal Topobathy Lidar (2006-2013)



Border Patrol Stereo Aerial Photos (2008-2009)

Digital Globe World View Stereo (2007-2018)

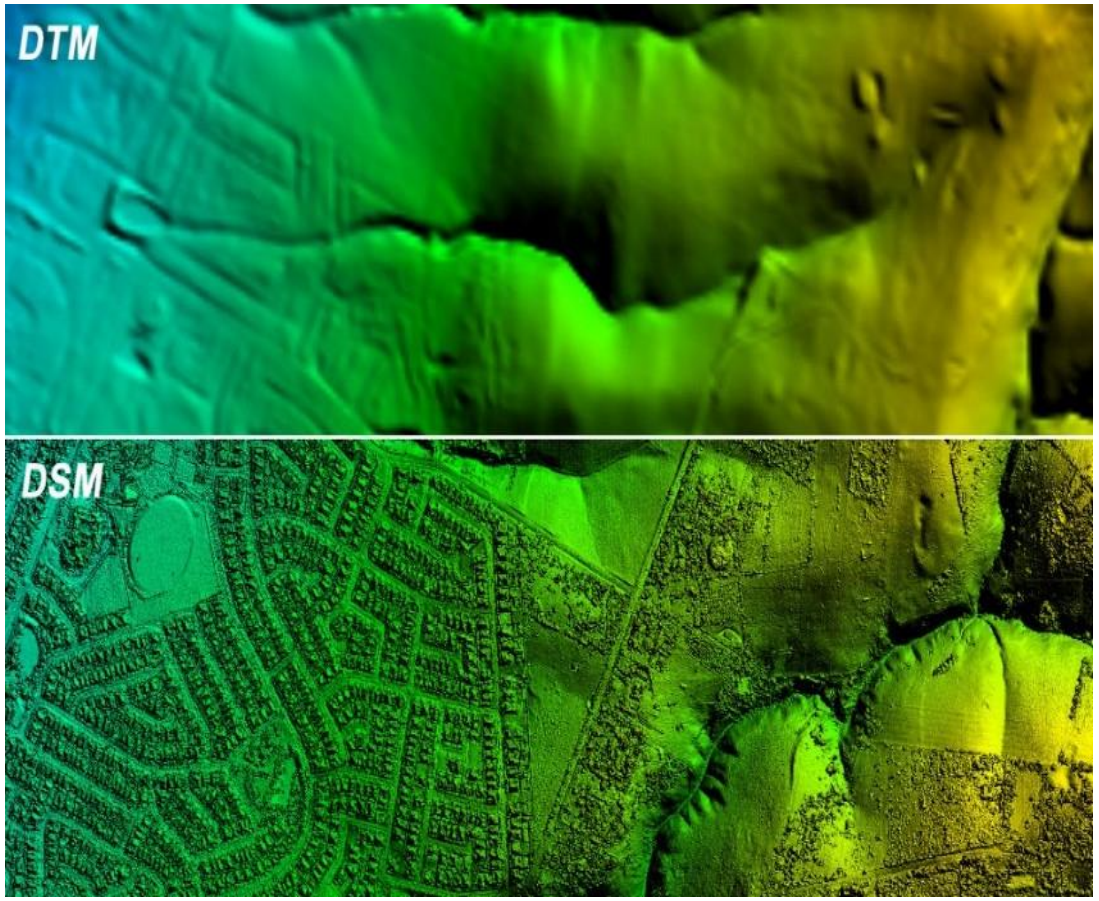


AIR PHOTO SUPPLY

Digital Elevation Model Subtypes

Digital Surface Model (DSM) and Digital Terrain Model (DTM)

- **DSM shows ‘tops of trees and structures’, DTM removes cover to show ‘bare earth’**
- **Both are important for modeling and mapping applications**



Steps

- Select pairs of overlapping images (math/GIS)
- Find matching features (messy math/stats)
- Estimate the position in space of each feature using what we know about the sensors, image locations, and the set of corresponding features (math that in theory is simple geometry, but much like this slide, is actually rather messy because nothing above is perfect).

The ArcticDEM

Brian Huberty
Midwest Region, U.S. Fish & Wildlife Service
Paul Morin
Polar Geospatial Center, University of Minnesota

Ian Howat & MJ Noh
Byrd Polar, the Ohio State University
Claire Porter & Michael Cloutier
Polar Geospatial Center, University of Minnesota
Michael Willis
Earth and Atmospheric Sciences, Cornell University

Ellef Ringers Island, Nunavut

Ames Stereo Pipeline

- What: 3D reconstruction from photographs
- Who: Intelligent Robotics Group at NASA Ames
- Where: https://ti.arc.nasa.gov/tech/asr/intelligent-robotics/ngt/stereo/
- License: Apache 2.0

Ames Stereo Pipeline

- Border Patrol Stereo Air Photos
- 16,268 pairs, 18.9 TB, over 160,000 sq.km.
- ~3 hours per pair.
- Hmmm....

SETSM

- What: Surface Extraction from TIN-based Searchspace Minimization
- Who: Byrd Polar & Climate Research Center
- Where: https://u.osu.edu/setsm/
- License: Apache 2.0

SETSM

- Digital Globe Satellite Imagery
- 15,000+ stereo pairs, 17TB+, 1,200,000 sq.km.
- Data is still being regularly collected.
- ~6 hrs per pair for 2m DSM
- Hmmm...

BLUE WATERS

SUSTAINED PETASCALE COMPUTING

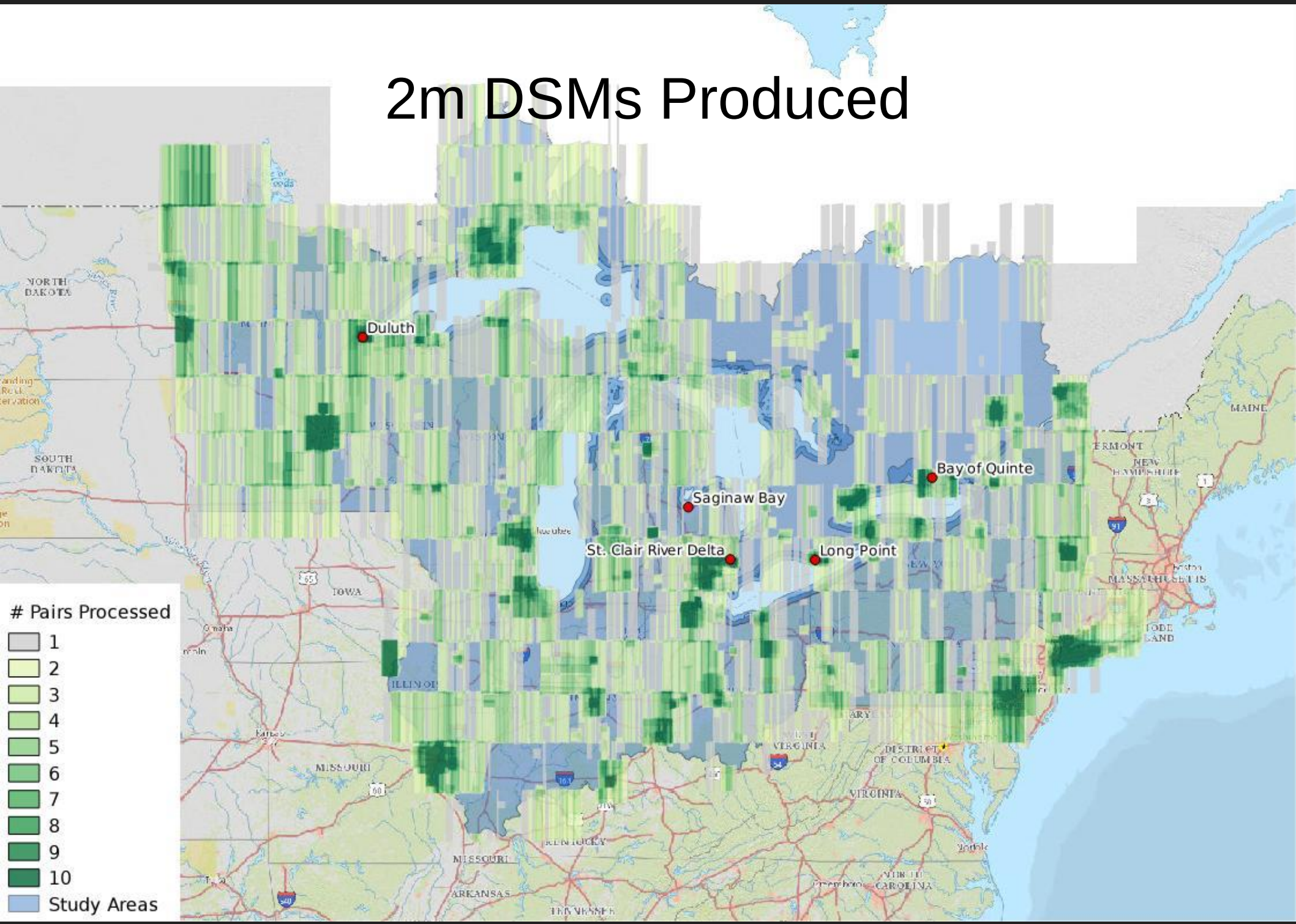
GREAT LAKES CONSORTIUM
FOR PETASCALE COMPUTATION

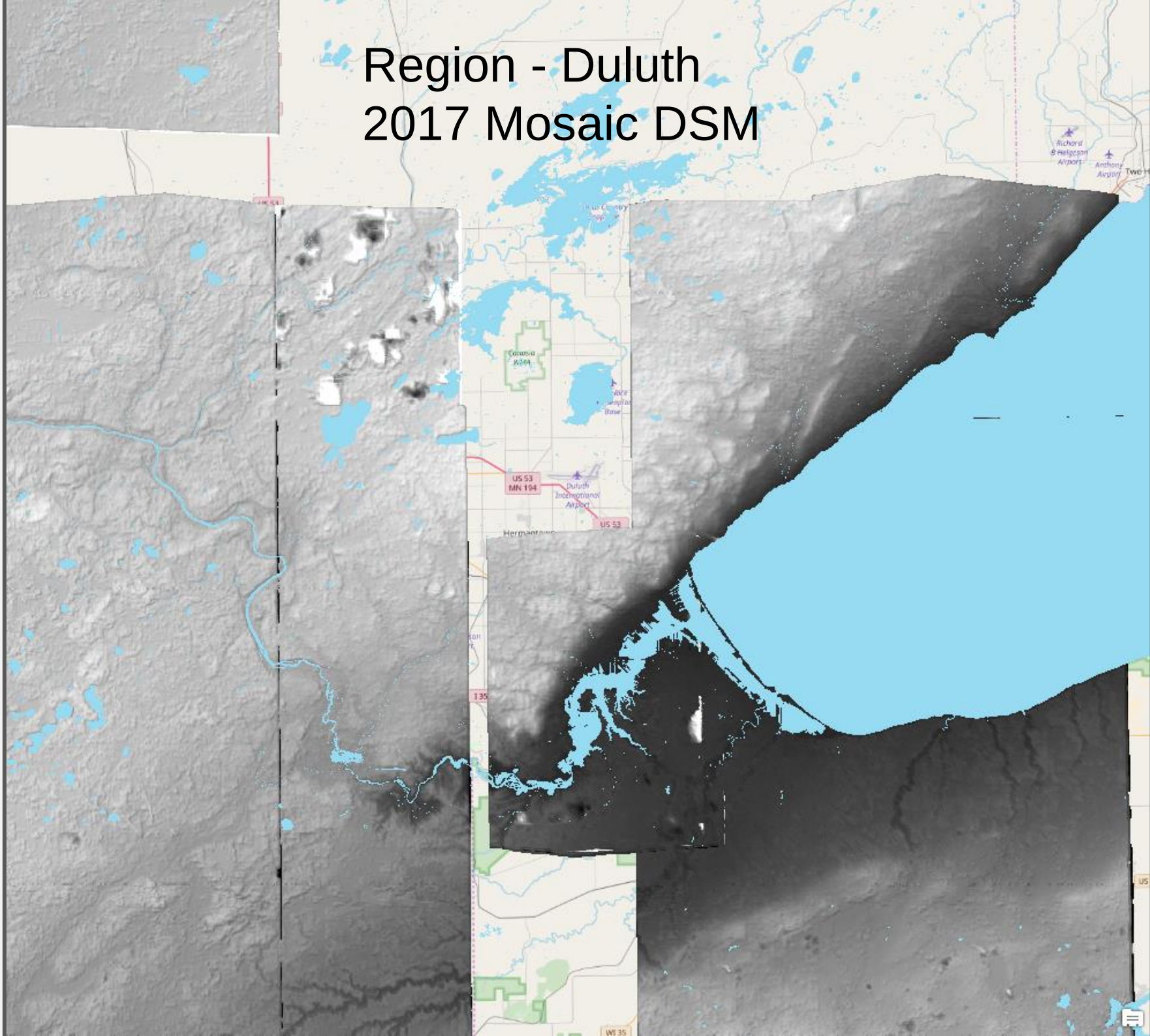
CRAY

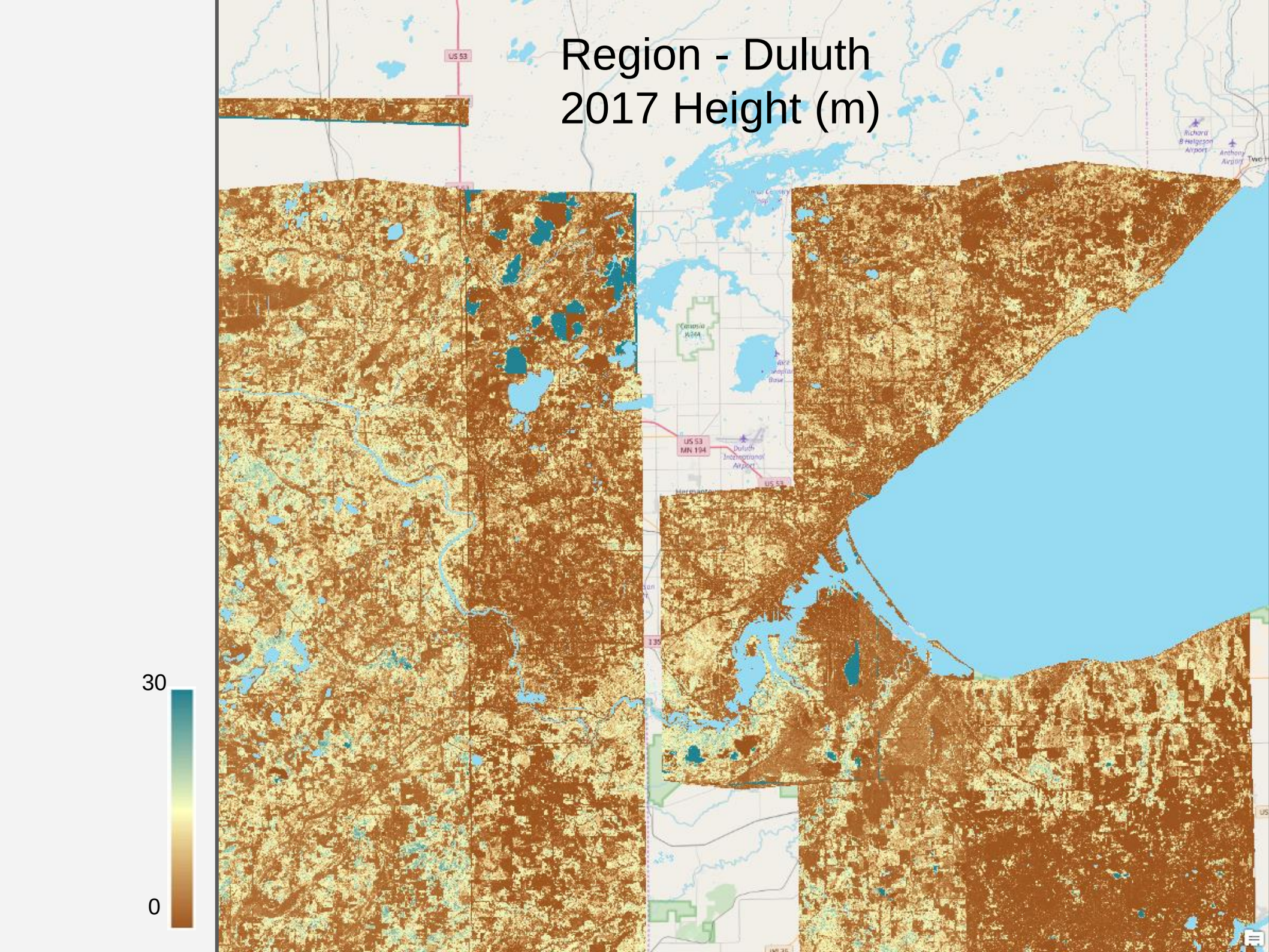
Progress

- Data collected and organized
- 2m DSMs created
- Exploring Results

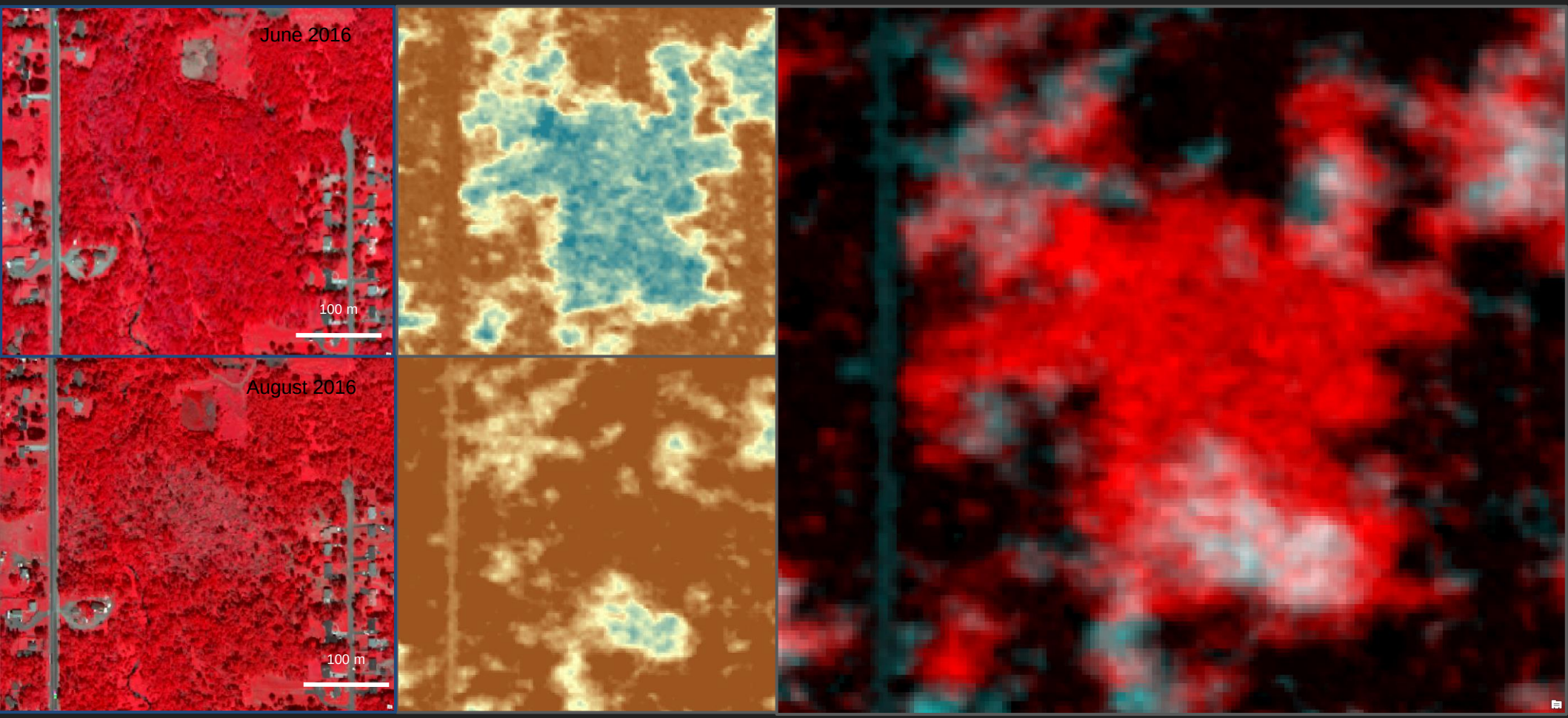
2m DSMs Produced



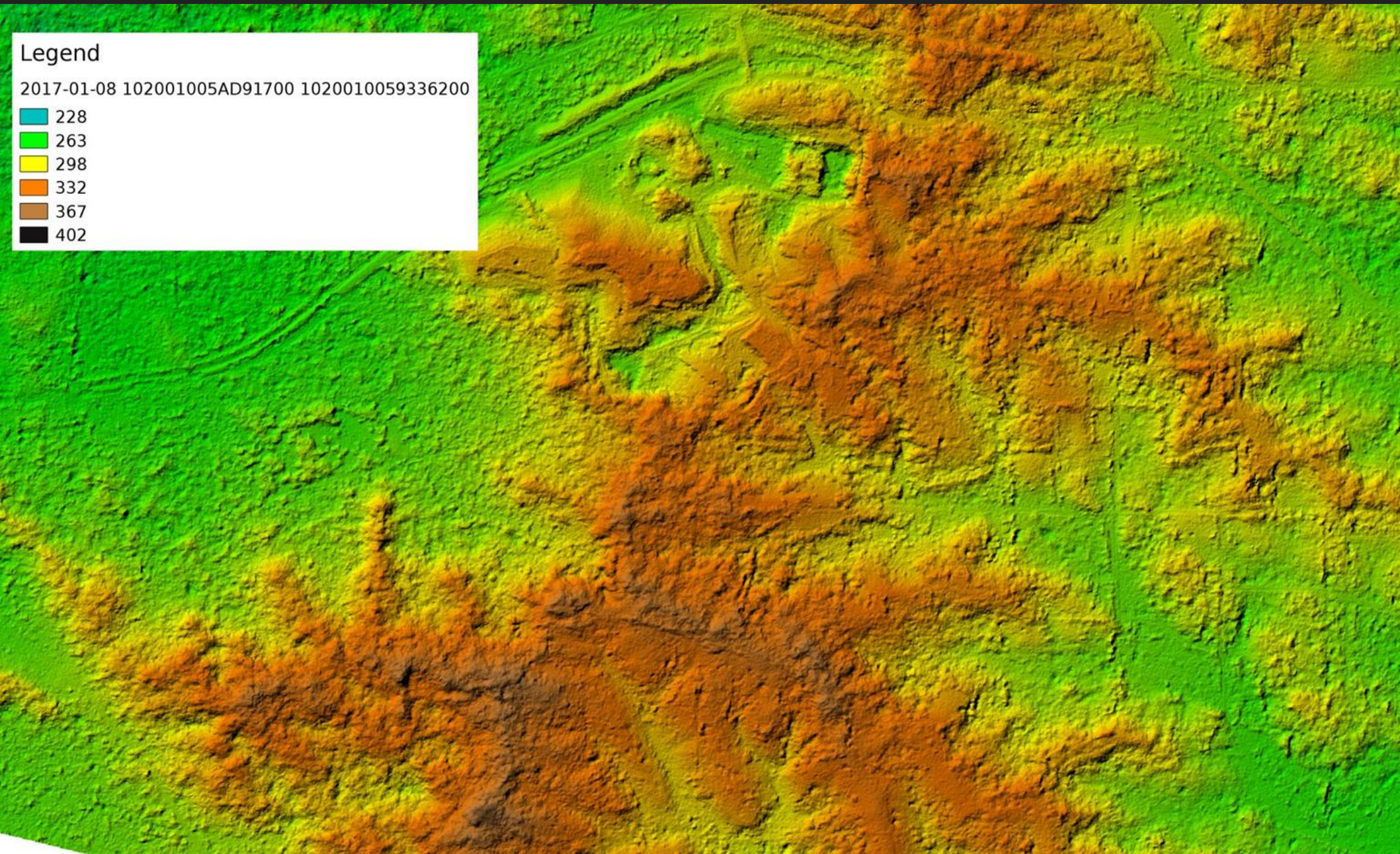

Region - Duluth
2017 Mosaic DSM


Region - Duluth
2017 Height (m)
30
0

Height Change – Blowdown Event



2017-01-08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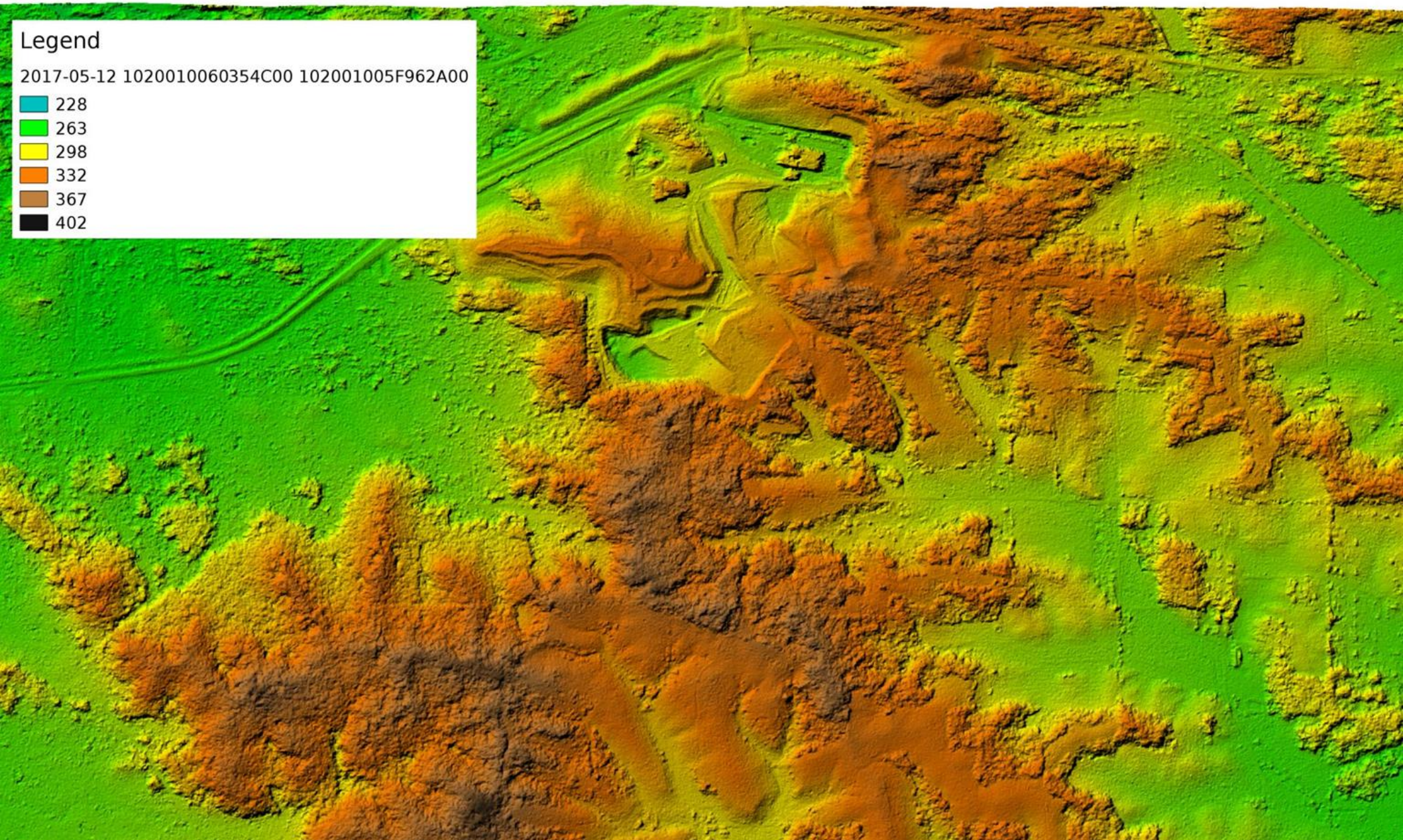
228
263
298
332
367
402

2017-05-12


Legend
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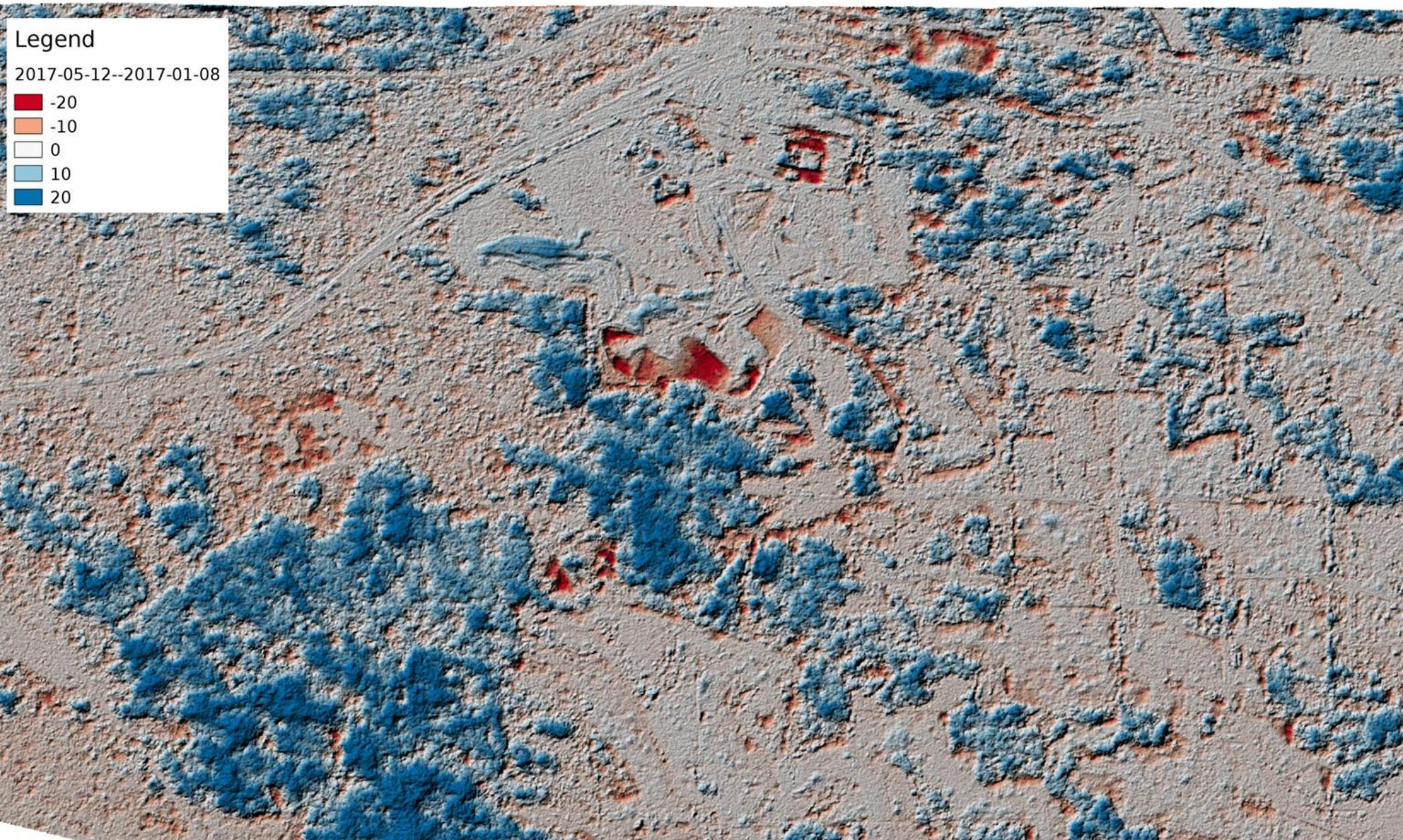
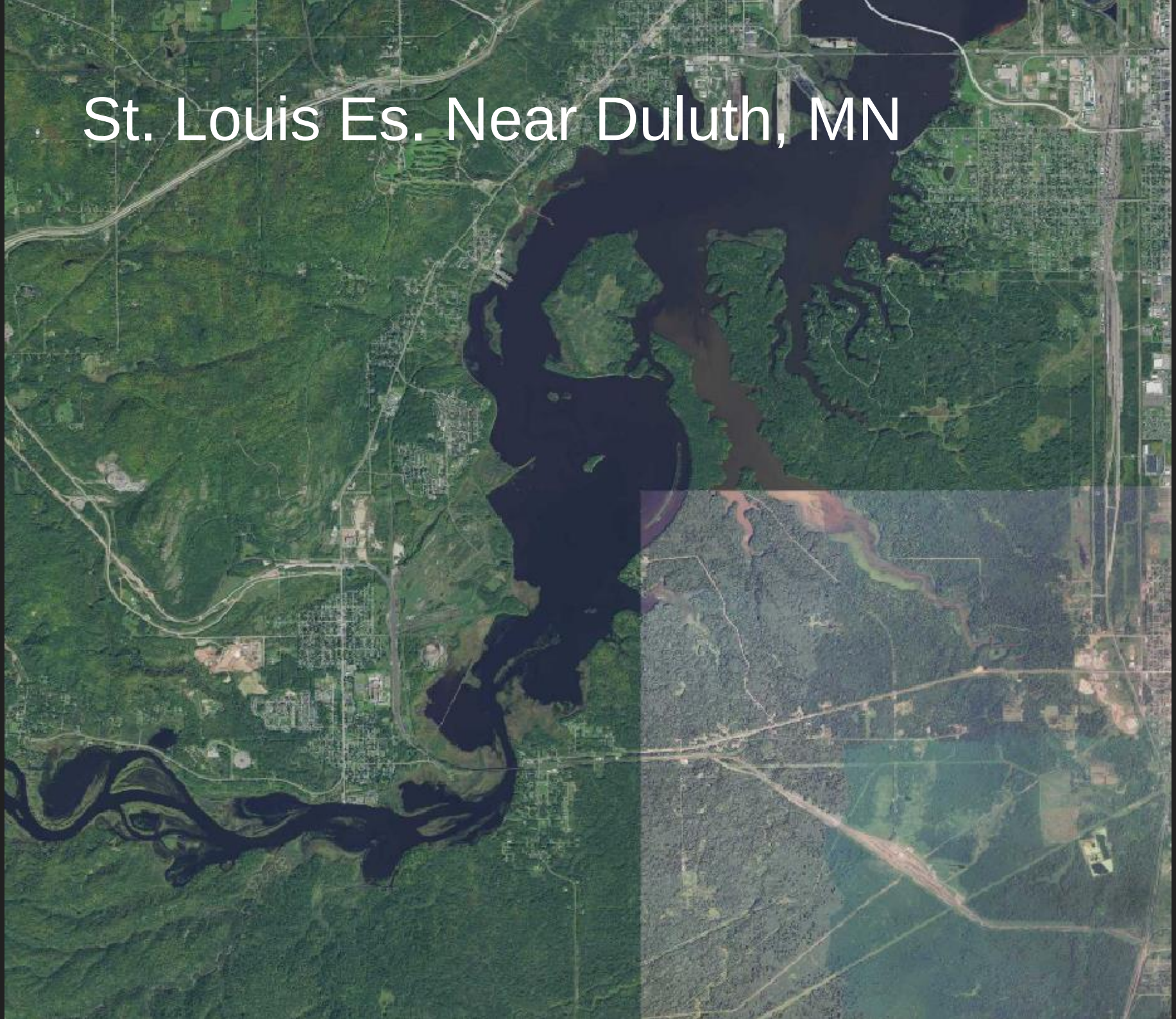
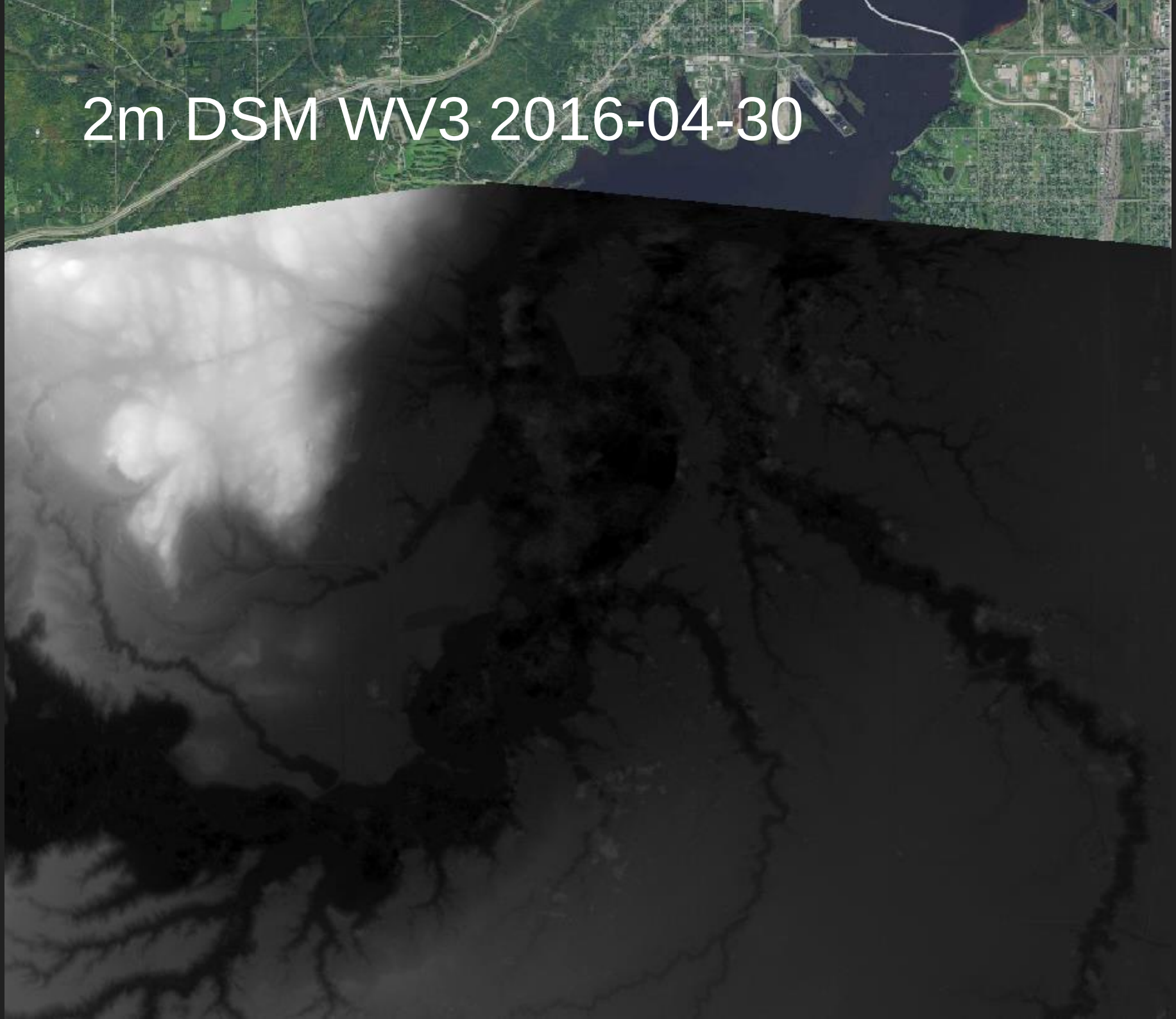
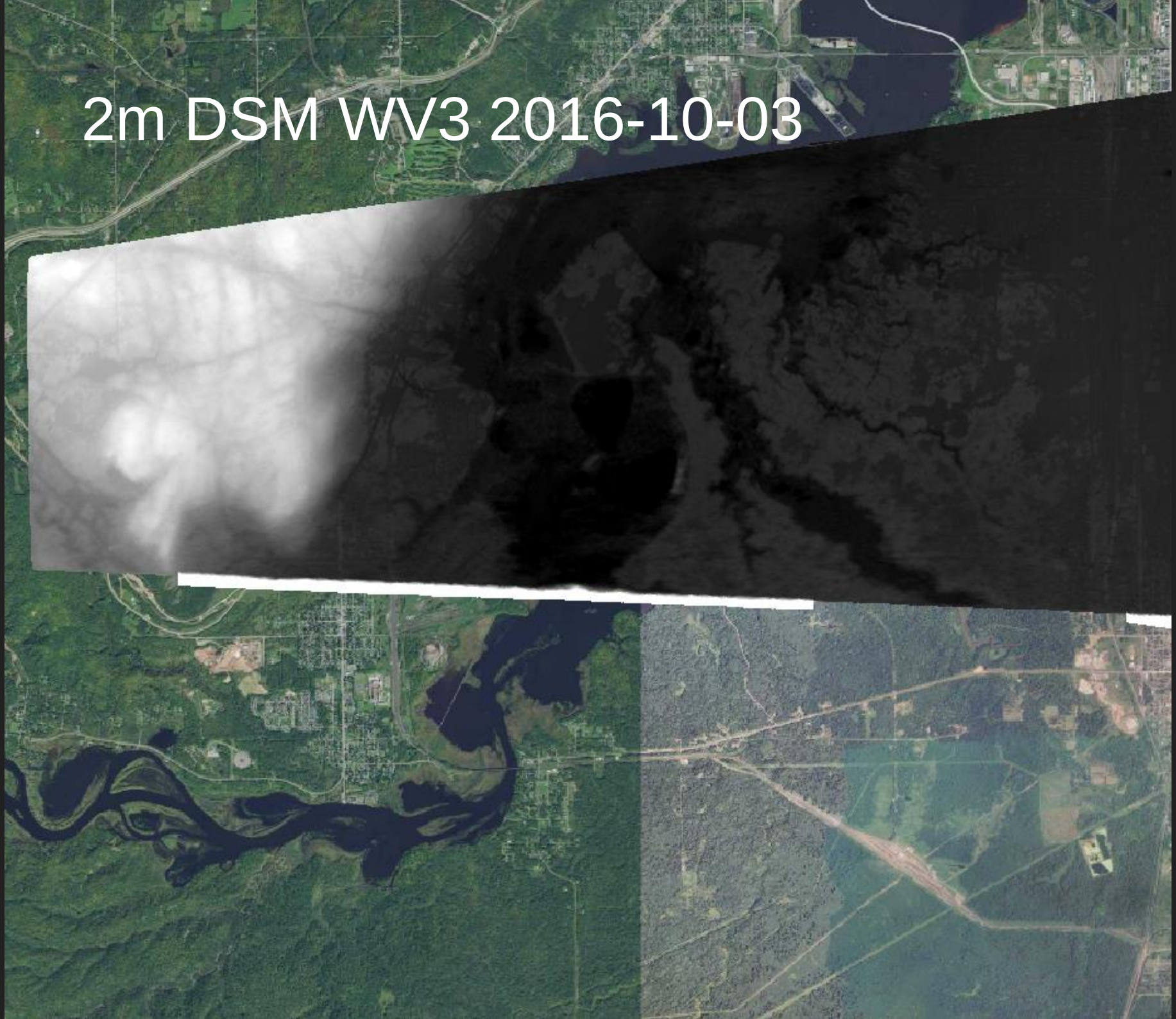
228
263
298
332
367
402

Change

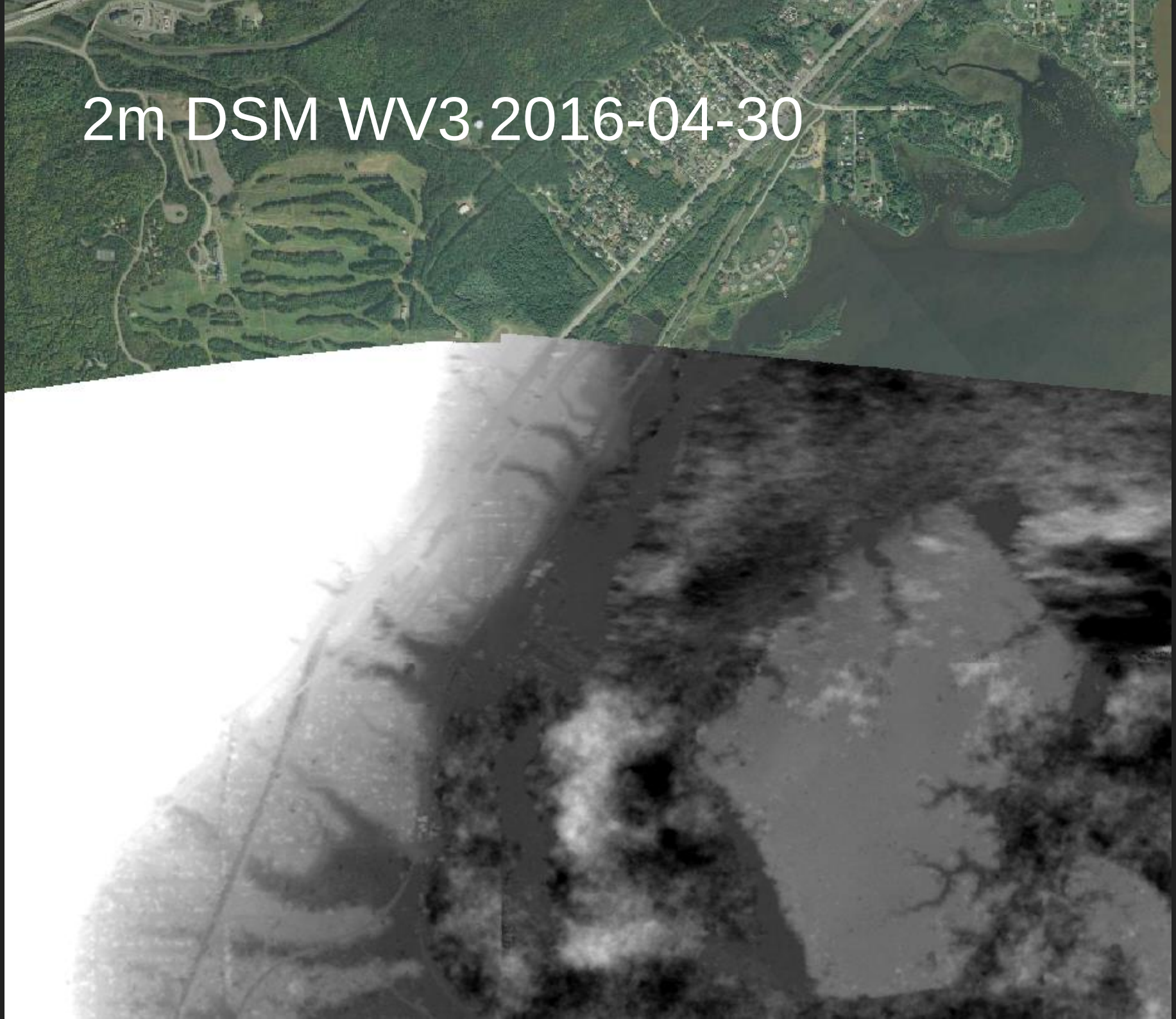


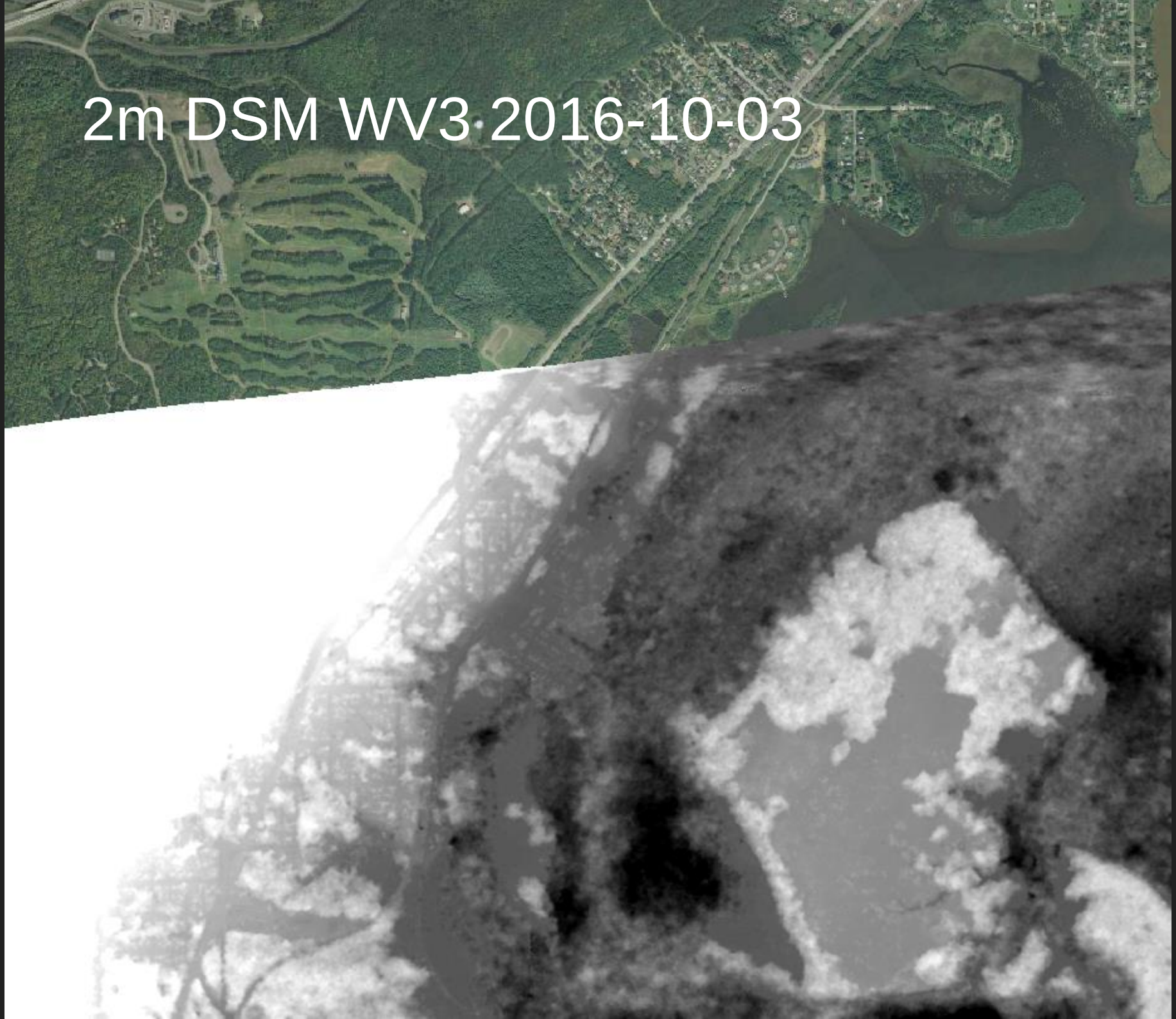

St. Louis Es. Near Duluth, MN

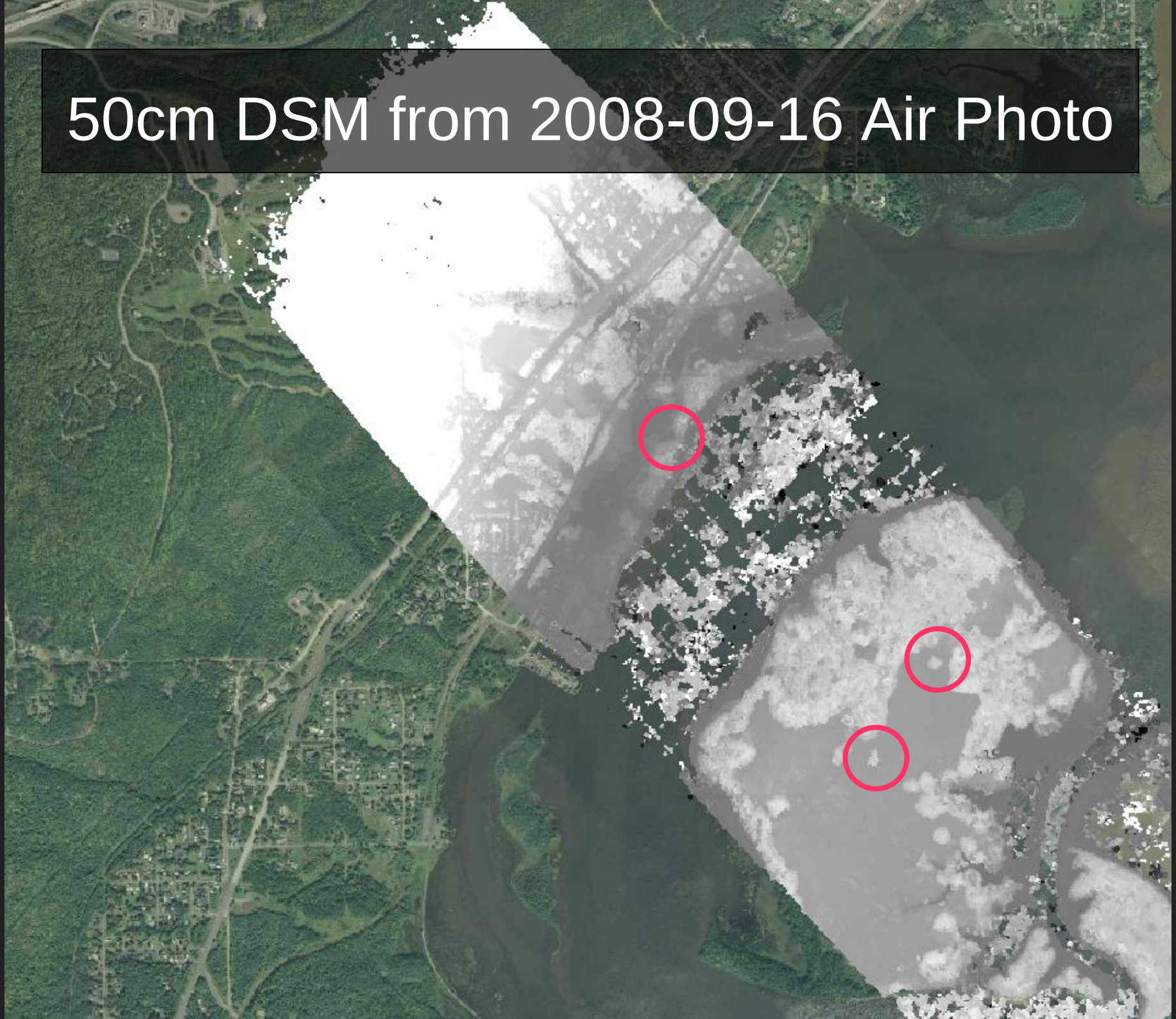

2m DSM WV3 2016-04-30

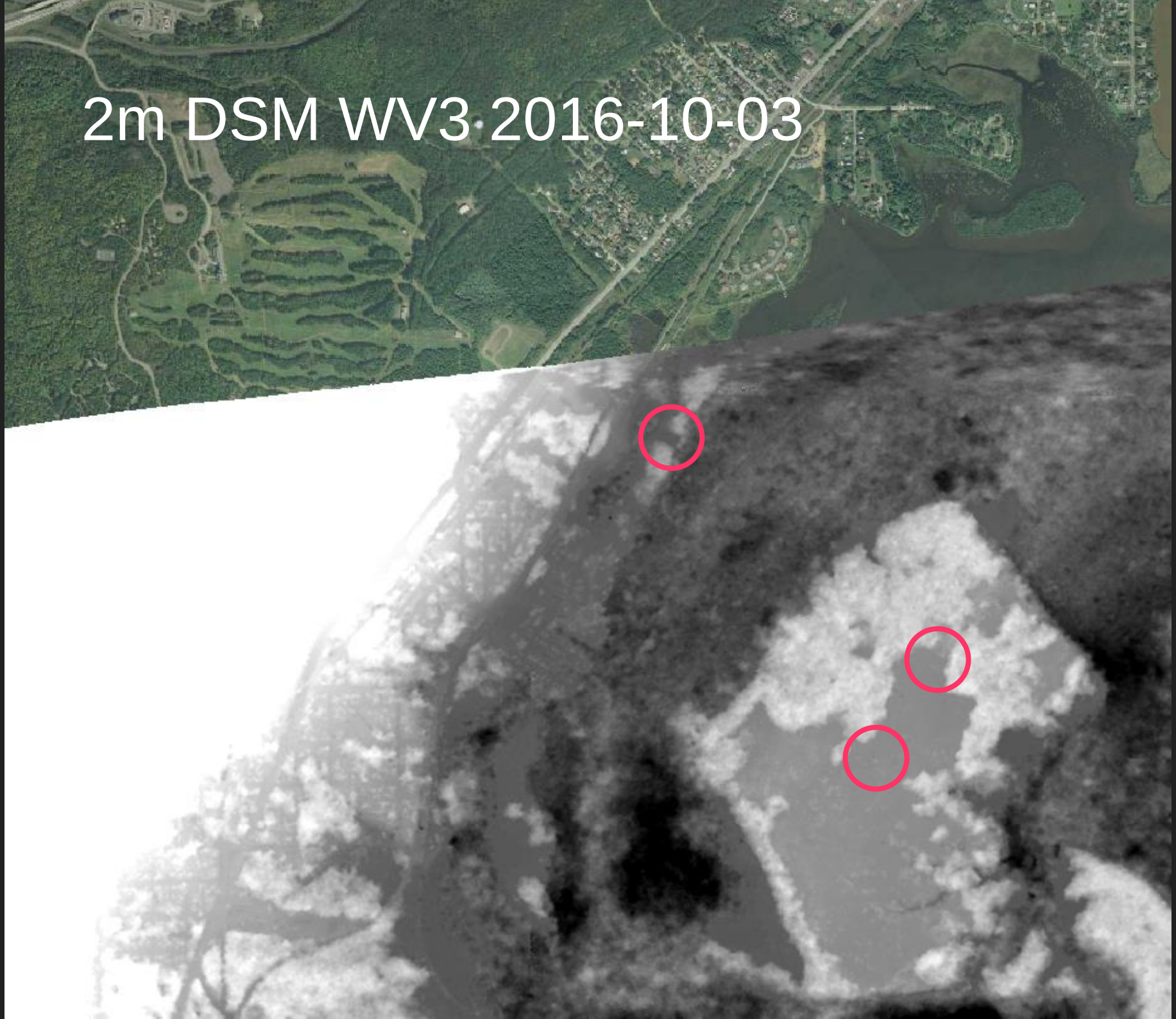

2m DSM WV3 2016-10-03

Tallas Is. Near Duluth, MN


2m DSM WV3 2016-04-30


2m DSM WV3 2016-10-03


50cm DSM from 2008-09-16 Air Photo


2m DSM WV3 2016-10-03

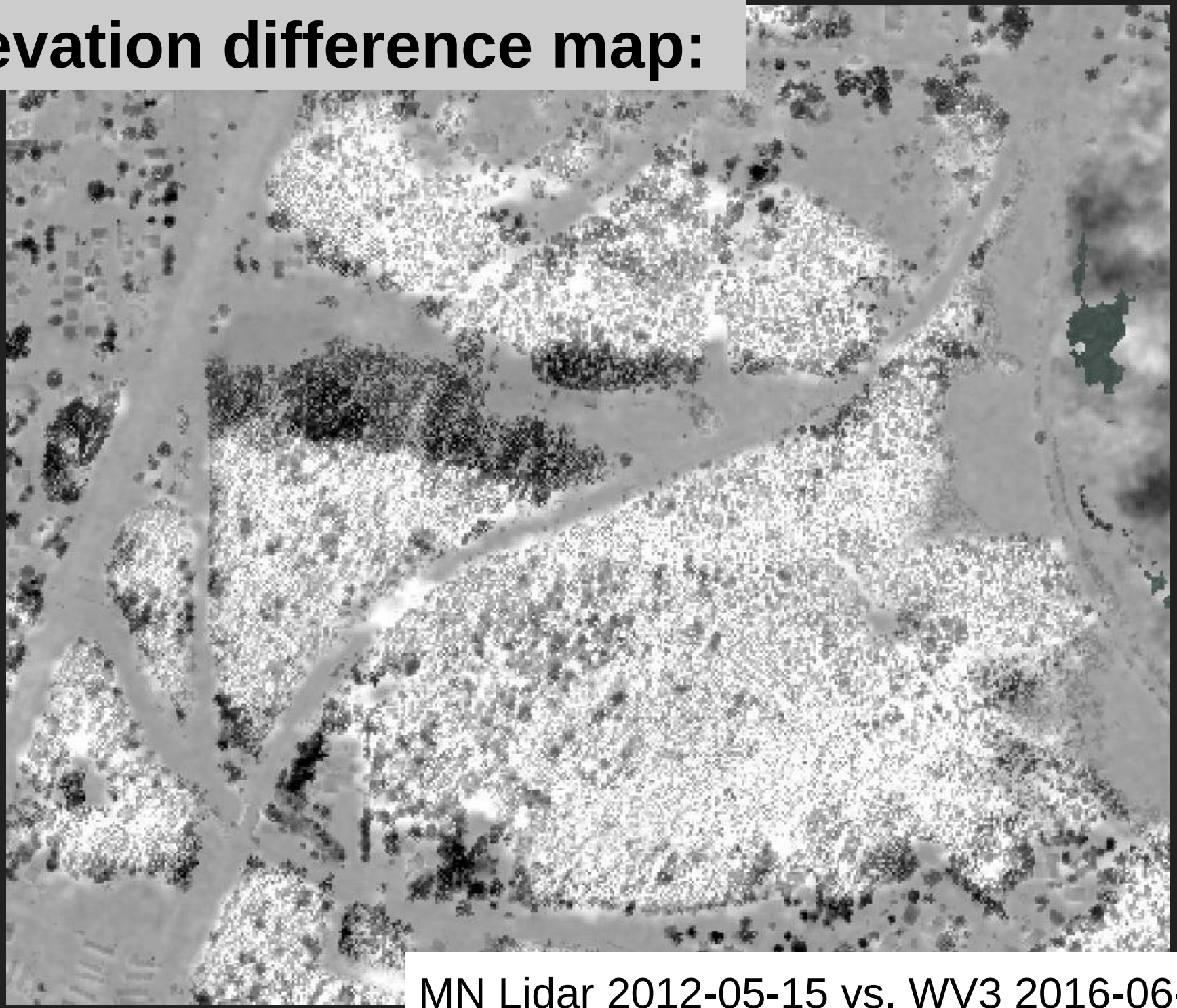
Construction Project

MnGeo Composite Image Service

Construction Project

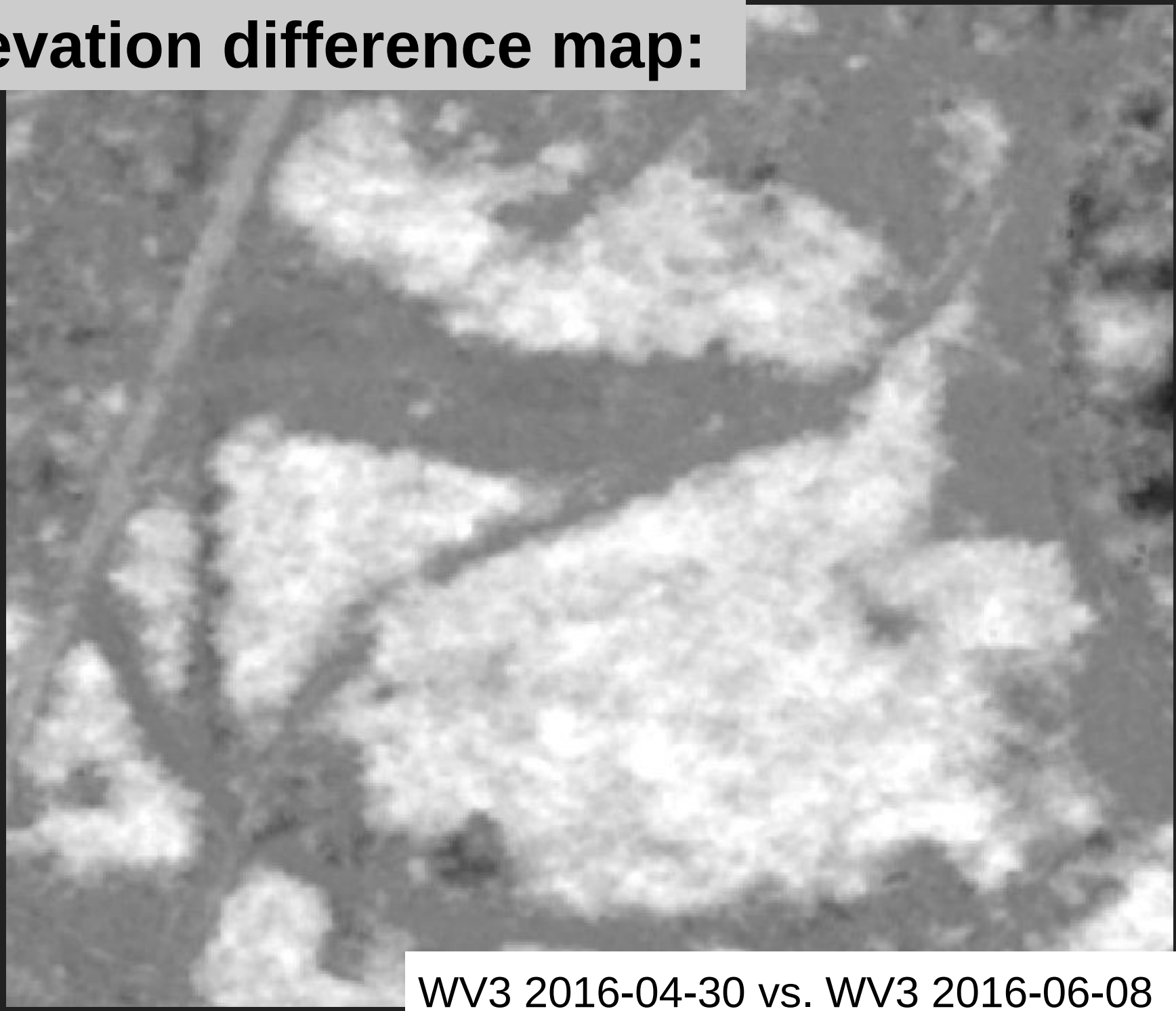
DigitalGlobe WV3 2016-06-08

Elevation difference map:



MN Lidar 2012-05-15 vs. WV3 2016-06-08

Elevation difference map:



WV3 2016-04-30 vs. WV3 2016-06-08

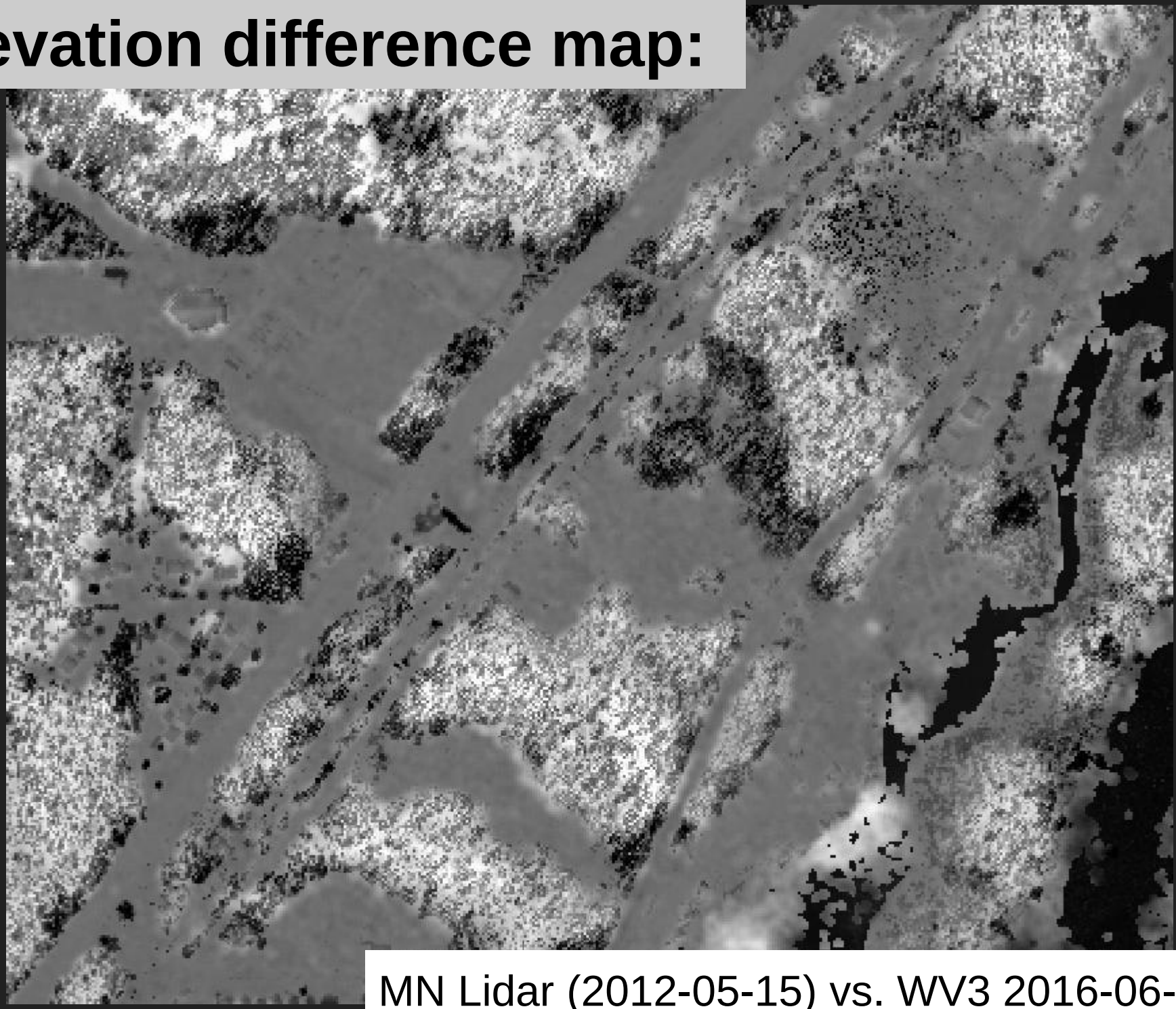
Near Tallas Island

MnGeo Composite Image Service

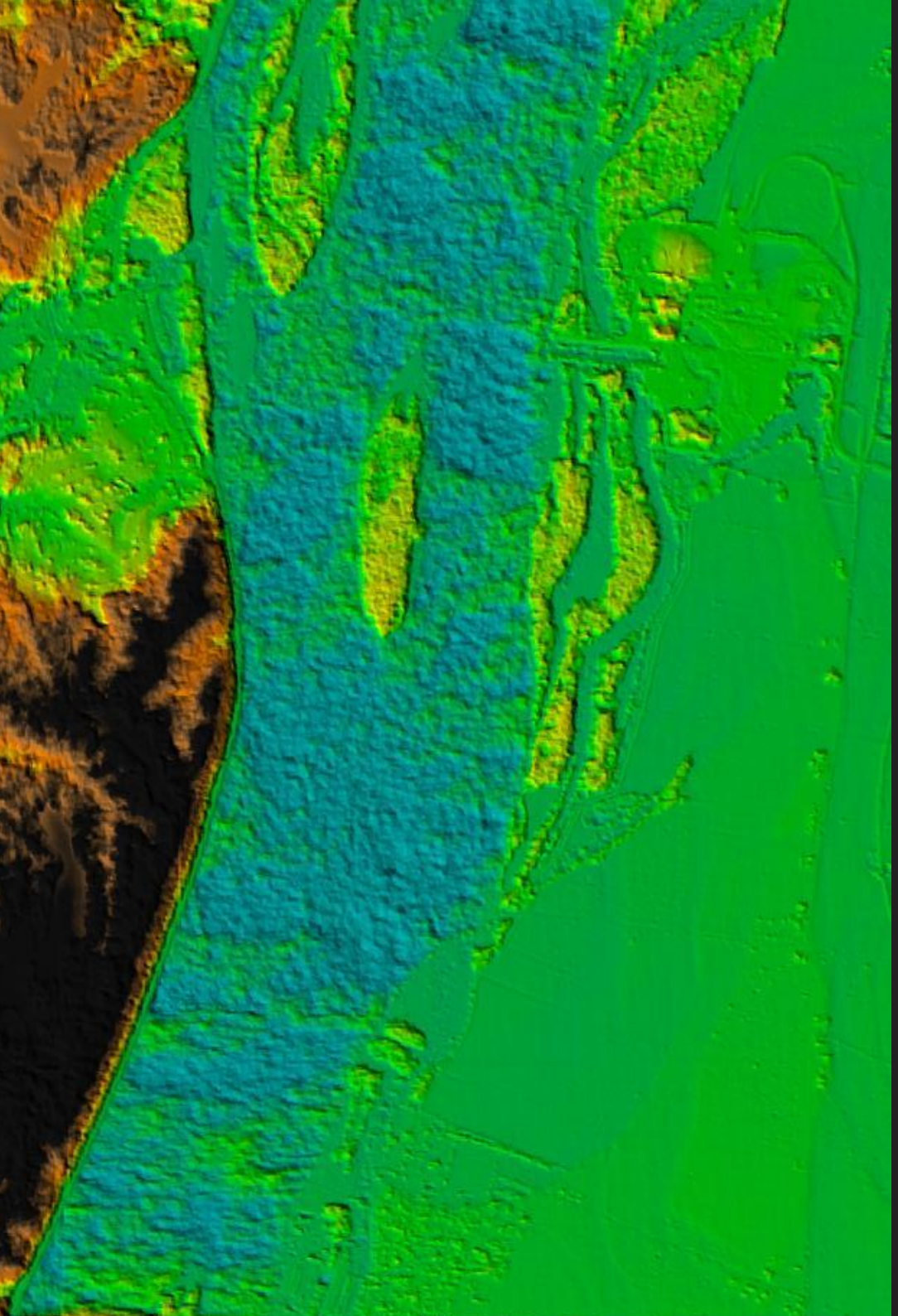
Near Tallas Island

DigitalGlobe WV3 2016-06-08

Elevation difference map:



MN Lidar (2012-05-15) vs. WV3 2016-06-08



To do:

- New imagery is still being collected
- Evaluate 50cm DSMs
- Automate Change Detection
- Automate DSM Mosaics
- Produce Orthos for OBIA
- Error analysis

ACKNOWLEDGEMENTS:

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Len Kne, U of MN U-Spatial
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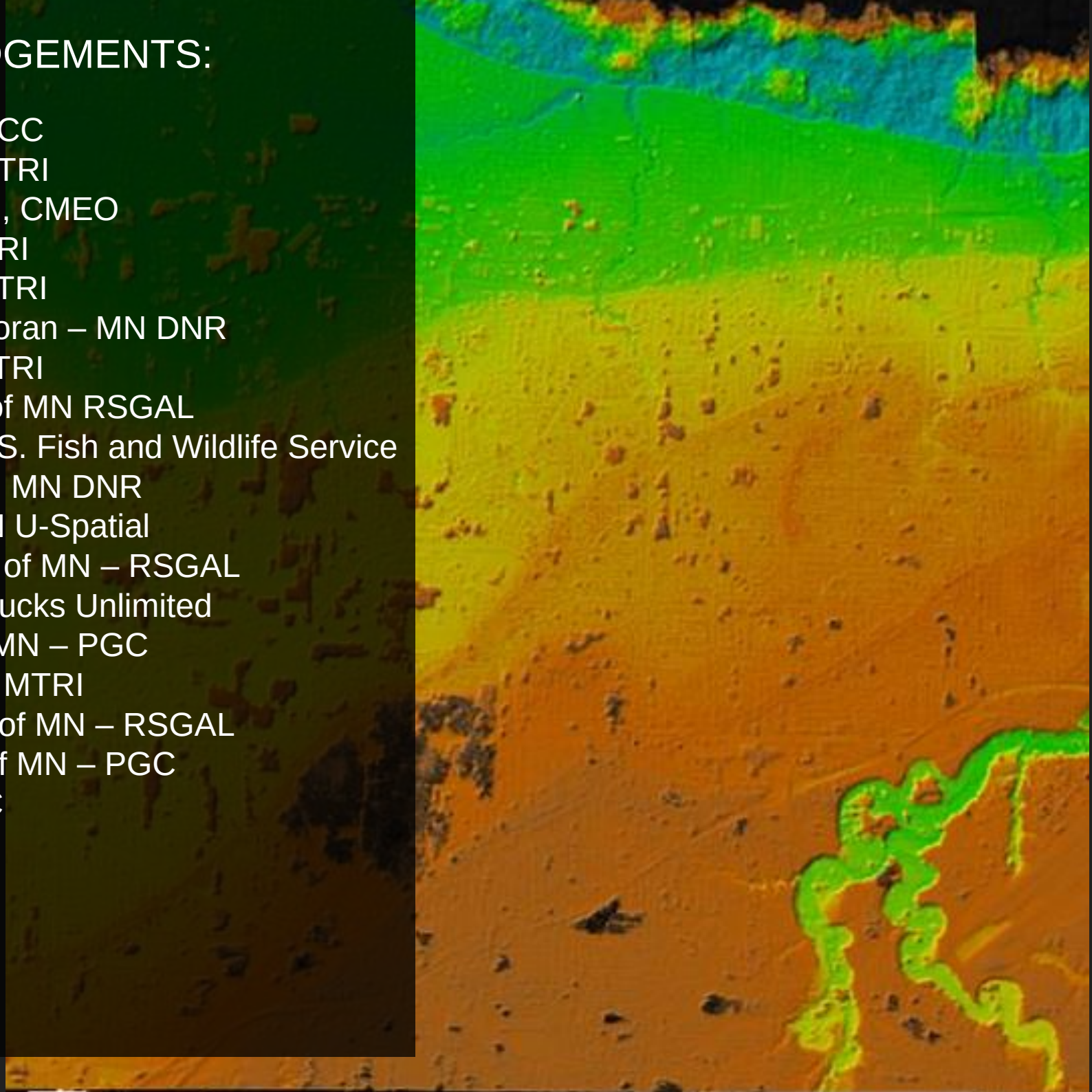
Dr. Chuck Olson, MTRI
Keith Pelletier, U of MN – RSGAL
Claire Porter, U of MN – PGC
Lori White, ECCC



Questions?