ASSESSING THE IMPACT OF WINTER HYDROPERIOD ON ANNUAL GROWTH RATE OF GREENTREE RESERVOIRS

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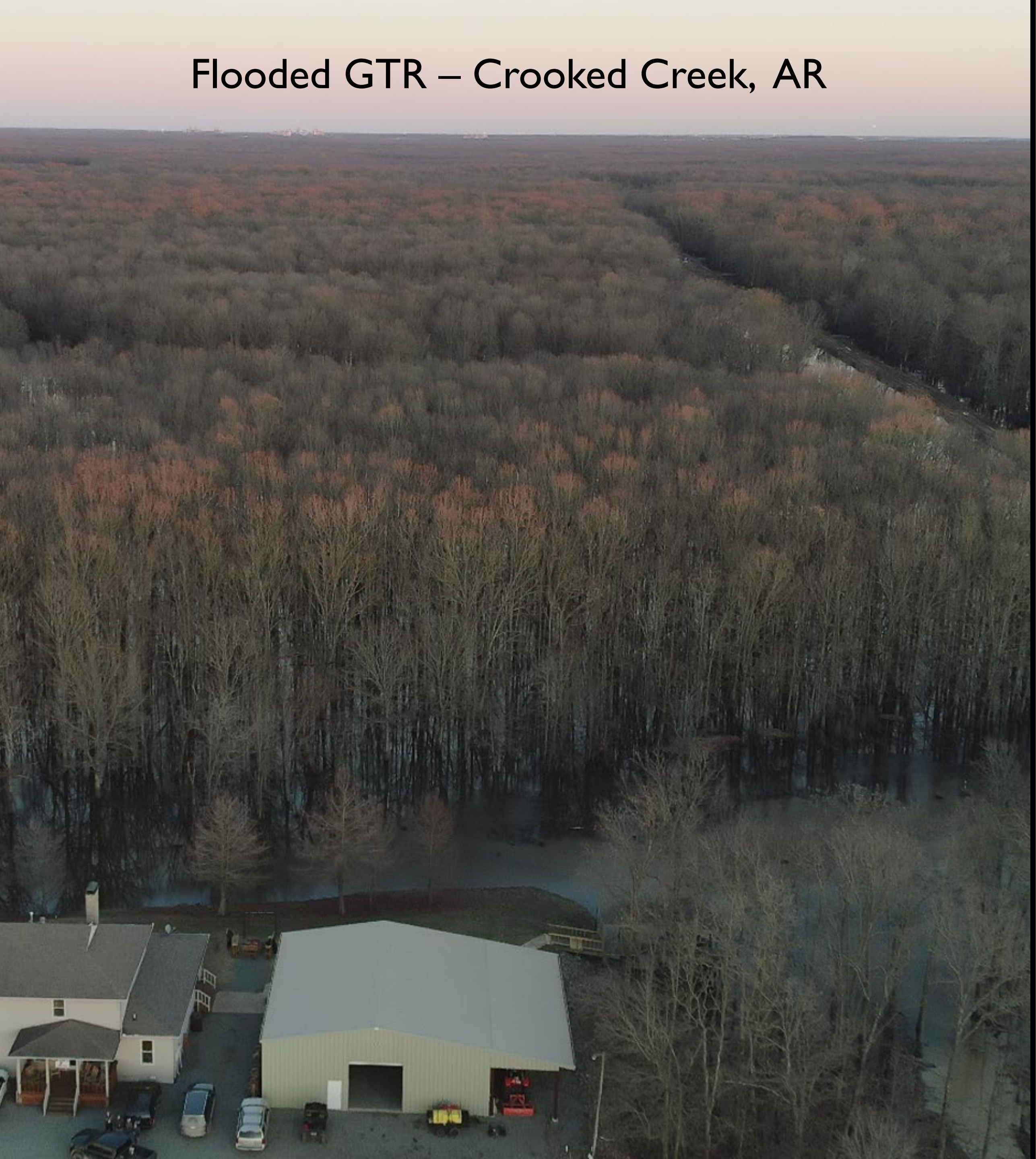
GEOL-7900 Final Presentation

QUESTION

- How does the winter hydroperiod influence the annual growth rate of wetland-dependent tree communities on Greentree Reservoirs in northeast Arkansas?

BACKGROUND

- Greentree Reservoirs (GTRs) offer red oak acorns and invertebrates for food as well as thermal cover and pair isolation—nearly everything ducks need during winter stopovers
  - Early GTR management (1930s) was simple: flood impoundments to full pool by the opening day of duck season (mid-November) and drain them the day after the season closes (early February)
  - Over time, however, the productivity of many GTRs declined as the long-term effects of early flooding took a toll on timber health and overall habitat quality
  - The health of red oaks in GTRs is of particular concern to habitat managers because their acorns are a bumper crop that provides an abundance of energy to ducks during their winter migration
  - Countless studies have since been conducted to better understand forest health and natural flooding regimes, identify management problems, and develop corrective measures.



BACKGROUND CONT'D

- As such, Arkansas Game and Fish have launched a statewide initiative to evaluate and rehabilitate more than 40 GTRs on public lands over the next decade and beyond
- Considering all this upcoming restoration work to create and improve GTRs, there exists an opportunity to assess the influence of winter hydroperiod on the annual growth rate of stands at varying successional stages:
  - Stand initiation (seedlings)
  - Stem exclusion (saplings)
  - Understory reinitiation (trees and shrubs)
  - Steady State (mature trees)

IMPORTANCE

- Flooded timber → ducks → money → restoration → ecological services
- Duck hunting contributes nearly $1 million to the state economy each day of the season.
  - 70+ days in a season
- A good chunk of that money goes back into restoration work in the state through Pittman-Robertson and other federal acts
- Restoring wetlands improves the ecological services provided by these habitats
  - Reduced flooding
  - Improved water quality
  - Carbon sequestration

HYPOTHESIS & OBJECTIVE

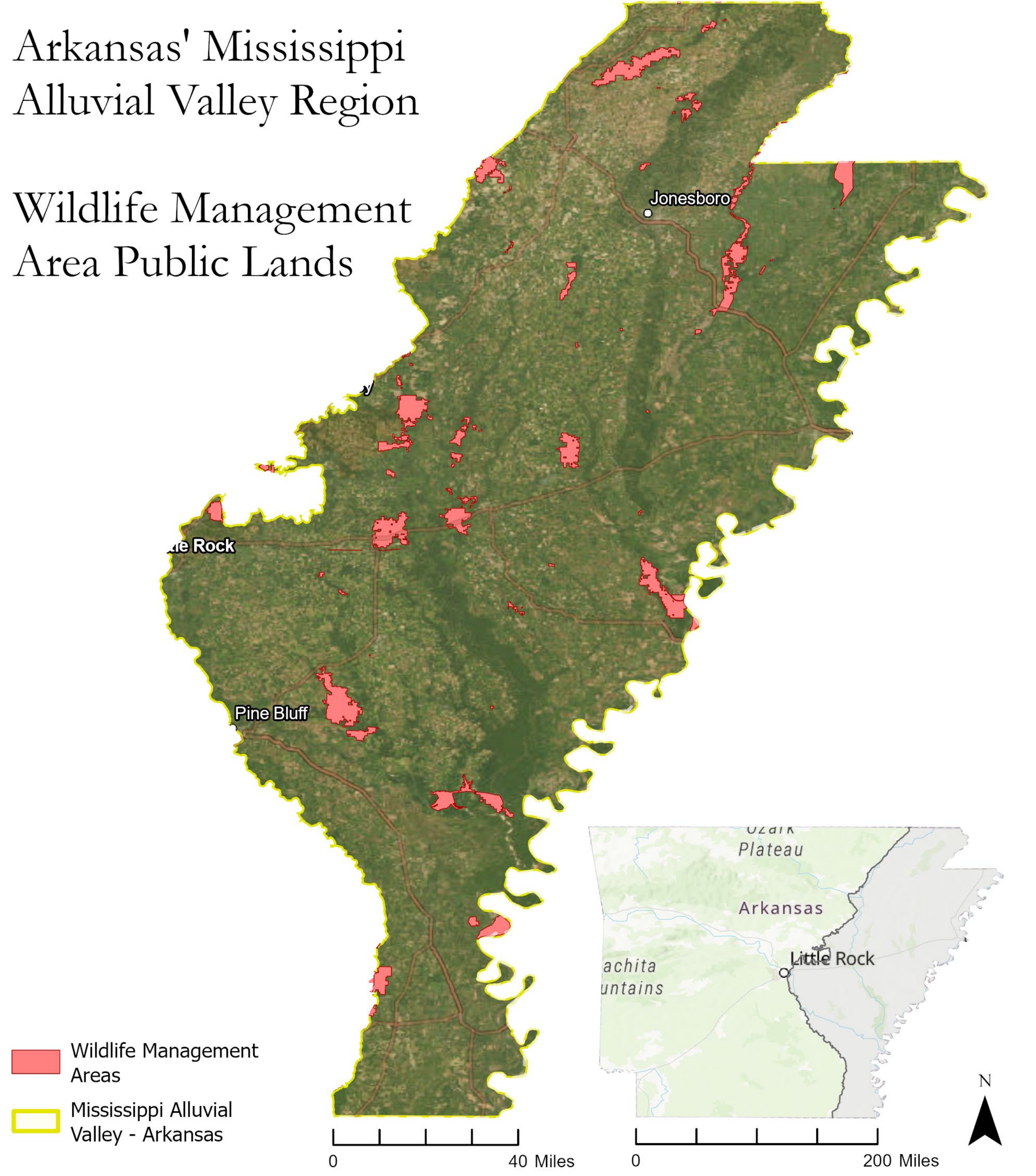
- Hypothesis 1: Heavy artificial flooding on GTRs during winter hinders tree growth and the overall success of restoration efforts

- Hypothesis 2: Early successional GTRs will be more sensitive to heavy artificial flooding than established communities

- Objective: Quantify the hydroperiod and flooding intensity effects on tree growth on restored GTRs in Arkansas' Mississippi Alluvial Valley region

STUDY AREA

- 12 public GTRs in the Mississippi Alluvial Valley region of Arkansas
  - 3 from each successional stage
- Prioritize wildlife management areas (WMAs)
- Target GTRs > 200 acres
  - This translates to ~ 8,100 pixels on the pre-processed SAR images

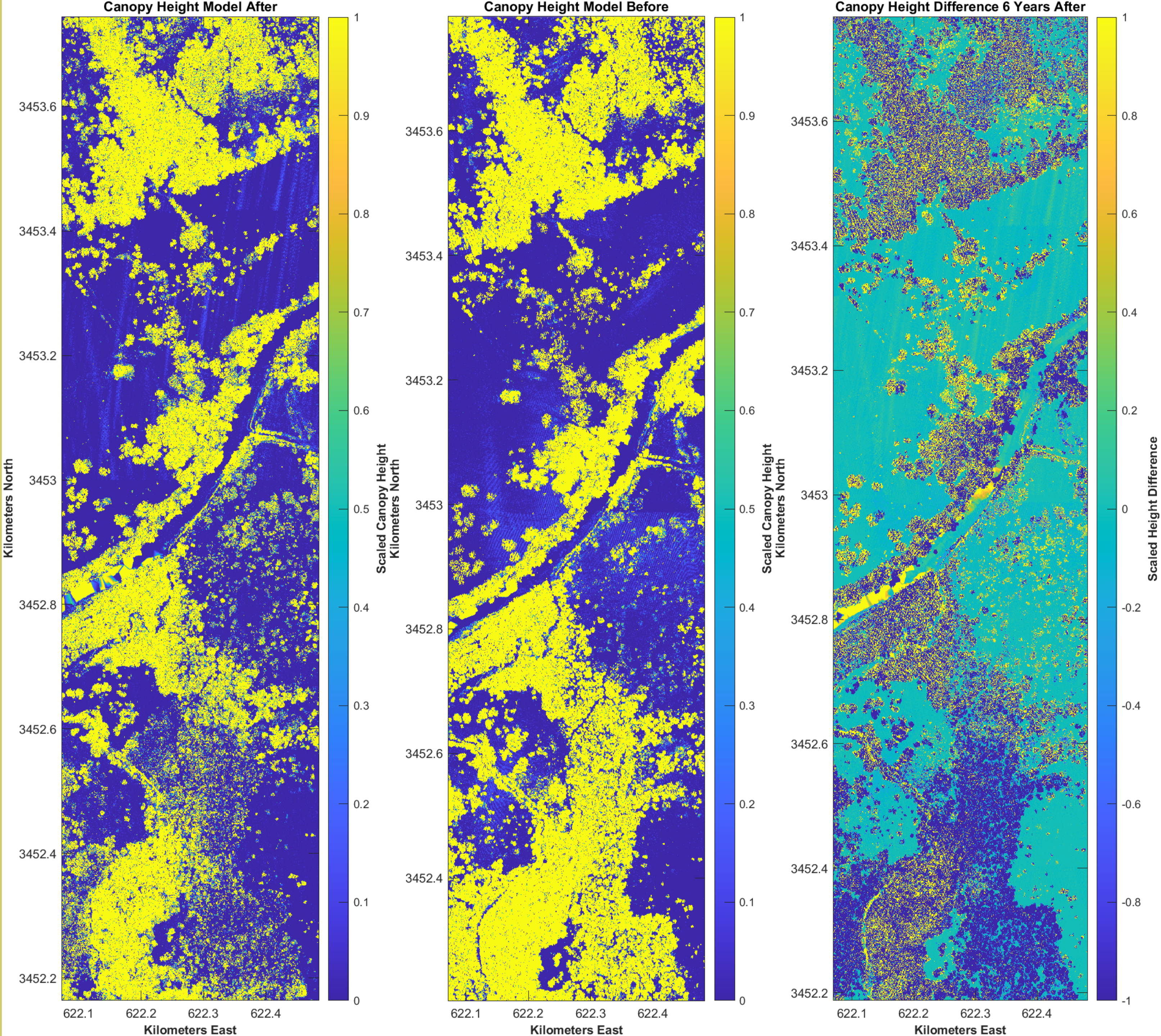


STUDY DESIGN

- Study period: Fall 24 – Fall 26
- Two active remote sensing methods: LiDAR and SAR
- LiDAR acquisition: Collect at each of the 12 sites using a drone
  - Annual collection in early November (2024, 2025, 2026)
    - This is the end of the growing season, right before leaf-off
- SAR scenes: Download for each of the 12 sites
  - Bi-weekly starting around November 1st through March 1st
    - November 1st is pre-duck season (post-growing season)
    - March 1st is post-duck season (pre-growing season)

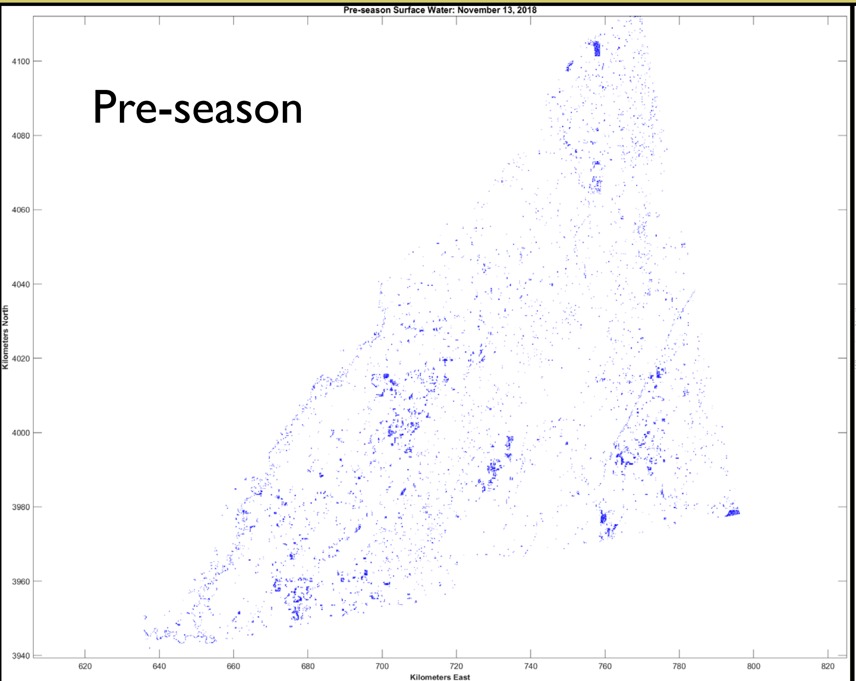
DATA DESCRIPTION – LIDAR

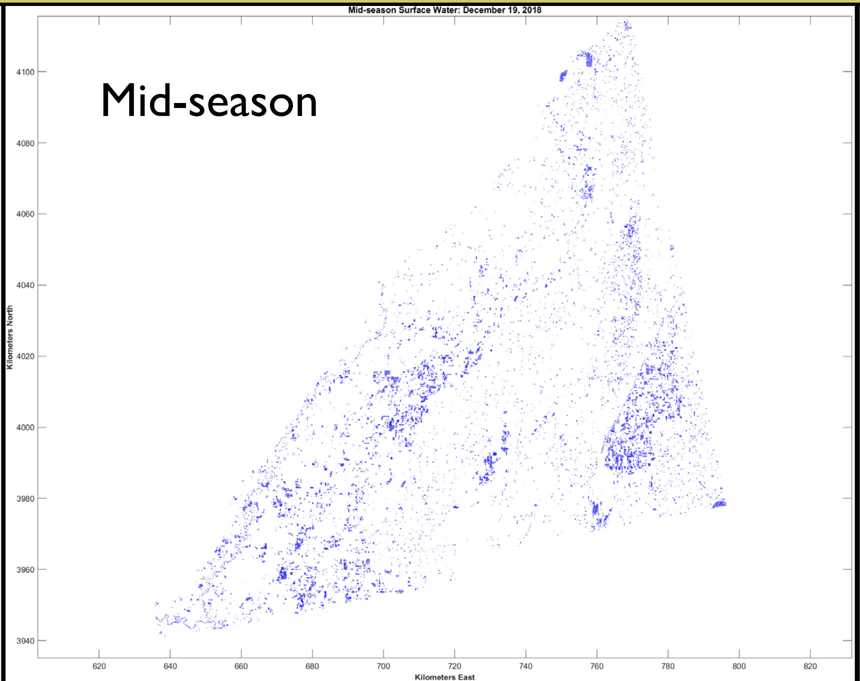
- Processed point cloud
- LiDAR-derived digital surface model
  - Surface (first) returns
- LiDAR-derived digital elevation model
  - Ground (last) returns

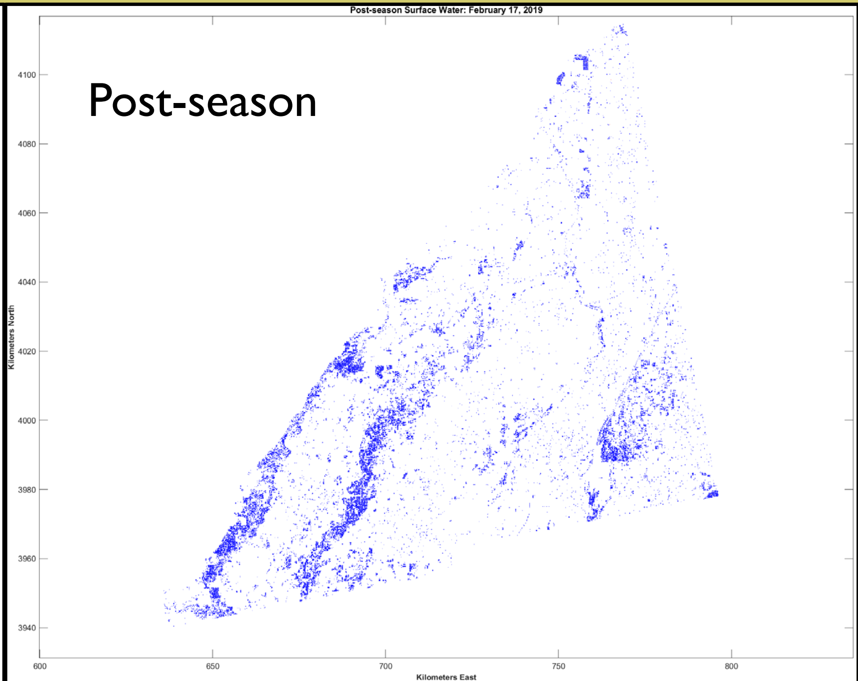


DATA DESCRIPTION – SAR SCENES

- ALOS-2 L-band SLCs
- Sigma naught radiometry
- Pixel values converted to decibel scale
- Co-registered using NED 10m DEM
- Speckle filtering to remove noise
- VV polarimetry (co-polar)







ANALYTICAL METHODS

- Create a LiDAR-derived canopy height model (CHM) at every site and for each year
  - $CHM = first\ returns\ - last\ returns$
- For each site, calculate annual tree growth by subtracting year n from year n+1 CHM
  - E.g., $\text{Growth} = 2025\ CHM\ - 2024\ CHM$
- Create a surface water mask at every site for all pre-processed SAR scenes in a season
  - Plot dB data to histogram
  - Determine bimodal split (dB threshold)
  - Mask out non-surface water using global dB threshold
- Quantify surface water percent cover at each site for each SAR scene in a season
  - Hydroperiod = amount of time a wetland is in standing water

WHY THESE METHODS ARE APPROPRIATE METHODS

- Vegetation growth using LiDAR:
  - Simple differencing of last and first returns allows for a high-resolution model of canopy height
  - Collecting annual LiDAR at each site right after the growing season allows you to compare canopy height models between years and calculate annual growth
  - LiDAR can also help you distinguish different stages of succession

- Hydroperiod using SAR:
  - ALOS-2 L-band wavelength is ~23.5 cm and can penetrate dense vegetation such as tree canopy to reach the water's surface
  - Pulling ALOS-2 scenes every two weeks (revisit time is 14 days) from right before duck season begins until right after it ends will provide a clear picture of each site's hydroperiod
  - Data is available

QUESTIONS?

Thanks!