Improved reconstruction of the southeastern Laurentide Ice Sheet deglaciation

Constraining ice thinning using *in situ* cosmogenic ^{10}Be and ^{14}C and critically evaluating different retreat rate chronometers

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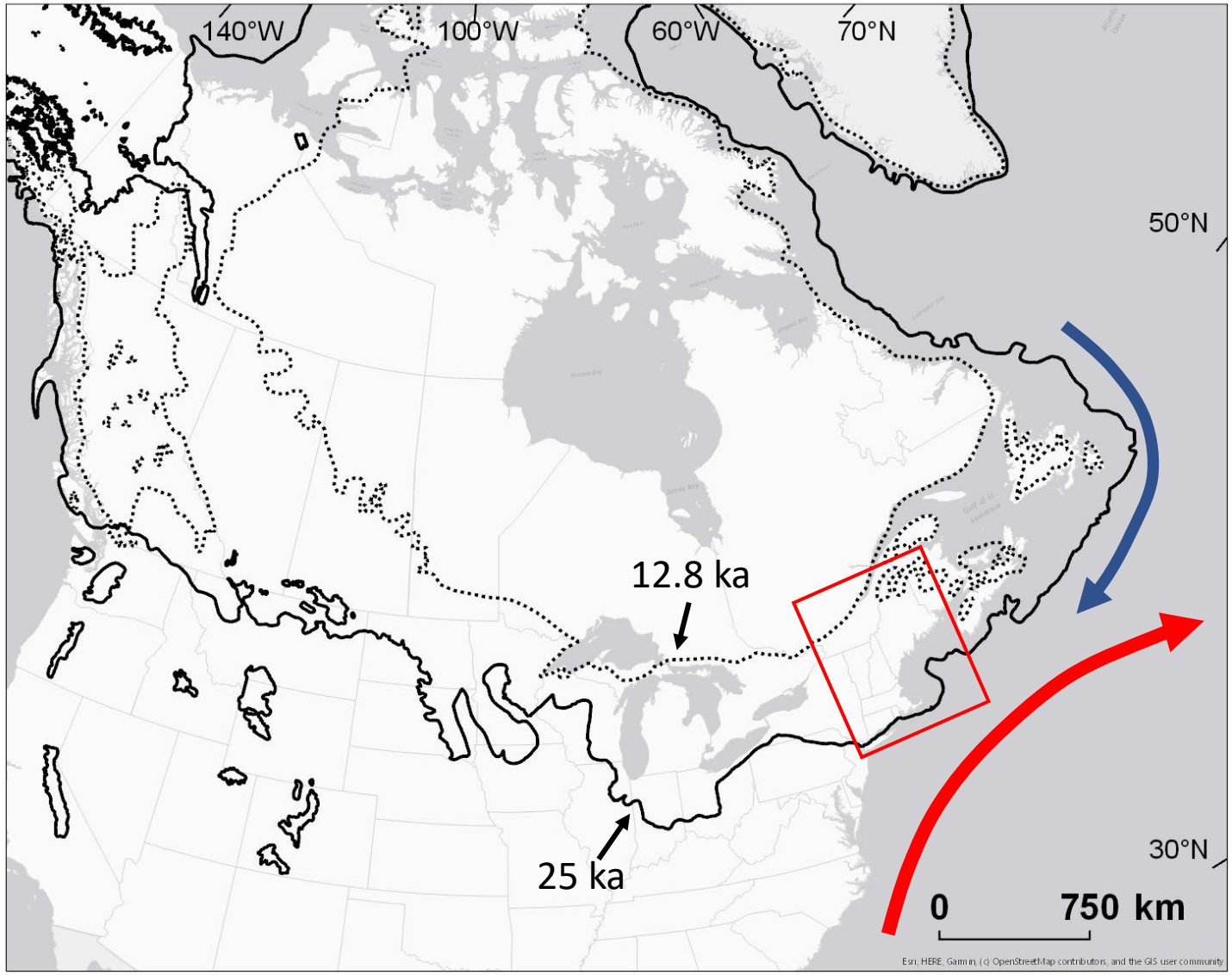
Southeastern Laurentide Ice Sheet Deglaciation

Approximate bounding dates of ice margin retreat through study area: 25 – 13 ka

Problems:

1. Few data to constrain ice thickness

2. Existing regional ice retreat reconstructions mostly based on minimum-limiting dates, are they accurate?



Laurentide ice sheet extent data from *Dalton et al. (2020)*

Problem 1: Few ice thickness data constraints

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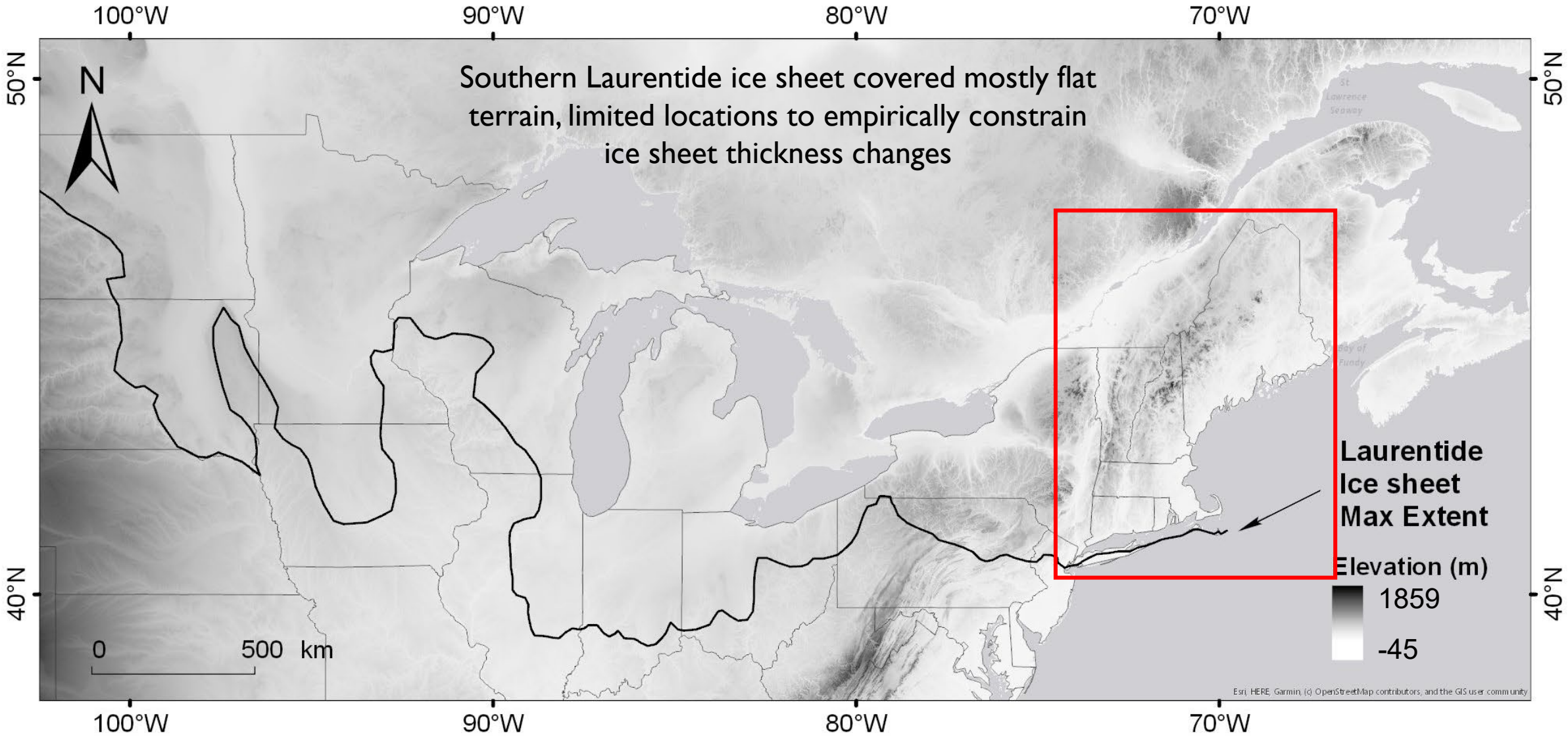
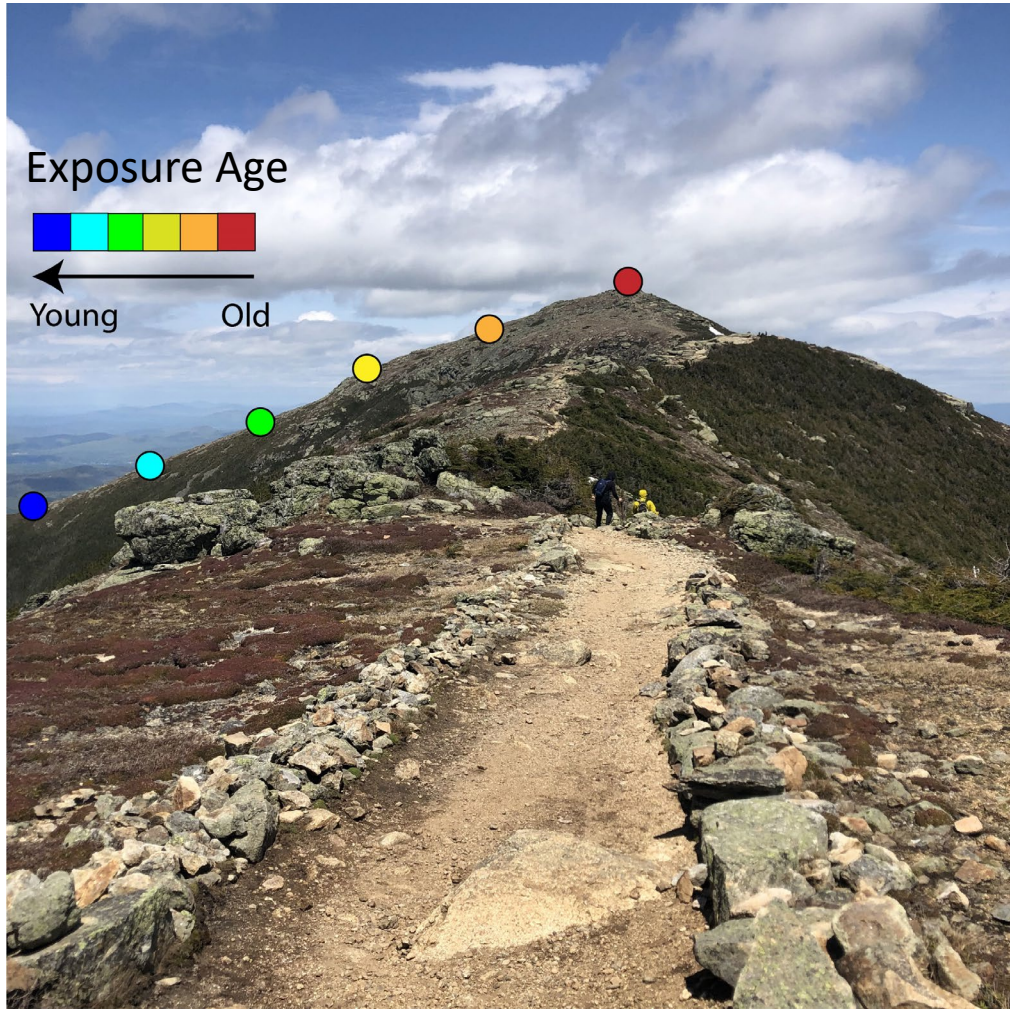


Northeastern United States – Sufficient topography for ice thinning reconstruction

Method – Ice Thickness Reconstruction

Measure *in situ* cosmogenic ^{10}Be exposure ages at various elevations on 12 mountains in the northeastern United States.

Measure *in situ* cosmogenic ^{14}C where ^{10}Be inheritance appears to be present

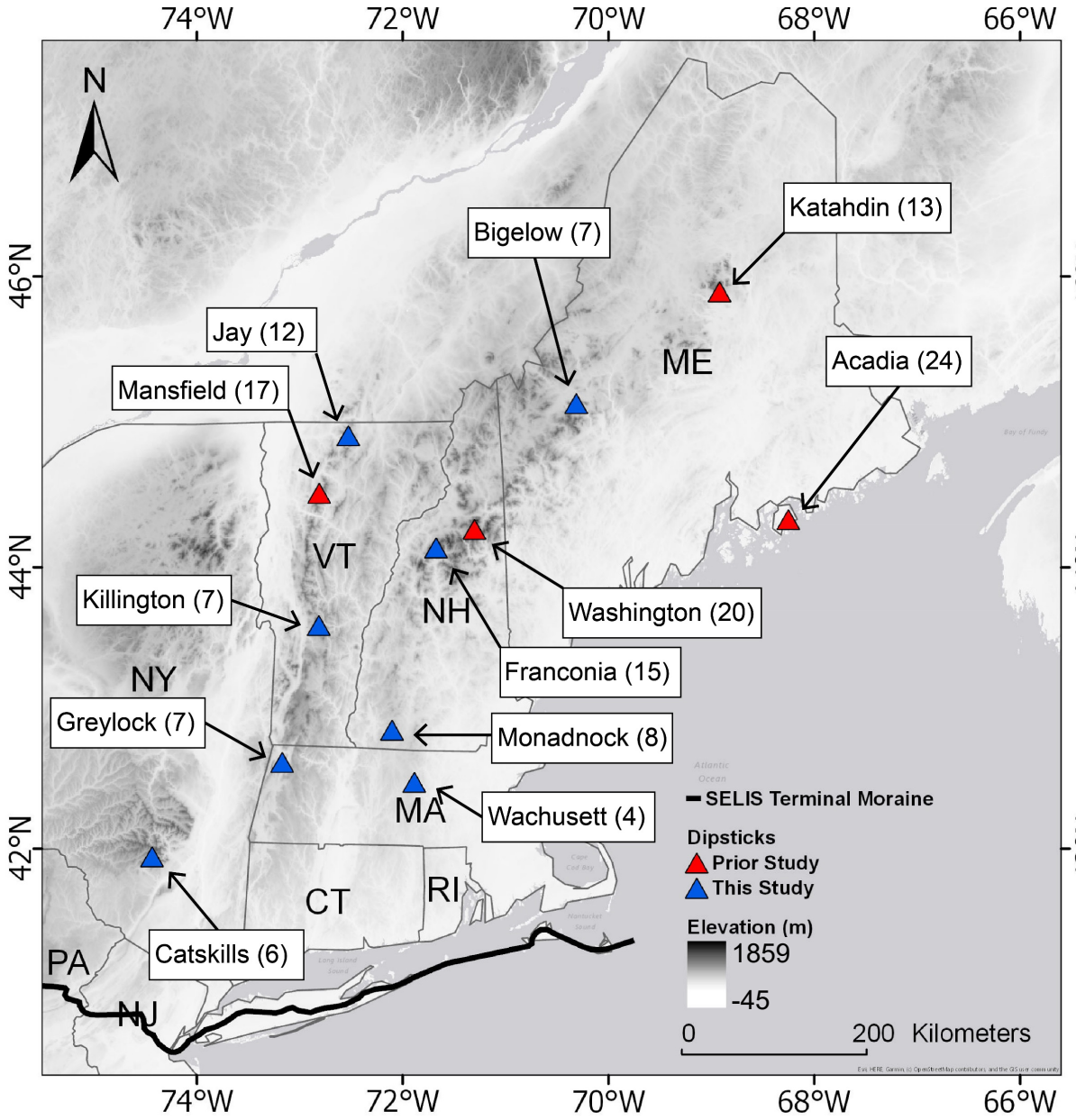


Mt. Lafayette, New Hampshire, USA

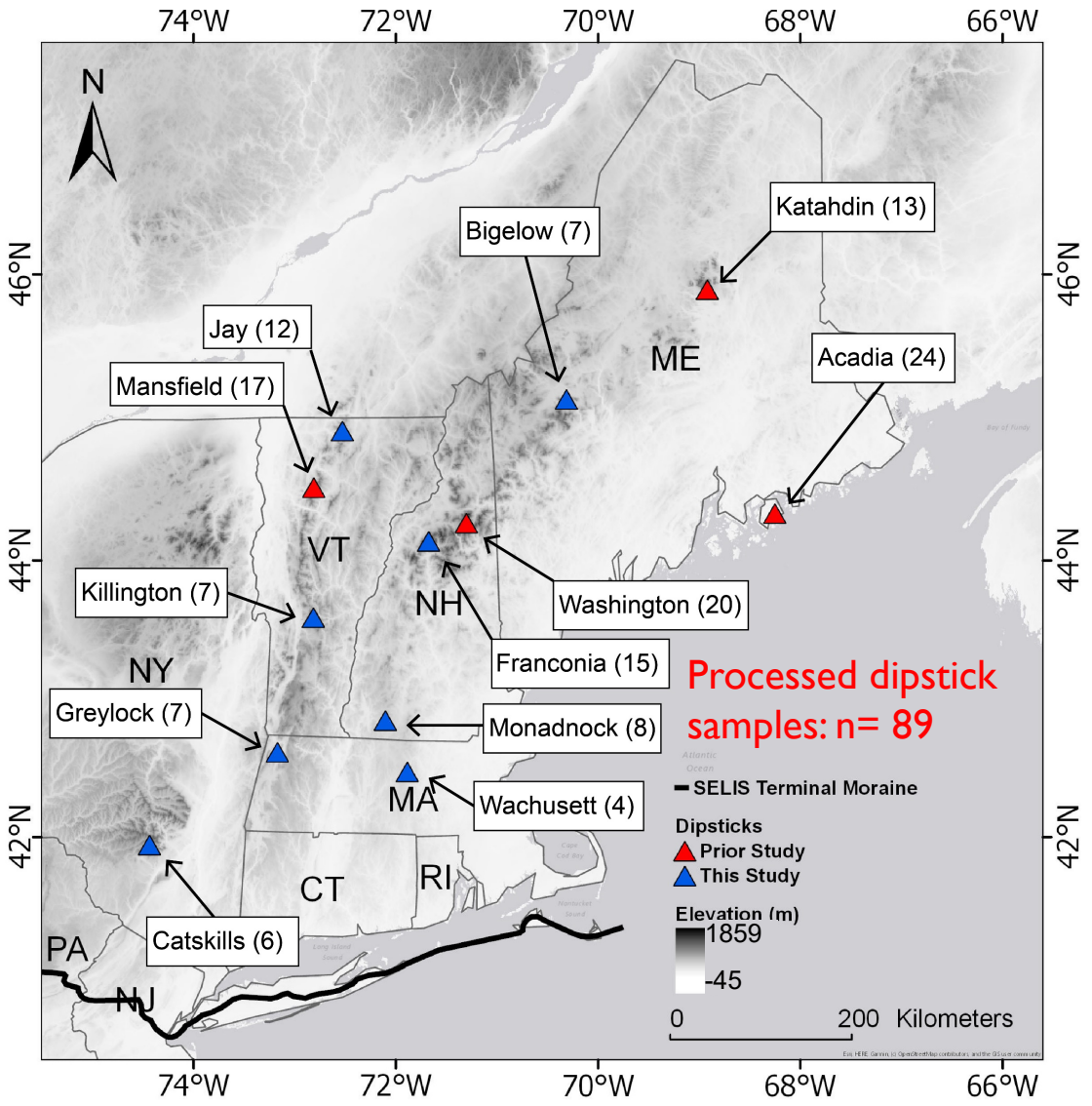
Method – Ice Thickness Reconstruction

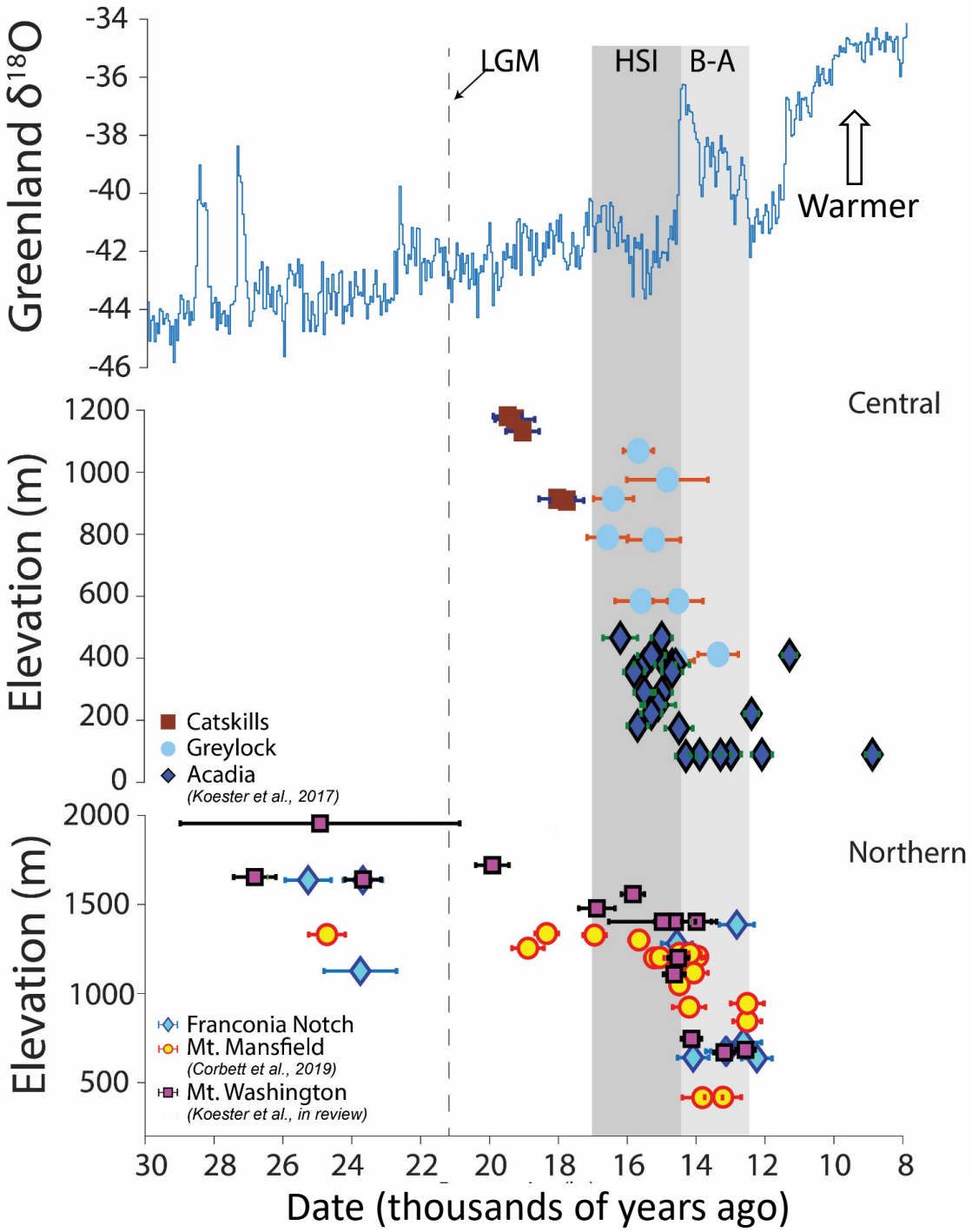
Sample mountain names, locations and sample numbers (in parentheses)

- Prior studies (associated with this project): n = 74
- This study: n = 66
- Total: n =140 samples to reconstruct Laurentide ice sheet thickness changes



Preliminary Results – Ice Thickness Reconstruction

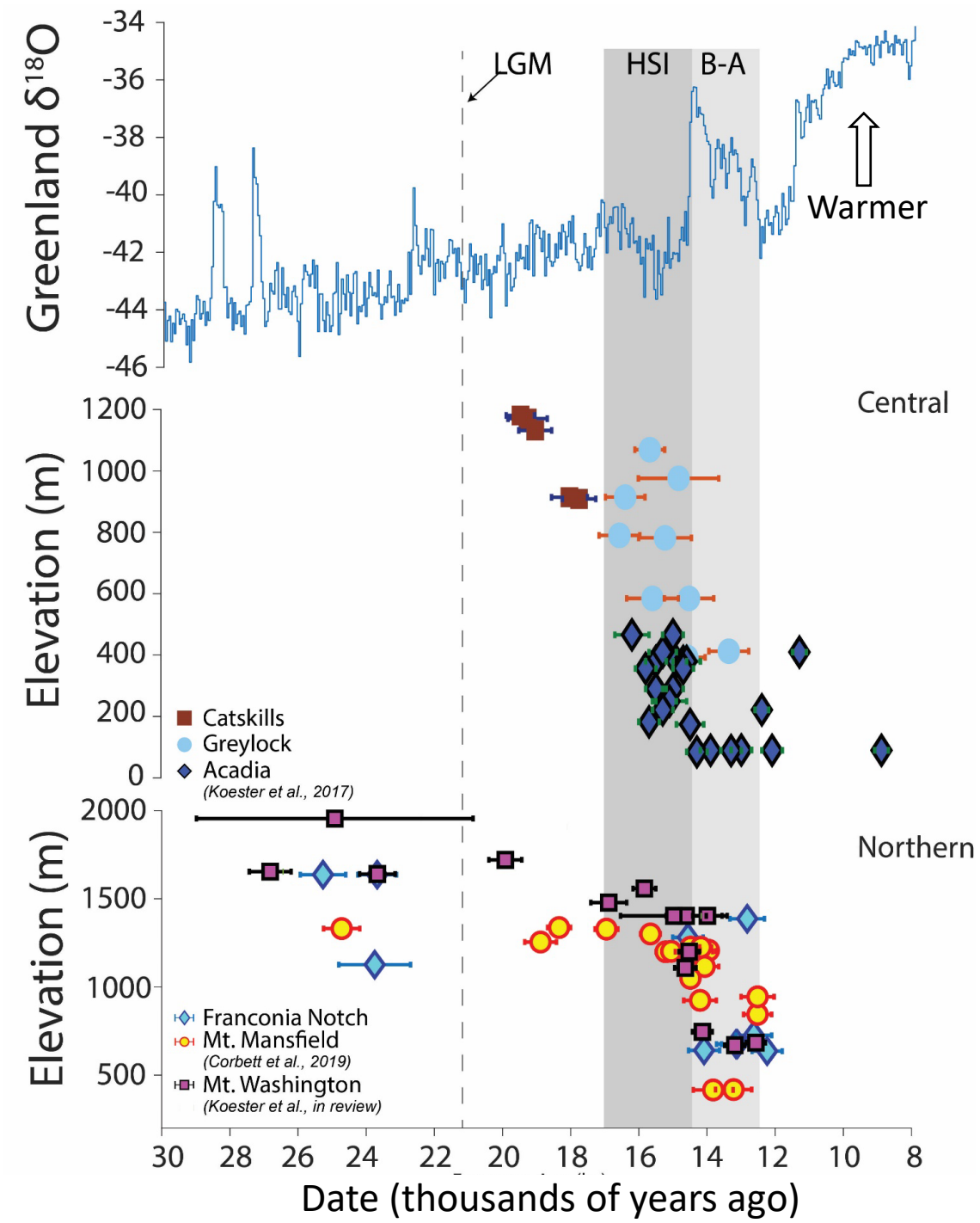




Preliminary Results – Ice Thickness Reconstruction

Summary:

- Near-margin ice sheet thinning early in deglacial period (~20-15 ka)
- Period of rapid ice thinning over 1000 m elevation during the Bølling-Allerød
- Evidence of *in situ* ^{10}Be inheritance above ~1200 m asl at northern mountain sample sites



Problem 2: Uncertainty about precision and accuracy of ice margin retreat reconstructions

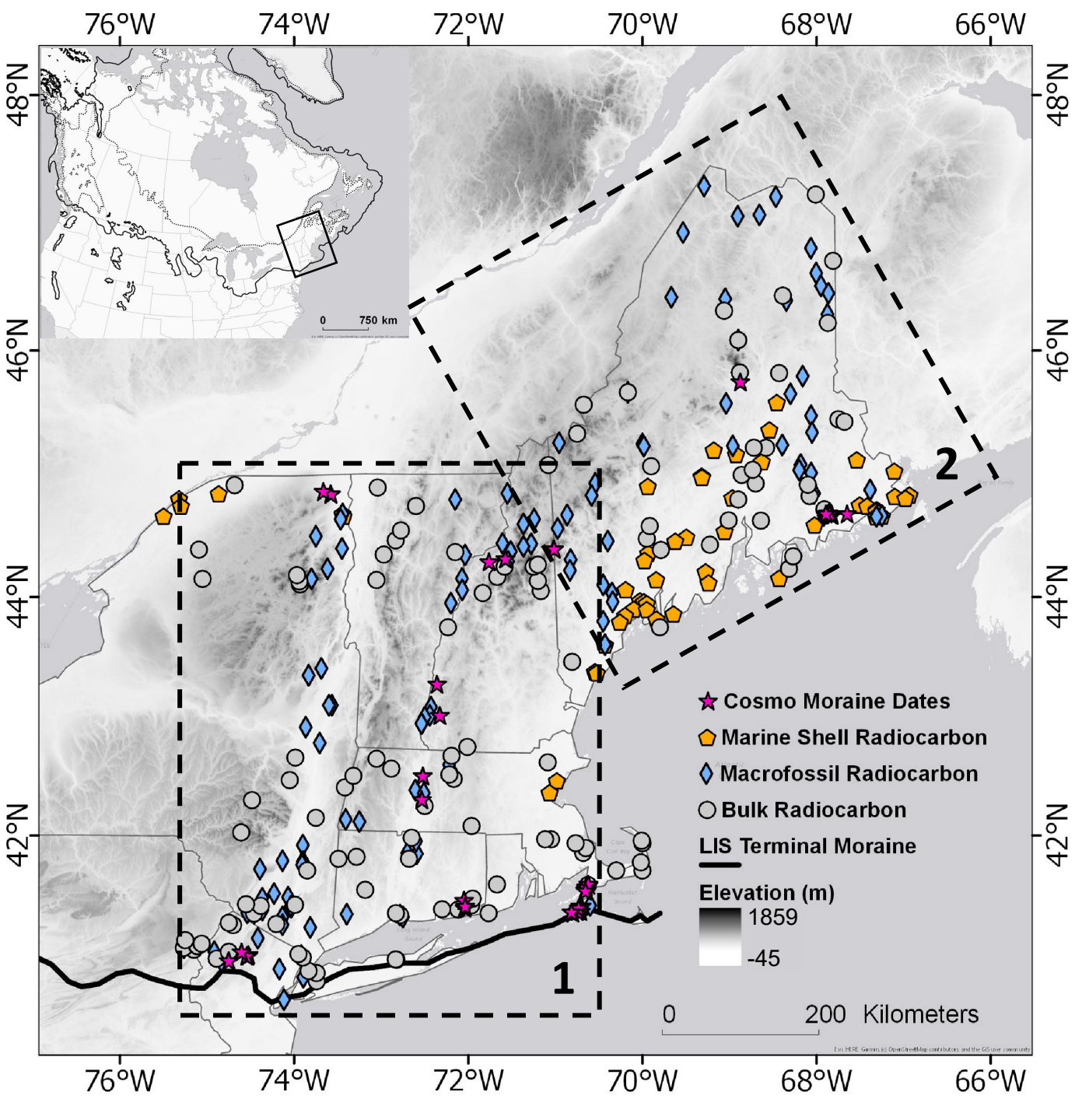
Method – Ice Margin Retreat

Ice retreat dates from:

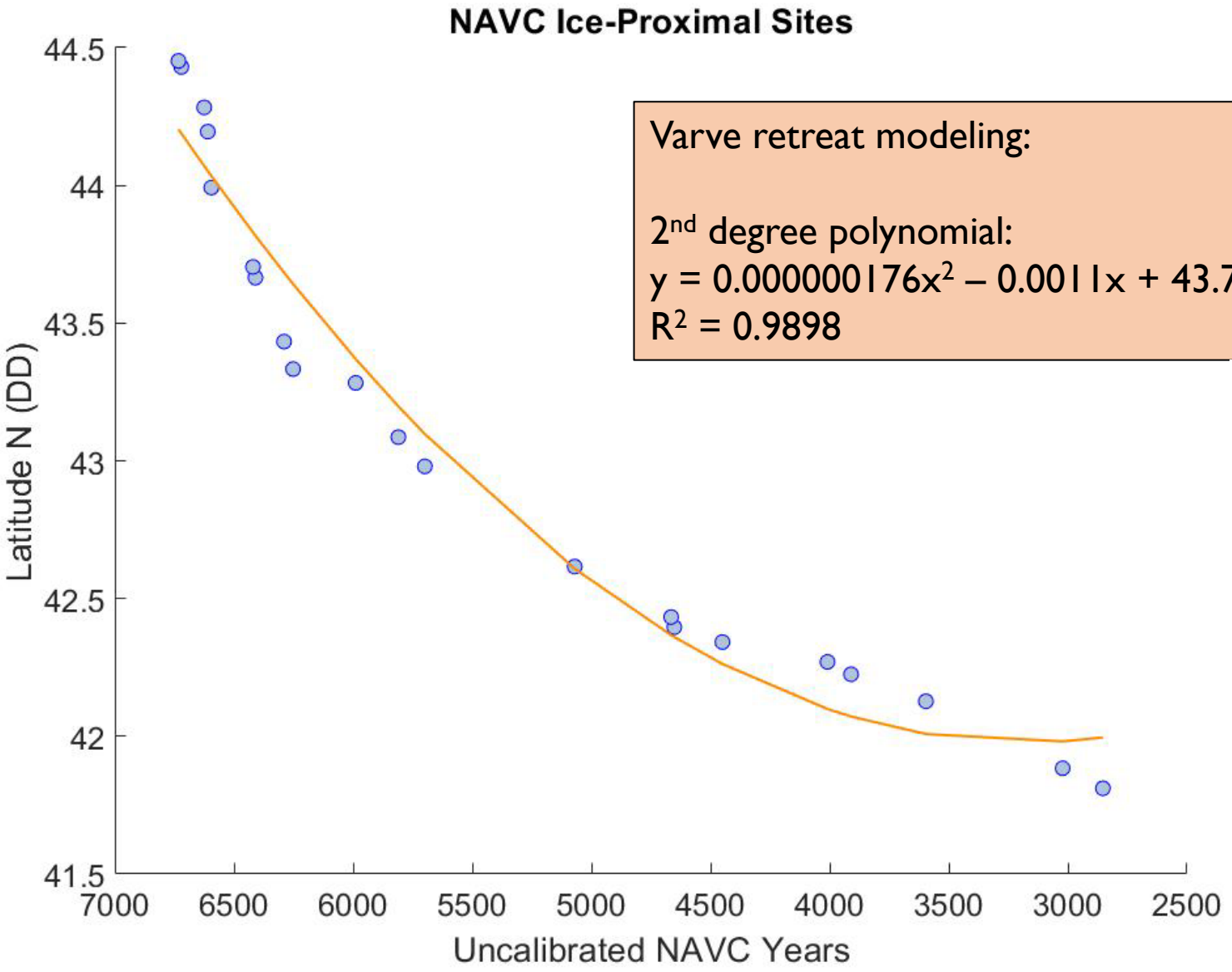
- Bulk-sediment radiocarbon
- Macrofossil radiocarbon
- Marine bivalve radiocarbon
- *In situ* cosmogenic ^{10}Be

Methods:

- Monte Carlo regressions of retreat date vs. distance
  - Quantify chronometer **precision**
- Compare indicated retreat patterns to 'control' pattern (uncalibrated varve chronology)
  - Assess chronometer **accuracy**



Method – Ice Margin Retreat



Varve retreat modeling:

2nd degree polynomial:

$y = 0.000000176x^2 - 0.0011x + 43.7542$

$R^2 = 0.9898$

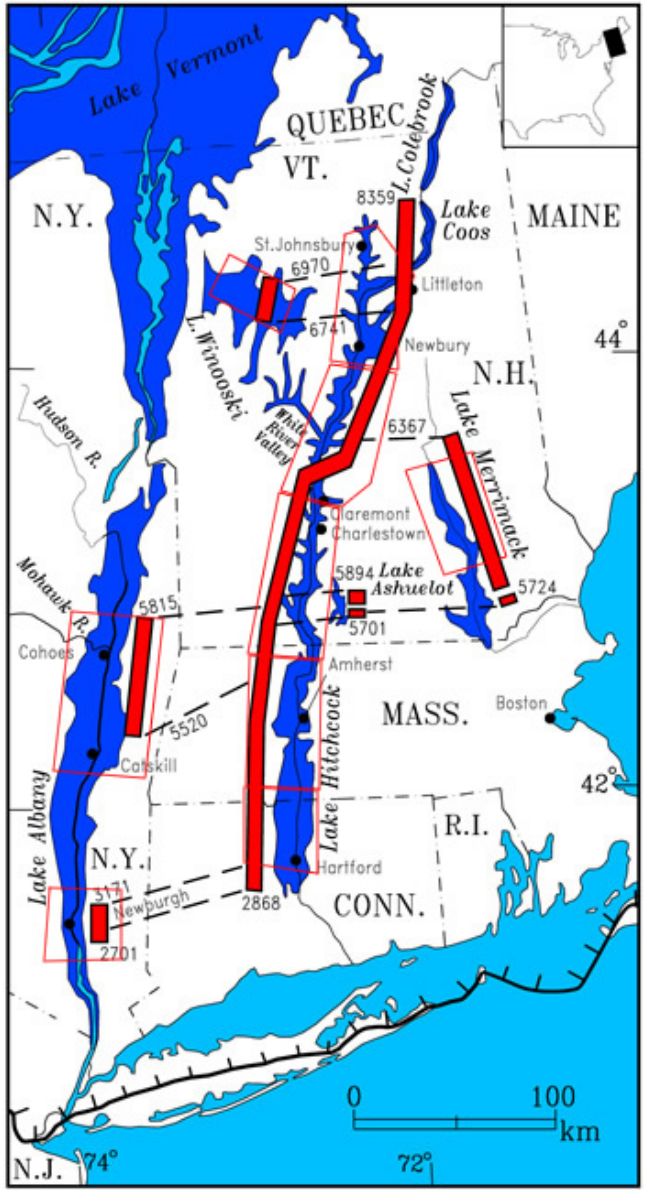
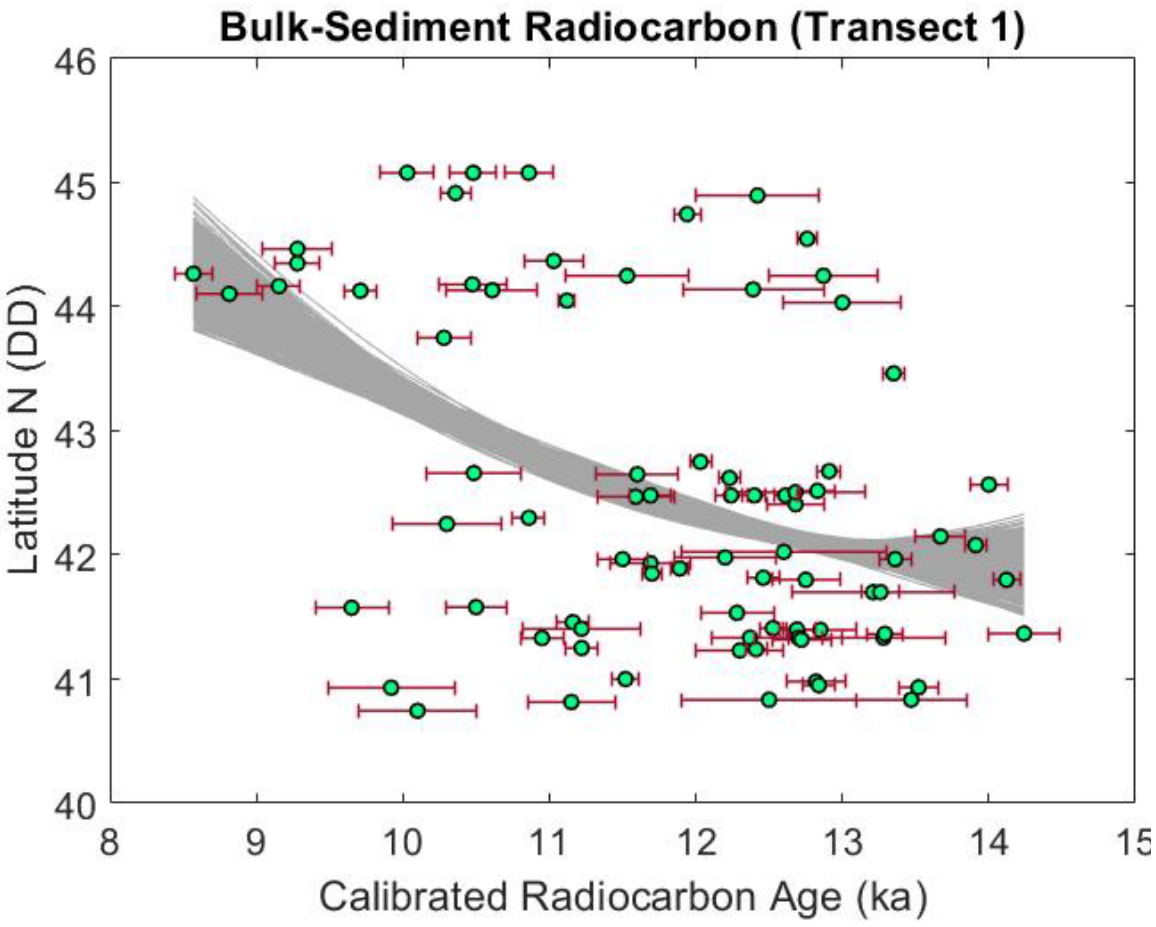
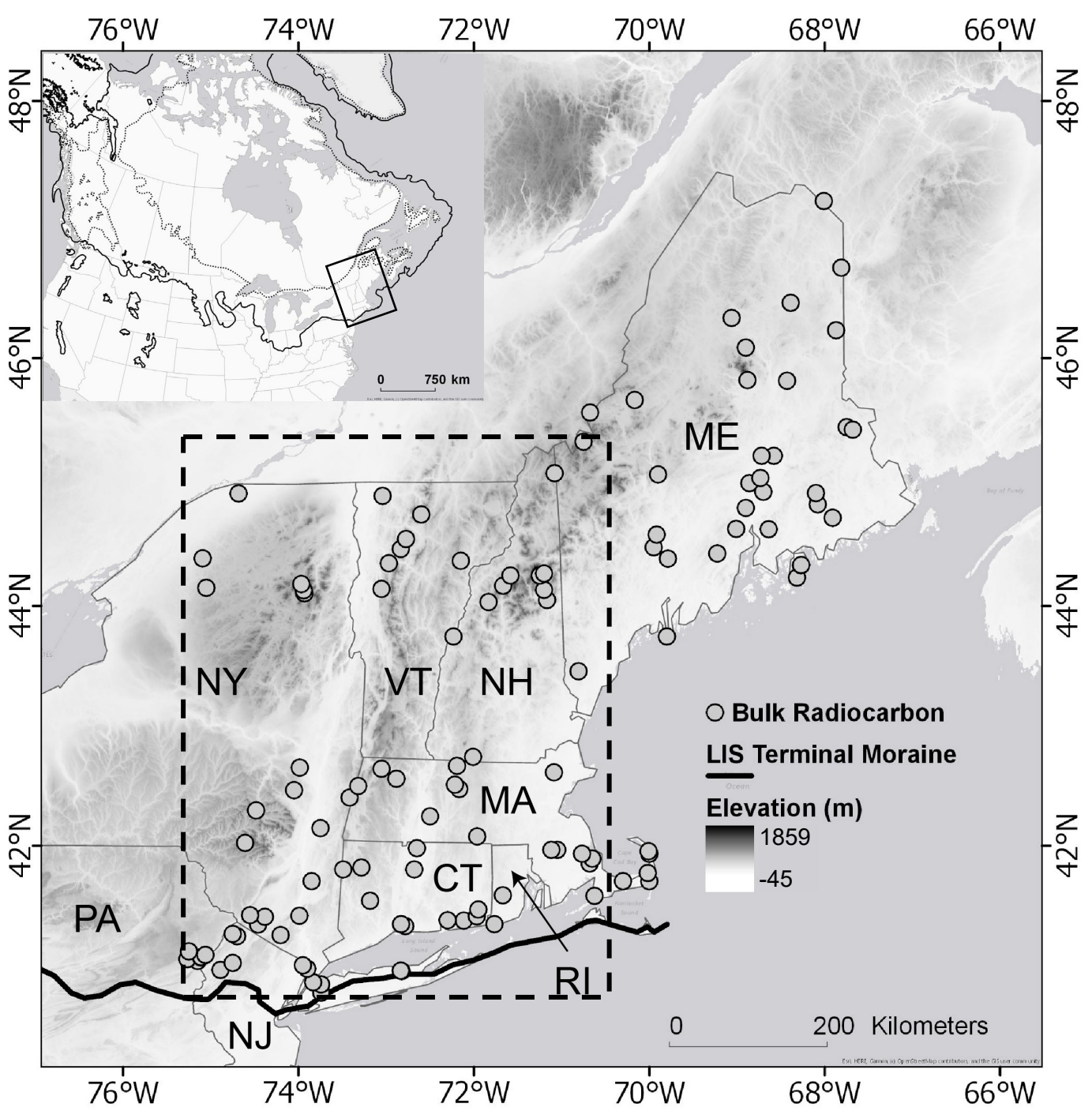


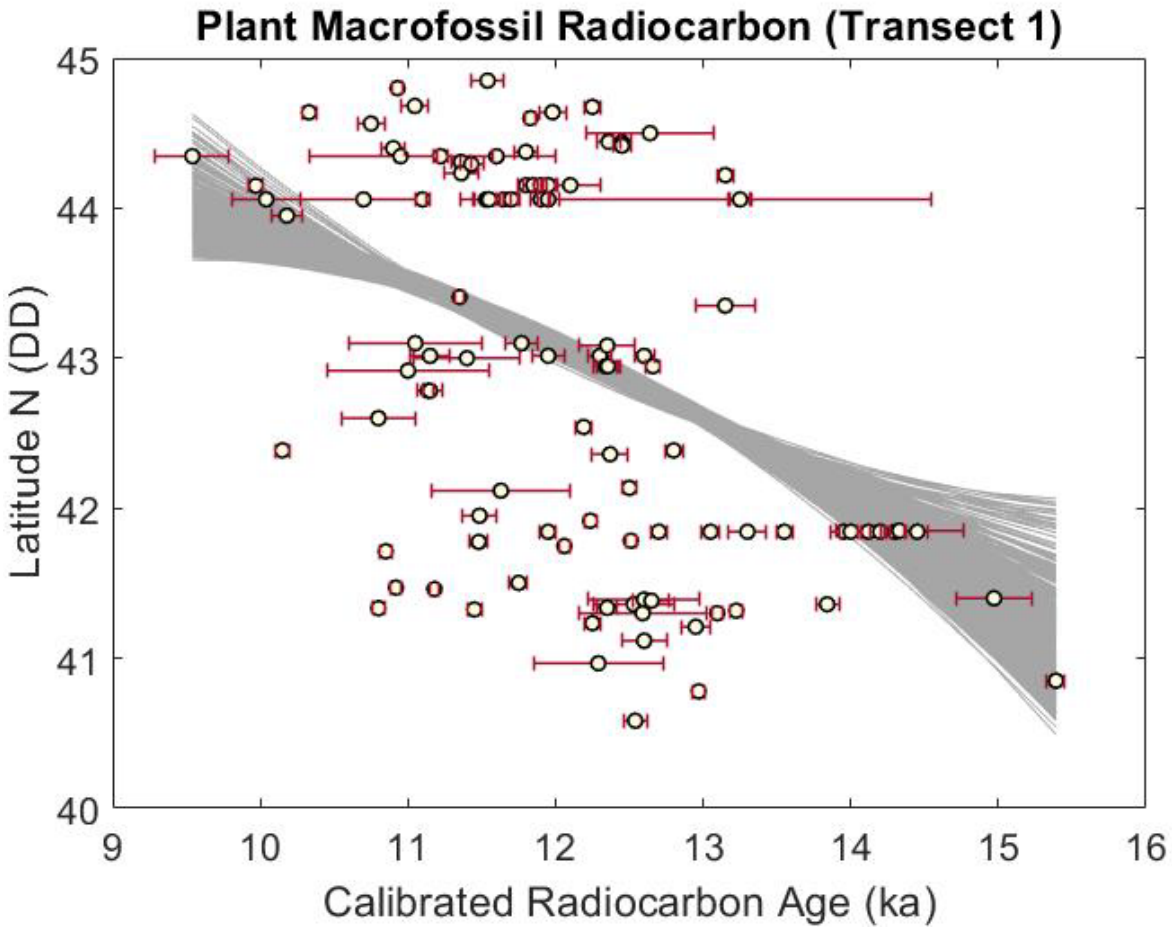
Figure from *Ridge et al. (2012)*

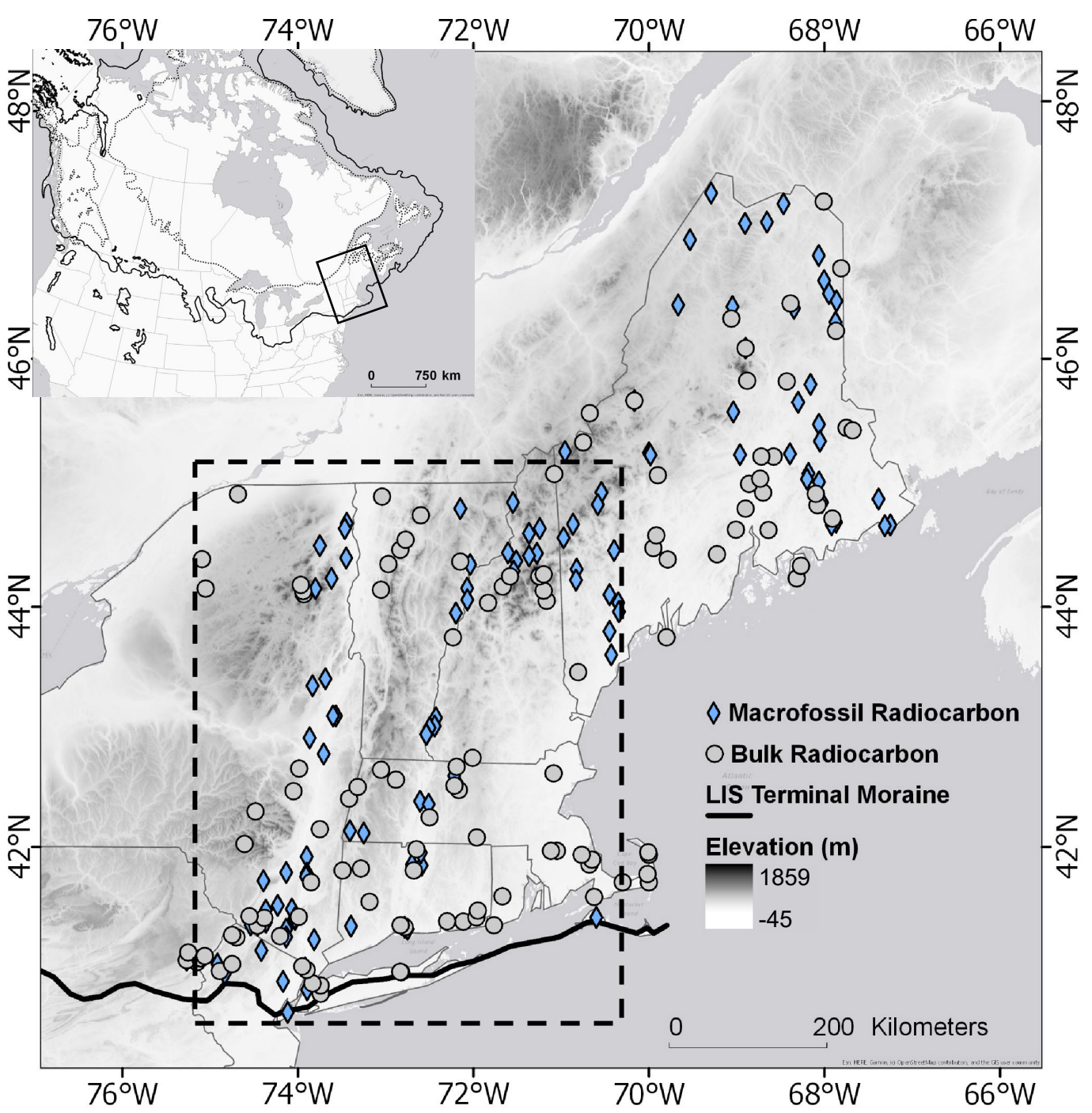
Preliminary Results (Retreat – Bulk Sediment Regressions)





Preliminary Results (Retreat – Macrofossil Regressions)





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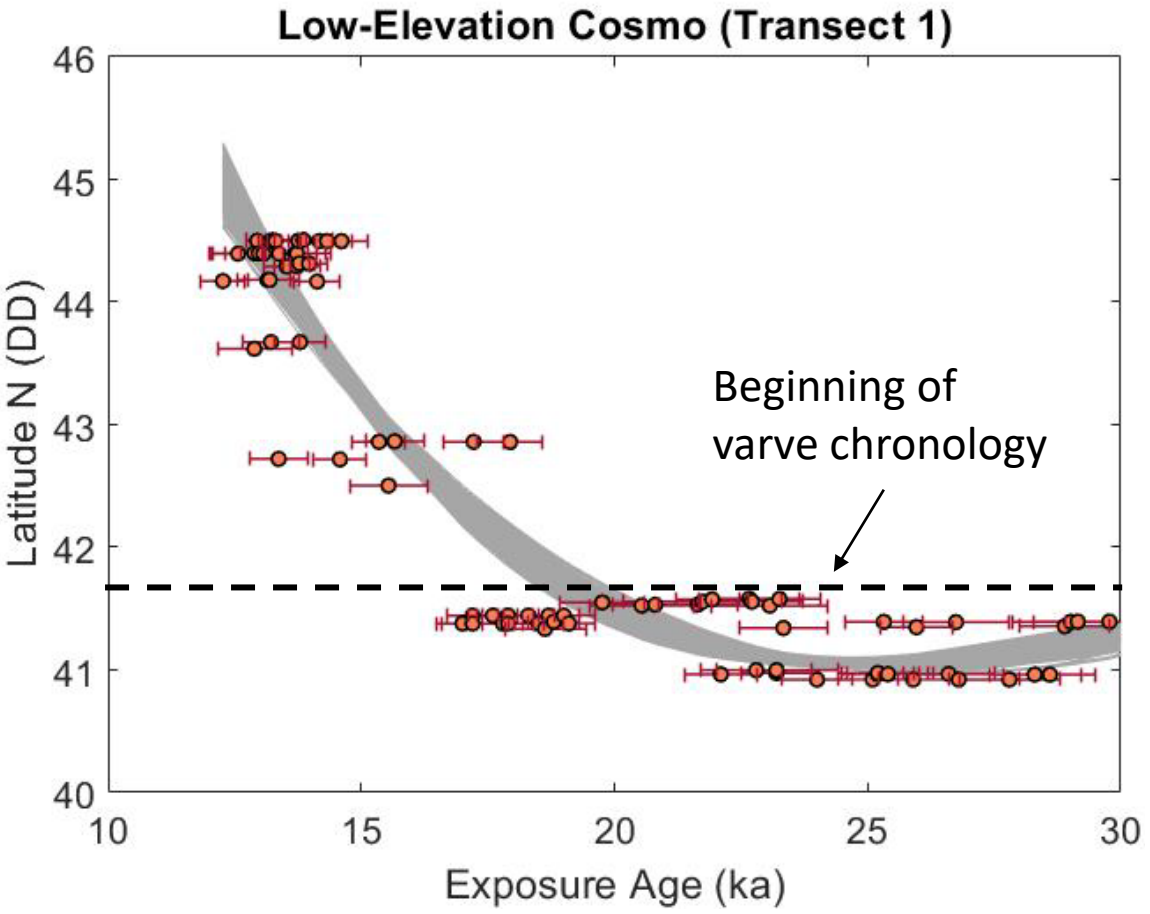

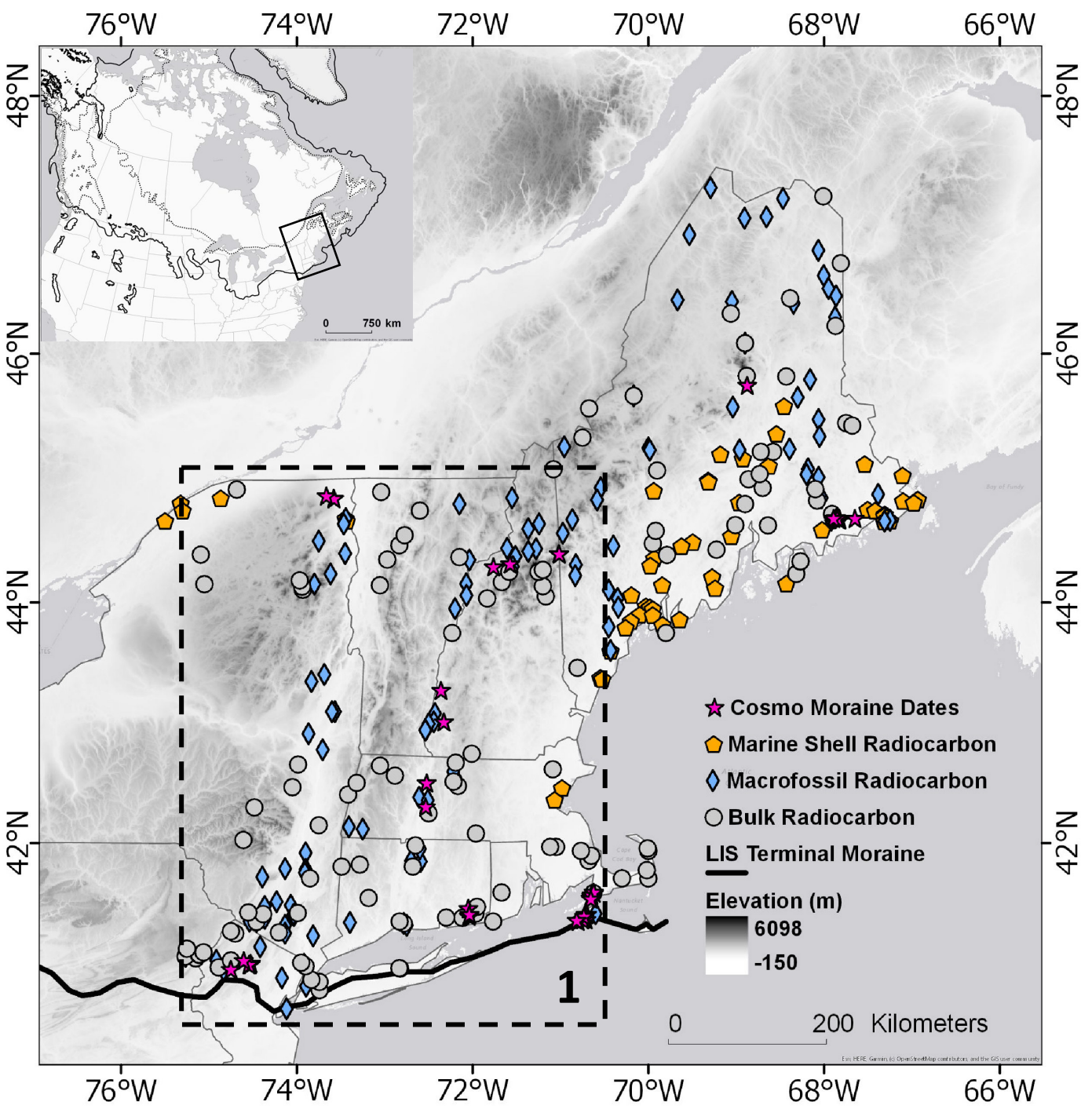

Preliminary Results (Retreat)

Summary:

- Southeastern LIS retreat approximated with a quadratic regression through varve chronology
- Both radiocarbon methods show high variance, low precision
- Cosmogenic exposure ages have higher precision, seem to replicate varve retreat pattern more accurately