# Towards an improved understanding of vertical land motion and sea-level change in eastern North America

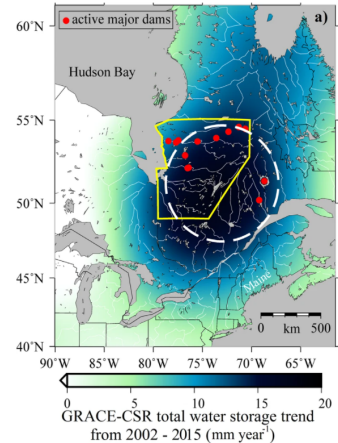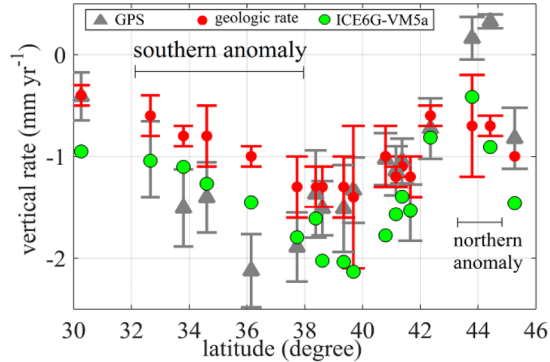Soran Parang, Glenn A. Milne, Makan A. Karegar, and Lev Tarasov

Motivation I

- Much of the Atlantic coast of North America is highly vulnerable to coastal flooding
  - Long-term land subsidence in response to deglaciation of the Laurentide ice sheet
  - Glacial isostatic adjustment (GIA) as a main driver to SLR and vertical land motion (VLM)
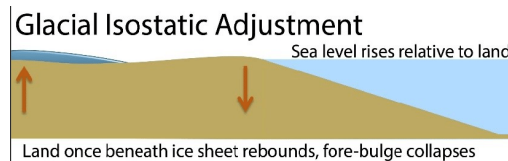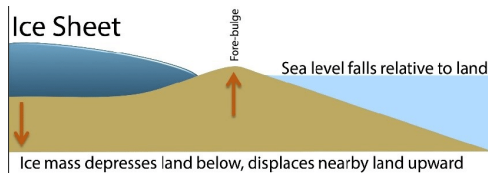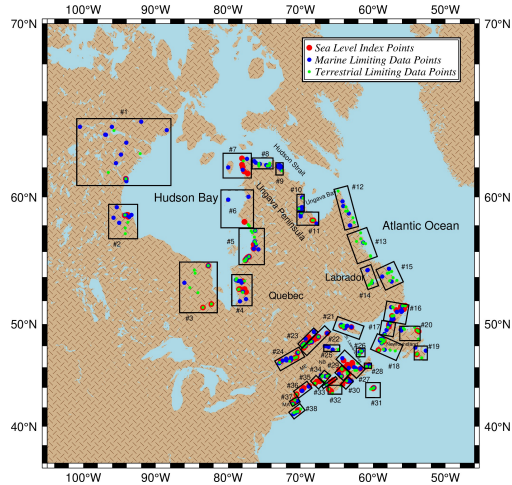

Figures from Boon et al. (2018)

Location of northern anomaly

Figures from Karegar et al. (2017)

RSL data points over 38 sites (or 7 sub-regions) [Engelhart and Horton (2012), Vacchi et al. (2018)]

Constraining the GIA signal with uncertainty

- Two regional RSL data compilations

- A large suite of 34 ice loading histories

  - 440 1D Earth viscosity models per each ice history

- 1D GIA modeling (14960 Earth-ice models in total)

- 1D GIA modeling + chi-squared misfit analysis:

 - Optimal Earth model parameters compatible with RSL observations

- Using spatio-temporally RSL data points as observations

- $\delta_{misfit} = \frac{1}{N} \sqrt{\sum_{i=1}^{N} \left(\frac{RSL_i^{data} - RSL_i^{model}}{\Delta_{rsl,i}} \right)^2 + \left(\frac{t_i^{data} - t_i^{model}}{\Delta_{t,i}} \right)^2}$ *For sea level index points (SLIPs)*
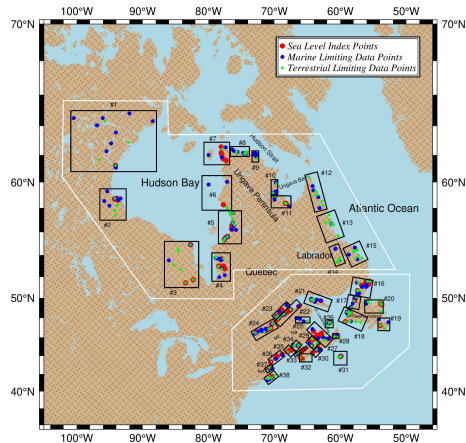
- $\delta_{misfit} = \frac{1}{N} \sqrt{\sum_{i=1}^{N} \left(\frac{RSL_i^{data} - RSL_i^{model}}{\Delta_{rsl,i}} \right)^2}$ *For limiting data (LD) points*

- Model uncertainty bounds from different approaches:
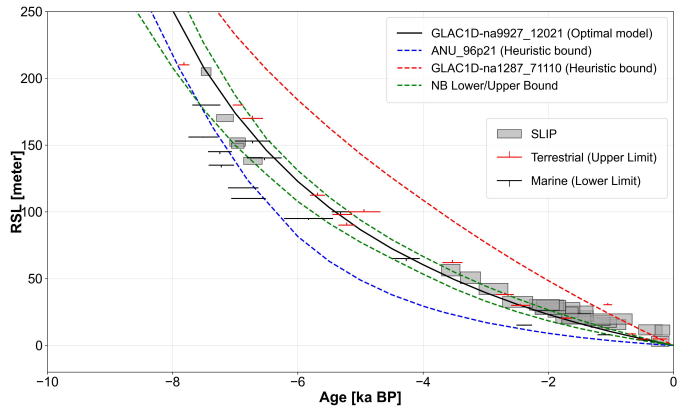   - Nominal Bayesian
    - Heuristic
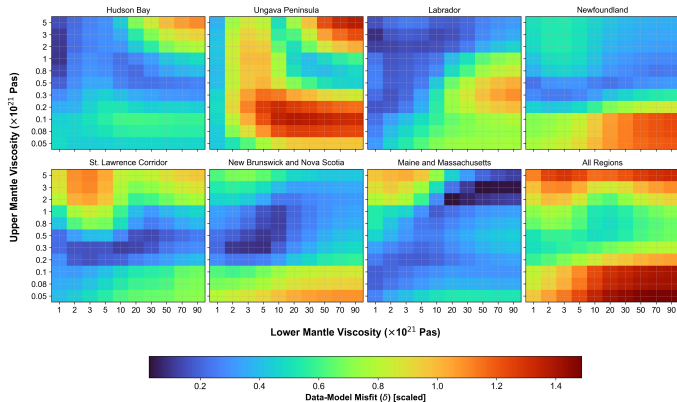
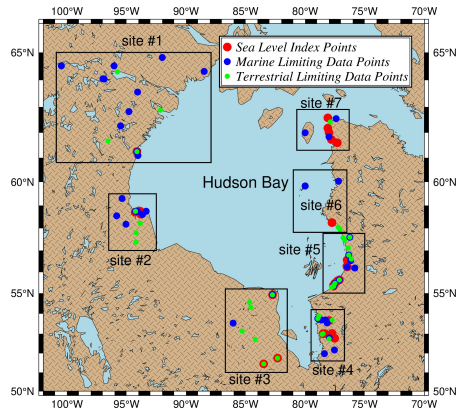Data-model misfit plots (δ) [GLAC1D-na9927, LT = 96 km]

Partitioning into 2 sub-regions

Results II

Bounding models at site #5

Summary and Next Steps

- Optimum Earth model parameter sets (with their uncertainty) derived from 1D analysis can fit well both SLIPs and LD except for some data points

  - Limitations: Parametric and structural uncertainty (e.g., linear Maxwell rheology in the modelling)

- Using 3D GIA modelling for assessing lateral viscosity structure

- Removing the GIA signal (with uncertainty) from geodetic measurements

  - To better isolate contemporary hydrological mass change signal and vertical land motion
  - To improve projections of mean sea level change and nuisance flooding in the coming decades

Many thanks for your attention