Contribution of GIA and deep mantle to gravity field anomaly in North America

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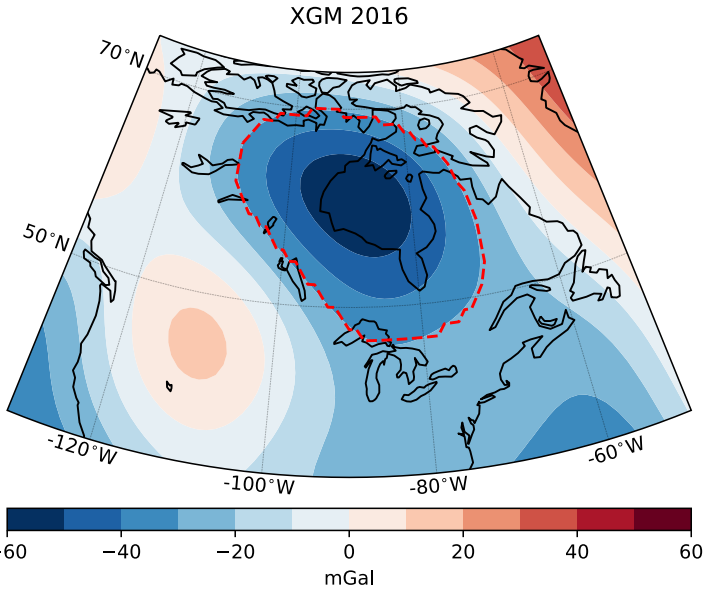
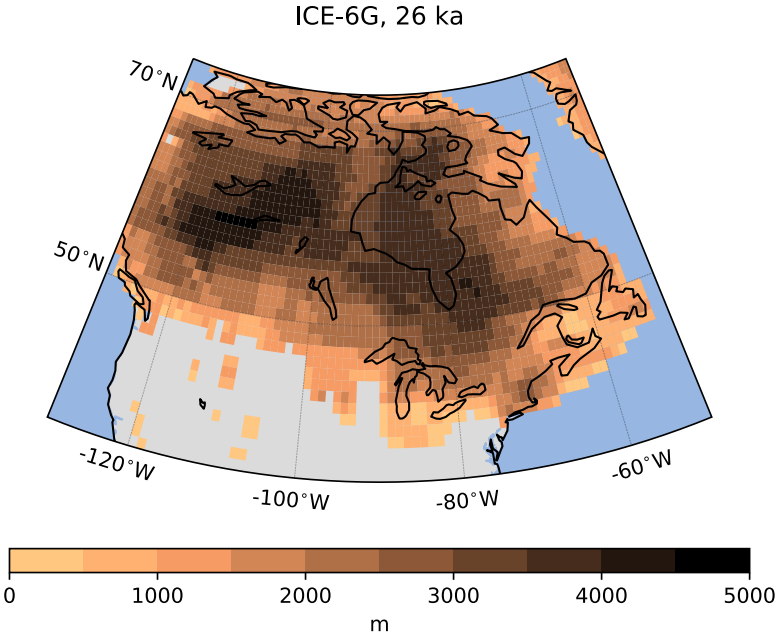
Introduction

Observations

Observations show a negative anomaly of up to 60 mGal in the gravity field over Hudson Bay



Because this area has been covered by the Laurentide ice sheet 26 thousand years ago, people are inclined to believe that this anomaly is related to glacial isostatic adjustment (GIA)



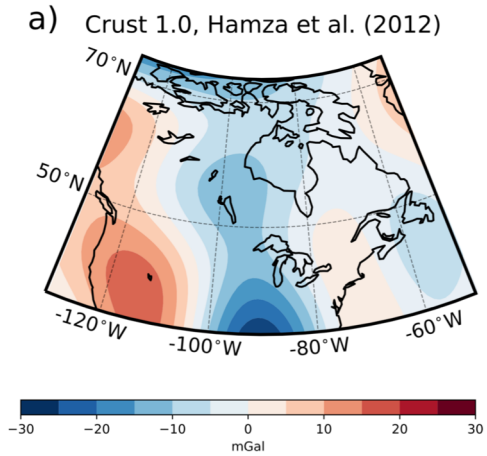
The model

Components

We will aggregate contributions from the Crust, the mantle and GIA.
Theoretically, the sum of these components should match the observed gravity field.

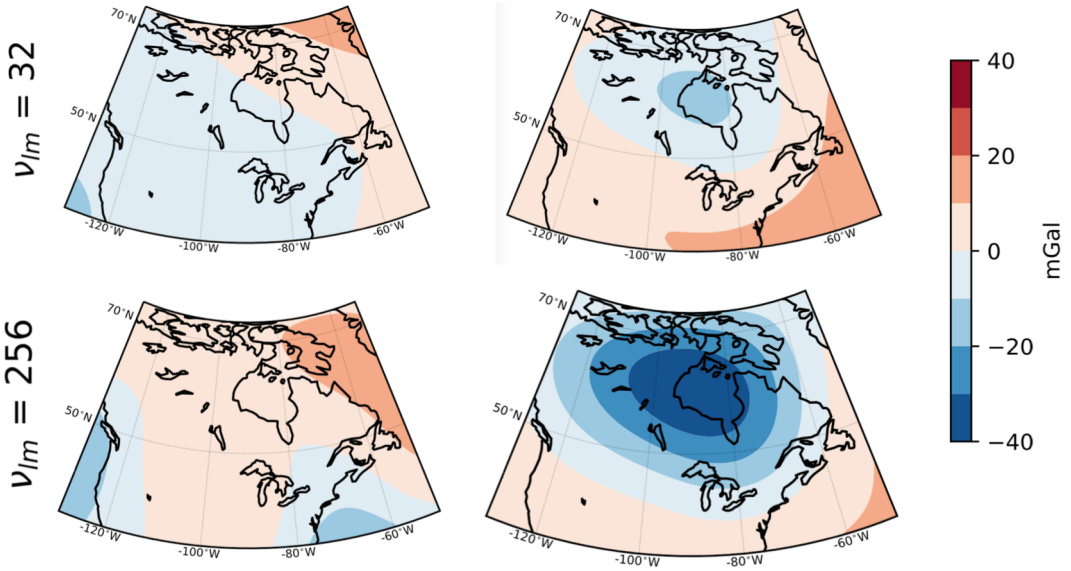
For the mantle and GIA models, two options are shown:
small $\boldsymbol{\nu}_{lm}$ ($<10^{22}$ Pa s) and
large $\boldsymbol{\nu}_{lm}$ ($>10^{22}$ Pa s).

Crust/lithosphere:



Mantle:

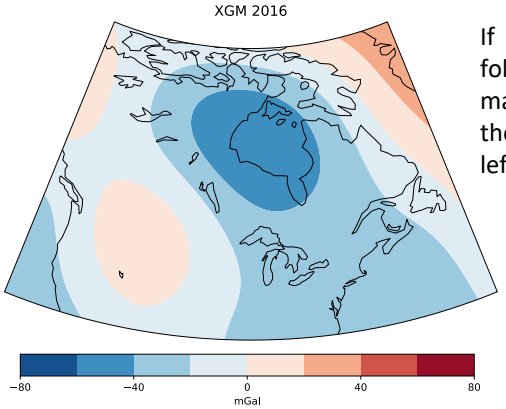
GIA:



$\boldsymbol{\nu}_{lm}$ = lower mantle viscosity (in 10^{20} Pa s)

Results

Total gravity field



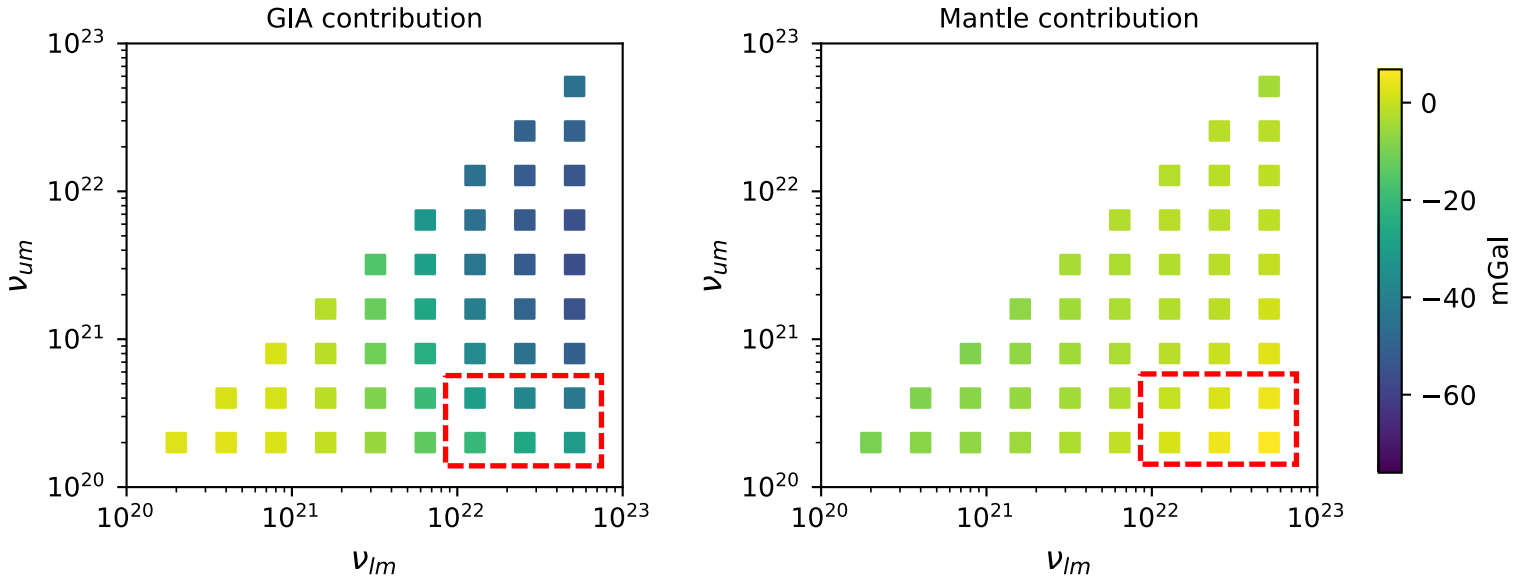
If you put these contributions together, you get the following results (depending on the upper and lower mantle viscosity, shown by the small subplots). In theory, these should match the observations (shown in the top left).

ν_{um} = upper mantle viscosity (in 10^{20} Pa s)

ν_{lm} = lower mantle viscosity (in 10^{20} Pa s)

Results

Relative contributions



Summary

- Gravity field comprises:
  - GIA
  - Crust / lithosphere
  - Mantle
- Mantle signal: <10 mGal, GIA: ~40 mGal, Crust: <15 mGal
- Preference for: lower mantle viscosity > 10^{22} Pa s.