Inferring Antarctic Postglacial Rebound rates from a combination of GRACE and altimetry

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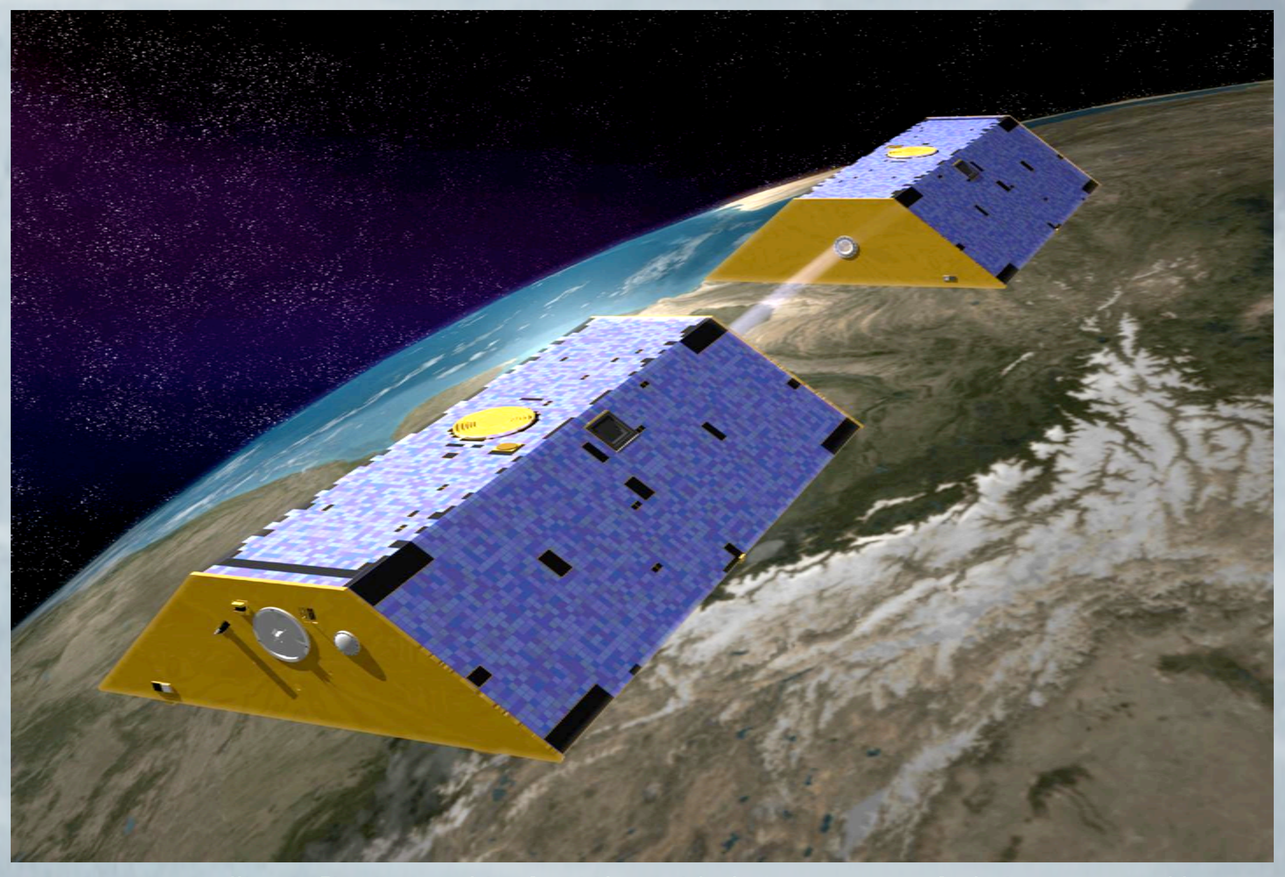
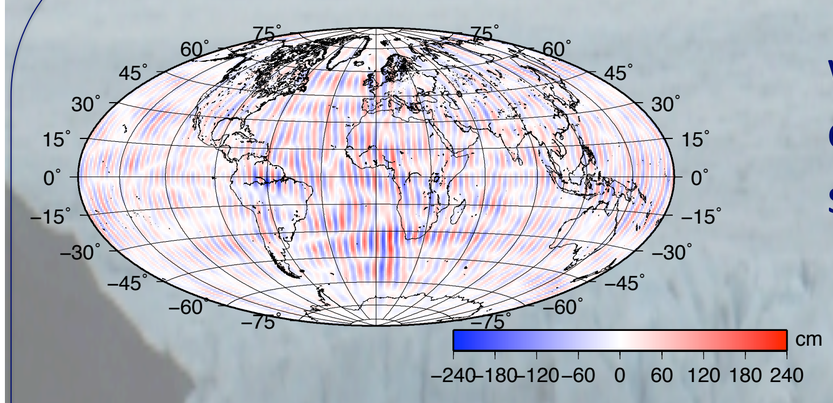
Background

IPCC predictions of future sea level rise are highly uncertain (ranges from 0.18 to 0.59m). Part of this uncertainty stems from uncertainties in the estimates of ice mass balance. Altimetry measurements of changes in the thickness of the Antarctic ice sheet are corrected for Postglacial Rebound, obtained from models, which introduces an error. In In this work, gravity measurements from the GRACE (Gravity Recovery and Climate Experiment) project are combined with measurements from the Envisat altimeter in order to calculate PGR directly:

$$h_{PGR} = \frac{\Delta m_{GRACE} - \rho_{surf} \cdot \Delta h_{alt}}{\rho_{rock} - \rho_{surf}}$$

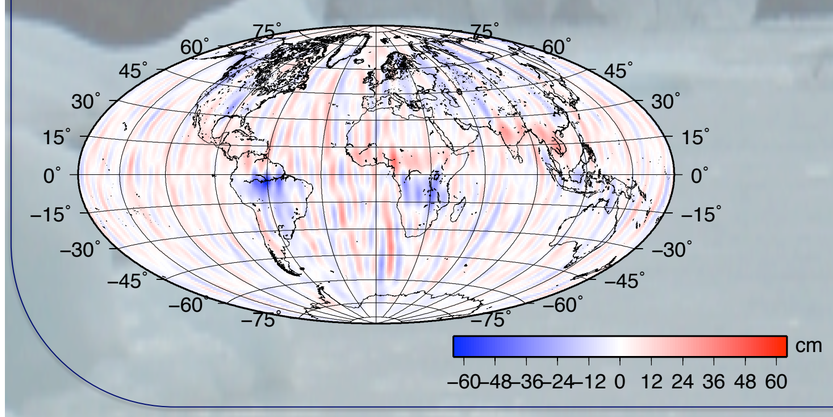


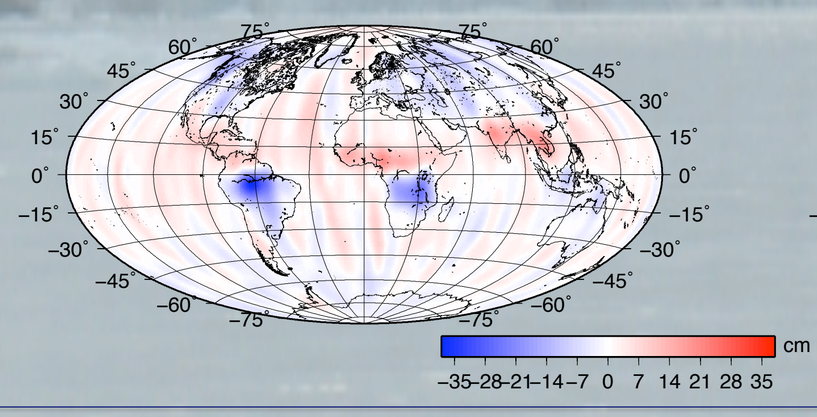
GRACE twin satellite. It flies in an orbit of ~500km, with the two spacecrafts being separated by 200km. A K-band (7mm) ranging system measures changes in the distance. Source: http://photojournal.jpl.nasa.gov/catalog/PIA04235

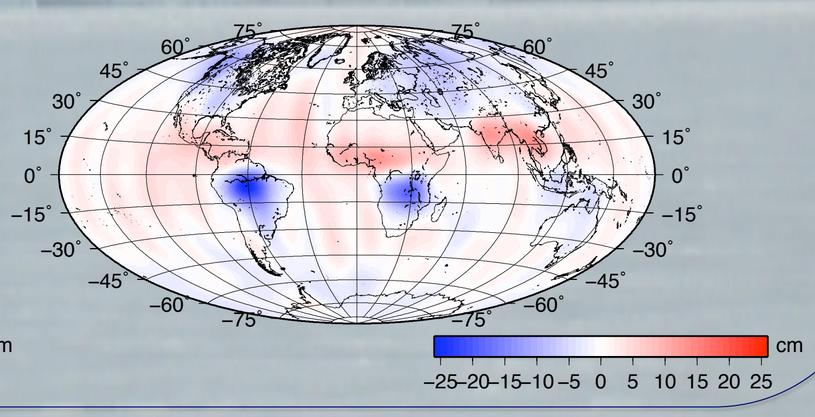


The coefficients of the global gravity field provided by the GRACE project were transformed into equivalent water heights. No modelled corrections of PGR were applied. The data suffers from errors (stripes) which are smoothed out with a Gaussian filter (W_l).

$$H(\theta,\lambda) = \frac{a_E \rho_E}{3\rho_W} \sum_{l=0}^{60} \sum_{m=0}^{l} \frac{2l+1}{1+k_l} W_l \tilde{P}_{lm} cos(\theta) [\hat{C}_{lm} cos(m\lambda) + \hat{S}_{lm} sin(m\lambda)]$$







An annual cosine function of the form:

$$f(x) = a + b * x + c * cos\left(\frac{2\pi x}{12} + \phi\right)$$

is fitted to the data. The annual amplitude and phase, as well as the trend over the measuring period are analysed. It becomes apparent that the effects of atmospheric background models applied to the gravity coefficients during processing are larger in the Antarctic than in the Arctic.

Remaining work

- replace certain coefficients with those obtained from Satellite Laser Ranging (SLR) or models
- apply de-striping algorithm
- compare gravimetry data to Envisat altimeter data