EGU 2020

Impact of the Icelandic hotspot on GPS uplift rates in southeast Greenland

Valentina R. Barletta, Andrea Bordoni and Shfaqat Abbas Khan

contact: vr.barletta@gmail.com

DTU Technical University of Denmark

Abstract

The mass lost from Greenland ice sheet makes for one of the most important contribution to the global sea level rise, and it is under constant monitoring. However, still little is known about the heat flux at the glacier bedrock, and how it affects dynamics of the major outlet glaciers in Greenland.

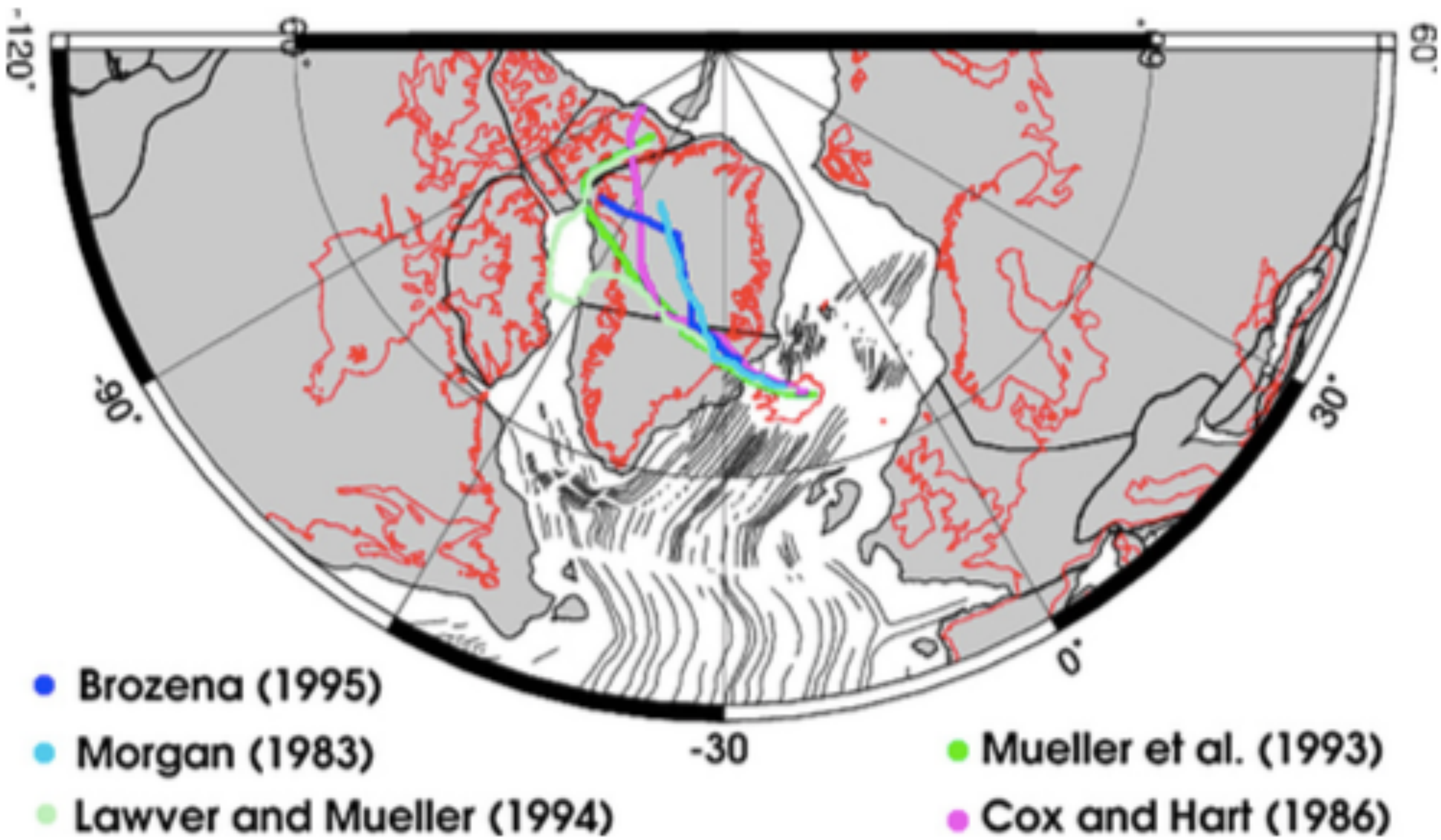
Recent studies suggest the hotspot currently under Iceland to have been under eastern Greenland at ~40 Ma BP and that the upwelling of hot material from the Iceland plume towards Greenland is ongoing. A warm upper mantle has a low viscosity, which in turn causes the solid Earth to rebound much faster to deglaciation.

We have good reasons to believe that mantle beneath SE-Greenland has very low viscosity (Khan, et al. 2016), as also suggested by the discrepancy between the GPS velocities and the predicted purely elastic deformations caused by present-day ice loss.

Here we present a preliminary computation of the Earth deformation (GIA) driven by a low viscosity mantle excited by the deglatiation since the little ice age (LIA) to the present day.

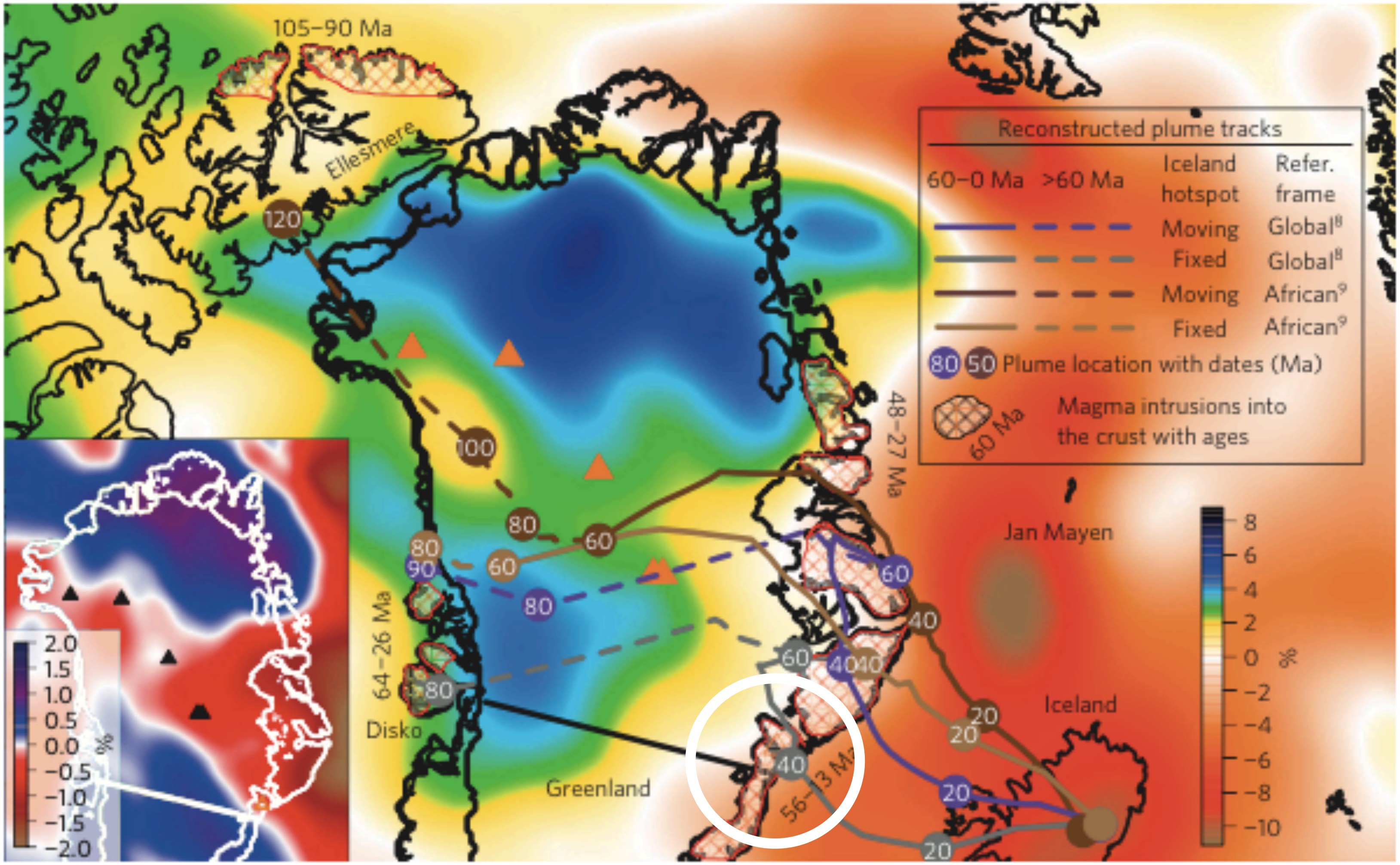
We produce predictions of such deformation (GIA models) and compare it with GPS uplift rates in the area of Kangerdlugssuaq glacier.

Hot spot tracks



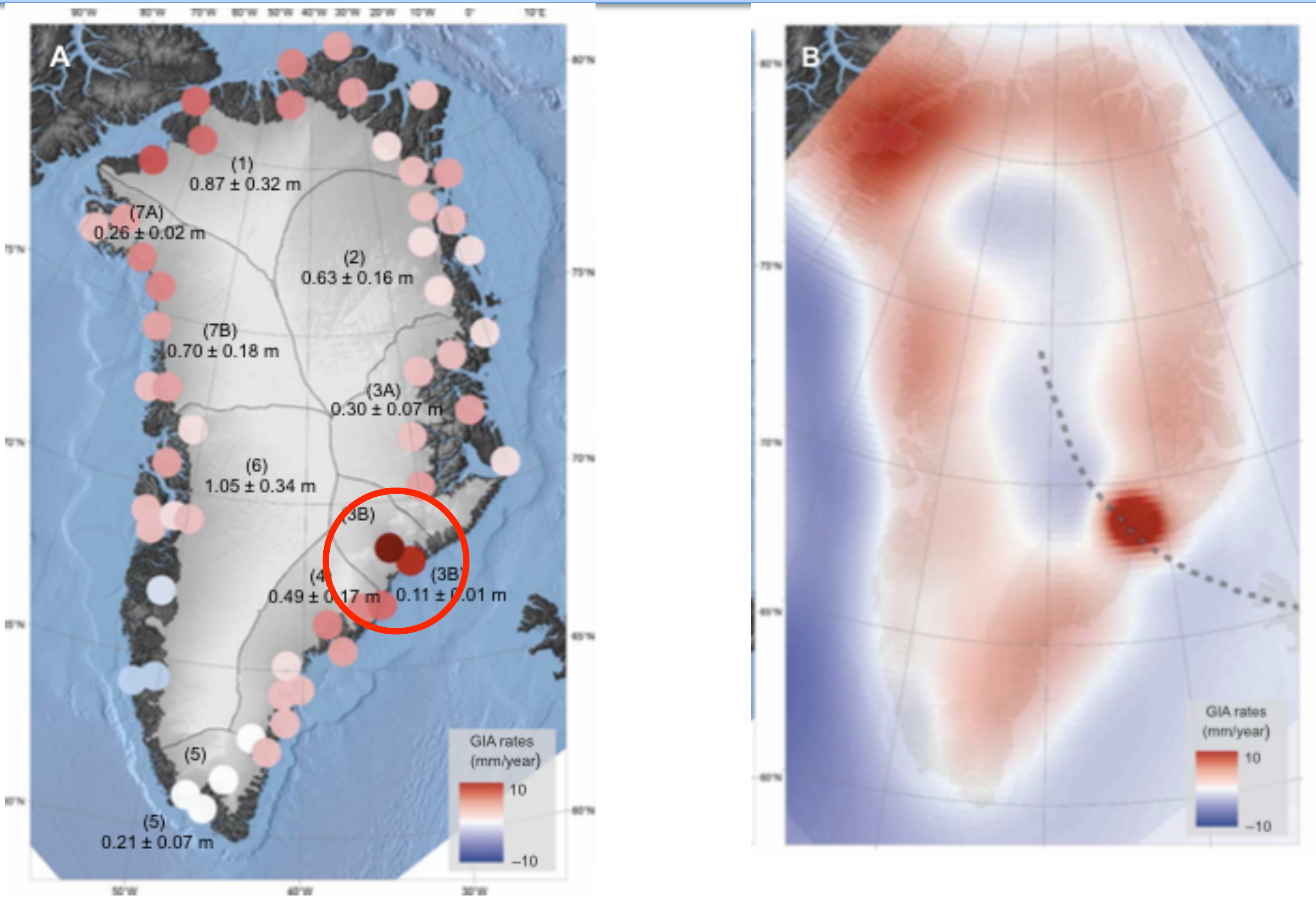
Braun et al. 2007 - EPSL

Hot spot tracks



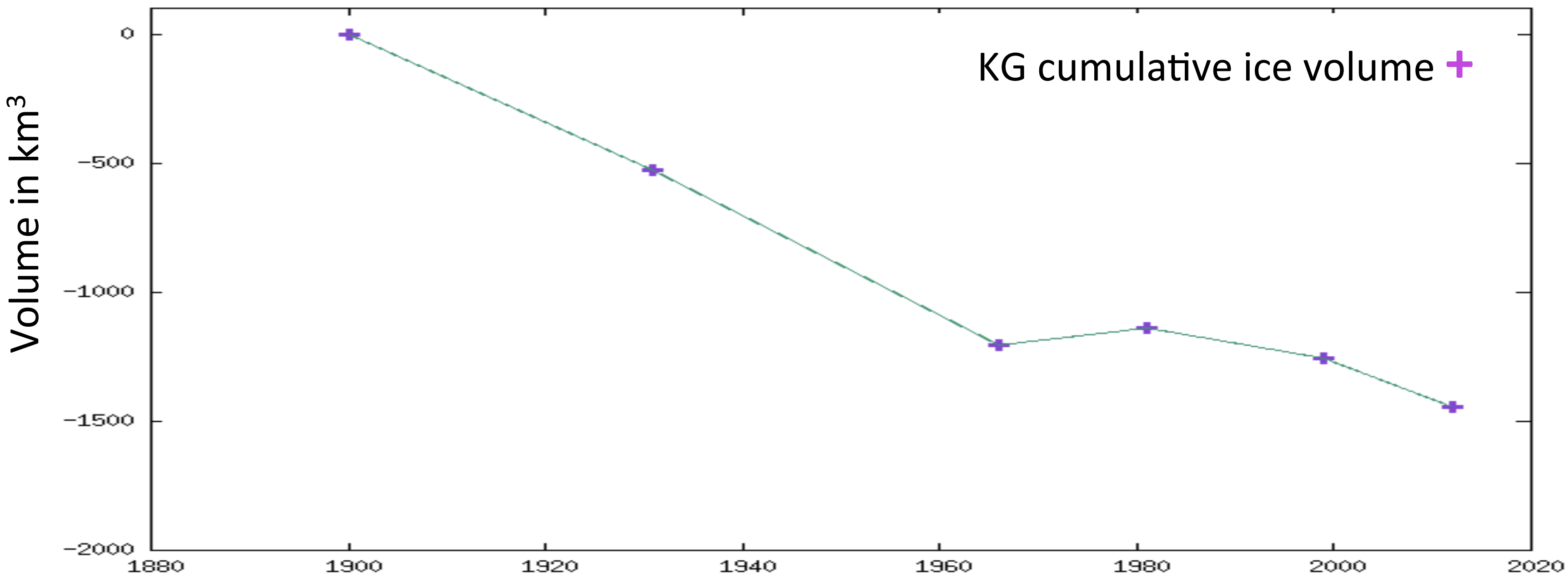
Rogozhina et al. 2016 - NatGeo

GPS uplift residual and Empirical GIA

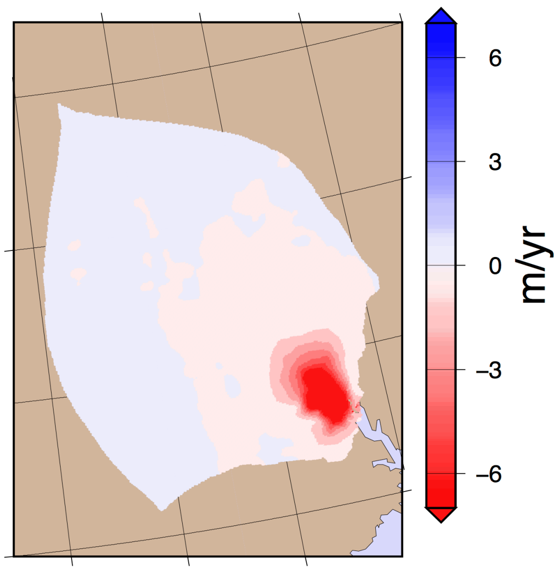


Khan, S. A., Sasgen, I., Bevis, M., Dam, T. V., Bamber, J. L., Wahr, J., ... Munneke, P. K. (2016). Geodetic measurements reveal similarities between post–Last Glacial Maximum and present-day mass loss from the Greenland ice sheet. *Science Advances*, *2*(9), doi.org/DOI: 10.1126/sciadv.1600931

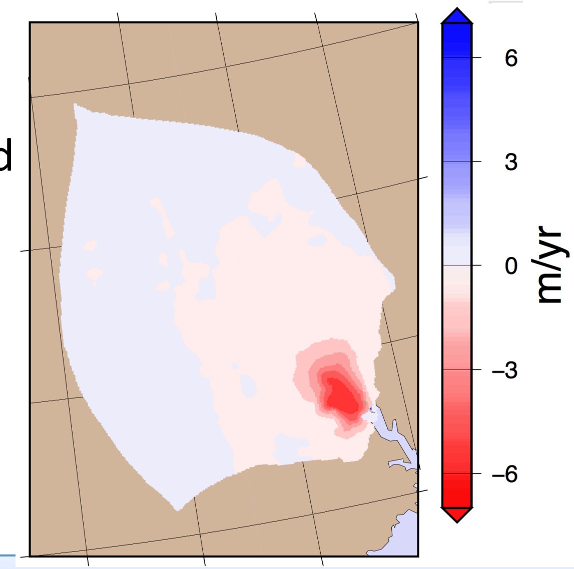
Estimate of ICE change since LIA (for our GIA models)



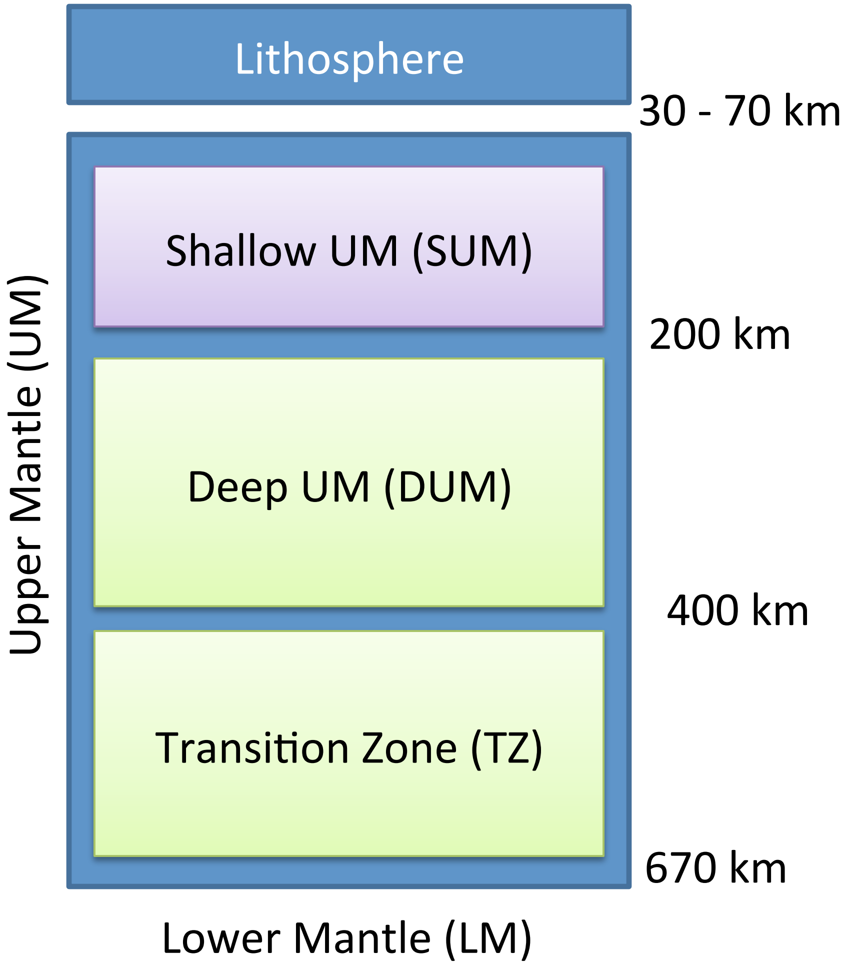
average trend 1900-1961



average trend 1981-2012



The low-viscosity mantle structure (for our GIA models)



1D viscoelastic compressible
Earth model used as local approximation

$\nu_{SUM} = 10^{18} – 6x10^{19}$ Pa s

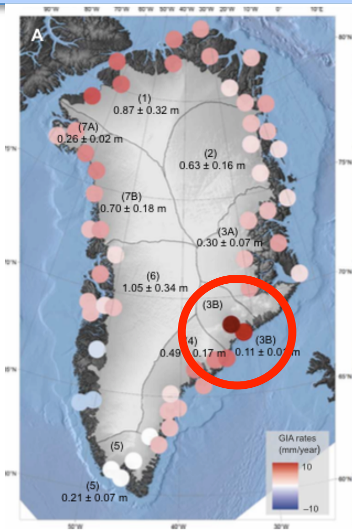
$\nu_{DUM} = 10^{19} – 5x10^{20}$ Pa s

$\nu_{TZ} = 5x10^{20}$ Pa s

$\nu_{LM} = 2x10^{22}$ Pa s

GPS residual vs GIA Model predictions

Photography not allowed



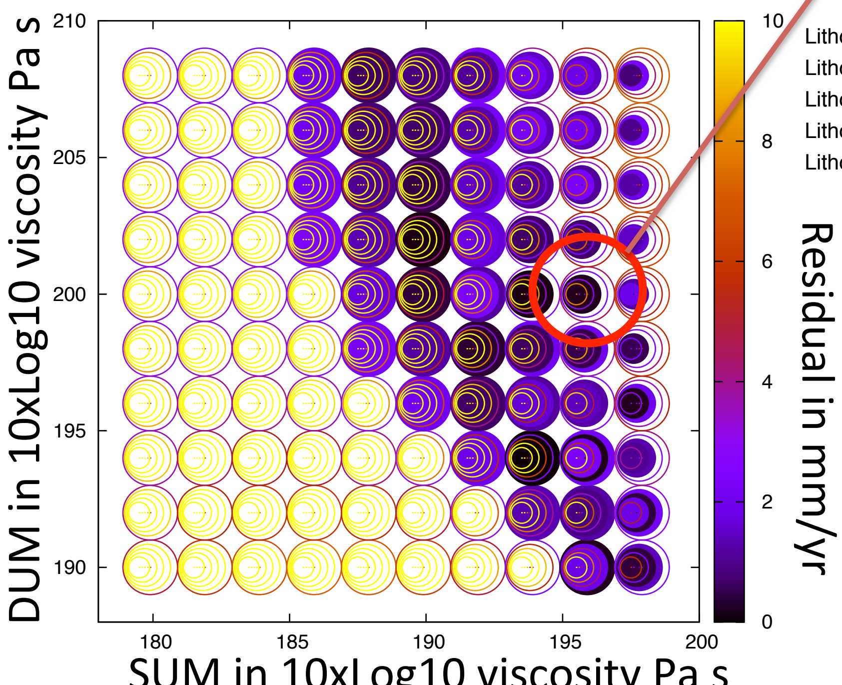
2 GPS uplift rate to be used as main constraints

MIK2 10.3 +/- 0.2 mm/yr

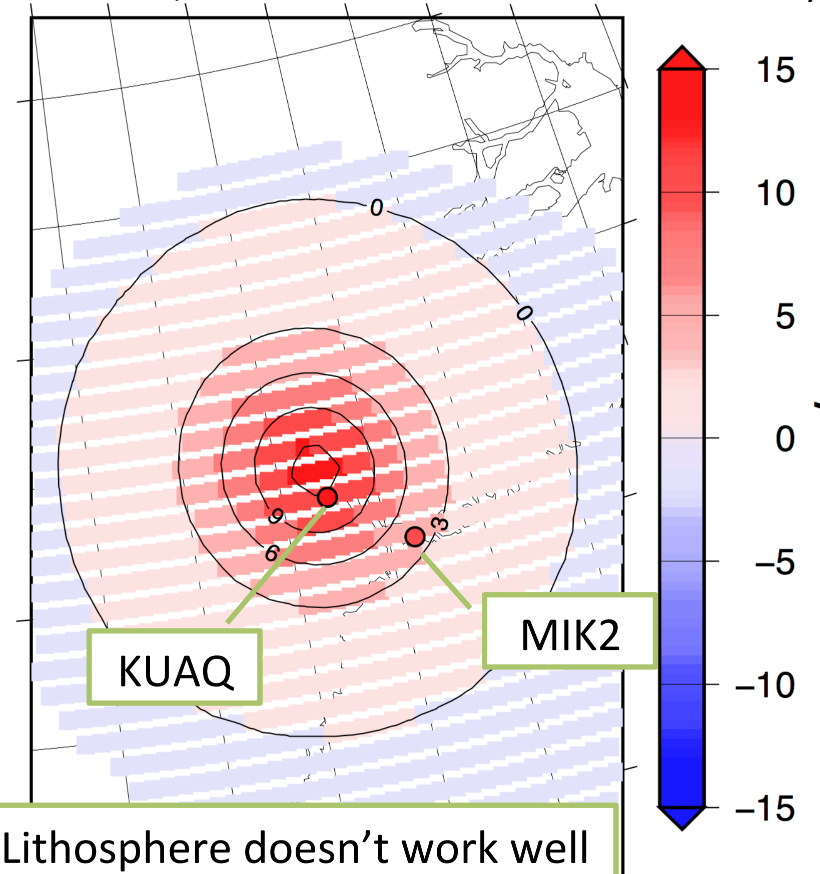
KUAQ 12.0 +/- 1.3 mm/yr

Khan et al. 2016

Residual for KUAQ

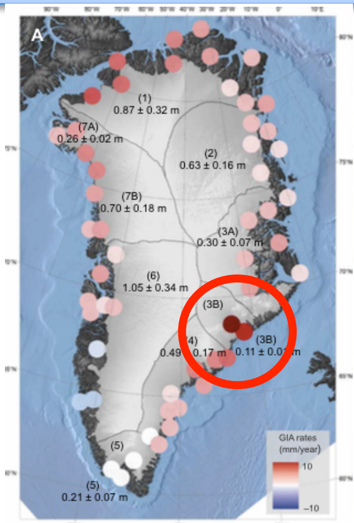


GIA (LT 50 km, SUM 4×10^{19} and DUM 10^{20} Pa s)



Thin Lithosphere doesn’t work well

GPS residual vs GIA Model predictions

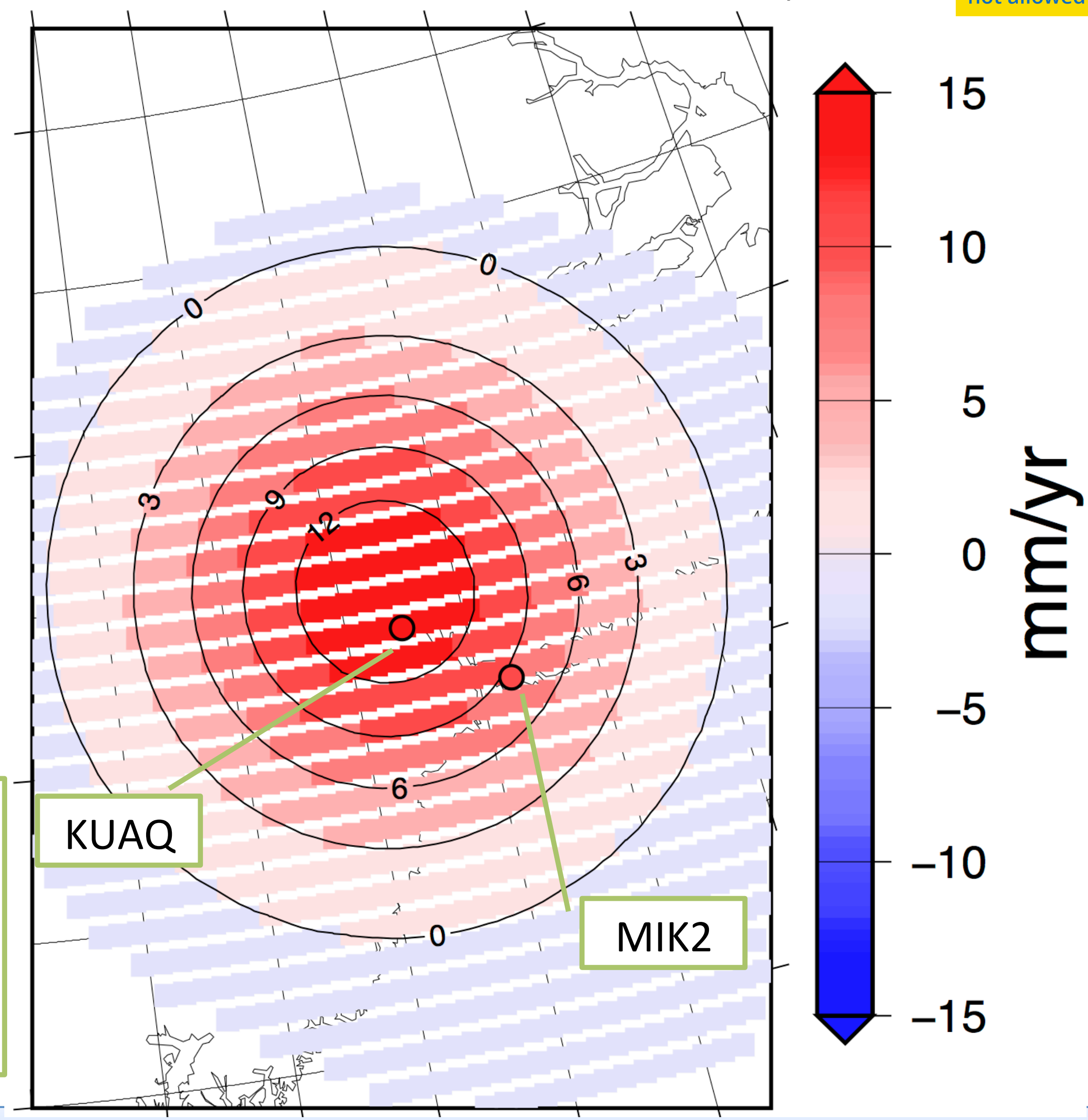


2 GPS uplift rate to be used as constraints

MIK2 10.3 +/- 0.2 mm/yr
KUAQ 12.0 +/- 1.3 mm/yr

To fit both GPS we need at least 70 km Lithosphere.
Some contribution of ice history might be missing and the Earth structure might be more complex.

GIA (LT 70 km, SUM 4×10^{18} and DUM 2.5×10^{20} Pa s)



Photography not allowed