

Work in progress

NKG201xGIA – a model of glacial isostatic adjustment for Fennoscandia

Holger Steffen, Valentina Barletta, Karin Kollo, Glenn Milne, Maaria Nordman, Per-Anders Olsson, Matthew Simpson, Lev Tarasov & Jonas Ågren

Thanks to Halfdan Kierulf, Per Knudsen, Martin Lidberg, Jens-Ove Näslund & Olav Vestøl for data and discussion

holger.steffen@lm.se

LANTMÄTERIET



Short history

- NKG2005LU will be substituted with NKG201xLU (see presentation by Vestøl et al.)
- NKG land uplift workshop in Reykjavik 2013 with a wish to support development of a GIA model for Fennoscandia
- Moral support to bring “modellers” of the NKG community together to work on such a model
- Modellers with interest to participate: Valentina Barletta (DK), Matt Simpson (N), Maaria Nordman (FIN) (see also next presentation), Karin Kollo (EST), Per-Anders Olsson & Holger Steffen (S) + help by Glenn Milne
- After discussion with Jonas Ågren & Olav Vestøl, modellers suggest to help with the underlying GIA model of NKG201xLU

Why a GIA model when we have a LU model?

A reference of/for

- Vertical motion (Present-day rate of uplift)
 - GPS, tide gauges, altimetry, levelling
- Horizontal motion
 - GPS, VLBI, DORIS(?)
- Gravity change
 - AG, RG, GRACE, GRACE-FO, GOCE(?)
- Geoid change
- Topography/bathymetry, sea level, uplift, geoid change at several times since the last glacial maximum

+

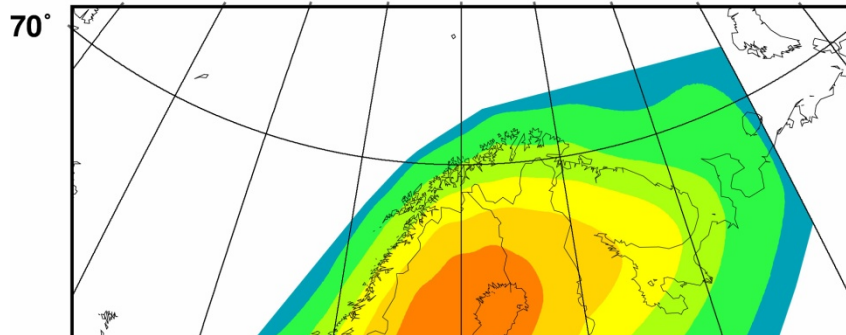
- Uncertainty estimates
- Last but not least: GIA refers to a certain process, but is all land uplift GIA? Therefore: determine differences due to tectonic and/or other effects(!)

Short history

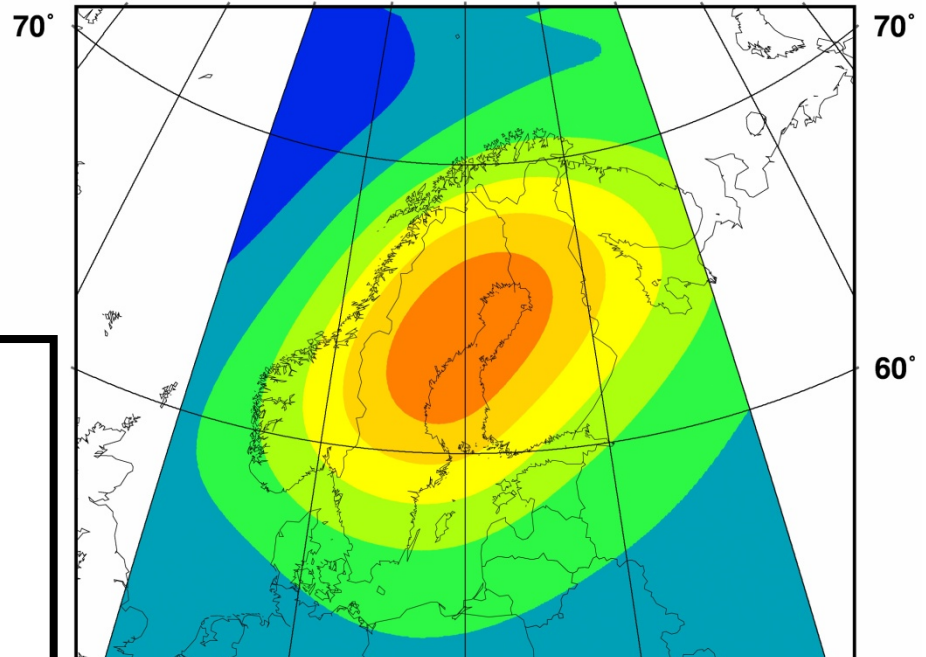
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NKG2005LU vs. Milne 120p55

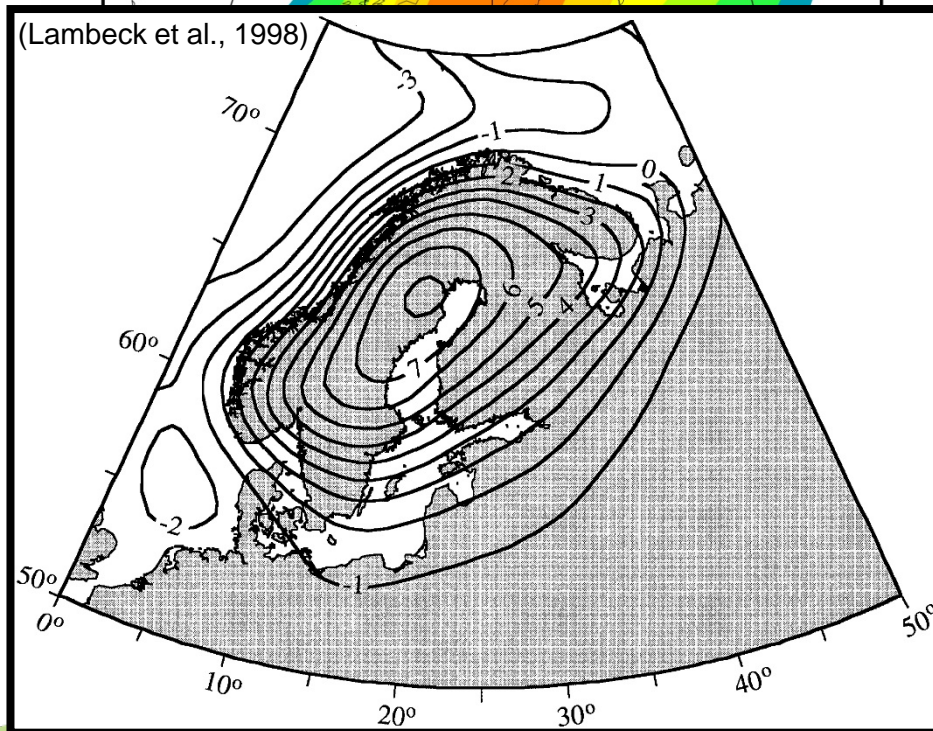
NKG2005LU



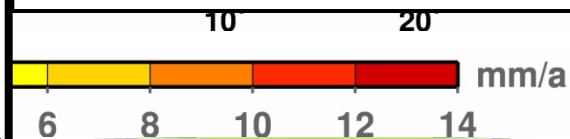
Milne 120-p5-5



(Lambeck et al., 1998)



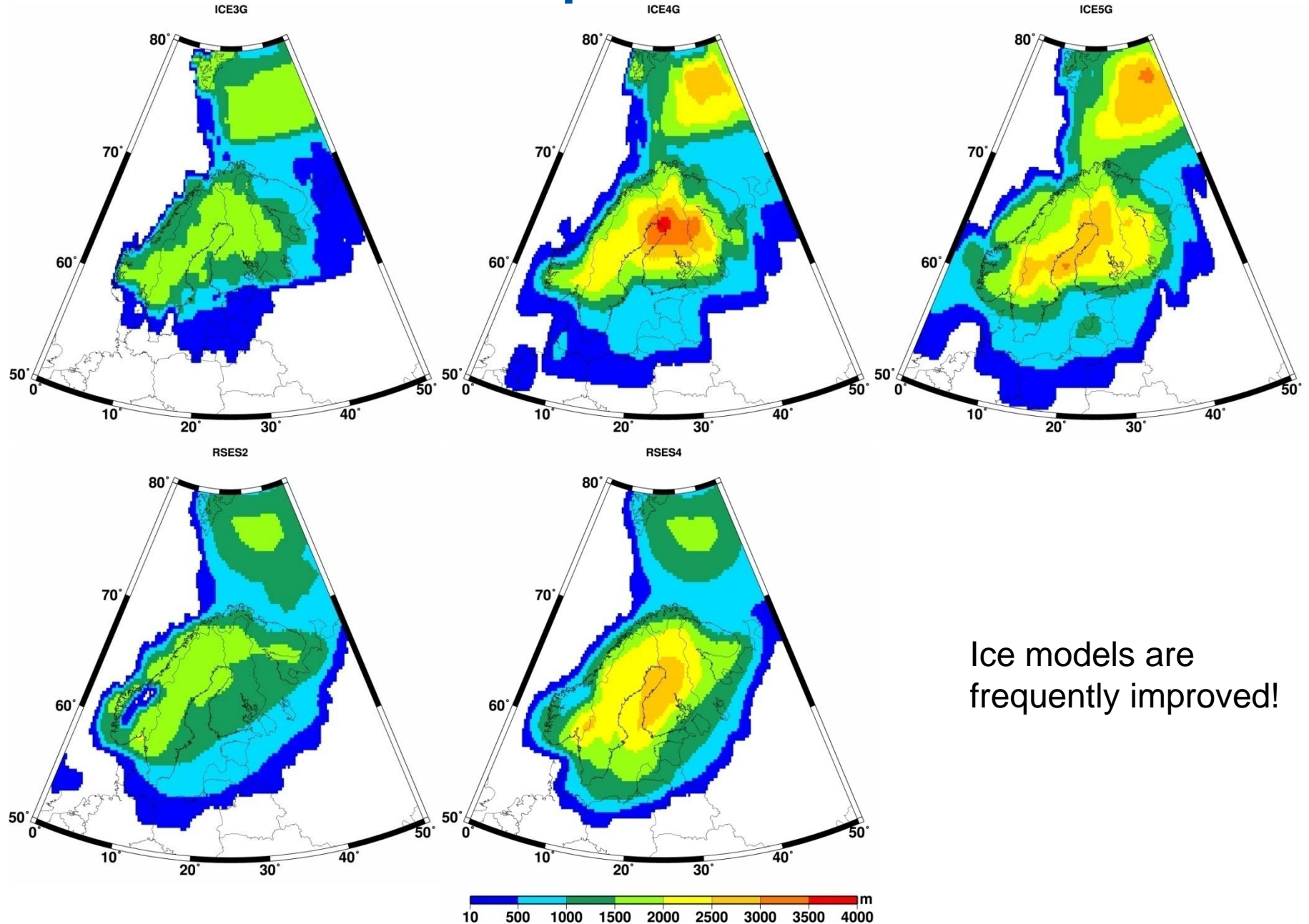
■ 120p55 should be called
120p55_ANU-ICE/ICE-3G*



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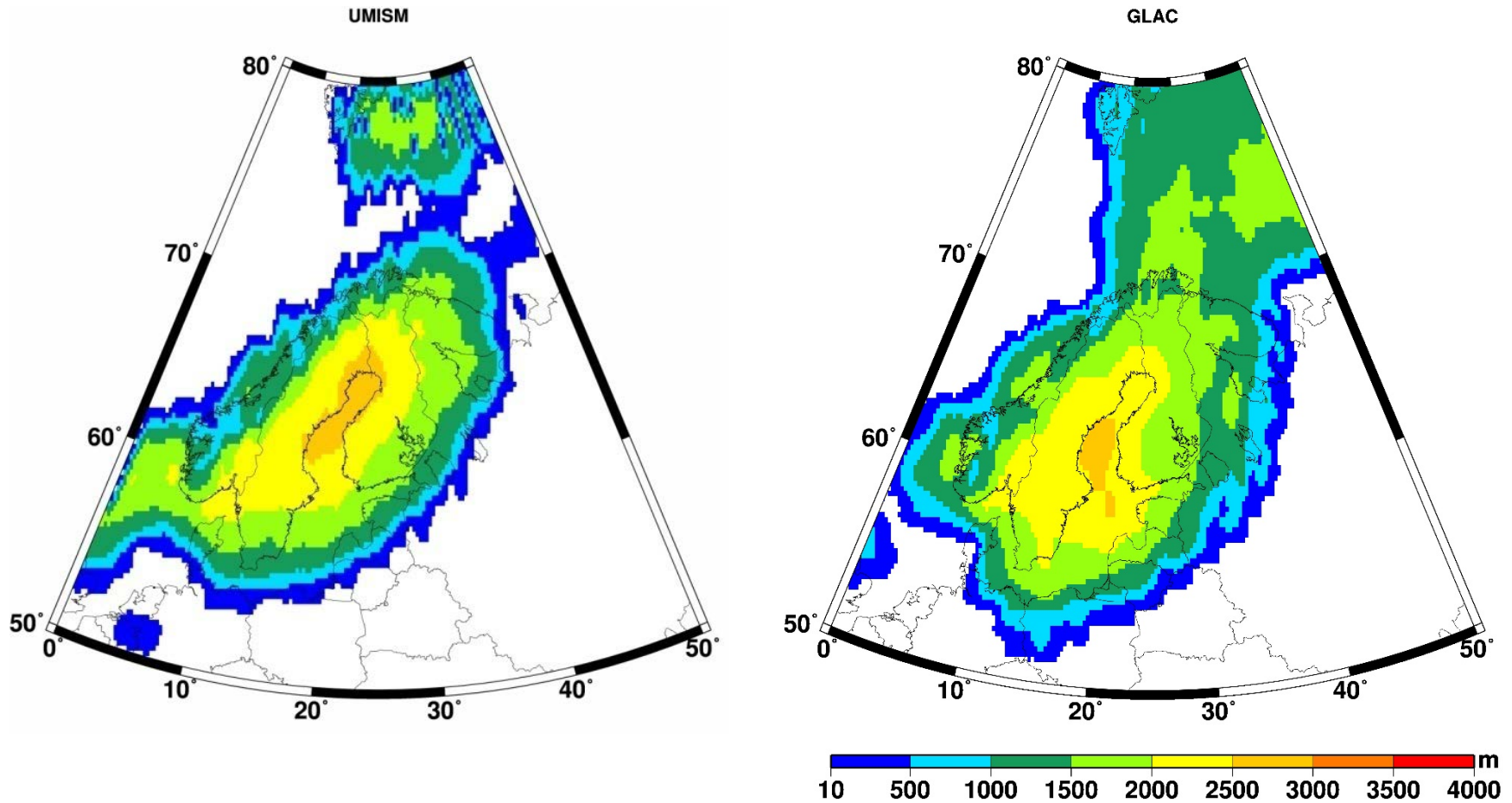


SLE ice model examples at LGM



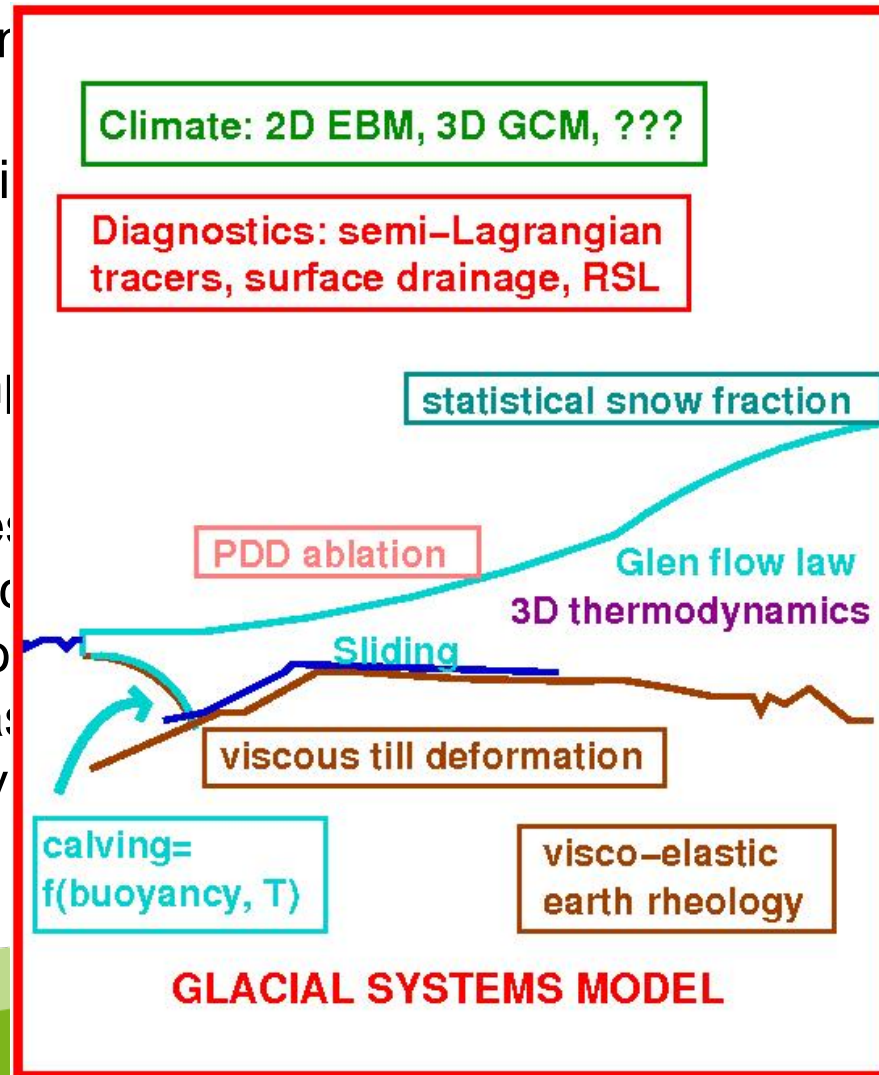
Ice models are frequently improved!

Thermo-mechanical ice model examples at LGM

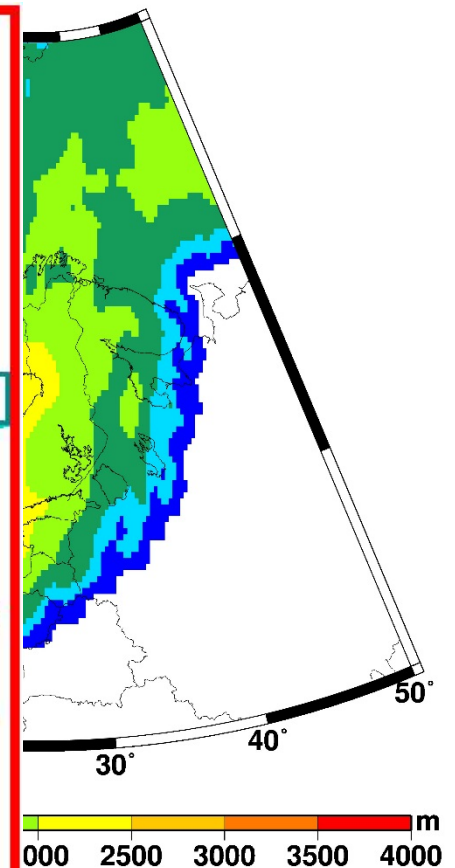


GLAC models by Lev Tarasov

- Glaciological Systems Model (GSM)
- 3D thermo-mechanically forced model
- Tuned to ice margin present-day uplift, records
- Contains further input (39 in total)
- Takes uncertainties and constraints into account and generates posterior distributions for past evolution (Tarasov et al.)
- See also following Nordman et al.

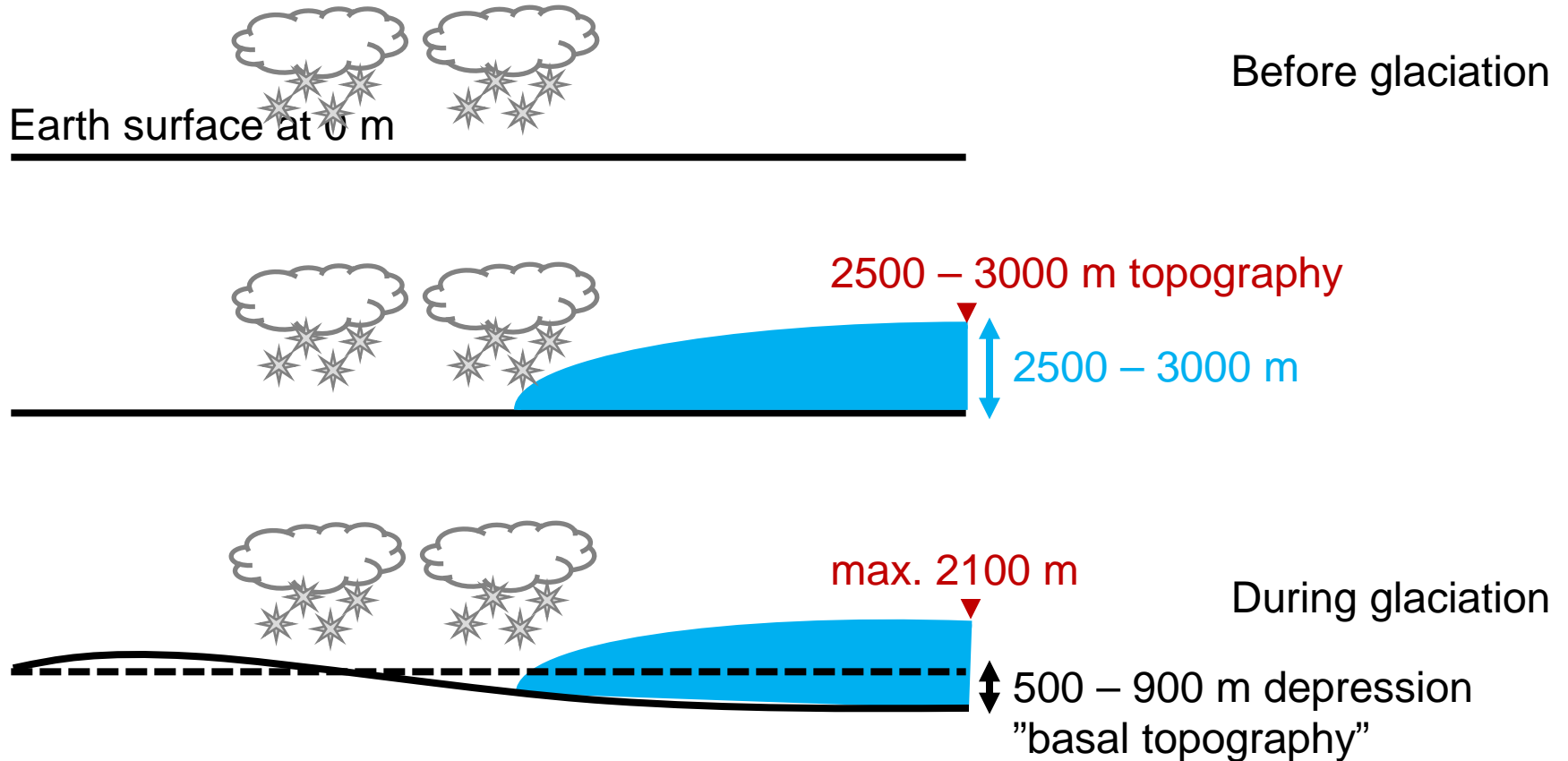


GLAC



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Earth model information in thermo-mechanical ice history models



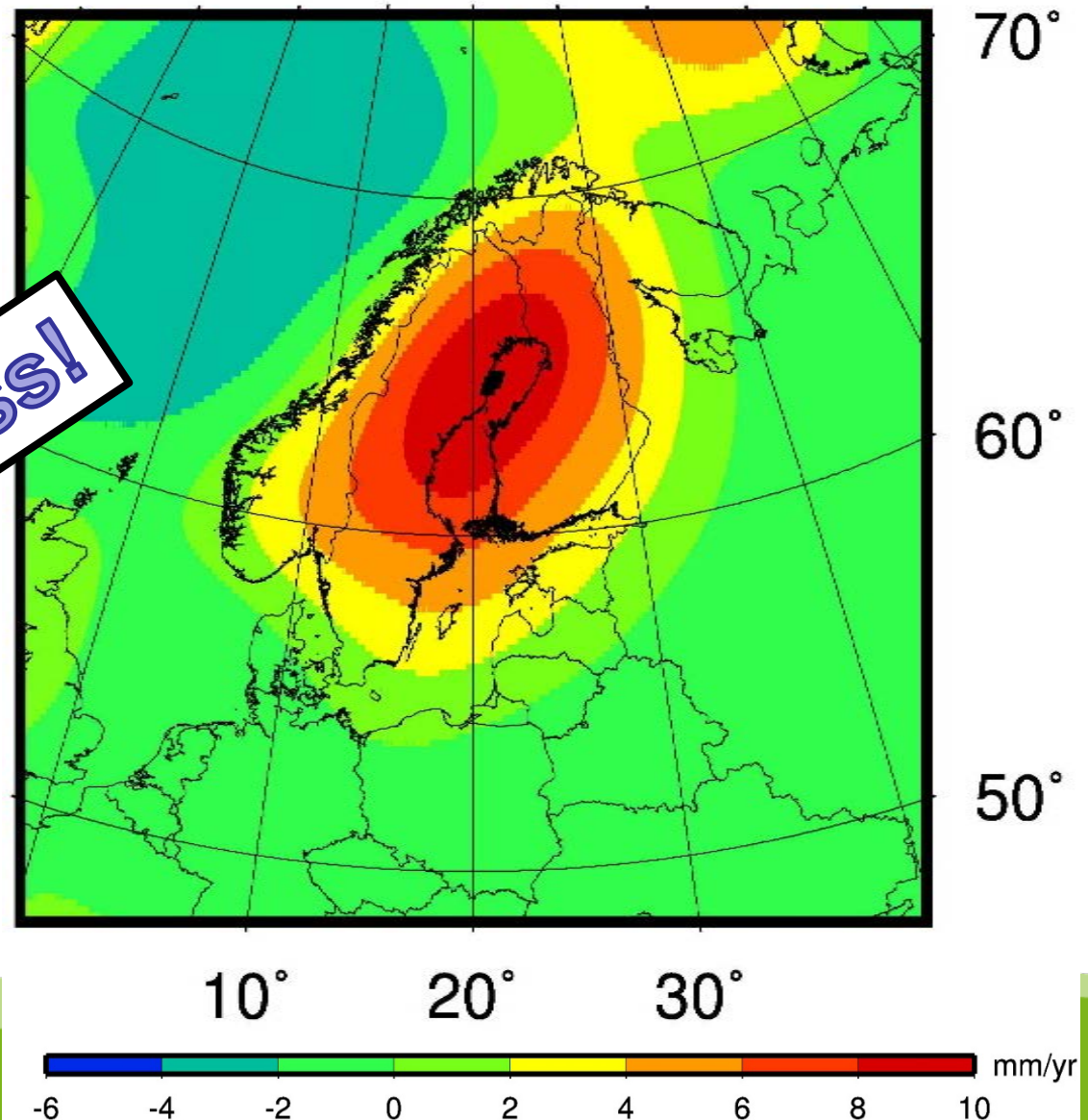
Initial model input for NKG2014LU_test

- Ice model:
 - Decision to use GLAC (Lev Tarasov & co-workers) for Fennoscandia and Barents Sea, other parts of the world from ICE-5G (Peltier) and tuned to fit sea-level equivalent; ICE-5G was multiplied by 1.02
- Earth model:
 - Close to VM5 in terms of lithosphere thickness (90 km) and mantle viscosity (7×10^{20} Pa s upper mantle; 2×10^{21} Pa s lower mantle), Maxwell rheology
 - Other model parameters (ice/water density, Earth radius, moments of inertia, π , etc.) as used in COST benchmark activity (see Spada et al. 2010)
- Observations:
 - BIFROST 2013 results as presented at IAG in Potsdam
 - Global RSL data (e.g. Barbados etc.) and Fennoscandian RSL data
 - Also comparison to latest tide gauge results from Per Knudsen (see poster) & GPS GIA-frame solution by Halfdan Kierulf (see presentation later today)

The ~~map~~ preliminary initial test model v0.9

Absolute uplift

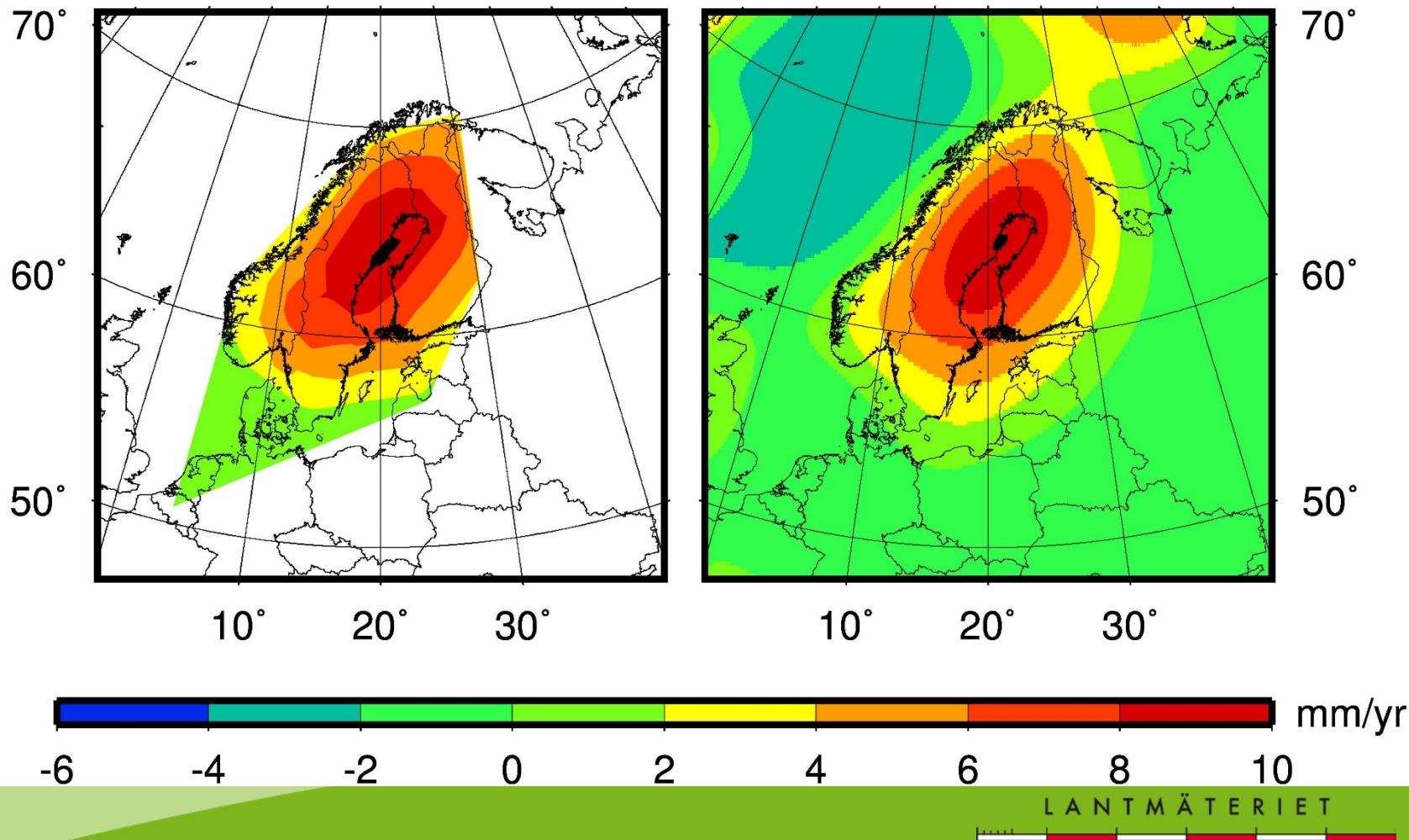
Work in progress!



Comparison to recent GPS observations

BIFROST 2013 (IAG pres.)

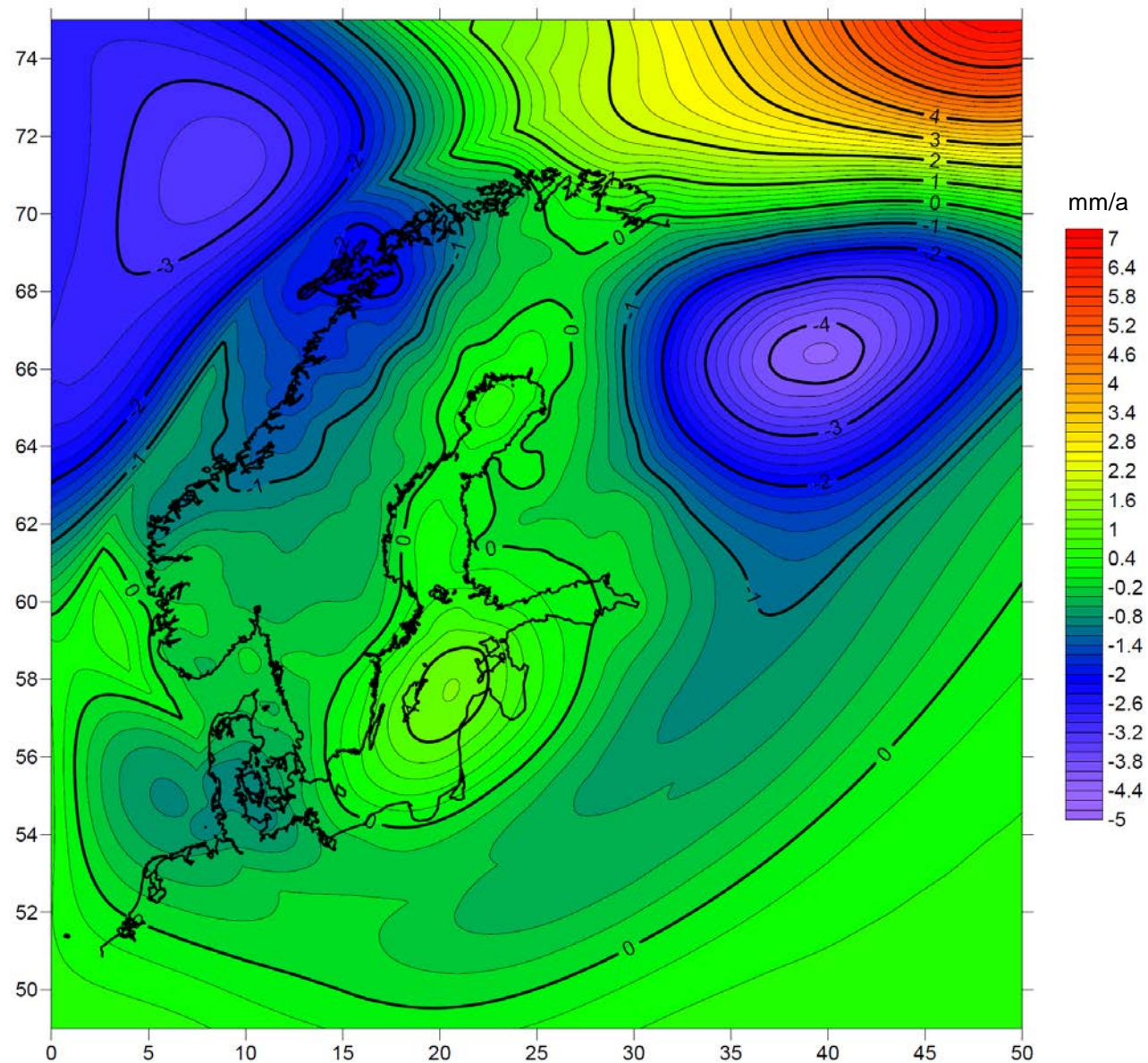
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First tests

Difference between the preliminary model and the „old“ NKG2005LU

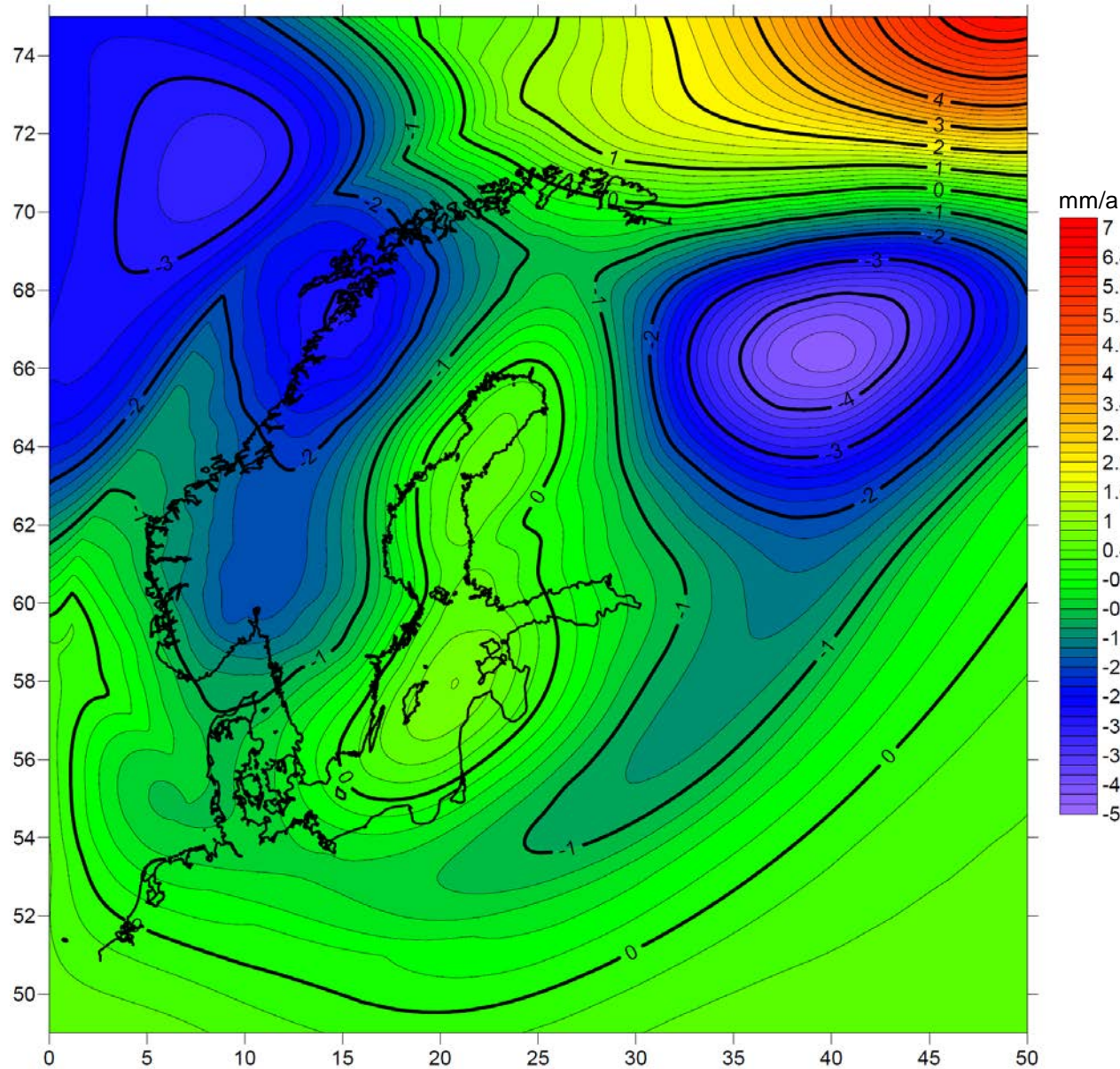
Note the strong differences in Lofoten area!



First tests

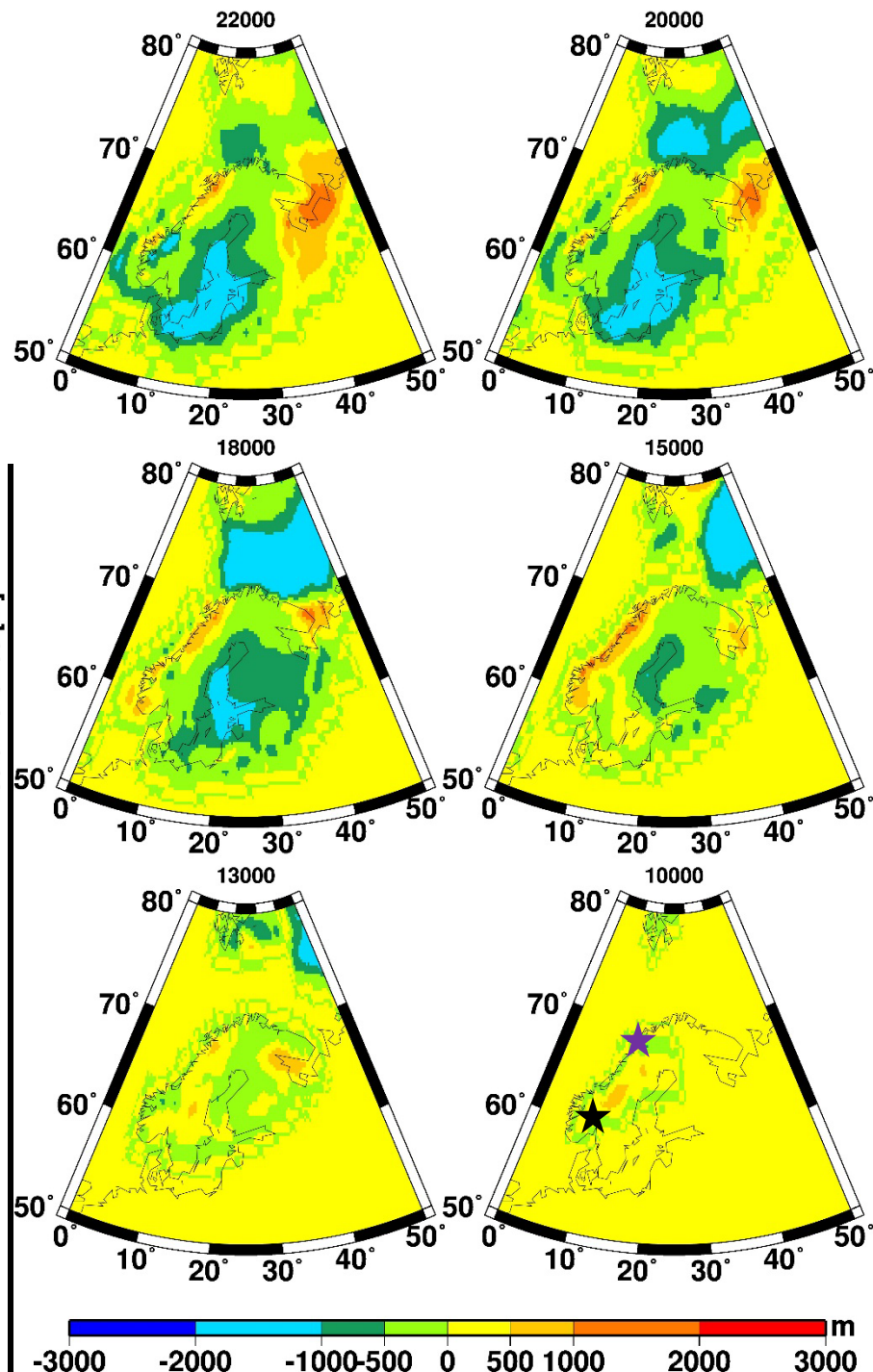
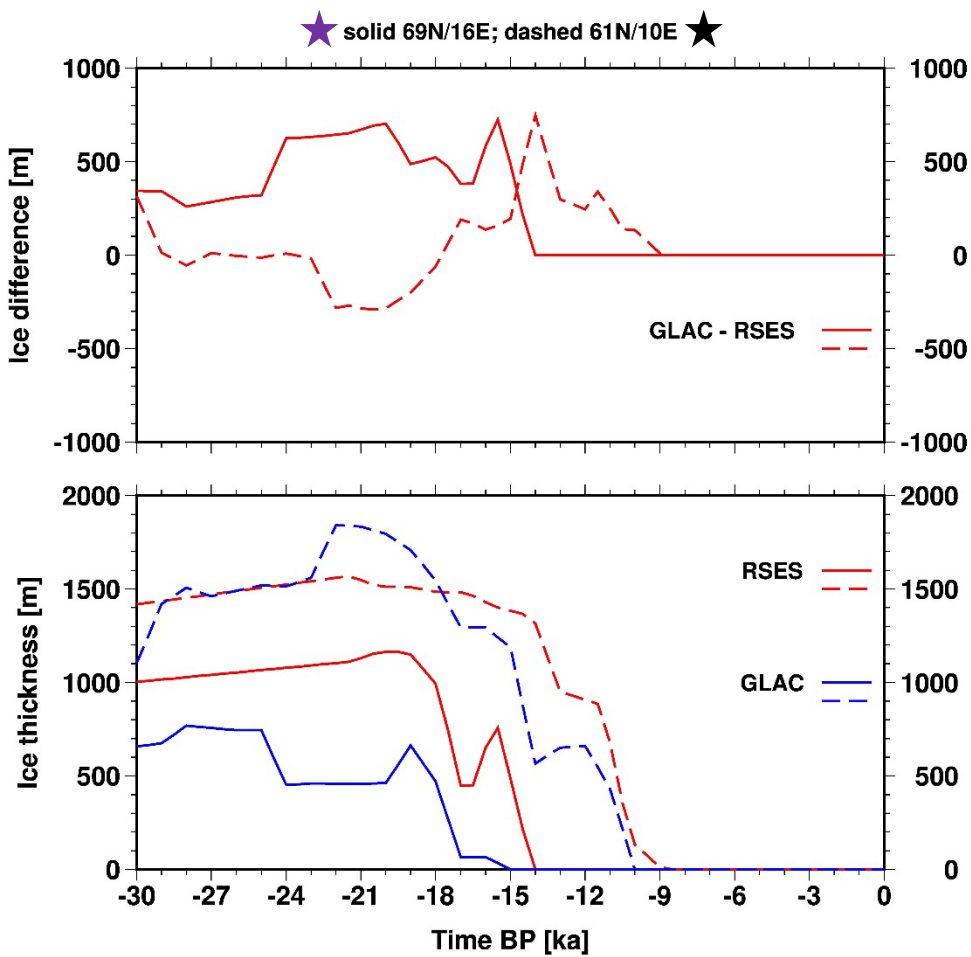
Difference between the preliminary model and Lambeck et al. 1998

Again, note the strong differences in Lofoten area!



Ice model differences

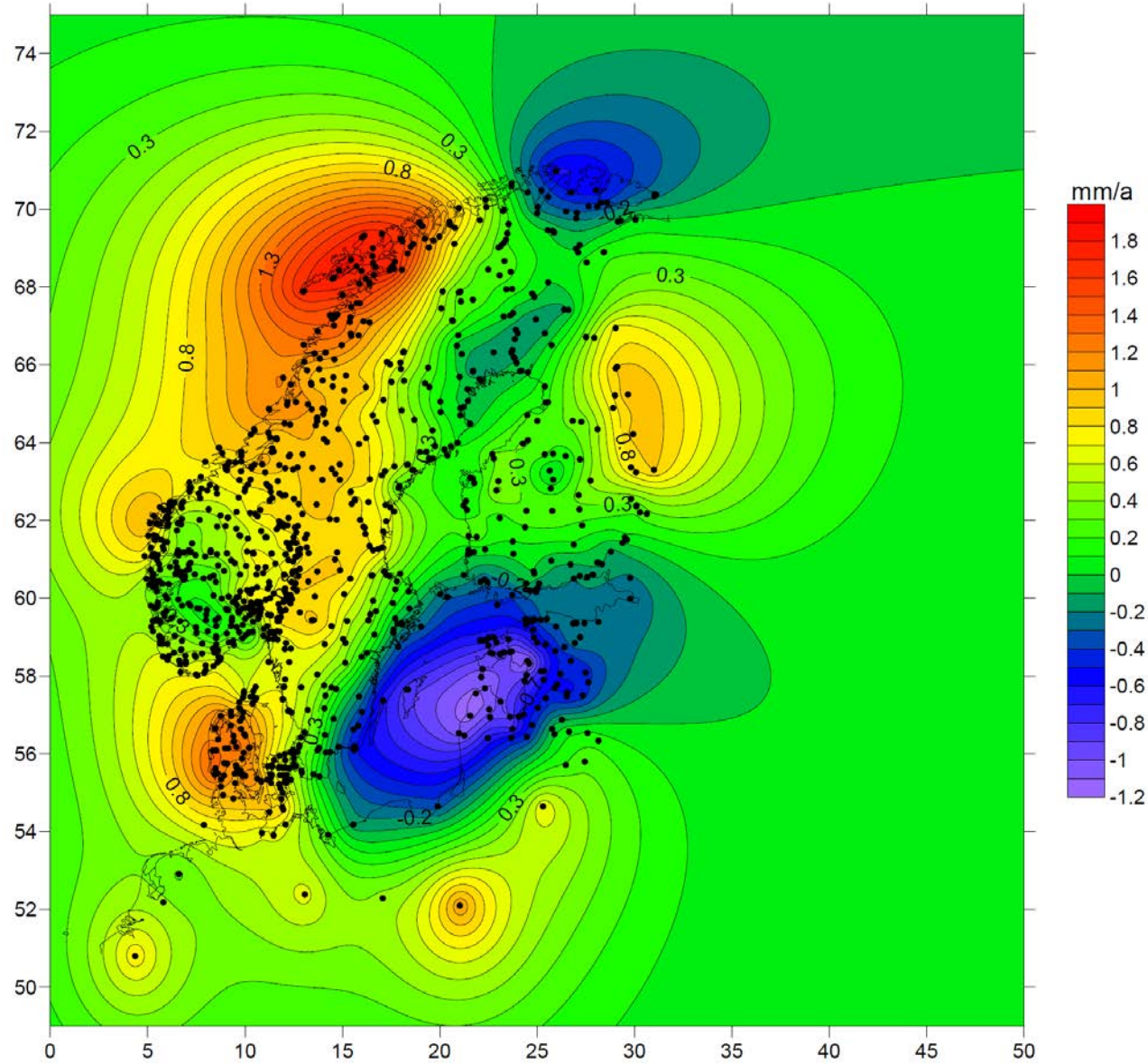
Difference between
ANU-ICE and GLAC



First tests

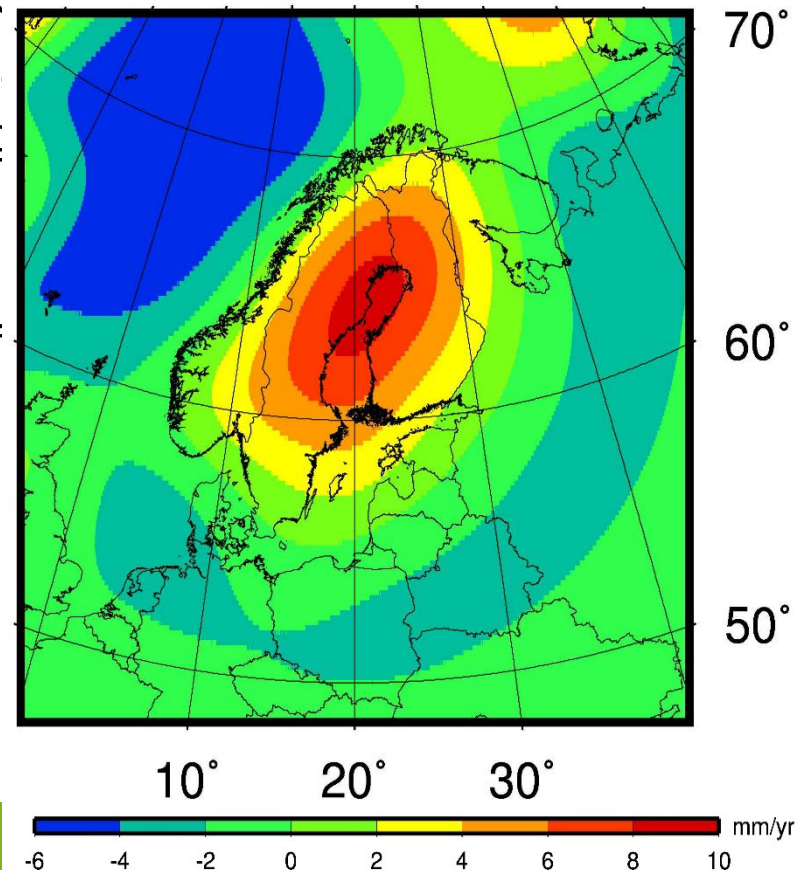
Difference between the initial GIA model and NKG2014_Up_test

Still, note the strong differences in Lofoten area!



Further cooperations

- Alar Rosentau (U Tartu, Estonia), RSL data in Estonia & Russia
- Andrei Panin (U Moscow, Russia), forebulge analysis near Smolensk
- Annemiek Vink (BGR, Germany), RSL data North Sea
- Anders Fischer (Danish Agency for Culture), global archaeological RSL data
- Lars Nielsen (GEUS, Denmark), GPR RSL data Denmark
- Lou Schmitt (U Gothenburg, Sweden), RSL S
- Thomas Hammarklint et al. (SMHI, Sweden)
- Sönke Dangendorf, Thomas Wahl (TU Sieg
Sea
- Rebekka Steffen (U Uppsala, Sweden), GIF
- Christian Brandes (U Hannover, Germany), f
- Patrick Wu (U Hong Kong), 3D GIA models
- Kvarken Council & Naturum Skuleberget, pu
- EGSIEM project: GIA model will be used for
- EUREF & NKG contacts (Diana Haritonova,



Conclusions

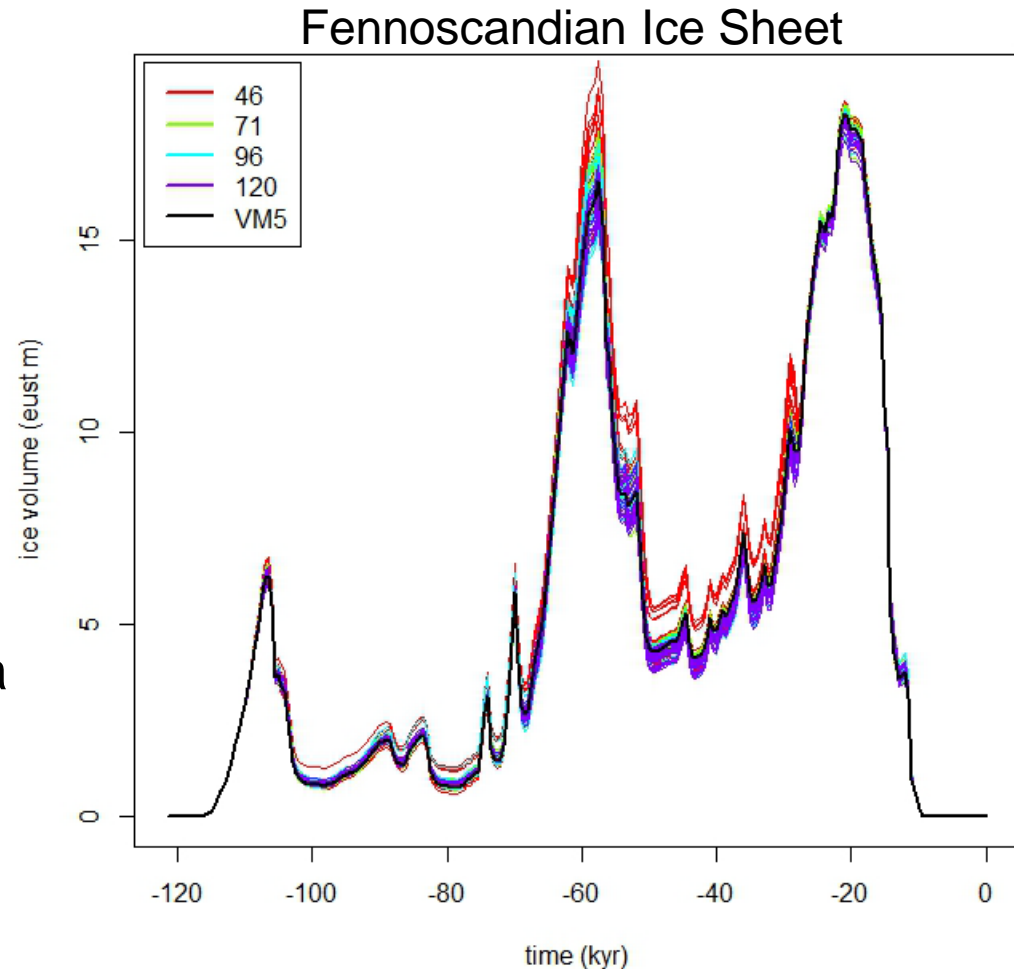
- A GIA model covers a much larger area than northern Europe and relates to a specific process!
- Start the “positive spiral upward” towards NKG201xGIA
- **GLAC is reference ice model (note: we do NOT say it is THE ice model)** – thus, other ice models can be tested later
- Individual tests on different ice and earth models based on expertise of modellers (high resolution ice sheet, rheology, lateral variations in lithosphere and mantle viscosity, etc.)
- Cooperation with scientists outside NKG are established to develop and test the model
- Next step: tune GIA model with levelling/tide gauge/GPS combination provided by Olav Vestøl and Jonas Ågren (likely to result in a new ice-earth model combination)
- A RSL database will be developed and made available (to be discussed in which form); Kurt Lambeck agreed to provide his Fennoscandian database

Thank you for your attention!



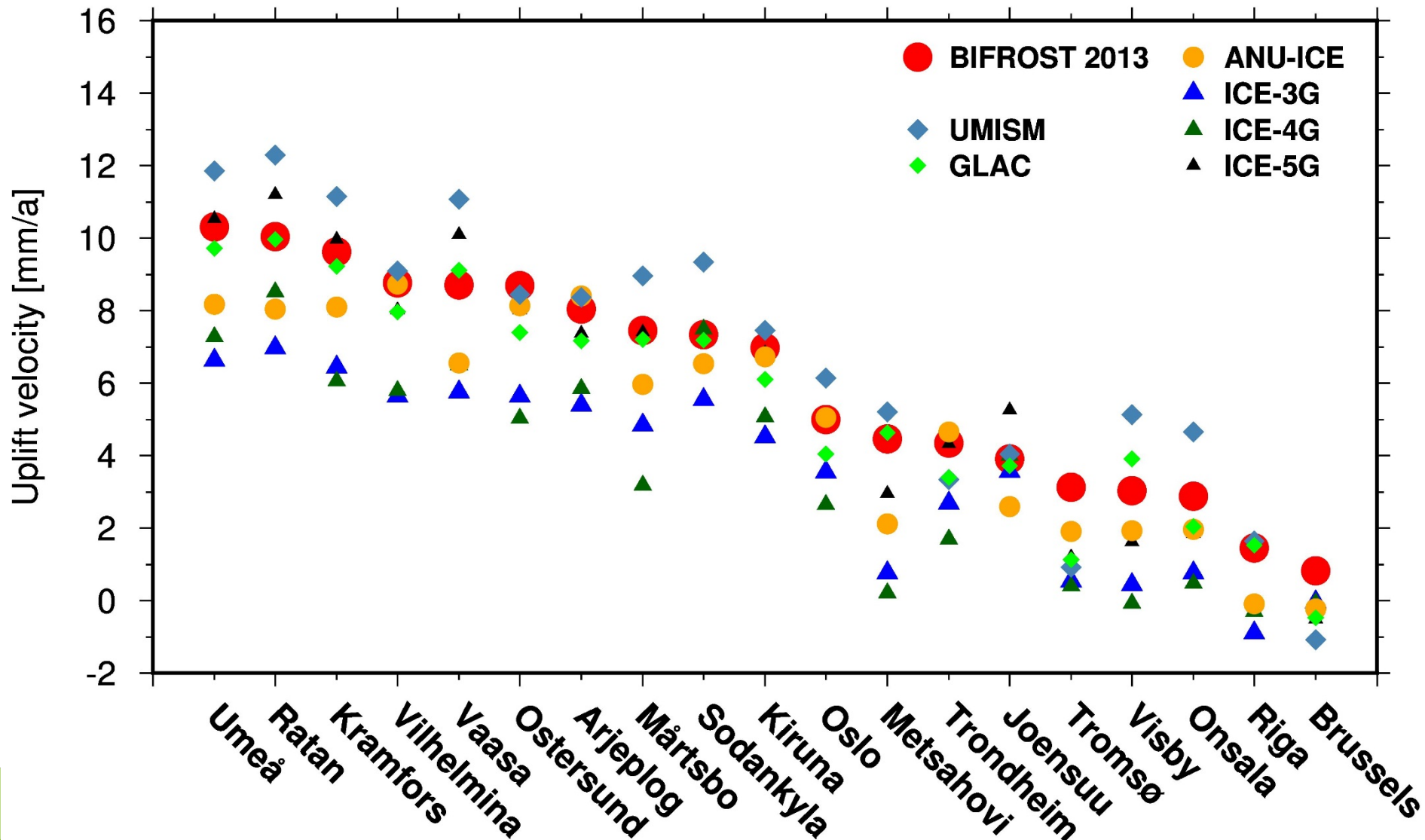
Ice volume and Earth models

- Number of Earth models was restricted using decay time analysis at Ångermanälven.
- The total ice volume and ice extent is affected by the choice of Earth model.
- Figure: In black the reference Earth model (VM5), in colours different lithospheric thicknesses. The scatter within a colour is caused by different upper and lower mantle viscosities.



Observations vs. GIA model results

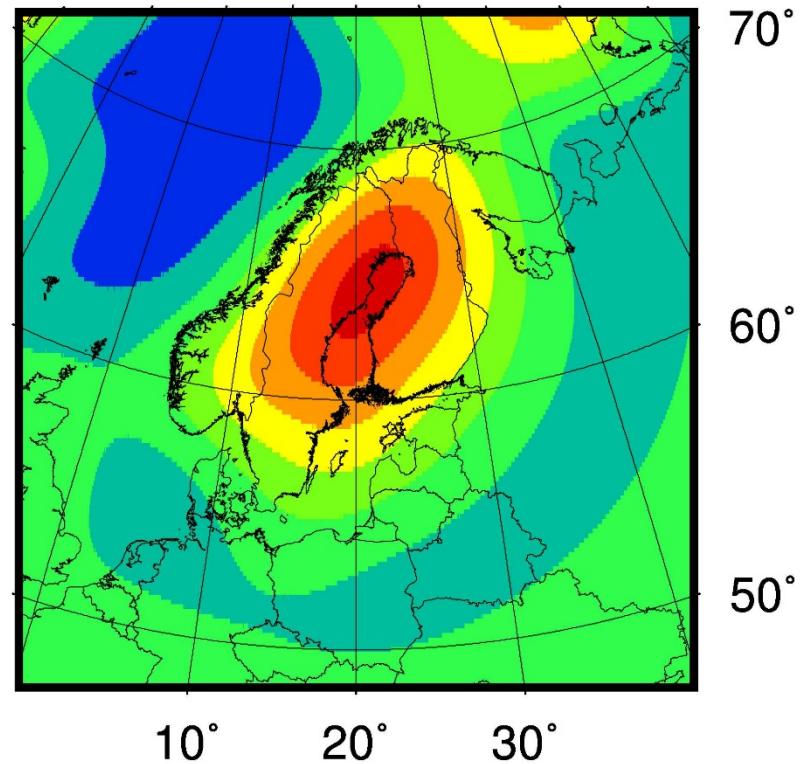
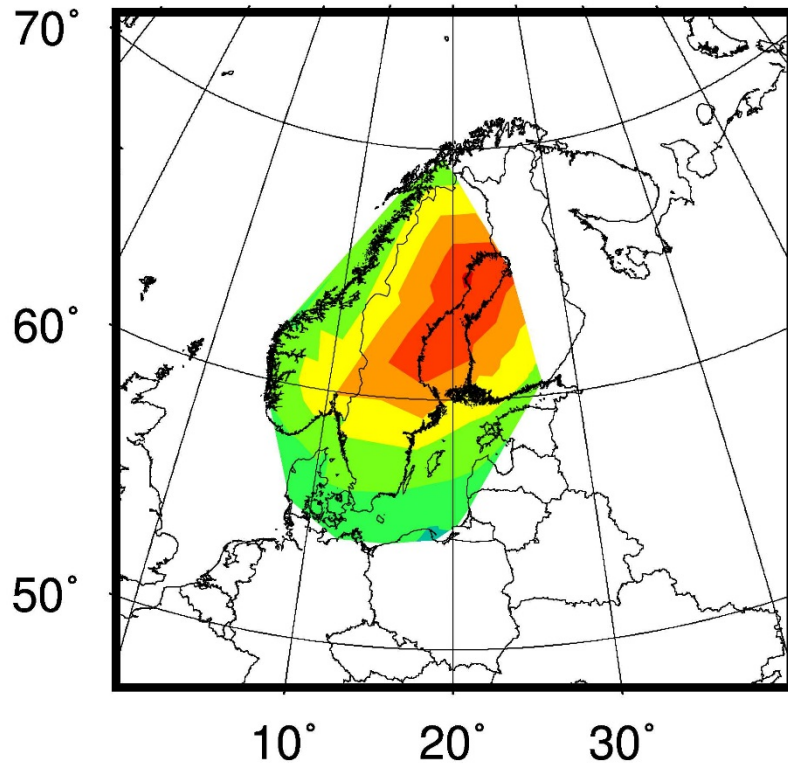
Different ice models with the same VM5-like earth model



Comparison to recent tide gauge analysis

Knudsen (2014) - h1

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Tuning the sea-level equivalent

