

DynaQlim

Upper Mantle Dynamics and Quaternary Climate in Cratonic Areas

A proposal for an ILP Task Force

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1. Introduction

We propose an inter-disciplinary project for studying the relationship between Glacial Isostatic Adjustment (GIA), upper mantle structure, dynamics and Quaternary climate. We aim towards an ILP-driven task force which integrates existing data and models from a variety of disciplines that consider processes over a range of spatial and temporal scales. The task force will bring together researchers world-wide with complementary expertise and knowledge to identify key scientific problems relating to the Quaternary evolution of cratonic regions that can be addressed through innovative and multidisciplinary collaboration.

During the Pleistocene, quasi-periodic transitions between glacial and interglacial periods varied with dominant periods closely related to those present in the Earth-Sun orbit. These Milankovich-paced variations in the cryosphere have played a key role in shaping the landscape and driving the geodynamic evolution of cratonic regions such as northern Eurasia and North America during the Quaternary. An extensive and varied suite of observations can be applied to study and understand the key processes involved, including geodetic land uplift measurements, geological observations of sea-level changes and past shore-lines, end moraines and other glacial deposits and various paleoclimatological proxies. These observations have played a vital role in a number of recent advances that have improved our understanding of the structure and dynamics of cratonic regions and the dominant influence of ice sheet growth and ablation.

Recent advances in studies of the glacial history of the northern Europe and Eurasia have significantly improved our understanding of the glaciation and deglaciation histories during the Weichselian and Holocene epochs over the past 100 ka (Svendsen et al. 2004). In addition, developing numerical modelling of glaciations has opened a new view to the processes involved as well as their mutual couplings (Forsström, 2005; Näslund et al., 2006; Zweck and Huybrechts, 2005; SKB, 2006). As a result, the latest generation of ice sheet models are significantly better constrained and more realistic than before.

The phenomenon of glacial isostatic adjustment with its unique temporal signatures is one of the great opportunities in geosciences to get information about earth processes. It contains information about the recent climate forcing, being dependent on the geologically recent on- and off-loading of ice sheets. It gives a unique chance to study the dynamics and rheology of the lithosphere and asthenosphere with an increasing detailed modelling, and it is of fundamental importance in geodesy, since the global reference frames, Earth rotation and Polar motion are influenced by it.

Inversion of deep temperature data in boreholes provides a direct access to ground temperature histories during glaciation times (Kukkonen and Jöeleht, 2003). Kimberlite-hosted crustal and mantle xenoliths and seismic velocity models and controlled-source seismic experiments have yielded direct information on the composition and temperature of the lithosphere and asthenosphere (Bruneton et al., 2004, Hjelt et al., 2006, Kukkonen et al., 2003, Olsson et al., 2007, 2006, Pedersen et al., 2006, Stein et al., 1989). These results can be used to develop more realistic models of mantle temperature and viscosity that are key factors controlling ice sheet dynamics and the Earth's response to ice mass change.

These advances in better constraining ice sheet evolution and upper mantle properties have yet to be incorporated into dynamic models of ice-Earth interaction. A key aim of this project will be to facilitate the development of such models in order to generate more accurate predictions of Earth and ice sheet evolution during the Quaternary. Of course, there still exist many open questions in relation to upper mantle dynamics and composition, rebound mechanism and uplift models, elastic thickness contra lithosphere thickness, as well as ice thickness during the late Quaternary. The proposed task force will serve as a vehicle to identify the gaps in our knowledge that are critical in arriving at an accurate model of ice-earth evolution. Such a model will have a number of applications, including present-day global change as well as future changes in response to a warming climate.

2. Aim of the project

The broad aim of DynaQlim is to understand the relations between upper mantle dynamics, mantle and lithosphere composition, and their physical properties, such as temperature and rheology, in order to study GIA, Quaternary climate variations and Weichselian (Laurentide and other) glaciations during the late Quaternary. The project will initiate new research and synergy between the disciplines, climatology, glaciology, geology, geophysics, oceanography, geochemistry and geodesy. This will result in a comprehensive understanding of the coupling between the lithosphere, mantle and past climate changes on the time scale of glacial cycles.

We aim to use the ILP task force as a tool for bringing together people specialized in various experimental and theoretical fields relevant to GIA studies. These include Quaternary climate and glaciation history, post-glacial uplift and geodynamics, ice-sheet dynamics and glaciology, post-glacial faulting, rock rheology, mantle xenoliths, past and present thermal regime of the lithosphere, seismic structure of the lithosphere, and potential fields.

As a result of DynaQlim, we expect to start several topical projects whose funding will be applied for elsewhere, but which will be essential contributions produced under the umbrella of DynaQlim. At the end of DynaQlim we expect to have a more comprehensive understanding of the Earth's response to glaciations. This is achieved by arranging topical sessions, workshops and researcher networks in an inter-disciplinary framework. Results of DynaQlim will be published in individual articles, special issues of international journals as well as monographs.

One should also mention related tasks, such as the TOPO-Europe initiative which is dedicated to 4D surface deformations in Europe. DynaQlim is focussing on the coupling processes between climate, earth dynamics and earth response and therefore the initiatives are complementing each other with expected synergy in the future. DynaQlim has the global aspect, connecting regional studies. One could also address the IAG sub-commission 3.2 Crustal Deformations (Chairman M. Poutanen) as a connection to the existing structures.

3. Proposed research and problems to be solved

The broad topics contain following research items:

- Further development of 3-D Earth modelling
- Physical and thermal properties of the lithosphere and asthenosphere
- GIA-related geodynamics, observations and modelling
- Gravity change and uplift
- Glaciation history and paleoclimate
- Ocean dynamics

Paleoclimate and glaciation history of the Pleistocene is a global complex problem and therefore, it should be solved in a joint program. Due to the natural laboratories, data and research activities, the two main glaciated regions, Fennoscandia and Laurentide will be covered first. The task will be initiated for Fennoscandia and then extended to Laurentide and other relevant areas, including Greenland and Antarctica. The emphasis will be on the globally interesting modelling of the climate forcing, and the effects on lithosphere and asthenosphere processes (Bintanja et al., 2005; van den Berg et al., 2006).

Our present knowledge of the rheology of the lower crust is based mostly on petrophysical inference from seismology and heat flow (Blundell et al., 1992). Continuous GPS observations of plate-wide strain, accompanied by seismological investigations, and followed by continuum mechanical modelling of GIA, seismic source and wave propagation, and studies of the post-glacial faults offer a new entry and will add new insights into the role and properties of the lower crust. Observations and models of post-glacial or glacially induced faulting can help to illuminate crustal stress fields and therefore crustal rheology issues. On the lithosphere-mantle scale we expect, mostly on the basis of on-going improvements and densifications of GPS observations, that the fully 3-D observations, augmented by gravity (GRACE and GOCE) and sea level change. Drawing from advances in thermodynamical and climatological ice sheet modelling will retrieve laterally heterogeneous structure of mantle and lithosphere from the observed motions.

Current GIA models are mostly based on radially (1D-)stratified Earth models with linear rheology (e.g., Sabadini and Vermeersen, 2004), though during the last few years progress has been made in the development of global, 3D-stratified earth modelling (Martinec 2000; Wu & van der Wal 2003; Whitehouse et al. 2006). However, due to computational restrictions, the latter models are confined to relatively low resolutions.

A collaborative project has been initiated on coupling interactively a regional (flat) 3D high-resolution finite-element model to a 3D thermomechanical ice-sheet model that includes ice shelves, with a special interest to apply this to Northern Europe. Recently a PhD-study has been completed on mantle xenoliths in the Caledonian lithosphere domain along the west margin of North-west Europe. Present and near-future work is therefore concentrated on this western margin part. In the future, interest will concentrate more on the eastern parts of NW Europe (Schotman and Vermeersen, 2005).

An important aspect is to construct and improve coupled models of glaciation and land uplift history, using both forward and inverse modelling. Geodesy provides accurate measurements of contemporary deformation and gravity change. There are systematic postglacial uplift observations for more than 100 years based on repeated precise levelling, geodetic high-resolution observations of recent movements, gravity change and possibilities to monitor

postglacial faults. Geologically, the uplift is documented in ancient shorelines (e.g. Lambeck et al. 1998) but the precise timing of the shorelines may become a limiting factor.

Space geodetic techniques, such as GPS, allow the construction of 3-D motions from relatively short (less than 10 years) time series. This was demonstrated in the BIFROST project (Johansson et al., 2002, Milne et al., 2001, Scherneck et al, 2002) and other regional studies (e.g. Sella et al, 2007; Wolf et al. 2006). Differences between models and observations for some regions possibly indicate an additional component in the uplift process.

One task is to couple existing GIA uplift data, uplift models and the most recent geological and paleoclimatological data on glaciation history. Northern Europe and Russia provide a study area with several recent contributions. With the land uplift models, the sensitivity of uplift data on variations in ice thickness and duration should be quantified, at least for the period of the last deglaciation, i.e. from the Last Glacial Maximum at about 22 ka B.P. to the present time. Inverse modelling of glaciation history may be a potential new approach previously not applied.

Existing data on experimentally studied lower crustal and mantle composition and 3-D structure derived from xenolith data, lithospheric thermal models (Kukkonen et al., 2003) and seismic studies (Bruneton et al., 2004, Sandoval et al., 2004, Yliniemi et al, 2004, Hjelt et al., 2006, Plomerova et al., 2006, Pedersen et al., 2006, Janik et al., 2007) should be utilized for forward rheological modelling of the lithosphere and for testing of dynamic uplift models. The presence and volume of fluids in the upper mantle and the influence of fluids on the mantle rheology is an open question. As dissociated water may provide an effective mechanism for electrical conductivity in the upper mantle, important implications on mantle fluids and lithosphere-asthenosphere system in general can be potentially obtained from recent deep electromagnetic measurements (Hjelt et al., 2006; Korja et al., 2002; Korja 2007).

Crustal deformation and sea level variation studies are based on stable reference frames. If one wants to study effects on a 1 mm/yr level, stability of 0.1 mm/yr in reference frames are needed over several decades. Such stability is not yet achieved. Geodesy's response to the requirement is the Geodetic Observing System (GGOS), a project of the International Association of Geodesy, (IAG). There are several ongoing plans for regional implementation of GGOS, as an example the Nordic Geodetic Observing System, (NGOS, Poutanen et al., 2007). NGOS plan includes also regular repeated absolute gravity measurements at the permanent GPS sites, a central element of this proposal. Gravity satellites GRACE and GOCE are already providing or will provide additional global and regional constraints on the gravity field (Müller et al, 2006; Pagiatakis et al., 2003; Tamisiea et al., 2007).

To achieve the goal of coupling multidisciplinary research and data requires a suitable data and information management. A shared internet portal enables search, evaluation, access, and visualization of data and models. Furthermore, the information management strives is to improve the re-use of data by referencing the digital data to related articles in the scientific literature and by making the data citeable through the use of digital object identifiers. The development of advanced visualization tools should facilitate scientific integration in addition to data integration and exchange. The portal will be established according to community standards and thus may contribute to a wider network of data bases, in line with the European policy on digital data accessibility (Haubrock et al., 2006, Klump et al. 2006).

4. Research team and structure of the task force

Already more than 40 top-level scientists from 10 countries have expressed their interest in participating in the DynaQlim and taking care of their special fields. The provisional list of principal investigators for the relevant fields is in the appendix, as well as the CVs of the proposers.

The task force can be divided into following broad categories comprising the field. The final structure of the working groups will be based on these topics.

- 1) Geodesy, geodynamics, ocean dynamics;
- 2) Post-glacial uplift, contemporary movements and gravity;
- 3) Dynamic ice sheets, glaciology;
- 4) Quaternary paleoenvironments and climate;
- 5) Geology and tectonics;
- 6) Dynamics, structure, properties and composition of the lithosphere;
- 7) IT, data management and outreach

The groups and their tasks will be defined, and group leaders agreed before the end of the year 2007. If accepted as a task force, the kick-off meeting where the structure will be finalised, will be arranged at the end of 2007 or early 2008.

5. Expected results and deliverables

As expressed in Chapters 2 and 3 we expect the following results from the task force:

- Comprehensive and improved understanding of the GIA through innovative research
- Publications and special issues from DynaQlim meetings
- Improved and updated 3-D uplift data sets
- Updated data on glaciation history
- Multidisciplinary data base and information portal
- Software and models
- Instrumentation development

6. Schedule

Duration of the task force will be 5 years: Oct. 2007- Sept. 2012 with following milestones

2008 January-February: Opening workshop and kick-off meeting (venue Copenhagen);
Proceedings issue to be edited in 2008

2008 April: DynaQlim sessions at EGU Vienna

2009 April: DynaQlim sessions at EGU

2009 November: DynaQlim workshop (Finland)

2010 April: DynaQlim sessions at EGU

2010 November: DynaQlim workshop

2011 April: DynaQlim sessions at EGU

2012 September: Final summarizing meeting and proceedings of DynaQlim

7. Funding plan

Most of the funding of the research groups will be arranged on national bases, or for seeking EU or similar funding. Majority of the activities are already initiated and facilities exist. Based on the ILP support, following activities can be covered: invited speakers, travel costs; workshop arrangements; support for travel costs of workshop participants (students); costs of the portal. To cover the rest of the workshop costs, small fees will be collected from participants.

References

- Berg J. van den, R. S. W. van de Wal, and J. Oerlemans, 2006. Recovering lateral variations in lithospheric strength from bedrock motion data using a coupled ice sheet-lithosphere model. *Journal of Geophysical Research*, Vol. 111, B05409, doi:10.1029/2005JB003790.
- Bintanja Richard, Roderik S.W. van de Wal, and Johannes Oerlemans, 2005. Modelled atmospheric temperatures and global sea levels over the past million years. *Nature, Letters*, Vol 437; 1 September 2005; doi:10.1038/nature03975.
- Blundell, D., Mueller, S., Mengel, K., 1992: A continent revealed; the European Geotraverse, Camb. Univ. Press, Cambridge,
- Bruneton, M., H.A. Pedersen, R. Farra, N.T. Arndt, P. Vacher, U. Achauer, A. Alinaghi, J. Ansorge, G. Bock, W. Friederich, M. Grad, A. Guterch, P. Heikkinen, S.E. Hjelt, T.L. Hyvonen, J.P. Ikonen, E. Kissling, K. Komminaho, A. Korja, E. Kozlovskaya, M.V. Nevsky, H. Paulssen, N.I. Pavlenkova, J. Plomerova, T. Raita, O.Y. Riznichenko, R.G. Roberts, S. Sandoval, I.A. Sanina, N.V. Sharov, Z.H. Shomali, J. Tiikainen, E. Wieland, K. Wylegalla, J. Yliniemi, Y.G. Yurov. 2004. Complex lithospheric structure under the central Baltic Shield from surface wave tomography. *Journal of Geophysical Research-Solid Earth*, 109 (B10): art.no. B10303. (F)
- Haubrock, S., Dransch, D., Kreibich, H., Merz, B., Plattner, S., Voigt, S., and Mehl, H., 2006. Natural Disasters Networking Platform (NaDiNe). In: Amman, W., Haig, J., Huovinen, C. & M. Stocker (Eds.): *Proceedings of the International Disaster Reduction Conference*, Vol. 1, Swiss Federal Research Institute WSL, 74.
- Hjelt, S-E., Korja, T., Kozlovskaya, E., Yliniemi, J., Lahti, I., BEAR and SVEKALAPKO Working Groups, 2005. Electrical conductivity and seismic velocity structures of the lithosphere beneath the Fennoscandian Shield. In: D. Gee, R. Stephenson (eds) *European Lithosphere Dynamics*, 541-559.
- Johansson, J.M., Davis, J.L., Scherneck, H-G., Milne, G.A., Vermeer, M., Mitrovica, J.X., Bennett, R. A., Jonsson, B., Elgered, G., Elósegui, P., Koivula, H., Poutanen, M., Rönnäng, B.O. and Shapiro, I.I. (2002): Continuous GPS measurements of postglacial adjustment in Fennoscandia 1. Geodetic results, *J. Geophys. Res.*, 107, DOI 10.1029/2001JB000400.
- Klump, J., Bertelmann, R., Brase, J., Diepenbroek, M., Grobe, H., Höck, H., Lautenschlager, M., Schindler, U., Sens, I., and Wächter, J. (2006) Data publication in the Open Access Initiative. *Data Science Journal* 5, 79-83.
- Korja T., Engels M., Zhamaletdinov A.A., Kovtun A.A., Palshin N.A., Smirnov M.Yu., Tokarev A., Asming V.E., Vanyan L.L., Vardaniants I.L., and the BEAR Working Group, 2002. Crustal conductivity in Fennoscandia - a compilation of a database on crustal conductance in the Fennoscandian Shield. *Earth Planets Space*, 54, 535-558.
- Korja T., 2007. How is the European lithosphere imaged by magnetotellurics? *Surveys in Geophysics*, Accepted.
- Kukkonen, I.T. and Jöeleht, 2003. Weichselian temperatures from geothermal heat flow data. *Journal of Geophysical Research*, 108 (B3), ETG-9, 11 p.
- Kukkonen, I.T., Kinnunen, K. and Peltonen, P., 2003. Mantle xenoliths and thick lithosphere in the Fennoscandian Shield. *Phys. Chem. Earth*, 28, 349-360.
- Lambeck, K., Smither C. and Johnston, P., 1998. Sea-level change, glacial rebound and mantle viscosity for northern Europe. *Geophys. J. Int.*, 134, 102-144.

- Martinec, Z. 2000. Spectral-finite element approach to three-dimensional viscoelastic relaxation in a spherical earth. *Geophys. J. Int.*, 142, 117-141.
- Milne G.A., J.L. Davis, J.X. Mitrovica, H.-G. Scherneck, J.M. Johansson, M. Vermeer and H. Koivula, 2001: Space-Geodetic Constraints on Glacial Isostatic Adjustment in Fennoscandia. *Science*, Vol. 291, p. 2381-2385.
- Müller, J., Neumann-Redlin, M., Jarecki, F., Denker, H., Gitlein, O., 2006. Gravity Changes in Northern Europe as Observed by GRACE. In: *Dynamic Planet*. P.Tregoning, C.Rizos (eds.), IAG Symposia 130, P. 523-527, Springer.
- Näslund, J.-O., Jansson, P., Fastook, J.L., Johnson, J. and Andersson, L., 2005. Detailed spatially distributed geothermal heat flow data for modeling of basal temperatures and meltwater production beneath the Fennoscandian ice sheet. *Annals of Glaciology*, 40, 95-101.
- Pagiatakis, Spiros D. and Salib, P., 2003. Historical relative gravity observations and the time rate of change of gravity due to postglacial rebound and other tectonic movements in Canada, *Journal of Geophysical Research (Solid Earth)*, 108, 2406, doi:10.1029/2001JB001676.
- Olsson S., Roberts, R.G., Bödvarsson, R., 2007. Analysis of waves converted from S to P in the upper mantle beneath the Baltic Shield, *Earth Planet. Sc. Lett.*, 257, 37 - 46, doi: 10.1016/j.epsl.2007.02.017.
- Paillard, D., 2001. Glacial cycles: Toward a new paradigm. *Rev. Geophys.*, 39, 325–346.
- Pedersen H.A., M. Bruneton, V. Maupin 2006. Lithospheric and sublithospheric anisotropy beneath the Baltic shield from surface-wave analysis. *Earth Planet. Sci. Lett.*, 244, 590-605.
- Poutanen M., P. Knudsen, M. Lilje, T. Nørbech, H.- P. Plag, H.-G. Scherneck, (2007): The Nordic Geodetic Observing System (NGOS). *Proceedings of the IAG Dynamic Planet Symposium, Cairns 2005*, IAG symposium vol. 130, p. 749-756. Springer Verlag,
- Sabadini, R., and L.L.A. Vermeersen, *Global Dynamics of the Earth: Applications of Normal Mode Relaxation Theory to Solid-Earth Geophysics*, Modern Approaches in Geophysics Series, Vol. 20, Kluwer Academic Publ., Dordrecht, The Netherlands, 328 pp., 2004.
- Scherneck, H.-G., J.M. Johansson, G. Elgered, J.L. Davis, B. Jonsson, G. Hedling, H. Koivula, M. Ollikainen, M. Poutanen, M. Vermeer, J.X. Mitrovica, and G.A. Milne (2002): BIFROST: Observing the Three-Dimensional Deformation of Fennoscandia. In *Ice Sheets, Sea Level and the Dynamic Earth*, (Eds. J.X. Mitrovica and B.L.A. Vermeersen). American Geophysical Union, Geodynamics Series, Volume 29, Washington, D.C., p. 69-93.
- Schotman, H.H.A., and L.L.A. Vermeersen., (2005): Sensitivity of glacial isostatic adjustment models with shallow low-viscosity earth layers to the ice-load history in relation to the performance of GOCE and GRACE, *Earth Planet. Sci. Lett.*, 236, 828-844.
- SKB, 2006. Climate and climate-related issues for the safety assessment SR-Can. Technical Report TR-06-23, Svensk Kärnbränslehantering AB, Stockholm.
- Sella, Giovanni F., Seth Stein, Timothy H. Dixon, Michael Craymer, Thomas S. James, Stephane Mazzotti, and Roy K. Dokka 2007. Observation of glacial isostatic adjustment in “stable” North America with GPS. *Geophysical Research Letters*, VOL. 34, L02306, doi:10.1029/2006GL027081.
- Svendsen, J. I., Alexanderson, H., Astakhov, V. I., Demidov, I., Dowdeswell, J. A., Funder, S., Gataullin, V., Henriksen, M., Hjort, C., Houmark-Nielsen, M., Hubberten, H. W., Ingólfsson, Ó., Jakobsson, M., Kjær, K. H., Larsen, E., Lokrantz, H., Lunkka, J. P., Lyså, A., Mangerud, M., Matiouchkov, A., Murray, A., Möller, P., Niessen, F., Nikolskaya, O., Polyak, L., Saarnisto, M., Siegert, C., Siegert, M. J., Spielhagen, R., Stein, R. 2004. Late Quaternary ice sheet history of northern Eurasia. *Quaternary Science Reviews* 23, 1229 – 1271.
- Stein, S., S. Cloetingh, N. Sleep and R. Wortel, 1989. Passive margin earthquakes, stresses, and rheology, in S. Gregerson and P. Basham (eds) *Earthquakes at North Atlantic Passive Margins*, 231-259, Kluwer.
- Tamisiea, M.E. and Mitrovica, J.X. and Davis, J.-L., 2007. GRACE Gravity Data Constrain Ancient Ice Geometries and Continental Dynamics over Laurentia, *Science*, 316, 881-, doi:10.1126/science.1137157.
- Whitehouse, P.L., K. Latychev, G.A. Milne, J.X. Mitrovica, & R. Kendall, 2006. The impact of 3_D Earth structure on Fennoscandian glacial isostatic adjustment: Implications for space-geodetic estimates of present-day crustal deformations. *Geophys. Res. Lett.*, 33, L13502, doi: 10.1029/2006GL026568.

- Wolf, D., Klemann, V. and Wünsch, J., Zhang, F.-P., 2006. A Reanalysis and Reinterpretation of Geodetic and Geomorphologic Evidence of Glacial-Isostatic Uplift in the Churchill Region, Hudson Bay, *Survey in Geophysics*, 27, 19-61
- Wu, P. and van der Wal, W., 2003. Postglacial sea levels on a spherical, self-gravitating viscoelastic Earth: effects of lateral viscosity variations in the upper mantle on the inference of viscosity contrasts in the lower mantle, *Earth Planet. Sci. Lett.*, 211, 57-68.
- Zweck, C and Huybrechts, P. 2005. Modeling of the northern hemisphere ice sheets during the last glacial cycle and glaciological sensitivity, *Journal of Geophysical Research D*, D07103, doi:10.129/2004JD005489.

Appendix: Provisional list of participants and sub-projects

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