Proposal for an ice-sheet intercomparison project as an ACSYS/CliC sponsored activity

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This proposal was tabled at the ACSYS/CliC meeting in Cambridge 17-20 September 2001 in closed session at the NEG and in summary in the plenary.

1. State of affairs

Ice-sheet modeling is a relatively young science. At the end of the eighties, only a few codes had been developed that were able to deal with the flow and behaviour of natural ice masses under real-world conditions. During the nineties, the art of ice-sheet modeling benefited greatly from the EISMINT (European Ice Sheet Modeling Initiative) Model Intercomparison venture that took place between 1993 and 1997. Main achievements were the production of published benchmarks for testing ice sheet and ice shelf codes under schematic conditions, and a series of experimental setups, including gridded datasets and forcing functions, for testing models of the Greenland ice sheet, the Antarctic ice sheet, and the Ross ice shelf. By the end of the EISMINT venture, about 10 state-of-the art ice sheet models (grounded ice) were available worldwide, and had been raised to a higher common standard. At the same time, 3 ice-shelf models had been developed and two coupled ice sheet/ice shelf models applied to the Antarctic ice sheet were in operation. Today, this situation has not dramatically changed. After 5 years I understand from my colleagues that in the light of current developments, the community would very much welcome picking up the intercomparison activity again. Under the auspices of EISMINT, a similar modeling exercise was also set up by Hans Oerlemans aiming at modeling glaciers and their response to climate change.

2. Nature of further ACSYS/CliC sponsored model intercomparison

Current ice-sheet modeling efforts essentially revolve around three themes, each of which is proposed to be a subject of an intercomparison activity.
The first theme concerns the marine ice sheet problem. Work is being performed to find out how to best deal with ice-sheet/ice-shelf interaction, the mechanism of grounding-line migration and the effect of a soft, wet-sediment deforming base on the flow.
A second theme concerns the development of higher-order local models to deal with smaller-scale features that are not well represented in current large-scale models. Issues of specific interest are application of such models to ice streams and outlet glaciers, the inclusion of longitudinal stresses, and coupling techniques for incorporation of such models in large-scale models (multiscale modeling, nesting, etc…).
A third theme concerns the interaction of ice sheet models with A/O GCM's and Earth System Models. Issues here are how to best perform such a coupling and how to best prescribe atmospheric (precipitation, temperature, melting,…) and oceanic (basal melting below ice shelves) boundary conditions, and how ice-sheet changes feed back
These themes naturally culminate in the modeling of the Antarctic ice sheet, which should therefore be the focus of the intercomparison activity. But these themes are also very relevant to the modeling of the Quaternary ice sheets on the continents of the northern hemisphere.
A likely product of the intercomparison venture could be a suite of simulations on the response of the Antarctic ice sheet under future climatic conditions which will put a range on modelled predictions of sea-level change, amongst other things.

3. Practical organisation and format of meetings

A succesful intercomparison exercise would require at least two workshops. A first workshop should bring together 5 to 10 key participants to discuss the setup of the experiments, locate suitable datasets and divide the work. This first meeting could very well coincide with the next NEG meeting. This way some (or all) of the participants could present their modeling work to meet the objective of the NEG meeting. The actual discussions on the drawing up of the experimental setups, on the other hand, should preferably be done in a separate session chaired by an experienced ice sheet modeller that has prepared for the subject. A half day or maximally a full day should suffice for getting the intercomparison setups established.

The actual intercomparison could then largely take place via E-mail. A website would need to be set up where participants could download all necessary information and datasets, similar to the procedure followed for EISMINT (http://homepages.vub.ac.be/~phuybrec/eismint.html). At least one year, and perhaps two, should be set aside for people to actually do the experiments. As was the case for EISMINT, such a period can be really productive as it stimulates participants to improve their models. A few months of time would be needed for the organizers to get the intercomparison results processed.

A second workshop is needed at the end of the process, perhaps by up to two years after the first one took place. This second workshop should bring 10-20 scientists together that were actually involved in the modeling experiments to discuss the intercomparison results. This workshop need not necessarily coincide with a NEG meeting.

The writing up of papers could then largely be done by E-mail.

Obviously the success of the intercomparison exercise will depend on the degree of funding by WMO/WCRP. Full participation of key modeling groups can probably only be guaranteed if WMO/WCRP is able to share most, if not all, of the workshop costs.

4. Publications arising from the EISMINT intercomparison work

Huybrechts, P., A. J. Payne and EISMINT Intercomparison Group. 1996. The EISMINT benchmarks for testing ice-sheet models. *Annals of Glaciology*, 23, 1-12.

Huybrechts, P., A. Abe-Ouchi, I. Marsiat, F. Pattyn, T. Payne, C. Ritz, and V. Rommelaere, 1998: *Report of the Third EISMINT Workshop on Model Intercomparison*, European Science Foundation (Strasbourg), 140 p.

MacAyeal, D. R., V. Rommelaere, P. Huybrechts, C. L. Hulbe, J. Determann and C. Ritz. 1996. An ice-shelf model test based on the Ross ice shelf. *Annals of Glaciology*, 23, 46-51.

Oerlemans, J., B. Anderson, A. Hubbard, P. Huybrechts, T. Johannesson, W.H.L. Knap, M. Schmeits, A.P. Stroeven, R.S.W. van de Wal, J. Wallinga, and Z. Zuo. 1998. Modelling the response of glaciers to climate warming. *Climate Dynamics*, 14, 267-274.

Payne, A. J., P. Huybrechts, A. Abe-Ouchi, R. Calov, J.L. Fastook, R. Greve, S.J. Marshall, I. Marsiat, C. Ritz, L. Tarasov, and M.P.A. Thomassen. 2000. Results from the EISMINT Phase 2 simplified geometry experiments: the effects of thermomechanical coupling. *Journal of Glaciology*, 46 (153), 227-238.