Geophysical Research Abstracts
Vol. 12, EGU2010-2038, 2010
EGU General Assembly 2010

On the use of the unstable manifold correction in a Picard iteration for the solution of the velocity field in higher-order ice-flow models

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Nonlinear iteration schemes are essential for a fast and stable solution of higher-order ice-flow models (HOIFM's). This topic is gaining momentum as now also ice-sheet models are planned to include higher-order mechanics. In 1996, Hindmarsh and Payne proposed the unstable manifold correction as a way to stabilise the numerical solution of implicit finite-difference discretisations of the time-dependent thickness-evolution equation for ice flow. Since 2002, Pattyn (e.g. Pattyn (2002), Pattyn (2003)) has been using the unstable manifold correction in a Picard iteration to facilitate the solution of the velocity field in HOIFM's. In more recent work, a variant of the original algorithm was used (e.g. Pattyn and others, 2004). Although this variant usually enables a relatively fast solution, it is theoretically less sound. Using a new 2D HOIFM implementation, we show that, in most cases, there is no need for the unstable manifold correction or its variant in a Picard iteration. We also present a more appropriate, stable and simple algorithm that speeds up the iterative solution of the velocity field in HOIFM's for problems with real data.

References

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