

The Cryosphere Discuss., referee comment RC2
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Comment on tc-2021-280

Anonymous Referee #2

Referee comment on "A new vertically integrated MOno-Layer Higher-Order (MOLHO) ice flow model" by Thiago Dias dos Santos et al., The Cryosphere Discuss.,
<https://doi.org/10.5194/tc-2021-280-RC2>, 2021

This paper presents a new vertically integrated ice flow model. This formulation approximates a classical Higher-order model (known as the Blatter-Pattyn model) by assuming a specific polynomial shape for the vertical variations of the horizontal velocities, which allows analytical integrations.

This paper gives a clear description of the model and its numerical implementation, so that it will be very useful for the community.

The model performances are tested against the original Higher-order model on standard ice flow model inter-comparison benchmarks. The results are clearly described.

I only have few minor comments listed below :

- The polynomial function used to approximate the horizontal velocities derives from analytical solutions of the Shallow Ice Approximation for an isothermal ice sheet, which may increase the differences in real application or will require further work. This is acknowledged in the discussion (lines 330-333). I think this should be already introduced and discussed in the derivation of the model (sec. 2.1).
- The main goal of a higher order model is to approximate the Stokes solution. The discussion of the ISMIP-HOM experiments focusses on the difference between the MOLHO and HO models, it would be good to give a brief summary of the inter-comparison results and especially how HO models approximate the Stokes solution.

Technical details:

- Line 48: "we precompute a depth-average "the" viscosity" => remove "the"
- Line 127:" (e.g., $v^b=[v^b_{\{x,1\}}, v^b_{\{x,2\}}, \dots, v^b_{\{x,3\}}]$)" should be "(e.g., $v^b=[v^b_{\{x,1\}}, v^b_{\{x,2\}}, \dots, v^b_{\{x,n\}}]$) with n the number of nodes"?
- 15 : just give a reminder that dv_z/dx and dv_y/dy are assumed to be negligible as assumed in the HO model.
- 16. An equation usually requires a comparison between terms.