

The Cryosphere - TC2015-226 "Similitude of ice-sheet dynamics against scaling of geometry and physical parameters" by Feldmann and Levermann.

This paper presents a similitude analysis of the Shallow Shelf Approximation (SSA) prognostic equations. Such similitude analysis which seems commonly employed in other fields or research might have been ignored by glaciologist. This contribution is therefore interesting to see the potential of such method. In this paper, the method is validated against 2D and 3D numerical simulations. Greater impacts of the paper should certainly been expected by directly applying the method to real outlets glaciers of Antarctica or Greenland, but is certainly beyond the scope of this first paper and would certainly require further developments. This is overall a well written paper, even if it contains quite a lot of equations (which I was not able to verify all) and I would recommend its publication in TC. I have few remarks that are listed below.

Remarks

Abstract: the abstract is too long and should be shorten. There are repetitions from the abstract and introduction that could be avoided.

page 1, line 30: I haven't done this bibliography, but people working on flubber experiment as an analogue of ice must have had these questioning about the similitude of their experiment and a real glacier. By the way, similitude of analogue experiments is an other domain of application for the method that should be mentioned.

page 1, line 40 and below: I guess there are much more references than the one cited so I would suggest to use "e.g." in front of the references.

page 1, line 63: I don't get the point. Which has been shown to what?

page 2, line 14: I don't understand what you mean by "which will be put to test in the forthcoming MISMIP+ intercomparison project"?

below Eq. (1): not all the notations introduced in this equation are explained (e.g. A).

Equation (4) is neglecting basal mass balance (basal melting). It should be mentioned.

page 3, line 20: the use of compression is confusing as compression could refer to the state of stress. Elongation/Shortening?

page 3, lines 49-51: I am not sure to clearly understand the two limits. Especially the case $\Phi \gg \theta$ since the case of a frozen bed cannot be modeled assuming the SSA. Also, to which equations do you refer when you said "in which non of the stress balance terms are neglected"? In the SSA, this is already not true as it neglects stress regarding to the Stokes equations. This should be clarified.

page 4, line 30: it is not the length of the entire ice-sheet, but only the grounded part (upstream the GL).

page 4, line 29: integration of (Eq. 4) over -> integration of Eq. (4) over (and at other places in the manuscript)

page 4, lines 31-35: I am not sure to follow what is really demonstrated here and not sure to see where is the consistency with the BLT of Schoof. Indeed, the equations derived by the BLT are based on the SSA ones, so that intuitively I would say that the similitude derived for the SSA also apply for the BLT? You should present it the other way, and derive directly the scaling relation (24)?

page 5, line 45: Is it really constant, which refer to time, whereas here one wants to say that it is the same value of the friction in the two experiments. "Same" or "identical" is may be better than "constant"? It should be modified accordingly all along the manuscript.

page 5, line 48: reference to Table 2 is broken

page 5, line 53: it should be mentioned here that the bedrock also varies in the transverse direction.

page 6, line 26: Vialov profiles are derived assuming the Shallow Ice Approximation (SIA) whereas here the SSA is used. Only in the conclusion it is mentioned that in a previous paper you have shown that SSA was conducting to similar profiles as Vialov ones. It should be mentioned here.

page 6, line 71: atmosphere: Rising -> atmosphere: rising (and at other places in the manuscript)

page 6, line 82: space (Fig. 7 accounts for only one value of m . -> space (Fig. 7 accounts for only one value of m).

page 7, line 22: To what refers "respectively"?

page 7, line 33: I don't understand what you mean here as you have already started from the SSA equations and not the full Stokes system of equations. There is a missing citation.

page 7, line 40: again, ϵ is used to derive the SSA from the Stokes equations so it has somehow been used already in the equations you are using here. This part is a bit confusing and would require some clarifications.

page 7, line 50: As already mentioned, I would say, but may be I misunderstood something, that this is normal as these BLT equations are derived from the SSA ones...

page 7, line 103: law still then still depends on -> law then still depends on

page 7, line 106: of m (9): Vertical -> of m (9): vertical

page 8, line 18: reasonably - and this should be said before.

page 8, lines 37-38: consider rewording and also avoid the repetition for the value of n .

page 10, line 33: to Eq. 27 with -> to Eq. (27) with

B1: define what is RHS and LHS

page 11, line 28: instantaneously, elimination

Figures 5 and 6: legend and axis label are not correct. Why not applying a scaling along x and t? How do you choose the part of the curve where is made the retreat rate comparison?
In the legend: overlaidn -> overlaid

legend Fig. 7: to Eq. 32. -> to Eq. (32).

legend Fig. 9: to Eq. 31 for -> to Eq. (31) for