Geosci. Model Dev. Discuss., 7, C915–C921, 2014
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Geoscientific Model Development Discussions

Interactive comment on "Formulation, calibration and validation of the DAIS model (version 1), a simple Antarctic Ice Sheet model sensitive to variations of sea level and ocean subsurface temperature" *by* G. Shaffer

Anonymous Referee #2

Received and published: 13 June 2014

* general comments

This paper describes a AIS model that is based on the (corrected) Oerleman's axi-symmetrical mass balance ice sheet model. To this model the author has incorporated modifications in the computation of the ice speed to capture the mass flux at the grounding line and melting at the ice-ocean interface due to subsurface ocean temperatures (generated from the Danish Center for Earth System Science (DCESS) Earth System Model). Recent advances in the understand of ice dynamics and the interaction with the ocean have identified these processes as likely being dominant in con-

trolling mass loss in AIS under the predicted warming environment. The author uses sea level equivalent estimates from the Last Interglacial, the Last Glacial Maximum, and the Holocene to constraint the paleo-reconstructions and from these 'calibrated' configurations the model is 'validated' against present estimates of mass loss.

The paper is fairly well written but would greatly benefit a careful re-edit; some of the sentences are difficult to interpret and the presentation style of repeated phrases is inconsistent. Please be consistent with either subsurface ocean temperature or ocean subsurface temperature. In addition, I only think you need to mention high latitude once. Be consistent with using AIS rather than Antarctic Ice Sheet. Once the acronym is introduced use it.

The length of the paper is fine and the progression/order of information is well presented and logical. The subject matter is highly relevant and it is always pleasant to see simple models being used to validate theory.

There were a number of instances where statements were made that had either no reference or were unquantified. They are noted in the specific comments

Most figures would benefit from a graticule.

The table needs some cleaning up to properly reflect the variables and parameters in the article text. See specific comments but please also re-review. Use SI units; i.e., not cmˆ-3.

I look forward to reading the corrected version.

* specific and technical comments I have combined these two types of comments because it was easier to document.

P1792, L1-L6: I appreciate it is difficult having acronyms within acronyms but is there anyway this sentence could be re-constructed to follow the traditional format of having the acronym after the phrase has been used.

P1793, L6 -> L8: is there a reference for the 'snow fall' statement, or at least could you discuss a little more.

P1793, L8: Add a comma after However

P1793, L29: Is this a new DAIS model or just the DAIS model

P1794, L1: sea level or global sea level?

P1795, L10: I am confused by the equation and the text after the i.e. 'i.e. for R > (b0 −SL)s−1 = rc, the distance from the continent center to where the ice sheet enters the sea.' Please be clear what rc refers too. Please be careful with comma placement. rc is not in the table.

P1796, L1: What is c?

P1796, L1, Where does the Precipitation law come from?

P1796, L14: Integration of B as formulated above over the ice sheet surface yields -> Integration of B, as formulated above, over the ice sheet surface yields

P1796, Eq8. If this equation has previously been presented incorrectly and you are correcting it, it would be useful to see a few more steps in the derivation, for example, in the appendix.

P1796, L25: Now? Do you mean Now, with the corrected signs, i.e., the updated model.

P1796, L25: What do you mean by an Antarctic temperature. Do you mean yearly average?

P1796, L22: 22 degC? Is that correct?

P1796, L27: You make no comment as to the validity of the Huybrecht's model given recent modelling advances.

P1796, L28: 'might be undertaken but I defer this to future work'-> possibly just drop

this phrase, if it will be future work say so, if it might be undertaken in the future, is sounds unlikely

P1797, L11: Is there a reference for this?

P1797, L15: Why the increase in bo?

P1797, L16: Never seen the word throughput in this context. Any distinction from mass flux?

P1798, L16: Reference for the 'proportional to the production of ocean flow speed and ocean temperature beneath the ice shelf, both of which increase linearly with ocean warming.' Specifically I'm asking about the ocean flow speed.

P1799, L6: What do you mean by remote forcing of the ice sheet?

P1799, L13: Do you mean the whole equation within curly brackets or just the last term within curly brackets. I think you mean the latter. Possibly use the word 'within' rather than 'in' for the last word on L13

P1800, L14: 'spanning glacial times into past (and future) global warming conditions.' -> I think you mean past warmer and cooler global climates and that the past warmer climate is analogous the predicted future conditions, but please specify.

P1800, L4: Sect. 3 has not been discussed yet. Maybe state at the end of the sentence "this will be discussed in section 3" or "discussed in greater detail in section 3"

P1800, L13: Volumes decrease rapidly for still warmer temperatures as summertime melting becomes important -> Beyond 5-7degC volumes decrease rapidly as summertime melting becomes important

P1800, L13: 'summertime melting'...It's not clear that the model has seasonal temperature forcing.

P1800, L18: 'Increased continental area is needed for reduced snowfall to balance ice

flux at the grounding line then' I am not clear what this sentence is saying. -> I think it means 'Due to the reduced snow fall, increased continental area is needed to balance the ice flux at the grounding line'

P1800, L22: To be clearer change 1. to (1) and 2. to (2) also A higher-order -> a higher-order and Ice flow increase -> ice flow increase

P1800, L25: 'In this case the third forcing variable – high latitude, subsurface ocean temperature, To – also comes into play' Change sentence to something like: 'In this case high latitude ocean subsurface temperature, To, becomes influential.

P1800: Where did Eq 15 come from?

P1801 L3: on temperature for cold temperatures? Please re-write. Start sentence with 'During colder periods...

P1801, L6: 'can keep up with' -> 'balances the' and remove 'to reach that balance" at the end

P1801, L9 for that balance -> for equilibrium

P1795, L6 'The mean Antarctic temperature reduced to sea level, T a' But in the table there is no 'Ta', just 'Ta,0' which is also 'Present day T a reduced to sea level'. This needs to be cleared up.

P1801, L21: What do you mean by first calibration? What is the second?

P1801, L22: 'waxing and waning' to me implies strengthening and weakening, maybe stick to growing and decaying or growing and shrinking of the ice sheet

P1801, L23: model -> reconstructed or modelled

P1801, L27: Use semi-colons for the list after the colon

P1802, L14: less than this for LIG global 15 temperatures less than 2 deg above present day ->less than this given that, during the LIG, global temperatures were no

more than 2 deg C above present day

P1802, L16: a LIG not an LIG

P1803, L127: Reconstruct the sentence beginning at the end of this line. It is not clear.

P1804, L4: an AIS size -> a HOL AIS size

P1804, L7: maybe use the word configuration rather than setups

P1805, L8: Qualify this sentence: 'This is an appropriate initial condition for the inter-glacial conditions at 240 kyrBP.' i.e., who says, or why, is it appropriate.

P1803, L15: I would like to know where you got your SLE to volume conversion factor.

P1803, L23: Now the timing -> In this case, the timing

P1803, L25: Not sure what you mean by commitment

P1804, L23: Antarctic Ice Sheet -> AIS, be consistent

P1804, L25: considered above -"considered in section 3.1.

P1804, L25: Why not use the same colouring scheme for the marker dots as in Fig. 6?

P1806, L4: Antarctic Ice Sheet -> AIS, be consistent

Fig 6 caption: Is there a better phasing than blowups?

P1807, L7: As shown in Fig. 1, the depressed bed of the DAIS model slopes in this manner. -> As shown in Fig. 1, the depressed bed of the DAIS model slopes in this manner at the periphery of the ice sheet.

P1808, L23 complex model -> Pollard and DeConto model

P1808. L2: robust confidence intervals on projections. I would question the use of the word robust given the simplicity, which admittedly is the strength, of the model. Please comment.

P1809, L3: conditions as warm as -> conditions no warmer that

P1809, L8: 'But this is a limitation shared by many other more complex models of the Antarctic Ice Sheet.' This is a very strong statement, please quantify a bit more, or refer to some paper that has analysed the ability of the more complex models to predict or fail to predict WAIS collapse

Appendix

P1803, L3: There are no detailed and reliable time series for sea level around Antarctica so I fall back upon global mean sea level estimates for SL - > last two words superfluous.

P1809, L27 'For this task I take a very simple approach that however is in tune with the scope of the present paper and model' -> For this task I take a simple approach in tune with the scope of the present paper and model

P1810, L19 Use brackets around 1. and 2. for '1. referenced to the 1961–1990 period by referencing to the mean temperature anomaly in the period 500–1500BP from Mann et al. (2008) and 2. divided by

P1811, L2: 'For this I used the relation T = $-$51.5+0.0802 [CH4(ppb)] from a linear regression of referenced Greenland temperature on Antarctic methane for the period 150–122 400BP.' Do you have a reference or justification for this?

Interactive comment on Geosci. Model Dev. Discuss., 7, 1791, 2014.