

Interactive comment on “Present and future variations in Antarctic firn air content” by S. R. M. Ligtenberg et al.

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This modeling study aims at evaluating the future changes of the firn air content (i.e. the height decrease caused by an hypothetical compaction of the firn into ice), its causes and consequences on the volume versus mass change of the Antarctic ice-sheet. This subject is very important to correctly estimate the ice-sheet mass changed with the methods using satellite altimetry/volume change and ice flux through the grounding line. The firn densification model developed in this paper is an improved version of the steady-state densification model described in a previous study (Ligtenberg et al. 2011). This clear, well-written and well-illustrated paper is a significant contribution to this question. I recommend that it is published in The Cryosphere after the following comments are addressed:

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1- The overall lack of comparison of the model outputs to observations weakens the credibility of the model and results. Such comparison could be introduced at two levels:

1-a The observations used Ligtenberg et al. 2011 for the validation of the steady-state model should be used again to validate the time-dependent model which provides different results. At least in the Section 3.1, the difference between the models should be put into perspective with the available observations.

1-b Ideally, the evolution of the time-dependent model need to be validated as well using density profile measured taken at different time during the last years or decades. If not possible or in addition, I suggest to use the model to provide recommendations on the necessary measurements accuracy required to validate the model on a short period (i.e. accessible future for a research program) . In other words, is it possible to validate the model by collecting density profiles every year over the next 5 years ?

2- As Robert Arthern, I suggest to clarify, early in the text, that the time-dependent model is a semi-empirical approach. I also suggest to test an alternative to compute the running average with a window size modulated by the local averaged accumulation and firn depth to account for the "sinking" rate of the firn, instead of the 40-year constant window.

3- A minor question: does the assumption of the density of ice (here chosen to a constant value of 910kg/m³) at depth have an influence on the results or not ? If yes, this should be addressed in the text.

Minor typo:

l12 p 422: remove the parenthesis, it is an important information l25 p 422: idem. (satellite) -> satellite l1 p435: can be become -> can become

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