Summary

This is a well-written article assessing the changes in RACMO2 surface fields over Antarctica after a major update of its atmospheric physics package. Figures, tables and legends are clear and precise. It shows that the major changes in RACMO results concern downward longwave radiative flux and the sensitive heat flux, inducing reduced negative biasses in surface snow temperature compared with the previous RACMO version. Other components of the surface energy balance remain almost unchanged, together with surface wind fields.

Contribution of the work

RACMO2 has been widely used and evaluated for polar climate, and its results are recognised by the scientific community to be very valuable, with a wide range of applications. It is thus of importance to be informed of the latest updates of the model in order to inform the community of the corrected and remaining biasses of the model and the possible consequences on the conclusions of previous studies.

However, I detected several major issues when reviewing the manuscript. These are outlined and explained below. In general, I would recommend publication after major revisions have been performed.

Major comments

1. Observation dataset (sections 2.2, 3.2 and 3.3)

[1.1] Explain why you chose these 9 AWS.

[1.2] For V10m and T2m, you can use the full READER dataset. It is more representative of the whole ice-sheet.

[1.3] For the radiative fluxes, is there no other AWS data available elsewhere in Antarctica ?

[1.4] Your analysis on AWS 4, 5, 6 and 9 is interesting as it allows to better understand the biasses in function of the local settings. However, in section 3.2 and 3.3, you mix the interpretation of biasses for all AWS with those of the 4 AWS, which can be confusing.

For example :

- in section 3.2, (p3239,l6-8) : «This improvement occurs year-round for the AWSs except for AWS 4, where the representation was already good due to the overestimated wind speed.» > We don't know if «except» concerns only AWS 4, 5 and 9 or all the AWSs

- in section 3.3, (p3240,l8), I guess that «all site» should be changed by «the 4 sites» (?)

Please separate more clearly the conclusions obtained by analysing the 4 AWSs from the conclusions obtained by analysing the whole dataset.

2. Organisation of the results (section 3)

As model updates are on atmospheric physics, it would be more logical to:

(i) present the atmospheric changes between the new and old version, without comparison with observation (cloud cover, downward radiative fluxes, temperature, wind, humidity, precipitation), as for fig. 9

(ii) present their impact on the modelled surface climate, including the comparison with observations : surface energy balance (surface radiative fluxes, surface turbulent fluxes), surface temperature, and SMB (missing in this version of the manuscript).

Concerning the atmospheric changes :

[2.1] You present LWnet and SWnet, but as changes are in the atmospheric physics and not in the snow physics, it would be more interesting to see the changes in downward radiative fluxes instead of net radiative fluxes.

Concerning the surface climate :

[2.2] As you show that surface wind is almost unchanged with the update, you can remove the comparison with observations for this field and concentrate on the fields which are significantly affected by the update.

[2.3] I insist that you should present the impact of the update on the simulated SMB, since it is one of the major application of the RACMO2 model. You say in section 2.1, (p3234,l26-28) that the update may have an impact on precipitation but you don't show results related to this statement.

[2.4] You say (p3236,l12) that LWd and SWd are measured. It would be more interesting to compare these fields than the net radiative fluxes with observations (see comment [2.1]).

Minor comments

a. Introduction (section 1)

a1. Put more emphasis on applications of the RACMO2 model for Antarctica by adding more references showing that RACMO2 is a reference model to study the Antarctic climate. This will highlight the interest of presenting the new updates and their consequences on RACMO2 results (which are the fields of interest in RACMO studies ? Can the conclusion of previous studies be modified by the update ?)

a2. First sentence of the introduction : How can we «improve our understanding of atmospheric processes» in «areas where few observational data are available» ? Does it mean that we improve our understanding based only on what models predict ? What can be our confidence on model outputs without a thorough model evaluation ?

b. Figures

b1. I suggest to show biasses (model-obs.) as a function of the surface elevation (or better but a little more complicated : of the distance from the cost) for an easier interpretation of the plots (Fig 3, 5 and 7)

b2. Section 3.3, (p3240,l12-20) : the explanation is difficult to follow. It will certainly be clearer with the figures changed as suggested above.

c. Statistics

c1. Add at least the rmse, as the correlation coefficient r does not indicate which of the newer or elder modelled data are closer to the observed data.

c2. Use r squared in place of r, as r2 can be interpreted as the proportion of response variation explained by the regressor in the linear model.

c3. Add the number of points used in the statistic in the figures.

c4. Add statistical tests to assess whether the differences in mean biasses are significant or not.

d. (p3233, l14) : tem perature > temperature

e. (p3233) : change the title : «2.1 RACMO2» by something more explicit like «2.1 RACMO2 physics update»

f. (p3235, l2 and l6) : «short-» > «shortwave»

g. (p3238) : Title «Simulation of wind speed ...» > «Simulation of surface wind speed ...»

h. (p3241,l4-14) : explain at the beginning of the paragraph why you show the potential temperature

(«to compensate for elevation differences ...»).

i. (p3243,l3-4) , Fig10 : «averaged over the period 2007–2010 (representative for the entire simulation)» > Why don't you average over the full period (1979-2010) ?

j. (p3242,l15-18) : Are the changes in SWdown and SWup significant between the 2 versions of RACMO at the scale of the ice-sheet ?