Geoscientific Model Development Discussions

Geosci. Model Dev. Discuss., referee comment RC2
https://doi.org/10.5194/gmd-2021-231-RC2, 2021

Comment on gmd-2021-231

Anonymous Referee #2

Referee comment on "Introducing CRYOWRF v1.0: multiscale atmospheric flow simulations with advanced snow cover modelling" by Varun Sharma et al., Geosci. Model Dev. Discuss., https://doi.org/10.5194/gmd-2021-231-RC2, 2021

General Comments:

Blowing snow and the associated sublimation for snow redistribution is an important process to incorporate in polar atmospheric models especially those that can capture fine spatial scales through consideration of nonhydrostatic dynamics, as done here with the WRF model. This represents an advance on existing capabilities with the hydrostatic models RACMO and MAR. One can only appreciate the impacts of blowing snow and the associated sublimation by doing runs with and without the blowing snow processes active, not done here.

This is an interesting manuscript on coupled atmosphere-snow cover modeling and its impacts that deserves to be published after some improvements. The “land surface” model implemented into WRF is SNOWPACK. The blowing snow scheme implemented is similar to Dery and Yau (2002) with differing treatments for terminal fall velocities of snow particles and thresholds for onset of snow transport from the surface.

Specific Comments:

- No mention is made of Polar WRF that has pioneered the use of WRF in the polar regions, adapted and added physics treatments, and provided guidance on the parameterization performance in high latitudes, underlying the Vignon et al. (2020) manuscript that is featured prominently here. A place to start is here: http://polarmet.osu.edu/PWRF/
- The big differences between CROWRF and WRF with NoahMP at South Pole (Fig. 6) are the large warm biases of the latter during the warmer part of the year and the much higher relative humidity values during winter. Any explanations? These biases are much larger than previous implementations of WRF/Polar WRF over the Antarctic: doi:

10.1029/2012JD018139. Moisture content of the air is challenging to measure at the low air temperatures at South Pole in winter. Are you certain that the higher relative humidity values simulated by WRF with NoahMP are not more correct? It is often thought that the air there is close to or exceeds saturation with respect to ice. Are your relative humidity values with respect to ice or liquid water? Surface pressure, 10-m wind speed, and 10-m wind diection are much closer, and consistent with previous Antarctic WRF studies.

- The surface mass balance components shown in Fig. 7 look in error to me. If the mean values listed are averages for all of Antarctica including the ice shelves then precipitation and surface mass balance are only 2/3rds the values given by van Wessem et al. (2018) for long-term averages that should approximate the values here. Does the sublimation refer to total values, i.e., blowing snow plus surface sublimation? Do you really think that large melting and refreezing is widespread over the two large ice shelves (up to 200 kg/m*m/yr)? These are cold even in summer. Melting does occur in summer but is limited on average. https://doi.org/10.1002/2013GL058138
- Incorporate this manuscript into your paper: https://doi.org/10.1029/2020JD033936
- Line 142: Add “atmospheric” before “stability corrections”.
- Line 433: Provide details about the vertical levels used in the model: How many? Vertical distribution? What is the lowest level? What is the highest level?
- Line 479: “Sublimation”.
- Line 549: “as well as an acceleration”. Don’t understand what is being said here.
- Line 576: “replace “detained” by “detailed”.
- Fig. 12 caption: Make clear that the contours are potential temperature.