

COMMENTARY  
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Coupled models may help clarify the drivers of observed icesheet melt season shift: comments on Liang et al. (2023)

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With a new machine learning based algorithm deriving melt extent from satellite data, Liang et al. (2023) have shown that the timing of the melt season over Antarctica has shifted over 1978-2020. Both later onset and end of the melt season result from complex interactions between the general circulation around Antarctica and sea ice cover impacting heat exchanges between atmosphere and ocean around the ice sheet. The authors have also demonstrated that this delay in the melt season with respect to the maximum of solar radiation has decreased the amount of solar radiation absorbed by the snowpack. It has therefore dampened the production of meltwater over the recent years. While the authors have clearly identified the drivers of this shift, there are a lot of interactions and positive feedbacks in climatology. By using observations only (satellite or reanalysis as used in Liang et al. (2023)), it is impossible to precisely estimate or isolate the role of each climate component in this shift as changes in one component could trigger or enhance changes in other components.

One solution to perform such estimate would be to use climate models and, in particular, polar regional climate models coupled with a regional ocean model (Huot et al., 2022) explicitly simulating the different processes driving the ice sheet – atmosphere – sea ice – open ocean interactions around Antarctica. With this kind of coupled tool, we are able to isolate one process and to estimate its direct and indirect impacts on the other components. By using fixed oceanic conditions (from a climatology) in a regional climate model, we could for example estimate the precise role of the recent general circulation changes driven by the Southern Annual Mode (SAM) variability in the timing of the melt season. Identically, by using atmospheric circulation from a typical year at the lateral boundaries of the regional climate model coupled with an ocean model (forced by the observed ocean at its lateral boundaries), we are able to estimate the impact of the recent sea ice extent change on heat exchanges between ocean and atmosphere around the ice sheet. Moreover, if we use typical annual cycle at the lateral boundaries of the ocean model, we should be also able to estimate the impact of the recent Antarctic Ocean warming in these changes. Finally, it will be interesting to check, once both atmospheric and oceanic models fully coupled, if the coupled model is able to simulate the shift of the melt season observed by Liang et al. (2023).

As this melt season shift has recently dampened the production of meltwater, it could therefore have a significant impact on the projected future melt increase. Such changes in the timing of the melt season are currently not suggested in the available future projections. Longer melt seasons are projected only, in particular over the ice shelves which will be more affected by the surface melt increase than by the heavier snowfall accumulation due to rising temperatures (Kittel et al., 2021, 2022). Therefore, the important role of the atmosphere-ocean interactions highlighted in Liang et al. (2023) shows the necessity to have coupled models (atmosphere – ice sheet – ocean) to better estimate future climate change of the Antarctica ice sheet stability. A model, resolving one component only with limited interactions with other ones, could miss important feedbacks enhancing or mitigating future changes. Such useful coupled models, difficult to implement and computer time expensive once run at high resolution, are for example planned to be developed in the framework of the ongoing European H2020 PolarRES (<https://polarres.eu/>) and CriceS (<https://www.crices-h2020.eu>) projects aiming to study these interactions over Antarctica.

Reference:

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