

Review of 'Daglacial Evolution of regional Antarctic climate and Southern Ocean conditions in transient climate simulations', by Lowry et al., Climate of the Past

This manuscript represents a useful contribution to our descriptive understanding of the extent to which transient paleo-simulations of Antarctic climate agree with paleoclimate proxy data for the surface of the Antarctic continent and the Southern Ocean. It provides quite a thorough comparison of two models and proxy data, showing where there is agreement and where there is not. The authors are not able to firmly conclude much about the driving mechanisms behind these discrepancies, apart from a clear impact of topography, and a likely feedback between sea ice and temperature. In general, I would have liked to see a little more discussion of ocean processes that could result in model bias.

Also, the authors mention correctly that subsurface ocean warmth can affect basal ice melt, and that subsurface temperature can evolve quite differently from SST. I would suggest that the authors look at each record of ocean temperature to check what depth it likely records (e.g. foram Mg/Ca ratios record the depth that the forams live, not necessarily SST), and check whether any new information can be gleaned in this way.

The figures and captions need some clarifying in order to be of real use to the reader. See suggestions and comments below. I would add to each map labels for latitude, and proxy record location labels for ease when referring to the figures from the text.

In my opinion, it would also help the paper if the authors could speculate more about what might constitute useful future steps, apart from simply running more simulations. For example, why stick to records of surface conditions? There are a few (very few) estimates of wind changes, which could be compared to the models in a similar way to sea ice extent. Also, there are growing numbers of deep-sea records which tell us about Southern Ocean circulation (e.g. Rae et al 2018, Nature and refs therein). While not appropriate for analysis/discussion in this study, the authors could round off this first significant attempt at Antarctic model-data comparison nicely by some more adventurous thinking about future steps.

Minor points

Fig 2: Caption – What do the authors consider a 'match', for putting black outlines round the filled points? Is this when the observations fit within the seasonal range? I think this becomes more clear in the text, but would be useful to state clearly here.

Figs 2, 3 and 6: Consider labelling cores on map. They are already labelled in Fig 1, but it would help not to have to skip back and forth while also referring to the text, especially when we get to Fig 6.

Figs 2 and 3, 6: What are the temperature changes documented in the time series panel relative to? I am not clear as to what is being compared here. Is it absolute temperature? If it is relative to the preindustrial era (as explained for Fig. 5 in response to a previous review comment), this needs stating in all relevant figure captions. Please clarify in the caption.

Fig 3: Does the coloured shading round the time series represent seasonal range, as for the temperature figures?

Line 98: Briefly outline what T21/T31 means (for non-modelers)

Line 105: Discuss the suitability of freshwater forcings based on McManus (there are more recent studies out there compiling a range of thorium/protactinium isotope data) and Greenland temperature. It would be useful to have some discussion (if brief) here, so those not in the know don't have to refer in detail back to the other papers. The following section describes how much meltwater is added to the model at different times, but doesn't go into why. Consider briefly adding this info.

Line 200: I would add the additional caveat to marine proxies that, because they are based on different species with differing depth habitats (which may change through time), they should be considered more carefully than simply being SST recorders. Have the authors thought in detail about this issue, or looked specifically at the records and species present to take depth into account?

Line 249: Can the authors comment on why the AP looks different to the other sites in this regard? i.e. DGns looks to have a large AP ACR signal in this case, despite having small change at other sites.

Line 260: The discussion of coastal precip anomalies based on model resolution seems ok, but what about the cause of the low precipitation at the pole?

Section 3.3: Please include many more references to specific figure panels throughout this discussion of scaling relationships, to help guide to reader.

Paragraph beginning Line 341: See point above regarding what the changes in temperature plotted in the time series are relative to. It is very difficult for the reader to see that four of the six sites show agreement to within 1 °C, when the records seem to be on different scales. Or are we looking at absolute temperatures for these figures?

Line 392: Rather than having the EAIS offshore sector in a sperate sentence, I would rather think it also is an exception.

Line 413: Should say Fig. 2 a,b

Section beginning line 559: I would add here some brief discussion of how coarse resolution climate models simulate the ACC and overturning, and changes in these when eddies are parameterised, versus changes when eddies are explicitly simulated. One important feature of model bias may be an overturning system that is too-sensitive to wind forcing (Farneti and Delworth 2010), which could feasibly lead to unrealistic changes in ocean temperature or frontal position. In my opinion, this is a source of likely very significant model bias, and should be discussed at least briefly in this paper. I would also note that many of the marine proxy records come from locations close to modern day major ocean frontal systems. Shifts in these systems across core locations would result in strong changes in SST/subsurface temperature, and so may lead to discrepancies between models and proxies, and to the regional differences in proxy records discussed. Given the data discussed here, it seems necessary that these ocean effects should be discussed.