Reviewer Comment-blue shade
Manuscript Changes-bold

Short comment response to reviewer:
We thank the reviewer for the helpful and detailed comments on our manuscript. Here we respond to a couple of questions the reviewer asked and point out an error in the discussion paper. Once the open discussion is closed we will upload a full response to all reviewer comments. The reviewer raised three main points that we respond to below.

Discussion of major points:
Reviewer point 1) - pg. 2651, lines 1-7: It would be interesting to briefly describe significant changes in the predicted Eocene aerosols from modern, if any. Could this be one cause of the different cloud responses (point 2 above)?

Response: CAM4 does not include a representation of the aerosol indirect effect on clouds (Gent et al., 2011), consequently there is no impact on low cloud fraction due to the differences between the Pre-Industrial and Eocene aerosol forcing datasets (Figure 1). The lines of text referenced by the reviewer were vague on this point and we apologize for this, we will clarify the role of aerosols in CAM4 simulations in a revised text.

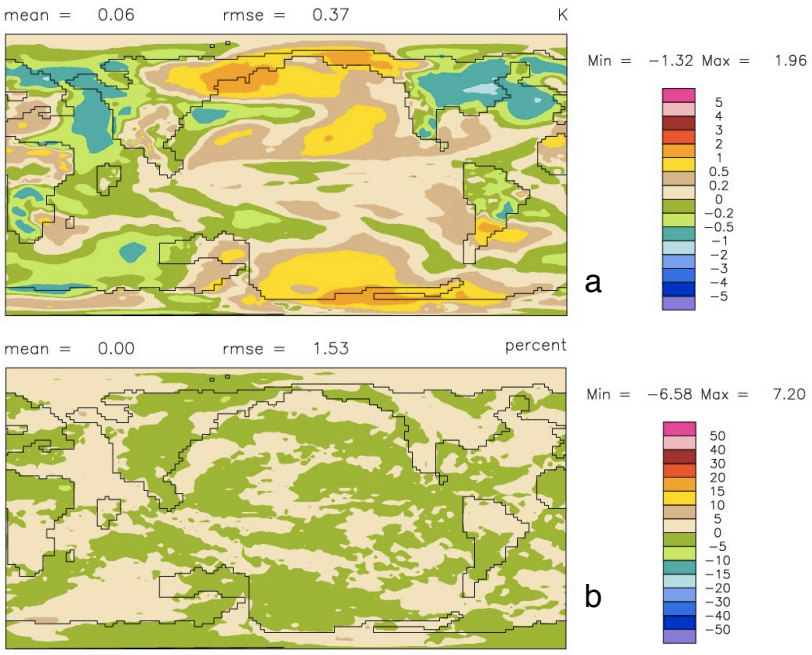

Fig 1. a) Temperature (K) and b) low cloud fraction (%) anomalies for the Eocene 1120 ppmv simulation with PI prescribed aerosol forcing file compared to Eocene 1120 ppmv simulation with CAM4 BAM derived aerosol forcing file.

Reviewer point 2) In a few places, the fact that Modern global temperature is warmer than the Eocene at the same CO2 level is invoked to explain differences in behavior (involving snow cover on Antarctic land, pg, 2658, line 7; and "less sea ice", pg. 2659, line 14). But some of the Eocene cases are colder than some of the Modern, as shown in Fig. 4, so these arguments may not hold across the board. or instance, the Eocene at 560 ppm is colder than Modern at 1120 ppm. Does this invalidate the arguments?

Response: The interior of Antarctica in Eocene unglaciated simulation at 560 ppm is warmer during the austral summer leading to reduced snowfall, sea ice, and albedo even though the MAT is lower compared to the unglaciated Modern 1120 simulation. The Modern 560 and 1120 unglaciated simulations remains below freezing during all seasons over Antarctica leading to increased snowfall, sea-ice, and albedo (Figure 2 a, b).

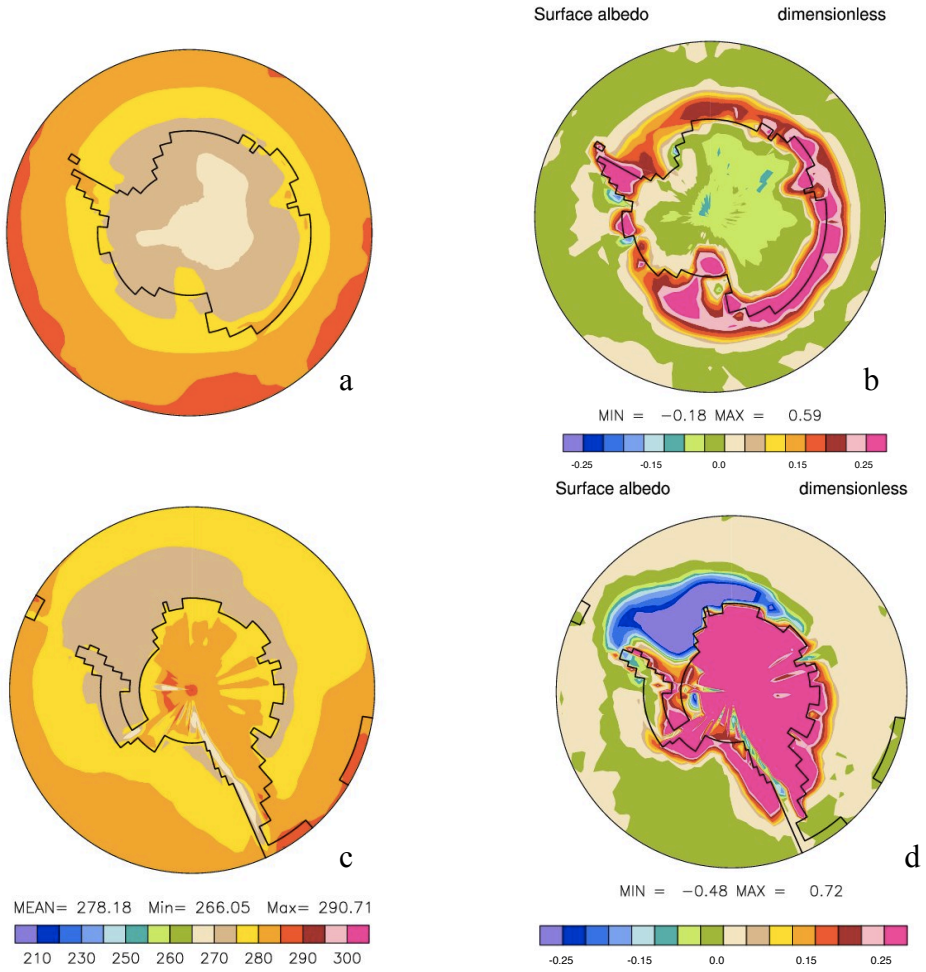

Fig 2. Austral summer temperatures (December, January, February) for the unglaciated Modern simulation at 1120 ppmv CO_2 (a), albedo anomaly (%) for glaciated Modern minus unglaciated modern at 1120 ppmv (b). Austral summer temperatures unglaciated Eocene simulation at 560 ppmv CO_2 (c), albedo anomaly (%) for glaciated Eocene minus unglaciated Eocene at 560 ppmv CO_2 (d)

Reviewer point 3) The text on pg. 2661, lines 23-28 is hard to follow, concerning low cloud changes over Antarctica vs. other regions. I suggest adding a figure showing zonal means of low clouds vs. latitude, for modern and Eocene, with and without ice sheet.

Response: There was an error in this sentence which may have lead to confusion and we apologize for this. The globally weighted quantity for low cloud fraction is averaged from 60˚S to 90˚N, which currently in the text is listed as 60˚S to 90˚S (The data points in figure 8 are unaffected by this error). There are negative cloud feedbacks outside the AIS forcing region in the Eocene and positive cloud feedbacks outside the AIS region in Modern (Figure 8-discussion paper). Below we present the suggested figure from the reviewer (Figure 3); we believe the zonal mean plots make it harder to see the opposite cloud signal and we prefer to keep figure 8 b,c as globally averaged quantities from 60˚S to 90˚N.

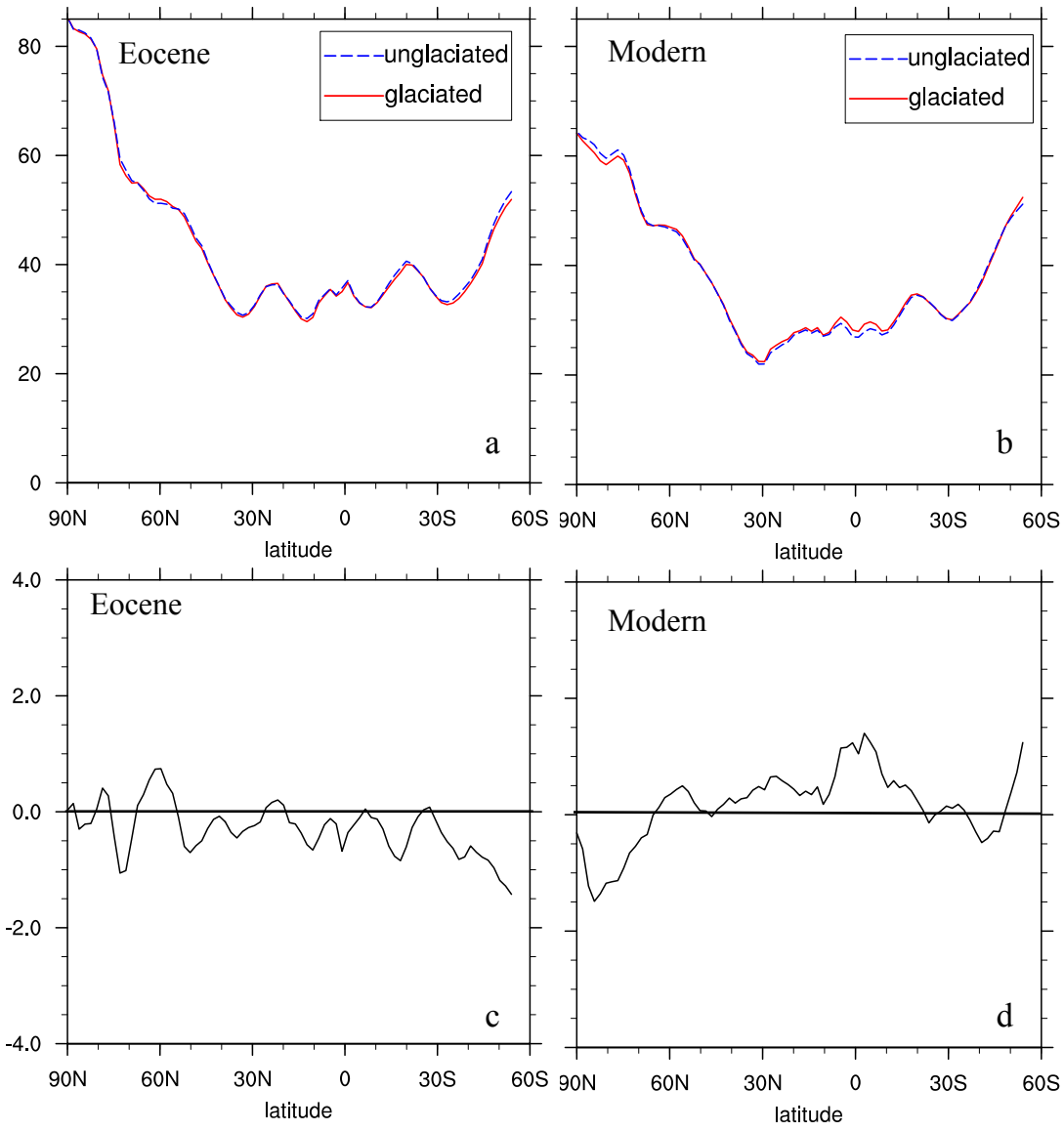

Fig 3. a) Low cloud fraction (%) for Eocene unglaciated case dotted blue line, glaciated case (alpha+oro) solid red line at 1120 ppm CO_2, b) low cloud fraction (%) for Modern unglaciated case dotted blue line, glaciated case (alpha+oro) solid red line at 1120 ppm CO_2, c) anomaly Eocene for glaciated minus unglaciated, d) anomaly for Modern for glaciated minus unglaciated.

Technical Points:
Reviewer technical comment 1: Make clear, especially in figure captions, that "glaciated vs. unglaciated" generally implies "albedo + orographic" forcing as in Eq. (2).

The revised manuscript will add clarifications to Figure 3 and Figure 4 making it clear what type of changes were done to the AIS.

Changes to Figure Caption 3 and 4 in text:

Fig. Caption 3
Surface albedos (%) for Modern and Eocene glaciated (α+oro) and unglaciated simulations averaged over the austral summer at 2240ppm CO2

Fig. Caption 4
The unshaded red colored circles represent the Eocene unglaciated simulations, while the filled red circles represent Eocene glaciated (α+oro) simulations. The unshaded blue circles represent the Modern unglaciated simulations, while the filled blue circles represent Modern glaciated (α+oro) simulations.

Reviewer technical comment 2: Suggested changes: pg. 2653, line 5; and Fig. 2 caption: "based off of" to "based on". pg. 2654, line 4: "a couple different" to "two different".
These suggested changes were incorporated into the revised manuscript

References:
Gent, Peter R., and Coauthors, 2011: The Community Climate System Model Version 4. *J. Climate*, **24**, 4973–4991. doi: http://dx.doi.org/10.1175/2011JCLI4083.1