We thank Dr. Louise Sime for her constructive comments on the manuscript. We reply to the major scientific concerns that the reviewer has raised. We assure that the minor editorial changes will be duly incorporated in the revised manuscript which will also include revisions of the style, explanations and references as suggested by the reviewer.

Abstract p1320, l10: "The experiments were designed in order to analyze the temporal and spatial variations of the oxygen isotopic composition of precipitation ($^{18}O_{precip}$) in response to individual climate factors."- are 'temporal' variations in isotopes analyzed? If not modify the sentence.

In our work we concentrate on the spatial variations of the global distribution of isotopes. We agree that the sentence is misleading in this context, and it will be rewritten in the revised manuscript.

Why GHG changes on own have little impact

The lack of an ocean component in our experiments is expected to reduce the impact of the GHG changes on the climate. A reduced atmospheric CO_2 concentration directly affects the amount of outgoing longwave radiation, and the positive feedback of the SST to the reduced atmospheric CO_2 concentration would have cooled the ocean surface (Manabe and Broccoli, 1985; Kim, 2004).

Regional cooling in the topography experiment

The temperature decreases with altitude, with a lapse rate of approximately 6.5 °C km^{-1}, which leads to a local cooling in the topography experiment. Furthermore, the change in orography has a predominant impact on the atmospheric circulation, causing splitting of the zonal flow and deviation of the flow patterns, which can affect the local temperature and precipitation patterns (Manabe and Broccoli, 1985; Broccoli, 2000). The changes in the atmospheric circulation patterns in the topography experiment were briefly discussed in Section 6.3 (page 1337).

Analysis of the seasonal distribution of isotopes

Atmospheric general circulation features such as monsoons or the seasonal migration of ITCZ are reflected in the distribution of $\delta^{18}O_{precip}$. The isotopic composition of summer precipitation is much lighter than of winter precipitation, which leads to the summer time depletion of the isotopes with the amount of precipitation, especially in the tropics (seasonality and amount effect of isotopes, Dansgaard, 1964). We chose to analyze the seasonal distribution to better understand the spatial variations of the isotopes with the seasons, and how the seasonal distributions in individual experiments differed from the control run. The enrichment of isotopes simulated in the summer season of the LGM-combined experiment was in agreement with previous studies indicating that tropical climate was probably much drier and the southwest summer monsoon weaker during the LGM (Manabe and Broccoli, 1985; Kutzbach and Guetter, 1986). Furthermore, in our study, we were able to address the seasonality of isotopes in the precipitation in the polar regions, which is important for the use of isotopes as a proxy for temperature for past climates.

Observational data and model results

As suggested by the reviewer, we used the results of our pre-industrial simulation to compare the spatial gradient of $\delta^{18}O_{precip}$ to surface temperature over Antarctica with the observational surface Antarctic snow composition data (Masson-Delmotte et al., 2008), and the present-day model simulations by Sime et al. (2008). For this, we regridded the annual mean results onto a 50 km equal area grid (using only the continental grid cells as in Sime et al., 2008). The spatial relationships of the $\delta^{18}O_{precip}$ to the surface temperature were calculated for the entire Antarctic, East Antarctic and the West Antarctic regions. The named regions were defined as per Sime et al. (2008). We obtained a slope of 0.51 ‰ $°C^{-1}$ over the entire continent, where the $\delta^{18}O$ gradient obtained by Masson-Delmotte et al. (2008) was 0.80 ‰ $°C^{-1}$. The spatial gradient estimated for our East Antarctic results was 0.55 ‰ $°C^{-1}$, which is lower than the slope obtained from observations (Masson-Delmotte et al., 2008) and the modeled present day slope of 0.73 ‰ $°C^{-1}$ by Sime et al. (2008). The slope for the West Antarctic region was estimated as 0.59 ‰ $°C^{-1}$, where Sime et al. (2008) obtain a value of 1.28 ‰ $°C^{-1}$. The reduced slope estimated in our result points to a lesser depletion of isotopes in precipitation with temperature in the model over the continent. The failure of some general circulation models in simulating the isotopic depletion inland of Antarctica has been reported before in the study by Masson-Delmotte et al. (2008). The underestimation of isotopic depletion over Antarctica is suggested to be related to the representation of the cloud microphysics in these models and their representation of the transport of moisture inland (Masson-Delmotte et al., 2008). The warm bias in our model over Antarctica could also be a contributing factor to the lack of depletion. In a revised version of the manuscript, we plan to include these results in Section 5.7 to put the comparison of the model-observational data into perspective.

References

Broccoli, A. J.: Tropical cooling at the Last Glacial Maximum: An atmosphere-mixed layer ocean model simulation, Journal of Climate, 13(5), 951-976, 2000.

Dansgaard, W.: Stable isotopes in precipitation, Tellus, 16, 436–68, 1964.

Kim, S.J.: The effect of atmospheric CO2 and ice sheet topography on LGM climate, Clim. Dyn., 22:639–651, DOI 10.1007/s00382-004-0412-2, 2004.

Kutzbach, J. E. and Guetter, P. J.: The influence of changing orbital parameters and surface boundary conditions on climate simulations for the past 18 000 years, J. Atmos. Sci., 43, 1726–1759, 1986.

Manabe, S. and Broccoli, A. J.: A comparison of climate model sensitivity with data from the last glacial maximum, *J. Atmos. Sci.*, 42, 2643-2651, 1985.

Masson-Delmotte, V., Hou, S., Ekaykin, A., Jouzel, J., Aristarain, A., Bernardo, R. T., Bromwhich, D., Cattani, O., Delmotte, M., Falourd, S., Frezzotti, M., Gall ´ee, H., Genoni, L., Isaksson, E., Landais, A., Helsen, M., Hoff mann, G., Lopez, J., Morgan, V., Motoyama, H., Noone, D., Oerter, H., Petit, J. R., Royer, A., Uemura, R., Schmidt, G. A., Schlosser, E., Simoes, J. C., Steig, E., Stenni, B., Stievenard, M., van den Broeke, M., Van de Wal, R., Van den Berg, W.-J., Vimeux, F., and White, J. W. C.: A review of Antarctic surface snow isotopic composition: observations, atmospheric circulation and isotopic modelling, J. Climate, 21, 3359–3387, 2008.

Sime, L. C., Tindall, J. C., Wolff, E. W., Connolley, W. and Valdes, P.J.: Antarctic isotopic thermometer during a CO_2 forced warming Journal of Geophysical Research, 113, (D24), 10.1029/2008JD010395, 2008.