Supplementary Material

The ability of GENESIS to simulate the modern-day distribution of stable isotope compositions ($\delta^{18}O$ and δD) in meteoric water has been reported in previous studies (Mathieu et al., 2002; Zhou et al., 2008; Poulsen et al., 2010). These studies conclude that GENESIS successfully captures the large-scale climate-isotope relationships including elevation-isotope relationships (altitude effect). Further documentation of the stable isotope compositions simulated by GENESIS is provided here (Figs. DR1 and DR2).

In general, GENESIS does a reasonable job of simulating high-elevation precipitation $\delta^{18}O$ (Figs. DR1 and DR2) over the North American Rockies, South American Andes, and Tibetan Plateau. As summarized in Blisniuk and Stern (2005), typical precipitation $\delta^{18}O$ values over these regions are -12 to -16‰ (Sierra Nevada), -9 to -17‰ (central Andes), and -20‰ (southern Tibetan Plateau). Over these same regions, GENESIS simulates values of approximately -13‰ (Sierra Nevada), -14‰ (central Andes), and -22‰ (southern Tibetan Plateau) (Fig. DR2, dashed line). As discussed in the manuscript, the use of a slab-ocean model in GENESIS results in slightly lower precipitation $\delta^{18}O$ over high elevations (Fig. DR2, solid line).

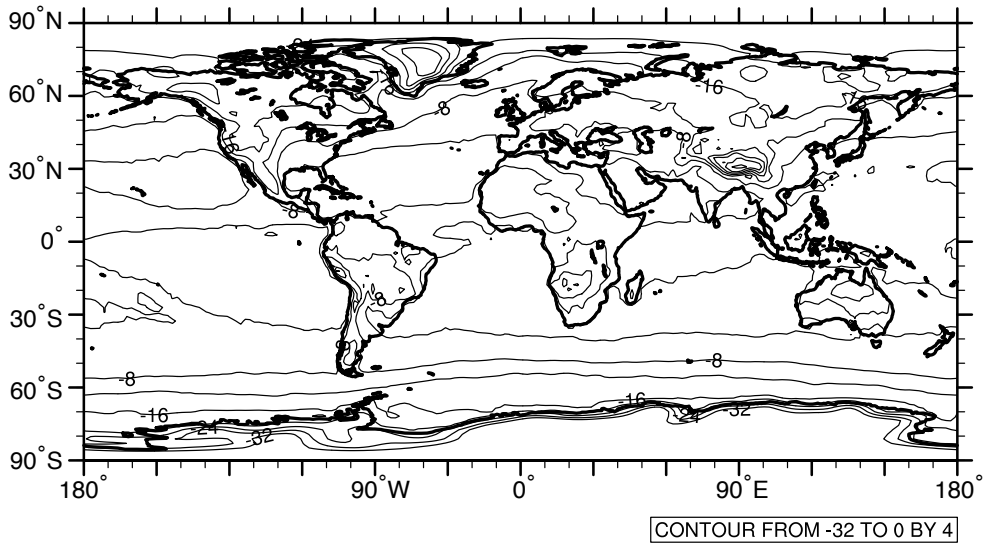
References

Blisniuk, P.M. and Stern, L.A., 2005, Stable isotope paleoaltimetry: a critical review: American Journal of Science, v. 305, p. 1033-1074.

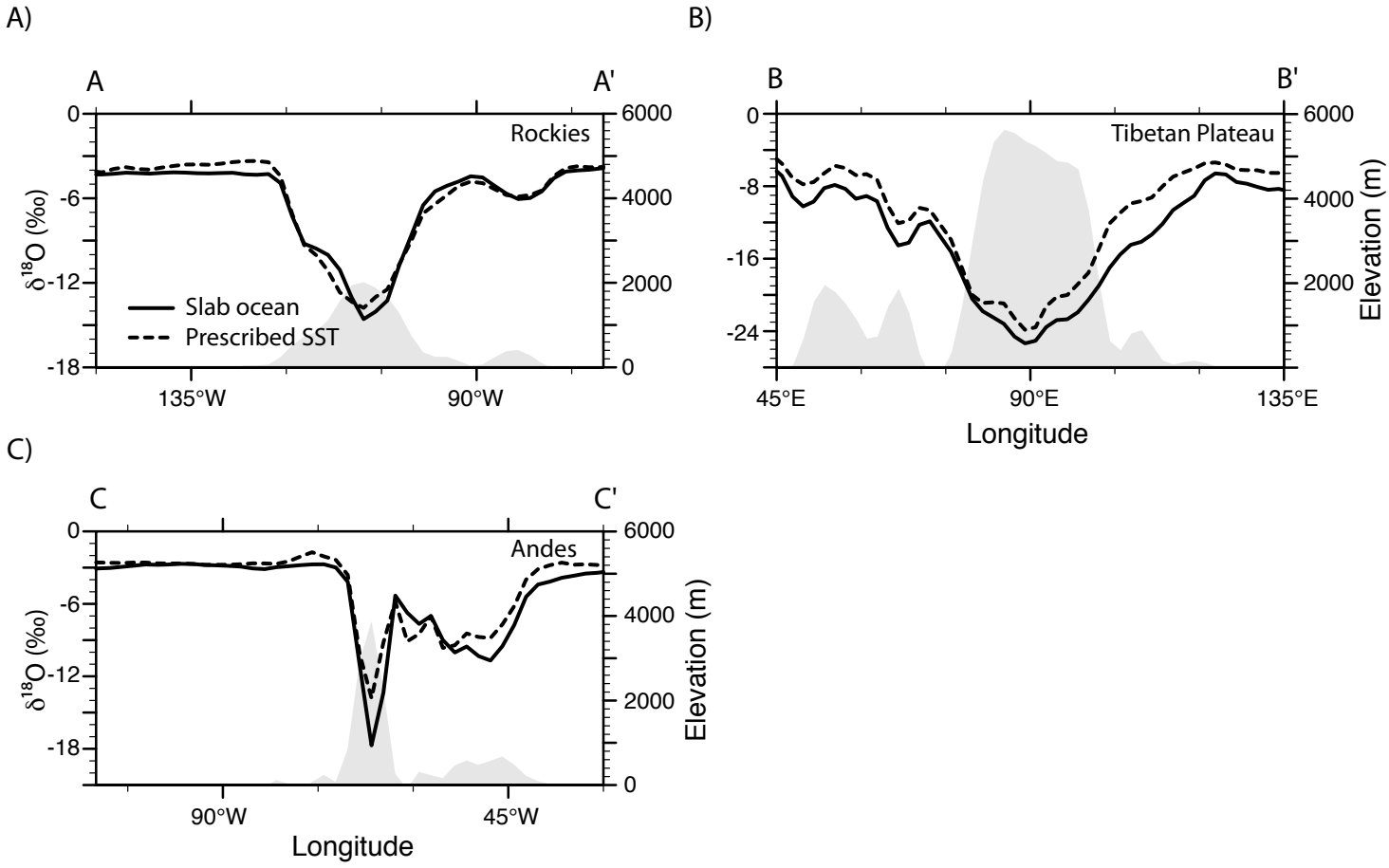
Mathieu, R.D., Pollard, D., Cole, J.E., White, J.W.C, Webb, R.S., and Thompson, S.L., 2002, Simulation of stable water isotope variations by the GENESIS GCM for modern conditions: Journal of Geophysical Research, v. 107 (D4), p. 2-1 to 2-18.

Poulsen, C.J., Ehlers, T., and Insel, N., 2010, Onset of convective rainfall during gradual late Miocene rise of the central Andes: Science, v. 328, p. 490-493, doi:10.1126/science.1185078.

Zhou, J., Poulsen, C.J., Pollard, D., and White, T.S., 2008, Simulation of modern and middle Cretaceous marine $\delta^{18}O$ with an ocean-atmosphere general circulation model: Paleoceanography, v. 23, PA3223, doi:10.1029/2008PA001596.



Supplemental Fig. DR1. Simulated annual amounted-weighted precipitation $\delta^{18}O_p$ (‰) for the modern climate.



Supplemental Fig. DR2. Annual amounted-weighted $\delta^{18}O_p$ (‰) predicted using prescribed sea-surface temperatures (dashed line) and a slab-ocean model (solid line). $\delta^{18}O_p$ is shown for three transects across: (A) Rocky Mountains (~35°N); (B) Tibetan Plateau (~31°N); and (C) Andean Plateau (~23°S) as in Fig. 1. The gray shading indicates the elevation. Note that the use of the slab-ocean model leads to lower $\delta^{18}O_p$ over the major orogens due to stronger subsidence.