EGU22-11955, updated on 14 Aug 2022
https://doi.org/10.5194/egusphere-egu22-11955
EGU General Assembly 2022

Last Glacial Maximum atmospheric lapse rates: a model-data study on the American Cordillera case

Masa Kageyama[1], Pierre-Henri Blard[2], Stella Bourdin[1], Julien Charreau[2], Lukas Kluft[3], Guillaume Leduc[4], and Etienne Legrain[5]

[1]Laboratoire des Sciences du Climat et de l'Environnement, IPSL, Gif-sur-Yvette Cedex, France (masa.kageyama@lsce.ipsl.fr)
[2]CRPG, Nancy, France
[3]MPI Meteorology, Hamburg, Germany
[4]CEREGE, Aix-en-Provence, France
[5]IGE, Grenoble, France

The amplitude of the Last Glacial Maximum (LGM) cooling compared to pre-industrial has long been a topic of debate, which partly arises from the fact that this cooling is spatially heterogeneous. Paleotemperature reconstructions shows that this cooling is larger on land than over the oceans, a feature which is well captured by Global Climate Models. However the amplitude of the LGM cooling at high altitudes is still not well constrained, with available data showing an important disparity from a region to another (Blard et al., 2007; Tripati et al., 2014). Here we present a new compilation of glacier-based temperature reconstructions at high elevation (> 2500 m) for the LGM, which are compared to synchronous changes of sea surface temperatures (Pacific Ocean), along the American Cordillera, from 40°S to 40°N. This new reconstruction confirms that lapse rates were steeper during the LGM in the tropics and shows that this feature relates to a drier atmosphere. To further analyse this observation, we first use the IPSL global climate model PMIP4 results (Kageyama et al., 2021), which, in agreement with the reconstructions, yields a steeper tropical lapse rate in its LGM simulation, compared with the pre-industrial one. Next, we disentangle the impacts of the lower atmospheric CO_2 concentration and of lower humidity using a single column radiative-convective equilibrium model (Kluft et al., 2019), and show the strong impact of changes in humidity in the tropical lapse rate steepening at the LGM.

References

Blard, P.-H., Lavé, J., Wagnon, P. and Bourlès, D : Persistence of full glacial conditions in the central Pacific until 15,000 years ago, Nature, **449**, 591–594, https://doi.org/10.1038/nature06142, 2007.

Tripati, A. K., Sahany, S., Pittman, D., Eagle, R. A., Neelin, J. D., Mitchell, J. L. and Beaucoufort, L.: Modern and glacial tropical snowlines controlled by sea surface temperature and atmospheric mixing, Nature Geoscience, 7, 205–209, https://doi.org/10.1038/ngeo2082, 2014.

Kageyama, M., Harrison, S. P., Kapsch, M.-L., Lofverstrom, M., Lora, J. M., Mikolajewicz, U., Sherriff-

Tadano, S., Vadsaria, T., Abe-Ouchi, A., Bouttes, N., Chandan, D., Gregoire, L. J., Ivanovic, R. F., Izumi, K., LeGrande, A. N., Lhardy, F., Lohmann, G., Morozova, P. A., Ohgaito, R., Paul, A., Peltier, W. R., Poulsen, C. J., Quiquet, A., Roche, D. M., Shi, X., Tierney, J. E., Valdes, P. J., Volodin, E., and Zhu, J.: The PMIP4 Last Glacial Maximum experiments: preliminary results and comparison with the PMIP3 simulations, Clim. Past, 17, 1065–1089, https://doi.org/10.5194/cp-17-1065-2021, 2021.

Kluft, L., Dacie, S., Buehler, S. A., Schmidt, H., & Stevens, B. (2019). Re-Examining the First Climate Models: Climate Sensitivity of a Modern Radiative–Convective Equilibrium Model, *Journal of Climate*, *32*(23), 8111-8125