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3D-climate reconstruction in the western Mediterranean during the Last Glacial Maximum: marine SST versus glacier equilibrium line altitudes

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I have compared the spatial pattern of annual average marine sea surface temperature (SST) reconstructions with glacier equilibrium line altitudes (ELAs) in the Last Glacial Maximum (LGM) in the western-central Mediterranean to trace similarities and differences. The spatial pattern in the LGM shares surprisingly many similarities with present climate, and especially with climate of the Little Ice Age. A major difference is the stronger NW-SE thermal gradient in the LGM, resulting from a cooling by up to 9 ºC in the Gulf of Lions (NW) relative to the present, and a cooling of only 2 ºC in the southern Ionian Sea, respectively. At higher elevation (snowline), however, the NW-SE thermal gradient was much less steep, showing a cooling by 9 ºC in the NW and by 6 ºC in the SE, respectively, which reflects invasion of polar air masses. The similarities of the spatial pattern appear to result from the guarding role of land-sea distribution and relief for the wind field at sea-level and at altitudes between 1 and 2.5 km. Steep lapse rates caused by relatively warm SST along the eastern margins of the western Mediterranean basin and the Ionian Sea in the LGM are probably supported by slight differences of surface-near wind trajectories, higher average wind speed in the western basin, and lower wind speed in the central basin, respectively. The steep lapse rates basically reflect southward invasion of polar air at higher elevation, which frequently did not penetrate down to the sea surface in the Ionian Sea, in contrast to the western basin including NW Africa.

A large-scale scenario for this pattern includes a higher frequency of a negative NAO index with a blocking high-pressure ridge from the Azores towards the NNE, which facilitated invasion of polar air into the western Mediterranean. The Alpine chain acted

as an obstacle to this SSW-directed polar air invasion and triggered more frequent formation of a cyclonal vortex in its rear in the Gulf of Genoa (cyclon tracks Va and Vb). In contrast to the present, Genoa cyclons of track Vb (Baltic track) seem to have been often blocked by central European high pressure, as the latter region remained dry. Thus, the southern flank of the Alps, northern Italy, and the Dinarides received relatively high amounts of precipitation, released by stationary Genoa cyclons. An ELA depression in the Gulf of Genoa suggests that vortex formation in the rear of the Alps frequently also affected the higher atmosphere and pulled down very cold air.