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The response of the Walker circulation to LGM forcing: Implications for petection in Proxies

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The response of the Walker circulation to Last Glacial Maximum (LGM) forcing is analyzed using an ensemble of six coordinated coupled climate model experiments. The tropical atmospheric overturning circulation strengthens in all models in a manner that is dictated by the response of the hydrological cycle to tropical cooling. This response is just opposite to the weakening of the tropical circulation in response to anthropogenic global warming. Analysis of the model differences shows that the ascending branch of the Walker circulation strengthens via this mechanism, but vertical motion also weakens over areas of the Maritime Continent exposed due to lower sea level. Each model exhibits a different balance between these two mechanisms, and the result is a Pacific Walker circulation response that is not robust. Further, even those models that simulate a stronger Walker circulation during the LGM do not simulate clear patterns of surface cooling, such as La NiÒa-like cooling or enhanced equatorial cooling, as proposed by previous studies. In contrast, the changes in the Walker circulation have a robust and distinctive signature on the tilt of the equatorial thermocline, as expected from zonal momentum balance. The changes in the Walker circulation also have a clear signature on the spatial pattern of the precipitation changes. A reduction of the east-west salinity contrast in the Indian Ocean is related to the precipitation changes resulting from a weakening of the Indian Walker circulation. These results indicate that proxies of thermocline depth and sea surface salinity can be used to detect actual LGM changes in the Pacific and Indian Walker circulations, respectively and help constrain the sensitivity of the Walker circulation to tropical cooling.