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Global scale energy and freshwater balance in the glacial climate

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Three Atmosphere-Ocean coupled General Circulation Model (AOGCM) simulations of the Last Glacial Maximum (LGM, 21 kyrBP: about 21,000 years before present) conducted under the protocol of the Paleoclimate Modeling Intercomparison Project Phase II (PMIP2) were analyzed from a viewpoint of large scale energy and freshwater balance. The cooled troposphere at LGM reduces the atmospheric watervapor content and decreases meridional latent heat transport over the most latitudes, but dry static energy (DSE) transport increases significantly over Northern-Hemisphere (NH) mid-latitudes synchronously with increase in meridional temperature gradient. Stationary wave over the Laurentide ice sheet contributes the enhancement of DSE transport. All the three models also produce enhanced Hadley cell in NH winter but DSE transport by mean meridional circulation rather decreases because of changes in vertical temperature structure of the tropical atmosphere. In place of it, decreases in equatorward latent heat transport contribute to increases in poleward heat transport. As a result, the atmospheric poleward heat transport increases from 0 N to 40 N at LGM with all the three models. On the other hand, the Atlantic heat transport increases in low latitudes and freshwater transport decreases in the subtropics consistently with responses in atmospheric heat and freshwater transport. It makes the North Atlantic Deep Water (NADW) relatively fresh and colder, and makes the Antarctic Bottom Water (AABW) more saline and relatively warm compared with changes in other ocean regions. An implication of these results on LGM THC response is discussed.