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Impact of greenhouse gas concentration changes on the surface energetics in the IPSL-CM4 model: regional warming patterns, land/sea warming ratio, glacial/interglacial differences

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The direct effect of greenhouse gas (GHG) changes is a warming of the atmosphere due to greater long-wave (LW) radiation absorption. Nevertheless, many other processes and feedbacks also take place which modify the whole climatic system and especially the surface energy budget, which determine the precise value of the surface temperature change.

In this study, we decompose the surface energy fluxes to determine and quantify the role of many different processes in explaining the surface temperature response to an increase in GHG forcing in a coupled Ocean-Atmosphere General Circulation Model (AOGCM), IPSL-CM4. In particular, we show that the direct feedback effect consisting of greater backward LW radiation due to greater LW emission is particularly strong as is the effect of an increase in water vapor in the atmosphere due to greater temperatures. Nevertheless, many other terms are also important. We use this decomposition to understand the role of the different processes in the polar amplification, the warming contrast between the oceans and the continents and the differences in the surface warming under interglacial (preindustrial) and glacial (Last Glacial Maximum) conditions. This decomposition could be usefull to compare the sensitivity of different AOGCMs to a GHG forcing.