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Inter-hemispheric differences in energy budget and cross-equatorial transport anomalies during the 20th Century

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The evolution of inter-hemispheric asymmetries in the energy budgets (EBs) and near-surface temperature anomalies during the 20th Century are here analyzed, as reproduced in CMIP5 simulations. Cross-equatorial energy transports (CETs) in the atmosphere and oceans, as well as inter-hemispheric temperature differences, are also considered. The analysis is conducted on two multi-model ensembles, one including only the spatially homogeneous GHG forcing evolution (GHG), another one the realistic superposition of all known evolving forcings (ALL). According to models, responses to the ongoing forcing during the 20th Century have been significantly different from what would have been the response to the GHG forcing alone. Particularly, when the GHG forcing acts, a clear inter-hemispheric asymmetry in near-surface warming emerges, whereas the EBs in the two hemispheres vary consistently with each other. This is mainly explained as a balance between increasing shortwave (SW) absorption and emerging Planck feedback on longwave (LW) radiation in both hemispheres. No significant trend in the CETs is found throughout the 20th Century. When the mix of all forcings (ALL) acts, the warming is homogeneous in the two hemispheres, whereas the energy imbalance grows much faster towards positive anomalies in the SH than in the NH. This is attributed to a larger reduction of SW absorption and an emerging Planck feedback response in the NH, whereas the latter is masked by other feedbacks in the SH. Consistently, anomalies in oceanic CETs towards the NH emerge in the second part of the 20th Century. Given that no significant correlation is found between oceanic CET anomalies and inter-hemispheric temperature differences, we argue that the former is primarily driven by energy budget asymmetries between NH and SH.