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Energetics of Climate Models: Net Energy Balance and Meridional Enthalpy Transport

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We analyze the publicly released outputs of the PCMDI/CMIP3 simulations performed by climate models (CMs) in preindustrial (PI) and Special Report on Emissions Scenarios A1B (SRESA1B) conditions. In the PI simulations, most CMs feature biases of the order of 1 W/m2 for the net global and the net atmospheric, oceanic, and land energy balances. This does not result from transient effects but depends on the imperfect closure of the energy cycle in the fluid components and on inconsistencies in the hydrological cycle. Thus, the planetary emission temperature is underestimated, which may explain the CMs' cold bias. In the PI scenario, CMs agree on the meridional atmospheric enthalpy transport's peak location (around 40°N/S), while discrepancies of $\sim$20% exist on the intensity. This is compared with the known inter-model disagreements in the representation of the cloud cover distribution. In the SRESA1B runs, the atmospheric transport's peak shifts poleward, and its intensity increases up to $\sim$10% in both hemispheres, thus contributing to polar amplification of global warming. Advances are needed for achieving a self-consistent representation of climate as a nonequilibrium thermodynamical system and for our ability to model it.