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## The Global Energy Balance as represented in CMIP6 climate models

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A plausible simulation of the global energy balance is a first-order requirement for a credible climate model. Therefore we investigate the representation of the global energy balance in the latest generation of global climate models (CMIP6). In the multi-model global mean, the magnitudes of the energy balance components of the CMIP6 models are often in better agreement with our reference estimates (Wild et al. 2015, 2019 Clim Dyn) as well as those from CERES/EBAF and NASA/NEWS than in earlier model generations (Wild 2020). However, the inter-model spread in the representation of many of the components remains substantial, often on the order of 10-20 Wm<sup>-2</sup> globally, except for the shortwave clear-sky budgets, which are now more consistently simulated by the CMIP6 models. The substantial inter-model spread in the simulated global mean latent heat fluxes in the CMIP6 models, exceeding 20% (18 Wm<sup>-2</sup>), further implies also large discrepancies in their representation of the global water balance. From a historic perspective of model development over the past decades, the largest adjustments in the magnitudes of the simulated present-day global mean energy balance components occurred in the shortwave atmospheric clear-sky absorption and the surface downward longwave radiation. Both components were gradually adjusted upwards over several model generations, on the order of 10 Wm<sup>-2</sup>, to reach 73 and 344 Wm<sup>-2</sup>, respectively in the CMIP6 multi-model means. Thereby, CMIP6 has become the first model generation that largely remediates long-standing model deficiencies related to an overestimation in surface downward shortwave and compensational underestimation in downward longwave radiation in its global multi-model mean. There are also indications for an overall improvement in the representation of the energy budgets in the CMIP6 models compared to CMIP5 on regional scales (regions considered here as defined by the NASA/NEWS project). Still substantial spreads between the energy balance components of individual CMIP6 models appear also on regional scales (Li et al. 2022).

### Related references:

Wild, M., 2020: The global energy balance as represented in CMIP6 climate models. *Clim Dyn.*, 55, 553–577

Li, D., Folini D., Wild, M., 2022: Assessment of regional energy budgets in CMIP6 models, submitted

