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The cloud-free global energy balance and cloud radiative effects

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Clear-sky fluxes in the latest generation of Global Climate Models (GCMs) from CMIP5 still vary largely particularly at the Earth's surface, covering in their global means a range of 16 and 24 Wm-2 for the surface downward clear-sky shortwave and longwave radiation, respectively. We assess these fluxes with monthly clear-sky reference climatologies obtained at more than 40 Baseline Surface Radiation Network (BSRN) sites based on Long and Ackermann (2000) and Hakuba et al. (2015). The comparison is complicated by the fact that the monthly shortwave clear-sky reference climatologies are derived from measurements under true cloud-free conditions, whereas the GCM clear-sky fluxes are calculated continuously at every timestep solely by removing the clouds, yet otherwise keeping the prevailing atmospheric composition during cloudy conditions. This induces the risk of biases in the GCMs due to the additional sampling of clear-sky fluxes calculated under atmospheric conditions representative for cloudy situations. To estimate the magnitude of these spurious biases in the monthly output from 40 CMIP5 models, we used their respective multi-century control runs, and searched therein for each month and each BSRN station the month with the lowest cloud cover. The deviations of the clear-sky fluxes in this month from their long-term means have then been used as indicators of the magnitude of the abovementioned sampling bias and as correction factors for an appropriate comparison with the BSRN climatologies, individually applied for each model and BSRN site. The overall correction is on the order of 2 Wm-2. This revises our best estimate for the global mean surface downward shortwave clear-sky radiation, previously at 249 Wm-2 inferred from the GCM clear-sky flux fields and their biases compared to the BSRN climatologies (Wild et al. 2017), now to 247 Wm-2 including this additional correction. With a global mean surface albedo of 13% and net TOA shortwave clear sky flux of 287 Wm-2 from CERES-EBAF this results in a global mean clear-sky surface and atmospheric shortwave absorption of 214 and 73 Wm-2, respectively. In comparison, the global mean shortwave absorption under all-sky conditions was estimated in Wild et al. (2015) at 80 Wm-2. The difference between the all- and clear-sky absorption represents the shortwave cloud-radiative effect on the atmospheric absorption, and is thus estimated to be 7 Wm-2. For the longwave fluxes, we obtained a best estimate for the global mean clear-sky downward flux at the surface of 314 Wm-2. Together with a surface and TOA upward longwave flux of 398 and 268 Wm-2, respectively, this leaves an atmospheric longwave divergence under clear-sky conditions of 184 Wm-2.

Wild, M., Hakuba, M., Folini, D., Schär, C., and Long, C., 2017: New estimates of the Earth Radiation Budget under cloud-free conditions and cloud radiative effects, AIP Conf. Proc., 1810, 090012; doi:10.1063/1.4975552

Wild, M., Folini, D., Hakuba, M., Schär, C., Seneviratne, S., Kato, S., Rutan, D., Ammann, C., Wood, E., and König-Langlo, G., 2015: The energy balance over land and oceans: An assessment based on direct observations and CMIP5 climate models, Climate Dynamics, 44, 3393–3429.