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The energy balance over land and oceans: An assessment based on direct observations and CMIP5 climate models

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The energy budgets over land and oceans are still afflicted with considerable uncertainties, despite their key importance for terrestrial and maritime climates. We evaluate these budgets as represented in 43 CMIP5 climate models with direct observations from both surface and space and identify substantial biases, particularly in the surface fluxes of downward solar and thermal radiation. These flux biases in the various models are then linearly related to their respective land and ocean means to infer best estimates for present day downward solar and thermal radiation over land and oceans. Over land, where most direct observations are available to constrain the surface fluxes, we obtain 184 and 306 Wm-2 for solar and thermal downward radiation, respectively. Over oceans, with weaker observational constraints, corresponding estimates are around 185 and 356 Wm-2. Considering additionally surface albedo and emissivity, we infer a surface absorbed solar and net thermal radiation of 136 and -66 Wm-2 over land, and 170 and -53 Wm-2 over oceans, respectively. The surface net radiation is thus estimated at 70 Wm-2 over land and 117 Wm-2 over oceans, which may impose additional constraints on the poorly known sensible/latent heat flux magnitudes, estimated here near 32/38 Wm-2 over land, and 16/100 Wm-2 over oceans. Estimated uncertainties are on the order of 10 and 5 Wm-2 for most surface and TOA fluxes, respectively. By combining these surface budgets with satellite-determined TOA budgets we quantify the atmospheric energy budgets as residuals (including ocean to land transports), and revisit the global mean energy balance. This study has recently been published online in Climate Dynamics.