Session: C31 Poster: W142A

The global energy balance from a surface perspective

Martin Wild [†]
[†] ETH Zurich, Switzerland
Leading author: martin.wild@env.ethz.ch

The genesis and evolution of Earth's climate is largely regulated by the global energy balance. Despite the central importance of the global energy balance for the climate system and climate change, substantial uncertainties still exist in the quantification of its different components, and their representation in climate models (e.g., Wild et al. 1998, Wild 2008). While the net radiative energy flow in and out of the climate system at the top of atmosphere (TOA) is known with considerable accuracy from new satellite programs such CERES, much less is known about the energy distribution within the climate system. Still not well established are the partitioning of solar energy absorption between the atmosphere and surface, and within the atmosphere between cloudy and cloud-free parts, as well as the determination of the thermal energy exchanges at the surface/atmosphere interface. Uncertainties in the components of the global mean surface radiation budget are therefore generally larger and less well quantified than at the TOA. Since the mid-1990s, accurate direct measurements become increasingly available from the networks of surface radiation stations, such as the Baseline Surface Radiation Network, which can serve as reference sites. This study presents our best estimates of the global mean values of the different components of the global energy balance, making use of the information contained in direct surface radiation observations in addition to satellite observations and modeling approaches. Our best estimate for the absorbed solar radiation at the surface is near 160 Wm-2, with a range of estimates compatible with surface observations covering 154 to 165 Wm-2. Combined with a best estimate of total absorbed solar radiation in the climate system (TOA absorption) from CERES EBAF (Loeb et al. 2009) of 240 Wm-2, this leaves a value around 80 Wm-2 for the absorption of solar radiation in the atmosphere. The corresponding best estimates for clear sky solar absorption are 215 Wm-2, 72 Wm-2, and 287 Wm-2 for surface, atmospheric and total (TOA) absorption, respectively (Wild et al. 2006, Loeb et al. 2009). In the thermal range, our best estimate for surface downwelling and upwelling thermal radiation is 345 Wm-2 (range of estimates compatible with surface observations covering 340 to 350 Wm-2), and -397 Wm-2 for the surface upwelling thermal radiation, resulting in a net thermal energy loss (net thermal balance) at the surface of -52 Wm-2 (Wild et al. 2001; Wild 2008). Combined with the TOA thermal emission to space from CERES EBAF of -240 Wm-2 this results in a best estimate of -188 Wm-2 for the atmospheric thermal cooling. Our best estimates for the clear sky thermal exchanges are 322 Wm-2 for the surface downwelling, -397 Wm-2 for the surface upwelling and -270 Wm-2 (from CERES EBAF) for the TOA clear sky thermal emission to space. The net radiation available at the surface for the non-radiative components of the Global Energy Balance (predominantly latent and sensible heat) sums therefore up to about 108 Wm-2. The atmospheric radiation balance is accordingly negative at -108 Wm-2, and corresponds to the energy that has to be balanced by the surface sensible and latent heat fluxes. References: Loeb, N. et al.(2009), Toward optimal closure of the Earth's top-of- atmosphere radiation budget, J. Climate 22, 748-766 Wild, M., and et al. (1998) The disposition of radiative energy in the global climate system: GCM versus observational estimates. Climate Dynamics 14, 853-869 Wild, M. et al. (2006), Evaluation of clear-sky solar fluxes in GCMs participating in AMIP and IPCC-AR4 from a surface perspective, J. Geophys. Res. 111, D01104 Wild, M et al. 2001: Downward longwave radiation in General Circulation Models. J. Climate, 14, 3227-3239 Wild, M. (2008), Shortwave and longwave surface radiation budgets in GCMs: a review based on the IPCC-AR4/CMIP3 models.