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Validation of the Global Land Data Assimilation System based on measurements of soil temperature profiles

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Soil temperature is a key parameter in the soil–vegetation–atmosphere system. It plays an important role in the land surface water and energy cycles, and has a major influence on vegetation growth and other hydrological aspects. We evaluated the accuracy of the soil temperature profiles from the Global Land Data Assimilation System (GLDAS) using nine observational networks across the world and aimed to find a reliable global soil temperature profile dataset for future hydrological and ecological studies. In general, the soil temperature profile data generated by the Noah model driven by the GLDAS forcing data (GLDAS_Noah10 and GLDAS_Noah10_v2) were found to have high skills in terms of daily, monthly, and mean seasonal variations, indicated by smaller bias and root-mean-square-error (RMSE) (both < 3 °C) and correlation coefficients larger than 0.90. Conversely, the Community Land Model (CLM) results (GLDAS_CLM10) generally showed larger bias and RMSE (both > 4°C). Further analysis showed that the overestimation by GLDAS_CLM10 was mainly caused by overestimation of the ground heat flux, determined by the thermal conductivity parameterization scheme, whereas the underestimation by GLDAS_Noah10 was due to underestimation of downward longwave radiation from the forcing data. Thus, more accurate forcing data should be required for the Noah model and an improved thermal parameterization scheme should be developed for the CLM. These approaches will improve the accuracy of simulated soil temperatures. To our knowledge, it is the first study to evaluate the GLDAS soil temperatures with comprehensive in situ observations across the world, and has a potential to facilitate an overall improvement of the GLDAS products (not only soil temperatures but also the related energy and water fluxes) as well as a refinement of the land surface parameterization used in GLDAS.