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Estimating Continental Energy Storage from CMIP5 Simulations

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The Earth's energy imbalance is a critical metric for understanding the current state of the Earth's climate system and its future evolution. Although much of the energy gained by the climate system over the last century has been stored in the oceans, the continental subsurface energy storage remains important because climate feedback processes such as soil carbon and permafrost stability depend on long-term subsurface energy storage. Here, for the first time, thirty two General Circulation Model (GCM) simulations from the fifth phase of the Coupled Model Intercomparison Project (CMIP5) were examined to assess their ability to account for the continental energy storage. The magnitude of the subsurface heat content derived from GCM simulations are consistently lower than the estimates from borehole temperature data for the second half of the 20th century. The estimates of continental heat storage from CMIP5 simulations also display a large range of variability which may be partially due to (1) the different bottom boundary depth of each GCM land surface component, limiting the subsurface heat storage, (2) the different energy exchange parameterizations between the lower atmosphere and the ground within each model, and (3) the different sensitivity of models to external forcings. Our results suggest that a deeper bottom boundary placement in the land surface component could improve the estimates of subsurface energy content within the GCM simulations.