Two New Datasets for Evaluating Simulated Water and Energy Cycle Fluxes

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Numerical analyses and reanalyses often emphasize replication of measured atmospheric variables. However, in an age of changing climate and strained water resources, accurate representation of the energy and water cycles is gaining importance. Large scale, well constrained water and energy flux datasets are needed. Here we describe two newly developed datasets that are well suited for evaluation of simulated water and energy fluxes.

The first dataset was generated by the NASA Energy and Water Cycle Study (NEWS) Climatology working group, whose initial goal was to develop "state of the global water cycle" and "state of the global energy cycle" assessments based on data from modern ground and space based observing systems and data integrating models. Several aspects made this effort unique. First, it focused on conditions during roughly the first decade of the 21st century, while previous studies have made use of earlier data records and often stopped near the turn of century. Second, it employed the most modern data products, integrating data from satellite remote sensing as well as conventional observing systems. Relatively speaking, this decade has been rich with Earth observations that are relevant to the water and energy cycles. Third, careful assessments of uncertainty in the data products, from the diverse group of data providers who composed the study team, were included with the dataset. Fourth, an optimization algorithm was used to compute the final water and energy flux estimates, utilizing the uncertainty assessments and constraining water balance on all scales: monthly, annual, continental, ocean basin, and global. Finally, the water and energy budget estimates of evapotranspiration and latent heat flux are consistent. This dataset provides a new benchmark for reanalysis evaluations and intercomparisons.

The second dataset described here comprises mean monthly evapotranspiration (ET) for large river basins, with associated uncertainty estimates. ET is difficult to measure, and different estimation techniques often produce divergent results. One option is to estimate ET as the residual of a terrestrial water budget over a river basin, with observation based precipitation, gauged runoff, and terrestrial water storage changes from the Gravity Recovery and Climate Experiment (GRACE) as inputs. While uncertainty in monthly water balance estimates of ET are often too large for those estimates to be useful, uncertainty in the mean annual cycle is small enough that it is practical for evaluating ET from reanalyses and model simulations. Here we demonstrate such an evaluation over seven major river basins (Mackenzie, Fraser, Nelson, Mississippi, Tocantins, Danube, and Ubangi). The value of the approach is evident in the two tropical river basins, one in Brazil and the other in central Africa, where the water budget technique indicates a weak seasonal cycle of ET with a defined level of uncertainty, while there remain large disparities among simulated estimates. The technique could be extended to other river basins, depending on sufficient basin size and the availability of river discharge data.

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