20th Conference on Hydrology

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Global GSWP2 Land Evaporation Estimates and their Contribution to a Global Water Cycle Assessment

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The Global Soil Wetness Project Phase 2 (GSWP2) provides global land model simulations, under a common experimental framework, at a 1°x1° resolution, spanning the years 1986-1995. From the multi-model compilation of the baseline (B0) and precipitation sensitivity (P1, P2, and P3) simulations, a collection of global land evaporation estimates is available for an integrated evaluation. In this analysis, we present these global evaporation estimates within the framework of a global water budget synthesis. To complete the global water cycle synthesis, global satellite-based, in-situ, and modeled precipitation, evaporation, and total precipitable water are used. Monthly global precipitation estimates from the Global Precipitation Climatology Project (GPCP) and the Climate Prediction Center (CPC) Merged Analysis of Precipitation (CMAP) span the years 1979 to 1999. Monthly global ocean evaporation estimates (GSSTF and HOAPS-G) are based on an SSM/I-based bulk aerodynamic calculation and span the period June 1987 to December 1999. Monthly total precipitable water (TPW) from the NASA Global Water Vapor Project (NVAP) spans the years 1988 to 1999. An additional Global Offline Land Dataset (GOLD) is used for the analysis that spans a 25-year period (1975 to 1999) that is obtained via global land model simulation forced by bias-corrected reanalysis data. The ***global budget*** analysis indicates that ***mean annual*** global precipitation (P) and evaporation (E) estimates are out of balance by approximately 5% or about 25,000 gigatons of water, and the imbalance exceeds the estimated uncertainty of global mean annual precipitation (~±1%). However, in some cases, the annual flux imbalance can be on the order of ~10% or about 50,000 gigatons of water, but the interannual global TPW variations suggest that the imbalance should be ~0.01% or about 50 gigatons of water. Further, these observationally based global precipitation and evaporation estimates show a very weak monthly and interannual variation consistency, contrary to what the global TWP results would suggest. In addition, substantial differences in the seasonality and amplitude of the annual mean cycle of global E-P estimates to the TPW observations exist. Using the GSWP2 results, the collection of land model simulations indicate a scatter in simulated mean annual global land evaporation of ~20,000 gigatons of water – or about 75% of the ***mean annual global*** water budget imbalance; this scatter is also larger than the simulated interannual variability from any of the GSWP2 models. Further, it is found that the inter-model differences in global land evaporation estimates are, relatively speaking, very insensitive to the choice of precipitation forcing, but rather, it is the model distinctions in their process-level formulation that cause the simulation scatter. It is therefore unlikely that any improvement in global land precipitation estimates will reduce the current uncertainty in global land evaporation rates. Rather, improved understanding and model formulation at the process-level is currently the most critical pathway for improvement of global land evaporation estimates, and subsequent improvements in global water cycle assessments.

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Session 1, Global water and energy cycle observations, models, and analyses
Tuesday, 31 January 2006, 1:45 PM-5:15 PM, A403

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