Land water storage from model and space, its effects on global sea level change

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The variation of continental storage may have important consequences on water ressources. We investigate here its evolution through a 56 year simulation with the Organising Carbon and Hydrology in Dynamic EcosystEms (ORCHIDEE) Land Surface Model (LSM), developed in France. To perform this study, we have built a 56 year atmospheric forcing data set for LSMs based on the NCEP/NCAR reanalysis project and a number of independent in-situ observations. The new data set has a 6-hourly time step from 1948 to 2003 and a spatial resolution of 1°x1°. The outputs of the ORCHIDEE LSM forced by the new forcing are compared to the observed discharges of the world's 10 largest rivers to estimate the combined errors of the forcing data and ORCHIDEE. The seasonal and inter-annual variations of these discharges are validated. The quality of forcing data is improved with the integration of the various observations. The precipitation correction has the most important impact on the simulated river discharges while the temperature correction has a significant effect only in high latitudes.

The outputs of the ORCHIDEE LSM, driven by the new forcing data set, are used to study land water storage. In comparing with the Gravity Recovery and Climate Experiment (GRACE) data, we show that the predicted land water storage values are quite comparable to the observations. The simulated groundwater reservoirs, recently integrated in the model, contribute of about half of seasonal variations of water storage over some large tropical basins such as the Amazon, the Congo, the Ganges, the Mekong. At continental scale, over the last half century, the model shows that no significant trends are detected but there is strong low frequency variability in the land water storage originating principally in the tropics. The contribution of land water to sea level, simulated by ORCHIDEE, is highly anti-correlated with the thermal expansion of the oceans, obtained via global ocean temperature data set. This result indicates that a warming of the oceans accelerates the water cycle and thus contributes to a reduction in the sea-level partly compensating the thermal expansion.

Keywords: land water storage, land surface model, atmospheric forcing, GRACE