Groundwater, Soil Moisture, Snow Water Equivalent, and River Water in the Seasonal Variation of Total Terrestrial Water Storage in Major River Basins

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Both the combined atmospheric-river basin water balance and the remote sensing by GRACE can estimate the variation of the total terrestrial water storage which consist the changes in ground water, soil moisture, snow water equivalent, and water in rivers, lakes, ponds, etc. What are the major components in the change of the total terrestrial water storage? One hand, the seasonal variation of the total water storage in major continental-scale river basins are estimated by the atmospheric-river basin water balance (AWB) method The global distribution of water vapor flux convergence was estimated using the ECMWF global analysis data for the period from 1986 through 1995. The 10 year mean value of the atmospheric water vapor convergence was adjusted to match with the climatological mean value of river runoff for 1961-1990. Then the seasonal changes of the total terrestrial water storage were estimated by AWB method combining the atmospheric water vapor convergence for major river basins and the runoff from the area. On the other hand, the components in the change of the total terrestrial water storage were investigated using the multi-model products forced by observed surface meteorology. Under the Global Land/Atmosphere Study (GLASS), the Phase 2 of the Global Soil Wetness Project (GSWP-2) produced the first global (excluding Antarctica) 1x1 degree Multi-Model Analysis (MMA) of land-surface variables and fluxes for the 10-year period of 19868211,1995 at the daily time scale. Thirteen land-surface models (LSMs) were driven by the best possible forcing data of the atmospheric conditions, such as precipitation, downward radiation, wind speed, air humidity and air temperature with temporal resolution of 3-hourly or higher. Water balance in major continental scale river basins were post-processed and the seasonal changes in ground water, soil moisture, snow water equivalent, and the water in river channel were analyzed using the Total Runoff Integrating Pathways (TRIP) and a simple ground water model of linear reservoirs. The seasonal changes of the total water storage in river basins estimated by both AWB method and GSWP MMA are compared, and basically they corresponded fairly well. It was found that in the case of the Amazon River basin, the storage term which appears in the runoff routing model plays a significant role in the seasonal change of the total water storage in the watershed. This result suggests that it is important to exclude the contribution of the changes of river water from the changes in the total terrestrial water storage in order to purely estimate the changes in ground water, and at the same time, this result is encouraging because it suggests that the storage term in the simple runoff routing scheme is not an imaginary term but a physically relevant variable.