

Climatological features of atmospheric and terrestrial water cycles in the three great Siberian rivers

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We examined several climatological features of atmospheric and terrestrial water cycles including river discharge, net precipitation (precipitation minus evapotranspiration) and moisture transport in the three great Siberian rivers; Lena, Yenisei and Ob. River discharge at the mouth of the river is outflow of water into the Arctic Ocean. On the other hand, net precipitation averaged over a river basin is net inflow of water from atmosphere to surface. In this study, the net precipitation is estimated by six atmospheric reanalyses (JRA25, ERA40, ERAI, MERRA, NCEP2 and CFSR) by means of atmospheric water budget method without using P and E datasets.

As expected from the terrestrial water budget, on average during 1980-2008, the amounts of net precipitation over the basins of the Lena, Ob and Yenisei Rivers were found to be comparable in magnitude to the observed river discharges at the mouths of each river. This indicates that the estimation of net precipitation on the basis of the atmospheric reanalysis is an effective way to evaluate and quantify the atmospheric and terrestrial water cycles of a large river basin. While the precipitation over the Ob River basin is largest among the three Siberian rivers, the river discharge and net precipitation of the Ob are smallest among them. The river discharge and precipitation of the Lena are smaller than that of the Yenisei, while the net precipitation over the Lena is as large as that over the Yenisei. These results indicate that the regional differences in evapotranspiration over Siberia result in those differences in river discharges and net precipitation among the Siberian rivers.

Seasonal cycles of the Lena, Yenisei and Ob River discharges show maximums in June due to river ice melting. While the precipitations over the three river basins show maximums in July, the net precipitations in that month show minimums at nearly zero flow over the Lena and Yenisei, and at large negative flow over the Ob. This indicates that the evapotranspirations in the warm season are as large as the precipitation over the Lena and Yenisei, and much larger than the precipitation over the Ob. Because these basins are covered with vast area of boreal forest, the transpiration from the forest may account for large part of the evapotranspiration and which plays an important role for the terrestrial water cycles.

During the past three decades, the annual mean river discharge of each of the three Siberian rivers is positively correlated with the net precipitation over each of the basins, respectively. While the annual mean discharge of the Lena corresponds to the net precipitation over the basin, those of the Yenisei and Ob Rivers show some differences. The correlation coefficients between the river discharge and net precipitation of the two basins are weak and amplitudes of the discharge are smaller than that of the net precipitation. We consider these differences are mainly due to the time lag between the river discharge and net precipitation. In addition, these variables do not show any significant trends during the past three decades (1980-2008).

Keywords: Siberia, Water Cycle, River Discharge, Net Precipitation, Atmospheric Reanalysis data