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Terrestrial water storage changes and the hydrological budget over Eurasian Pan-Arctic river basins from 2003-2009

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High-resolution retrievals of recent changes in the Earth's gravity field using GRACE (Gravity Recovery and Climate Experiment) offers insights into Earth system processes encompassing the atmosphere, ocean, land water hydrology, and land ice. Here, we focus on the Eurasian Pan-Arctic region, where water/ice mass fluxes and sea ice cover are rapidly changing with potentially large impacts on river discharge and ground storage of greenhouse gases. We use GRACE observations to infer the spatio-temporal pattern of terrestrial water storage changes and compare them with the permafrost distribution in this region. During its 7 years of measurements, GRACE reveals pronounced inter-annual variations, significant parts of which are collocated with regions of discontinuous permafrost. In combination with estimates of the atmospheric precipitation and evaporation fluxes from re-analysis data sets (e.g., the Japanese re-analyis JRA-25) as well as discharge observations for the largest rivers, we can also determine variations and trends in freshwater river discharge from the entire Eurasian Pan-Arctic river basins into the Arctic Ocean from 2003 to 2009. This analysis yields new quantitative insights into annual to inter-annual dynamics of the Pan-Arctic hydrologic mass-balance, in particular for regions of un-gauged discharge. By using datasets that carry redundant information, we are also able to quantify uncertainties and biases in the datasets and observations.