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Snow accumulation in four large-scale river basins of Northern Eurasia: relations to the recent climate changes and impact on runoff variations

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Composite analyses, based on daily snow depth, snow water equivalent (SWE), time series of Northern Hemisphere circulation patterns and monthly discharge of four river basins (Volga, Ob, Yenisey and Lena) are used to examine spatial/temporal peculiarities of snow accumulation over the large-scale river basins and their relation to the dominant atmospheric variability modes of the recent climate changes in order to asses its impact on annual runoff variations. Patterns of the spatial distribution of the following parameters: snow accumulation (mean snow depth and SWE) for the end of winter; correlation coefficients between snow accumulation and annual runoff; average snow accumulation anomalies, associated to the anomalies of various circulation indices, have been derived for the studied river basins. Comparison of the patterns corresponding to various basins and analysis of runoff/snow-depth cross-correlation functions demonstrate that impact of snow accumulation variations on annual river runoff differs in various basins. It depends on relative share of winter and summer precipitation, as well as spatial peculiarities of snow accumulation over the basing. North-Atlantic oscillation (NAO) is recognized as a dominant atmospheric circulation mode of recent warming in Northern Eurasia. Although the investigated river basins extend over the regions of influence of different circulation modes, for almost all of them NAO signal seems to be significant in the interannual variations of the basin-averaged snow depth. Quasi-decadal variations of snow depth are reflected by the annual runoff to some extent over all of the studied basins. However, long-term changes of snow accumulation on the one hand and runoff on the other hand do not coincide in Ob and Lena

basins, probably due to prevailing share of summer precipitation variations. For Volga and Yenisey basins the positive trend of runoff since 1970s is caused by increased snow accumulation associated with positive phase of NAO. At the same time, variance spectrum and coherency function between Volga annual runoff and winter NAO index show that quasi-decadal fluctuations is negatively correlated to NAO. The latter can be explained by negative snow depth anomalies over the south-west of the basin associated with positive phase of NAO. This work has been supported by the Russian Foundation for Basic Research (grant 06-05-64349) and Division of the Earth Sciences of the Russian Academy of Sciences, program 11.4