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MODELING FUTURE MASS BALANCE OF THE ARCTIC GLACIERS: CASE STUDY IN THE ALTAI MOUNTAINS

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The Arctic glaciers (excluding the Greenland Ice Sheet) have been reported to be a major contributor to present sea level rise, representing about one fourth of sea level rise contribution of all glaciers (excluding Greenland and Antarctica) since 1960. Note that most of the current mass loss from the Arctic glaciers is probably attributable to a change in the surface mass balance. These mass losses are expected to increase in the future, as these glaciers are located in the region of highest predicted air temperature increase during the coming decades. Hence, for better understanding what future fluctuations of glacier behavior imply for their atmospheric forcing on multi-decadal scale and impact on future sea level rise, there is an urgent need for the assessment of future glacier mass balance in the Arctic region. The Altai Mountains, located in the southern periphery of the Asian Arctic basin, contain 1281 glaciers with an area of 1191 km^2. These glaciers are at the headwaters of many prominent rivers, which affects the water discharge of large rivers such as the Ob and Yenisei Rivers. During the past decades, these glaciers experienced considerable mass loss, especially in the western part of the Altai Mountains. In this study, we implement a temperature-index-based glacier model that considers the feedback between the surface mass balance and changing glacier hypsometry to project the surface mass balance of all the individual glaciers of the Altai Mountains, The model is forced by the outputs of the latest 10 general circulation models (GCMs) participating in the fifth phase of the Coupled Model Intercomparison Project (CIMP5) under two representative concentration pathway scenarios (RCP4.5 and RCP8.5). The model is validated against 66 observed annual mass balances of 5 glaciers in the region. Despite large differences in the surface mass balance from site to site, we project an increase in negative mass balance in the Altai Mountains for two RCPs, which is caused primarily by an increase in air temperature. In particular, changes are more remarkable under RCP8.5, under which most of all small glaciers are projected to be disappear by the end of this century.