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Comparative glacio-climatological analysis of mass balance variability along the geographical margin of Europe

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Glacio-climatological studies recognise glacier mass balance changes as high-confident climate indicators. The climatic sensitivity of a glacier does not simply depend on regional climate variability but also influenced via large- and mesoscale atmospheric circulation patterns. This study focuses on recent changes in the mass balance using records from three border regions of Europe, and investigates the relationships between the seasonal mass balance components, regional climatic conditions, and distant atmospheric forcing.

Since glaciers in different macro-climatological conditions (i.e. mid-latitudes or high-latitudes, dry-continental or maritime regions) may present strongly diverse mass balance characteristics, the three analysed regions were selected from different glacierised macroregions (using the database of the World Glacier Monitoring Service). These regions belong to the Caucasus Mountains (Central Europe macroregion), the Polar Ural (Northern Asia macroregion), and Svalbard (Arctic Islands macroregion).

The analysis focuses on winter, summer, and annual mass balance series of eight glaciers. The climatic variables (atmospheric pressure, air temperature, precipitation) and indices of teleconnection patterns (e.g., North Atlantic Oscillation, Pacific Decadal Oscillation) are used from the gridded databases of the University of East Anglia, Climatic Research Unit and the National Oceanic and Atmospheric Administration, National Center for Environmental Prediction. However, the period and length of available mass balance data in the selected regions vary greatly (the first full record is in 1958, Polar Ural; the last is in 2010, Caucasus Mountains), a comparative analysis can be carried out for the period of 1968-1981.

Since glaciers from different regions respond to large- and mesoscale climatic forcings differently, and because the mass balance of glaciers within a region often co-vary, our specific objectives are (i) to examine the variability and the integrative climatic signal in the averaged mass balance records of the selected regions; (ii) to analyse the possible coupling between the mass balance and climatic variables, including the dominant patterns of Northern Hemisphere climate variability; and (iii) to compare the main characteristics of the three regions. Furthermore, (iv) a short discussion is given considering the significant decreasing trend of the cumulative annual mass balances in every region under the detected climatic changes in the second half of the 20th century.

Preliminary results suggest that the strongest teleconnection links could be between winter mass balance and winter NAO for the Polar Ural ($r=0.46$, $p<0.05$), and between annual mass balance and PDO for Svalbard ($r=-0.43$, $p<0.05$). Neither seasonal, nor annual mass balance records showed significant correlation with any of the examined circulation indices for the Caucasus.