Geophysical Research Abstracts
Vol. 20, EGU2018-12447, 2018
EGU General Assembly 2018

Seasonal prediction of European glacier mass balance using the Arctic Oscillation

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Estimates of the magnitude of glacier melt during the coming summer season are highly beneficial for water resource management but predicting meteorological conditions with a lead time of several months is challenging. Here, we explore the potential of large-scale atmospheric indices to explain and predict observed variations in long-term mass balance of Swiss glaciers.

We rely on a comprehensive 70-year data set of seasonal mass balance observations from up to a dozen Swiss glaciers. Monthly indices of the major atmospheric/ocean modes (NAO, AO, AMO, ENSO) are available for the entire study period. By correlating aggregates of the indices over various combinations of months against observed winter, summer and annual glacier mass balance anomalies, we investigate the skill of the large-scale indices to explain mass balance variability.

No significant correlations with Alpine winter mass balances were found. Also, indices averaged over the summer season or annual periods did not correlate with annual or summer balances. However, we found a significant correlation between the January-to-May Arctic Oscillation Index (air pressure differences in the North Atlantic) and glacier melt during the subsequent summer season. Fitting a regression model based on the AO index over 1948-2008 enables to correctly predict the sign of summer balance anomalies of the last decade in 90% of the cases and with a lead time of four months.