



## **Eurasian autumn snow and winter NAO: The interdecadal story**

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As the leading climate mode to explain wintertime climate variability over Europe, the North Atlantic Oscillation (NAO) has been extensively studied over the last decades. The strength and sign of the winter NAO strongly modulates near surface temperatures as well as precipitation patterns over Europe (Hurrell 1996, Wanner et al. 2001). Since its configuration has severe socioeconomic, ecological and hydrological impacts for this very populated subcontinent, seasonal to decadal predictions for the state of the winter NAO are highly demanded.

Europe's surface climate as well as the state of the NAO itself can be influenced by many key components of Earth's climate system, may it be internal or external forcing factors (Wanner et al. 2001). Recently, studies highlighted the state of the Northern Hemispheric cryosphere as possible predictor for the wintertime (DJF) NAO (Cohen et al. 2014). Although several studies could find a seasonal prediction skill in observational (mostly re-analysed) data (Orsolini et al. 2016, Gastineau et al. 2017, Duville et al. 2017, Han & Sun 2018), experiments with atmosphere-only general circulation models (AGCMs) as well as ocean-atmosphere general circulation models (AOGCMs) still show conflicting results and are not able to point to a reliable predictor among sea ice and snow cover (Furtado et al. 2015, Handorf et al. 2015, Francis 2017, Gastineau et al. 2017). Moreover, Peings et al. 2013 and Duville et al. 2017 found that the autumn snow to winter NAO relationship is not stable throughout the 20th century.

In this study we use long-term reanalyses to further investigate the promising results of Han & Sun 2018, who defined valuable core regions to create autumn snow indices which seem to inherit high value for winter forecasts in the European domain. Moreover, by using steady state and transient AOGCM model runs we look into inter-decadal changes of this prediction value.

We confirm the findings of Han & Sun 2018 to be valid also for the whole 20th century, where the November snow index is correlated with a negative NAO response in the following winter. We also found an inter-decadal negative correlation between the state of the NAO and the October snow index, as well as a positive correlation between the November snow index and the state of the AMO. The results from the AOGCM runs indicate, that both AMO and ENSO states are important players in modulating the autumn snow to winter NAO on inter-decadal time scales.