



## **The anomalously zonal structure of the Atlantic jet during winter of 2009-10 - possible causes and implications**

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The Northern Hemisphere winter of 2009-10 was characterized by an anomalously negative North Atlantic oscillation, extreme cold temperatures in North America and Europe (which were preceded by anomalous fall snow cover over Siberia), El-Nino conditions in the Pacific, and two Sudden stratospheric warmings. A strikingly anomalous flow feature which has not received much attention is the strong zonality of the Atlantic jet – the southward shifted jet connected to the African jet, forming an unusually zonal structure that persisted throughout the entire winter.

In this study we characterize this anomalous state of the east Atlantic jet by defining an appropriate jet zonality index that captures its unusual state during the winter of 2009-10. We use this index to find other months with a similar jet structure, and to determine the relation to other phenomena or flow states, for example, the occurrence of sudden stratospheric warmings, NAO, ENSO, synoptic wave breaking, and subtropical Atlantic meridional SST gradients.

We show that a high zonality of the Atlantic jet is related to a negative NAO state and weak lower stratospheric winds. We will also discuss the relation to ENSO, which we find to be dependent on the NAO and lower stratospheric wind structure. An anomalously zonal Atlantic jet is also concurrent with a strong negative subtropical Atlantic meridional SST gradient. During winter of 2009-10, the combination of an El-Nino, a persistent negative NAO, two stratospheric sudden warmings, and anomalously negative subtropical meridional Atlantic SST gradient led to an unusual zonal Atlantic jet configuration, which persisted for an unusually long period. We also examine how synoptic wave breaking statistics are related the zonality of the jet, and discuss the effects on Mediterranean storms.