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A regime view of Stratosphere-Troposphere coupling

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Stratosphere-troposphere coupling is often viewed from the perspective of the annular modes and their dynamics. Despite the obvious benefits of this approach, recent work has emphasised the greater tropospheric sensitivity to stratospheric variability in the Atlantic basin than in the Pacific basin. In this study, a new approach to understanding stratosphere-troposphere coupling is proposed, with a focus on the influence of the stratospheric state on North Atlantic weather regimes. The influence of the strength of the lower stratospheric vortex on four commonly used tropospheric weather regimes is quantified. The negative phase of the North Atlantic Oscillation is most sensitive to the stratospheric state, occurring on 33% of days following weak vortex conditions but on only 5% of days following strong vortex conditions. An opposite and slightly weaker sensitivity is found for the positive phase of the North Atlantic Oscillation and the Atlantic Ridge regime. A logistic regression model is developed to further quantify the sensitivity of tropospheric weather regimes to the lower stratospheric state. The logistic regression model predicts an increase of 40-60% in the probability of transition between other states and the negative phase of the North Atlantic Oscillation for a one standard deviation reduction in the strength of the stratospheric vortex. Similarly it predicts a 10-30% increase in the probability of transition between other states and the positive phase of the North Atlantic Oscillation for a one standard deviation increase in the strength of the stratospheric vortex. The stratosphere-troposphere coupling in the European Centre for Medium-Range Weather Forecasts, Integrated Forecasting System model is found to be consistent with the re-analysis data by fitting the same logistic regression model. Together, the analysis shows that there is a strong dependence of the stratosphere-troposphere coupling strength on the pre-existing tropospheric state.