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The role of stratospheric processes in the trans-seasonal connection between spring and summer northern annular modes

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The summer northern annular mode (NAM) variability plays a crucial role in the summer climate variability and extremes of the Northern Hemisphere. In this study, we report a significant negative correlation between the March NAM and summer NAM during 1979–2022 and reveal the role of the spring stratosphere in this seasonal linkage. Particularly, it is found that the negative phase of March NAM features a strong meridional shear in the extended-North-Atlantic jet, which tends to generate planetary scale Rossby waves that propagate upward and poleward into the stratosphere. This increased stratospheric planetary wave activity in March transitions to weakened wave activity in May, leading to positive zonal wind anomalies in the polar stratosphere in May, extending downward to the troposphere in June and promoting the formation and persistence of positive summer NAM. The results provide both statistical and dynamical evidence for the role of the spring stratosphere in connecting the spring and summer circulation.