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How does the Troposphere Amplify Stratospheric Variability?

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Stratospheric changes, with a timescale of a few weeks, are associated with substantial effects on surface weather and climate, especially on the Northern Annular Mode (NAM) with associated long-lasting shifts in the jet streams, storm tracks, and precipitation. Despite unambiguous observations of this phenomenon, as well as numerical simulations, a quantitative physical explanation of this downward coupling remains elusive. Stratospheric variability triggers a tropospheric feedback mechanism that amplifies polar surface pressure anomalies. The tropospheric flux of heat into the polar cap is modulated by stratospheric variability, leading to low-level polar temperature anomalies which oppose those in the stratosphere. Polar cold anomalies induce higher pressure, while warm anomalies induce lower pressure. These surface pressure anomalies are of the same sign as those in the stratosphere, thus amplifying the stratospheric signal.

These results have practical implications for climate and weather models. Beyond an understanding of how the troposphere modifies stratospheric variability, we now have a quantitative diagnostic tool to assess how well a model's stratosphere-troposphere coupling compares to observations.

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