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Title: Impact of the representation of the stratosphere on tropospheric weather forecasts
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Abstract:
The mid-winter polar stratosphere has great potential as a source of additional predictability for medium and extended-range weather forecasts. Several studies have demonstrated that during particularly dynamically active periods in the stratosphere known as stratospheric sudden warmings (SSW), tropospheric forecasts can be sensitive to the stratospheric evolution on timescales of 10 days. A key limitation of these studies has been their idealised nature. Similarly, there has been little investigation of how and why changes to the stratosphere influence tropospheric behaviour and what this means for the design of future numerical weather prediction systems.

This work addresses the above issues by performing a series of ensemble experiments using the Met Office Unified Model with a range of different vertical resolutions. These include a ’low top’ model with an upper boundary in the mid-stratosphere and two ’high top’ models with a similar upper boundary in the mesosphere, but with differing stratospheric vertical resolutions. The forecasts were run at these resolutions around the SSW of February 2010. The focus is on the subseasonal timescacle and so the forecasts are only out to 30 days. Statistically significant differences in surface fields, with mean differences in surface pressure of up to 3hPa are found between ’high top’ and ’low top’ simulations as soon as 5 days into the forecast. These tropospheric differences resemble a negative North Atlantic Oscillation pattern, and are likely related to the inability of the ’low top’ model to effectively capture the SSW. No statistically significant differences are detected in surface fields between the two ’high top’ models, suggesting that the extra vertical resolution does not influence the surface forecast at this timescale.

The second part of this study investigates whether the dynamical interaction between the stratosphere and the troposphere is mediated by changes to the development of baroclinic eddies. A wave breaking detection method is developed to assess Rossby wave breaking in the troposphere. Changes in wave breaking are detected between simulations containing a SSW and those without, suggesting that the stratosphere may affect the development of Rossby waves in the troposphere. The tropospheric changes are consistent with observed climatological influences of stratospheric conditions on tropospheric wave breaking.
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