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# Satellite observations of gravity wave activity and dissipation during sudden stratospheric warmings

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Sudden stratospheric warmings (SSWs) are a circulation anomaly that occurs mainly at high northern latitudes in boreal winter. During major SSWs the eastward directed polar jet reverses, and, for a certain period, the stratosphere is governed by anomalous westward winds. It is known that both planetary waves and gravity waves contribute to the formation and evolution of SSWs.
However, the small horizontal scales of gravity waves (tens to a few thousand km) challenge both observations and modeling of gravity waves. Therefore, the role of gravity waves during SSWs is still not fully understood. In particular, gravity waves should play an important role during the recovery of the stratopause and of the eastward directed polar jet after major SSWs. This is indicated by several modeling efforts. However, validation by global observations of gravity waves is still an open issue.
Gravity wave momentum fluxes and potential gravity wave drag were derived from HIRDLS and SABER satellite observations, and the role of gravity waves during recent SSWs in the boreal winters 2001/2002-2013/2014 is investigated.
We find that gravity waves with slow horizontal phase speeds, likely mountain waves, play an important role during SSWs. Both gravity wave momentum fluxes and gravity wave drag are enhanced before the central date of major SSWs. After the central date, gravity wave momentum fluxes and gravity wave drag in the stratosphere are strongly reduced. Still, gravity wave drag contributes to the wind reversals related to the anomalous westward winds. Another finding is that, after major SSWs, the contribution of gravity wave drag at the bottom of re-established eastward directed polar jets is small. At the top of those jets, however, strong gravity wave drag is found, which indicates that gravity waves contribute to the downward propagation of newly formed polar jets and of elevated stratopauses to their "climatological" altitude. This confirms recent modeling work by, for example, Hitchcock and Shepherd (2013). The zonal average distribution of gravity wave momentum fluxes during the recovery phase after major SSWs indicates that poleward propagation of gravity waves from midlatitudes likely contributes to the enhanced gravity wave drag on top of the re-established polar jets.