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Which factors could have favored the occurrence of the unexpected Major Midwinter Warming of 2009?

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In January 2009 a very intense major midwinter warming (MMW) took place in the boreal polar stratosphere. This MMW was unexpected since all the typical external factors that influence the occurrence of this kind of events (QBO phase, sunspot cycle or ENSO) were in favor of an undisturbed and strong polar vortex for the 2008/09 winter.

In this work, NCEP/NCAR reanalysis data are used to study this event in more detail and, particularly, the preceding atmospheric state and the wave activity injection into the stratosphere surrounding the date of the MMW 2009. Concerning the wave activity, we have decomposed it into their different contributors (climatological planetary waves, anomalies associated with Rossby wave packets and the interaction between them) according to the diagnostic tools by Nishii et al. (2009).

Among other results, we show that, in contrast to previous MMWs, the stratosphere was not preconditioned by a weak vortex during the month before the phenomenon; on the contrary, the polar night jet was much stronger than the climatology and its axis did not show a clear poleward shift. When focusing on wave-activity injection into the stratosphere related to this MMW, we have identified two main peaks around the MMW 2009 onset. The earliest and most important peak (just preceding the MMW) appears mainly due to the contribution of anomalies associated with Rossby wave packets. The second peak (just after the MMW) is mainly due to the sum of similar contributions from anomalies associated with Rossby wave packets and the interaction between these anomalies and climatological planetary waves. These results highlight the fundamental role of internally generated tropospheric wave forcing for the generation of MMWs beyond influences like solar cycle, QBO and ENSO.

Nishii, K., H. Nakamura, and T. Miyasaka, 2009: Modulations in the planetary wave field induced by upward-propagating Rossby wave packets prior to stratospheric sudden warming events: A case-study. Q. J. R. Meteorol. Soc., 135, 39-52.