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Multi-tool analysis of winter 2012-2013 major stratospheric warming in the frame of the ARISE project

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A remarkable split-type major sudden stratospheric warming (SSW) occurred in early January 2013. Our study proposes to analyze this event using data issued from a variety of sources, in the frame of the European project ARISE. January 2013 major stratospheric warming is compared to the statistics - presented in a previous paper [Angot et al., 2012] - as well as to previous recent specific major SSW cases (displacement-type SSW in January 2006 and split-type SSW in January 2009).
Lidar temperature measurements performed in the Observatoire de Haute-Provence in southern France are extended to ground level using collocated radiosonde temperature measurements. The evolution of resulting temperature profiles (from the ground to the high mesosphere) during the whole winter show a high-amplitude warming which matures in 15 days. The temperature evolution also features characteristic split-type event patterns.
The analysis of planetary waves amplitudes reveals a preconditioning of the atmosphere by wavenumber 1 wave and wavenumber 2 wave. During a ten-days period, around one month before the date of the major SSW, this preconditioning seems to be related to the type of warming (i.e. split-type or displacement-type) to come. This is in good agreement with the results obtained when the same analysis is carried out on other stratospheric warming cases (January 2006 and January 2009). The triggering of the actual major SSW event (i.e. the reversal of the zonal mean zonal wind) brings to light a possible role of wavenumber 3 wave.
In addition to the comparison to previous SSW events, we put these hypothesis to the test using the mechanistic model RACCORD. Sensibility tests performed on this model also allow to evaluate the role of different parameters in the development of SSWs : the vertical ranges and the intensities of both the meteorological nudging and the climatological nudging of the model are studied, as well as the pressure level where the geopotential height forcing occurs. The different simulations tested do not always produce a major stratospheric warming, especially when the meteorological nudging intensity or vertical range have been reduced too much, which corroborates the idea that the occurrence of a major SSW requires a singular state of the atmosphere. We find this is all the truer for split-type events. Concerning the two criteria defining a major SSW, our results show that the reversal of the zonal mean zonal wind at 60°N and 10 hPa is a more decisive factor (i.e. it is a criterion less often completed) than the reversal of the temperature gradient between the pole and 60°N at 10 hPa.
Mesospheric airglow data measured in OHP is also examined to further enrich our analysis of winter 2012-2013 major stratospheric warming. Differences with lidar measurements are discussed.