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Statistical characteristics of sudden stratospheric warming as observed over the Observatoire de Haute Provence (44N̊, 6˚E) during the 1981-2001 period

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Many observational studies were carried out so far using temperature measurements from LiDAR to characterize the occurrence of sudden stratospheric warming (SSW) over Northern and Southern Hemispheres. Such warming events have been individually classified as major, minor and canadian warming based on temperature and zonal wind. Most of these events are documented in literature as a case study and there were a very few statistical characteristics.

The present study delineates the characteristics of SSW events observed over the *Observatoire de Haute Provence* (OHP: 44˚N, 6˚E). The study uses 21 years of Rayleigh LiDAR temperature measurements for the 1981-2001 periods which corresponds to 2631 daily temperature profiles. The characteristics of warming events are presented in terms of type of warming, magnitude of warming, height of occurrence, day and period of occurrences and the source mechanisms.

Together with daily LiDAR profiles, the NCEP reanalysis data have been used to identify and classify the observed warming events over OHP. Two kinds of warming have been examined according to the following criteria:

- a **major SSW** is identified when the warming is significantly greater than 10 K and the mean zonal wind reverses from westerly to easterly through the polar region (at 60˚N)
- a **minor SSW** is obtained when the warming is significantly greater than 10 K but there is no reversal of the mean zonal wind in the polar region.

As expected, following the criterion above, our study shows that all SSW events occur by winter, i.e., between November and March. From 1237 daily winter profiles, 42 cases are detected as SSW over OHP. Most of them (76%) have been classified as minor SSW and thus nearly a quarter of them (24%) have been classified as major SSW.

The observed major and minor SSW are associated with descent of stratopause layer by 1 to 7 km. The height of occurrences of major SSW are distributed between 38 km and 54 km with magnitude in the 12-31 K temperature range, while the minor SSW appear at 42-53 km, closer to the usual stratopause layer and with a larger range of temperature magnitude (10-34 K).

In the present statistical study the observed major and minor events are examined with regard to state of the Quasi-Biennial Oscillation (QBO), and by investigating the corresponding wave-mean flow interactions through Eliassen-Palm flux and effective diffusivity parameters using ECMWF data.