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The relationship between the polar vortex and ozone in the boreal stratosphere from ERA-40 reanalysis

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The relation between the ozone and the polar vortex in the stratosphere has an outstanding role in climate studios, and also a large repercussion in the improvement of the climate models. This importance is due to the combination of two reasons: the key role of the stratospheric ozone in the Earth climate due to its radiative properties, and that the most important dynamic activity in the high-latitude stratosphere is associated with the polar vortex (present during the whole winter and part of the spring). This work focuses on the spring months, a transitional period in the stratospheric circulation between the winter westerlies (the stratospheric polar vortex, SPV, is completely developed) and summer easterlies (SPV has already disappeared). This breakdown of the SPV is known as the Stratospheric Final Warming, SFW.

Using ERA-40 data, currently the longest-period reanalysis (1979-2002) with a sufficiently realistic representation of the stratosphere circulation, we analyze different aspects about the relation between the ozone concentration and the intensity of polar vortex in the boreal stratosphere during the springtime.

Among other results, we see that the 24-yr mean evolution of the stratospheric ozone, averaged over the polar region (60ºN-80ºN), exhibits a slow increase along March followed by a progressive decrease during April and May. The interannual variability of the monthly mean of zonal wind and ozone mixing ratio at 50 hPa in the analyzed polar region decreases gradually along the season as well. When analyzing the springtime stratospheric preconditioning, we found that almost all the warm Februaries are not associated with low ozone content and strong SPV at the beginning of March; and that none cold February was followed by a weak SPV in the first third of March.

Also, the stratospheric conditions around the SFW occurrence have been studied. It is seen that the 50-hPa ozone over the polar region is nearly constant prior to the SFW, while it gets lower progressively after the SPV breakdown. The 50-hPa zonal velocity of this region suffers a little recovery after de SFW, although the positive values, that is, the westerlies, are not observed again up to the next winter.

Finally, it should be added that some years in the 1979-2002 period showed discrepancies with the 24-yr mean behavior, which is reasonable as other factors and processes also involved in the studied topic have not been included in the present work. However, the main results obtained can be considered robust and consistent coming from ERA-40 reanalysis.