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Interannual variability in the wave activity of spring months for years with early or late breakup of the stratospheric polar vortex

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It is well known that the stratospheric final warming (SFW) is one of the most relevant processes in the springtime stratosphere, since it means the final transition of the polar stratospheric circulation from the typical wintertime westerlies to the summertime easterlies. This phenomenon shows a large interannual variability in its timing, which some authors have partially related to variations in the wave activity propagation from the troposphere to the stratosphere. The present work is a contribution to the study of this relation by analysing the differences of the wave activity in the Northern Hemisphere troposphere-stratosphere column in spring months (March, April and May) between years with early SFW and years with late SFW using ERA40 data. To do that, firstly, we have identified the dates of the polar vortex breakup in the period of 1958-1999, which has allowed us to select the early SFWs (in March) and the late SFWs (in May). The relationship between the timing of the SFWs and variations in the wave activity is evaluated by analysing the two Eliassen-Palm flux components (F_φ, F_p) and its divergence using composite techniques.

Among other results, we have found the major differences between early SFWs and late SFWs in March and April, and in the "vertical" component of EP flux (F_p). This result is very interesting, since F_p is related to the meridional eddy heat transport and gives us information about the vertical propagation of the wave activity.

Concerning March, F_p in 'early years' shows negative anomalies along the extratropical tropospheric column and just the opposite in 'late years'. These negative (positive)

anomalies of F_p reach stratospheric levels, what in turn involves a deceleration (acceleration) of the polar vortex according to the negative (positive) anomalies of the EP-flux divergence found in this study as well.

The results obtained for April of F_p and EP-flux divergence anomalies show relevant differences with those for March. First, both months display opposite sign of the anomalies for EP-flux divergence in the upper stratosphere and for F_p in the whole column. Also, a southward shift of the highest F_p anomalies over high latitudes through the tropospheric column in 'early years' is obtained. On the other hand, in April, the latitudes with major 'early'-minus-'late' differences of F_p at 500-hPa coincide with the European region where the corresponding differences in the perturbation kinetic energy (PKE) are statiscally significant. The differences of 500-hPa PKE between early and late years were obtained in a previous work, and were found to be linked to changes in other tropospheric fields and in the precipitation.

To sum up, the results obtained in this study give evidences that variations in the persistence of the stratospheric polar vortex in springtime affect the troposphere and its dynamics.