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Hemispheric ozone variability indices derived from satellite observations and comparison to a coupled chemistry-climate model

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Abstract. Total column ozone is used to trace the dynamics of the lower and middle stratosphere which is governed by planetary waves. In order to analyse the planetary wave activity a Harmonic Analysis is applied to global multi-year total ozone observations from the Total Ozone Monitoring Spectrometer (TOMS). As diagnostic variables we introduce the hemispheric ozone variability indices one and two. They are defined as the hemispheric means of the amplitudes of the zonal waves number one and two, respectively, as traced by the total ozone field.

The application of these indices as a simple diagnostic for the evaluation of coupled chemistry-climate models (CCMs) is demonstrated by comparing results of the CCM ECHAM4.L39(DLR)/CHEM (hereafter: E39/C) against satellite observations. It is quantified to what extent a multi-year model simulation of E39/C (representing "2000" climate conditions) is able to reproduce the zonal and hemispheric planetary wave activity derived from TOMS data (1996–2004, Version 8).

Compared to the reference observations the hemispheric ozone variability indices one and two of E39/C are too high in the Northern Hemisphere and too low in the Southern Hemisphere. In the Northern Hemisphere, where the agreement is generally better, E39/C produces too strong a planetary wave one activity in winter and spring and too high an interannual variability. For the Southern Hemisphere we reveal that the indices from observations and model differ significantly during the ozone hole season. The indices are used to give reasons for the late formation of the Antarctic ozone hole, the insufficient vortex elongation and eventually the delayed final warming in E39/C.

In general, the hemispheric ozone variability indices can be regarded as a simple and robust diagnostic to quantify model-observation differences concerning planetary wave activity. It allows a first-guess on how the dynamics is represented in a model simulation before applying costly and more specific diagnostics.

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