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A revised linear ozone photochemistry parameterization for use in transport and general circulation models: multi-annual simulations

D. Cariolle[1,2] and H. Teyssèdre[3]
[1]Météo-France, Toulouse, France
[2]Centre Européen de Recherche et Formation Avancée en Calcul Scientifique, Toulouse, France
[3]Centre National de Recherches Météorologiques, Météo-France, Toulouse, France

Abstract. This article describes the validation of a linear parameterization of the ozone photochemistry for use in upper tropospheric and stratospheric studies. The present work extends a previously developed scheme by improving the 2-D model used to derive the coefficients of the parameterization. The chemical reaction rates are updated from a compilation that includes recent laboratory work. Furthermore, the polar ozone destruction due to heterogeneous reactions at the surface of the polar stratospheric clouds is taken into account as a function of the stratospheric temperature and the total chlorine content.

Two versions of the parameterization are tested. The first one only requires the solution of a continuity equation for the time evolution of the ozone mixing ratio, the second one uses one additional equation for a cold tracer. The parameterization has been introduced into the chemical transport model MOCAGE. The model is integrated with wind and temperature fields from the ECMWF operational analyses over the period 2000–2004. Overall, the results from the two versions show a very good agreement between the modelled ozone distribution and the Total Ozone Mapping Spectrometer (TOMS) satellite data and the "in-situ" vertical soundings. During the course of the integration the model does not show any drift and the biases are generally small, of the order of 10%. The model also reproduces fairly well the polar ozone variability, notably the formation of "ozone holes" in the Southern Hemisphere with amplitudes and a seasonal evolution that follow the dynamics and time evolution of the polar vortex.

The introduction of the cold tracer further improves the model simulation by allowing additional ozone destruction inside air masses exported from the high to the mid-latitudes, and by maintaining low ozone content inside the polar vortex of the Southern Hemisphere over longer periods in spring time.

It is concluded that for the study of climate scenarios or the assimilation of ozone data, the present parameterization gives a valuable alternative to the introduction of detailed and computationally costly chemical schemes into general circulation models.