Deutsches Zentrum
für Luft- und Raumfahrt e.V.
in der Helmholtz-Gemeinschaft
Institut für Physik der Atmosphäre

Lagrangian Transport in the CCM E39C: Benefits for Stratospheric Dynamics and Chemistry

(00121)

The upgraded CCM E39C-A

The climate-chemistry model E39C used so far (Dameris et al., 2005; 2006; Eyring et al., 2006; 2007) has been further developed (Stenke et al., 2008). In the new version of E39C, i.e. E39C-A, the following important change has been implemented:

- Replacement of the semi-Lagrange advection scheme (Williamson and Rasch, 1994; SLT hereafter) by the full Lagrange scheme ATTILA (Reithmeier and Sausen, 2002).

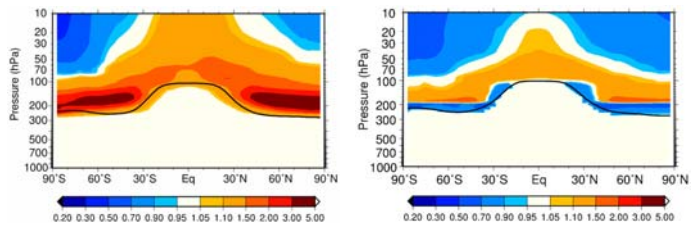
Further updates in E39C-A are:

- Introduction of a parameterisation to consider bromine chemistry (pers. comm. M. Rex, 2006).
- Use of improved net heating rates to describe impact of large volcanic eruptions (Stenchikov et al., 2006).

Specific Humidity

Ratio of ECHAM4/**SLT** H_2O to HALOE

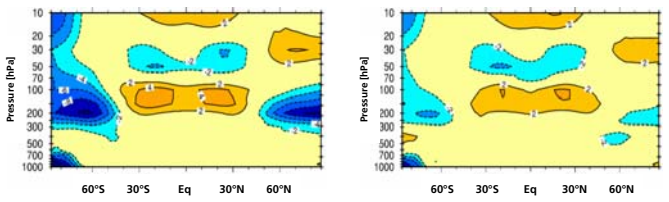
Ratio of ECHAM4/**ATTILA** H_2O to HALOE



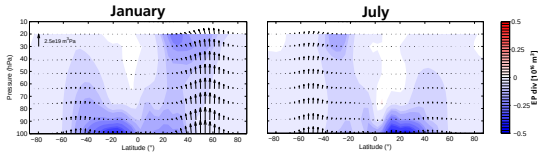
Annual Mean Temperature

Difference of ECHAM4/**SLT** and ERA15

Difference of ECHAM4/**ATTILA** and ERA15



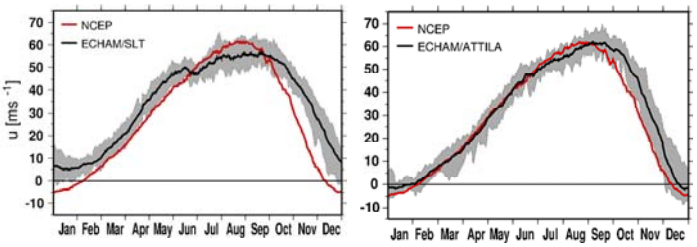
Planetary wave activity in E39C-A



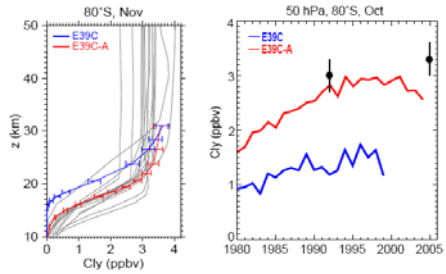
Climatologies of EP fluxes (black arrows) and their divergences (coloured) over the years 1960-1999. In contrast to E39C (not shown), E39C-A shows a realistic seasonal behaviour and reproduces hemispheric differences in planetary wave activity.

Stratospheric Circulation

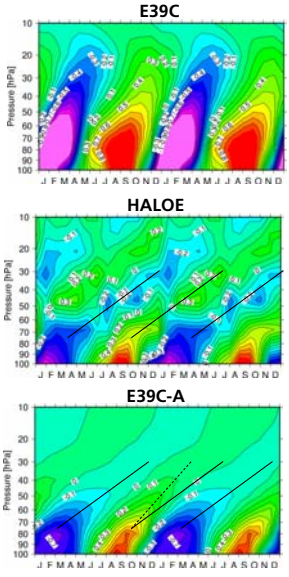
Zonal Wind (60°S, 30 hPa)



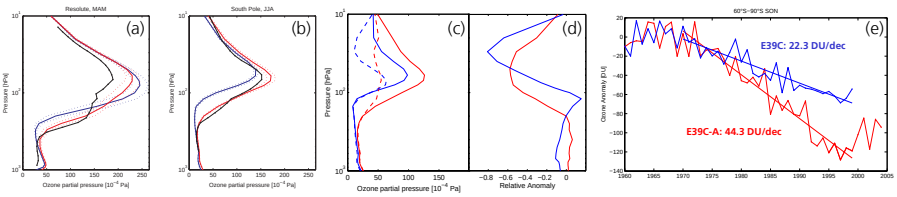
Chlorine in the stratosphere: E39C vs. E39C-A



Tape Recorder



Ozone profiles and depletion



(a), (b): Mean ozone partial pressure profiles of 1983-1989 from models (red: E39C-A, blue: E39C) and observations (black). (c): October mean ozone profiles for the South Pole, red: E39C-A, blue: E39C, solid = early 1980s, dotted = 1990s. (d): Relative differences derived from (c), i.e. [(1980s-1990s)/1980s]. (e): Time series of total ozone anomalies averaged from 60°S to 90°S for September to November, calculated with respect to the 1960-1969 mean value.

Summary

Results of a transient simulation (1960-2004) using the upgraded CCM E39C-A show significant improvements, e.g.

- ✓ obvious reduction of cold bias and a much better representation of stratospheric wind variations due to a realistic distribution of water vapour concentration in the extra-tropical lowermost stratosphere;
- ✓ vertical distribution and temporal evolution of stratospheric chlorine is now in agreement with analyses derived from observations and other CCMs leading to a better assessment of ozone destruction;
- ✓ shape of ozone profiles in better agreement with observations; in particular the "ozonopause" is well captured.

→ More detailed information can be found in Stenke, A., M. Dameris, V. Grewe, and H. Garny , Implications of Lagrangian transport for coupled chemistry-climate simulations, *Atmos. Chem. Phys. Discuss.*, **8**, 2008.

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