Helmholtz Climate Initiative

Regional Climate Change

Topic 5: Chemistry-climate interactions on global to regional scales

The study of reactive nitrogen intrusions into the stratosphere with vertically extended EMAC.

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Introduction

The impact of the variable solar activity on the tropospheric weather and climate is a subject to active discussions within scientific community and a topic of steady attention from the general public. Lately the triggering of atmospheric composition changes by high-energetic precipitating particles has been suggested as another possible mechanism linking solar variability and Earth's climate. More specifically the events of the downward transport of the reactive nitrogen presumably from the MLT to the stratosphere under the polar winter conditions have been observed by satellite instruments, such as MIPAS on-board the ENVISAT. Such intrusions may have a significant impact on the NOy budget of the middle atmosphere and hence on the ozone chemistry. Such atmospheric coupling can only be captured and understood in models describing all involved regions consistently, including chemical tracers spanning the thermosphere to the stratosphere. We report the results of the vertically extended version of the EMAC Climate Chemistry model. The extension should allow to realistically simulate mesosphere/lower thermosphere coupling processes.

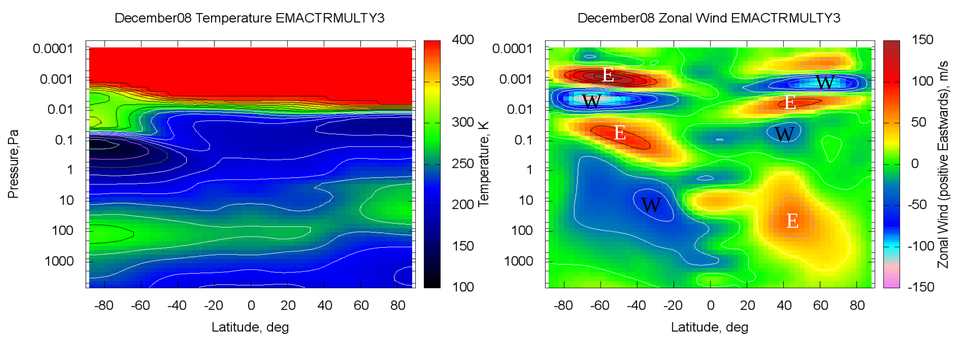
Recent development

- Upper boundary extended up to ~170 km (L74SMA: EMAC T42L39 up to ~50 hPa and 1/3 scale height from top on)
- Standard FUBRAD
- Standart Hines GW-parameterisation with the correction of molecular diffusion from HAMMONIA
- Molecular diffusion of temperature, momentum and tracers from HAMMONIA
- Non-LTE and CO2 NIR radiation from HAMMONIA
- NO cooling in the lower thermosphere from KASIMA
- Setup for injection of passive tracers and tracers with simplif ed photolytic loss

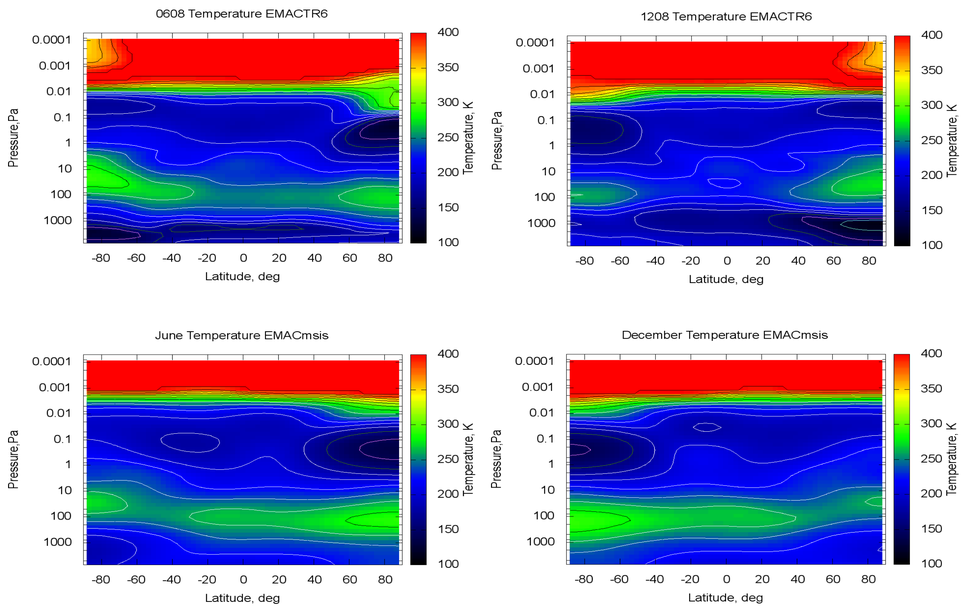
Global mean temperature

- Nudged run 2005-2009
- No interactive chemistry
- Constant solar activity
- No chemical heating
- No ionospheric effects

Zonal means around equinox

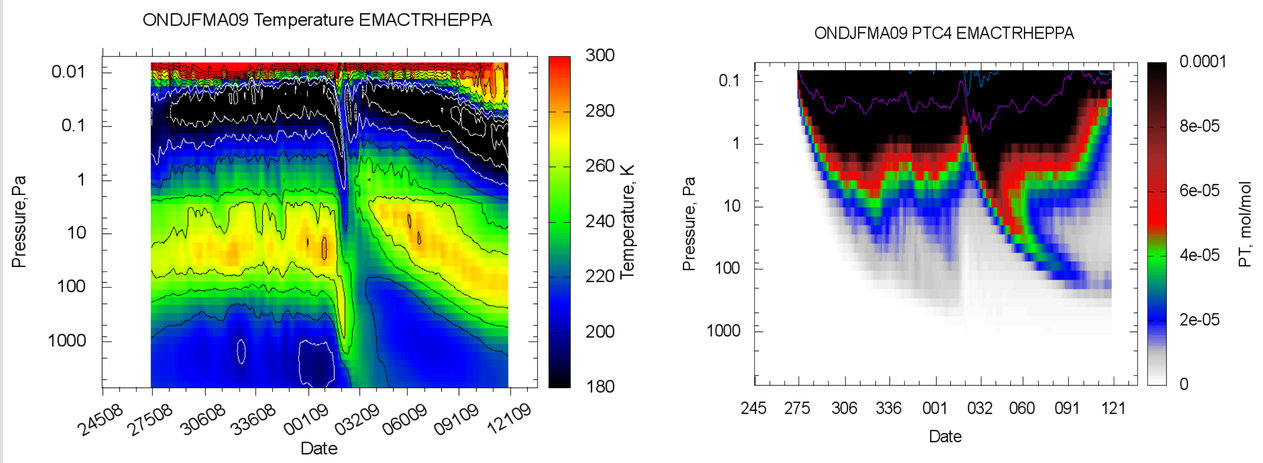


Zonal means vs standart atmosphere (MSIS)

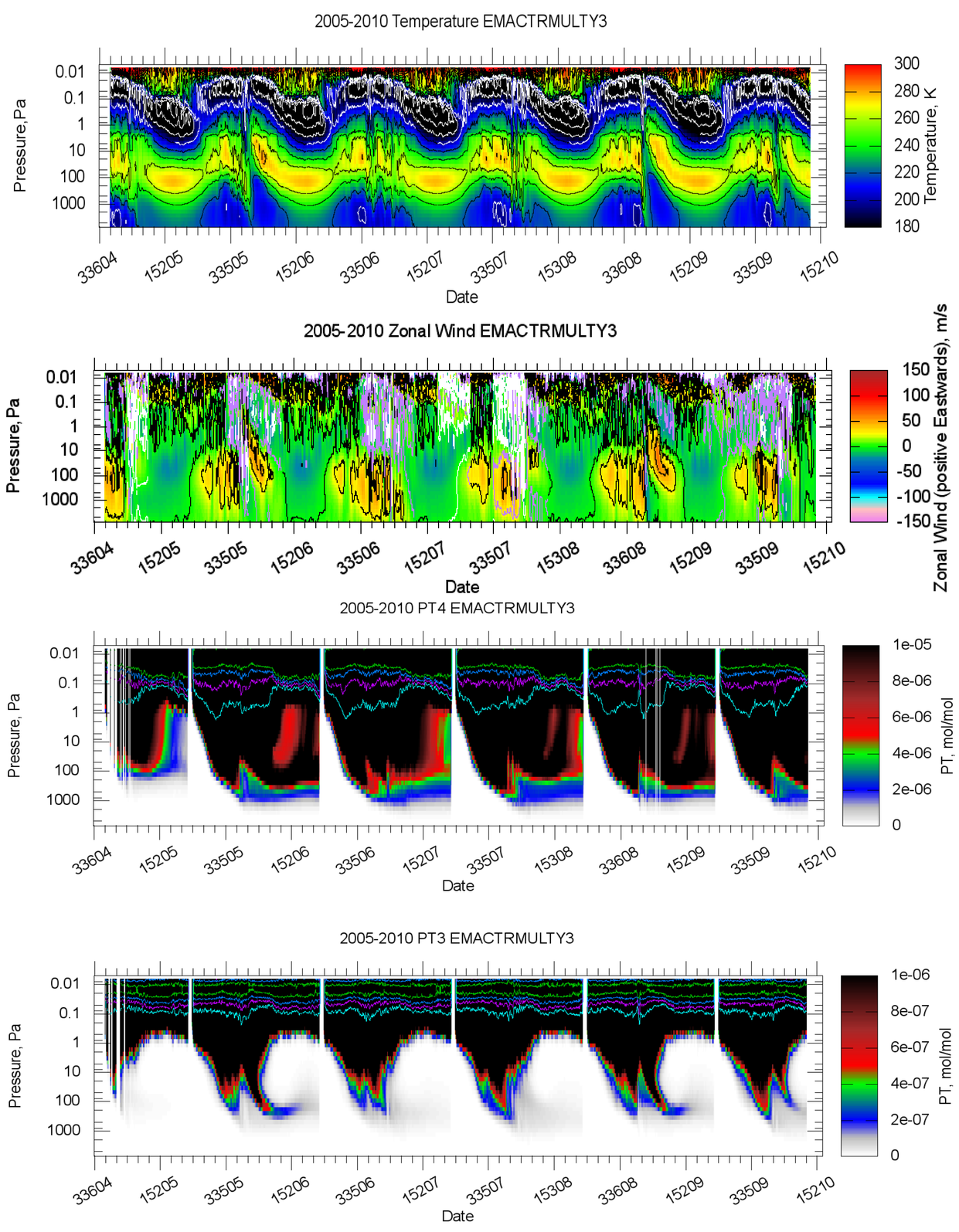


Sudden Stratospheric Warming and thermospheric tracer intrusion

(Passive tracer onstantly released at ~110 km) Winter 2008/09, 71N



Multy year run 2005-2010 with thermospheric tracers



Conclusions

1. The extended model runs stable for several years.
2. The thermal structure and winds are realistic.
3. Sudden stratospheric warming are realistically reproduced.
4. Cross-Mesopause transport of tracers is working.
5. Simplif ed photolysis enables relatively realistic reproduction of reactive nitrogen intrusions.