The interactive chemistry climate model MAECHAM4-CHEM, longterm simulations for near past, present and near future

Part 2; Sea surface temperature effects on stratospheric circulation and polar chemistry

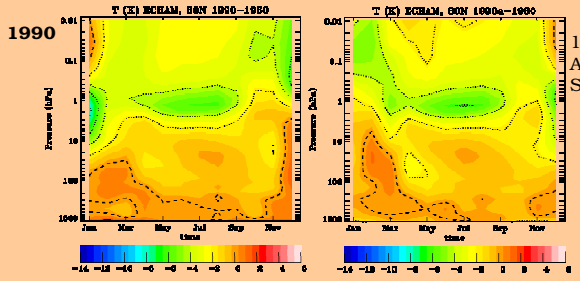
Christoph Brühl, Benedikt Steil, Max-Planck-Institut für Chemie, Mainz;
Elisa Manzini, Nat.Inst. for Geophysics and Volcanology, Bologna

AFO 2000

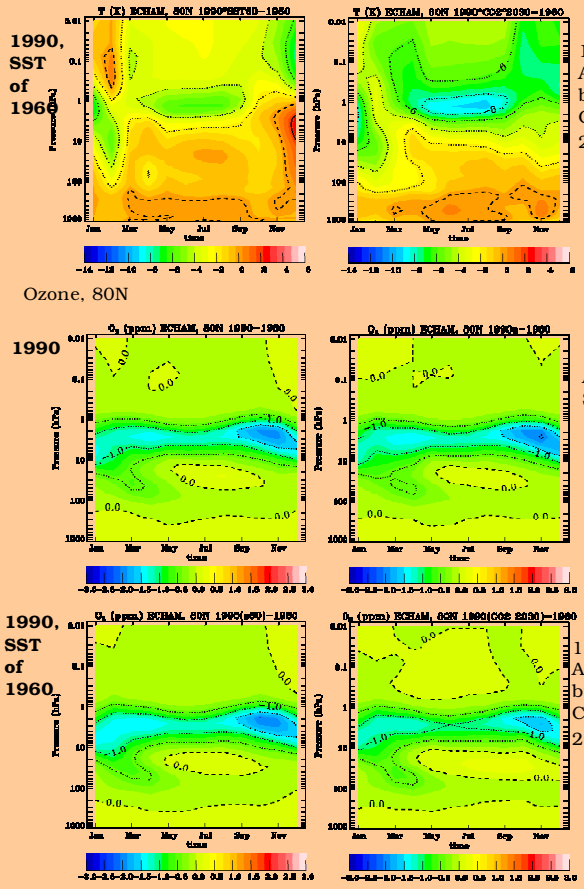
MAX-PLANCK-GESELLSCHAFT

Changes for 1990 against 1960 using different SSTs or CO_2 forcing, altitude/season

Temperature, 80N



Ozone, 80N



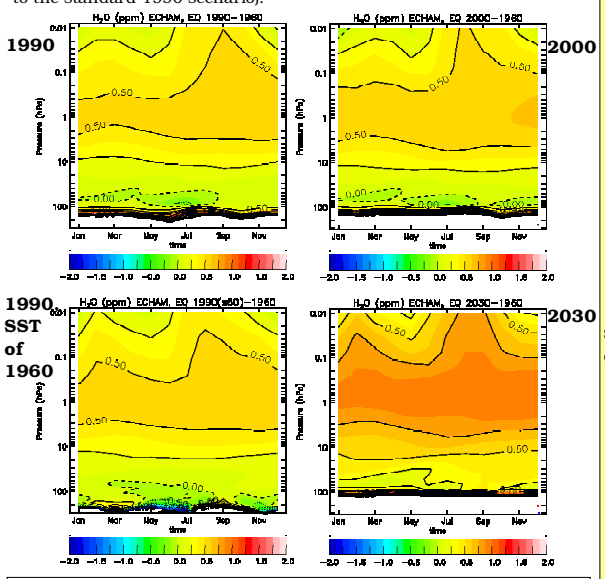
MA-ECHAM4, Middle Atmosphere version of the European Center model in Hamburg, spectral GCM with:
-horizontal resolution T31, surface to 80km
-fully interactive chemistry using the family technique.
More details see Part 1 or references.

Additionally to the **7** '**time-slice**'-scenarios (20yrs each) described there, here for the 1990 time-slice **2 sensitivity** studies on Sea Surface Temperature (**SST**) are included:
-instead of GISS-HADLEY use of the AMIP-dataset (Gates)
-chemistry and greenhouse gases of 1990, but SST of 1960
The scenario with chemistry and SST of 1990 but CO_2 of 2030 (also in part 1) is also a scenario where the state of the lower troposphere is inconsistent to greenhouse forcing.

Steil, B. et al, A new interactive chemistry climate model: 1. present-day climatology and interannual variability of the middle atmosphere using the model and 9 years of HALOE-UARS data. *J. Geophys. Res 108*, D9, 4290, 2003.

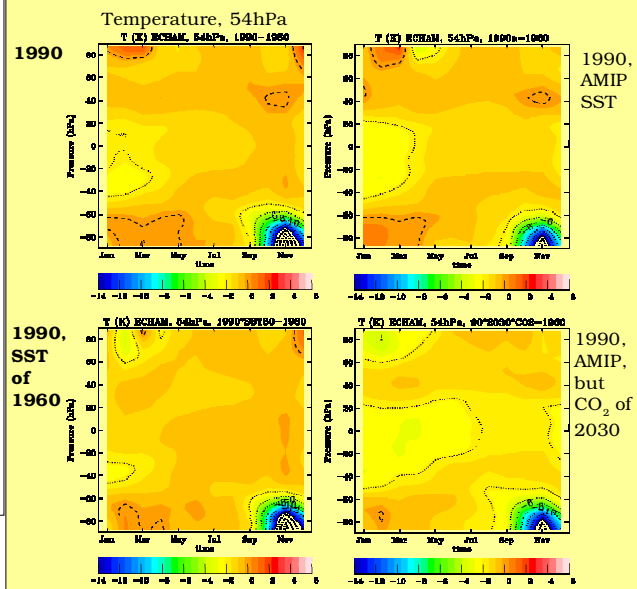
Manzini, E, B. Steil, C. Brühl, M. A. Giorgetta and K. Krüger: A new interactive chemistry-climate model. II. Sensitivity of the middle atmosphere to ozone depletion and increase in greenhouse gases: Implications for recent stratospheric cooling. *J. Geophys. Res.*, 108, D14, 4429, 2003.

Change of **water vapor** in the tropics, note the increase in the lower stratosphere in the 1990 scenario with suppressed SST increase (reduced Brewer Dobson circulation and warmer tropopause compared to the standard 1990 scenario).

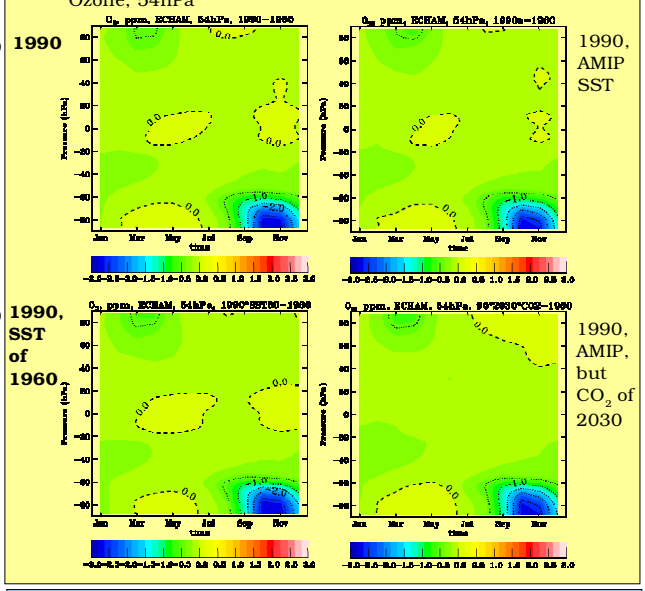


Changes for 1990 against 1960 using different SSTs or CO_2 forcing, latitude/season

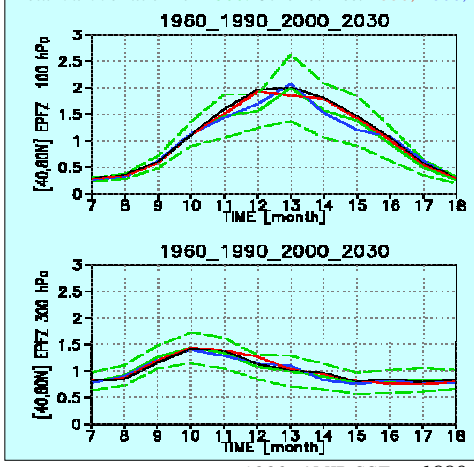
Temperature, 54hPa



Ozone, 54hPa



Monthly mean vertical component of the EP-flux (40-80°N area weighted average), normalized to the 20yr annual average of 1960. Dashed: +/-1 standarddeviation for 1960. Other curves: 1990, 2000, 2030.



Conclusions

- Changes in sea surface temperature (due to different data bases) have a small effect in Arctic spring but are important in winter, and also for stratospheric water vapor (via tropics).
- In the two scenarios with tropospheric greenhouse effect suppressed by fixing the SST the residual circulation is weakened, leading to a colder Arctic lower stratosphere in winter than for the scenarios with consistent SST, i.e. artifacts like a large delay in ozone recovery.
-Different representations of the ice-edge modify the strength of the Antarctic vortex

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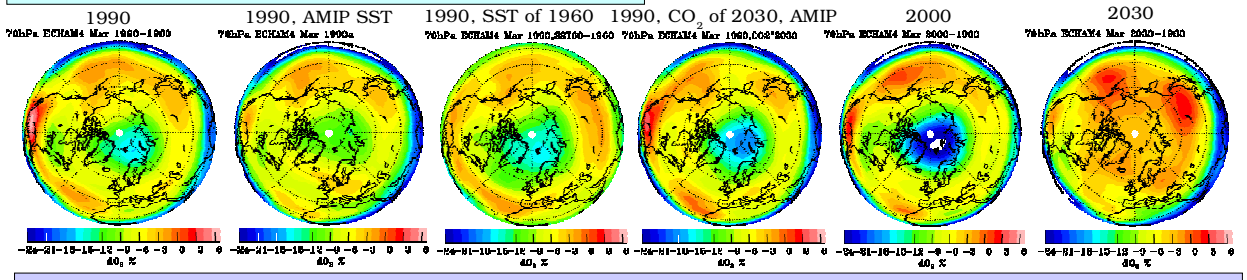
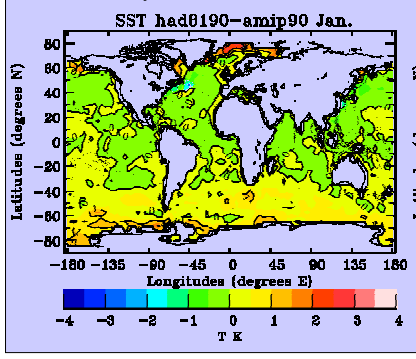
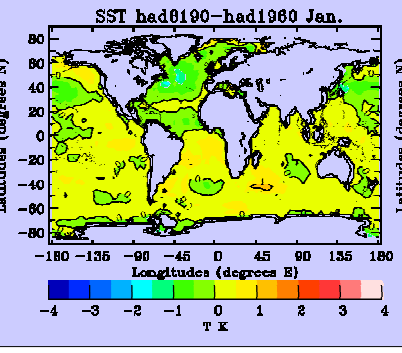
In the scenarios with SST inconsistent to the forcing the number of years where chlorine is still activated on March 29 is larger than in the consistent scenarios shown on poster 1:
1990: 6 yrs; 1990, SST 1960: 7-8 yrs; 1990, CO_2 2030: 9-10yrs
Mean ozone change in March at 70hPa, compared to 1960 (20 yrs)



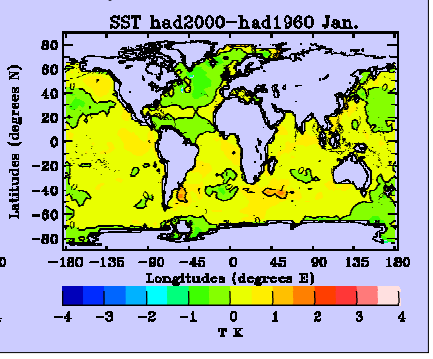
Differences in SST (monthly mean, 10 yrs), January
1990, Hadley -AMIP



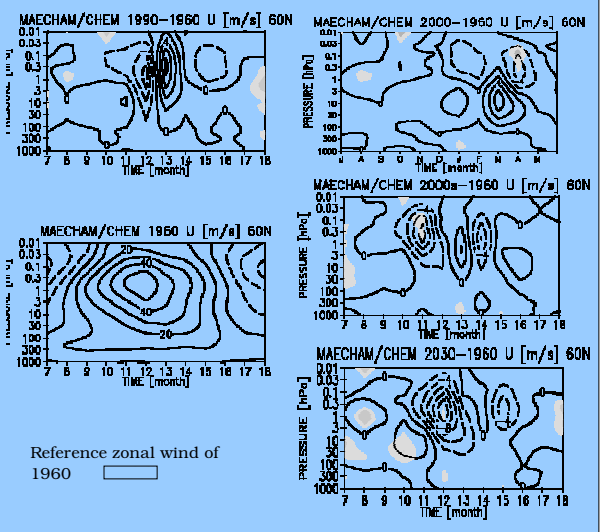
Hadley, 1990-1960



Hadley, 2000-1960

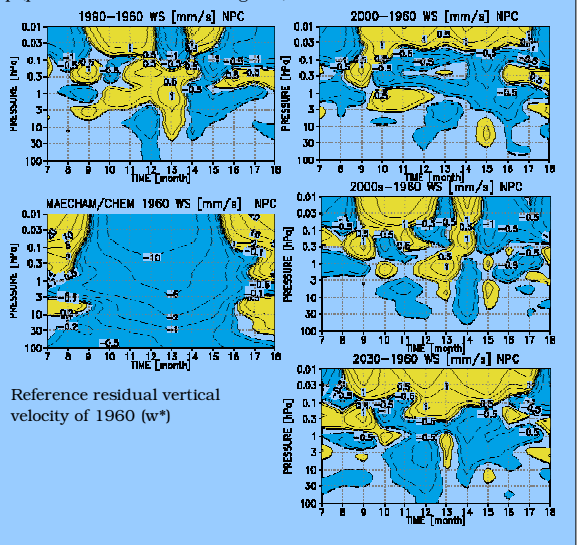


Changes in mean zonal wind, scenarios of poster 1, 60°N, grey shades indicate 99% (95%) significance.



Reference zonal wind of 1960

Changes in residual vertical velocity, scenarios of poster 1, north polar cap (poleward of 60°N, area weighted)



Reference residual vertical velocity of 1960 (w*)