OSLO CTM2 - MODEL SIMULATIONS FOR THE PAST AND THE FUTURE

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INTRODUCTION

UiO is participating in the ENSEMBLES project with model simulations using our chemical transport model (Oslo-CTM2) to estimate past and future changes in the chemical distribution.

Future changes in stratospheric ozone depend on the scenarios used for chlorine, bromine as well as nitrous oxides and methane emissions. We have adopted historic emissions up to 2000 and the IPCC (2001) SRES scenarios for 2100 for CO, NMVOC, NOx, CFCs, N_2O and CH_4 emissions studies. Both natural and anthropogenic emissions are considered.

The future scenarios are connected with large uncertainties particularly towards the end of the century. We have therefore adopted 3 different scenarios for the compounds to estimate the possible range in ozone recovery.

The model used is the Oslo CTM2 model (Berglen et al., 2004). Time slice simulations have been performed both for the past and the future. For all simulations presented here, the model is forced by the ERA-40 1990 meteorology.

THE MODEL

Meteorology:	**ERA-40** data
Vertical res.:	60 layers, surface – 0.1 hPa
Horizontal res.:	T21
Advection:	**S.O.M.** scheme
Chemistry:	tropospheric **and** stratospheric chemistry (incl.het. chem. and on-line J-values)

BL mixing, convective transp., lightning and aircraft emissions, dry/wet deposition are included

MODEL EXPERIMENTS

PAST: Time slice runs for 1850, 1900, 1950 and 1980 using the Edgar/Hyde database (Van Aardenne et al., 2001) for surface emissions and for 2000 the POET database (Olivier et al., 2003) .

FUTURE: Time slice runs for 2100 using IPCC SRES scenarios A1B, A2 and B1 (IPCC, 2001)

TIME SLICE RUNS FOR THE PAST

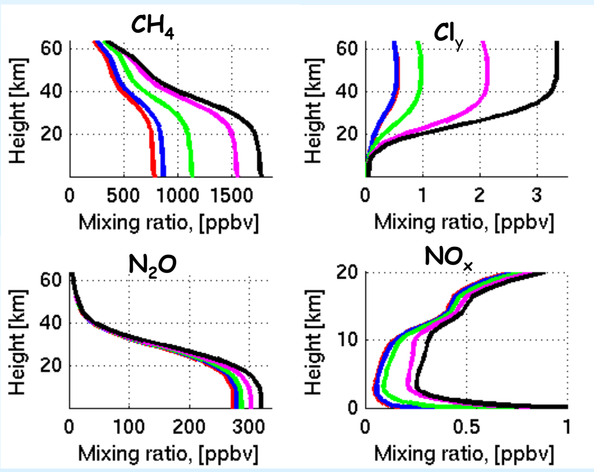

Figure 1: Vertical profiles of CH_4 (upper, left) and N_2O (lower, left), Cl_y (upper, right), NO_x (lower, right), red:1850, blue:1900, green:1950, magenta:1980, black:2000

➢The abundances of methane, nitrous oxide, chlorine and odd nitrogen as well as carbon monoxide, NMVOC and bromine have increased since pre-industrial times.

➢For the changes between 1980 and 2000 the decline in ozone in the stratosphere is large and the increase in the troposphere is small due to less increase in the ozone precursors.

➢The calculated decreases in stratospheric ozone are due to increased levels in chlorine, bromine and nitrogen with the largest relative decrease in the time period 1980 to 2000.

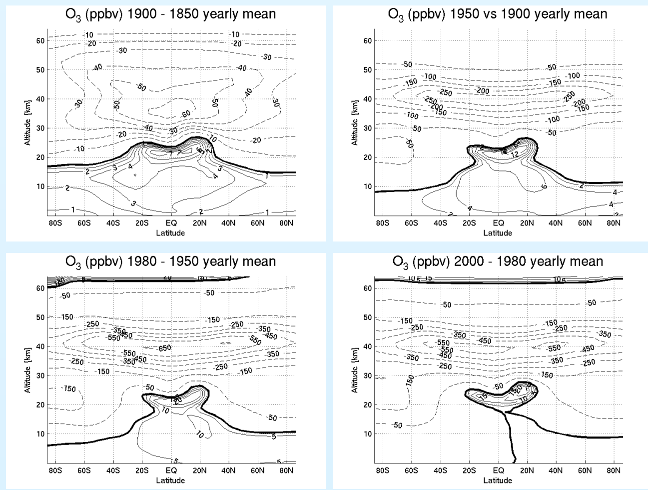

Figure 2: Absolute changes in yearly mean O_3 shown for 4 different time periods, 1900-1850, 1950-1900, 1980-1950 and 2000-1980.

TIME SLICE RUNS FOR THE FUTURE

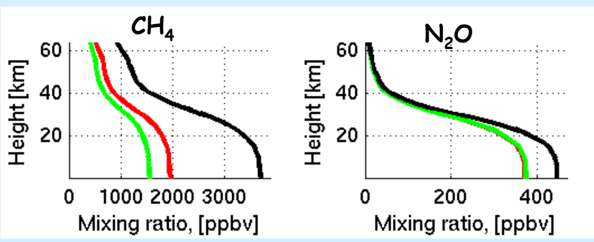

Figure 3: Vertical profiles of CH_4 (left) and N_2O (right) for 2100 for the 3 future scenarios, red:A1B, green:B1, black:A2

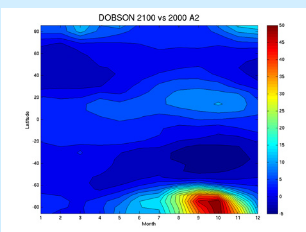

Figure 4: Calculated percentage changes for global ozone column between 2000 and 2100 shown for scenario A2.

➢Since N_2O induced reduction occurs mainly in the middle stratosphere and CH_4 induced production occurs in the troposphere and lower stratosphere the changes in the height profiles of ozone are significantly affected by this in addition to the effect of chlorine reduction.

➢Due to higher abundances of nitrogen in A2, the increase in column ozone between 2000 and 2100 at high latitudes are lower in A2 than in A1B and B1.

➢Decrease in column ozone is calculated between 2000 and 2100 at low latitudes, and the decrease is smaller in A2 than in A1B and B1 because of much higher abundance of CH_4.

➢Global mean ozone column in 2100:

A1	345.0
A2	347.5
B1	323.2

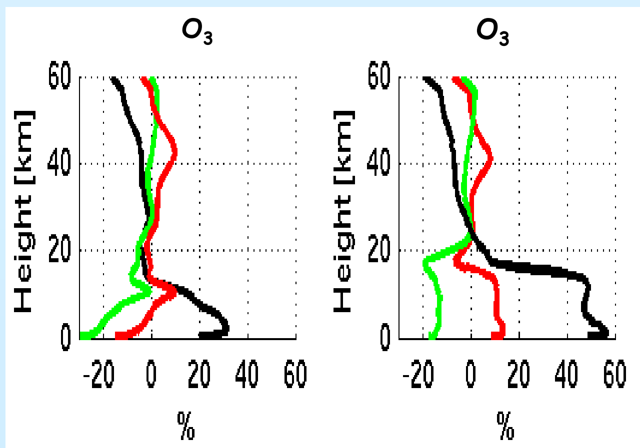

Figure 5: Vertical profile of calculated percentage change between 2000 and 2100 for yearly mean O_3 at 60°N (left) and Equator (right), red:A1B, green:B1, black:A2.

Summary

➢ Ozone column densities in 2100 are dependent on the adopted scenario including the relative changes in methane and nitrous oxides.

➢ Methane enhances the ozone columns and nitrous oxides reduces the ozone columns.

➢The largest increase in the global mean ozone column is calculated in the IPCC A2 scenario.

References

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