REanalysis of the TROpospheric chemical composition over the past 40 years (RETRO)

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Summary

The RETRO project aims at undertaking a comprehen- sive reanalysis of the global trends in air pollution over the past 40 years. Several global chemistry-transport models recently performed the first multi-decadal simulations of tropospheric ozone chemistry constrained by assimilated meteorological data from the ERA-40 reanalysis of ECMWF. New data sets of anthropogenic and vegetation fire emissions and a new climatology of lower stratospheric ozone concentrations were developed as boundary conditions. The RETRO project will terminate in June 2006, but the analysis of model results will continue beyond the funding period. This poster highlights some of the major project achievements. More details are given in the oral presentations and other posters of this session. For additional information, a list of RETRO publications, etc., please contact retro@dkrz.de or visit our web page http://retro.enes.org.

Observational Data Base

Considerable efforts have been spent in RETRO to develop a new data base of observations at NILU, which is equipped with a user-friendly web interface. Data sets from different sources were collected and stored in a common data format including standardized metadata information. Other work in this area includes the extension of the former TRADEOFF data base of aircraft observations at ETH-Z, and the analysis of early ozone measurements from the GASP program, from ozone sondes, and from aircraft campaigns of the 1950

Status of the NILU data base of observations

Data origin	Data type	Number of stations	Number of files
WOUDC	ozone sondes	109	40484
WDCGG	surface ozone	26	26
GMD/CMDL	surface CO	38	38
EMEP	surface O_3, SO_2, NO_2	79	1949
GOME	column NO_2, CH_2O	global fields	N.A.

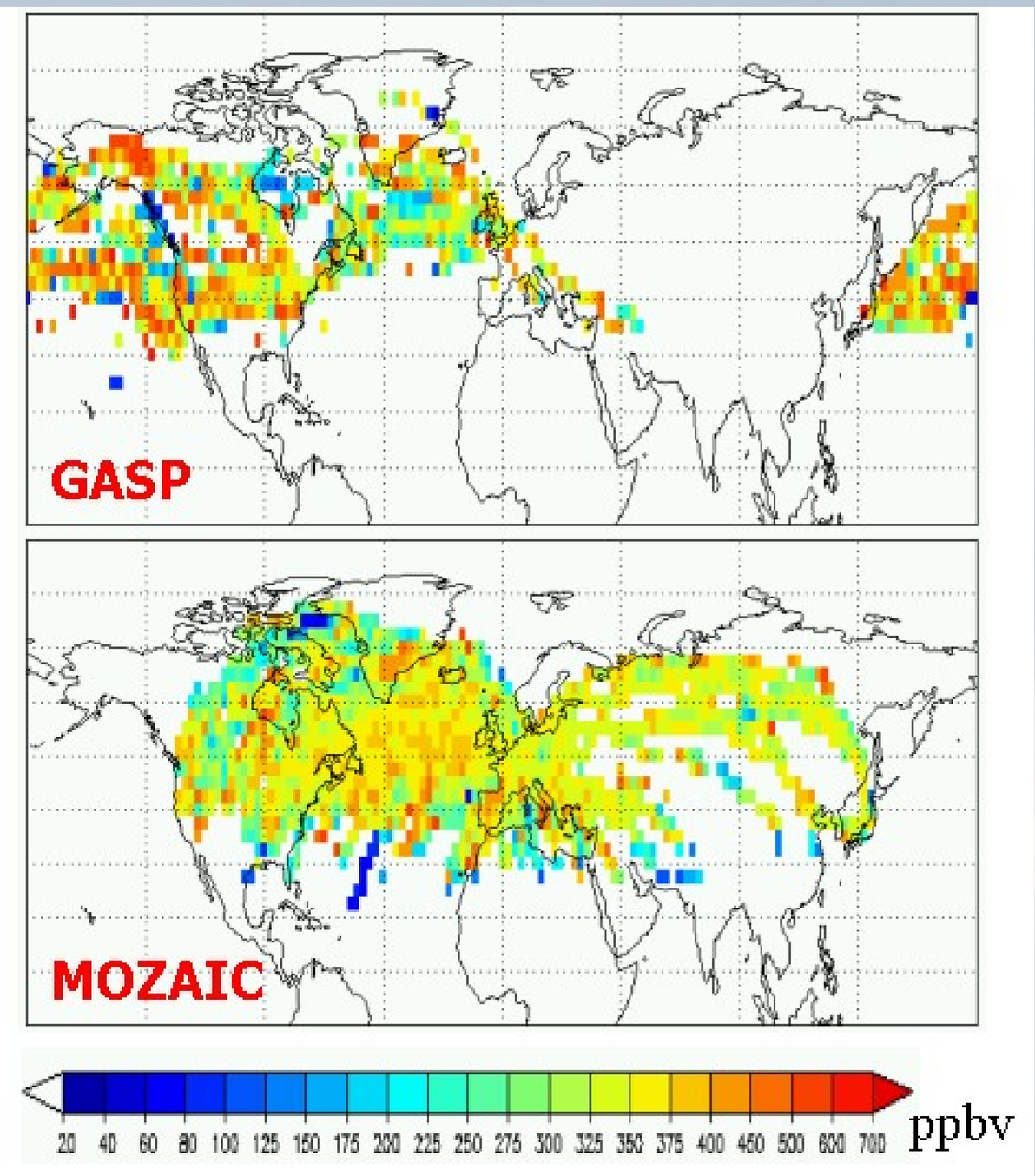
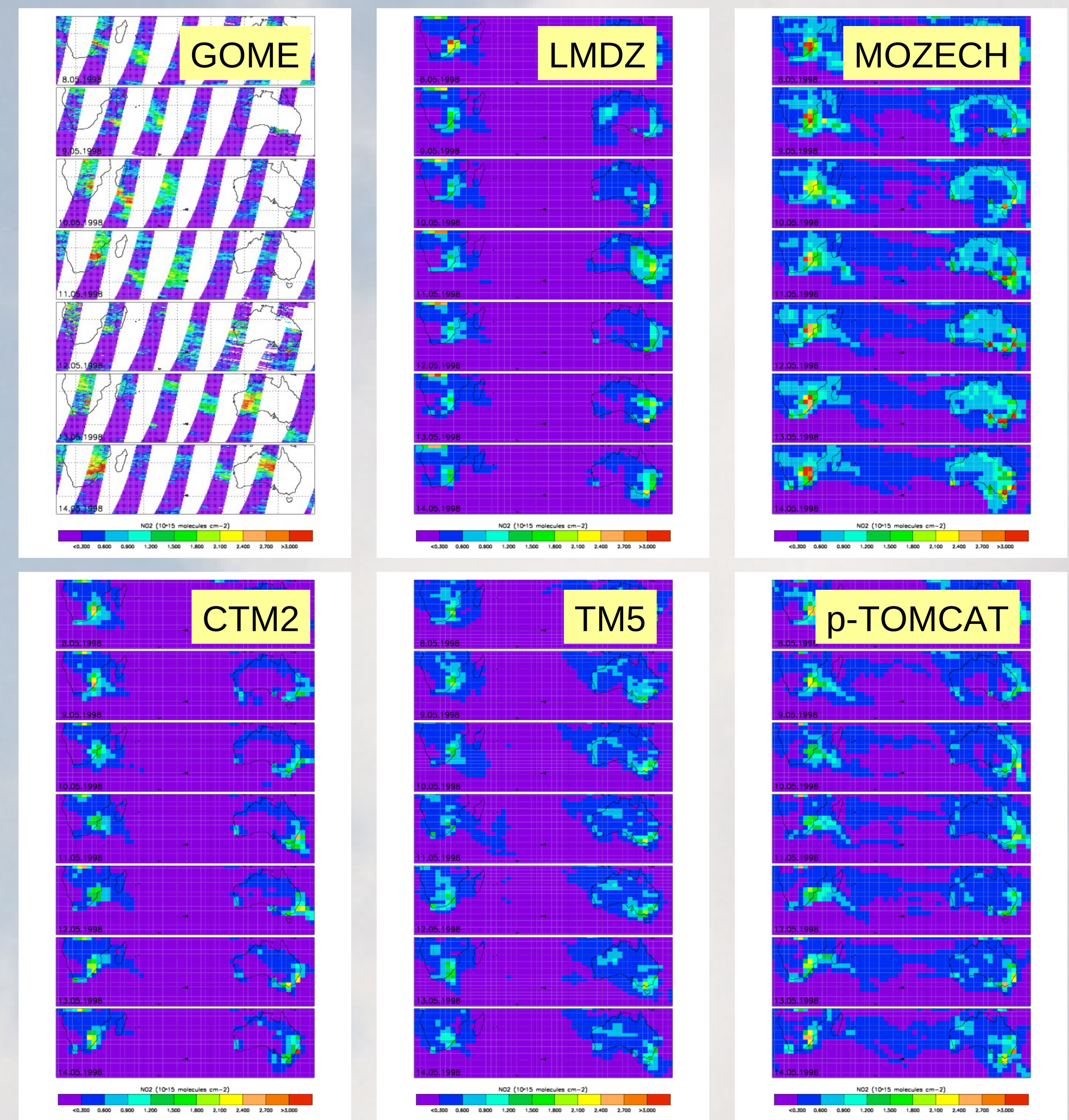


Figure 3: Comparison of ozone climatologies from GASP (1975-1979) and MOZAIC (1994-present).

Sensitivity Studies

In order to investigate the causes for the observed trends in background ozone and precursor concentrations, a number of sensitivity studies were performed where either emissions or meteorology were kept constant. By participating in the ACCENT/IPCC Photocomp experiment, all RETRO models were also run with a different set of emissions data.

The quality of the model results has been tested by careful evaluation with different data sets. As one example, figure 5 (on the right) shows a comparison of GOME NO2 column measurements (Bremen retrieval) with the different models for a selected episode of long-range transport from South Africa into the South Pacific region. While all models capture the event as such, the simulated NO_2 concentrations are rather different.



Emissions

A new data base of anthropogenic activities, technology penetration, and emission factors was developed at TNO. Global gridded emission data sets with monthly time resolution were produced for CO, NO_x, and 23 NMVOC species (Figure 1). The TNO data was augmented with emissions from international ship traffic derived from Endresen et al., 2003 with trend estimates deduced from bunker fuel sales. Vegetation fire emissions were derived from a literature review with input from a newly developed ecological fire model.

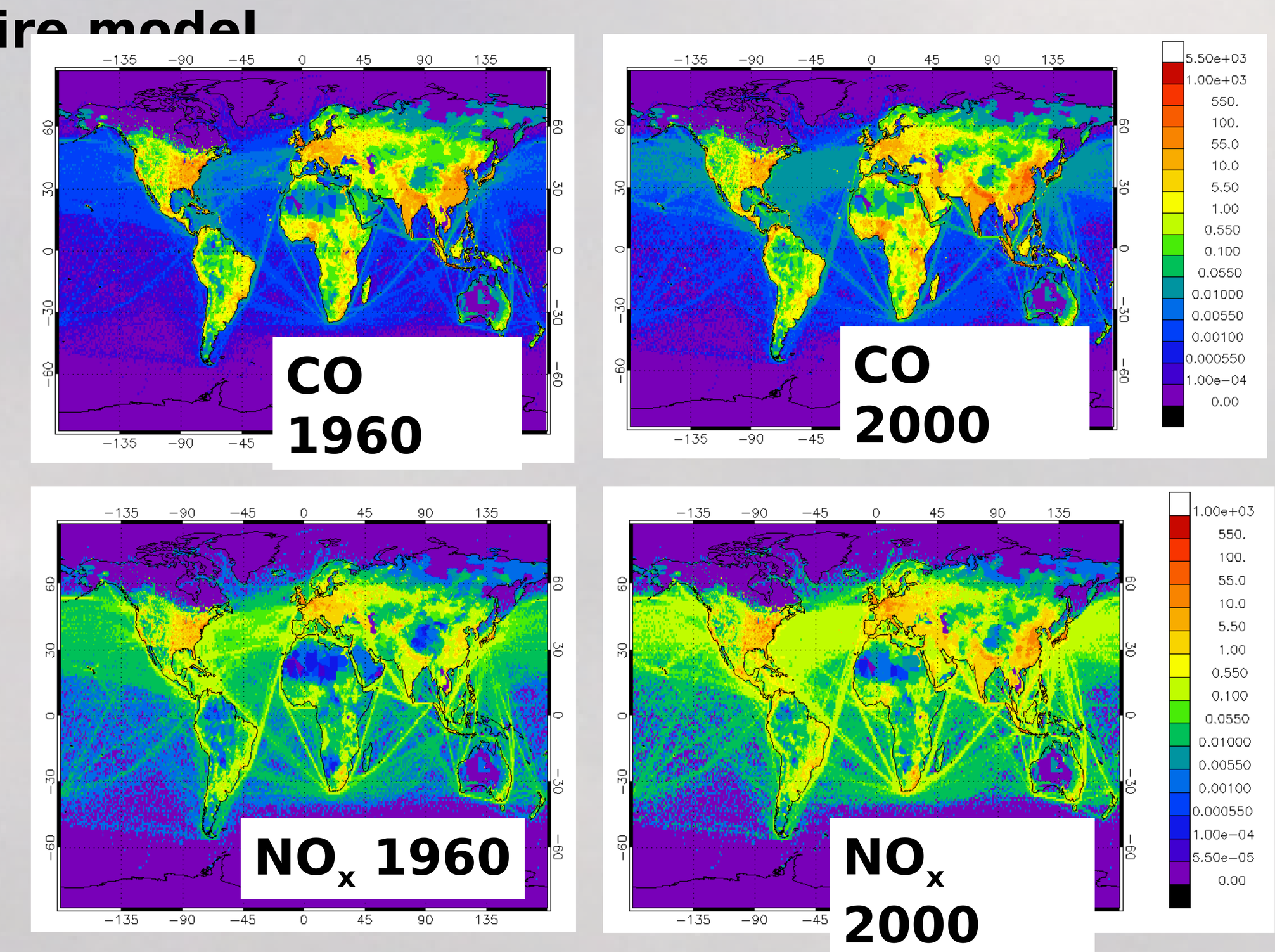


Figure 1: Anthropogenic CO and NO_x emissions for 1960 and 2000 [ktons/gridbox/year]

For many species, the dominant trends arise from changes in road traffic and in the residential sector. The general increase in global emissions until about 1980 is levelling off or even declining afterwards (Figure 2). Emission decreases in western countries are balanced by increasing emissions in Asia. Inter-annual variability is largely determined by vegetation fire emissions.

NOx emissions from lightning and biogenic VOC emissions were computed interactively. All RETRO emission inventories are publically available: http://retro.enes.org/emissions.

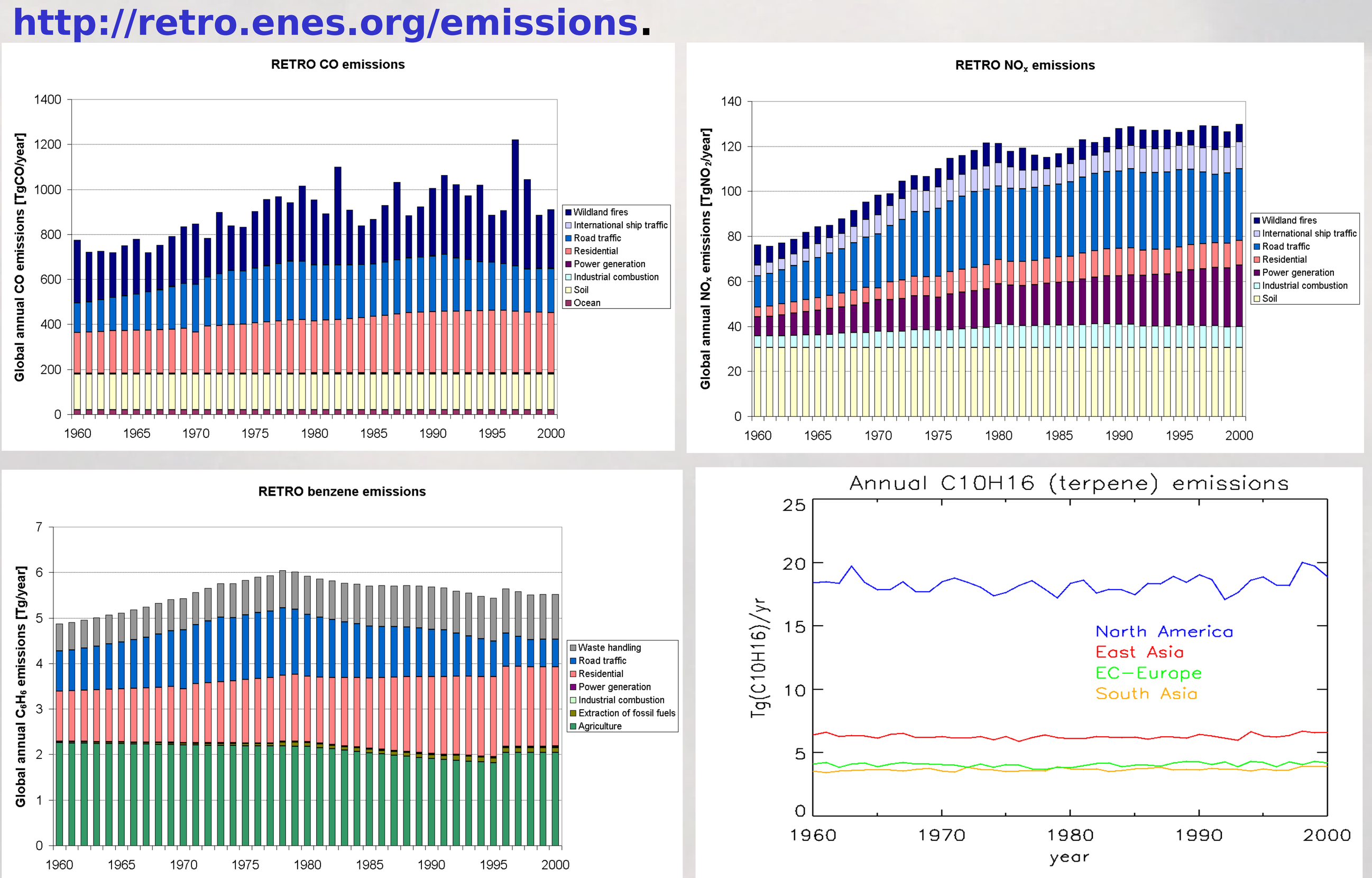


Figure 2: Time series of RETRO emissions for CO, NO_x, and benzene and regional emission trends of biogenic terpene emissions computed interactively in MOZECH

Reanalysis Simulations

Three of the five RETRO models have simulated the complete 40-year period from 1960 to 2000. Until now, we have analysed trends of the tropospheric ozone budget, regional ozone burdens, and the tropospheric lifetimes of methane and methyl chloroform (see other RETRO posters at this conference). Concentration maps and zonal mean cross sections of several important trace gas species are made available at the interactive web interface at http://retro.enes.org/if/index.html

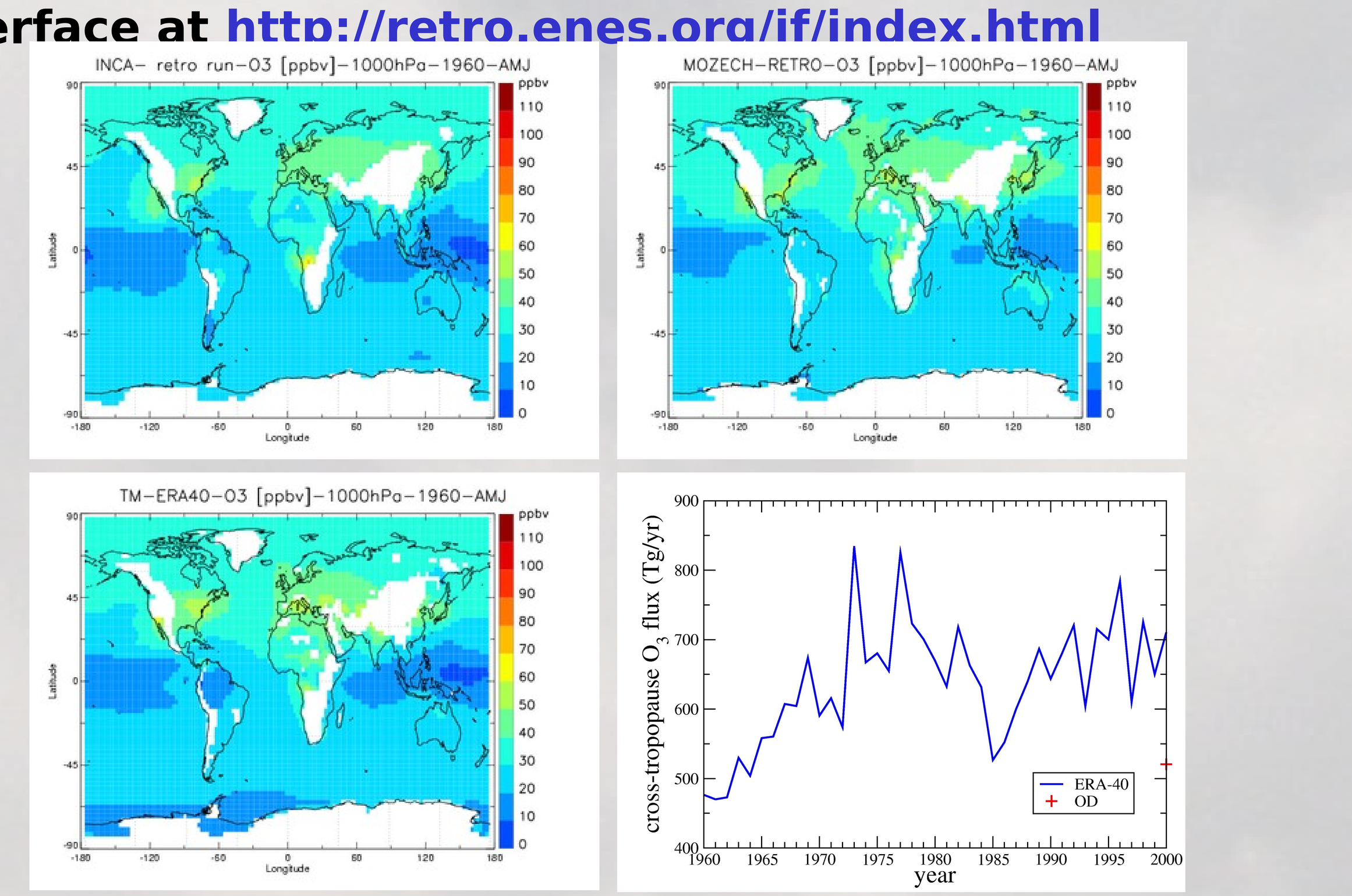
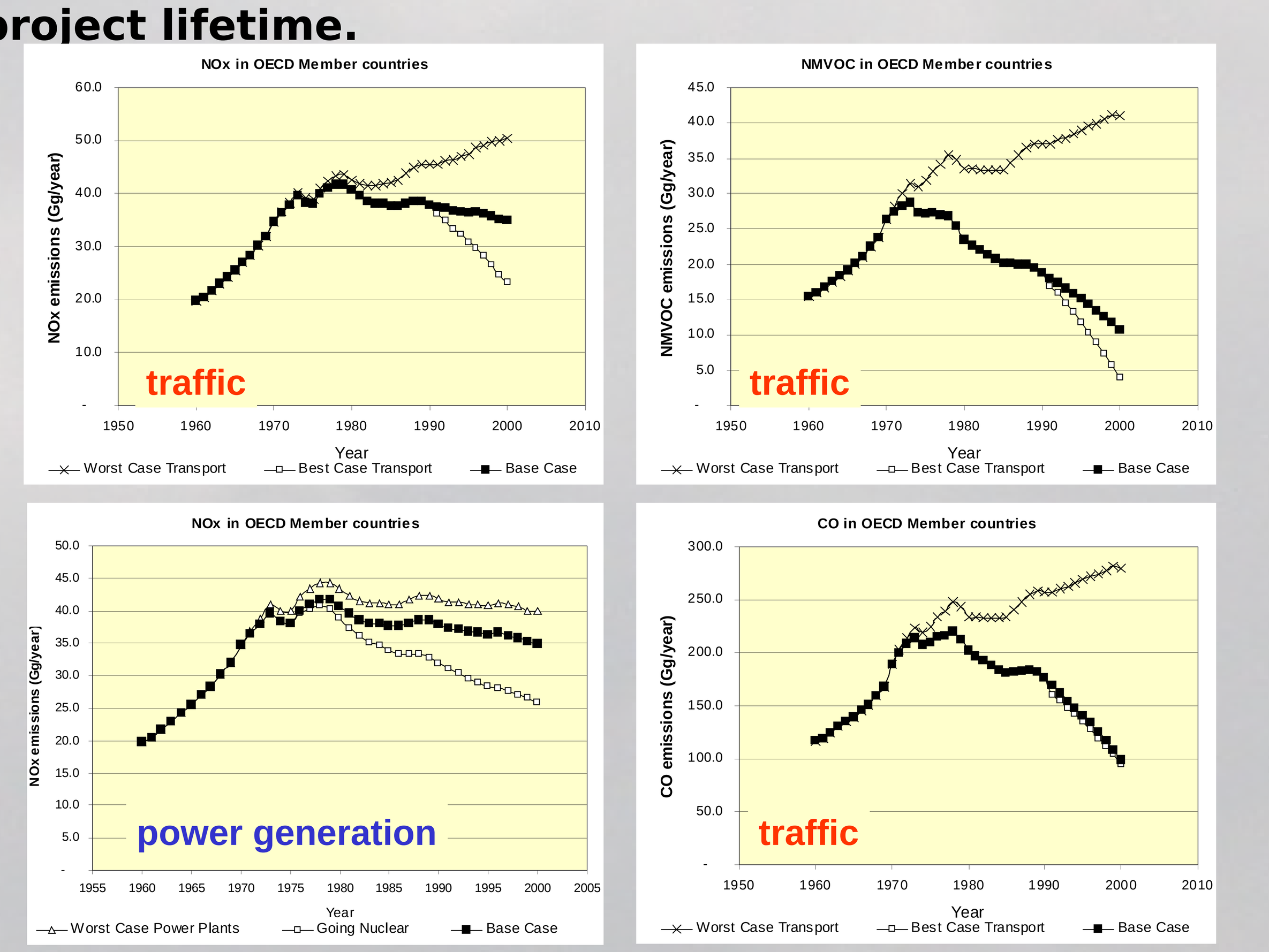


Figure 4: Surface ozone concentrations for spring 1960 from three selected models and 40-year trend of simulated stratosphere-troposphere exchange flux of ozone from TM

Policy Implications

In the final phase of the project we will investigate the relevance of our results for past and future emission control measures. We have selected two main topics for this purpose: emissions from car traffic and emissions from power generation. TNO used its TEAM data base to develop different scenarios, and the RETRO models will soon run sensitivity simulations with these. Some partners plan to continue this activity beyond the actual project lifetime.



Other RETRO contributions to this conference

- J Staehelin et al., TROPOSPHERIC OZONE TRENDS [...] IN THE NORTHERN HEMISPHERE [...]: oral A-04399
- A. Prevot et al., AIR POLLUTION TRENDS AROUND THE ALPS SINCE 1992: oral A-04748
- D. Hauglustaine et al., A MULTI-MODEL SIMULATION OF THE TROPOSPHERIC COMPOSITION OVER THE LAST 40 YEARS: oral A-09464
- S. Rast et al., MULTIMODEL ANALYSIS OF THE SENSITIVTY [...] TO EMISSIONS: oral A-04450
- S. Rast et al., ANALYSIS OF TRENDS [...] SIMULATED WITH MOZECH: poster A-04463
- S. Szopa et al., TRENDS AND VARIABILITY OF TROPOSPHERIC OZONE [...] OVER EUROPE [...]: poster A-03926
- N. Savage et al., STUDIES OF SEASONAL CYCLES AND SENSITIVITY [...]: poster A-04221
- T. van Noije et al., MODEl SIMULATIONS OF TROPOPHERIC NO2 COMPARED WITH GOME RETRIVALS [...]: poster A-08247
- F. Wittrock et al., MODEL SIMULATIONS OF FORMALDEHYDE COMPARED WITH GOME OBSERVATIONS: poster A-08770
- A. Vik et al., THE RETRO DATABASE FOR OBSERVATIONS: poster A-07737

Acknowledgement

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