IMAU
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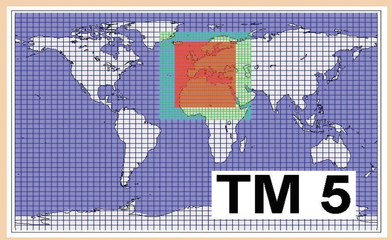
Modelling the composition of the atmosphere

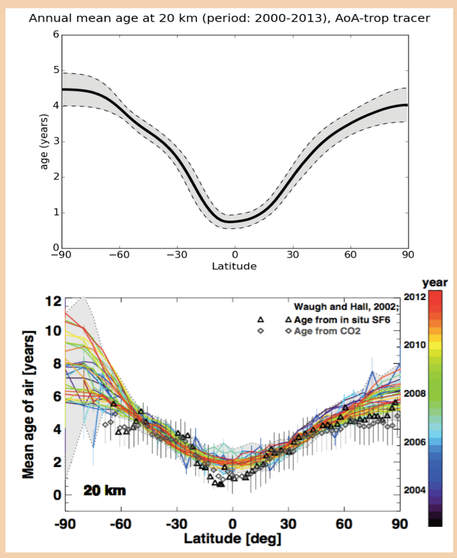
Within the IMAU atmospheric physics and chemistry group (APCG) atmospheric transport and chemistry models are used to investigate the composition of the atmosphere. We study the transport of atmospheric pollutants, the interactions between atmospheric chemistry, aerosols and climate, and we derive emissions of greenhouse gases based on a wide range of ground-based and satellite data. Some examples are shown below.

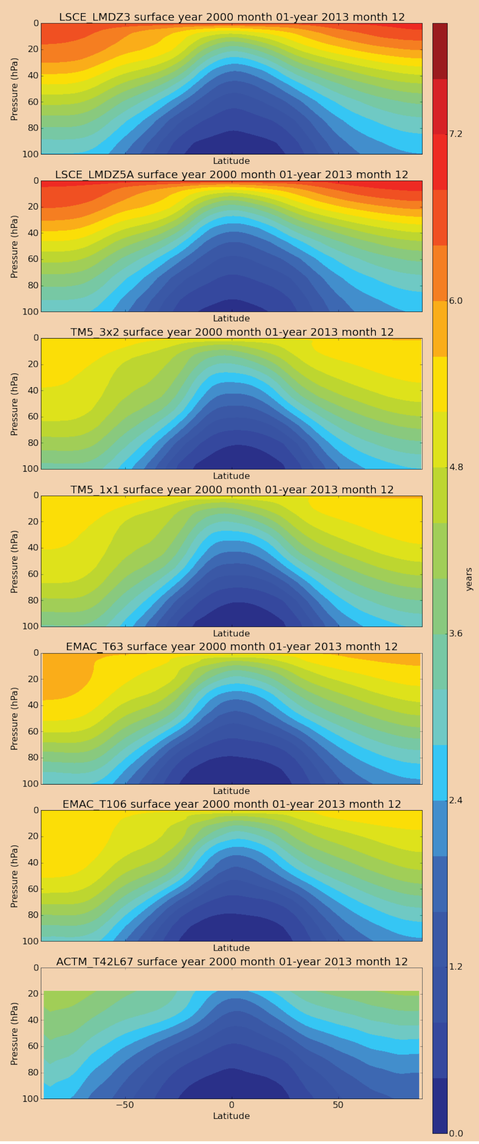
Atmospheric transport

We use the TM5 global transport model to simulate greenhouse gas concentrations, air quality, atmospheric chemistry and aerosols, and to optimize emissions based on ground and satellite observations.



The TM5 model participated in the TRANSCOM Age of Air model inter-comparison, which aims to compare several important transport characteristics in models, such as exchange between the stratosphere and the troposphere. The transport timescales in TM5 are compared to those in other modes (figures on the right) and to estimates based on observations of SF_6 and CO_2 (figures below).

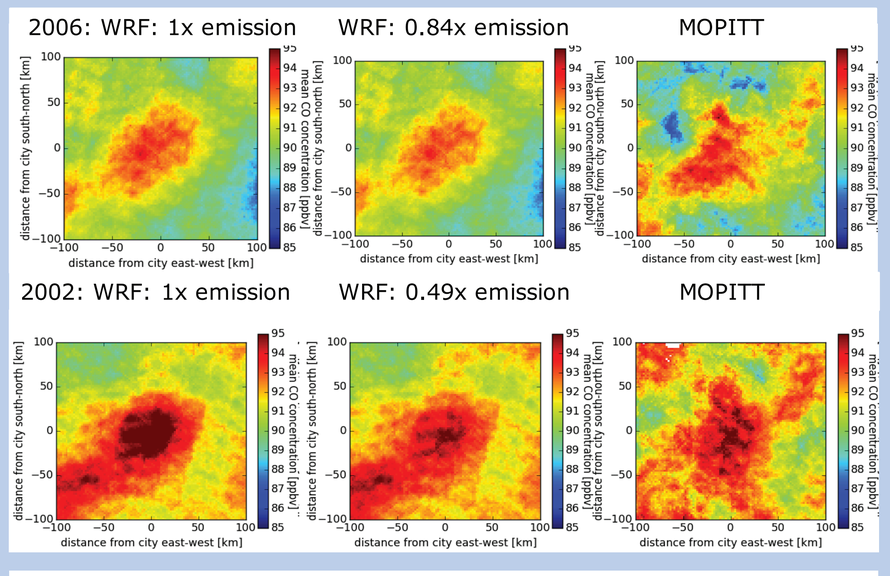


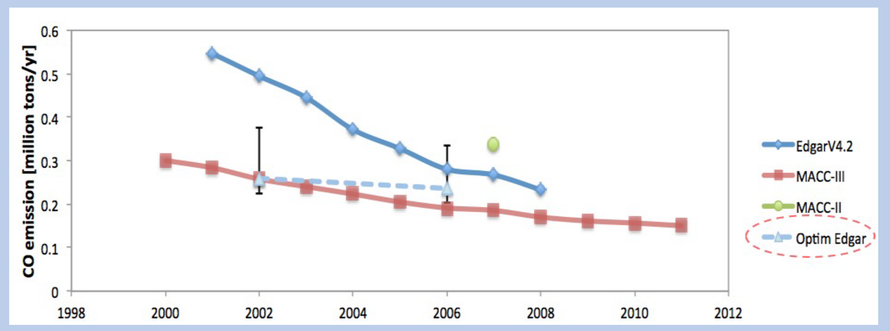


Use of satellite data

With the improving availability and quality of satellite data products, these are increasingly being used for estimating emissions of different pollutants in the atmosphere.

In this case, CO emissions and emission trends are estimated for the city of Madrid based on the MOPITT data, using the WRF regional transport model.
The MOPITT data do not confirm the significant decrease in CO emissions over the period 2002-2006 that is estimated by emission inventories.



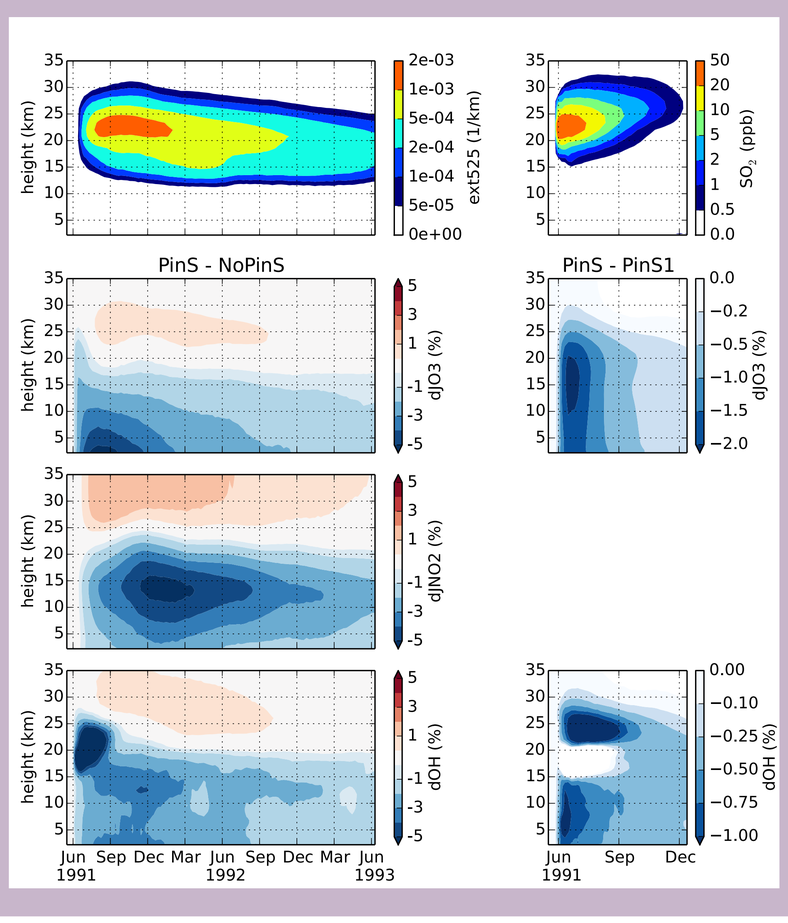


Atmospheric chemistry and aerosols

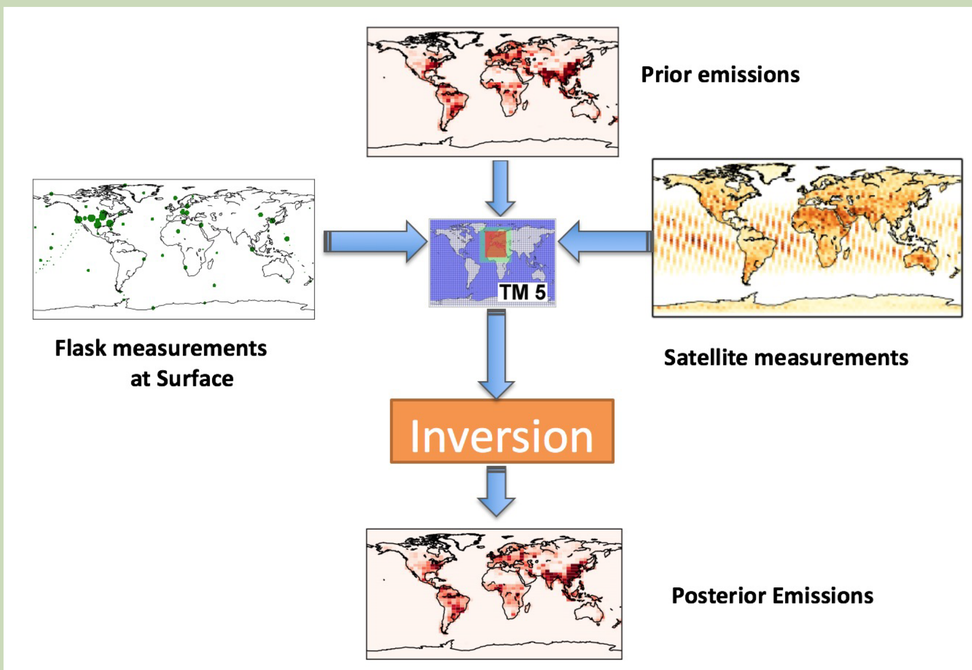
We investigate aerosol and chemistry processes using the chemistry version of the TM5 model. We also use TM5 within the EC-Earth global climate model to look at interactions between aerosols, chemistry and climate.

An important compound in the atmosphere is the hydroxyl radical OH, the 'detergent' of the atmosphere, which reacts with many compounds such as CO and CH_4 and controls their atmospheric lifetimes. OH concentrations are determined by complex photo-chemistry that occurs in the presence of UV radiation.

The plots below illustrate the OH chemistry changes caused by stratospheric sulfate aerosols and SO_2 from the Pinatubo eruption in 1991. The amount of UV reaching the troposphere decreased, causing a decrease in photolysis rates of ozone and NO_2 and a corresponding decrease in OH.



Inverse modelling of greenhouse gases



The inverse modelling technique is used to estimate emissions of greenhouse gases and pollutants based on measurements on ground and from satellites.
A priori emission estimates from emission inventories are used as first guess in the inverse modelling machinery, which also includes the atmospheric transport model TM5. The optimization system then generates posterior emissions, which are consistent with flask and satellite measurements of the GHG (CH_4, CO_2, etc).

A CH_4 inversion was performed for the year 2010 assimilating GOSAT satellite observations and NOAA flask measurements. The results show that emissions in Temperate Eurasia (mostly in China) are overestimated by ~25 Tg/yr. At the same time, emissions in Southern America and Southern Africa are underestimated by the prior inventories EDGAR and GFED.