LOTOS-EUROS v1.7

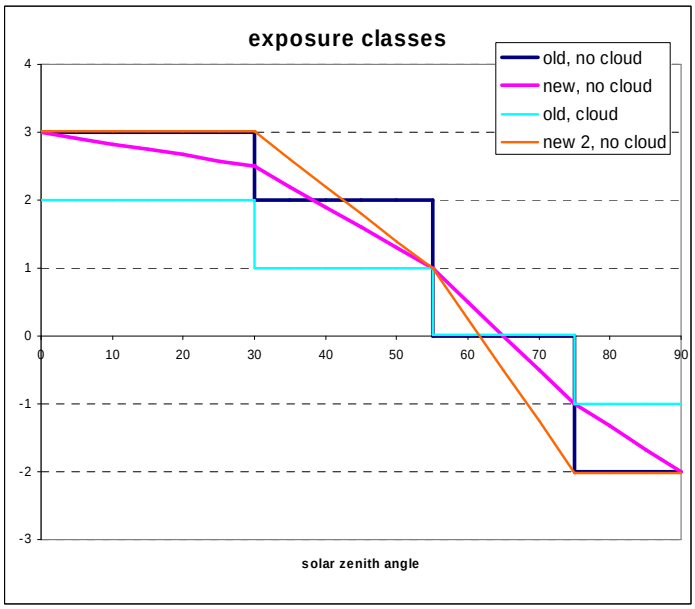
Validation report, 18-1-2011
Astrid Manders and Renske Timmermans

New features of the model

The basis of this version was version 1.6 plus patch 1 to 3. Functional changes with respect to this version are made in the following processes:

Stability

- Exposure class was a function of solar zenith angle, but in discrete steps of 15-30 degrees. This has been altered in a more smooth function of solar zenith angle



- Stability is calculated explicitly for each land use class (code from MAPESI project). The overall average is still used for mixing to observation height (2.5 m).
- Htop was set to 25 m. In the calculation of the stability parameters the vegetation height can be taken into account in principle, but this leads to inconsitencies for the translation of model level to ground level where the grid-cell average is used. Therefore the vegetation height was set to zero. Furthermore, for urban are this height was 0 in the previous formulation., whereas buildings may even be higher than trees.

Deposition

- Emberson parameterisation is now default instead of wesely (was default). Wesely and Baldocci are still optional by using a switch in rc_gas.F90. For Baldocchi's ozone flux calculation a correcton according to Simpson was implemented for the leaf are aindex, this is not done for the Emberson ozone flux calculation. The routine rc_gas.F90 is not yet adapted to benefit from running in parallel.
- The land use dependent Ra is now included in the calculation of deposition. For the deposition of particles however, the grid cell averaged z0 is still used
- Daily ozone fluxes can be put out as part of the deposition output.

An additional module was made (depoparameters.F90), containing all land-use dependent parameters, so that when changing these parameters, they only need to be changed at 1 location. However, the exception is that in rc_gas.F90 still many hard-coded if structures occur. (if (landuse.eq.1) then….). Also for the calculation of sea salt the land use class for sea (water) is still stated explicitly in seasalt.F90

Sea salt

- Martensson parameterisation for particles < 1um, so for PM2.5 the interval is divided into 2 parts. Martensson requires sea surface temperatures. If they are not available, the old Monahan routine can be readily used.
- For the Baltic sea a correction was used to compensate for the much lower salinity in this region. This results in a factor 10 lower sodium emission for this area.
- For the Ijsselmeer and Wadden Sea region, the sea salt emission is set to zero, since the land use map does not discriminate between sea and inland water.
- For wind speeds higher than 12.5 m/s, the effective wind speed for the whitecap coverage was set equal to 12.5 m/s
- If sea water temperature is not available, one can use the traditional Monahan routine, by adding the project seasalt_monahan to the rc-file

If sea salt is the main subject of study, it is strongly recommended to extend the modelling domain to 30 W.

Meteorology: in rc-file the option ecmwf_extra should be used, to be able to read fields which are important for sea salt emissions which are now part of the basic version.

Ouput conventions: Some meteorological variables were not written to file in the units that were indicated (h, rain,), which was corrected.

Results

Validation was mainly done for 2003, to be compatible with the previous validation documents and to because of the availability of observations to compare with. The validaion was done with the old Monahan sea salt routine. A separate validation of the new sea salt routine is given at the end of the document. First, annual averages and time series are compared. In the figures, time series are in ppb, annual averages in ug/m3. Then the results are compared with observations.

Main observations

- Overall, concentrations have decreased slightly because of the new deposition scheme. Notable exceptions are ozone concentrations, which have increased in some areas, and NO2 concentrations which have increased slighly in the marine environment.
- Ozone fluxes have been put out but were not validated
- The run time of the new version has increased in the order of 10%, partly because of the new deposition scheme. When using additional meteorology and meteorological fields from a larger domain, the reading and handling of the meteorology also takes more time.
- Comparison with EMEP observations show that the correlation has remained the same, but that most species are underestimated a few percent more.

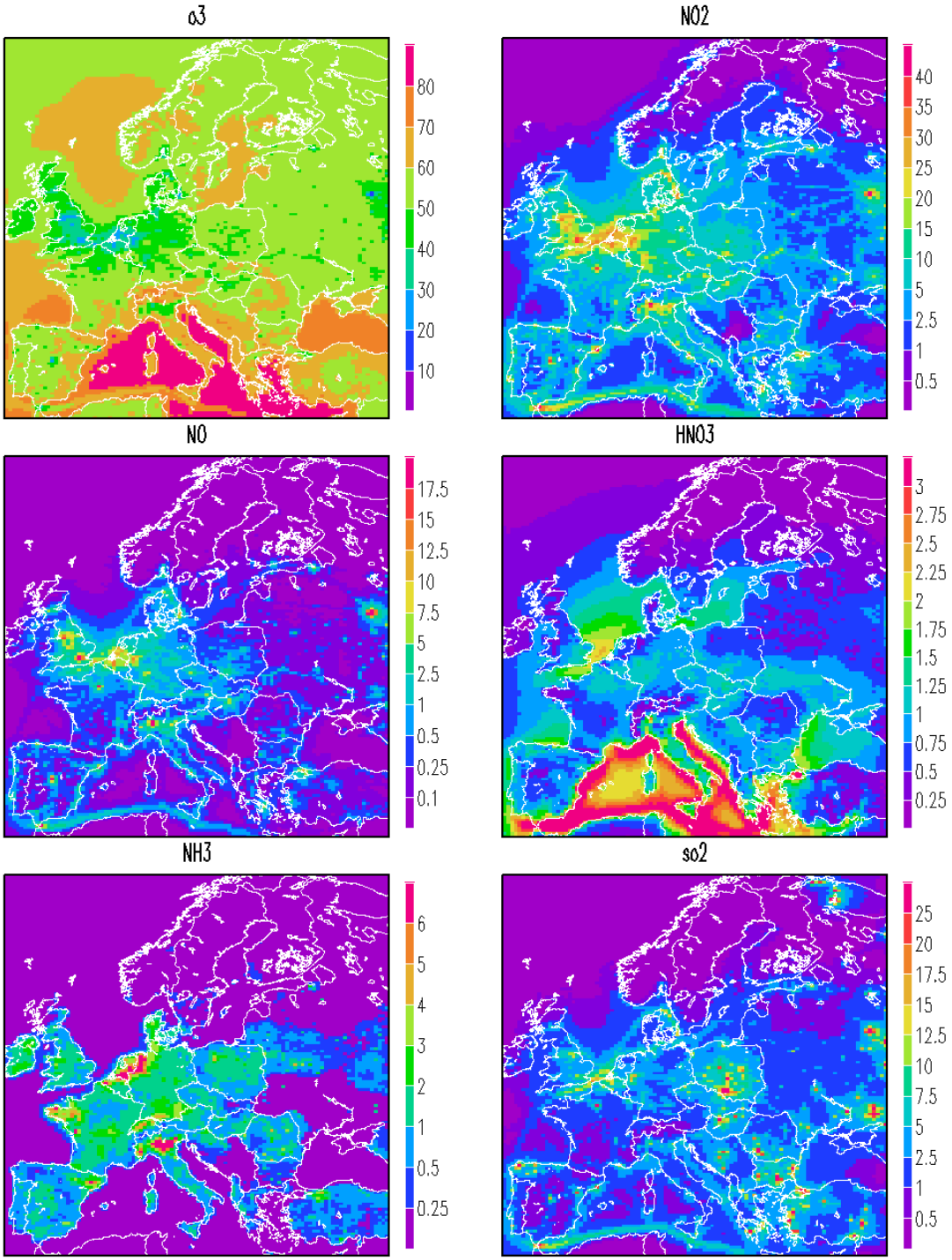


Figure 1: annual mean gas concentrations, v1.6.3

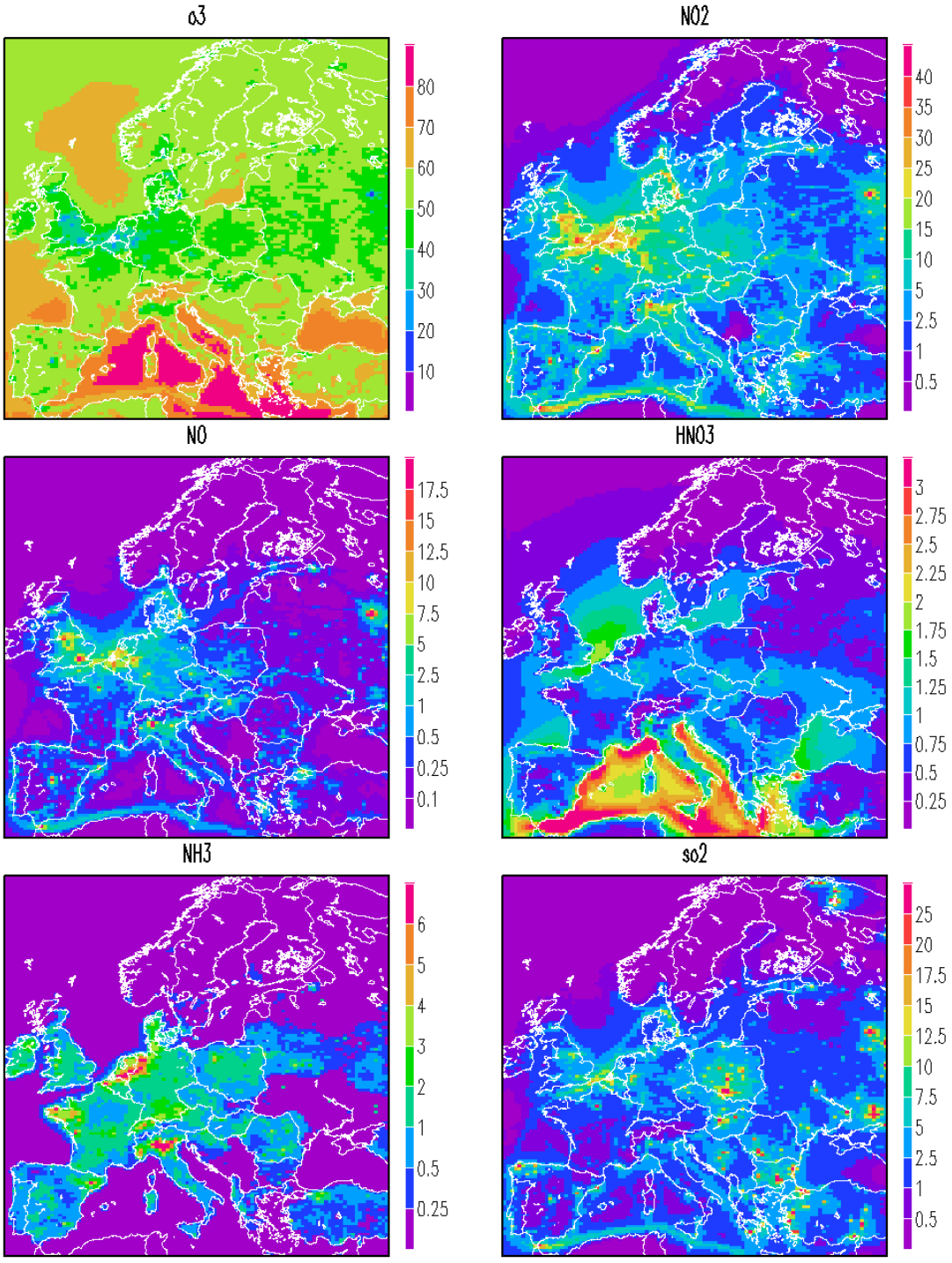


Figure 2: Annual mean gas concentrations 2003, v1.7

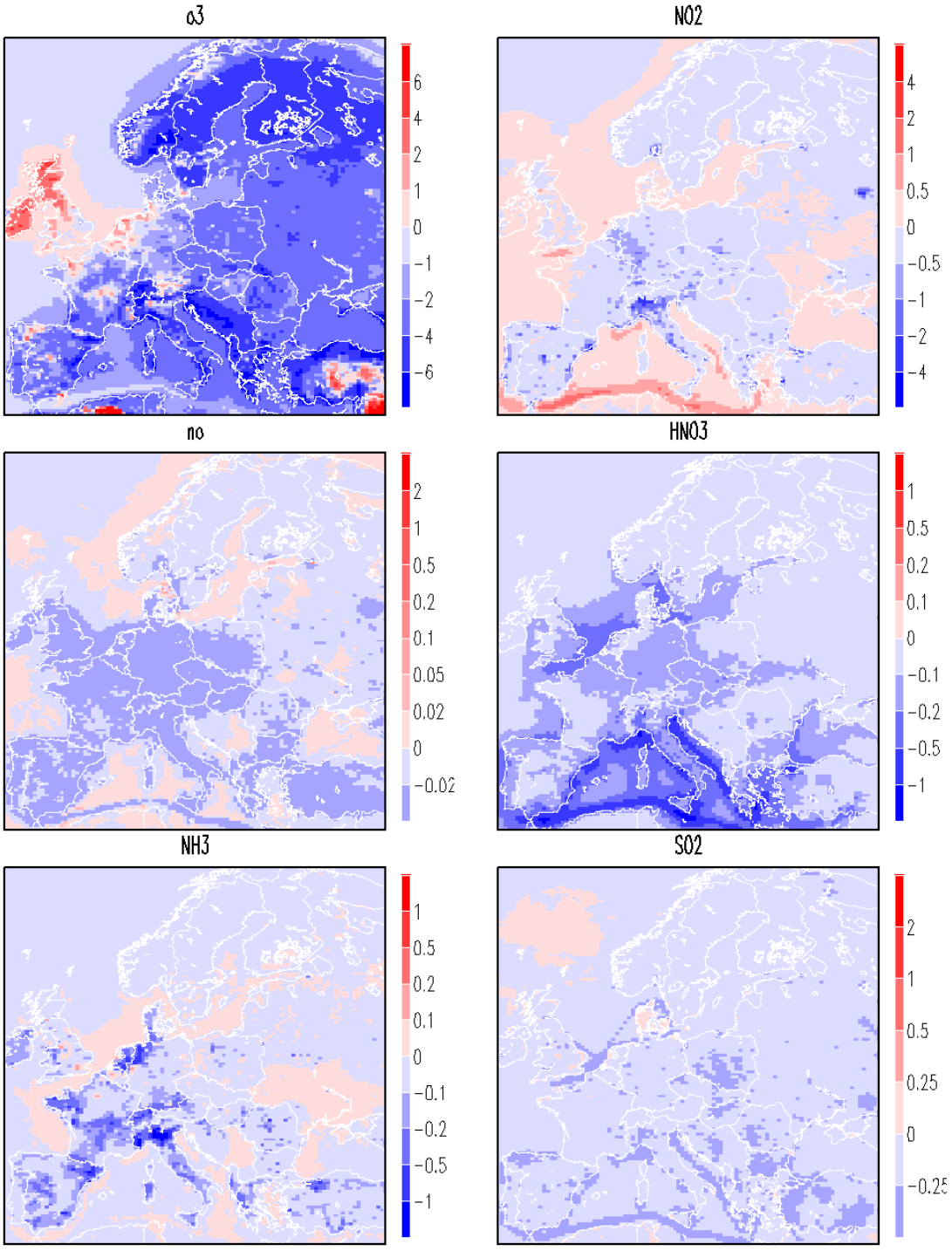


Figure 3, diffecence in annual average gas concentrations 2003 , v1.7-v1.6.

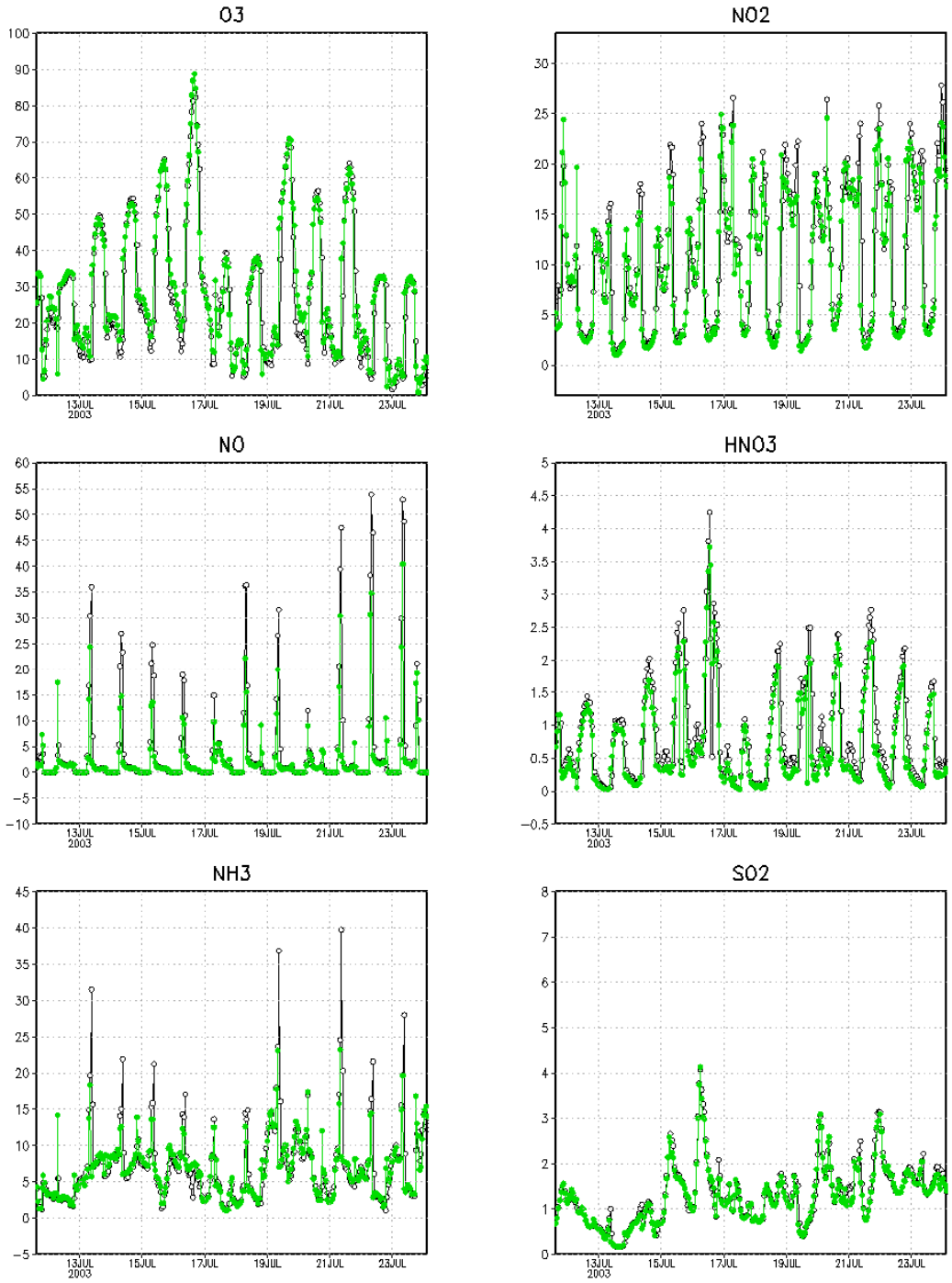


Figure 4: Time series of gas concentations (ppb), 52 N 5 E, black=v1.6.3, green=v1.7

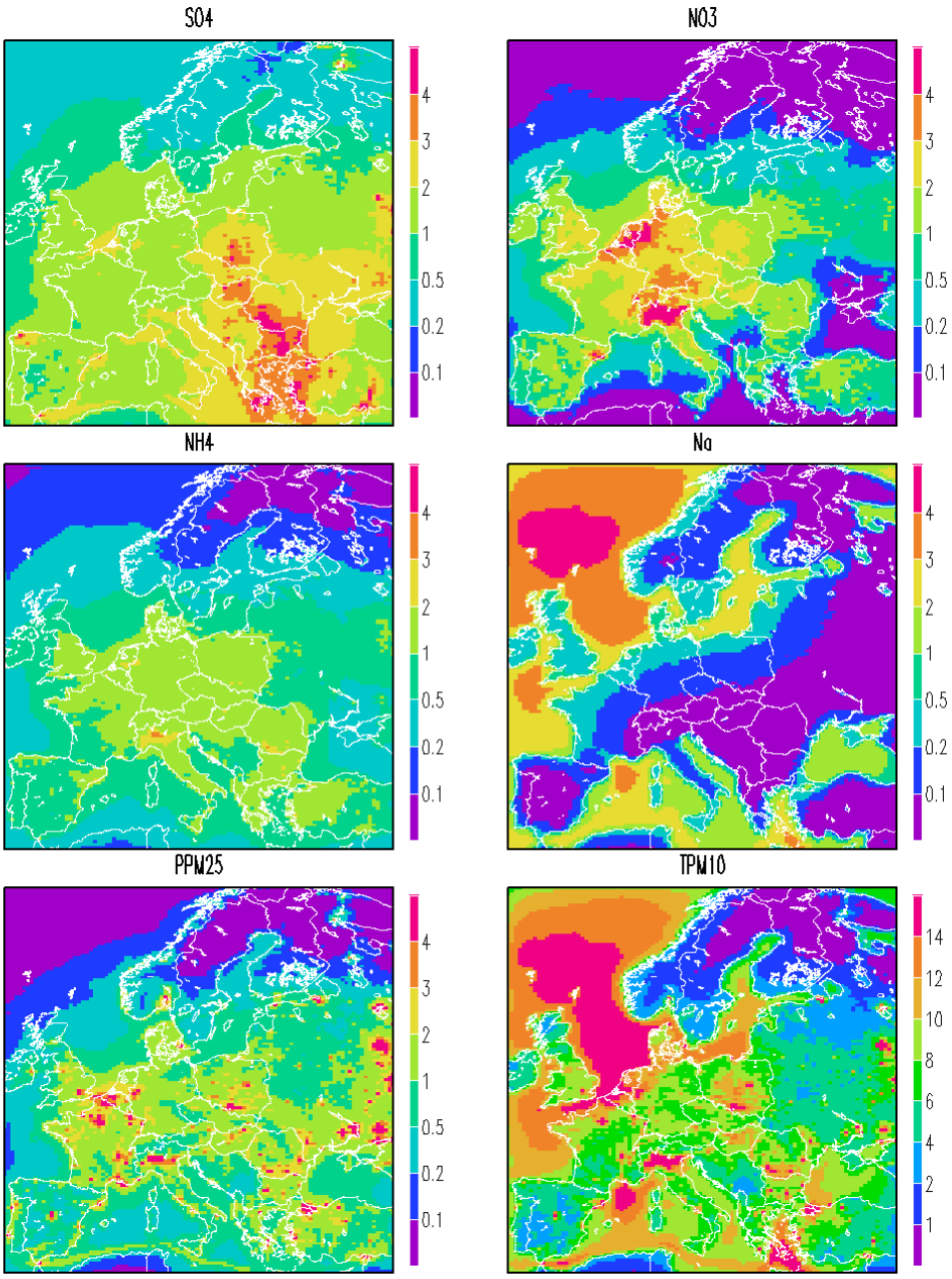


Figure 5: Annual mean aerosol concentrations 2003, v1.6.3

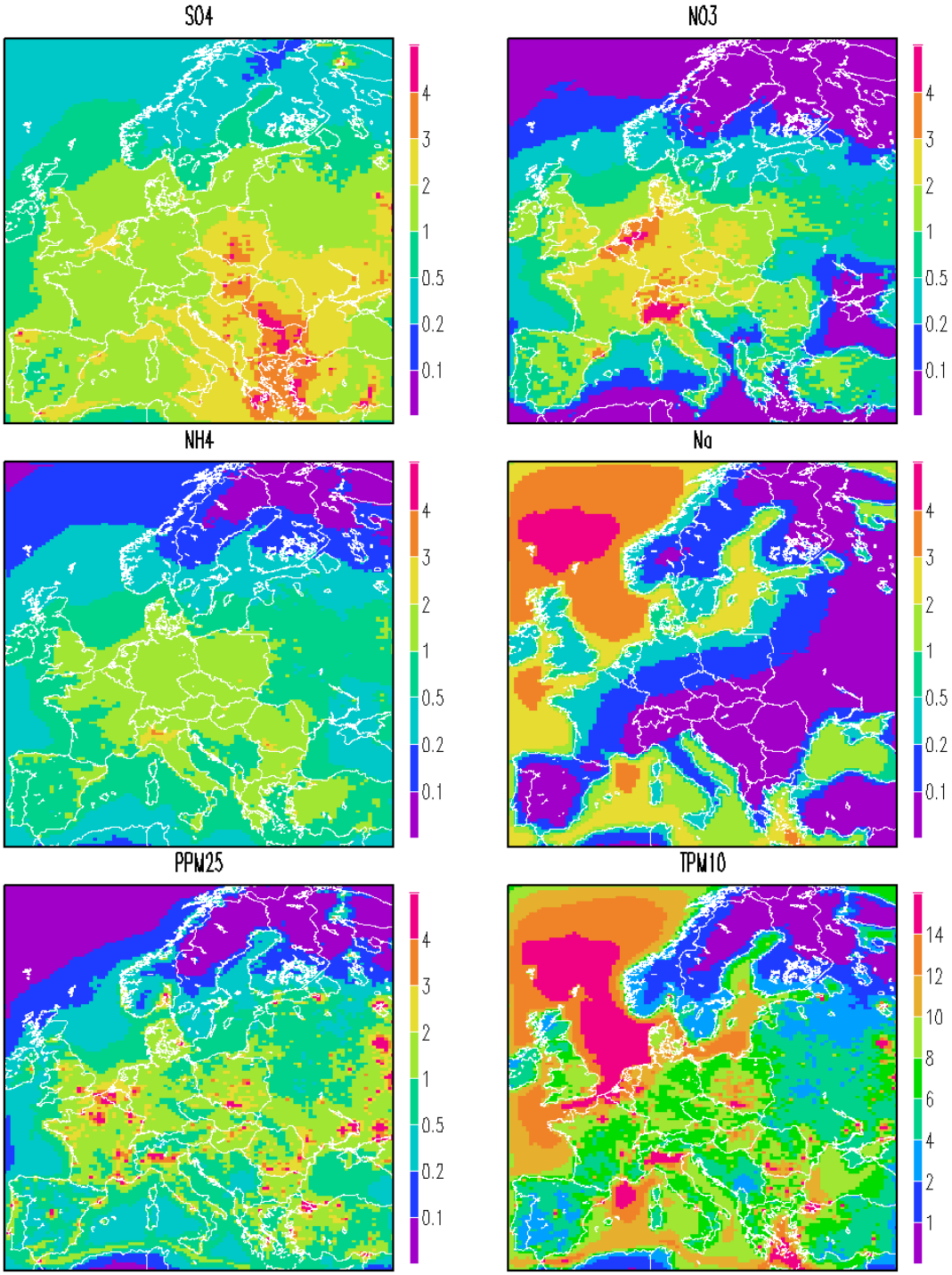


Figure 6: Annual mean aerosol concentrations, 2003 v1.7

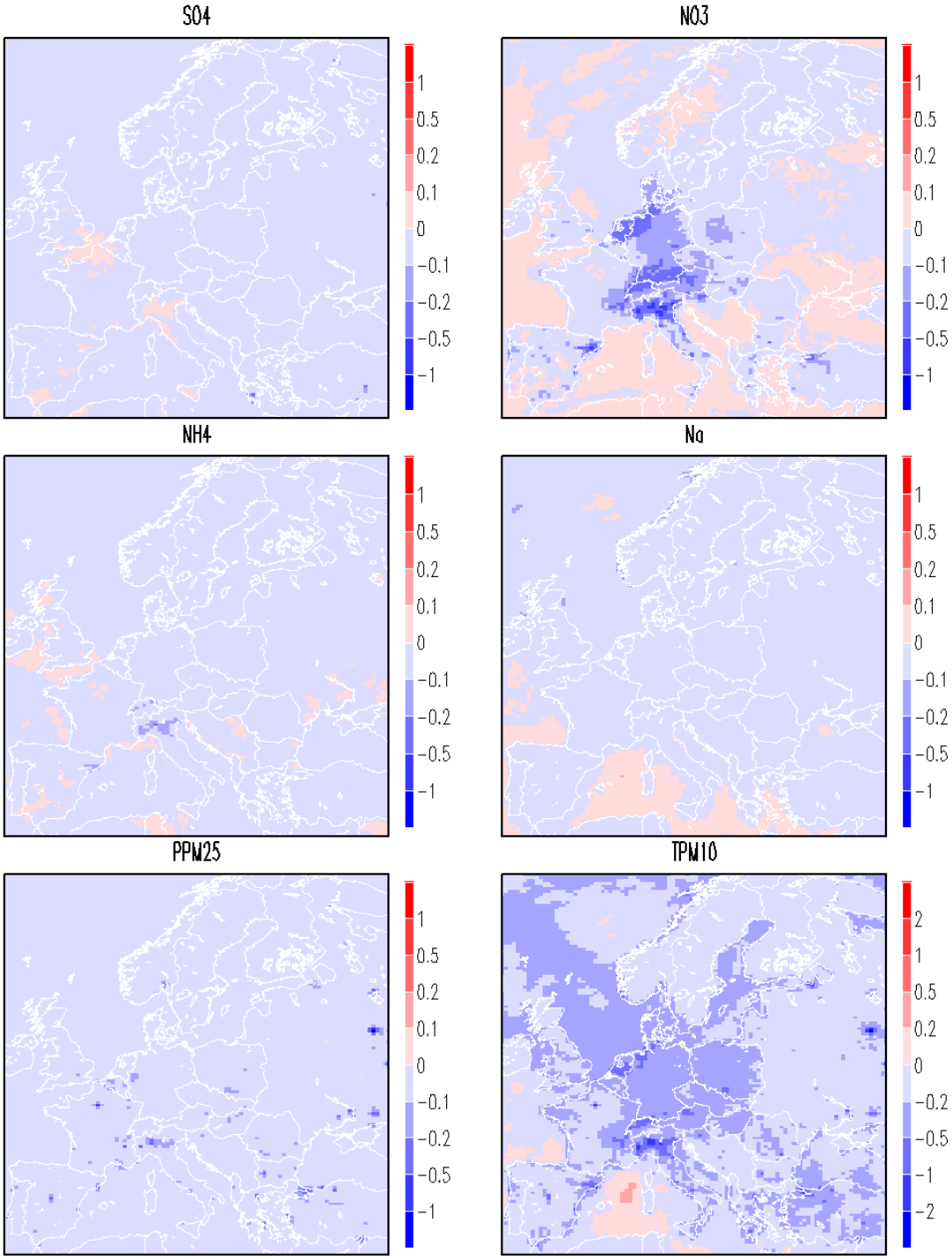


Figure 7: Difference in annual mean aerosol concentrations, v1.7-v1.6.3.

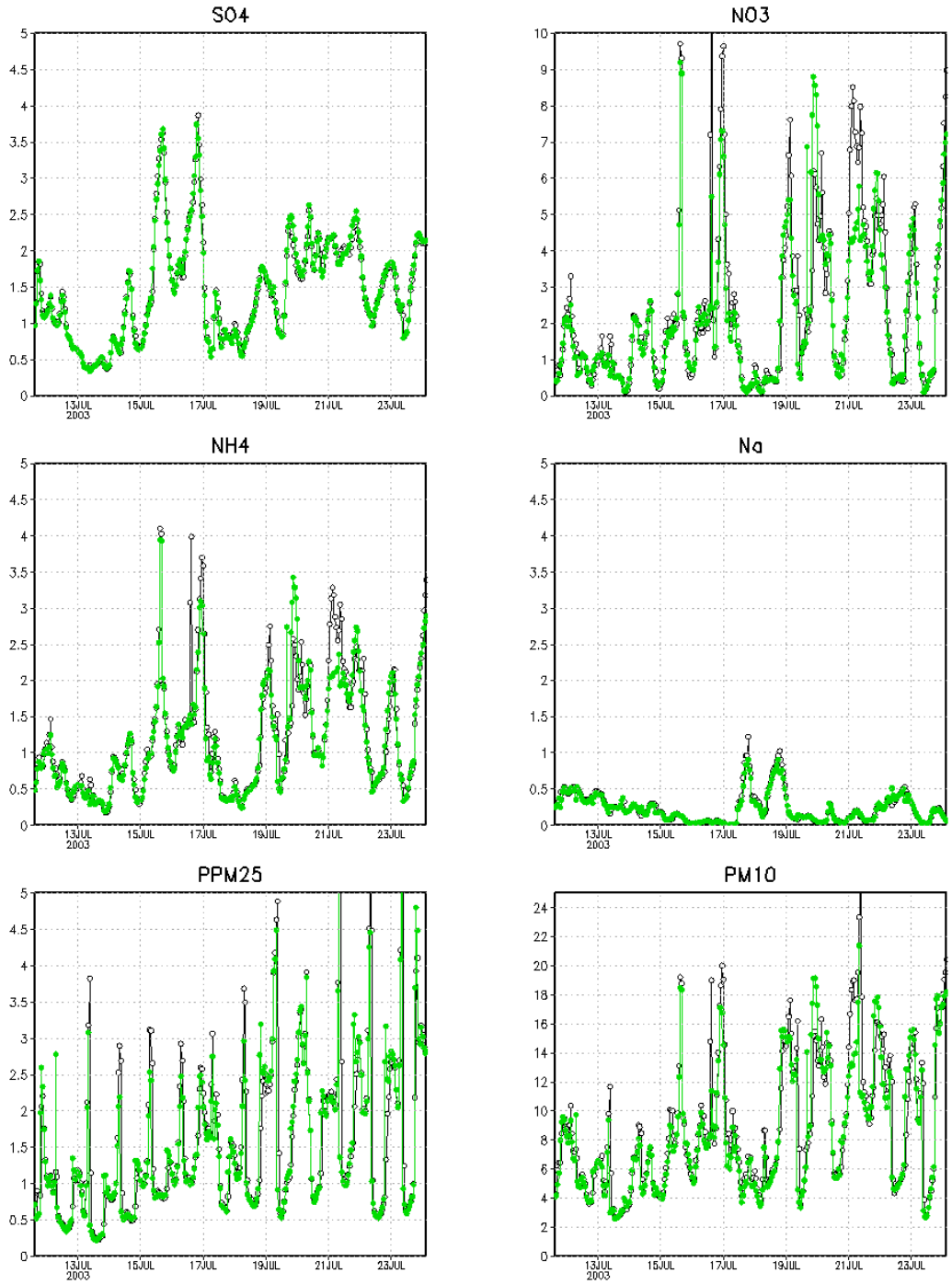
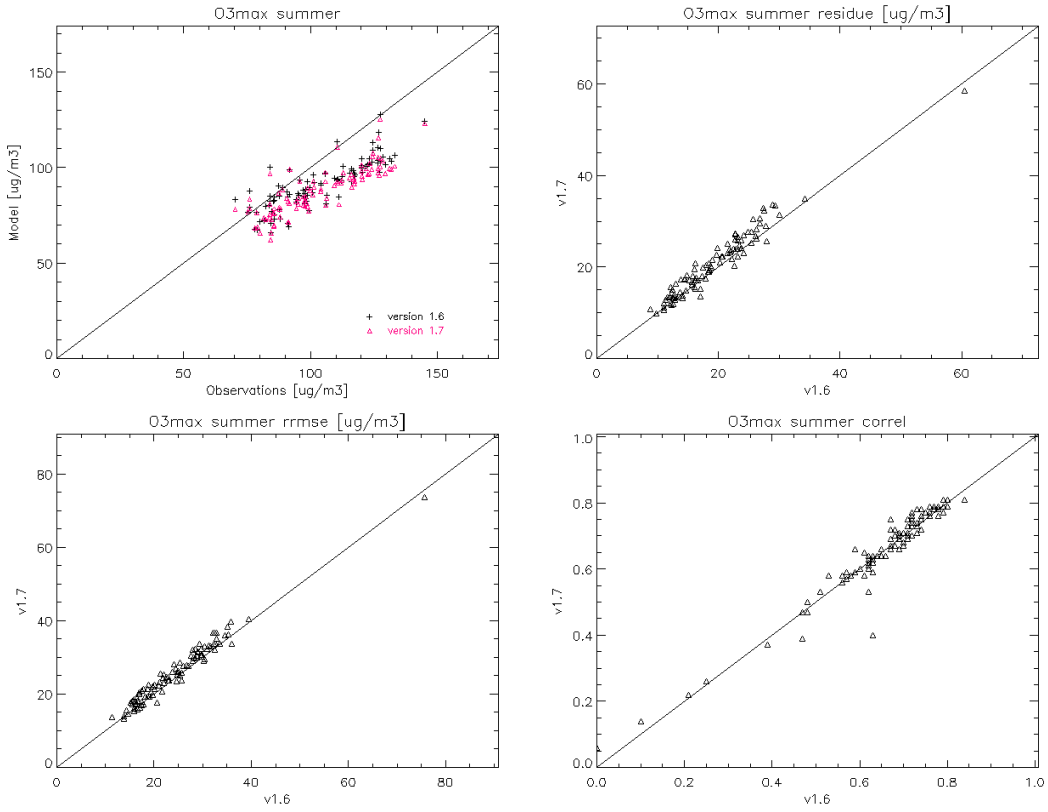


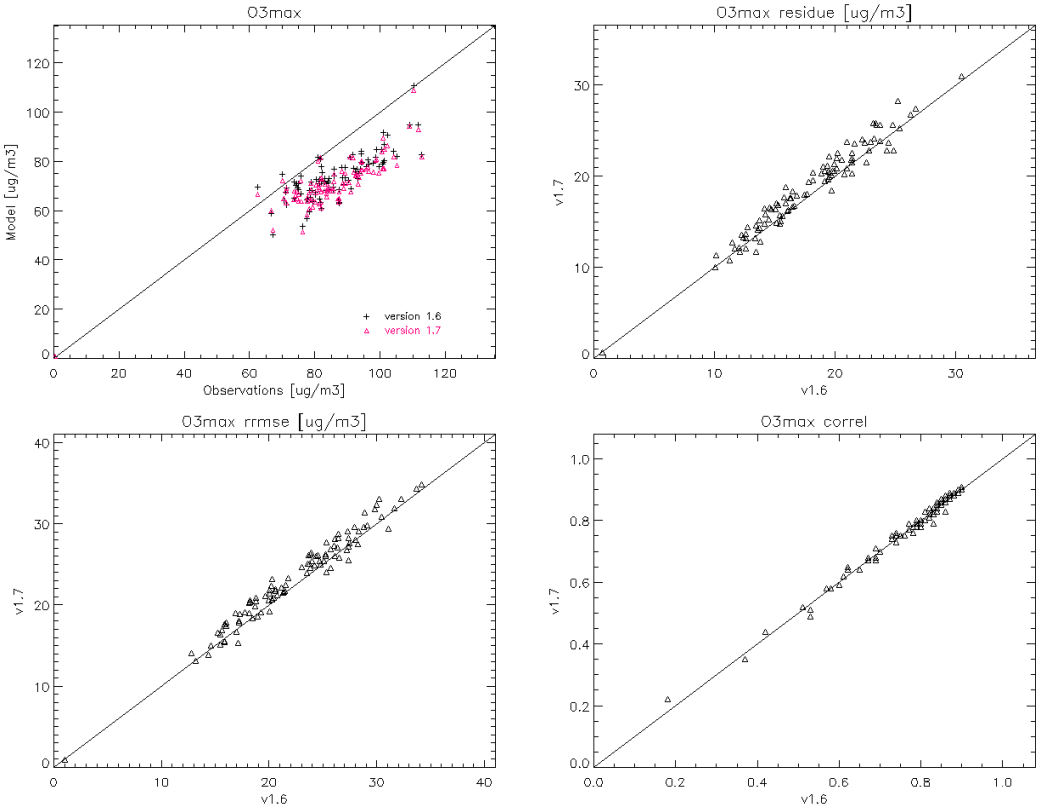
Figure 8: Time series of aerosol concentration (ug/m3), 52 N 5 E, black =v1.6.3, green=v1.7

Scatter plots:
EMEP stations, 2003, Only stations < 700 m a.s.l were taken into account

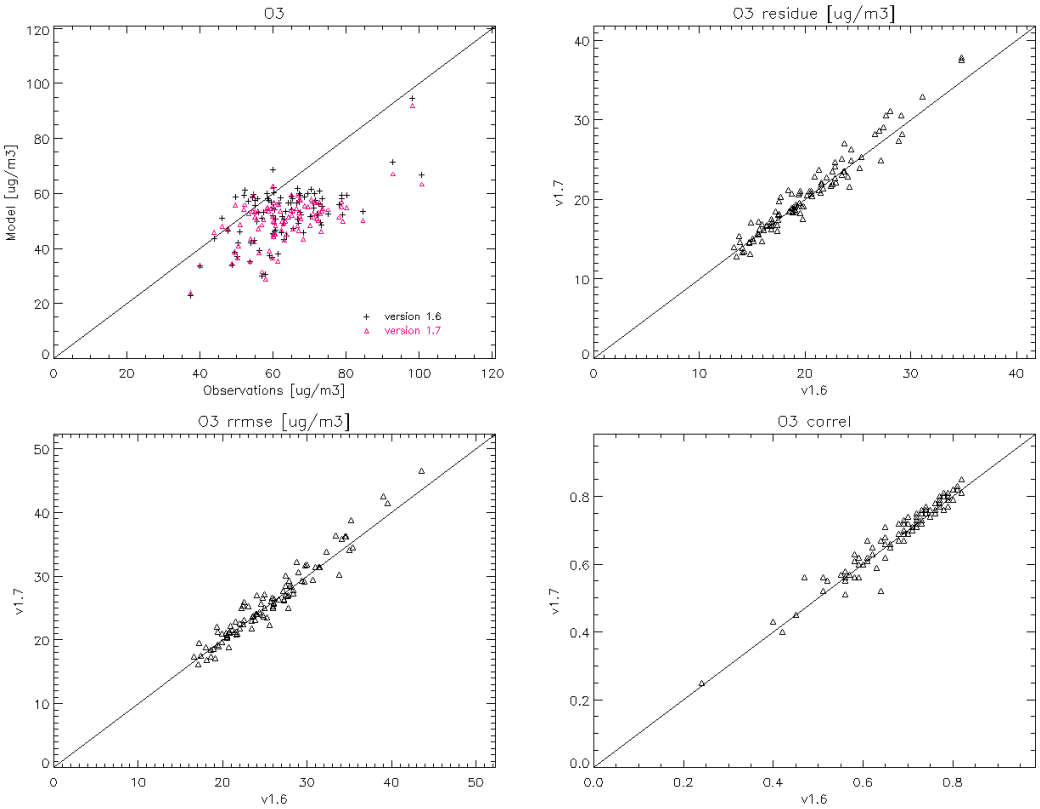
O3 max summer (1 april-30 sept)



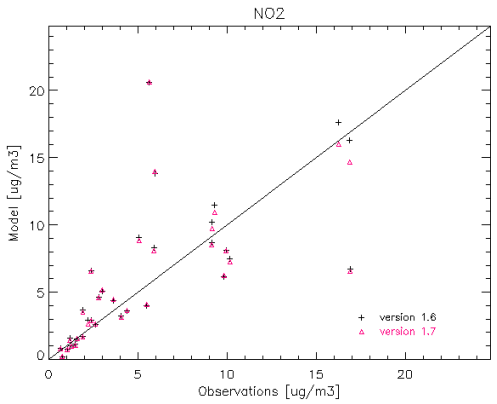
O3 max 2003:

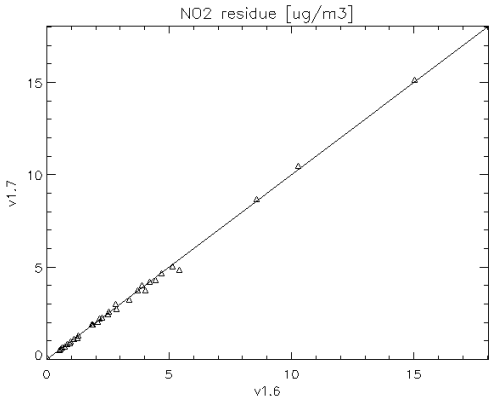


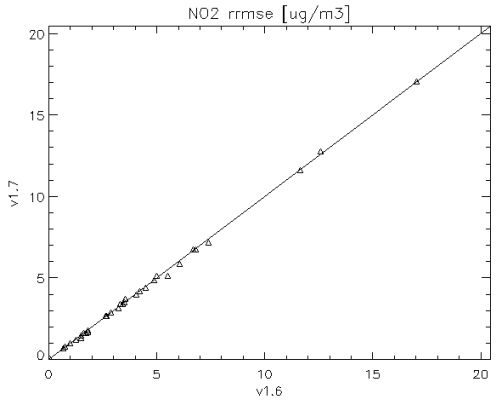
O3 2003:

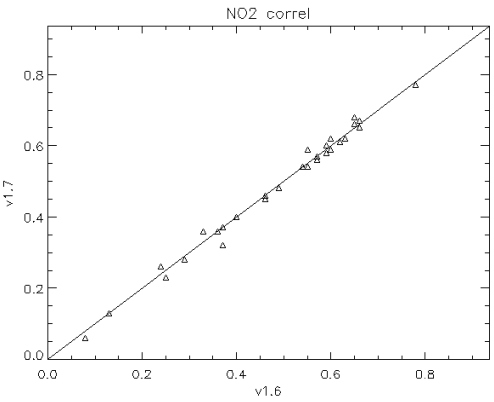


NO2 2003:

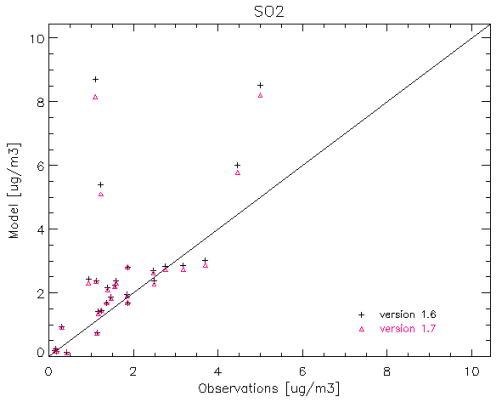


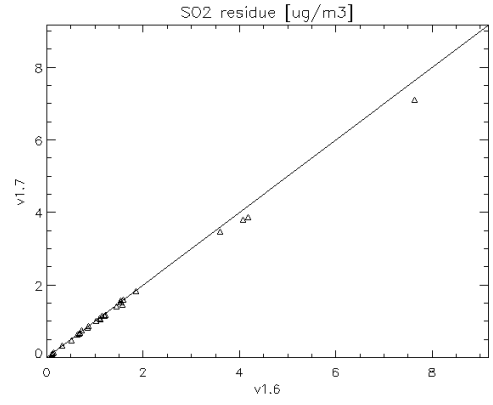


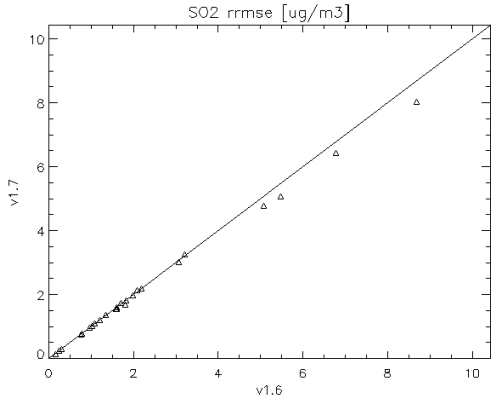


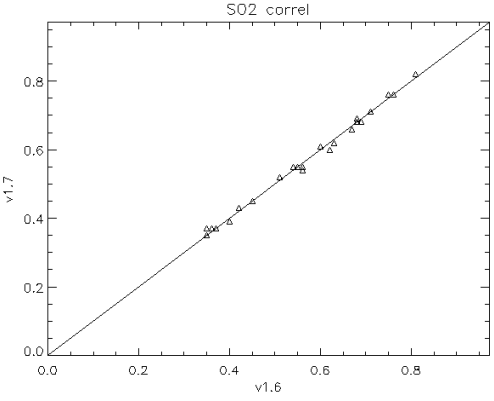


SO2 2003:

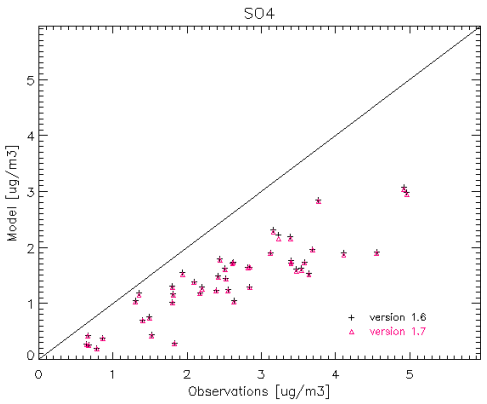


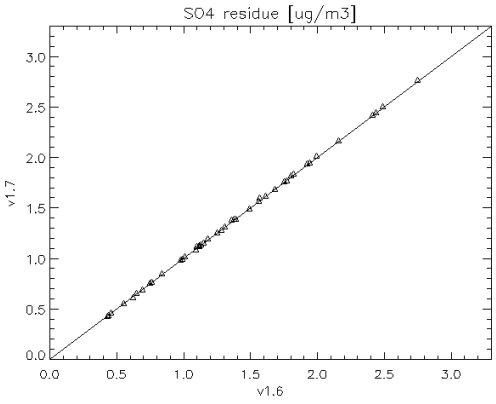


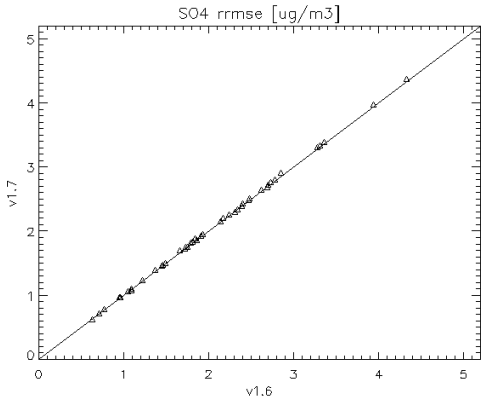


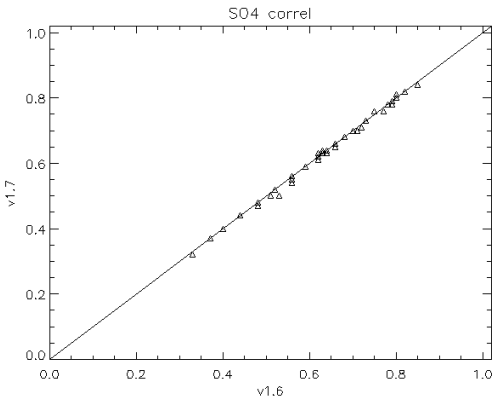


SO4 2003:

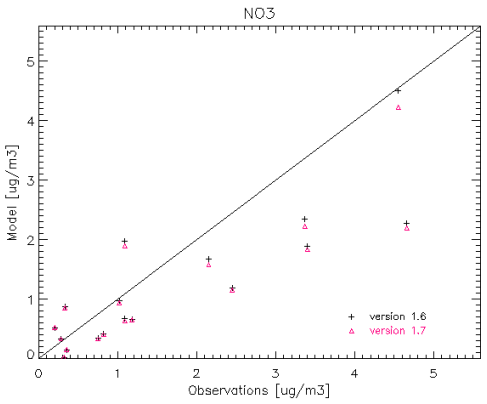


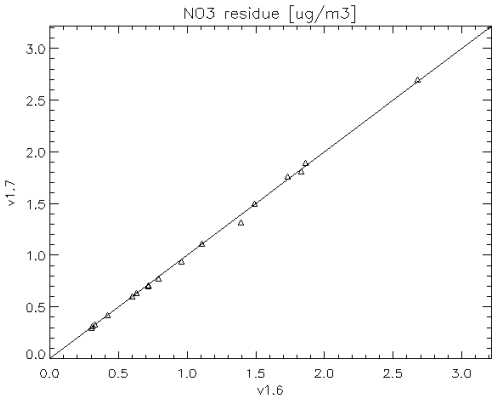


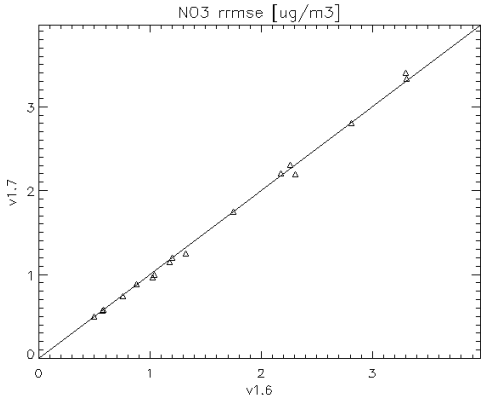


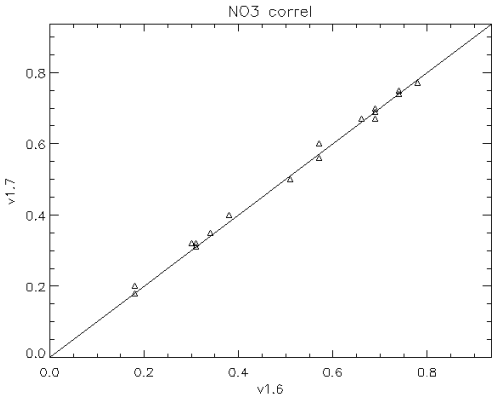


NO3 2003:

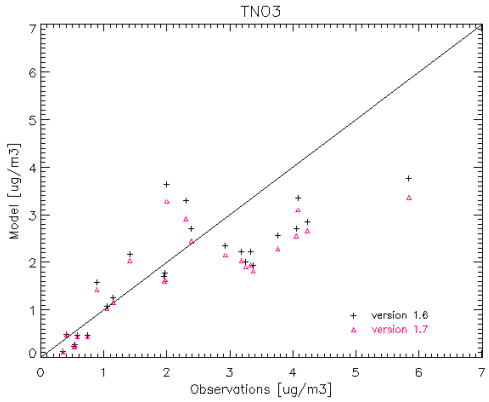


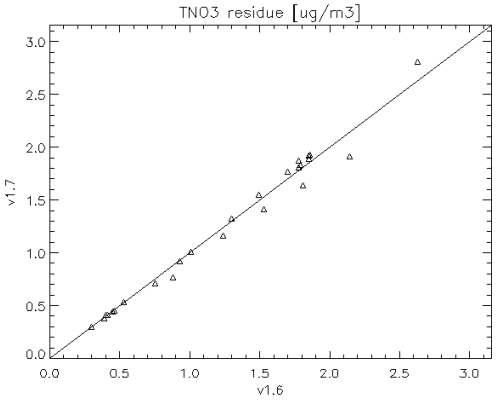


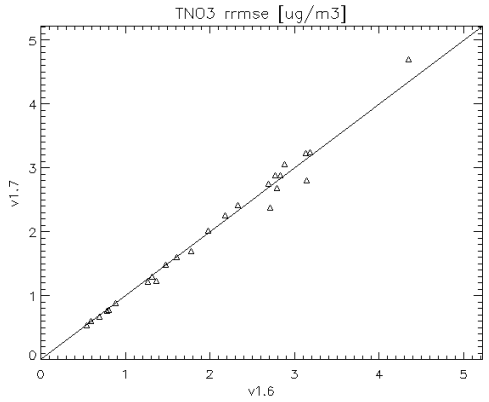


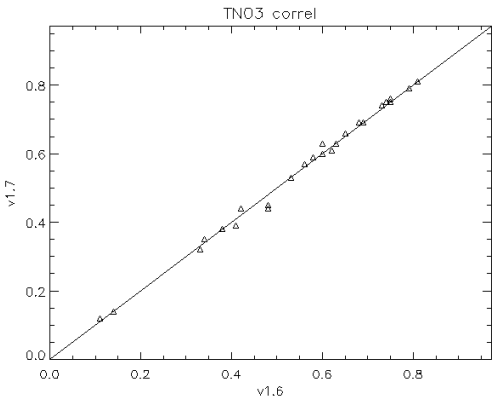


TNO3 2003:

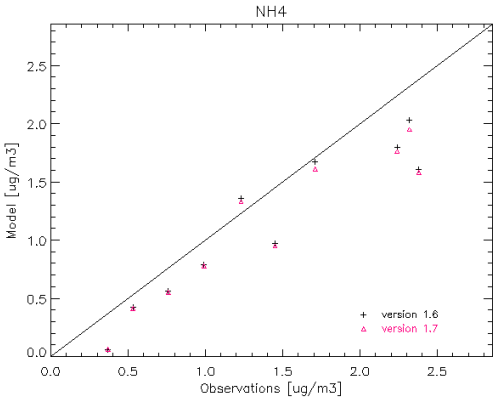


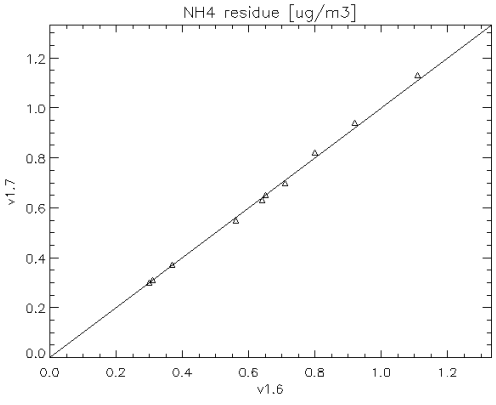


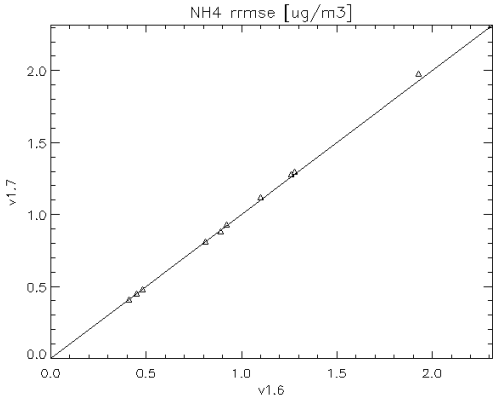


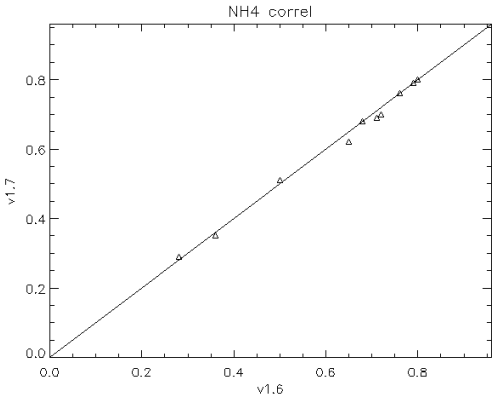


NH4 2003:

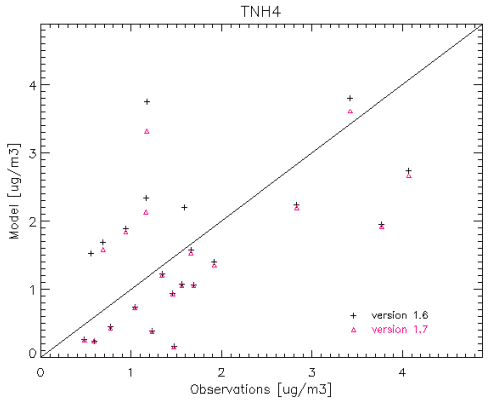


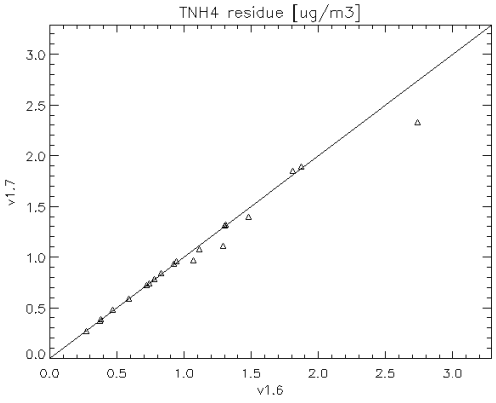


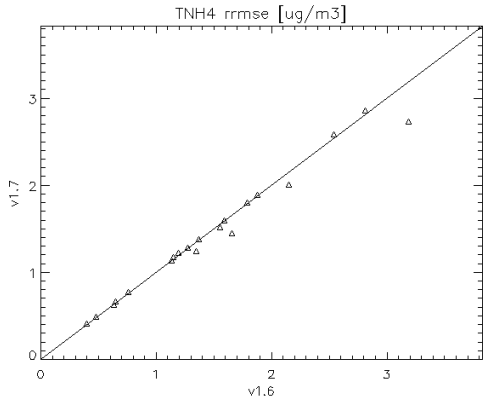


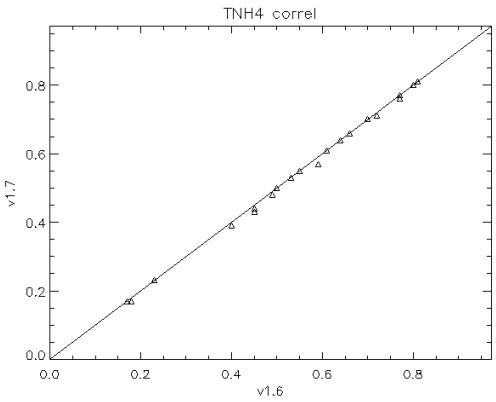


TNH4 2003:

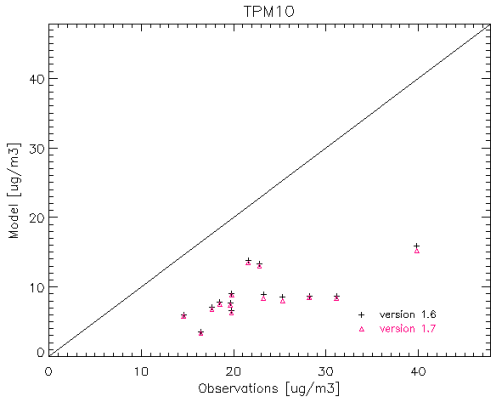


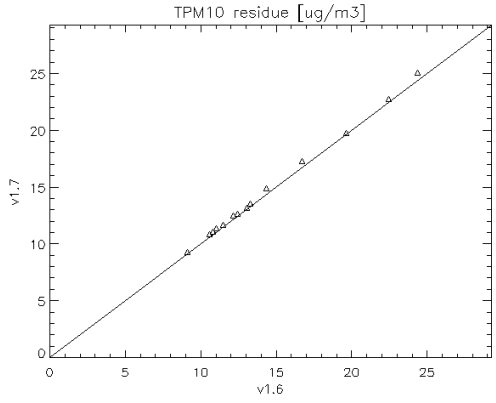


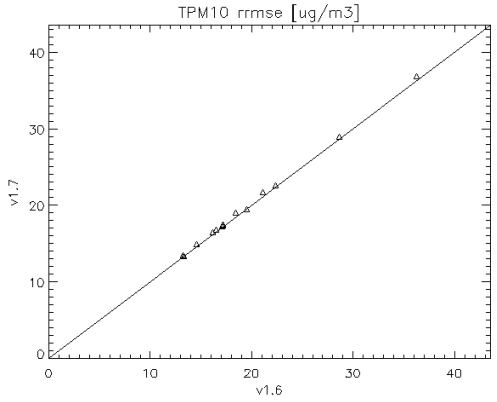


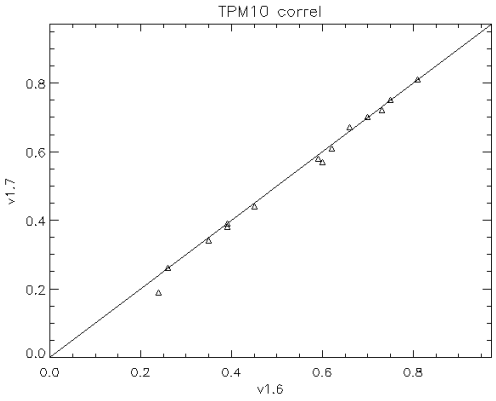


TPM10 2003:

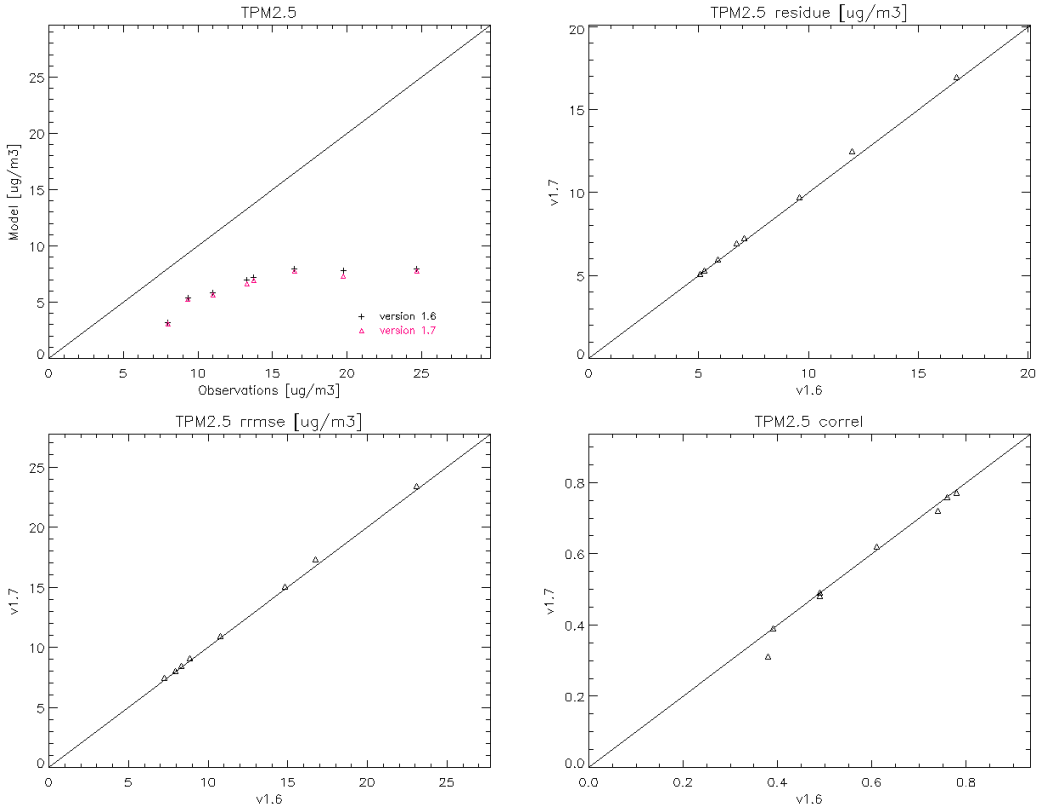




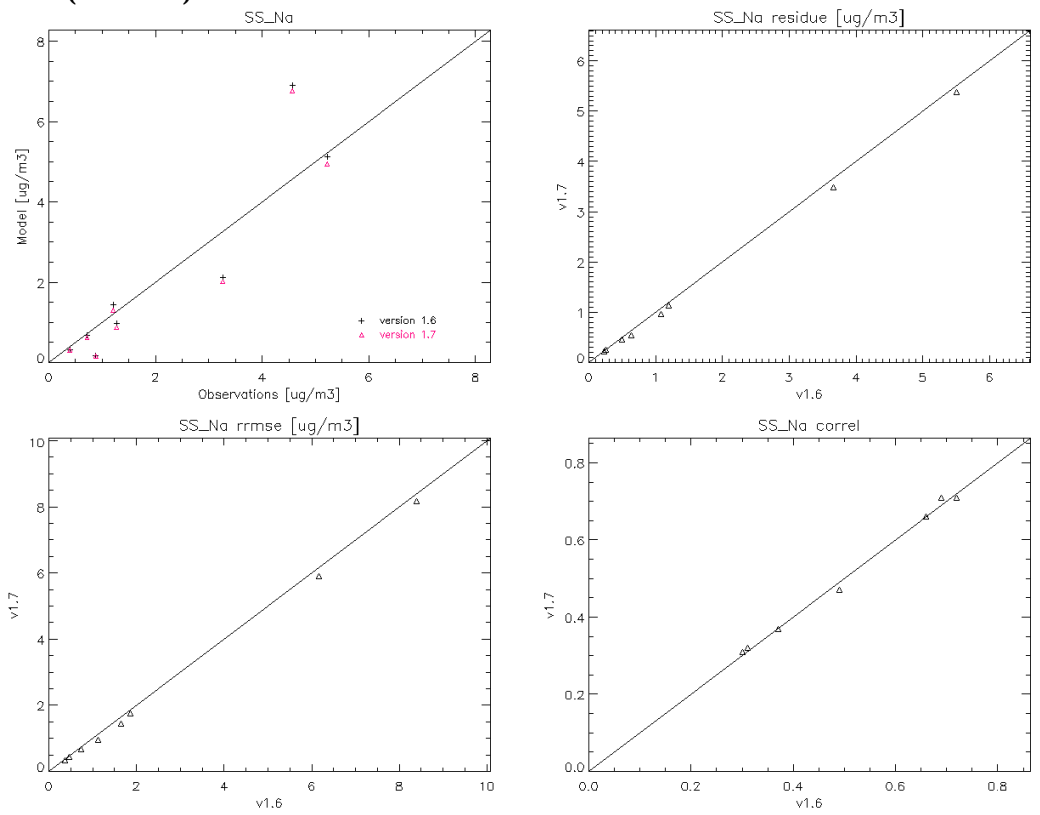




TPM2.5 2003:



SS 2003 (=Na*3.26):



Zoom test

A zoom test was performed using the boundary conditioins from the basic run for june 2003. The results from the zoomed version seem OK from the snap shots (fig. 9)

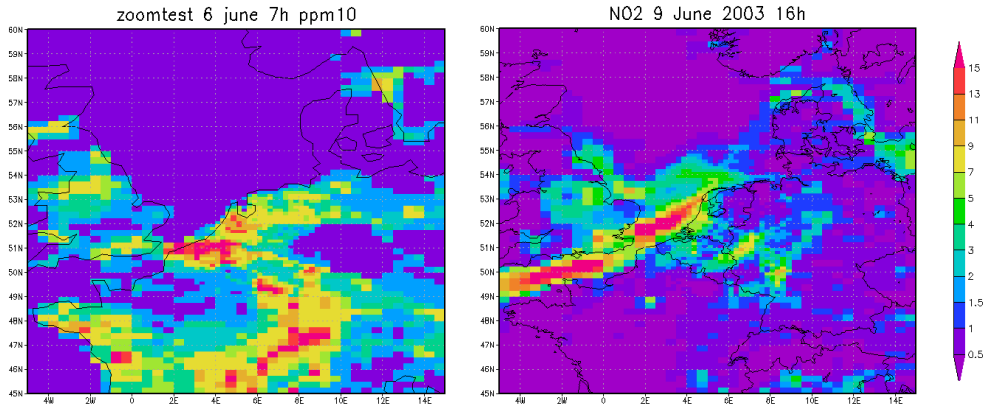


Figure 9: Snap shots of PPM10 and NO2.

Running in parallel

Results from a run in parallel mode (4 threads) were close to the results from the sequential run, with small but non-neglible differences (up to 5-10%) at isolated locations. These differences change in time and the largest differences are not always at the same location. This behaviour was already found in v1.6 and cannot be attributed to the new version.

VOC/Nox sensitivity

The VOC and Nox sensitivity were not tested since the chemistry routines were left unaltered.

Effect of new sea salt emission

For 2005 sea surface temperature was available and the effect of the new sea saltparameterization could be investigated. Annual mean sodium concentrations have become lower in the new version, in particular in the Baltic Sea but also for large parts of the Atlantic Ocean, the North Sea and the Gulf of Lyon.

For the Baltic Sea this is in accordance with the lower emission factor in the Baltic area to account for the lower salinity. For the other areas this will be a result of limiting the whitecap cover for large wind speeds, which reduces the emissions for the largest wind speeds. The effect is largest in the areas with the highest wind speeds. This behaviour is confirmed by the time series which show nearly unaltered sodium concentrations for low to moderate sodium concentrations, but a significant reduction for the highest sodium concentrations. The effect cannot be serarated fully from differences in deposition velocity between the model versions, but the other aerosol components show only small differences due to the differences in deposition velocity. The limit on the whitecap coverage is not always effective, since for northwesterly winds concentrations can be very large due to the long fetch, even for wind speeds below 12.5 m/s.

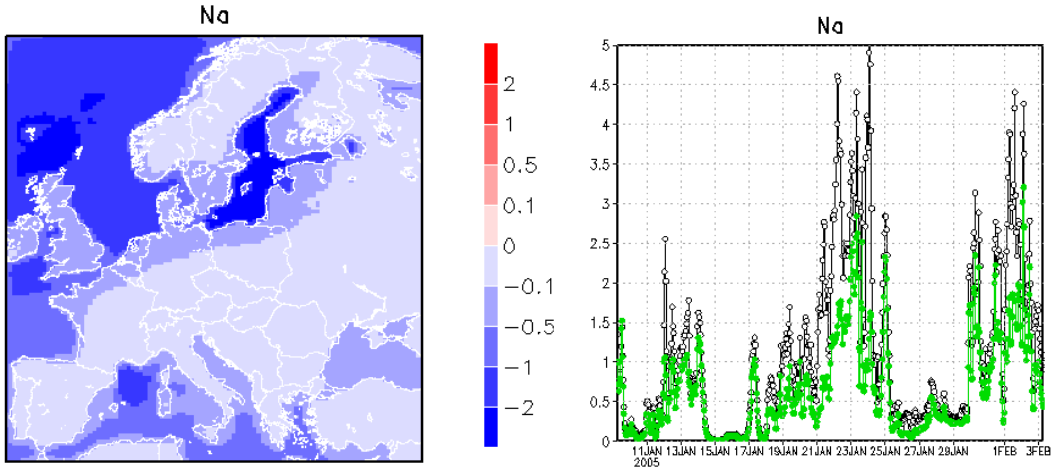


Figure 10: Difference in annual mean concentrations of aerosol in 2005, v1.7.0-v1.6.3 (left) and time series (right) at 52 N 5 E, January 2005. Black: v1.6.3, green v1.7.0

Deposition

Changes in the parameterization of stability and deposition have resulted in changes in the amount material that was deposited by dry deposition. The effect on the quantity of deposited material is larger than for concentraions. For june 2003, monthly averages of the old and new version were compared. The largest differences are found for Nox, for which the deposition has inceased nearly everywhere. For Sox and NHx the pattern is more mixed, with both increases and decreases. For these species, in the relative difference plots in the southe some striped patterns appear at 5 and 35 W, which result from the difference in definition the exposure class (see first point of the description of the functional changes).

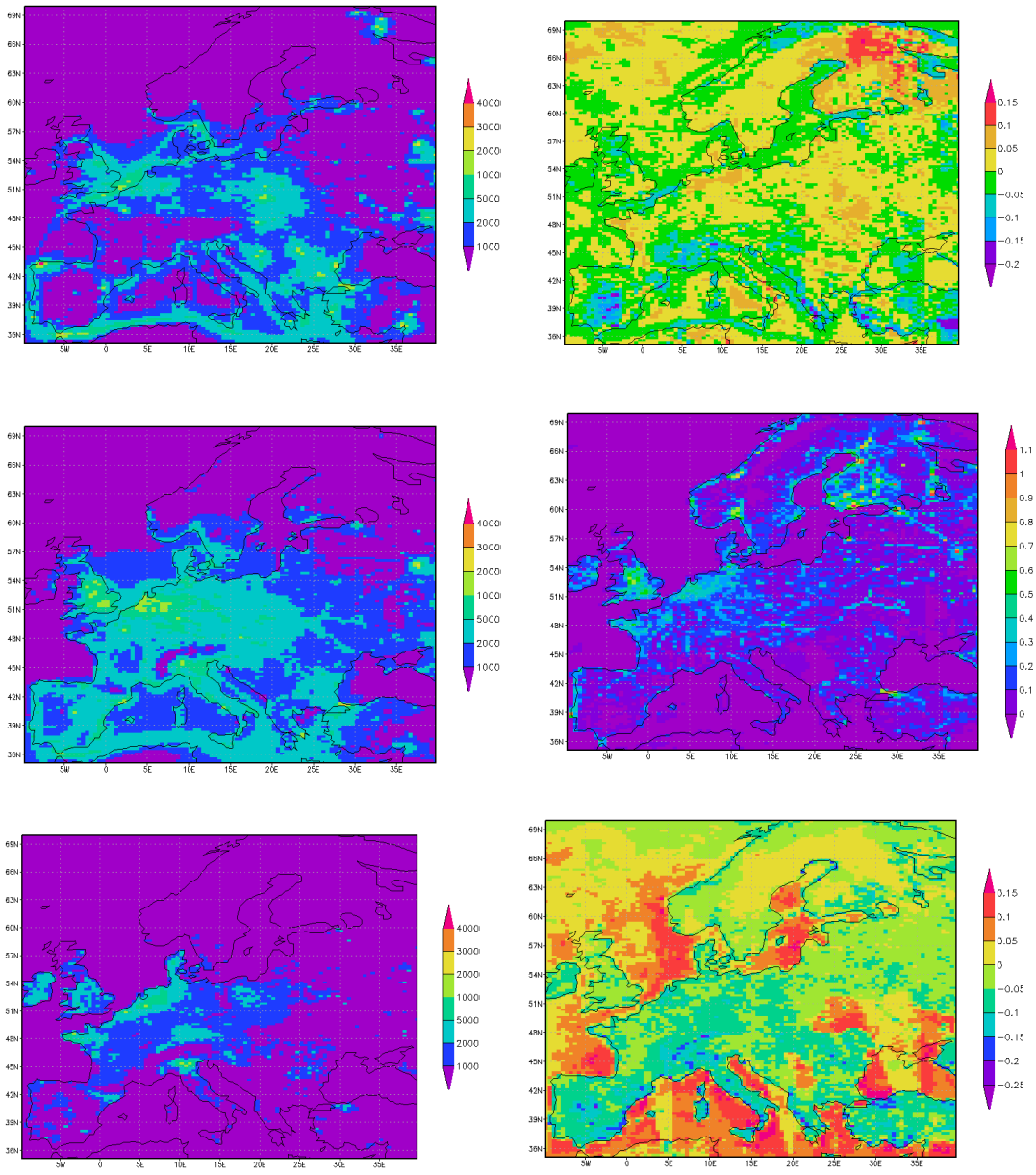


Figure 11: Monthly mean dry deposition of Sox (upper panels), Nox (middle panels) and NHx (lower panels)) for v1.7, june 2003 (left) and relative difference with v1.6.3 ((v1.7-v1.6.3)/v1.6.3))