Regional and local scale air pollution in the area north of the Brennero/Brenner pass

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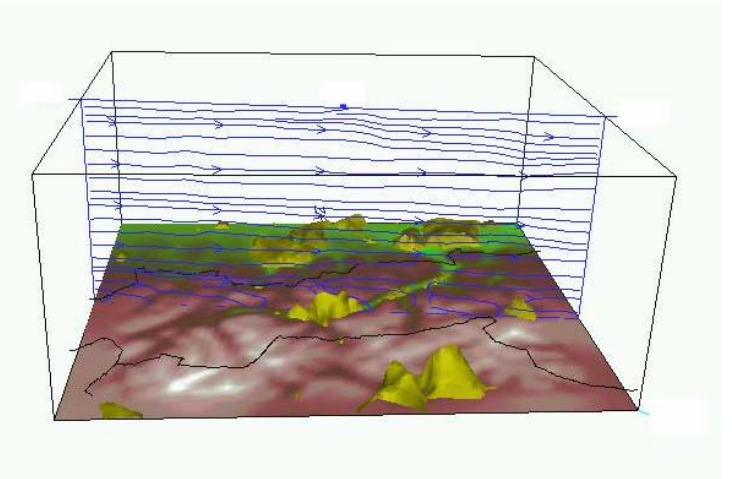
Activities of IMK-IFU during ALPNAP

Long-term regional simulations with the coupled climate-chemistry model MCCM for the year 2004



Measurements of small scale meteorological structures and of NO_x with SODAR with DOAS during winter 2005/2006

Focus of the investigations

The regional simulations permit the investigation of

- ***temporal and regional distribution of pollutant fields with complete spatial coverage***
- ***contributions of different sources***
- ***formation of secondary pollutants***
- ***effect of changed emissions***

The measurements permit the investigation of

- ***small scale vertical and temporal structures***
- ***local effects and small scale horizontal gradients***

Regional modelling

MCCM (Mesoscale climate chemistry model)

Meteorological part

- *Based on MM5*
- *Non-hydrostatic*
- *Nesting capability*
- *Soil and snow model*

Online chemistry part

- *RADM2, RACM, RACM-MIM*
- *Photolysis model*
- *Aerosol module MADE/SORGAM*
- *Biogenic emission module*

Input *Any met. input suitable for MM5, initial concentrations of chemical compounds and hourly anthropogenic emissions in MM5-format*

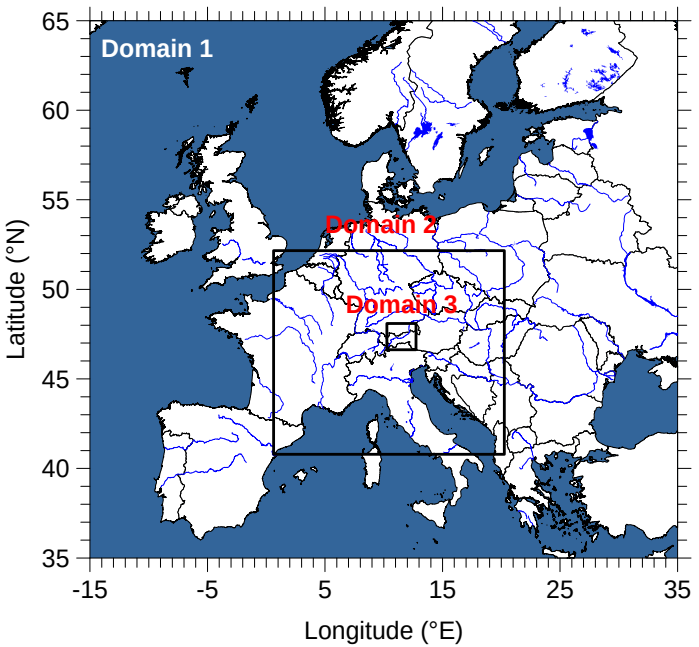
Output *3-d meteorological fields, snow height, photolysis frequencies, concentrations of chemical compounds in the gas and particle phase,*

Applications *Episodes and sensitivity studies*
Real time air quality simulations
Regional climate chemistry simulations

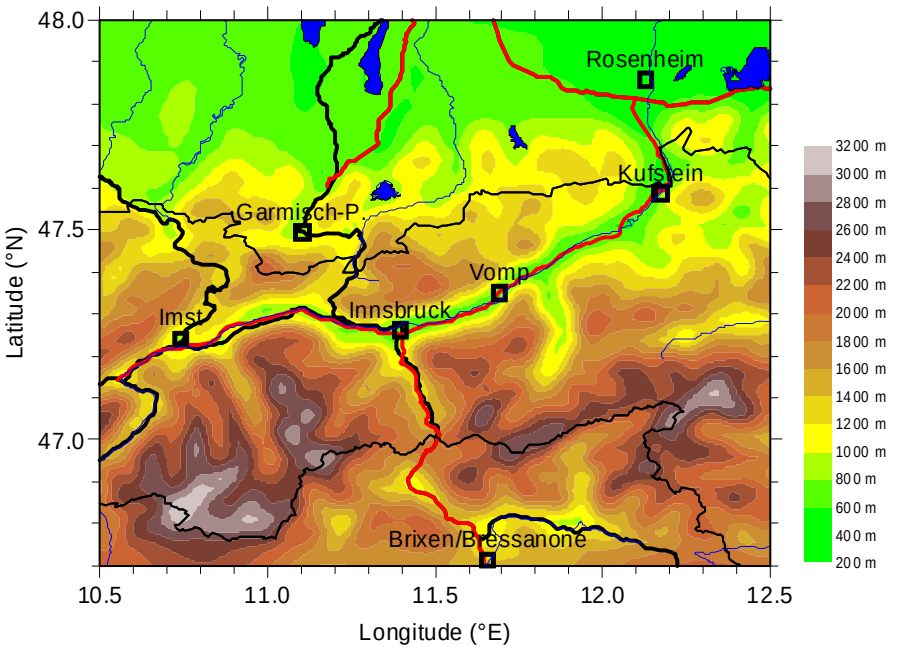
Grell et al. 2000, Atmospheric Environment

Setup of regional modelling

- ***Simulation of the entire year 2004***
- ***Three nested domains with horizontal resolutions of 60 km, 12 km, and 2.4 km***
- ***Meteorological boundary conditions for Domain1 from NCEP reanalysis***



D3: Topography

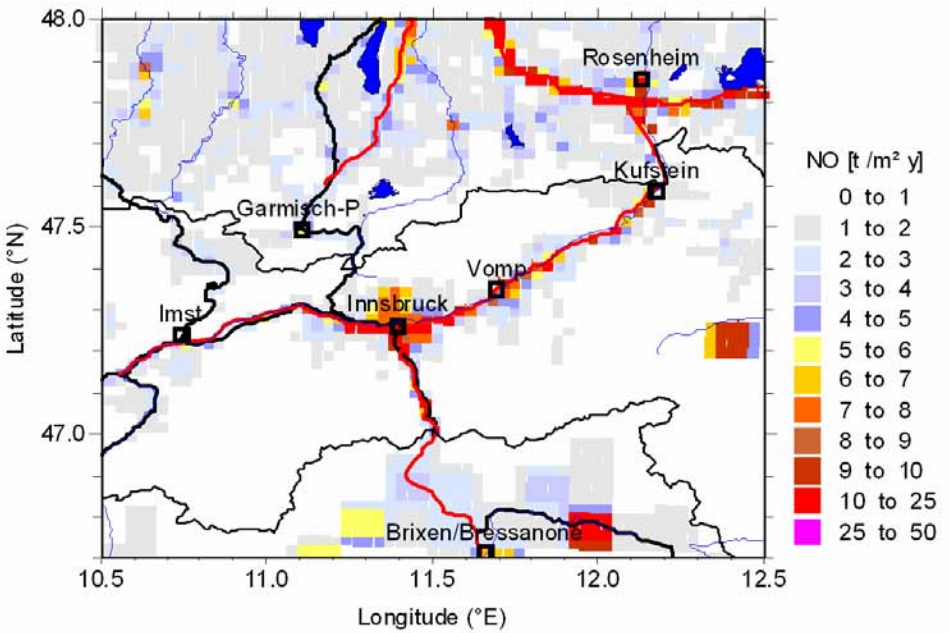


Emissions for regional modelling

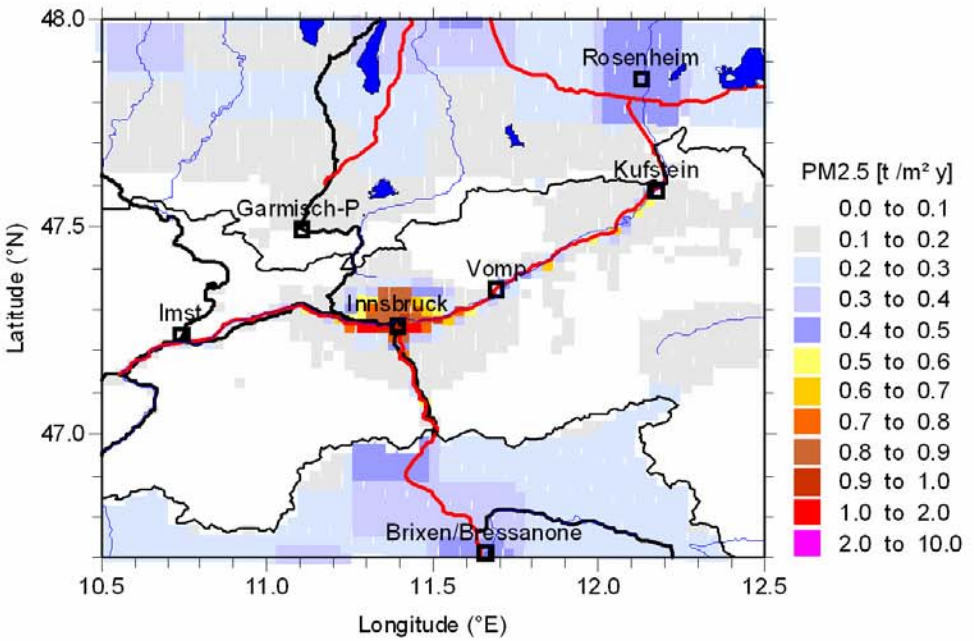
Emissions for all model domains needed

- ***Five different data sets (not consistent)***
- ***PM emissions are probably underestimated***

D3: NO emissions for all sectors



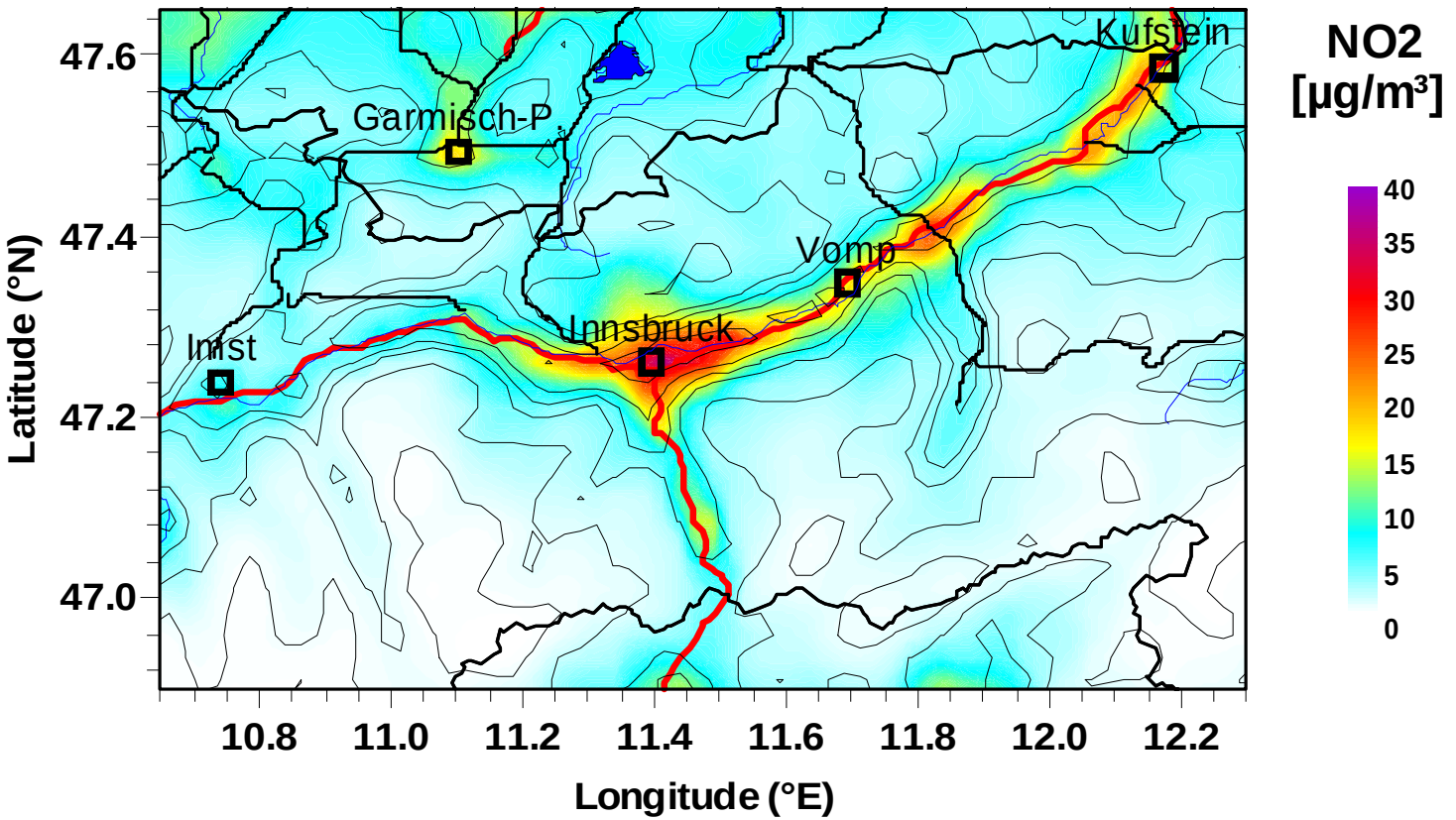
D3: PM2.5 emissions for all sectors



Road traffic emissions for Tyrol: U. Uhrner, Univ. Graz; Amt der Tiroler Landesregierung
Domestic heating emissions for Tyrol: Amt der Tiroler Landesregierung,
Emissions from other sources and emissions outside of Tyrol: IER Stuttgart and EMEP

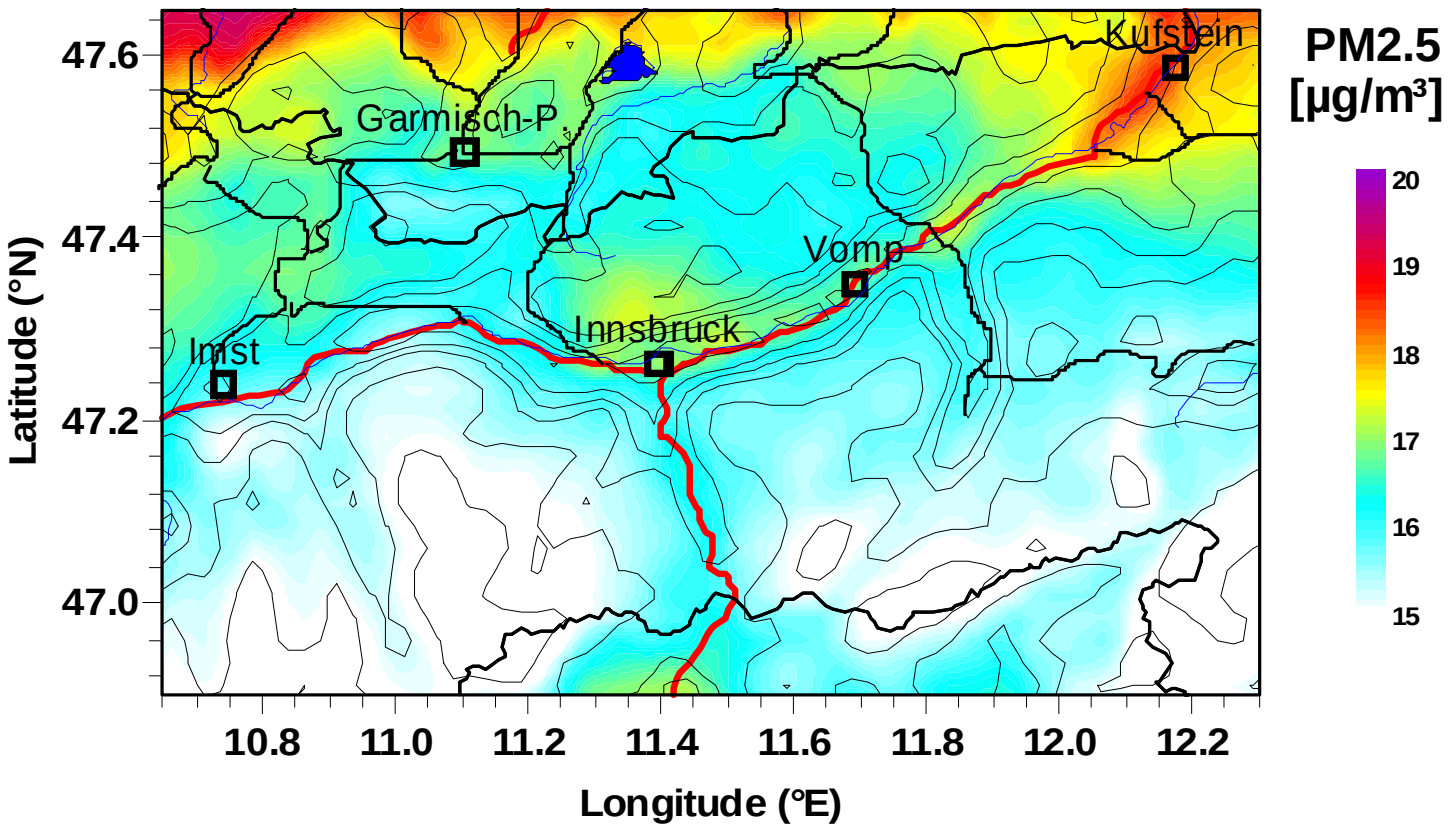
Regional modelling results

Spatial distribution of annual mean NO_2



Regional modelling results

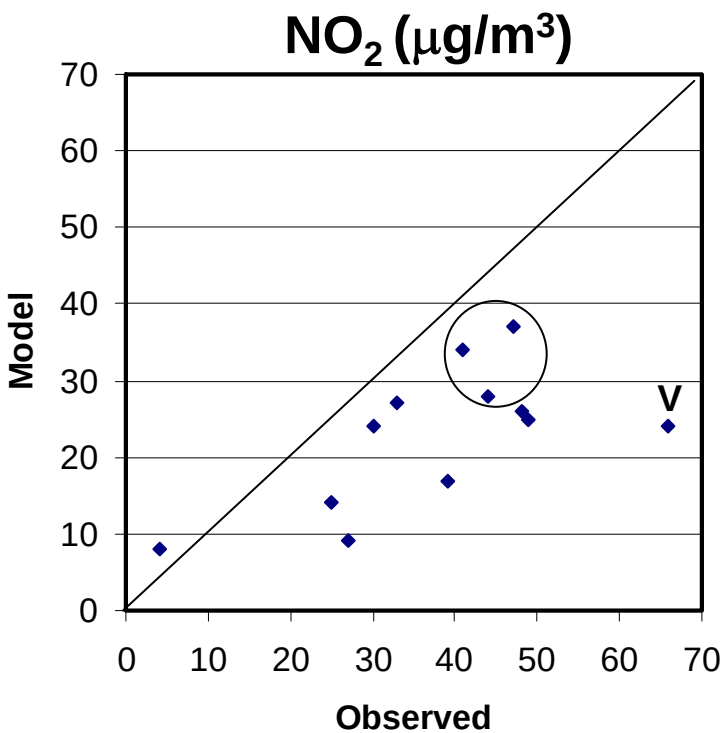
Spatial distribution of annual mean PM2.5

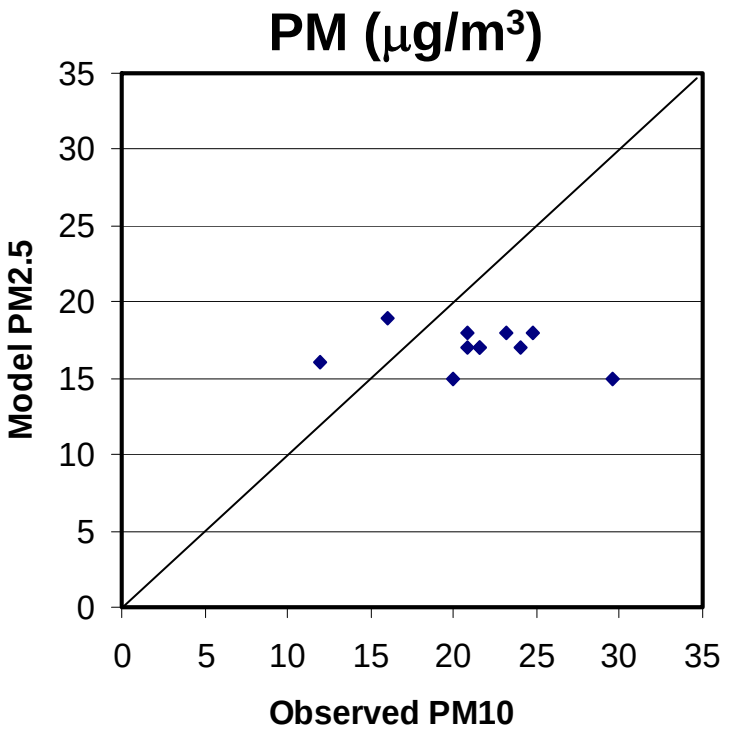


Comparison with observations

Mean values at observational stations in Tyrol

NO_2: Poor agreement for site Vomp Raststätte (marked by V) due to bad representativity of the measurements for an area of the size of the model grid, better agreement for the sites located in the city of Innsbruck (circle)

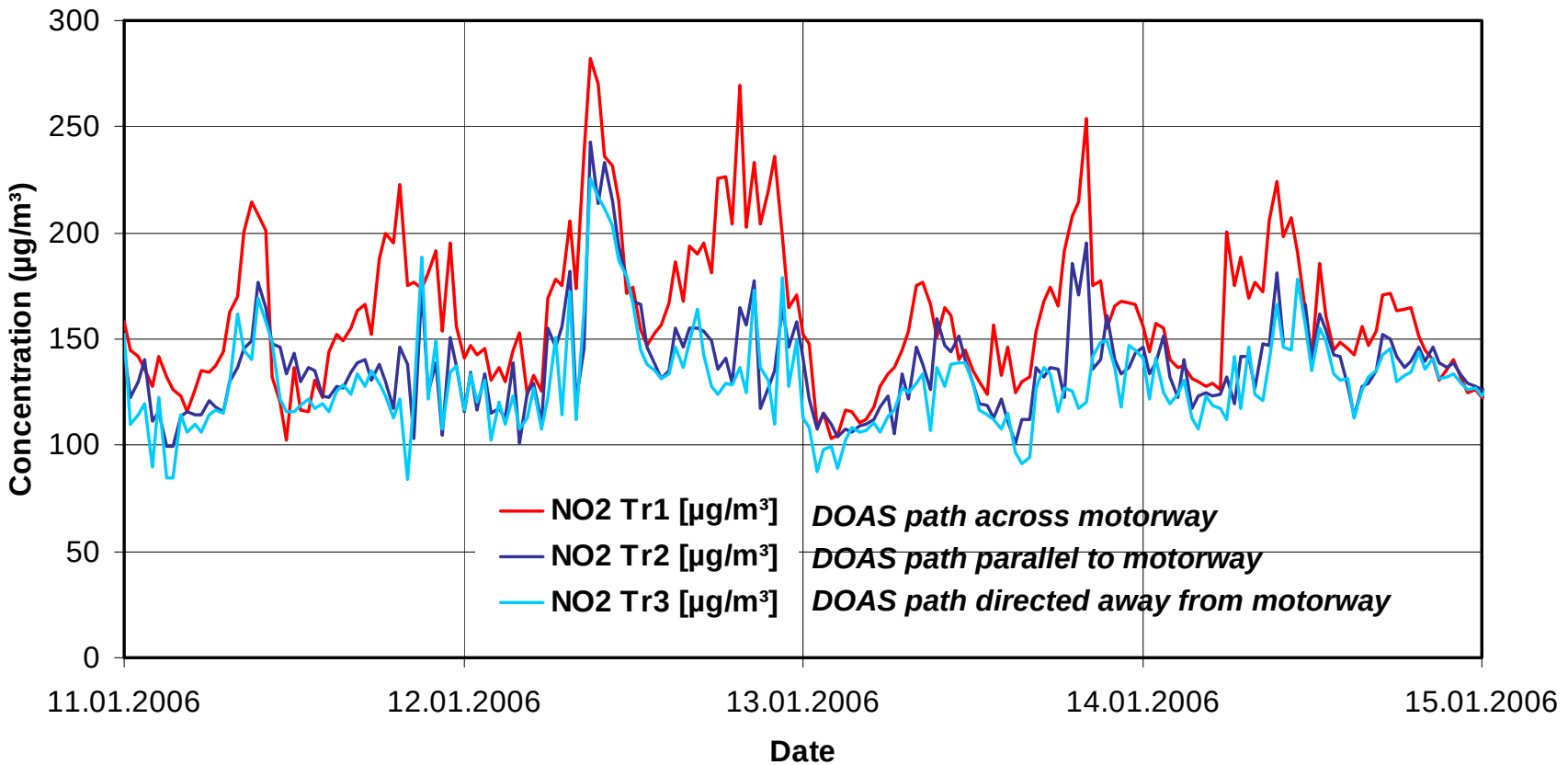




Observations from Amt der Tiroler Landesregierung Abt. Waldschutz/Luftgüte

Measured local effects

Pronounced local NO_2 gradients near motorway A12
(cannot be expected to be resolved by a regional model)

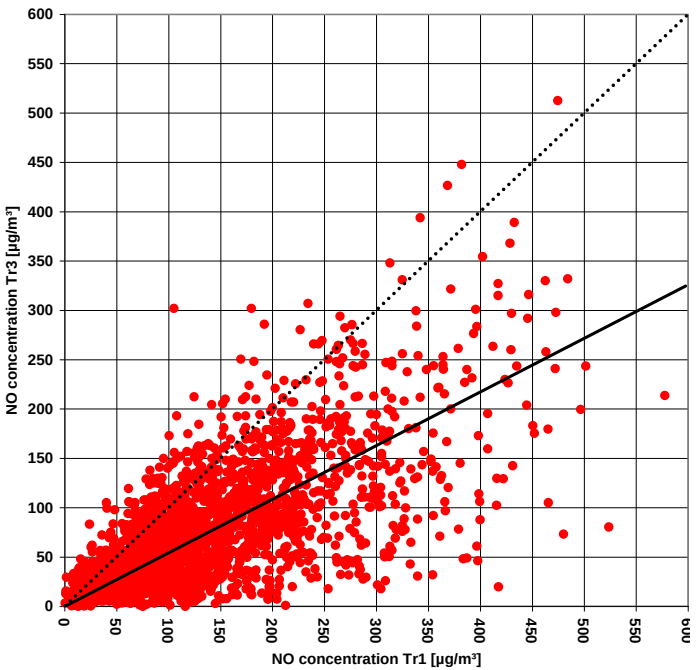


NO_2 measurements with DOAS: K. Schäfer, C. Jahn, M. Hoffmann, IMK-IFU

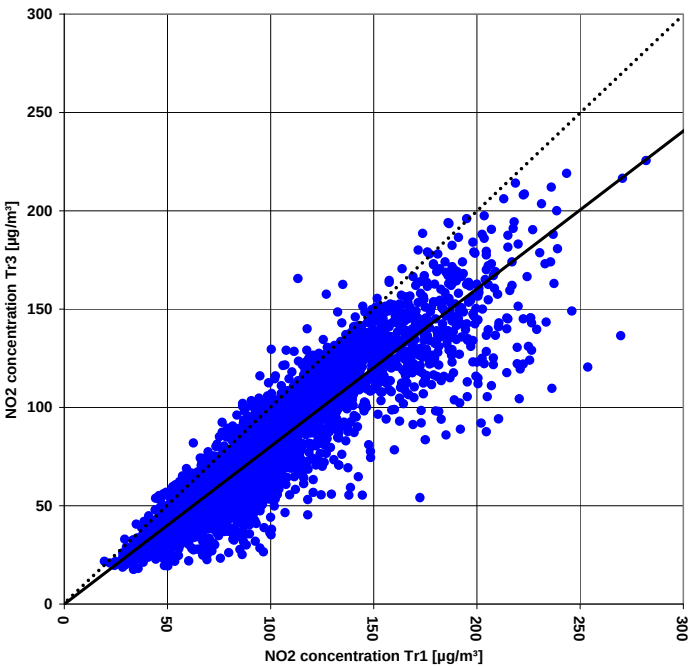
Measured local effects

Conversion of emitted NO
NO and NO_2 ratios near motorway A12

NO

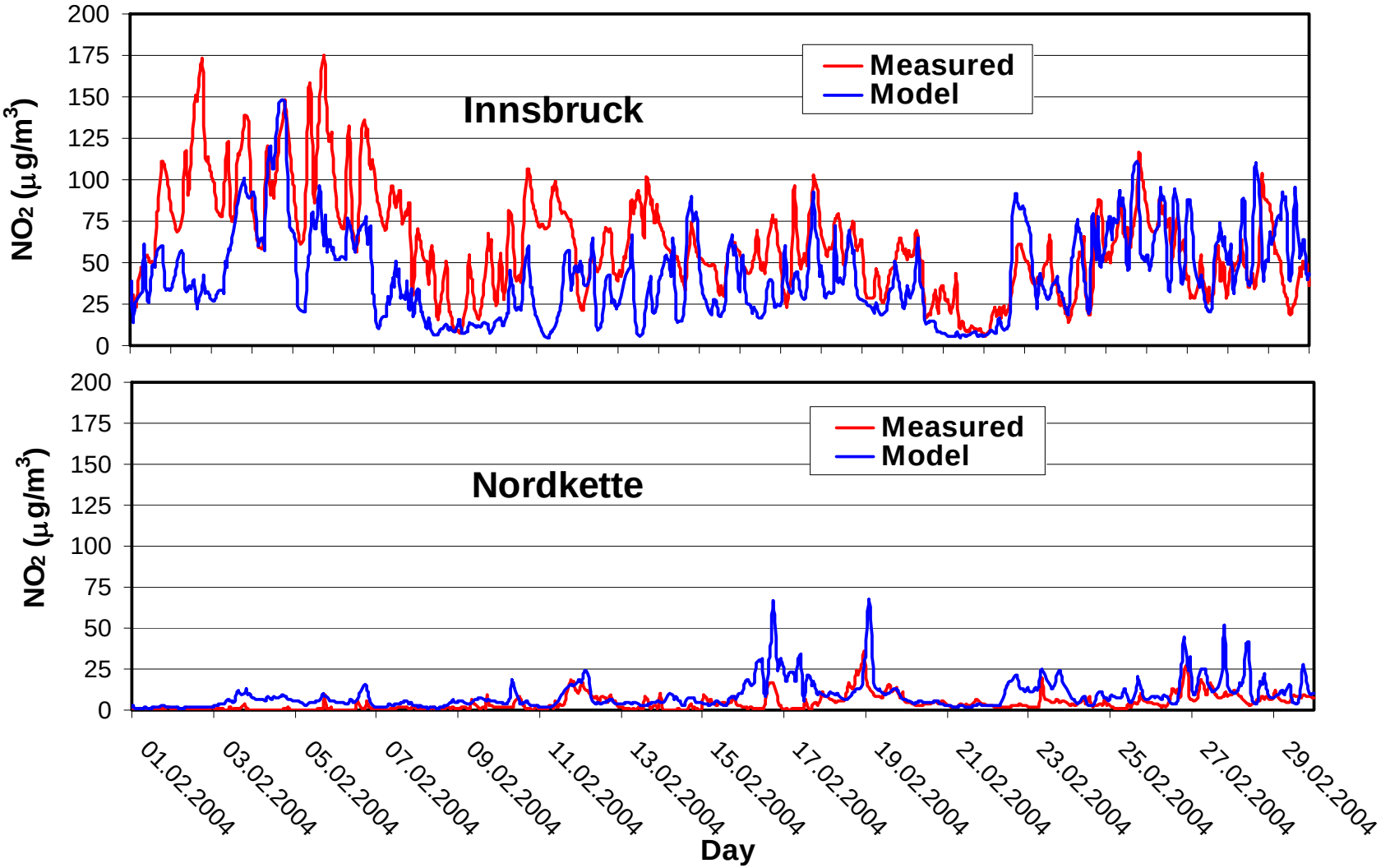


NO_2



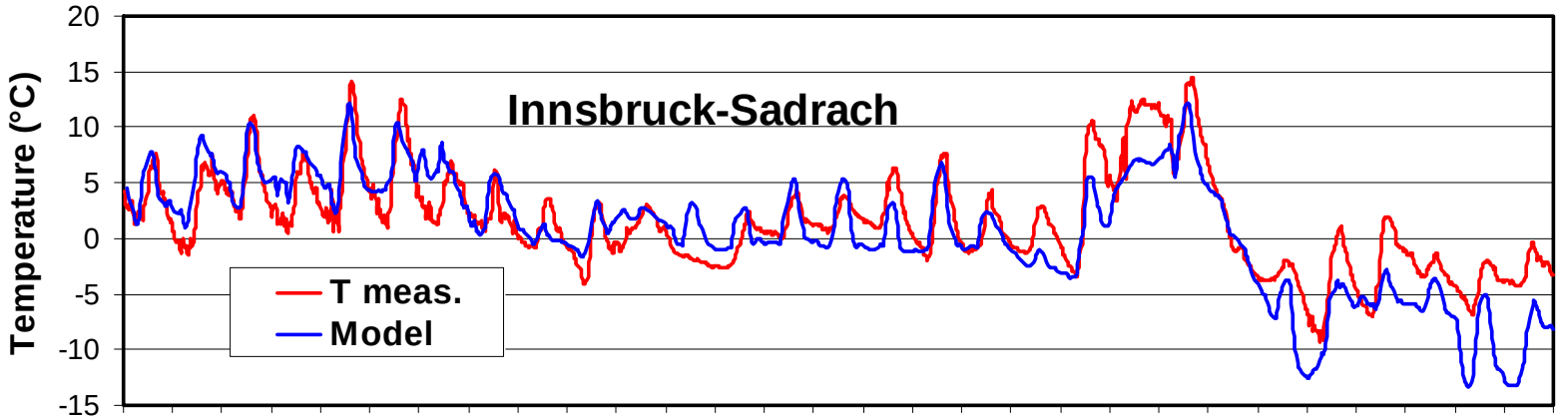
NO and NO_2 measurements with DOAS: K. Schäfer, C. Jahn, M. Hoffmann, IMK-IFU

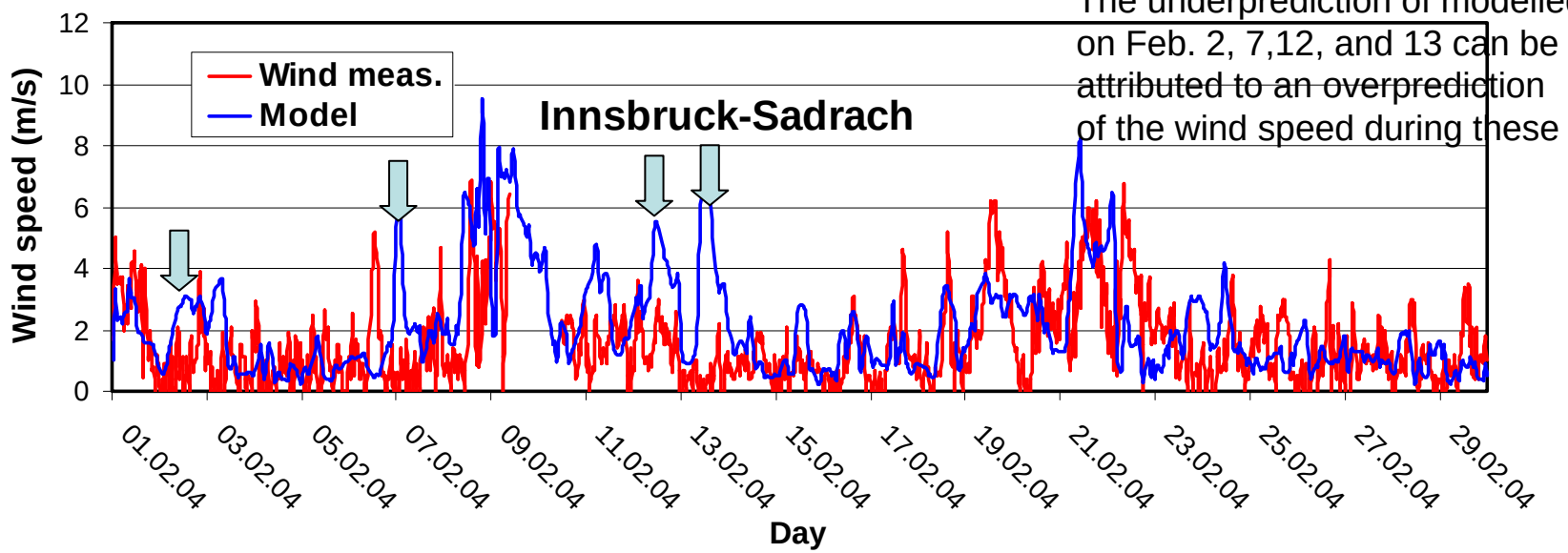
Regional modelling results



Comparison with measurements by Amt der Tiroler Landesregierung Abt. Waldschutz/Luftgüte

Regional modelling results





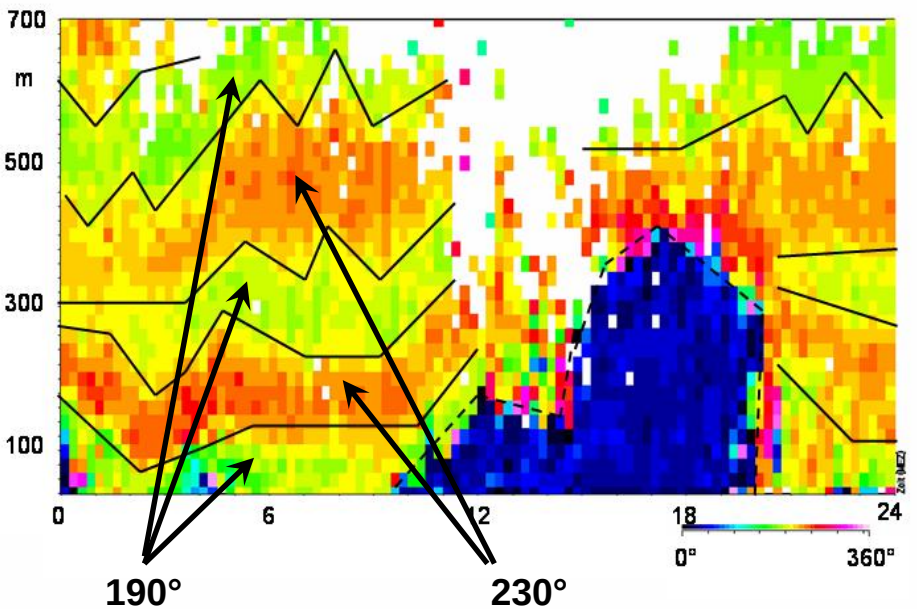
The underprediction of modelled NO_2 on Feb. 2, 7,12, and 13 can be attributed to an overprediction of the wind speed during these days

Observations:Amt der Tiroler Landesregierung Abt. Waldschutz/Luftgüte

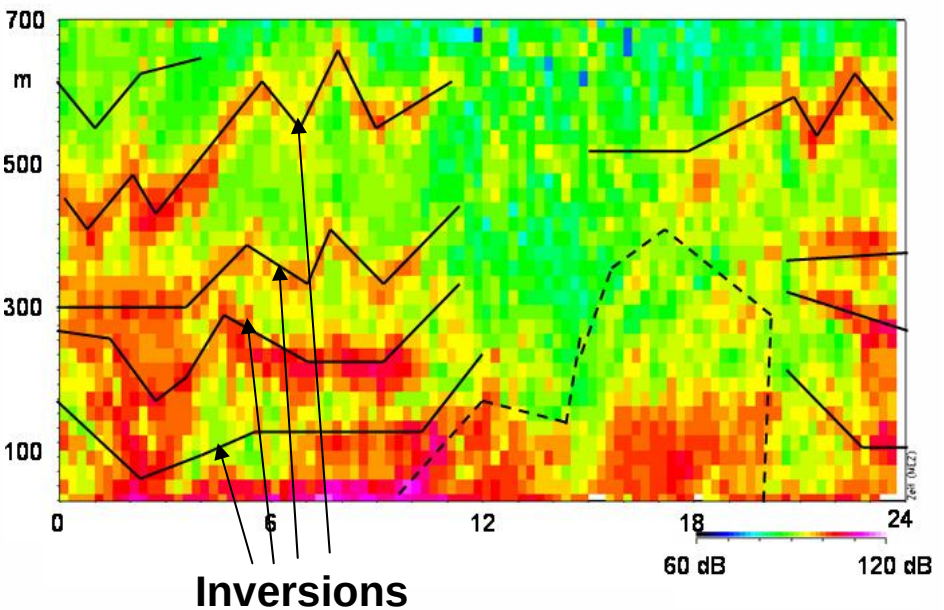
Measured local effects

Measurements show complex structures with multiple inversions and layers with different wind directions

Daytime up-valley wind (blue) is reproduced by the model, but not the observed complex structures with multiple inversion layers



Wind direction



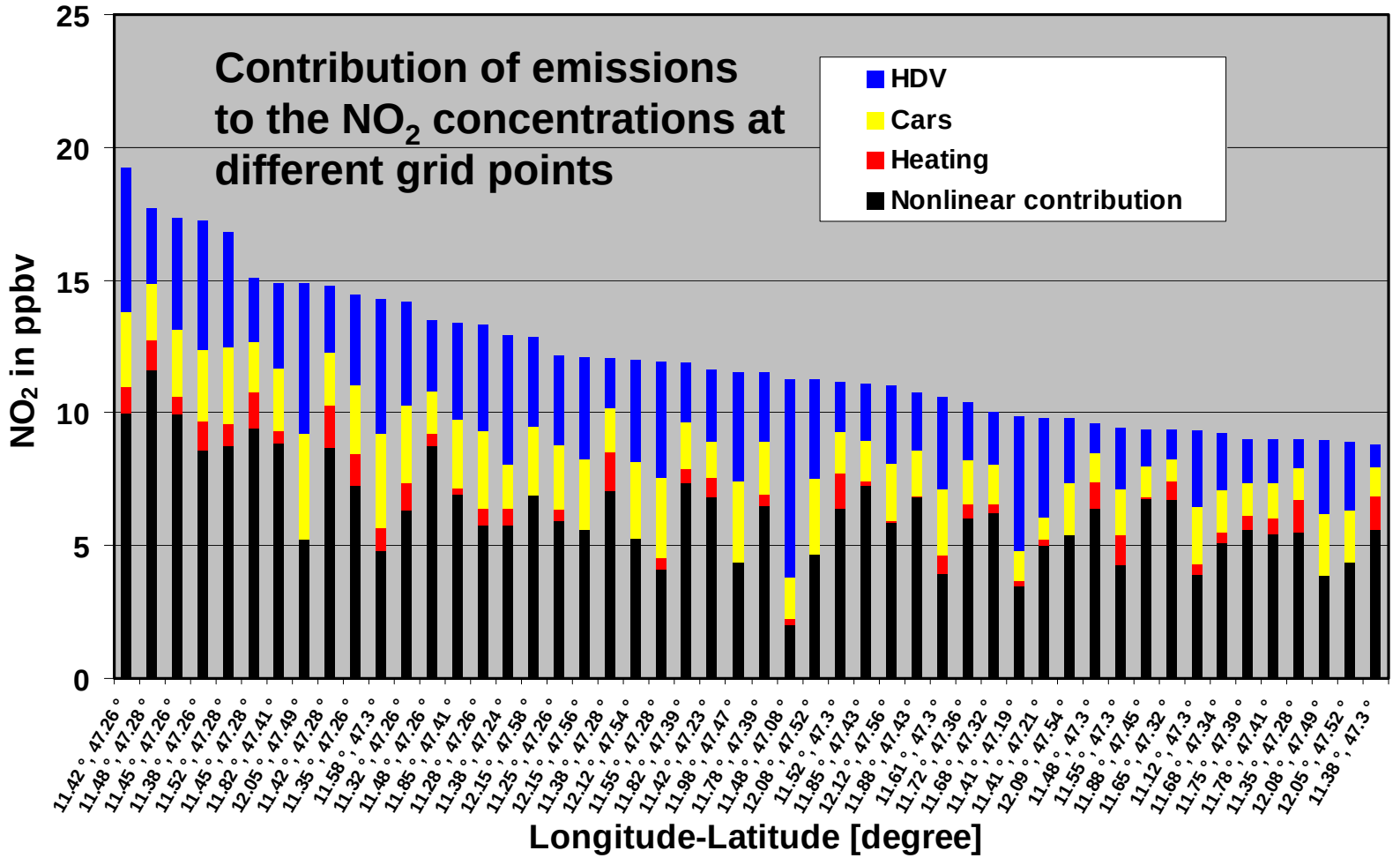
Inversions

Backscattering intensity

SODAR measurements: S. Emeis, C. Jahn, IMK-IFU

Analysis of modelling results

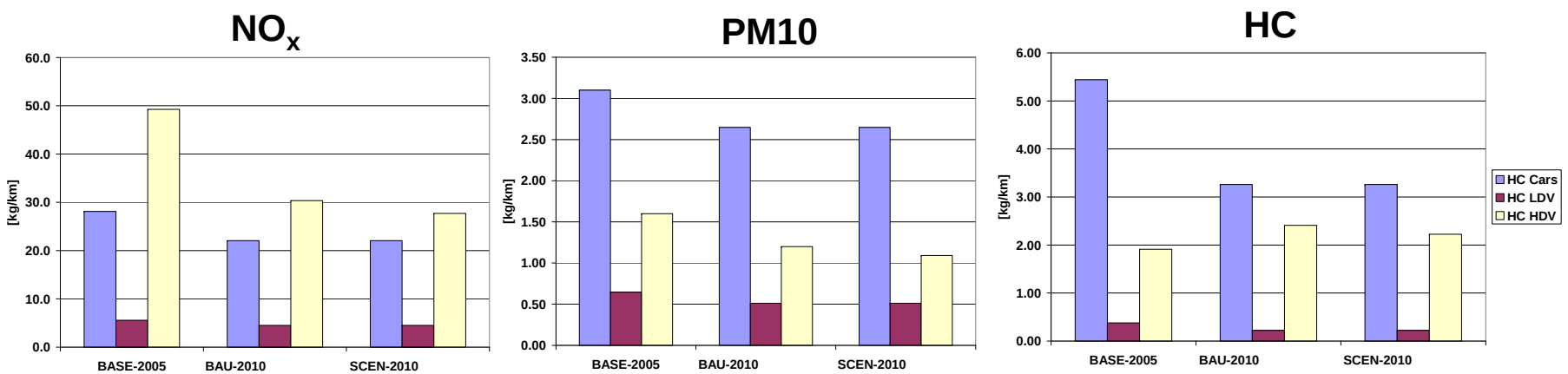
Receptor analysis for NO_2



Scenario simulations

Setup of scenario

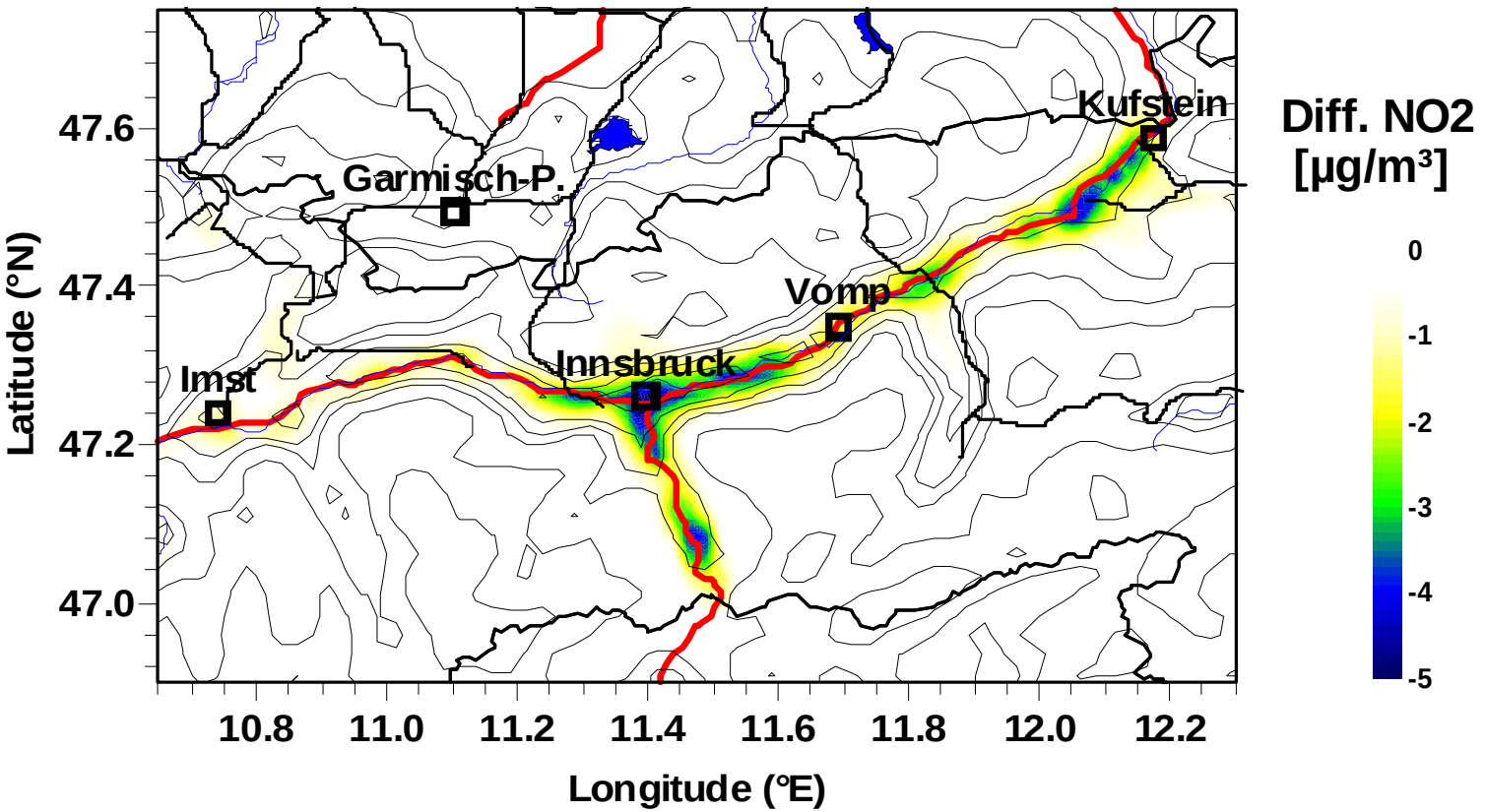
- Same meteorological conditions as in 2004
- Emission scenario SCEN-2010 (based on MONITRAF traffic development scenario + some measures for HDV)
- Unchanged NO_2/NO ratio for traffic emissions assumed



Scenario emissions: U. Uhrner, TU Graz

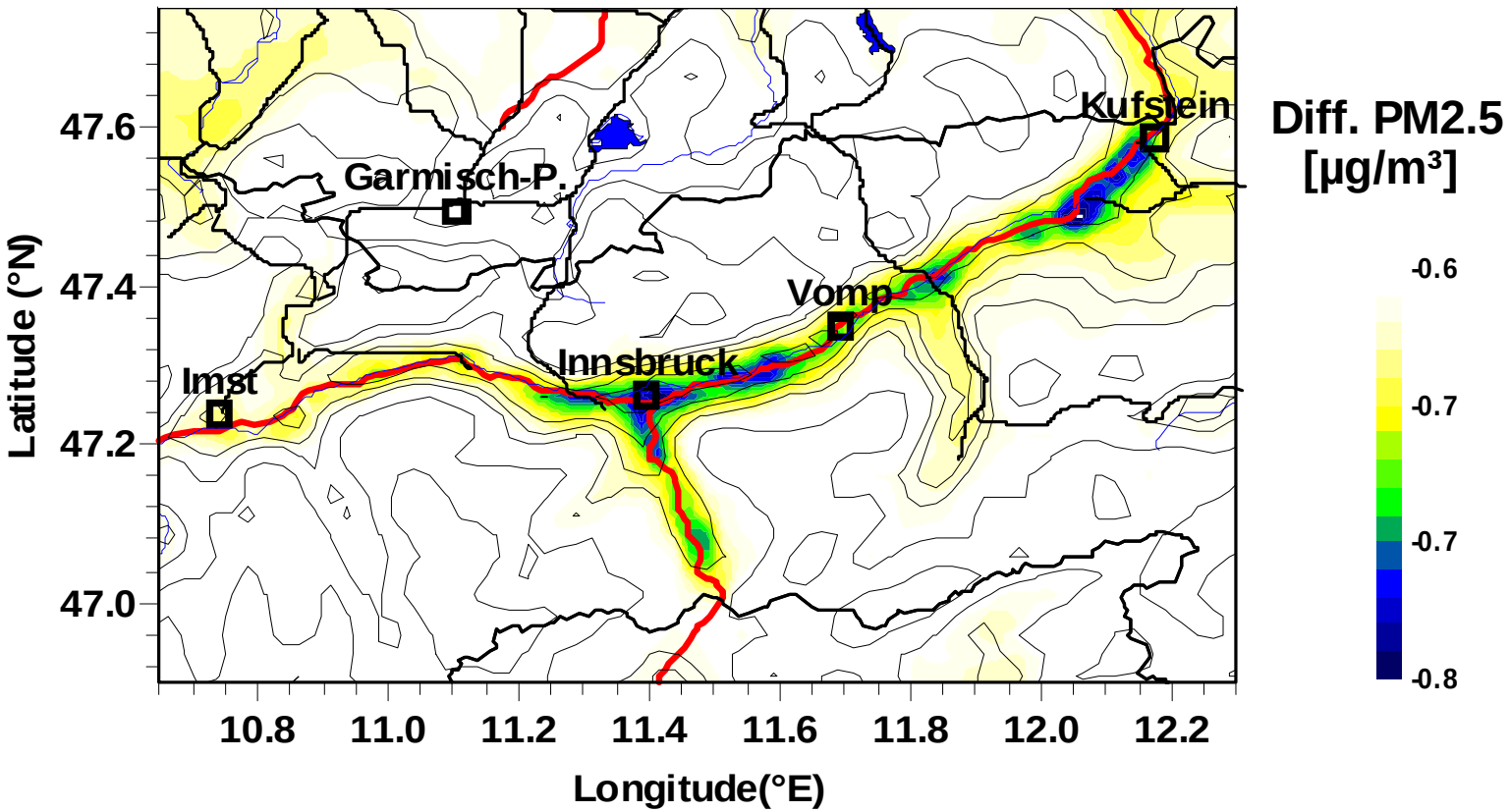
Scenario simulations

Difference between scenario NO_2 and NO_2 concentration simulated for the base case



Scenario simulations

Difference between scenario PM2.5 and PM2.5 concentration simulated for the base case

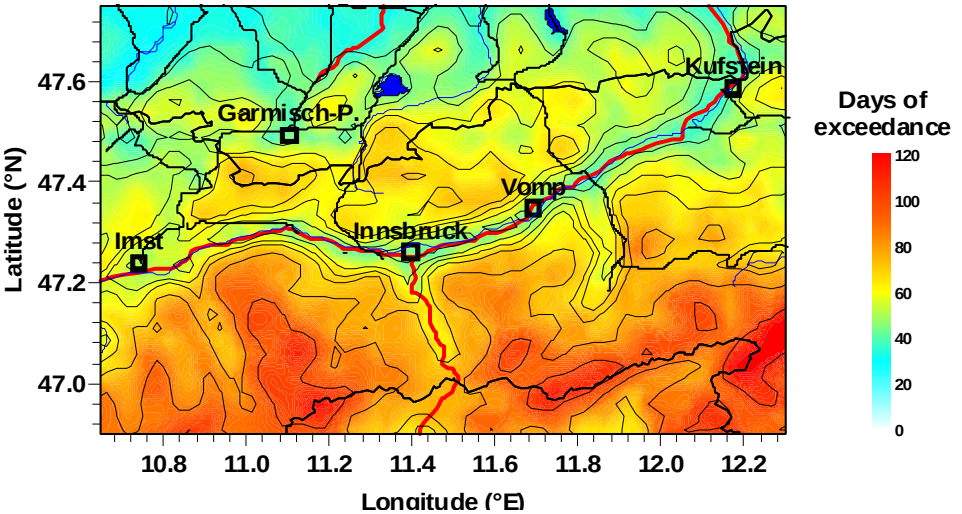


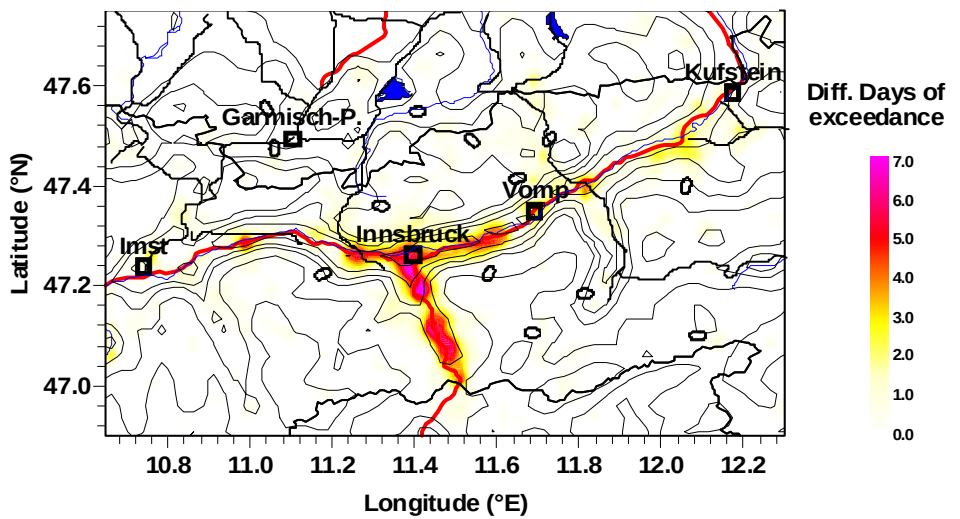
Scenario simulations

Effect on ozone

Ozone production depends on the concentrations of NO_x and hydrocarbons and might therefore be affected by changes in traffic emissions

Number of days with exceedance of the threshold of 120 $\mu g/m^3$ for the 8-hourly mean ozone concentration





Conclusions

Regional modelling

- ***Many observed features (spatial and temporal) are well reproduced, some are not represented***
- ***Long term simulation yields correct soil conditions and snow cover ⇒ better temperature simulation***
- ***General good agreement for NO_2, but not for PM***
- ***Regional modelling is a useful tool. However, sometimes local effects of meteorology and source distributions cannot be expected to be reproduced***
- ***Regional versus local effects – The gap between mesocale and microscale can only be partly filled by finer resolution or microscale models***

Conclusions

Emissions for regional modellings

- ***Reliability of model results can be improved by a consistent and complete emission inventory for the Alpine region***
- ***In particular the emission data base for PM needs further improvement***

Conclusions

Air quality

- ***Contribution of local traffic emissions to total NO_2 ranges between 30 and 80 % in polluted areas***
- ***Reduction of NO_2 for the MONITRAF scenario is up to 25 %***
- ***For PM reduction effect is less pronounced and uncertain in this case study***
- ***Effect on ozone is significant, though limited to the vicinity of roads and urban areas***
- ***Shift of the NO_2/NO_x ratio of the traffic emissions in the future can compensate the effect of mitigation measures***

Thank you for your attention