

# The online coupled meso scale climate-chemistry model MCCM - a modeling tool for short as well as for climate periods

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## Overview

- Introduction to the modeling system *MCCM*
- Short outline about the type of applications
- Examples and results
- Summary

## Online coupled meso scale climate chemistry model

### Meteorological part

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

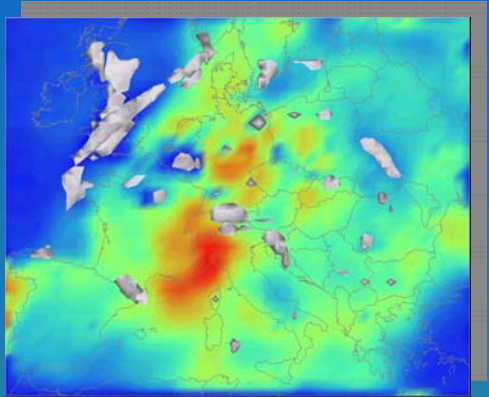
### Chemistry part

- RADM2 / RACM chemistry
- KPP preprocessor for chemical mechanisms
- Photolysis model
- Aerosol module (SORGAM)
- Biogenic emission module

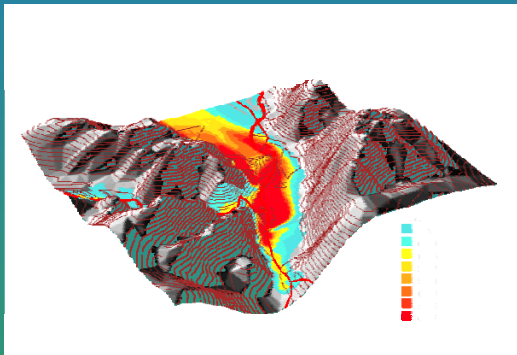
### Output:

Fields of temperature, humidity, cloud water and ice, rain water, snow, photolysis frequencies, concentrations of chemical compounds in the gas and particle phase, snow height ...

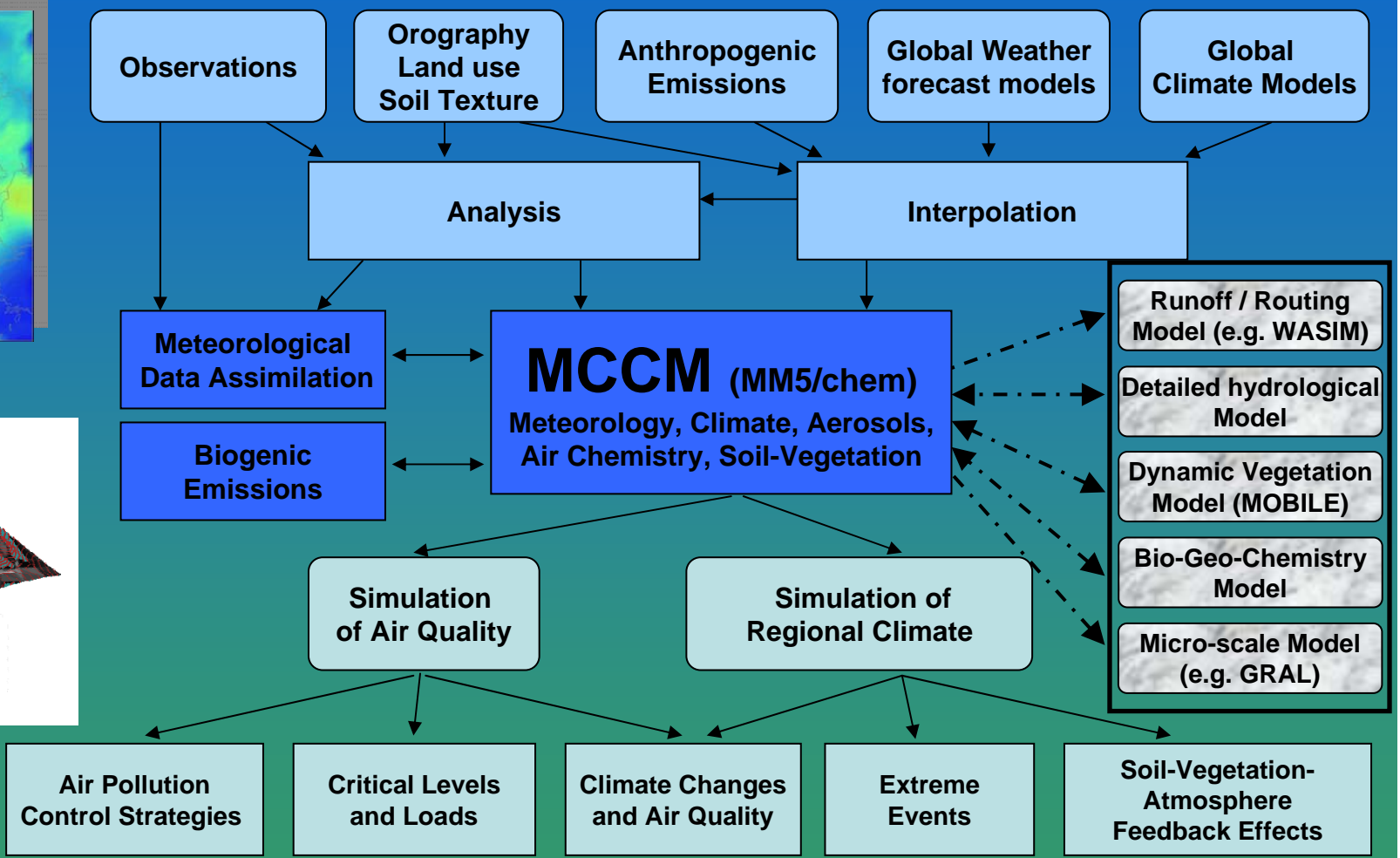
## Mesoscale-Climate-Chemistry-Model (MCCM)



**regional**



**local**



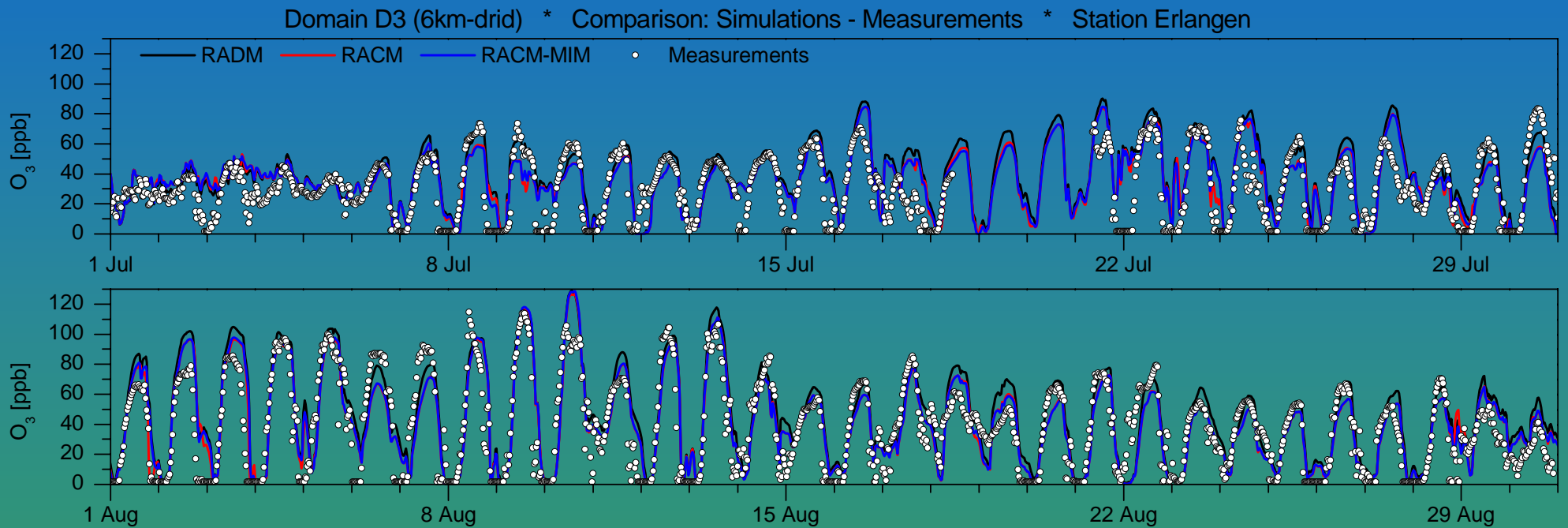
## Chemistry Mechanisms

- **RADM2 (Stockwell et al. 1990)**  
63 chemical species, 21 photolysis reactions and 136 chemical reactions of higher order
- **RACM (Stockwell et al. 1997)**  
77 chemical species, 23 photolysis reactions and 214 chemical reactions of higher order
- **RACM-MIM (Geiger et al. 2003)**  
84 chemical species, 23 photolysis reactions and 221 chemical reactions of higher order  
(based on MIM-Isoprene-Mechanism; this mechanism reflects an advanced description of the chemistry of biogenic ozone precursors like isoprene and others)

## Applications

- Evaluation studies about chemical schemes and numerical methods  
(→ Bavaria)
- Short time simulations, validation, comparison, strategies and scenarios of air quality studies  
(→ Mexico City, Santiago de Chile, Munich, Augsburg, Berlin)
- Long time simulations with the background on annual thresholds  
(→ Alpine region)
- Operational forecast for  $O_3$  and  $PM_{10}$   
(→ Southern Germany, Bavaria, Southern Austria)
- Climate-chemistry simulations for present and future climate  
(→ Southern Germany, Mexico)

# Evaluation Studies - Chemical Mechanisms



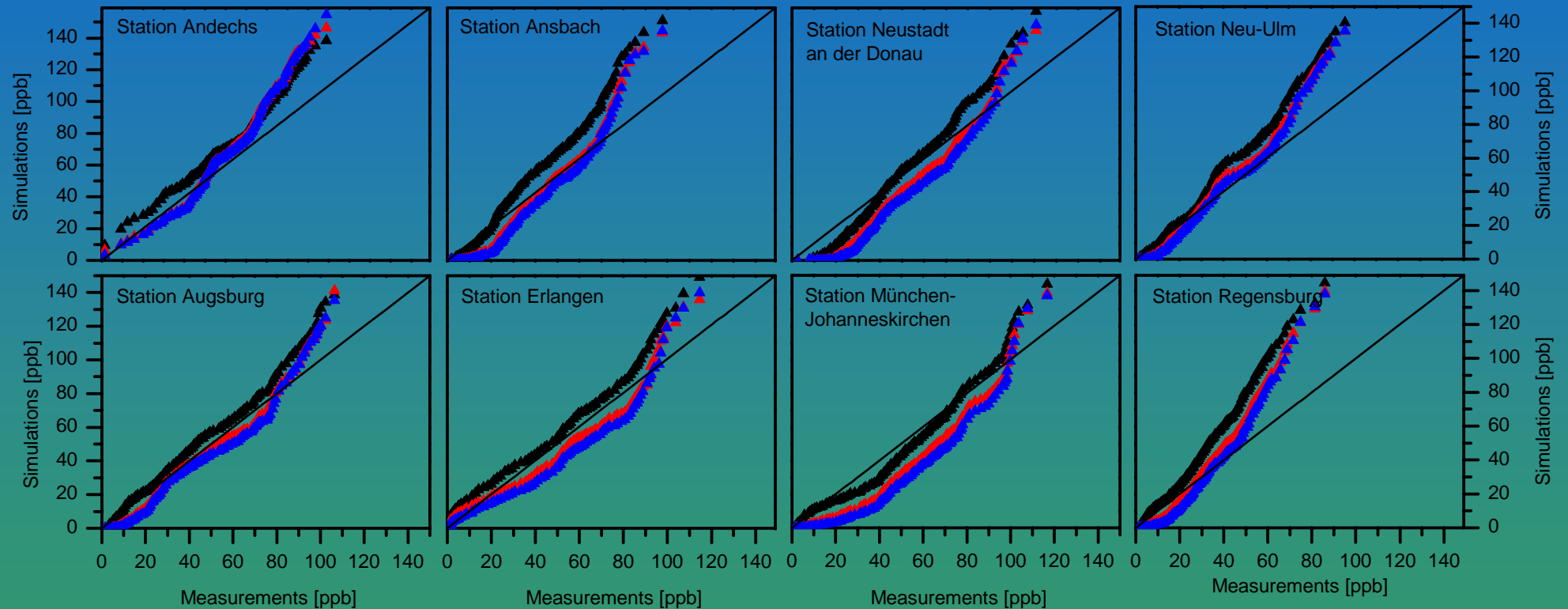
PhD thesis / Edwin Haas 2007

Setup: 54-18-6-2 km grid  
2 month period  
Southern Germany

# Evaluation Studies - Advection Schemes

D3: Quantile-Quantile-Plot

▲ MPDATA    ▲ BOTTM    ▲ BOTTP



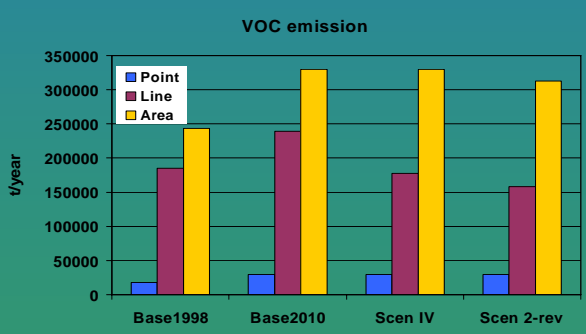
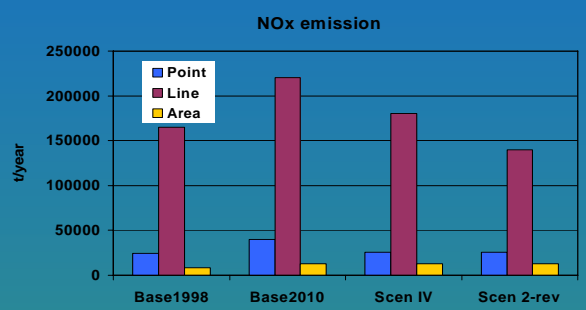
Setup: 54-18-6-2 km grid  
 10 days period  
 Southern Germany

PhD thesis / Edwin Haas 2007

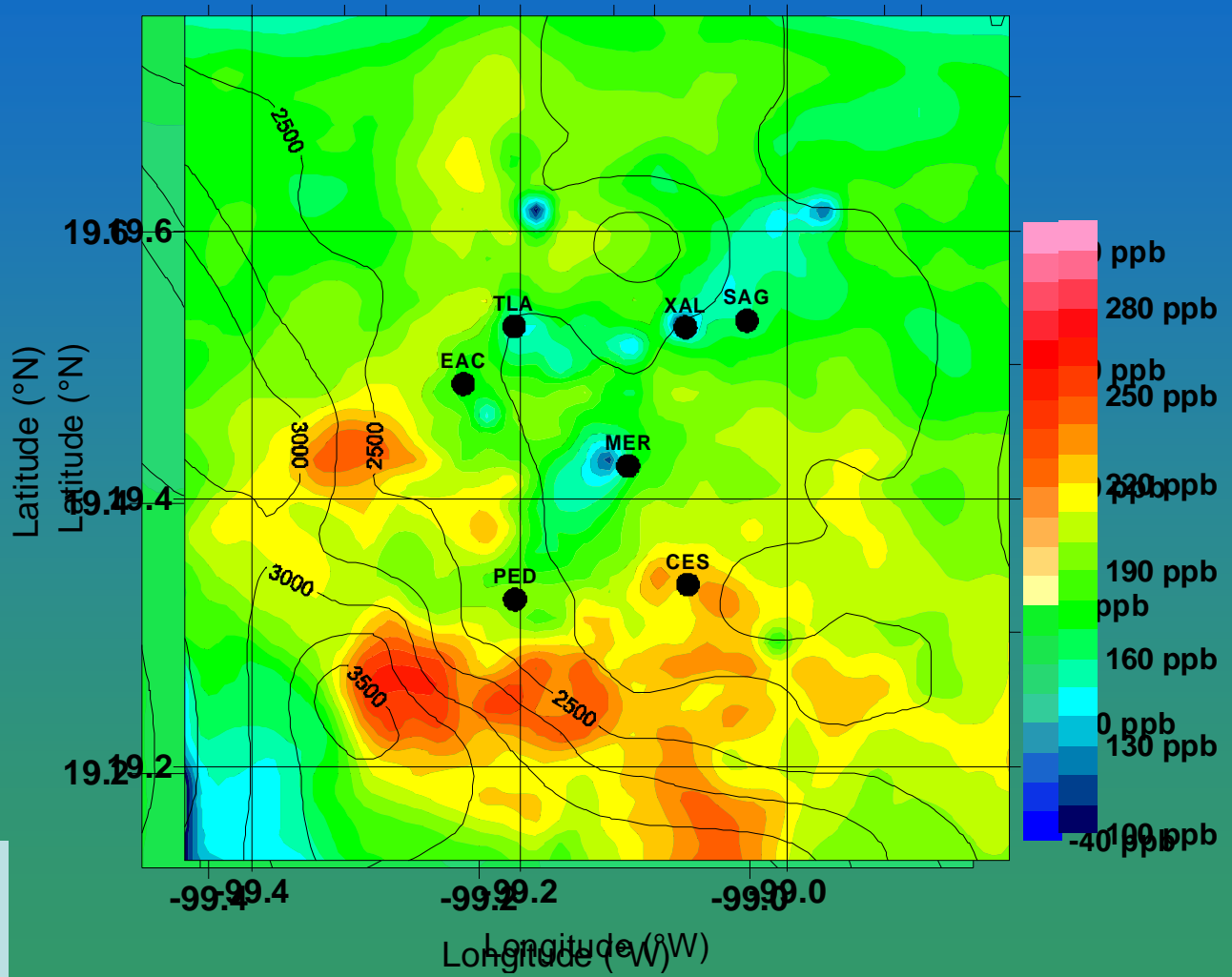


# Air Quality Studies - Scenarios

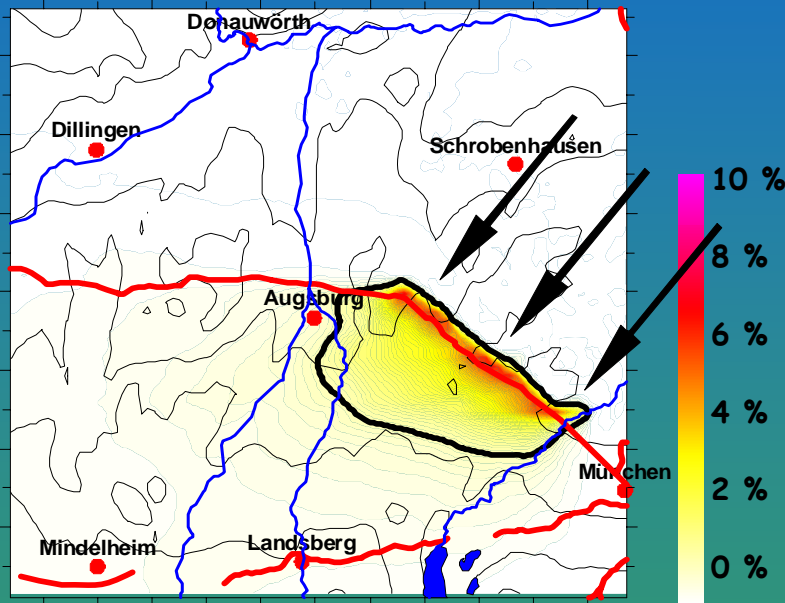
## O<sub>3</sub> Differences 2010



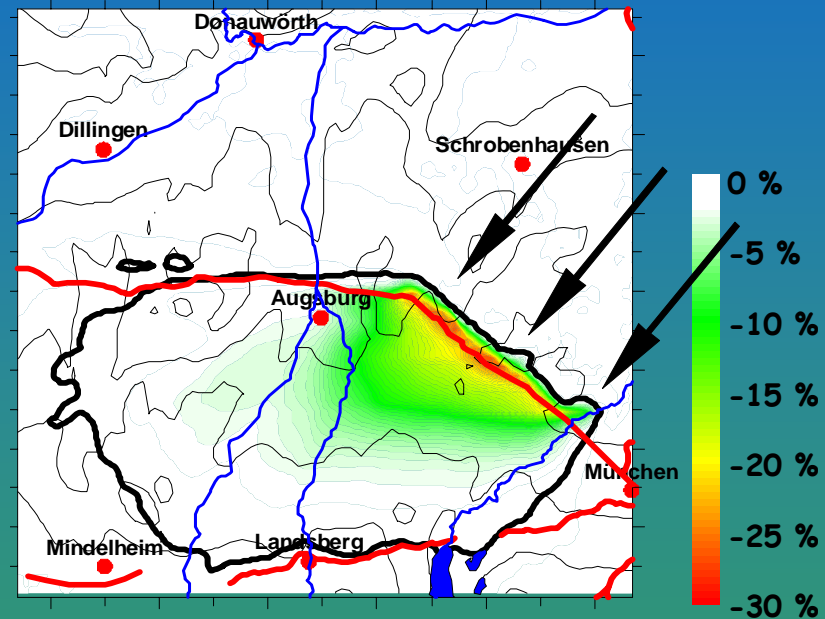
Setup: 18-6-2 km grid  
 days period  
 Mexico City



# Air Quality Studies - Emission Strategies



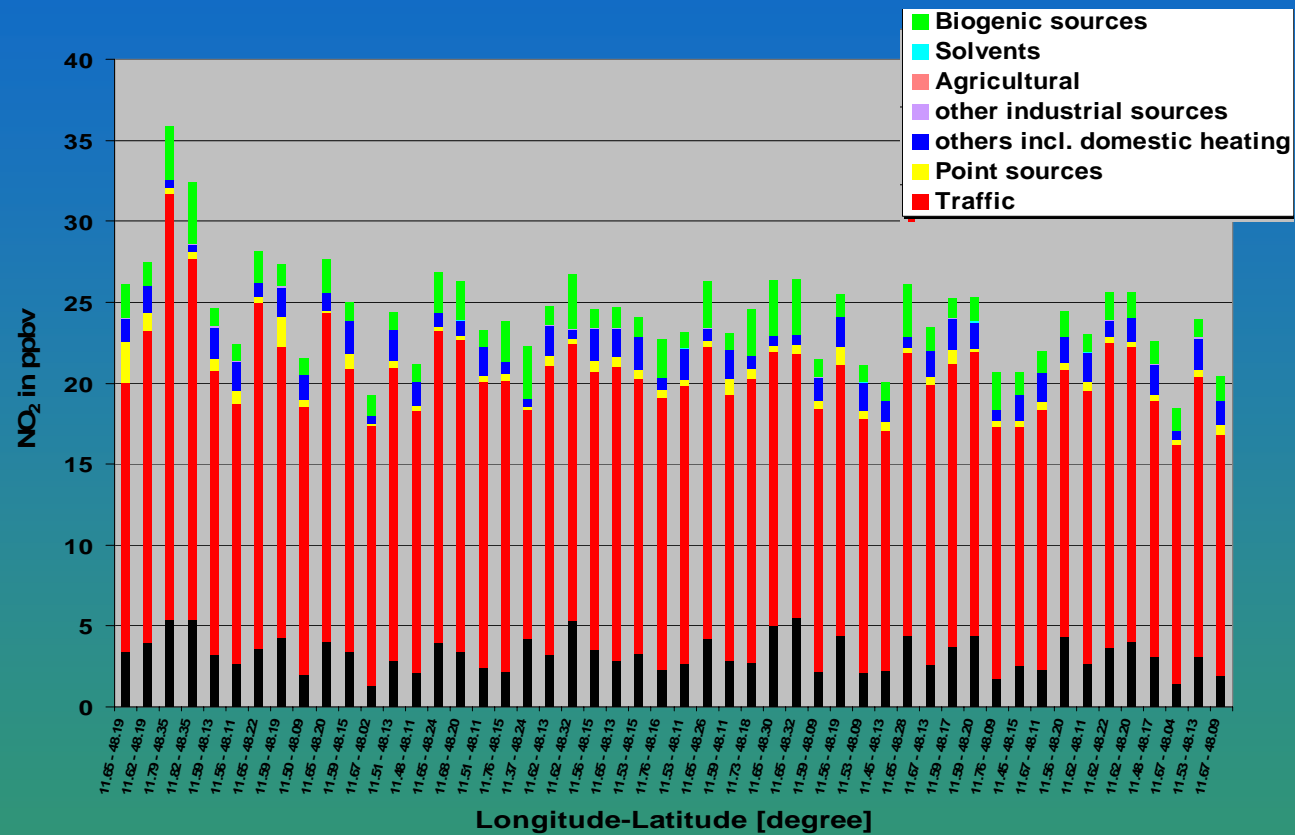
O<sub>3</sub> change



NO<sub>2</sub> change

Setup: 27-9-3-1 km grid  
4 days period  
Southern Germany

# Air Quality Studies - Methodology

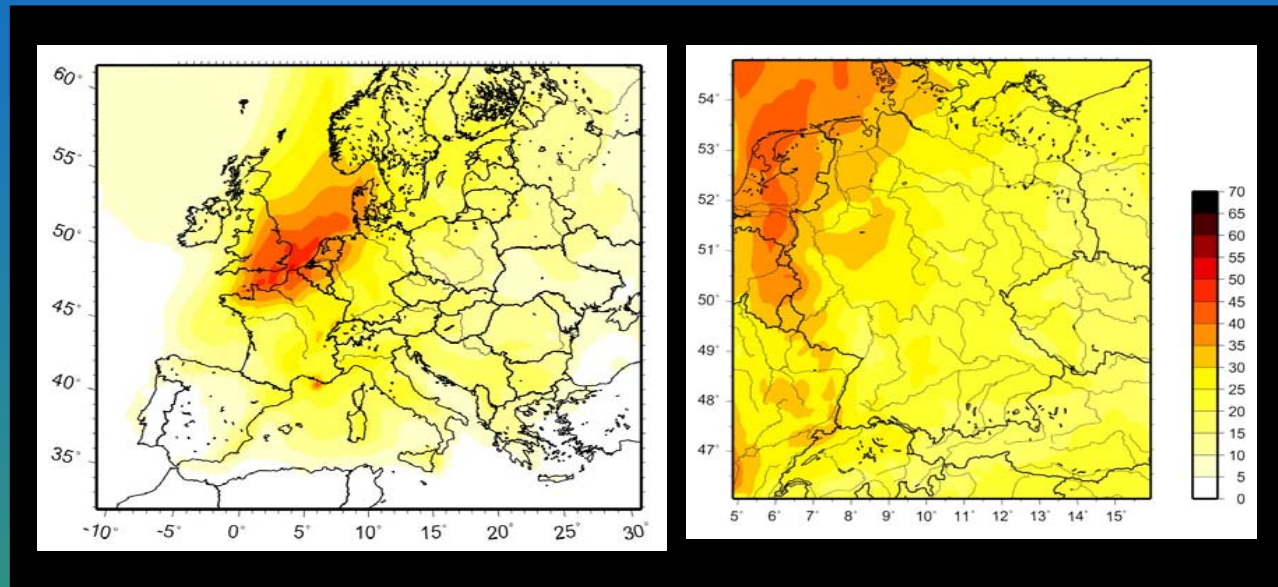


Source-receptor analysis for NO<sub>2</sub> within the conurbation of Munich

Setup: 54-18-6-2 km grid  
5 days period  
Southern Germany



# Operational Forecast e.g. PM<sub>10</sub>

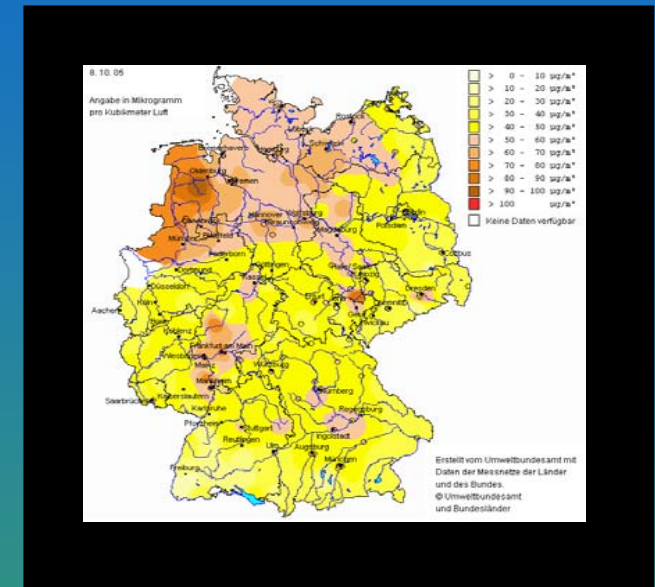


1 day forecast: 8th Oct. 2005

Domain 1: 60 km

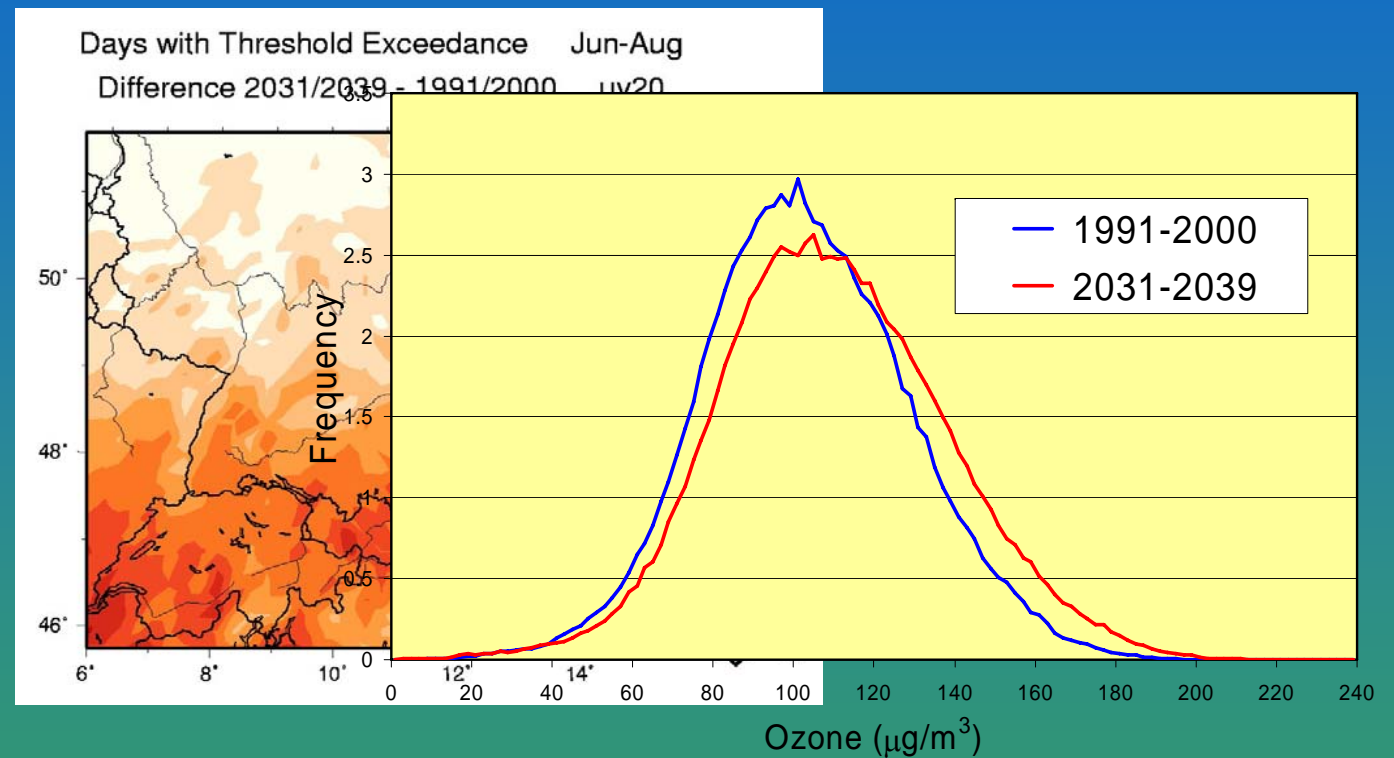
Domain 2: 15 km

Setup: 60-15 km grid  
3 days forecast  
Germany



Measurements: 8th Oct. 2005  
(Source: UBA)

# Climate-Chemistry Simulations - Air Quality



Threshold exceedances in ~~Distribution~~ distribution of daily  $\text{O}_3$  maximum

Setup: 60-20 km grid  
2x10 years period  
Southern Germany

## Summary

- Meso-scale Climate-Chemistry Model (MCCM) .....
- ✓ based on a well known and validated meteorological model (→ MM5)
- ✓ performs with validated chemistry mechanisms
- ✓ short- and long term simulations, assessment of emission strategies, forecast, climate impact assessment
- ✓ Regional and urban areas (e.g. alpine environments; urbanized conglomerations)



## Remarks and Outlook

- Modeling tools are only a part of a integrative description of the air quality
- Models results are only as good as its input data
- Model diversity against community model



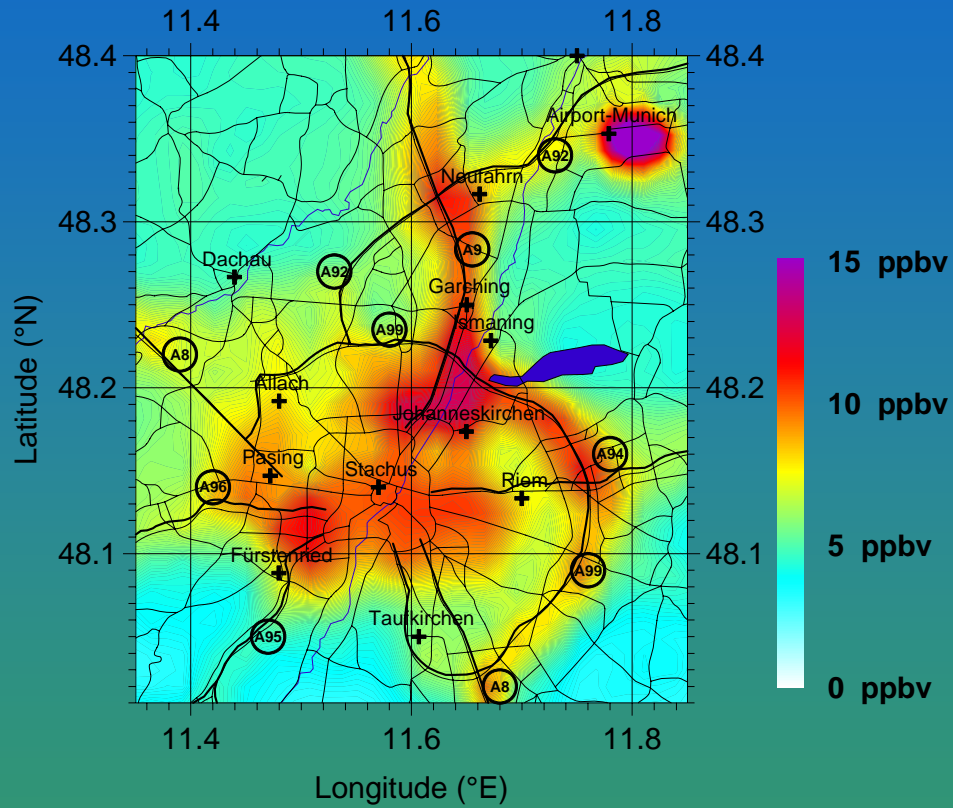
- Focus on climate-chemistry simulations with emphasis on urban conglomerations
- Model coupling within the compartments of the bio-, hydro- and atmosphere



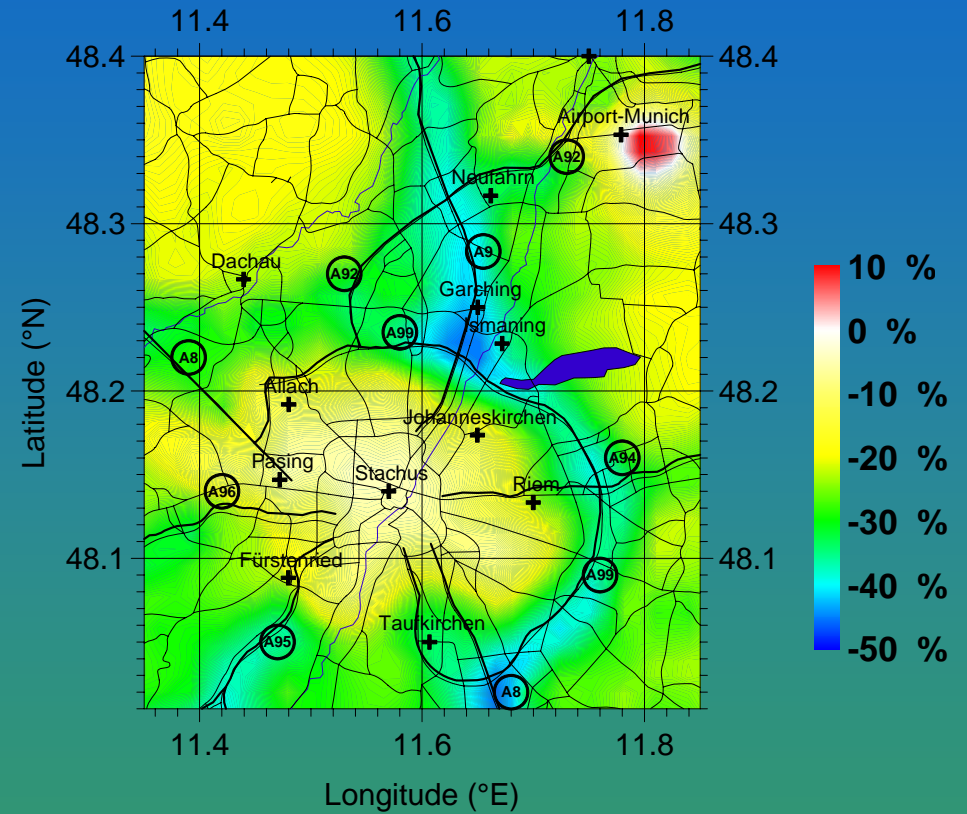
Thank you for your attention



# Air Quality Studies - Emission Strategies



**NO<sub>2</sub> distribution  
in 2000**



**NO<sub>2</sub> difference to the  
projection in 2010**



# Operational Forecast - e.g. $O_3$

