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
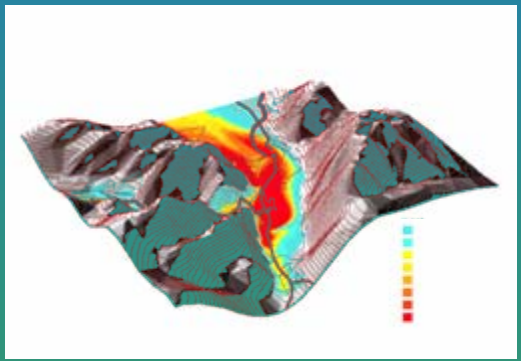- Aerosol module (SORGAM)
- Biogenic emission module

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 ...
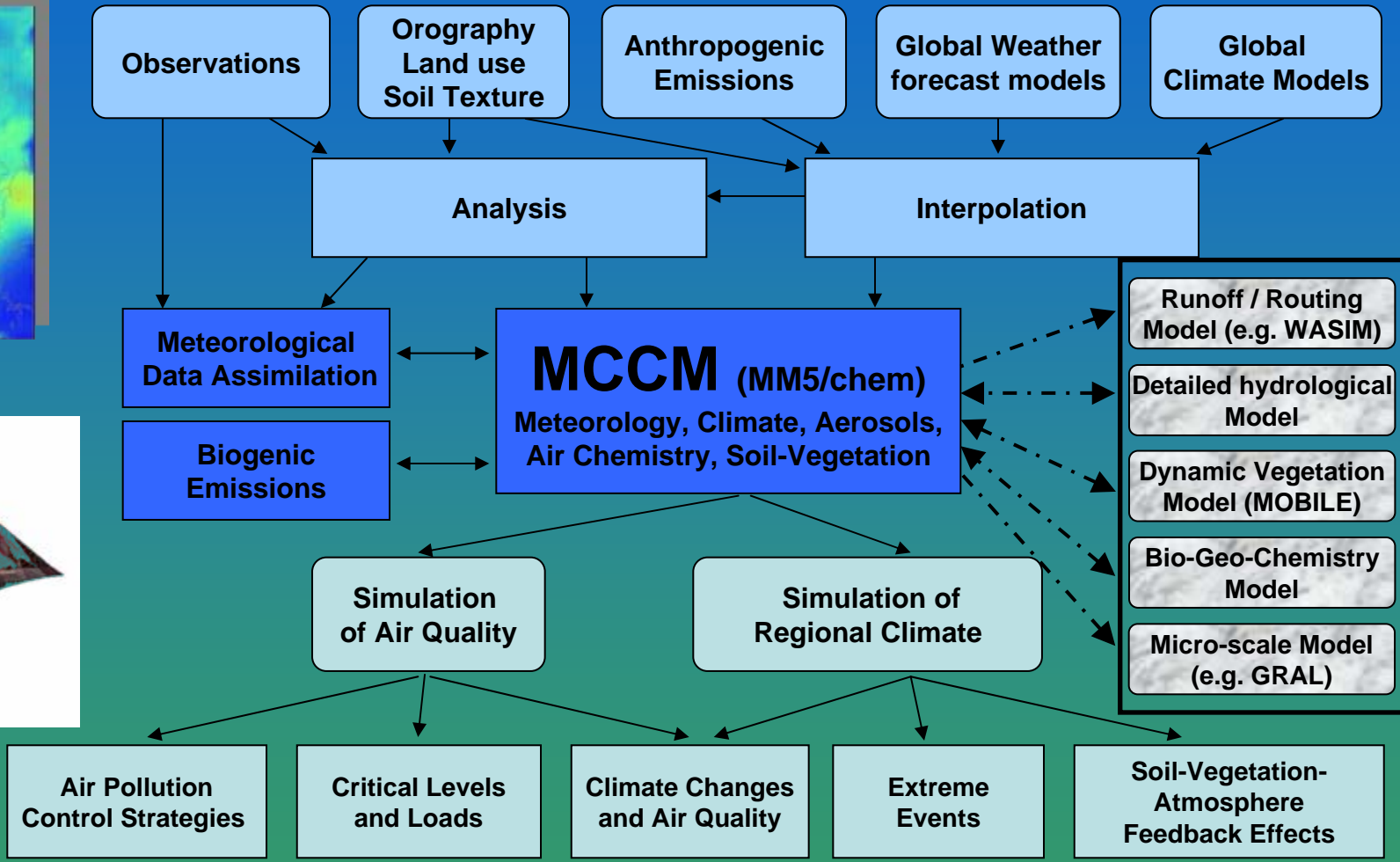
Mesoscale-Climate-Chemistry-Model (MCCM)
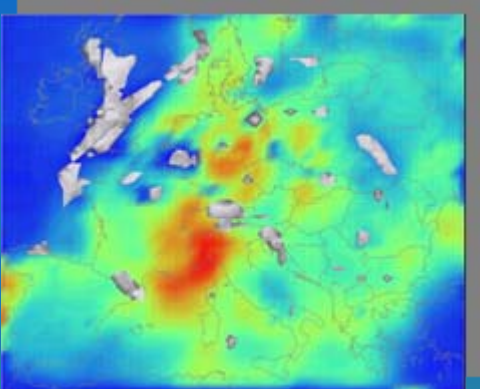
regional

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
   ($\rightarrow$ Bavaria)

➢ Short time simulations, validation, comparison, strategies and
   scenarios of air quality studies
   ($\rightarrow$ Mexico City, Santiago de Chile, Munich, Augsburg, Berlin)

➢ Long time simulations with the background on annual thresholds
   ($\rightarrow$ Alpine region)

➢ Operational forecast for O_3 and PM_{10}
   ($\rightarrow$ Southern Germany, Bavaria, Southern Austria)

➢ Climate-chemistry simulations for present and future climate
   ($\rightarrow$ Southern Germany, Mexico)

Evaluation Studies – Chemical Mechanisms

Domain D3 (6km-drid) * Comparison: Simulations - Measurements * Station Erlangen
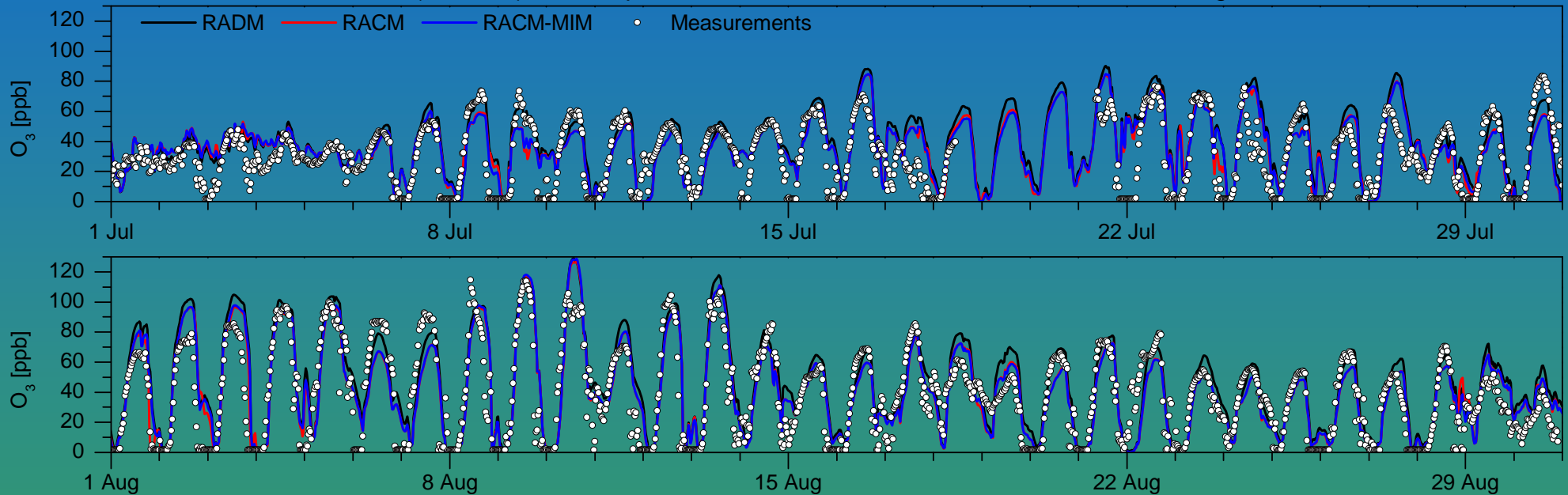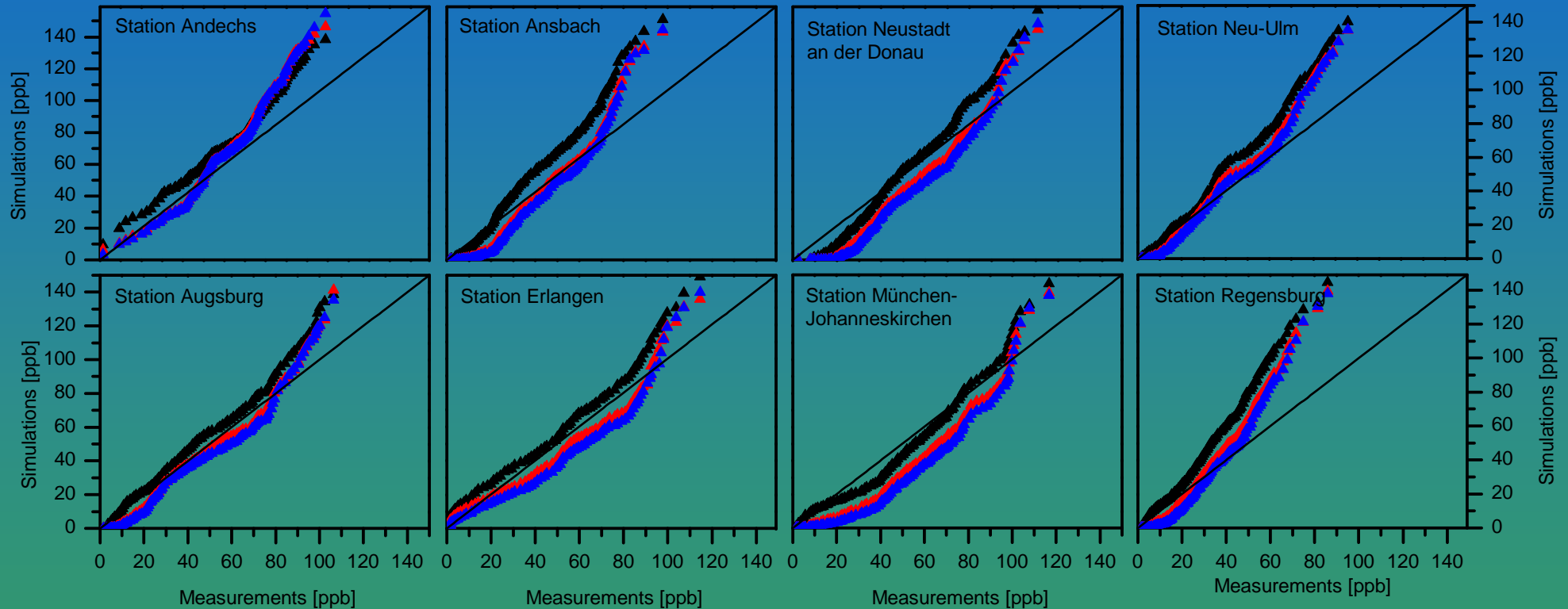

PhD thesis / Edwin Haas 2007

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

Evaluation Studies – Advection Schemes

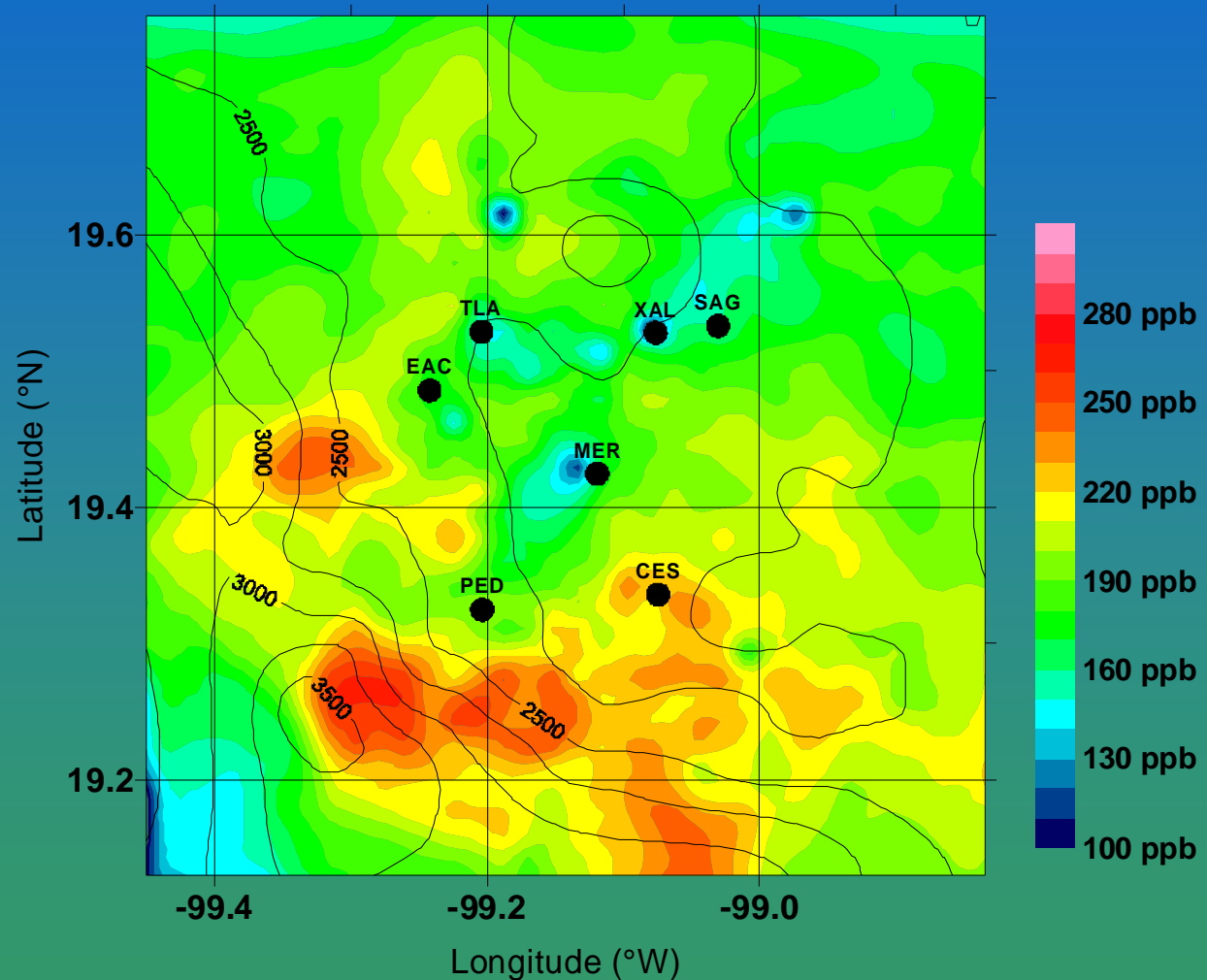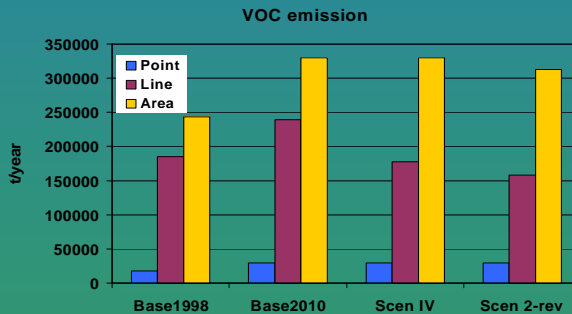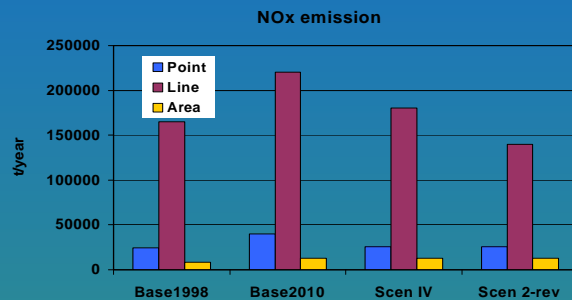D3: Quantile-Quantile-Plot

▲ MPDATA ▲ BOTTM ▲ BOTTP

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

Air Quality Studies - Scenarios

O$_3$-concentrations in 2010

NOx emission

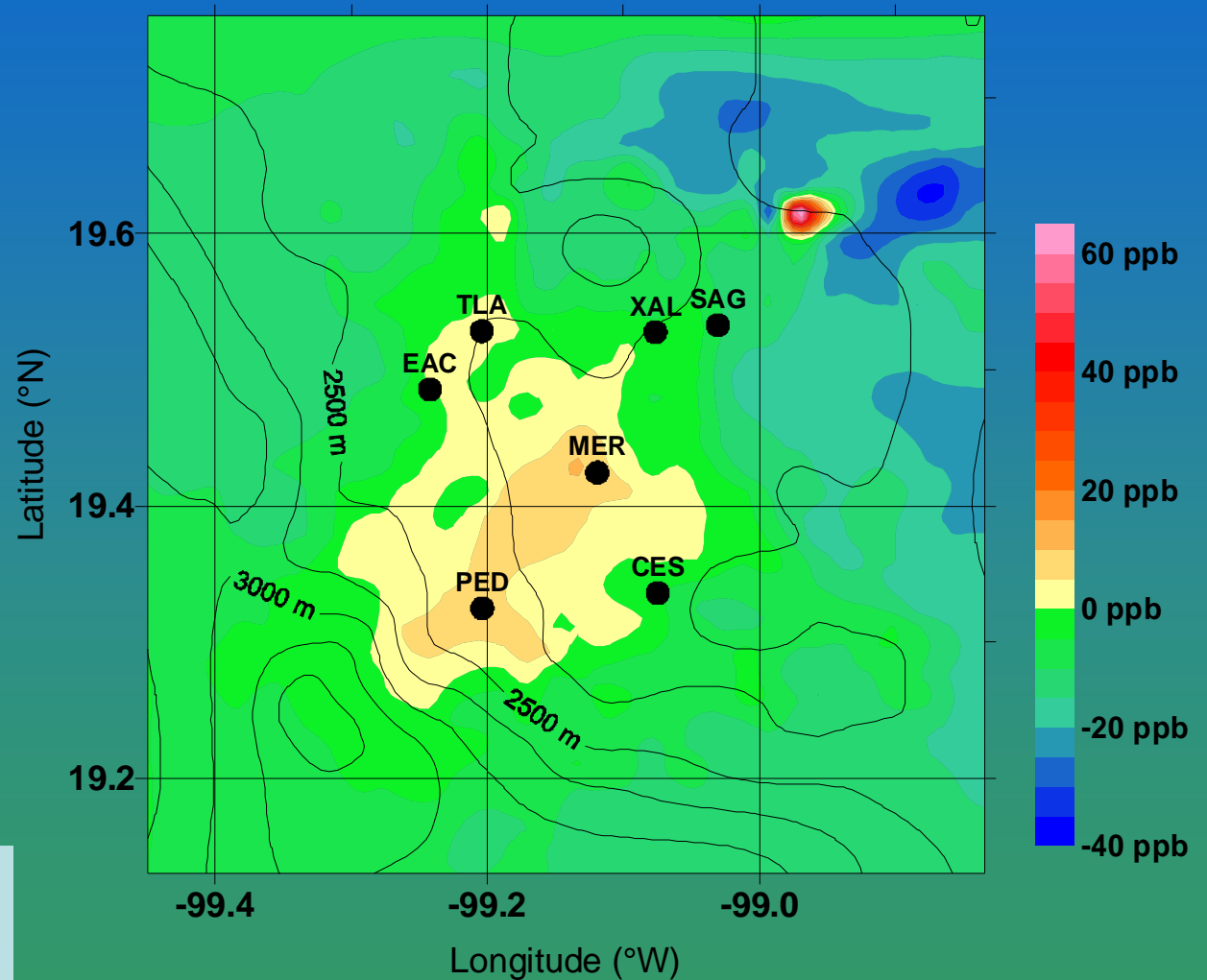**VOC emission**

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

Air Quality Studies - Scenarios

O₃-Difference in 2010

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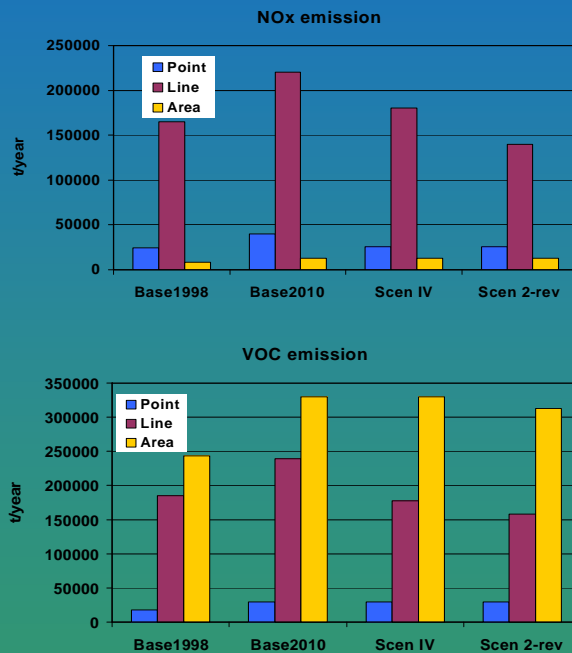
VOC emission
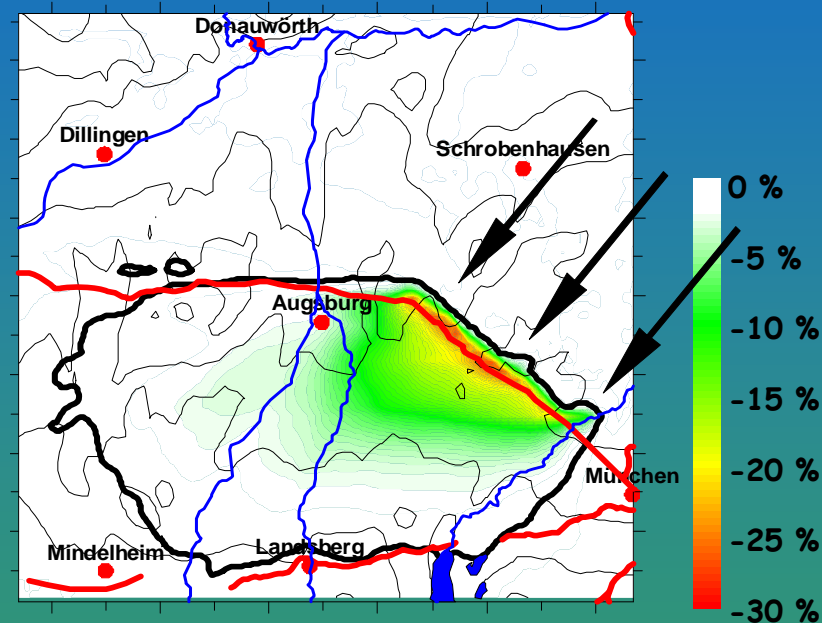
Setup: 18-6-2 km grid
          days period
          Mexico City

Air Quality Studies – Emission Strategies
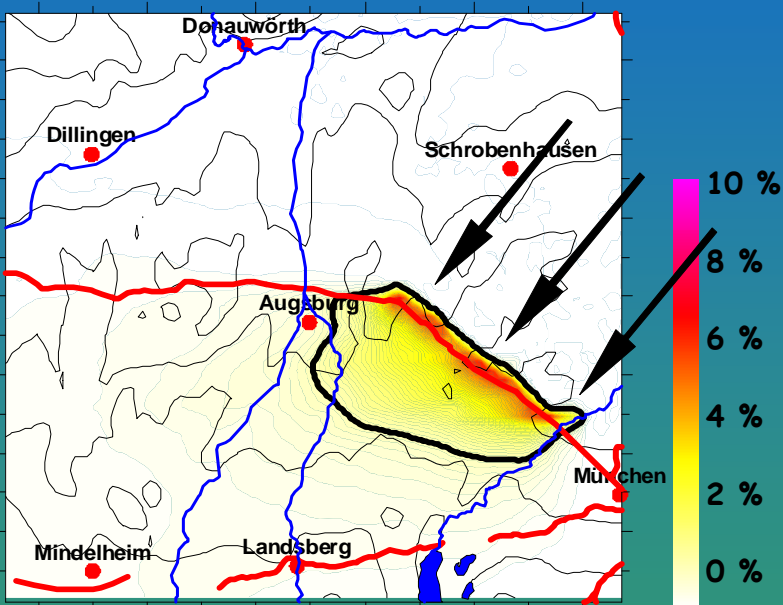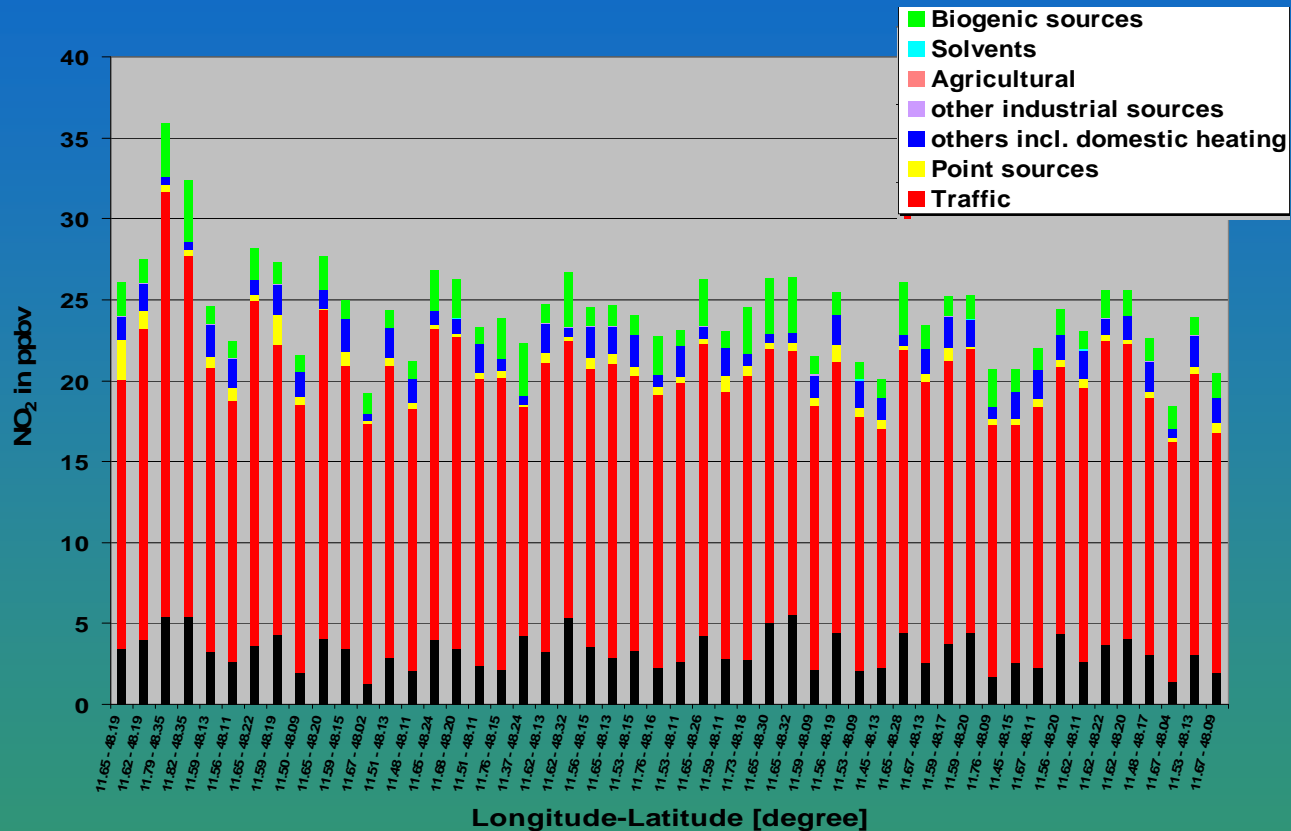

O₃ change

NO₂ change

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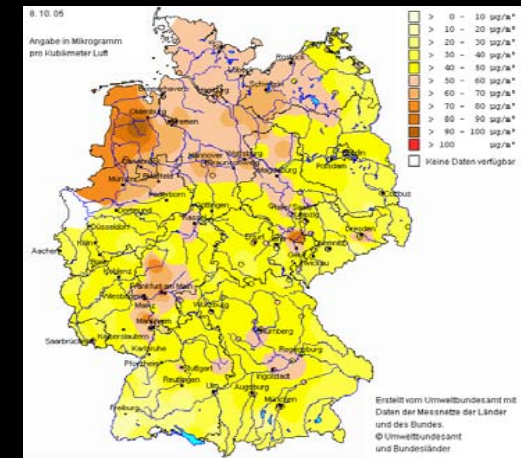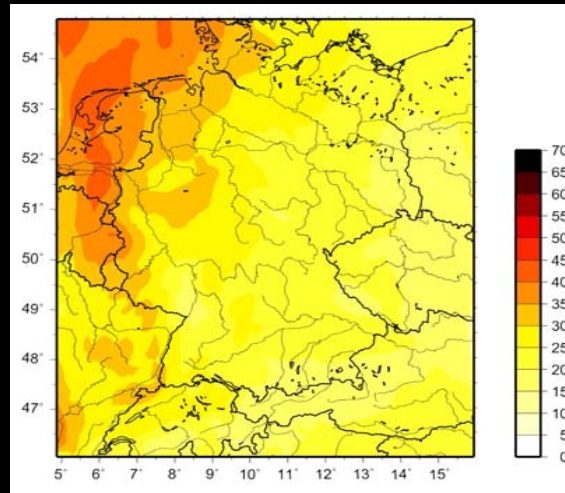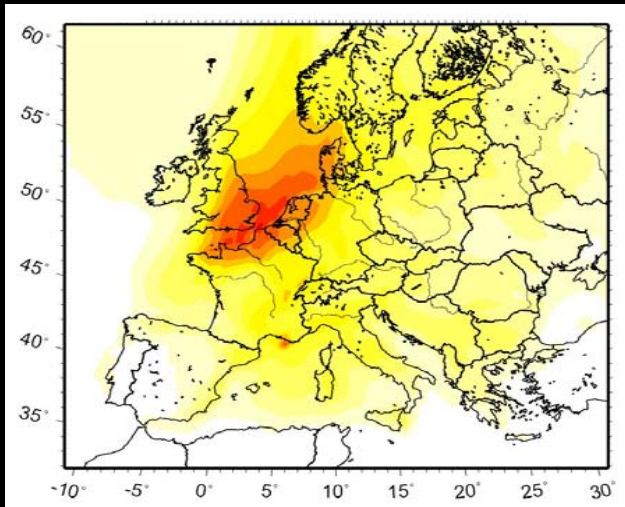   4 days period
           Southern Germany

Air Quality Studies - Methodology

Source-receptor analysis for NO$_2$ within
the conurbation of Munich

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

Operational Forecast e.g. PM_{10}

1 day forecast: 8th Oct. 2005
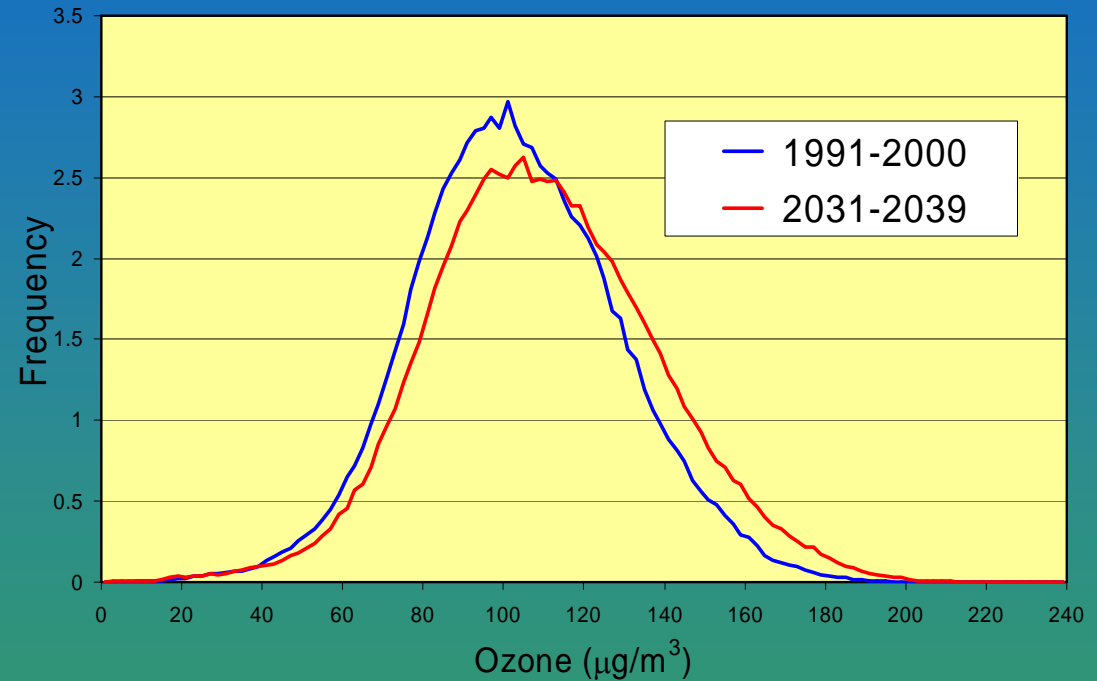**Domain 1: 60 km**   **Domain 2: 15 km**

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

Setup: 60-15 km grid
          3 days forecast
          Germany

Climate-Chemistry Simulations – Air Quality

Days with Threshold Exceedance   Jun-Aug
Difference 2031/2039 - 1991/2000   uv20
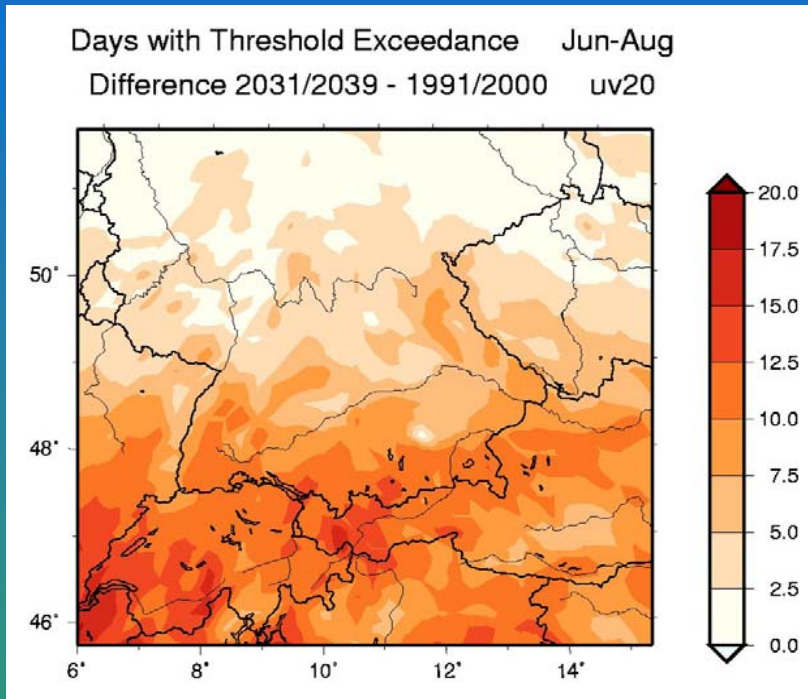
Threshold exceedances in the future

Distribution of daily 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 <u>only</u> 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