Helmholtz Climate Initiative

Regional Climate Change

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Topic 9

Regional modeling of the impact of climate change on air quality in Southern Germany

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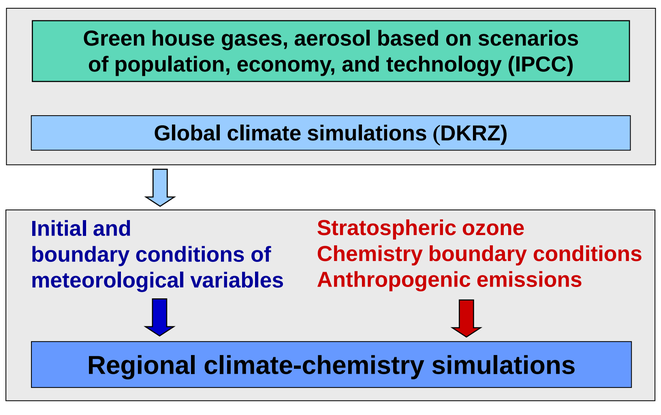
Introduction

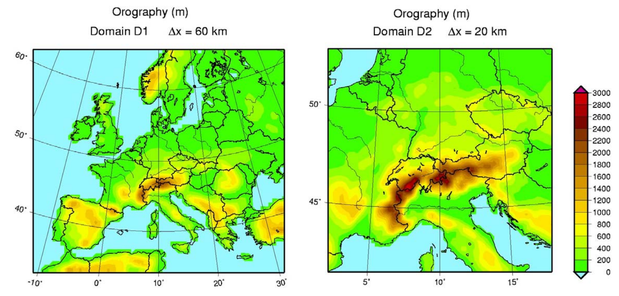
To investigate the potential effects of climatic change on air quality in Southern Germany, regional scenario simulations with the online coupled 3-dimensional meteorology-chemistry model MCCM were performed for present day and possible future conditions. The simulations were part of the joint project BayForUV (Bavarian Research Cooperation: Increased UV-radiation – Consequences and recommendations). To our knowledge, this was the first time that an online coupled meteorology-chemistry model has been applied for regional climate chemistry simulations over a period of several years.

Setup of the regional climate-chemistry simulations

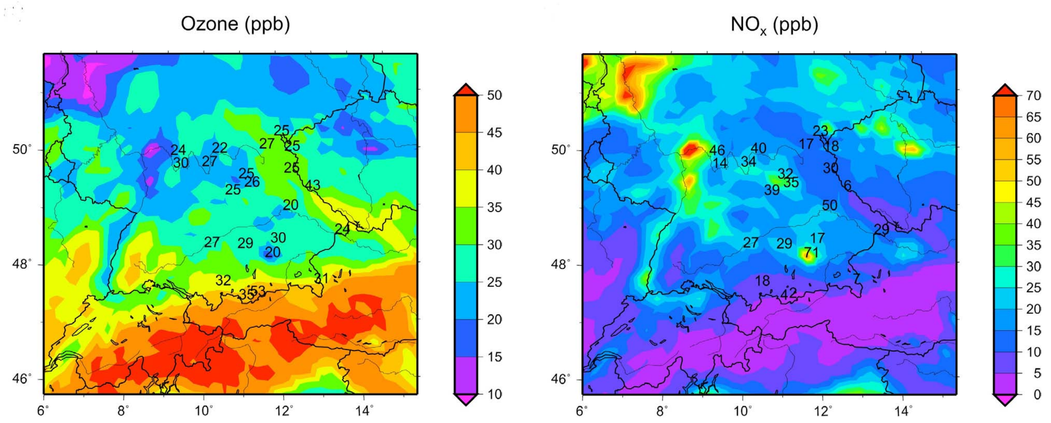


In two consecutive one-way nesting steps, a global ECHAM4 simulation with resolution T42 was downscaled to a resolution of 60 km for Europe and 20 km for Central Europe and the Alpine region.

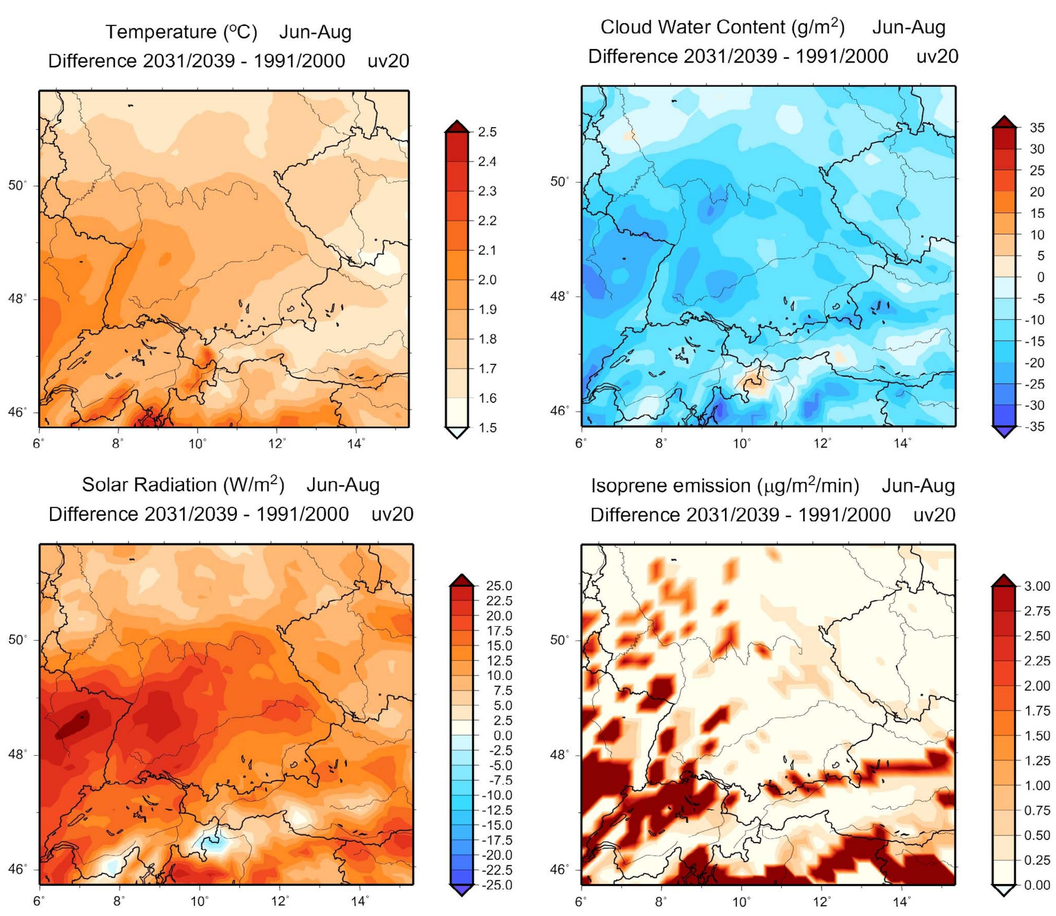
The dynamical downscaling was performed with the online coupled climate-chemistry model MCCM (Grell et al., 2000). Two time slices of about 10 years were selected for the regional simulations: the 90ths of the previous century and the 30ths of this century.



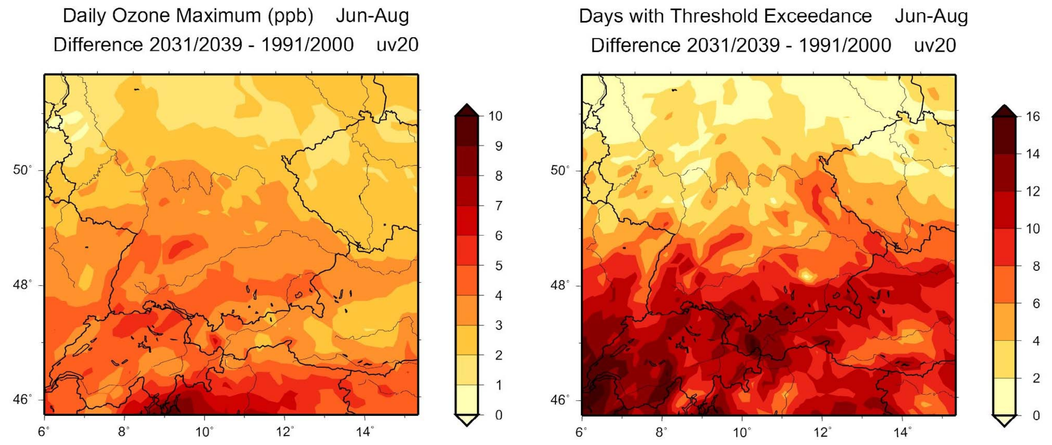
Results

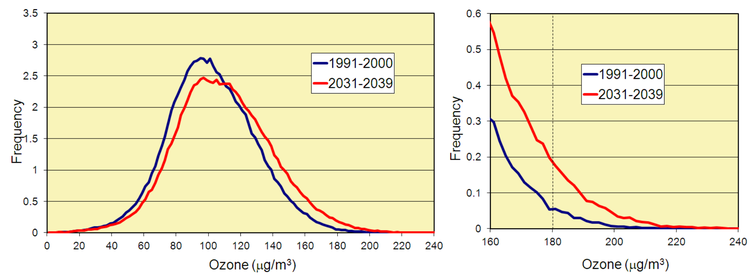


Evaluation for the summer months 1996-2000 (numbers refer to observations by LfU Bayern)



For the considered scenario, a temperature increase by two degrees was found and lower cloud water and cloud ice in summer. This results in about 10% higher solar radiation and photolysis frequencies. Increased temperatures and solar radiation result in 10-20% higher isoprene emissions.





Occurrence of maximum ozone concentrations above 90 ppb (180 µg/m³) increases by a factor of 4 over Southern Germany (from 99 station-events per year to 384 station-events per year)

Summary of results

Effects of regional climate change scenario on photochemistry under the assumption of unchanged anthropogenic emissions and no CO_2 impact on isoprene emissions:

- Ozone
  - Increase of daily ozone maximum by 5 – 10 %
  - Higher frequency of threshold exceedances
  - Increased occurrence of very high ozone concentrations
- HO_x, H_2O_2, HCHO: 15 – 20 % higher values in regions with high isoprene
- HNO_3: 10 – 15 % higher values in urban areas
- PAN: General decrease, increase by 5% in mountainous regions

Publication

Forkel, R. and R. Knoche (2006) Regional climate change and its impacts on photooxidant concentrations in southern Germany: Simulations with a coupled regional climate-chemistry model, J. Geophys. Res., 111, No. D12, D12302, doi:10.1029/2005JD006748 (13pp.)