Wet deposition simulations based on meteorological objective analyses

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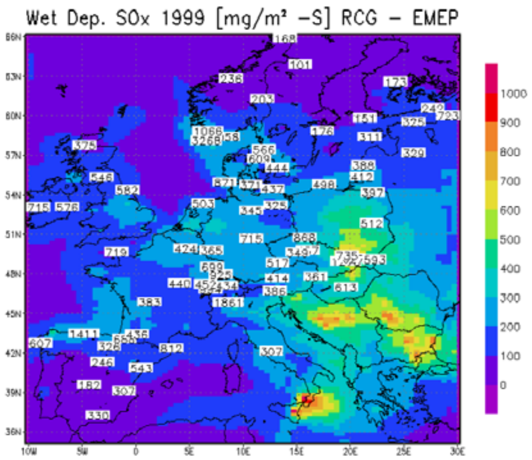
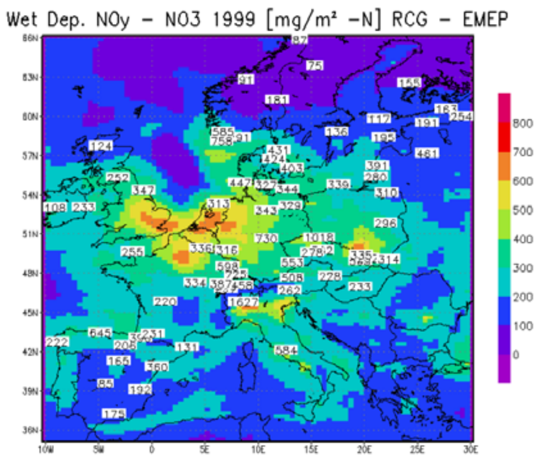
Objective of project

Wet deposition is an important removal process in the pollution budget of the atmosphere. Wet deposition processes refer to the uptake of gaseous pollutants and aerosol particles into cloud water and precipitation, and its subsequent transfer to the ground. The objective of this project is to simulate wet deposition with the CTM REM_CALGRID (RCG) and validate the simulation with measurements. The wet deposition module of RCG has been extended by in-cloud scavenging and an improved below-cloud scavenging. RCG is driven by the diagnostic driver TRAMPER which is based on a statistical interpolation of meteorological measurements.

Old wet deposition scheme performance



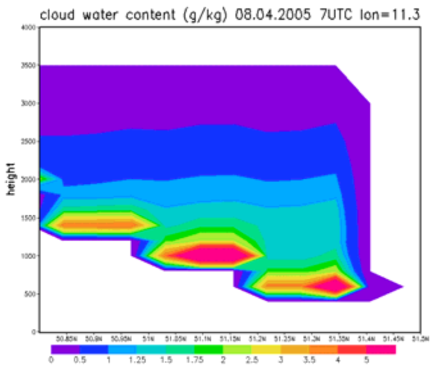
The figures show a RCG annual mean wet deposition simulation (coloured) and the corresponding EMEP-measurements (numbers) for the year 1999. The RCG is able to reproduce correctly the spatial distribution of the wet deposition of sulphur and nitrogen but underestimates the absolute amount especially in regions with high emissions.



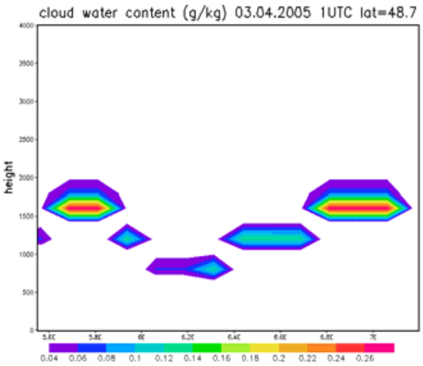
TRAMPER 3D-clouds

TRAMPER 3D-clouds are generated by using synoptic observations from WMO and cloud parameter statistics. As a next step the cloud water content field of the prognostic COSMO-EU Model of the German Weather Service will be utilized as first-guess field.

By using observations as a source the TRAMPER output-field represents cloud parameters and precipitation as realistic as possible.



convective clouds



stratiform clouds

Wet deposition scheme

Within the old scheme wet deposition was simulated using simple constant scavenging coefficients for gases and particles for below-cloud scavenging, only.

The new scheme for wet deposition utilizes the optimal description of precipitation and information of clouds based on observations and includes a cloud water content-dependent in-cloud scavenging and an improved below-cloud scavenging (Seinfeld and Pandis, 1998).

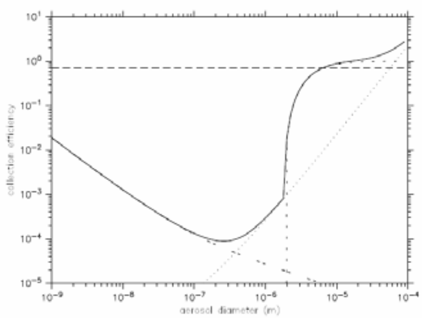
Gas in-cloud scavenging coefficient:

$$\lambda_{ic_g} = \lambda_{aq} + \lambda_g = \frac{4.2\cdot 10^{-7}\cdot E_g\cdot P\cdot H\cdot c_g\cdot cwc}{d_d\cdot c\cdot \rho_w} + \lambda_g$$

Particle below-cloud scavenging coefficient:

$$\lambda_{bc_p} = \frac{4.2\cdot 10^{-7}\cdot E_p\cdot P}{d_d}$$

λ_g : gas-phase scavenging coeff.
E_g : collection efficiency (gas)
P : precipitation rate
H : Henry constant
c_g : gas concentration
CWC : cloud water content
d_d : drop diameter
ρ_w : water density
E_p : collection efficiency (particle)



E_p–particle diameter-dependency

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