Geophysical Research Abstracts
Vol. 14, EGU2012-2971, 2012
EGU General Assembly 2012

Simulation of dimming and brightening in Europe from 1958 to 2001 using a regional climate model

E. M. Zubler, U. Lohmann, D. Lüthi, C. Schär, and M. Wild

ETH Zurich, Institute for Atmospheric and Climate Science, Department of Environmental Sciences, Zurich, Switzerland (elias.zubler@env.ethz.ch)

This study applies a regional climate model with coupled aerosol microphysics and transport in order to simulate dimming and, in particular, brightening in Europe from 1958 to 2001. Two simulations are performed, one with transient emissions and another with climatological mean emissions over the same period. Both simulations are driven at the lateral boundaries by the ERA-40 reanalysis and by large-scale aerosol concentrations stemming from a global simulation with the general circulation model ECHAM5-HAM. We find distinct patterns of dimming and brightening in the aerosol optical depth and thus clear-sky downward surface shortwave radiation (SSR) in all analyzed subregions. The strongest brightening between 1973 and 1998 under clear-sky conditions is found in Mid-Europe (+3.4 W m^{-2} per decade, in line with observations).

However, the simulated all-sky SSR is dominated by the surface shortwave cloud radiative forcing (CRF). The correlation coefficient R between five-year moving averages of the CRF and all-sky SSR equals 0.87 for entire Europe. Both model simulations as well as the driving ERA-40 reanalysis show a similar evolution of cloud fraction and thus all-sky SSR. On the one hand, this is not surprising as the RCM inherits the circulation pattern at the lateral boundaries from the reanalysis. On the other hand, this supports the finding that transient aerosol emissions only have a minor impact on all-sky SSR as compared to clouds. For most subregions, the modeled differences in all-sky SSR due to transient versus climatological emissions are insignificant in comparison with estimates of the model's internal variability. However, an evaluation of all-sky SSR trends with station data all over Europe indicates that particularly in Eastern Europe the model tends to underestimate the role of aerosols.