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The signature of climate change on surface ozone: Using the Online integrated climate-chemistry model (EnvClimA)

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The signature of climate change on European surface ozone was studied using the online integrated climate-chemistry model for Environmental applications (EnvClimA). The EnvClimA is an environmental version of the regional climate model of the International Centre for Theoretical Physics (ICTP) (RegCM-CHEM4, Shalapy et al., 2012). The model domain has a horizontal resolution of 50 $\times$ 50 km and 18 vertical sigma levels. In this study, a 20 year simulation was preformed for the selected European domain for the reference (2000-2009) and future (2040-2049) periods. For both simulations, the initial and boundary conditions for the meteorological fields are provided every six hours from the global ECHAM5-r3 model. The chemical boundary conditions over Europe are provided also every six hours by the Danish Eulerian Hemispheric Model (DEHM). The anthropogenic emissions of nitrogen oxides, sulfur dioxide, ammonia, non-methane volatile organic carbon and carbon monoxide were taken from the IPCC-RCP4.5 future emission scenario. In this simulation the biogenic isoprene emissions are not considered, because the MEGAN module (on-line coupled with the land surface scheme in EnvClimA) tends to overestimate (almost twice) the total emitted biogenic isoprene.

The EnvClimA results indicated zonal behavior of average daily maximum concentrations for the surface ozone (O_3). In winter, model has a substantial negative bias for both mean and daily maximum O_3. This may be due to an underestimation of the winter air temperature over north-eastern Europe and due to feedback (included in the model) of O_3 on the meteorological variables. Although the model spatial correlation is rather poor for diurnal average concentration, but for the average of daily maximum O_3 concentrations the model showed correlation coefficients higher than 0.8 during summer. The model always showed the highest spatial correlation over central and southern Europe. The general pattern indicated an increase of surface ozone changes in southern Europe and a decrease in northern Europe for a chosen climate scenario. The change in surface ozone caused by climate change should also be related to anticipated changes in European precursor emissions. In this study it was found that changes in surface O_3 due to climate change are much smaller than what can be expected from anthropogenic emission reductions over the same time period from previous studies. This study is also a contribution to the Nordic project “EnsClim” and authors are thankful to all partners involved.