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Assessment of climate change impacts on air quality in the Aveiro Region

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Air quality (AQ) is strongly dependent on meteorological conditions and it is therefore sensitive to climate change (CC). According to the latest report of the Intergovernmental Panel on Climate Change (IPCC), CC will have complex effects on chemistry, transport and deposition of local air pollutants. Nowadays, the Region of Aveiro (centre region of Portugal) is recognized as one of the regions affected by poor AQ, being nitrogen dioxide (NO_2), tropospheric ozone (O_3) and particulate matter (PM10), the most critical air pollutants. This highlights the need of studies that assess the future CC effects in the AQ of Aveiro Region at a high-resolution level, which might allow early climate adaptation strategies.
For this analysis, the Weather Research and Forecasting (WRF) model, forced by the Max Planck Institute Earth System Model - low resolution (MPI ESM-LR), at a high-resolution level, was applied. To improve the simulation performance, detailed Land Use/Cover data for Continental Portugal were used and reclassified with a high-resolution (100 m) according to the 33 classes of the United States Geological Survey. Four online-nested domains with increasing resolution at a downscaling ratio of five were used, with the coarser domain of 25 km horizontal resolution covering part of Europe and part of the North Atlantic Ocean, and the innermost domain of 0.2 km horizontal resolution focusing on a confined area, which comprises the Aveiro Region. Two temporal periods were considered, one statistically representative of the medium-term future climate scenario (2041-2070) and other statistically representative of the recent past climate (1976-2005), used as a reference scenario. For the future simulations, the IPCC greenhouse gas concentration scenarios RCP4.5 and RCP8.5 were adopted. The meteorological outputs were used as inputs for the 3D chemistry transport model CAMx (Comprehensive Air Quality Model with Extensions). Emissions for all domains were taken from the TNO-MACC_II European emission inventory. The same emissions were used in both scenarios, in order to only analyze the influence of CC in future AQ.
The assessment of CC was performed through the analysis of climatic variables, such as temperature, precipitation and wind intensity, as well as some indicators related to extreme events. The evaluation of AQ in the study area was performed for the three critical pollutants: NO_2, O_3 and PM10.
Preliminary results of CC indicate a trend towards higher values of daily minimum and maximum temperatures, as well as a reduction of cumulative precipitation in a future climate scenario. The impacts of CC in AQ promote the increase of NO_2 and PM10 concentrations in urban areas, up to 15% and 8%, respectively. Due to the increase of NO_2, a decrease in O_3 concentrations of about 3% is expected. These results were observed for both RCP scenarios, although more pronounced in RCP8.5. The approach used constitutes an added-value in the evaluation of CC and its impacts in the AQ over the Aveiro Region, since it considers the effects related to complex topography, riverbeds and oceanic coastline which characterize the area under study.