

Influence of a High-Resolution Land Cover Classification on Air Quality Modelling

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Abstract : Poor air quality is one of the main environmental causes of premature deaths worldwide, and mainly in cities, where the majority of the population lives. It is a consequence of successive land cover (LC) and use changes, as a result of the intensification of human activities. Knowing these landscape modifications in a comprehensive spatiotemporal dimension is, therefore, essential for understanding variations in air pollutant concentrations. In this sense, the use of air quality models is very useful to simulate the physical and chemical processes that affect the dispersion and reaction of chemical species into the atmosphere. However, the modelling performance should always be evaluated since the resolution of the input datasets largely dictates the reliability of the air quality outcomes. Among these data, the updated LC is an important parameter to be considered in atmospheric models, since it takes into account the Earth's surface changes due to natural and anthropic actions, and regulates the exchanges of fluxes (emissions, heat, moisture, etc.) between the soil and the air. This work aims to evaluate the performance of the Weather Research and Forecasting model coupled with Chemistry (WRF-Chem), when different LC classifications are used as an input. The influence of two LC classifications was tested: i) the 24-classes USGS (United States Geological Survey) LC database included by default in the model, and the ii) CLC (Corine Land Cover) and specific high-resolution LC data for Portugal, reclassified according to the new USGS nomenclature (33-classes). Two distinct WRF-Chem simulations were carried out to assess the influence of the LC on air quality over Europe and Portugal, as a case study, for the year 2015, using the nesting technique over three simulation domains (25 km², 5 km² and 1 km² horizontal resolution). Based on the 33-classes LC approach, particular emphasis was attributed to Portugal, given the detail and higher LC spatial resolution (100 m x 100 m) than the CLC data (5000 m x 5000 m). As regards to the air quality, only the LC impacts on tropospheric ozone concentrations were evaluated, because ozone pollution episodes typically occur in Portugal, in particular during the spring/summer, and there are few research works relating to this pollutant with LC changes. The WRF-Chem results were validated by season and station typology using background measurements from the Portuguese air quality monitoring network. As expected, a better model performance was achieved in rural stations: moderate correlation (0.4 – 0.7), BIAS (10 – 21 µg.m⁻³) and RMSE (20 – 30 µg.m⁻³), and where higher average ozone concentrations were estimated. Comparing both simulations, small differences grounded on the Leaf Area Index and air temperature values were found, although the high-resolution LC approach shows a slight enhancement in the model evaluation. This highlights the role of the LC on the exchange of atmospheric fluxes, and stresses the need to consider a high-resolution LC characterization combined with other detailed model inputs, such as the emission inventory, to improve air quality assessment.

Keywords : land use, spatial resolution, WRF-Chem, air quality assessment

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