13B.4 The response of atmospheric chemistry to dynamical boundary layer processes associated to temporal transitions and surface heterogeneity

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ABSTRACT

We study how the atmospheric boundary layer dynamics impact atmospheric chemistry, guided and constrained by observations taken above the boreal forest during the HUMPPA-COPEC-2010 campaign. Based on the vertical profiles of potential temperature and specific moisture, obtained from 132 radio soundings, the vertical stratification is determined. Data is then classified according to different prototypes of the atmospheric boundary layer. By selecting a singular day that is characterized by a convective boundary layer and using a mixed layer model, the main dynamic contributions that influence atmospheric chemistry are determined. We will present how the evolution of the boundary layer height affects the concentrations of atmospheric chemical species. Our findings show the importance of an adequate knowledge of this evolution and, consequently, the need to account for large scale dynamical forcings (subsidence, advection) in order to represent atmospheric chemistry. Extra attention is directed at investigating the impact of temporal (morning) transitions and surface heterogeneity. More specifically, we investigate the impact of mixing with a residual layer aloft during the morning transition on atmospheric chemistry. Specific observed features in the time evolutions of the NO_x and O_3 concentrations, like morning concentration peaks, can be explained and represented by adequately incorporating the transition of the boundary layer dynamics from nocturnal to diurnal conditions.
We complete the analysis by studying the effect of surface heterogeneity and the efficiency of turbulent mixing on the chemical reactivity using a Large Eddy Simulation model. We find that under heterogeneous surface forcings boundary layers become deeper, thereby affecting the dilution capacity of the boundary layer. We will also show that local instantaneous virtual vertical profiles of temperature and chemical species concentrations obtained from the Large Eddy Simulation model deviate more from area and time averaged profiles for heterogeneous surface conditions. In addition, the influence of non-uniform turbulent mixing on the chemical reactivity in the boundary layer is studied under homogeneous and heterogeneous surface conditions. We will present a sensitivity study how this effect, quantified by the intensity of segregation, depends on the surface (e.g., length scale of heterogeneity, differences in emissions) and dynamical conditions.
We find that in order to represent atmospheric chemistry in a numerical model, dynamical and chemical effects should be resolved simultaneously.

For a manuscript that treats these results, the reader is referred to the publication of Ouwersloot et al. (2012).

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