Impact of urban land surface and black carbon on ozone chemistry

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Urbanization affects air quality mainly through two ways. First, the meteorological fields and surface properties changed by urban land surfaces alter the spatial distribution, chemical reaction conditions, and deposition of primary and secondary air pollutants. Second, urbanization processes increase local human activities and hence increase anthropogenic emissions of air pollutants. Both types of effects have crucial and complex impacts on air qualities in urban and surrounding areas. In this study, the impact of upstream urban land surface forcing on downstream photochemistry and the impacts of black carbon (BC) on surface ozone were conducted by numerical simulations in summer season over megacities of Yangtze River Delta.

The results show that the upstream urban Shanghai has a significant impact on the boundary layer structures and circulations over Kunshan and further affects Kunshan’ s O_3 air quality by redistributing O_3 and its precursors. Horizontal transport of O_3 and its precursors, from Shanghai to Kunshan, are suppressed in the lower boundary layer but are strengthened in the upper boundary layer because of strong urban heat island circulation. As a result, O_3 chemical production is a little decreased in the lower boundary layer of Kunshan (~2 ppbv) but is increased significantly in the upper boundary layer (~40 ppbv).

With the impact of BC, surface ozone concentration reduced by more than 10% in the morning (10:00~12:00). High contribution of vertical mixing process demonstrates that the depression of boundary layer caused by BC takes important responsibility for the ozone reduction. With the application of online ozone source apportionment method coupled in the WRF-Chem, the changes of surface ozone source-receptor relationship are listed. It shows that, with the impact of BC, the contributions of ozone from Jiangsu (JS), Anhui (AH) and outside the model domain ($O_{3\text{-}INFLOW}$) decreased, whereas ozone contributions from other source regions change little during this period.

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