Quantifying nonlinear regional contributions to ozone and fine particles using an updated response surface modeling technique

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Besides local sources, regional emission sources can have substantial contributions to ozone and fine particle concentrations. However, responsiveness of such regional contributions to secondary pollutants is still challenging to simulate. In this study, we used a novel extended response surface modeling (ERSM) technique to quantify the nonlinear regional contributions to ozone and fine particles. The new ERSM (ERSM2.0) was updated from a previous version of ERSM (ERSMv1.0) by adding an explicit representation of interregional effects among multiple regions. The new ERSMv2.0 model was successfully applied in a case study in Beijing-Tianjin-Hebei region in China, exhibiting a better performance in reproducing the nonlinearity in the response of ozone and $PM_{2.5}$ to precursors compared to the previous versions of ERSMv1.0.
The new ERSMv2.0 model presents abilities in attributing the regional contributions to either 1) directly transporting the pollutant from source area to receptor area, or 2) transporting precursors from source area and produce the secondary pollutant at receptor area. In the case study of Beijing-Tianjin-Hebei, we apportioned the ozone and $PM_{2.5}$ responses to three components, i.e., local chemistry, regional transport and indirect effects. Results suggest that in most cases, the apportion of $PM_{2.5}$ formed locally in the receptor region is more than that of regional transport of $PM_{2.5}$ formed outside the receptor region. The opposite way is found for ozone that the regional sources contribute more than formed at local. Besides, the contribution from regional sources becomes larger during more polluted episodes for both ozone and $PM_{2.5}$, suggesting the importance of joint controls on regional sources for reducing the highest pollution level.

Keywords: response surface model, regional contribution, ozone, fine particles

