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A novel approach to identify the impacts of local and non-local emissions of precursors to ambient ozone and their long-term trends

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Ozone levels show a consistently increasing trend in major city clusters in China along with decreases of most types of ambient pollutants. Formulation of effective control strategies on ozone precursors are essential to curb the deteriorating ozone pollution. From a control policy-making point of view, it is of great importance to quantitatively characterize the impacts of precursor emissions to ambient ozone, so as to identify the reasons for the ozone increase in the past and to shed light on ways for effective precursor control to reduce ozone level in the future.
At any given location, ambient ozone is contributed by both local production and non-local transport. In addition, ozone level is shaped by the changing meteorological factors. Therefore, the impacts of precursor emissions should be assessed by a two-step analysis, first to even out the meteorological impacts during the analysis period to reflect ozone change that are solely driven by emission changes, and then to separate the meteorological impact-free ozone change into local and non-local contributions. In this study, a novel approach which essentially reflects this two-step analysis is developed by combining multivariate statistical method for meteorological adjustment and empirical orthogonal function followed by absolute principle component scores (EOF+APCs) for local / non-local separation.
This approach was applied to the two economic developed areas in China with serious ozone pollution, Pearl River Delta (PRD) and Yangtze River Delta (YRD). In the PRD during 2006-2015, solar radiation and temperature are the key meteorological factors and wind is an additional factor. After meteorological adjustment, the ozone increase becomes steeper which demonstrates that meteorology actually becomes more favorable for ozone sink. Overall, non-local contribution dominates ozone changes, while the local contribution is even negative in the center of PRD which indicates the titration effect by the intense NO_x emissions. It is also found that increased non-local contribution is responsible for the ozone increase in the first several years, while local contribution takes over to be responsible in the following years. The key meteorological parameters and the driving factors for the local and non-local ozone trends in the YRD are also analyzed, and the similarities and discrepancies between the two regions are investigated.