Impact of Future Emissions and Climate Change on Surface Ozone Over China

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China's immense ambient air pollution problem and world-leading greenhouse gas emissions place it at the forefront of global efforts to address these related environmental concerns. Here, we analyze the impact of ECLIPSE (Evaluating the Climate and Air Quality Impacts of Short-Lived Pollutants) future emissions scenarios representative of current legislation (CLE) and maximum technically feasible emissions reductions (MFR) on surface ozone (O_3) concentrations over China in the 2030s and 2050s, in the context of a changing climate. We use a suite of simulations performed with the NOAA Geophysical Fluid Dynamics Laboratory's AM3 global chemistry-climate model. To estimate the impact of climate change in isolation on Chinese air quality, we hold emissions of air pollutants including O_3 precursors fixed at 2015 levels but allow climate (global sea surface temperatures and sea ice cover) to change according to decadal averages for the years 2026-2035 and 2046-2055 from a three-member ensemble of GFDL-CM3 simulations under the RCP8.5 high warming scenario. Evaluation of the present-day simulation (2015 CLE) with observations from 1497 chiefly urban air quality monitoring stations shows that simulated surface O_3 is positively biased by 26 ppb on average over the domain of China. Previous studies, however, have shown that the modeled ozone response to changes in NOx emissions over the Eastern United States mirrors the magnitude and structure of observed changes in maximum daily average 8-hour (MDA8) O_3 distributions. Therefore, we use the model's simulated changes for the 2030s and 2050s to project changes in policy-relevant MDA8 O_3 concentrations. We find an overall increase in MDA8 O_3 for CLE scenarios in which emissions of NOx precursors are projected to increase, and under MFR scenarios, an overall decrease, with the highest changes occurring in summertime for both 2030 and 2050 MFR. Under climate change alone, the model simulates a mean summertime decrease of 1.3 ppb and wintertime increase of 3.3 ppb by 2050. Adjustment of the observed site-level MDA8 O_3 distribution to include regionally interpolated projected changes from AM3 allows us to examine changes in the number of days in exceedance of MDA8 O_3 Level I (50 ppb) and Level II (80 ppb) Chinese national ambient air quality standards.