5.144 Top-down NOx emissions for China (2005-2012): a hybrid inversion method and trend analysis.

Early Career Scientist

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Abstract:

Emissions of nitrogen oxides (NO_x) cause environmental and human health problems. Traditional top-down estimates have provided important constraints for NO_x emissions in China and improved air quality simulations for further understanding these issues, but are either time-consuming (e.g., 4D-Var) or only crudely represent influences of atmospheric transport and chemistry (e.g., mass balance). Here we develop an approach combining mass balance and 4D-Var that facilitates decadal-scale NO_x emission inversions. Validation using pseudo observations shows this approach decreases the difference between posterior and true emissions by 87%, compared to a 43% decrease using mass balance alone. Using this hybrid method, OMI satellite observations, and the GEOS-Chem chemical transport model, we derive posterior emissions with several interesting features. While more than 10^(-7) kg N/(m^2·month) of increased emissions are estimated over most of East China, leading to a 12% growth of national budget, emissions in urban centers (e.g., Beijing, Guangzhou, Shenzhen, Zhuhai, Hong Kong) have decreased by 10% - 26% from 2005 to 2012. During the Olympic and Paralympic Games (Aug-Sep 2008), Beijing's NO_x emissions are found to decrease by ~ 20%-30% compared to average emissions in the same months of other years, suggesting effective local reductions of transportation and industrial activities. Moreover, since 2011, a decreasing trend (compared to 2010) of NO_x emissions is estimated in Beijing (~15%), the Yangtze Delta River area (16%-19%) and nationally (~3%), coinciding with China's enforcement of its 12^{th} 'Five-Year Plan', which specified for the first time a national commitment to reduce NO_x emissions. We also identify influence of meteorology on air pollution in Beijing in 2012, when local NO_x emissions have decreased but transport leads to a higher column compared to 2011. These findings help evaluate existing emission control strategies and guide more effective regulations to mitigate impact of NO_x on human health and the environment.