Constraining sources of air pollution using air quality adjoint models and remote sensing observations

Abstract:
Air quality models provide relationships between sources and impacts of pollution, from human health to climate change. Here we present insights gleaned from the application of adjoints of air quality models. This form of an air quality model allows us to calculate source-receptor relationships at unprecedented levels of detail, revealing key differences between the impacts of emissions from different locations, species, sectors or seasons. We consider the marginal impacts of emissions on factors such as premature deaths associated with exposure to $PM_{2.5}$, damages to crops and ecosystems from ozone and nitrogen deposition, and increases in mean surface temperature. In each case, we examine scenarios where the roles of atmospheric chemistry and transport lead to disparities in the per-emission impact of various sources. We also consider how these same tools can be used for reducing uncertainty in our estimates of pollutant source locations and magnitudes through inverse modeling, and to guide the design of satellite measurement strategies. These topics are examined in the context of developing efficient emissions control strategies and integrated assessment tools for decision support activities at national and international scales.