Urban Inversion of CO_2 Emissions at High Resolution Over Indianapolis

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Urban emissions of greenhouse gases (GHG) represent a large fraction of the global fossil fuel GHG emissions and will likely increase as large metropolitan areas are projected to grow twice as fast as the world population in the coming 15 years. Monitoring these emissions using atmospheric measurements can provide a more robust approach than current reporting activities, but a better understanding of the underlying human activities remains critical for policy decisions and mitigation strategies. The Indianapolis Flux Experiment (INFLUX) aims at monitoring carbon emissions over the Indianapolis metropolitan area using high-resolution GHG emission products (Hestia) and a robust atmospheric inversion system. The density of the observing surface network combined with an advanced atmospheric data assimilation system provides the potential to constrain carbon dioxide (CO_2) emissions at high temporal and spatial resolutions. But several key components of the system can impair our ability to quantify fossil fuel emissions accurately, including long-term monitoring and high-resolution mapping, essential for regulatory purposes. Here, we present sensitivity experiments over a 8-month period (September 2012 to April 2013) addressing the most critical sources of uncertainties in urban-scale inversion systems. We present strategies to address the boundary inflow problem of CO_2 based on wind direction and tower locations. We evaluated the impact of transport errors using multiple transport model configurations and created an error propagation model to inform the inversion system with more accurate transport error estimates. We present the impact of error structures in emission products and the relative observational constraint from various deployment strategies. Finally, we show that the inversion system produces emissions comparable to the high resolution Hestia product over the period within 10%, i.e. about 4.6 to 5.1MtC over the 8-month period, indicating that convergence between the two approaches has been obtained over the dormant season of 2012-2013.

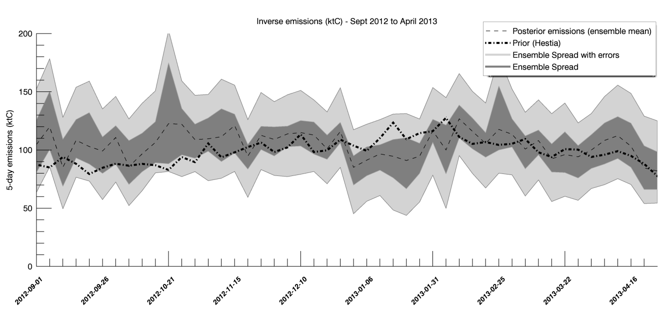

Figure 1. Ensemble of 5-day inverse emission estimates in ktC over the metropolitan area of Indianapolis using multiple inversion configurations, i.e. varying the prior error correlation length, the background definition, or the transport model errors, from September 2012 to April 2013.