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The effect of model spatial resolution on Secondary Organic Aerosol predictions

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Abstract

Between 20-90% of submicron aerosol mass throughout the continental boundary layer consists of secondary organic aerosol (SOA). As such, the ability of chemical transport models to accurately reproduce the continental boundary layer aerosol greatly depends on their ability to predict SOA. Although there has been much recent effort to better describe SOA formation mechanisms in models, little attention has been paid to the effects of model spatial resolution on SOA predictions. SOA predictability should improve with model resolution; however, it is unclear how finely resolved a model must be to make accurate predictions. The Whistler Aerosol and Cloud Study (WACS 2010), held between June 22^{nd} and July 28^{th}, 2010 and conducted at Whistler, BC, Canada provides a unique data set for testing simulated SOA predictions. The study consisted of intensive measurements of trace particles and gases in the atmosphere in a mountain valley. We test the ability of the global chemical transport model GEOS-chem (www.geos-chem.org) to predict the aerosol concentrations during this event and throughout the campaign. Simulations were performed using three different resolutions of the model: 4ºx5º (∼400 km), 2ºx2.5º (∼200 km) and 0.5ºx0.667º (∼50 km). The 4ºx5º version of the model significantly under predicts organic aerosol (max organics $\sim$1.5μg m^{-3}when measurements were $\sim$7μg m^{-3}), while the 2ºx2.5º and 0.5ºx0.667º versions are much more closely compared with measurements (max organics $\sim$5μgm^{-3}). In addition to analysis at Whistler, data from the same simulations was used to perform a comparison across North America between the 4ºx5º and 0.5ºx0.667º versions of the model. It was found that, on average, the 0.5ºx0.667º were significantly higher (∼2-4 μg m^{-3}) for various places in North America (near sources and near coastlines), which suggests that sub-grid variability in temperature and semi-volatile partitioning causes the 4ºx5º simulations to underpredict SOA concentrations relative to higher resolution simulations.