Response to Anonymous Referee #2 on "The effect of model spatial resolution on Secondary Organic Aerosol predictions: a case study at Whistler, BC, Canada" *by* C. D. Wainwright et al.

General Comments

1) **Comment:** Nonvolatile POA: The implication of this study is that the finer resolution improves the performance of traditional (semi-volatile SOA) models since it captures hotspots but GEOS-Chem lacks a semi-volatile POA treatment such as that used in Robinson et al. (2007 Science). What about locations where "POA" is dominant? Since GEOS-Chem treats POA as non-volatile, is there not an inherent assumption that the model is not representing very near-source processes including partitioning? How does the assumption of non-volatile POA influence your choice of model resolution? Is there an intermediate resolution (spatial and temporal) at which non-volatile POA is an appropriate treatment?

Response: Given the parameters of the model, there really is no resolution for which non-volatile POA is appropriate. If POA is treated as semi-volatile it would lead to large hotspot effects around anthropogenically dominated regions. No non-volatile treatment of POA can really capture this properly.

We have added the following text to the conclusions regarding semi-volatile POA: "In particular, the inclusion of semi-volatile primary organic aerosol (POA) (e.g. Robinson et al., 2007) could intensify this hotspot effect as this semi-volatile POA would have high partitioning ratios near large anthropogenic sources."

2) **Comment:** Global budgets: I would be interested to see this work expanded to include the effect if resolution on global budgets. A significant fraction of SOA in GEOS-Chem eventually evaporates at coarse resolution. Does capturing hotspots lead to an increase in net production or does it eventually evaporate? What is the effect of resolution on global aerosol lifetime where wet deposition dominates over dry deposition?

Response: Unfortunately, we do not have the global-high resolution data, which makes this analysis of global budgets between resolutions very difficult. In terms of deposition effects, wet deposition dominates for aerosols, while for gases whether it depends on wet/dry is dependent on species. In the paper we argue that the "lifetime effect" is due to changes in secondary organic

gases (SOG, where SOG has a fast dry deposition lifetime); thus, we don't expect changes in wet vs. dry deposition to have significant effects on the conclusions on the global scale.

3) **Comment:** Ground network evaluation: Given that the authors have simulated the entire US with the 3 different resolutions, it could be evaluated against US ground based observations. When compared to organic aerosol from IMPROVE or CSN networks, does the finer resolution show better performance?

Response: Unfortunately, speciated $PM_{2.5}$ time series data doesn't exist online for the year 2010 yet (we checked http://www.epa.gov/ttn/airs/airsaqs/detaildata/downloadaqsdata.htm and http://vista.cira.colostate.edu/improve/Data/data.htm. A comparison however, was done with the data from Hand et al., 2012, which provided the mean OM concentrations of both the IMPROVE and CSN network locations from 2005-2008. We averaged the winter and summer simulations to produce a pseudo-annual mean. Correlations between measured and model OM for this data were weak at all resolutions, and there was no apparent improvement between resolutions.

We have added the following text to the paper at the end of section 3.2: "To determine if increasing resolution and resolving the hotspot effect improves OM predictions, we compared the model results at each resolution to the IMPROVE and CSN ground networks across North America using the speciated $PM_{2.5}$ data from Hand et al., (2012). Unfortunately these measurements time-averaged for the years the years 2005-2008 (speciated time series data for 2010 is not yet available online). We averaged the winter and summer simulations to produce a pseudo-annual mean. The correlations between model and measured values were generally weak ($r < 0.4$) with little to no change in correlations between resolutions. An analysis where the model and measurements are co-sampled can be done when the 2010 time series data becomes available."

Minor Comments

1) **Comment:** One month of spin-up seems short for a global model. What was the state of the model at the start of the spin-up period?

Response: The initial model concentrations before the 1 month spin-up are from a 1 year spin up of the 4x5 model. The given concentrations, however, do not correspond to the month that the spin-up starts, thus the need for the extra month.

Added the text "It should be noted that initial concentrations in the model prior to the one month spin up are from a one year spin up of the 4x5 model."

2) **Comment:** I agree with the previous review about replacing some of the online references with journal articles (such as Barkley et al 2011 JGR).

Response: All of the online references have been replaced with the relevant journal articles save the online references for the boundary layer fix within GEOS-Chem, which at the current time does not yet have a relevant journal article for citation.