Response to the reviewers' comments on manuscript "Impacts of Changes in Land Use and Land Cover on Atmospheric Chemistry and Air Quality over the 21st Century" (Manuscript Number: acp-2011-307).

We thank the reviewers for their valuable comments. We have added in the text more analysis and discussion, in particular those related to the uncertainty in this study.

We have made itemized responses to all the comments as described below. The reviewers' comments are repeated below in italics and our responses are in normal and bold font.

Point-to-point response:

abstract: the changes in concentrations of ozone or SOA listed here – over what time scale are these calculated? Daily average? Yearly average?

Response:
They are both for seasonal average (June-August) over the period of 2000-2100.
Revised text reads -
"Our results indicate that climate- and CO_2-induced changes in vegetation composition and density between 2100 and 2000 could lead to decreases in summer afternoon surface ozone of up to 10 ppb over large areas of the northern mid-latitudes."

"Summertime surface concentrations of secondary organic aerosols are calculated to increase by up to 1 μgm^{-3} for large areas in Eurasia over the period of 2000-2100."

p3: Regarding the first sentence, haven't previous studies investigated the feedback of climate driven CO2 changes on isoprene emissions?

Response:
We have acknowledged in the text –
p5 - "Changes in atmospheric CO_2 concentrations are likely to affect the isoprene emissions (Arneth et al., 2007; Centritto et al., 2004; Constable et al., 1999; Heald et al., 2009; Possell et al., 2005; Rosenstiel et al., 2003), but these effects are not accounted here".

p4: "SOA formation from monoterpenes. . . is based on the algorithm by Chung and Seinfeld [2002]. . ." Isn't this the same algorithm of equilibrium partitioning that is used to treat isoprene SOA?

Response:
Yes, the equilibrium partitioning algorithm is the same. To clarify this, we have revised the text to -
p5 -"Formation of SOA in the GEOS-Chem model follows the algorithm developed by [Chung and Seinfeld, 2002] for gas-particle equilibrium partitioning between SOA and semivolatile VOC oxidation products. SOA production from isoprene

photooxidation follows the work of Henze and Seinfeld [2006], which is based on chamber experiments of reaction of isoprene with OH at low NOx condition [Kroll et al., 2006]. Further details about the SOA formation mechanisms in GEOS-Chem are provided in Liao et al. [2007].”

p5: When discussing the impacts on isoprene emissions, I would think it might be relevant to mention again that these effects may be opposite in sign if CO2 inhibition of isoprene emissions were accounted for. Or would they? Can the authors estimate, based on previous studies, to what extent these impacts might cancel out?

Response:
We have added in the text (discussion section) –
p9 - “We note again that the possible CO2 inhabitation effect on isoprene emissions is not accounted here. Heald et al. [2009] estimated that this inhabitation effect could imply a 30% decrease in global isoprene emissions by 2100 following the A1B scenario, but the magnitude of the inhibition is uncertain [Centritto et al., 2004; Possell et al., 2005].”

p5: “This appears to be largely driven by the increase in ozone dry deposition. . .” Can the authors investigate their model results / setup in a way to make this assertion more definitive?

Response:
We have added in the text:
p6 - “For areas with decreasing surface ozone, the ozone dry deposition velocities are generally calculated to increase by 10-50% by 2100m, with the strongest increases found over northern mid-latitudes”.

Table 1: How is it that the 2100 simulation including all effects (right column) has increases in isoprene and monoterpene emissions but a decrease in SOA burden? Is there a volatility effect at play?

Response:
We have added in the text:
p8 – “The little change in 2100 SOA burden compared to 2000 despite the significant increases in biogenic emissions (Table 1) also reflects the changes in seasonality of biogenic emissions. Increased cropland imply that the biogenic emissions would be shifted more to the growth season (such as summer) when biogenic VOCs have the shortest atmospheric lifetime.”