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***Interactive comment on* “Evaluation of improved land use and canopy representation in BEIS v3.61 with biogenic VOC measurements in California” by J. O. Bash et al.**

Anonymous Referee #2

Received and published: 21 January 2016

This study describes recent updates to the BEIS (v3.61) biogenic emissions model, which now includes a two layer canopy model for estimating leaf temperature and PAR within the shaded and sunlit portions of the canopy, as well as updates to the underlying BELD landuse dataset used in the model. The impact of these updates on biogenic emission estimates in California were evaluated through a series of CMAQ simulations with different biogenic emission inputs (e.g., BEIS v3.14 with BELD 3; BEIS v3.61 with BELD 3; BEIS v3.61 with BELD 4) and the CMAQ output was compared to ambient measurements of directly emitted biogenic species and their oxidation products from the CARES and BEARPEX field studies. In addition, the impact of utilizing simulated PAR from WRF vs. satellite derived PAR was investigated, and emission estimates

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from a second biogenic emissions model (MEGAN v2.10) were also evaluated.

Both the BEIS and MEGAN models are widely used in the research and regulatory communities, making this study highly relevant and useful to both communities and worth publication. However, the manuscript would benefit from addressing the following:

(Section 2.2) It is not clear what underlying Leaf Area Index (LAI) data was used in the BEIS simulations (2006 MODIS?) and how that data differs from the LAI data used in the MEGAN simulations? LAI directly impacts biogenic emission estimates and can change substantially from year-to-year (see http://acmg.seas.harvard.edu/presentations/aqast/nov2012/Cohan_tiger_team_biogenics_Nov_2012.pdf slide 10). If there are differences between the BEIS and MEGAN LAI data, please discuss how those differences may influence the results. In addition, assuming that year-specific LAI data was not used (e.g., the LAI data is not from the same year as the field studies used to evaluate the biogenic emissions) please discuss how using year-specific LAI data would influence the results.

(Section 2.4 and Section 2.5) CMAQ modeling was conducted from 3 June through 31 July 2009 and results were compared to measurements made during BEARPEX (which coincides with the modeling time period) and CARES, which occurred during June 2010 (Figures 6 and 7). I find it problematic to compare modeling from 2009 with observations from 2010 since meteorology has such a strong influence on biogenic emissions and can lead to large variability in emission estimates from year-to-year. Please discuss what implications differences in meteorology from 2009 to 2010 may have on the findings of this work.

(Section 3.1) Figure 1 shows that MEGAN predicts a higher leaf temperature than does BEIS at the higher end of the distribution (i.e., at higher temperatures). This is of critical importance since it's these peak temperatures that drive higher biogenic emissions (and is likely a major cause of the difference between the BEIS and MEGAN

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emissions presented in this study). Some discussion about the difference between the canopy models in BEIS and MEGAN would be useful to help to better interpret the results.

(Section 3.2) The authors state that there are currently no databases to quantitatively evaluate the fractional tree species data coverage. The California Gap Analysis Project (http://www.biogeog.ucsb.edu/projects/gap/gap_home.html) may provide the needed information. Although this data is also a bit outdated, it would be more up to date than the Critchfield and Little (1966) and Little Jr. (1971, 1976) data cited in the manuscript.

Davis, F. W., D. M. Stoms, A. D. Hollander, K. A. Thomas, P. A. Stine, D. Odion, M. I. Borchert, J. H. Thorne, M. V. Gray, R. E. Walker, K. Warner, and J. Graae. 1998. The California Gap Analysis Project—Final Report. University of California, Santa Barbara, CA. [http://legacy.biogeog.ucsb.edu/projects/gap/gap_rep.html]

(Section 3.4 and Table 3) It would be useful if the meteorological model evaluation was expanded to include additional monitors in the study areas covered by CARES and BEARPEX, with a particular emphasis on predicting peak temperatures. Average temperatures provide little useful information with regard to biogenic emission estimates since the magnitude of the emissions is driven by peak temperatures rather than average temperatures. In addition, CMAQ model output at any location is potentially impacted by emissions throughout the entire region, not just by emissions at a single location. Therefore, it would be useful to know how well WRF is able to predict peak temperatures on a regional basis and not just at a few select monitors.

Please also discuss the potential uncertainties associated with using photochemical model output to validate a biogenic inventory (e.g., errors in the WRF meteorological field – temperature, PBL heights, wind speed/direction – or uncertainties in the chemical mechanism could lead to what looks like an over/under-prediction compared to the ambient mixing ratios even if the emissions were perfect).

I find it interesting that Table 3 shows significantly more isoprene in the two

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CMAQ/MEGAN simulations compared to the three CMAQ/BEIS simulations, but that the simulated ozone only shows minor differences. Is this due to the photochemical regime in the area (i.e., NO_x limited), so that large changes in isoprene do not have an appreciable effect on ozone or is it an artifact from only showing isoprene at the Blodgett Forest site while showing ozone results for the entire region? To put these results into a bit better context it would be useful to compare regional emission totals from the different biogenic inventories to see if the differences seen at Blodgett are consistent with regional differences in the inventories.

Typographical Corrections:

P. 8122, lines 1-3: Please update the references to: “methods of Jenkins et al. (2003) and Chojnacky et al. (2014). Plot level tree biomass estimates were corrected for sampled bole biomass and scaled to a per hectare basis following O’Connell et al. (2012).” Also note that “bases” was changed to “basis”

P. 8132, lines 8-12: Please update the references to: “Figure 2 shows the BELD 4 and Blackard et al. (2008) estimates of forest biomass for this model domain at 4 km resolution. The Blackard et al. (2008) 250 m grid resolution data set was projected and aggregated to the CMAQ 4 km grid resolution projection using rgdal and raster libraries in R (Bivand et al., 2014). The BELD 4 estimates evaluated well against those of Blackard et al. (2008) with a”

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