

General Comments

This is a review of “On the formation of biogenic secondary organic aerosol in chemical transport models: an evaluation of the WRF-CHIMERE (v2020r2) model with a focus over the Finnish boreal forest” by Ciarelli et al., submitted to GMD. This paper investigates predictions from WRF-CHIMERE versus measurements at a boreal forest site (SMEAR II in Hyytiälä Finland). The predictions compare well with most meteorological data (temperature, wind speed, RH, and wind direction) and gas phase species (monoterpenes, O₃, NO_x), but struggles with isoprene concentrations and precipitation events. The authors focus on the model’s ability to predict biogenic secondary organic aerosol (BSOA) formation. To this end, the authors run a series of sensitivity simulations, altering the OH reaction rates and the isoprene emission rates. This manuscript could be improved by more clearly detailing which simulation is being discussed at any given time, and the goal and conclusions of running these different simulations (see below specific comment about this). This paper should be published after the below specific comments are addressed, and should be of interest to readers of GMD.

Technical comments

Section 2.2: can you add an explanation of *why* these different simulations are performed? I’m confused on the role of these simulations and what is discussed where in the following sections. The next time these simulations are mentioned as defined here is not until section 4.3/ line 303.

Line 234: can you quantify “a slight underestimation” in the text (from Table 3)? Can you speculate why this is occurring? It looks like the model predicts a lower nighttime temperature on almost every night except a handful, and actually does best during the heat wave, while capturing the daytime highs?

Line 236: it looks like the model misses all or almost all of the rain events, even the relatively large one during the heat wave, do you know why? Are they short-lived, or low total volume (i.e. do they have to last a specific amount of time or have a minimum volume to be captured)?

Line 242: an r value is provided for the wind speed, is it possible to also provide this for wind direction (on line 240 probably, or table 3)?

Line 250: what is causing the relatively high isoprene emissions in the “localized” area?

Figure 7: recommend making the percentages larger and bold, the text is small relative to the size of the wedges and hard to read.

Line 270: can you add a statistic to the text to quantify how much isoprene is “largely overestimated”? Either one of the values from Table 4 or something like number of days overestimated, average % overestimation, etc?

Figure 10: I don’t think this figure adds much, suggest removing/moving to SI or combining with Figure 9

Line 296: this is the first time ASOA is mentioned in the body of the manuscript (not just the introduction), so suggest defining it again here

Figure 11: why is there a hot spot in POA over Turku but not ASOA?

Lines 294-305 & Figure 11: the discussion of ASOA feels misplaced since the discussion is focused on BVOC and BSOA up until here. Suggest adding some details to the methods section, or removing the discussion of ASOA.

Figure 12: similar to figure 7, suggest making text on the wedges larger

Section 4.4: I think this section would follow more logically if it was before current section 4.3?

Figure 14: I think this figure also might be removed or put in the SI

Line 360-361: can you quantify the diurnal O₃ agreement and overestimation of NO_x in the text (from table S4)?

Line 387: I assume "a.s.l." means "above sea level"? Suggest defining, and I'm not familiar enough to know if it's typically capitalized?

Grammatical comments

The manuscript is well written, although several minor grammatical errors exist throughout. While they do not impede the reader's understanding, the entire manuscript should be checked over before publication. Specific instances listed below, although please note I didn't not write them all down.

Line 23: "heat waves episodes"—waves should be singular

Line 73: "ration" should be "ratio"

Line 88&99: "where" should be "were"

Line 103 &140: "oxidization" should be "oxidation"

Line 194: "measurers" should be "measures"

Line 256: "there" should be "they"

Line 253: "measurement" should be plural

Line 257: "relatively" should be "relative"

Line 261: "differently" should be "different"

Line 262: "document" should be "documented"

Line 279: "instrumentation" should be "instrument" or could be removed entirely\

Line 295: "it is noticed" should be "is noticed"

Line 296: should "San Petersburg" be "Saint Petersburg"?

Line 314: "identify" should be "identified"

Line 320: "underestimate in the accumulation" should be "underestimate the accumulation"

Line 345: "increased" should be "increase"

Line 348: “over few regions” should be “over a few regions”

Line 349: “in the order” should be “on the order”

Line 350: “reacts” should be “react”

Line 354: “to have also important effect” should be “to also have important effects”

Line 376: “detailed” should be “details”

Line 379: “simulated period” should be “simulation period”

Line 379: “since, the latest, yields the” is worded awkwardly and parenthesis are misplaced. Maybe something like “since it yields the...”?

Line 386: “respect to” should be “with respect to”

Line 398: “slight” should be “slightly”

Line 392: I think “statistically-significant” should be “statistically significantly”?