Response to reviewer #1

We thank reviewer #1 for the positive assessment of our work. Reviewer comments are in italics.

I have enjoyed reading the manuscript and find it a remarkable piece of work, stretching from individual measurements to continental scale impact estimates. At each level, interesting results are presented, starting with uncertainties connected with assumptions regarding emission potential and temperature sensitivity in standard emission models. The analysis is timely and thorough although the literature overview could be a bit more comprehensive. The text is well written and the conclusions are sound. My only concern is that disregarding the CO2 effect in the scenario analyses might call for exaggerated calls for action. Thus, I would appreciate a 7th simulation to account for this, e.g. a scenario such as the 6th run but with increased CO2, despite the fact that I am aware of the inconsistency with the measurements (and also with some uncertainties C1 related to a shift of temperature response curves under higher CO2 as shown by Sun et al.).

The CO_2 effect is easy to add, and we have included a 7th simulation as suggested.

The text at line 239 has been changed to say: "The climate2050 run does not include the associated increases in CO_2mixing ratios, to be consistent with our measurements which were also not conducted in a higher CO_2 atmosphere. A 7th simulation assumes a 550 ppm CO_2 atmosphere on top of the delta-scaled surface temperatures, employing Heald et al's (2009) method for calculating short and long term CO_2 activity factors, γC. Fixing the atmospheric CO_2 to 550 ppm reduces the isoprene emissions by 5% in the short term and 13% in the long term."

An extra column has been added to table 4 to show simulation 7 has γC added.

Add results from this experiment to line 280 "The addition of a higher CO_2 atmosphere has reduced the daytime isoprene by 15 - 26 % from the climate2050 run, across the three campaigns."

To avoid too many panels in figure 5, we'll leave the climate 2050 run as the upper end to the range in results. However, figure 6 now contains the time series from the climate2050_γC run. Figure 6 has been altered to have the Sydney results on the left and the Darwin results on the right.

Change text at line 310 "However peak O_3 in Sydney increases by 10 – 15 ppb as an hourly average in the FC_γT+LEF differences, but by 12 - 17 ppb in the climate2050_γC differences and 15 - 21 ppb in the climate2050 differences (Figure 6a,b). These increases represent 10 - 21 % of the O_3 NEPM."

Change the text at line 320 "The climate2050 (and γC) differences show days with an increase of 0.42 μg m^{-3} in Sydney and 0.14 μg m^{-3} in Darwin (2 % and 1 % of the $PM_{2.5}$ 2025 NEPM, respectively)."

Make minor changes to conclusions at line 350 "Three future experiments were conducted, the first using current day meteorology, the second using a delta-scaled surface temperature change to projected 2050 summertime temperatures, and the third using a 550 ppm atmospheric CO_2 on top of the delta scaled temperatures."

And at line 354. "The climate2050 experiment showed much larger increases in isoprene, O_3 and biogenic SOA across Australia, tempered slightly by the addition of increased atmospheric CO_2."

Also adjust abstract at line 13 to include "A 550 ppm CO_2 atmosphere in 2050 mitigates these peak Sydney O_3 mixing ratios by 4 ppb. Nevertheless, these forecasted increases in O_3 are up to one fifth…"

From the few specific remarks, I would like to stress the benefits from an improved literature overview (i.e. L25ff). The generally high emission potential of eucalypts in comparison with other species have firstly been depicted in Evans et al. 1982 and can also been derived from Kesselmeier and Staudt – although the values concentrate on E.globulus. Karlik and Winer as well as Geron et al. provide an additional emission rate of E.camaludensis (28, 14.6, add to Table 1) and a couple of other eucalypt species – although not under Australian conditions.

Add text at line 26 "Native to Australia, eucalypt trees are amongst the highest BVOC emitters of any plant species (Benjamin et al., 1996; Evans et al., 1982; Kesselmeier and Staudt, 1999)"

Add *E. camaldulensis* emission rates from Karlik and Winer (2001) to table 1. The value listed in the Geron et al (2001) reference is the measurement by He et al (2000) already listed in table 1. Geron et al convert He et al's measurement to a dry weight of carbon (ug C g^{-1} h^{-1}) which is why the value is slightly different. Here we're using μg isoprene g^{-1} h^{-1}.

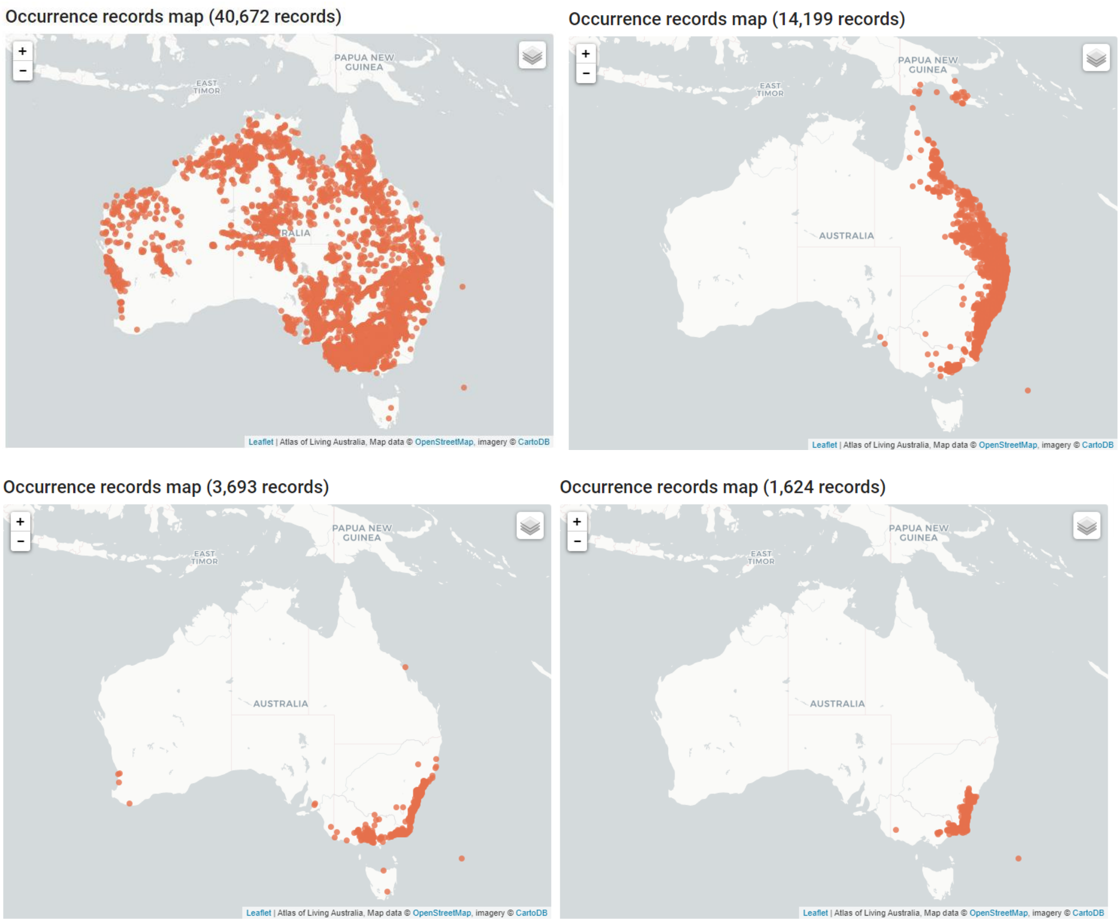
You may also note that different temperature responses and emission factor variability have been obtained before, starting with the original Guenther et al. 1991 publications and widely discussed e.g. in Niinemets et al. 2010 (e.g. L44ff).

True, and I noted from Guenther et al (1993) when one of the early models for isoprene emission with temperature was defined, it was based on "empirical coefficients which were determined by nonlinear best fit procedures using eucalyptus, sweet gum, aspen, and velvet bean emission rate measurements."
Change text at line 45 "Whilst the MEGAN parameterisations are fitted from a wide range of ecosystem responses to environmental conditions, there are spatial and temporal exceptions to these standards which are comprehensively reviewed by Niinemets et al (2010)"

In the end of chapter 2.2 (93ff), I got the impression that the authors are carried away a bit. First, the last paragraph seems to fit better into a discussion; and second, the first sentence is not logical (the measurements are hardly going to change but emission rates and species abundance probably will). By the way, I am still uncertain to which degree these 4 eucalypt species are actually representative for the Australian forests or how abundant the are in relative terms (L163).

We've decided to drop the first part of this paragraph and include more details of how the eucalypt species are spread in the earlier part of section 2.2. We also include species occurrence maps from the Atlas of Living Australia in the supplementary section, reproduced below.

At line 75 "*E. camaldulensis* and *E. tereticornis* have a wide geographical representation within Australia, with a latitudinal native growing range of 9-38 °S (Atlas of Living Australia, 2019), (supplementary figure S1). *E camaldulensis* is the most widely naturally distributed species of all eucalypts in Australia (Atlas of Living Australia, 2019). The native climatic distribution range of *E. botryoides* and *E. smithii* are restricted to the south east coastal regions. All four species are forecast to exist in future, but only *E. camaldulensis* is predicted to expand its growing area by 2085 (González-Orozco et al., 2016). "



Occurrence records map (40,672 records)

Occurrence records map (14,199 records)

Occurrence records map (3,693 records)

Occurrence records map (1,624 records)

Figure S1 clockwise from top left. ***E camaldulensis, E tereticornis, E smithii, E. botryoides*.**

With one sole reference, the protective functions of isoprene to sun flecks and very high temperatures are not very well acknowledged (L268ff). There are several publications (e.g. Behnke et al.) and reviews (Loreto and Fineshi) that illustrate this function. In fact, emission is prolonged even under carbon deficit conditions (Yanez-Serrano et al.).

At line 270 "Hot and windy conditions would cause lots of sun-flecking within the tree canopy, causing sudden temperature spikes on the leaf surface. Physiologically, the increased production of isoprene during temperature and light spikes helps to maintain photosynthesis during times of mild stresses (Loreto and Fineschi, 2015), above and beyond leaf cooling via transpiration processes (Sharkey et al., 2008). High isoprene emitters can better survive prolonged heatwaves (Yáñez-Serrano et al., 2019), although Aspinwall et al's (2019) study on our four eucalypt species showed trees grown under future climate conditions suffered greater heatwave damage than the same species in current climate conditions."

Finally, the thought came to my mind that instead of removing the trees (which is of course not recommended), the forest management might be compelled to introduce species others than Eucalypts that are not emitting isoprene (L314ff). However, given the protective function mentioned above, this option might not be advisable because non-emitters might not be able to withstand the coming heat (Penuelas and Munne-Bosch, Ryan et al.).

We're not recommending eucalypt trees are removed, though will add a sentence about non emitters being unable to cope with heat stresses.

At line 315 that “new urban developments should consider the BVOC emission potential of trees before planting (Paton-Walsh et al., 2019), taking into account that non or low emitting trees may not withstand climate induced heatwaves (Peñuelas and Munné-Bosch, 2005).”

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