

Review of Improved isoprene emission estimates over the Finnish boreal forest using the MEGANv3.2 model

Bettineschi et al.

The authors thank the editor for their effort in reading and providing positive and constructive feedback for the improvement of this article. Below, we report in red the editor's comments and in black the authors' answers. In the authors' reply, *italic purple* is used to report text from the previous version of the manuscript, while *italic blue* is used for the updated text. All the lines number refers to the new track-changes version.

Answers

...because monoterpenes and sesquiterpenes play a larger role

L443-444: *Overall, the modifications introduced here led to more realistic isoprene emissions and concentrations, and a reduction in model biases for both BVOCs and OA, even though the impact on OA is small as monoterpenes and sesquiterpenes play a larger role in OA formation.*

Please add this to SI

Added.

Please add this reasoning to the introduction

This was added to the introduction, L73-75: *Improving the representation of isoprene is therefore particularly important because of its strong influence on atmospheric oxidation chemistry, including OH radical budgets, ozone formation, and SOA production. In addition, focusing on a single BVOC class allows a more process-oriented evaluation of the effects of the revised emissions without the added complexity arising from simultaneous changes in multiple interacting compounds.*

Please add this explanation to the manuscript

This was added in the FLEXPART section, L258-264: *It is important to highlight that using a fixed integration depth could potentially bias the AME metric. However, integrating over a fixed vertical depth is a standard approach used in many other studies (Aliaga et al., 2021; Hakala et al., 2022; Bettineschi et al., 2025). The reason is that it provides a framework independent of uncertainties in planetary boundary layer height estimation, which can vary substantially across models and calculation methods. Using a fixed depth avoids introducing additional variability and potential errors associated with diagnosing PBLH. Furthermore, Bettineschi et al. (2025) showed that using a fixed depth or a depth that varies with the*

PBLH (simulated by WRF) does not result in substantial differences in the resulting metrics, suggesting that the sensitivity of AME to the choice of integration depth is limited.

Please add this to the discussion of implications

No further modifications were added, as the addition in L73-75 already included that information. Additionally, in the discussion, we already included limitations of the study and suggestions for further improvement for future studies.

how relevant? Can you give an estimate how much it would change the results?

We added the following statement in the discussion section, L495-498: *This effect is expected to be relevant in boreal environments and should be considered when interpreting model-measurement discrepancies. Specifically, because the chemical mechanism used in this study underrepresents OH recycling during low-NO_x isoprene oxidation, it likely overestimates the OH-scavenging effect of isoprene. As a result, the simulated enhancement of monoterpene oxidation and OA formation following isoprene emission reductions likely represents an upper-bound response relative to simulations using more recent isoprene chemistry.*

please include an uncertainty in your results then

We added the following in the Isoprene emission potential section, L215-219: *Consequently, the choice of a representative value (e.g., median) may influence the resulting emissions. We can quantify the uncertainty introduced by this choice by evaluating the interquartile range of reported values, which yields an estimated uncertainty of approximately -85% to +370% relative to the median. However, the full literature range represents an extreme upper-bound uncertainty that is unlikely to be representative at the ecosystem scale, where spatial averaging across many trees and environmental conditions is expected to reduce the influence of extreme individual measurements.*

Please add this to SI

Added.