



Supplement of

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

Manuel Bettineschi et al.

Correspondence to: Manuel Bettineschi (manuel.bettineschi@helsinki.fi)

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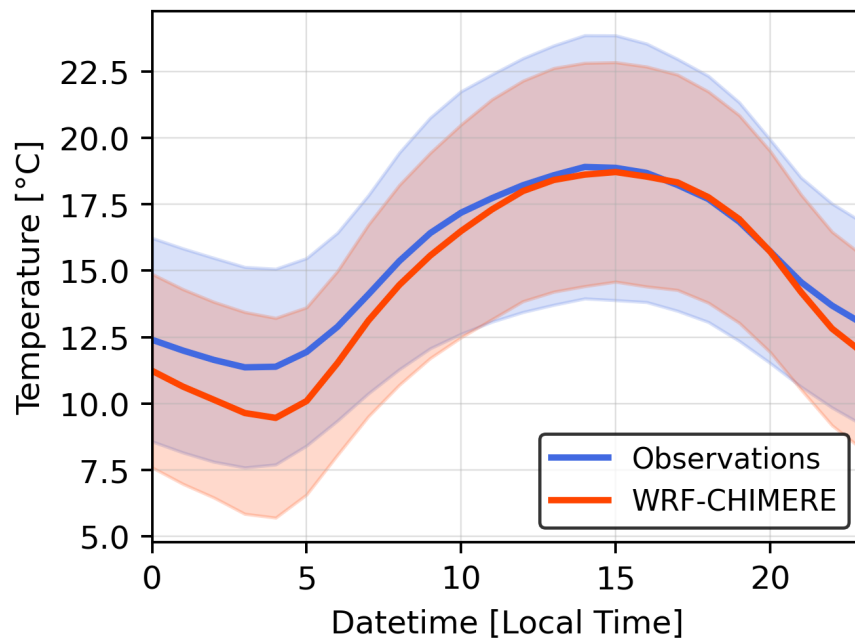


Figure S1. Diurnal variation of observed and WRF-CHIMERE modeled temperatures at SMEAR-II, showing the mean (solid lines) and the standard deviation (shaded areas) for both datasets.

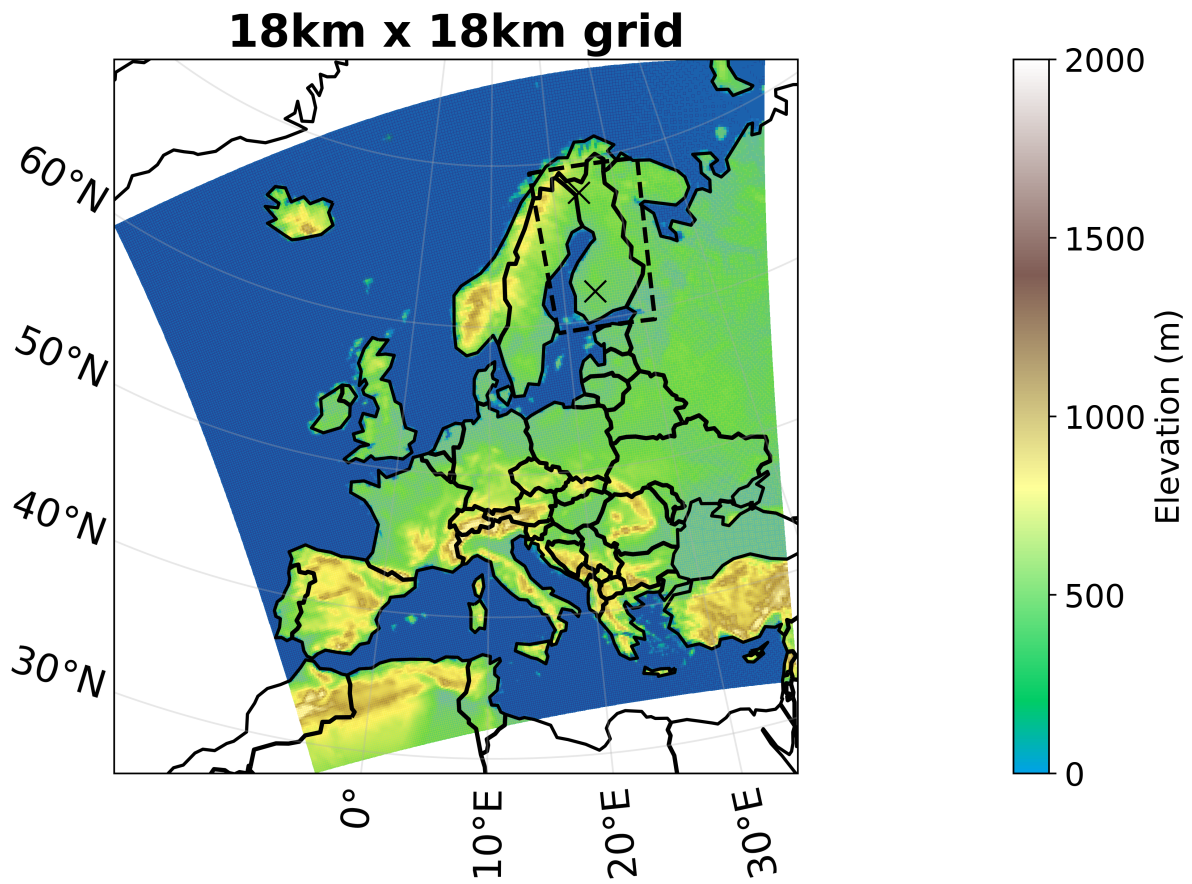


Figure S2. Domain configuration for the sensitivity simulation MEG3-UPD-CC-newD01. The nested domain is not modified.

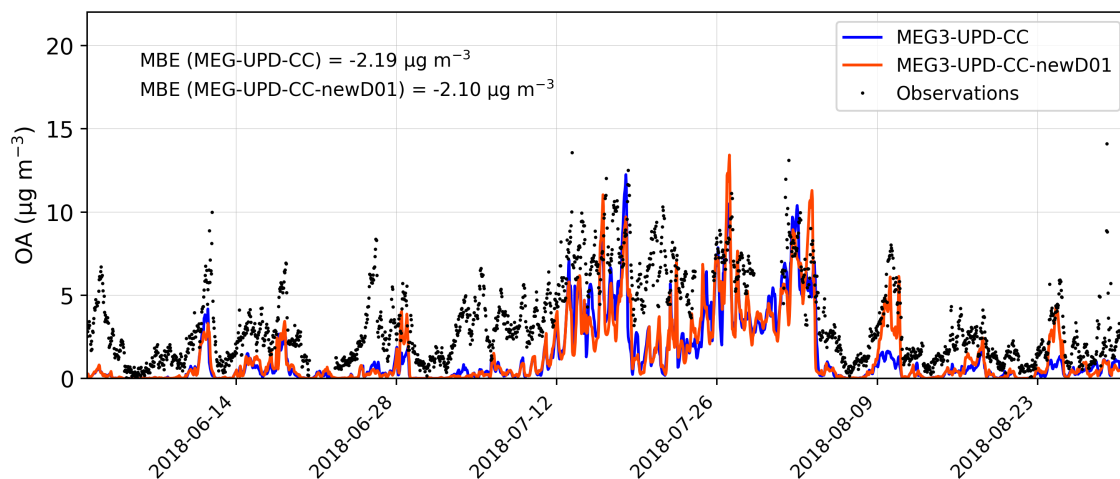


Figure S3. Evaluation of the organic aerosol concentration in Hyytiälä. The observations (black dots) are compared to the MEG3-UPD-CC simulation and the MEG3-UPD-CC-newD01 simulation which include a larger first domain covering the whole Europe.

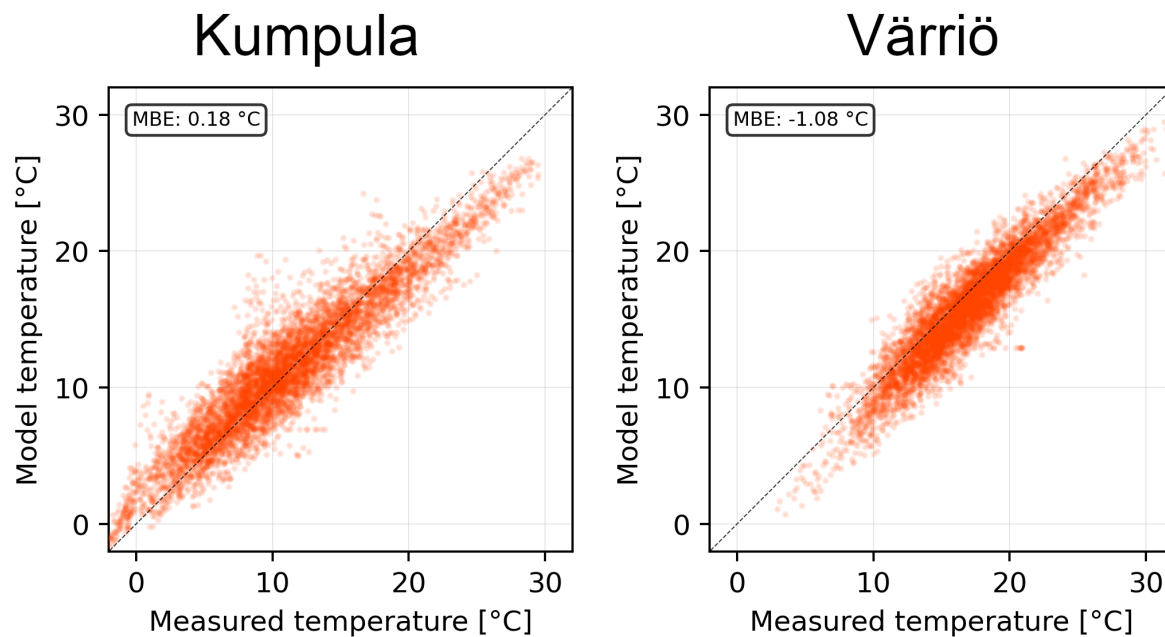


Figure S4. Observed vs modelled hourly 2-meter temperature in Kumpula (Helsinki) and Värriö.

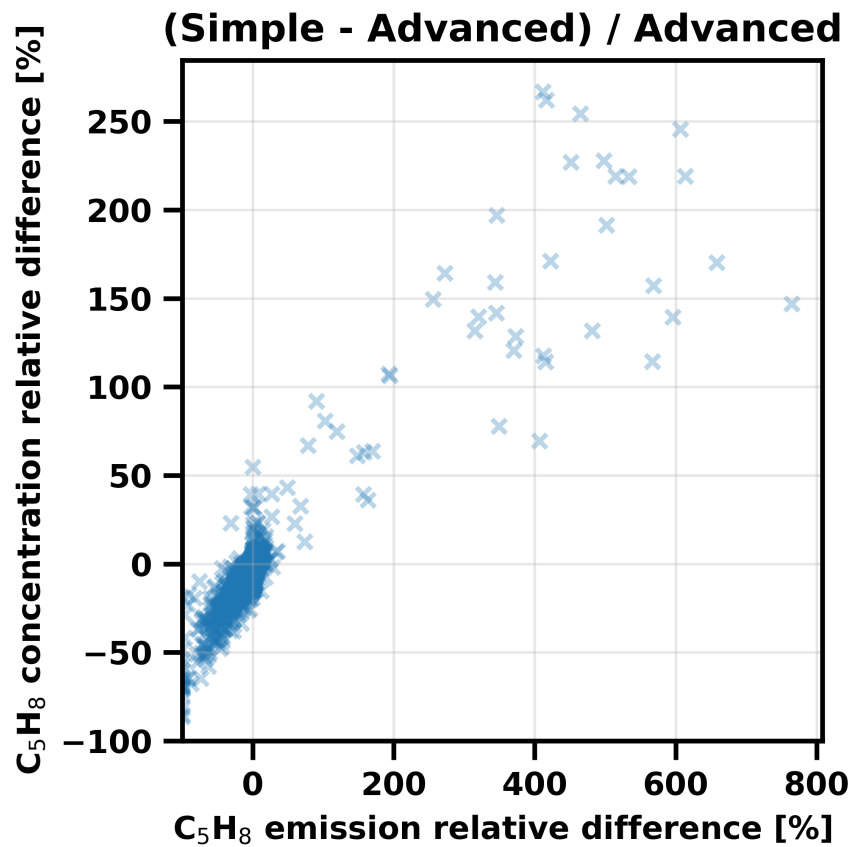


Figure S5. Average relative difference, for each grid cell in Finland, between C₅H₈ emissions and concentrations. The relative difference is calculated between the simulation using the "simple" and the "advanced" speciation.

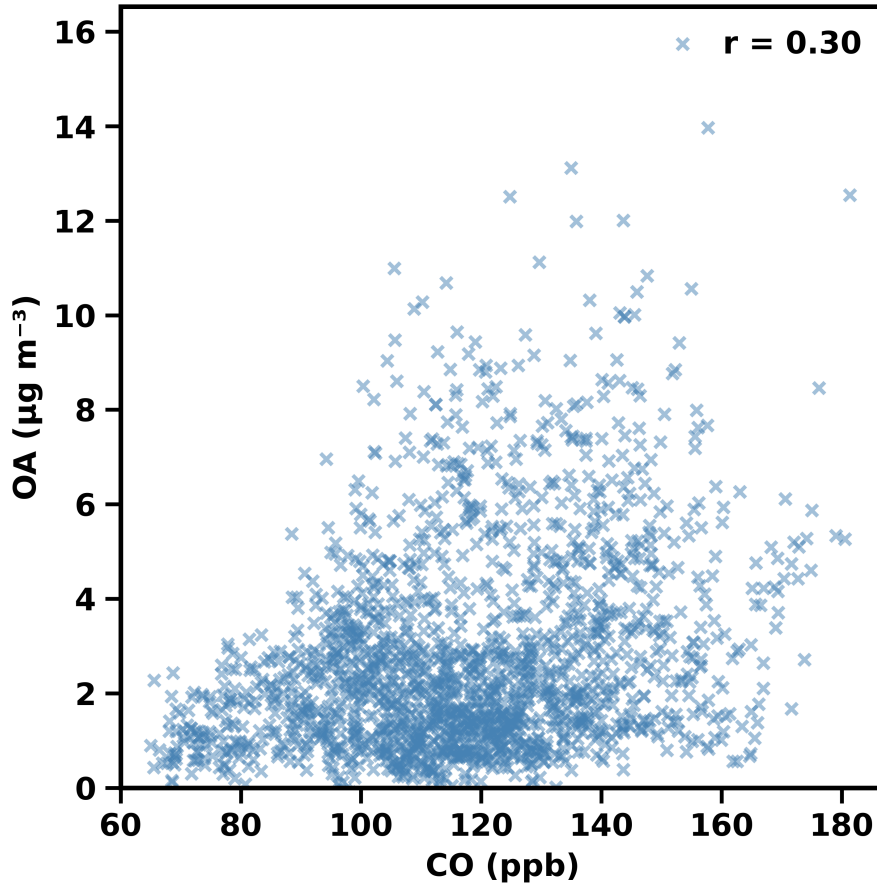


Figure S6. Scatter plot of the observed CO vs OA concentration at Hyttiälä during summer. To assess the potential influence of fire emissions on the observed OA concentrations, we computed the Pearson correlation between the measured OA and CO concentrations (JJA 2017–2019, Hyttiälä SMEAR II station). The low correlation ($r = 0.30$, $R^2 = 0.09$) indicates that only 9% of the variance in observed OA can be explained by CO variability. This confirms that fire influence is not a dominant driver of OA at this site during the study period.

S1 Canopy correction

As described in Cholakian et al. (2022), in the standard version of WRF-CHIMERE, vertical diffusion (K_z) is calculated using the parametrization (Eq. 1) from Troen and Mahrt (1986).

$$K_z = kw_s \frac{z}{h} \left(1 - \frac{z}{h}\right)^2 \quad (\text{S1})$$

- 10 where k is the von Kármán constant and the vertical velocity scale w_s is calculated depending on the atmospheric stability, for stable condition:

$$w_s = \frac{u_*}{1 + 4.7 \frac{z}{L}} \quad (\text{S2})$$

while for unstable conditions:

$$w_s = (u_*^3 + 2.8ew_*^3)^{1/3} \quad (\text{S3})$$

15 where z is the altitude of the layer, h is the boundary layer height, u_* is the friction velocity, and L is the Monin-Obukhov length, and $e = \min(0.1, z/h)$.

In this paper we used a diffusivity and horizontal wind correction factors ($\phi_w(\xi)$ and $\phi_h(\xi)$, respectively) as described in Cholakian et al. (2022):

$$\phi_w(\xi) = \begin{cases} 1.25(1 + 3|\xi|)^{-1/3}, & -2 \leq \xi < 0, \\ 1.25(1 + 0.2\xi), & 0 \leq \xi < 1, \end{cases} \quad (\text{S4})$$

$$20 \quad \phi_h(\xi) = \begin{cases} (1 + 16|\xi|)^{-1/2}, & -2 \leq \xi < 0, \\ (1 + 5\xi), & 0 \leq \xi < 1, \end{cases} \quad (\text{S5})$$

where the stability factor ξ is calculated according to:

$$\xi = \begin{cases} \frac{h_c}{L}, & z < z_{ruf}, \\ \frac{z-d}{L}, & z \geq z_{ruf}, \end{cases} \quad (\text{S6})$$

where h_c is the canopy height, z is the altitude, d is the zero-plane displacement for momentum, and $z_{ruf} \simeq 2.3h_c$. In the end, K_z and the horizontal wind speed components in the first layer of the model are multiplied by $\phi_w(\xi)$ and $\phi_h(\xi)$ respectively.

25 **References**

- Cholakian, A., Beekmann, M., Siour, G., Coll, I., Cirtog, M., Ormeño, E., Flaud, P.-M., Perraudin, E., and Villenave, E.: Simulation of organic aerosol, its precursors and related oxidants in the Landes pine forest in south-western France: Need to account for domain specific land-use and physical conditions, *Atmospheric Chemistry and Physics Discussions*, 2022, 1–41, <https://doi.org/10.5194/acp-23-3679-2023>, 2022.
- 30 Troen, I. and Mahrt, L.: A simple model of the atmospheric boundary layer; sensitivity to surface evaporation, *Boundary-Layer Meteorology*, 37, 129–148, <https://doi.org/10.1007/BF00122760>, 1986.