



Supplement of

Dispersion of particulate matter (PM_{2,5}) from wood combustion for residential heating: optimization of mitigation actions based on large-eddy simulations

Tobias Wolf et al.

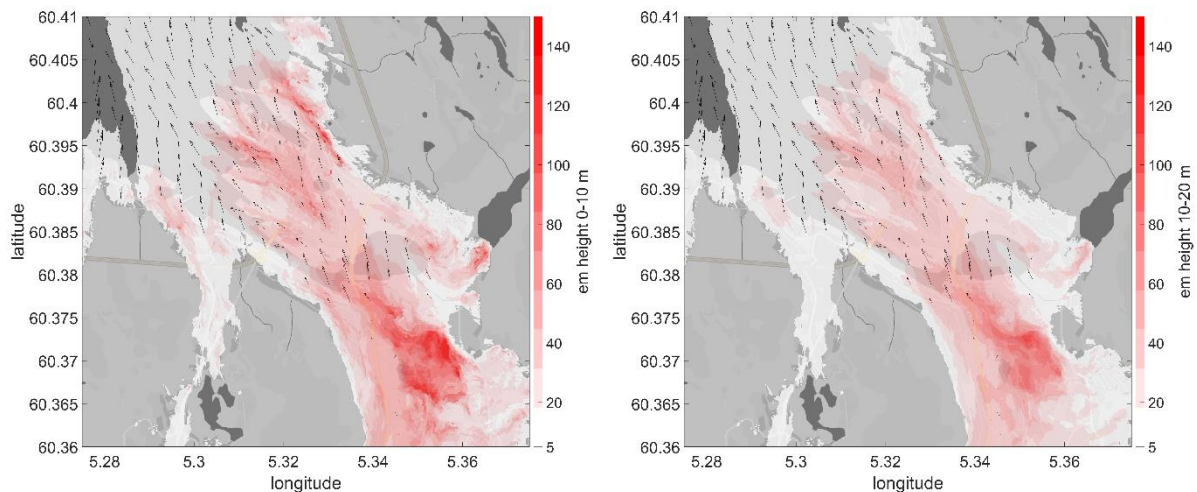
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2 Sensitivity to emission height

3 In Wolf et al. (2019) we used tracer emissions directly at the ground, meaning that all $PM_{2.5}$ emissions
4 were assumed to be initially placed into the first grid-cell above the surface. This setup was criticized
5 as one leading to overestimation of the near-surface concentrations due to the excessively weak
6 turbulent mixing in the first grid box above the surface. In this study, we use higher emission heights
7 of 15 m above the surface for the entire model domain. Thus, the pollutant is ingested into the second
8 grid box above the surface. This modified setup reduces concentrations as compared to Wolf et al.
9 (2019). In order to assess the impact of the elevated emission height on this reduction, a full sensitivity
10 study is necessary. We simulated the surface (at 5 m) $PM_{2.5}$ concentration using four different emission
11 heights and a smaller computational domain studied in Wolf et al. (2019). The updated emission factor
12 from the present study is used. The $PM_{2.5}$ maps are shown in Figure S1. The absolute surface layer
13 concentrations of particulate matter are decreasing with increasing emission height. Simultaneously,
14 the pollution pattern remains very similar. The sharp spatial gradients that exist in some places for
15 emissions into the lowest grid-box above topography are reduced gradually with increasing emission
16 heights.



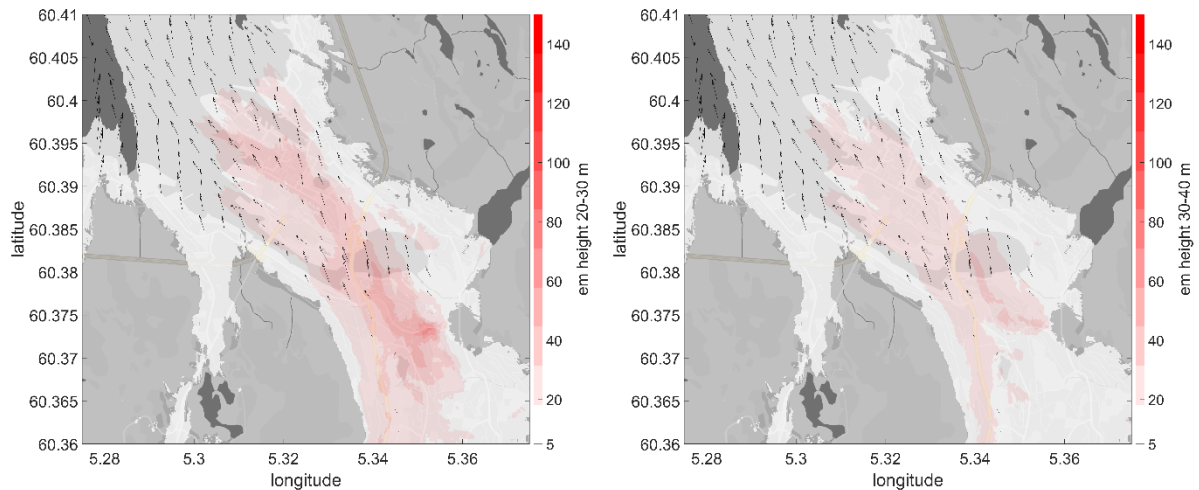


Figure S1: PM_{2.5} concentrations resulting from emissions at different heights (the centre box heights at 5, 15, 25 and 35 m) above the ground in the model. Data overlay the grayscale map from Map data @2019 Google.

17 In terms of absolute numbers, the distribution of surface concentrations of PM_{2.5} for the different
 18 emission heights is summarized in Figure S2. A clear decrease in the median pollutant concentration
 19 (of all grid boxes in the computational domain) is visible for increasing emission heights. For emissions
 20 into the lowest grid-box above topography, the median PM_{2.5} concentration is 16.18 µg/m³ with
 21 maximum values as high as 157.65 µg/m³. For emissions into the second grid-box above topography,
 22 these values are reduced to 16.18 µg/m³ and 122.67 µg/m³, respectively. For emissions into the fourth
 23 grid-box above topography, the values have decreased to 6.68 µg/m³ and 43.27 µg/m³. The most
 24 extreme concentrations decrease faster than the median concentrations possibly due to the reduced
 25 emission of pollutants in the areas with near surface local cold-pools and high local accumulation.

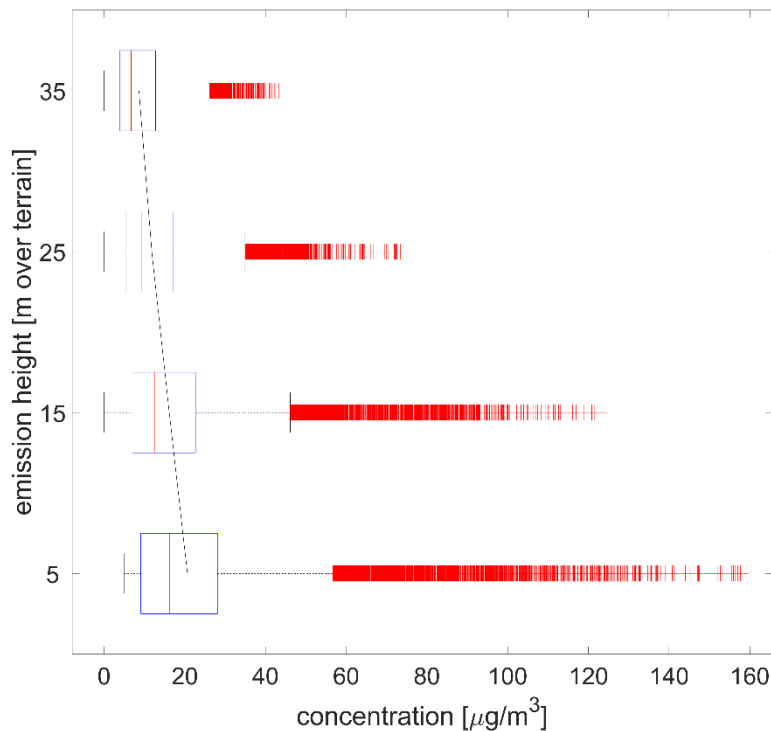


Figure S2: Box- and whiskers plot of the PM_{2.5} concentrations for emissions at different emission heights in the model. The y-axis indicates the centre height of the grid-boxes, where initial emissions were ingested. Boxes show the 25'th and 75'th percentile of the simulated data. The red lines indicated median, while the dotted(?) black line indicates the mean values. Whiskers are maximum 1.5 times as long as the distance of the 25'th and 75'th percentiles. Larger values are indicated by red markers.

26 This, however, also indicates that the factor 10 reduction in the emission values in both studies most
 27 likely is not connected to an underestimated emission height. Initial emissions at between 30 and 40
 28 m above topography are unrealistic for small houses and the prevailing inversion conditions.
 29 Simultaneously, PM_{2.5} concentrations would still be strongly overestimated even for such a high
 30 emission height. Other explanations for this overestimation of the emission factors could be an
 31 overestimation of the expected usage of wood-ovens in general, or an overestimation of the amount
 32 of burned fuel per oven over a given period. However, we have not further investigated this but used
 33 input information provided. An improved emission mapping would be helpful for future studies
 34 involving studies of local PM_{2.5} distribution from burning wood for heating.

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