

## ***Interactive comment on “A chemical transport model study of plume rise and particle size distribution for the Athabasca oil sands” by Ayodeji Akingunola et al.***

### **Anonymous Referee #1**

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The manuscript by Akingunola et al. presents an interesting set of sensitivity simulations to plume rise modelling from stacks in the framework of the Canadian mesoscale chemistry-transport eulerian model GEM-MACH. The study is timely since simulation of the subgrid plume dynamic processes are still affected by significant uncertainties, as also confirmed by this work, and it is relevant for air quality applications considering the large role that emissions from elevated stacks plays nowadays and will play also in the near future. I found the manuscript generally well written and clear and I recommend publication to ACP after some minor corrections and clarifications as detailed below.

C1

- P. 1, L. 19: "...reducing the magnitude of the original surface PM<sub>2.5</sub> negative biases by 32%". Would be more clear to specify the range of change: from bias x to bias y.
- P. 1, L. 24: "...with 39 to 60% of predicted plume heights ...". I suggest to specify what the given range is referring to, e.g. rephrasing the sentence adding a compact summary of what are the best and worst performing cases.
- P. 1, L. 28: "...between the surface and 1km elevation". I suggest to clarify the concept. From my understanding this refers to the bias in the simulated lapse rate  $dT/dz$  as compared to observations.
- P. 2, L. 6: "... (it is not created by chemistry)". Suggest to change "chemistry" in "photochemical reactions in the atmosphere".
- P. 2, L. 10-11: "Anthropogenic SO<sub>2</sub> emissions are the main source of most atmospheric sulphur deposition". Suggest to add a reference for this statement.
- P. 3, L. 17-18: Please specify to what conditions/cases the given ranges (34 to 52% and 0 to 11%) are referred to.
- P. 3, L. 22: typo "Sulpher" should be "Sulphur"
- P. 4, L. 15: typo "as-phase" should be "gas-phase"
- P. 5, L. 2: Would be more informative to add the height of the levels in the bottom 1 km of the model.
- P. 5: Moreover, given the relevance for the results, I recommend to add a description of the parameterizations adopted in the model for the PBL and the surface layer turbulence.
- P. 8, eq. 6: Please check the second condition " $0.5 < H < 1.5$ " since the range seems to refer to a unitless quantity, but here only H is given.
- P. 9, L. 6: "top of the atmosphere" is confusing: is it perhaps the top of the PBL?

C2

- P. 9, L. 8: “value of  $h_s$  was assumed”, perhaps is “value AT  $h_s$  was assumed”. Moreover, the “s” of “ $h_s$ ” should be a subscript.
- P. 10, L. 5: typo “and =  $h_s$ ”, please check the left-hand side.
- P. 11, L. 21: “modstat” should be “modStat”
- P. 12, L. 27: “. . .negative bias has decreased by 34%” it is not perfectly clear here and in the following if these bias changes are actual relative changes or absolute changes of the normalized mean bias. Please clarify.
- P. 12, L. 31-32: “Figure 2 shows that . . . less than 5  $\mu\text{m}$  diameter . . .”. Please double check this statement. The figure shows the PM<sub>2.5</sub> concentrations binned as a function of CONCENTRATION not SIZE.
- P. 15, Table 2: Please check the values that should be given in Italics, since not all the rows seem to contain it.
- P. 16: referred to the discussion of SO<sub>2</sub> overestimation and SO<sub>4</sub> underestimation: can the two things be linked? E.g. by slow SO<sub>2</sub> to SO<sub>4</sub> conversion in the model, perhaps by slow aqueous chemistry?
- P. 17, L. 4-7: the paragraph seems to imply the presence of at least a (b) point, but only (a) is given. Please check or rephrase.
- P. 19, L. 11: “. . .took place between 16:30 and 20:30 on Aug 24th. . .”. Although I am assuming the intervals are given in local time and not in UTC, it would be useful to have a confirmation in the paper. Here and also at least in the caption of the first figure showing time series (Figure 5).

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