We thank the reviewer for the comments, which have led to improvements of our manuscript. We believe that we have addressed all the comments/concerns. Our point-by-point responses are in blue and Italic font below. Revised texts are highlighted in yellow in the updated manuscript.

In this study, the authors considered and implemented different treatments of below-cloud scavenging. Compared to the previous scheme that is based on Slinn (1984), a new scheme that considers multiphase hydrometeors explicitly from the microphysic scheme shows a better agreement with observations. In addition, a semi-empirical model based on Wang et al. (2014) shows a better performance than the previous scheme (Slinn, 1984). Overall, however, the differences are quite small especially for nitrate and ammonium aerosols and their wet depositions. I would recommend adding more supportive analyses or conclusive remarks for NO3 and NH4 species.
Specific comments:

1. Abstract is too long, so please make it more concise. Also, I wonder if the references are necessary in the abstract.
We have shortened the abstract and removed the references.

__Revised Abstract.__ Below-cloud scavenging (BCS) is the process of aerosol removal from the atmosphere between cloud-base and the ground by precipitation (e.g. rain or snow), and affects aerosol number/mass concentrations, size distribution, and lifetime. An accurate representation of precipitation phases is important in treating BCS as the efficiency of aerosol scavenging differs significantly between liquid and solid precipitation. The impact of different representations of BCS on existing model biases was examined through implementing a new aerosol BCS scheme in the Environment and Climate Change Canada (ECCC) air quality prediction model GEM-MACH and comparing with the existing scavenging scheme in the model. Further, the current GEM-MACH employs a single-phase precipitation for BCS: total precipitation is treated as either liquid or solid depending on a fixed environment temperature threshold. Here, we consider co-existing liquid and solid precipitation phases as they are predicted by the GEM microphysics. GEM-MACH simulations, in a local-area domain over the Athabasca oil sands areas, Canada, are compared with observed precipitation samples, with a focus on the particulate base cation NH_4^+, acidic anions NO_3^-, $SO_4^=$, HSO_3^- in precipitation, and observed ambient particulate sulphate, ammonium and nitrate concentrations.

Overall, the introduction of the multi-phase approach and the new scavenging scheme enhances GEM-MACH performance compared to previous methods. Including multi-phase approach leads to altered SO_4^{2-} scavenging and impacts the BCS of SO_2 into the aqueous phase over the domain. Sulphate biases improved from +46% to -5% relative to Alberta Precipitation Quality Monitoring Program wet sulphate observations. At Canadian Air and Precipitation Monitoring Network stations the biases became more negative, from -10% to -30% for the tests carried out here. These improvements contrast with prior annual average biases of +200% for $SO_4^=$, indicating enhanced model performance. Improvements in model performance (via scores for correlation coefficient, normalized mean bias, and/or fractional number of model values within a factor of two of observations) could also be seen between the base-case and the two simulations based on multi-phase partitioning for NO_3^-, NH_4^+, and $SO_4^=$. Whether or not these improvements corresponded to increases or decreases of NO_3^- and NH_4^+ wet deposition varied over the simulation region. The changes were episodic in nature – the most significant changes in wet deposition were likely at specific geographic locations and represent specific cloud precipitation events.

The changes in wet scavenging resulted in a higher formation rate and larger concentrations of atmospheric particle sulphate.

2. I wonder how equation (2) can be connected to the other equations (4–6) that describe the scavenging coefficient.
Equation (2) represents the scavenging coefficient by precipitation (rain and snow) for various aerosol species. To provide additional clarity, we have changed it to a capital letter, "Λ".
Slinn (1984) separated this equation to two different equations (e.g. 3 and 4) to introduce below-cloud scavenging coefficients for rain and snow, respectively.

3. Line 203. a "uniform" environmental temperature threshold can be misleading. May be "constant" or "fixed" better?
Thank you for the input – it has been changed to "constant".

4. Line 309. "the modeling science" sounds awkward.
Thank you for the input – The phrase has been replaced with "based on an earlier version of the GEM-MACH mode".

5. Line 319. I'm not sure if this assertion is right. Particulate nitrate concentrations can be higher in winter than in summer. Considering that HNO3 gas is very soluble, either HNO3 and particulate NO3 would be well scavenged by cloud water. I think the amount of emitted NOx can be higher in winter, so recommend seeing if NOx emissions are higher in winter than in summer.
Thank you for your comment - While the uptake of higher particulate nitrate concentrations into cloud water is a contributing factor, we acknowledge the influence of elevated NOx emissions in the winter due to increased energy demand. We believe the manuscript reflects this - We also added Line 319 to address this: This is further influenced by the elevated NOx emissions during the winter due to increased energy demand.

6. Line 335–343. Explanation for sulfate seems straightforward. However, nitrate and ammonium do not. My question is why the model performance for NO3 and NH4 wet deposition is better with the new schemes compared to the old one. As seen in Fig. 8 and Fig. 9, the difference in NO3 and NH4 fluxes vary greatly across regions and their *significant scores are below a 90% confident level over the most of the region.*
Thank you for your question - For sulfate particles, our model's improvements are consistent because sulfate tends to behave similarly in cloud processes. It dissolves well and gets washed out effectively by rain and snow. However, for nitrate and ammonium, things are a bit more complicated. Their wet deposition and their behavior depends on local conditions like temperature and rainfall rates. This can lead to irregular patterns in their wet deposition. As a result, the differences in wet deposition depend on the nature and size of the particles and how they react to different weather conditions. The confidence intervals in our results reflect these variations.

7. Line 388–399. I think that a comparison with a previous study, Makar et al. (2018) is not an apple-to-apple comparison. As the authors mentioned, in this study, they updated dry deposition, so the higher dry deposition velocities in this study than in the previous study can be a reason of the better performance of this study. If possible, how about comparing the new below-cloud scavenging schemes to the old one when the same dry deposition scheme is used?

Thank you for your comment - We can confirm that there were no changes made to the dry deposition scheme in our study compared to Makar et al. (2018). We removed the wrong statement from the manuscript.

8. I wonder if the better agreements with new schemes and corresponding explanation (reasoning) can be consistently applied to all species (SO4, NO3, and NH4). Also, wonder if the improvements can be due to some wrong reasons.

Thank you for the comment - Our study shows that the changes we made, e.g. using the multi-phase and Wang et al. (2014) schemes, improves our model's performance. These improvements are especially noticeable when dealing with sulfate wet deposition. The variations we see in nitrate and ammonium wet deposition are not the same everywhere; they come and go with specific weather conditions. When we compare our model's results with real observations, it's evident that the Wang et al. (2014) scheme, along with considering multi-phase approach, provides a better match with actual conditions.

9. Overall, figures need to be improved to highlight clearly the differences or conclusions that they want to deliver. Please adjust colors or value scales accordingly. Also, I'd recommend combining Fig. 8 and Fig. 9 if possible; for example, you can add hatched lines or stipples over regions only where the score >= 1 on Fig. 8. Same for Fig. 10 and Fig. 11, and Fig. 13–15.

Thank you for the comment - We've improved our figures based on the first reviewer's suggestions and will upload a new version. We value both reviewers' feedback.