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Comment on acp-2022-426

Anonymous Referee #3

Referee comment on "Seasonal modeling analysis of nitrate formation pathways in Yangtze River Delta region, China" by Jinjin Sun et al., Atmos. Chem. Phys. Discuss., https://doi.org/10.5194/acp-2022-426-RC3, 2022

General Comments

This study quantified the contributions of local emissions and transport from other regions both directly and indirectly to the particulate and total nitrate formation by comparing the results of CMAQ simulation with different emission scenarios. The study also suggests the contributions of chemical formation pathways, aerosol processes, physical transports, and dry deposition to the total and particulate nitrate formation using the CMAQ process analysis tool (Integrated Process Rate (IPR) and Integrated Reaction Rate (IRR)). Since the proportion of nitrate in $PM_{2.5}$ has been increasing in recent years, understanding the mechanisms of particulate and total nitrate formation is important. In this respect, this study suggests interesting and meaningful scientific information. Considerable indirect transport effects on nitrate formation are of particular interest.

Nonetheless, this reviewer suggests minor revisions to the manuscript and raises a few questions or concerns that would hopefully be addressed in the revised manuscript to improve readers' understanding.

Major Comments

The authors used IPR and IRR to quantify the contributions of various processes to the formation of particulate nitrate, gaseous HNO3, and total nitrate, and these are one of the main results of this study. However, insufficient information on IPR and IRR can make readers confused who are not familiar with CMAQ models. IRR includes chemical reactions in the aerosol phase (which is included in AERO), correct?

Minor Comments

- Line 87: dinitrogen à dinitrogen pentoxide?
- Line 163 – 164: "Detailed configurations of the WRF model provided in the studies of Hu et al. (2016) and Wang et al. (2021), shown in Table S1,." --> not easy to understand
- Line 199: Unlike F_{Local}, F_{Direct}, $F_{Background}$, $F_{Indirect}$ is not easily understood. Suggest adding a brief explanation for this term.
- Line 273: "The results in this study show a better model performance" à Quantitatively, how much the model performance in this study is better than previous studies? What are the most significant differences between this and previous models that affected the model performance?
- Line 274–276 and 283–286: In Fig. S1, predicted $PM_{2.5}$ appears to agree quite well with the observed time series but predicted nitrate in Fig. 2 was underestimated, particularly in April and October. Isn't nitrate an important species for those periods? or overestimation of other species compensated for these underestimations? Or underestimates of RH can explain this?
- Line 299: year respectively à year, respectively
- Line 360: Vertical mixing would be acceptable. However, the development of the PBL starts after sunrise, but the authors discuss the nighttime process.
- Line 380: To avoid confusion, "opposite with the first-peak time of NO3- production"
- Line 404: Incorrect use of "respectively."
- Line 450–451 and 454–456: TRAN (vertical and horizontal transport) processes were the largest SINK in particulate nitrate formation. In Line 450–451, regional transport (although only direct transport is considered) accounts for about 15%. How does "sink" contribute to nitration formation? Is TRAN different from regional transport conceptually?