Response to Referee #3

First of all, the authors thank the referee for submitting helpful and meaningful comments, which lead to improvements and clarifications within the manuscript.

Below, we provide our point-by-point responses. For clarity and easy visualization, the Referee's comments (***RC***) are shown from here on in black. The authors' responses (***AR***) are in blue color below each of the referee's statement. In addition to the responses to referees' comments, we further modified the manuscript to increase its clarity and readability. The summary of minor changes is included at the end of this document. We introduce the revised materials in green color along/below each one of your response (otherwise directed to the Track Changes version manuscript).

The paper is not appropriate for publication. The paper tries to link INP properties and precipitation events of different strength. I was expecting at least some interesting results in Sect. 3.3 (INP results), after reading 8 pages of introductory and technical aspects...and after further reading of the result sections 3.1 and 3.2. But at the end there were no solid findings and convincing results. The paper contains many figures and many speculative statements. This not sufficient and satisfactory.

AR: The authors appreciate these general remarks and diplomatic criticisms regarding our manuscript by Referee #3. We believe that the data presented in the revised manuscript are unique and analysis is robust. We have very good data. The authors sincerely hope the referee considers reading the revised manuscript. We respectfully admit that we have made some insufficient discussions, leading some of our data interpretations in an original manuscript to be speculative. Based on the peer-review comments, we removed/modified them to motivate the research. To allay the reviewer's concerns and mitigate any misgivings, the authors have decided to change the title of manuscript to "**Ice-nucleating particles in precipitation samples from West Texas**", reflecting our changes and articulate what is truly presented in the revised version paper. We have also revised our abstract as well as the conclusion to reflect all of our major revisions - **please read the Track Changes version paper**. Below, we provide our point-by-point responses in hopes of our manuscript being considered for another review by the reviewer. Please know that problems are not stop signs for the authors. We consider these as important guidelines, and we again thank the reviewer for providing us with ones.

RC: My main problem with the manuscript: I am not convinced that one can try to simply link INP concentration measurements at ground with rain events. You need to know cloud base where most of the aerosol particle enter the rain-producing cloud, you need to know cloud top height where ice nucleation typically starts, there may be entrainment of INP from the side...

AR: We apologize for extending the analysis to interpret the implications towards raised research questions. The discussion on raised topics is removed in the revised manuscript. It is clear that using our n_{INP} values in precipitation samples collected at the ground level to assess the impact on precipitation properties at cloud height (and vice versa) is not appropriate. Concerning this and many other issues raised by all peer reviewers (e.g., cloud water ≠ precipitation water), the authors decided to substantially revise the manuscript to focus on presenting the observed variation in precipitation properties but somewhat similar $n_{INP}(T)$ in different precipitation systems and metagenomics analysis. Our major revisions include the following:

- Our abstract has been revised to reflect all major revisions.
- **Sect. 1.3**: Ambiguous/speculative statements referring to the cloud height condition vs. ground level have been removed; i.e., P3L100-102 and P4L117-120.
- **Sect. 1.4**: Now the study focus is on presenting the ground level observations and measurements, and it is reflected in this particular section with reduced tones.
- **Sect. 3.1**: All repetitive and insufficient statements have been removed or rephrased (e.g., P9L317-322). The authors believe that the readability of this section has improved.
- **Sect. 3.2**: The main focus of this section has been changed to mainly discuss on the wet deposition based on our Air Quality PM sensor data.
- **Sect. 3.3**: Our new data interpretation and comparison to Vali (1968) are now introduced, and our previous statistical analysis has been remove. We re-analyze the n_{INP}, precipitation type observed at the ground level, meteorological season, and precipitation intensity data entirely using histograms (new **SI Sect. S5**).
- **Sect. 3.4**: The authors clarified the connection between feedlot and precipitation samples. We have removed some ambiguous results out of a limited number of samples (i.e., previous Figs. 7b and 7c). All associated texts have been modified, and an unnecessary reference has been removed.
- **Sect. 3.5**: Major caveats and limitations are discussed in this new section. After going through the revision process, the authors realize that including caveats for the reader is as important as offering scientific findings.
- Conclusion is also revised to reflect all major changes addressed above.
- **SI Sect. S4**: Detailed discussion of our interpretation of wet scavenging and its impact on our precipitation INP measurements are discussed in this new SI section. The overview is provided in the main manuscript **Sect. 3.2**.

RC: The strength of the thunderstorm or more generally of the rain event depends on the water vapor reservoir and meteorological conditions (sounds trivial) all this is not known here.

AR: The reviewer is right. To address what is raised by the reviewer, the authors decided to discuss all caveats (including dynamical factors and thermodynamic conditions) in the new **Sect. 3.5** - Please see the Track Changes version of the manuscript. In addition, the authors also include the discussion of the potential impact of dry conditions (plus other ambient and precipitation properties) on our observations as well as the seasonal variation in aerosol episodes near our study area in **Sects. 3.1 and 3.2**, respectively.

RC: Furthermore, on the way to the surface the rain drops collect a lot of aerosol particles (scavenging of pollution, biological and dust particles). All this material you will finally find in the collected rain water.

AR: Thanks for clarifying. To explore the scavenging question, we provide examples and implications of scavenging towards our results in **Sect. 3.2** and **SI Sect. S4**. Some implications and examples of potential wet scavenging in our INP data are given **in Sect 3.3**. Please see the Track Changes version of the manuscript and SI.

RC: So many questions, I got during reading and reviewing, remained open. The paper must be rejected.

AR: The authors hope our responses mitigate the referee's misgivings. We hope this does not end just as an educational opportunity. The authors consider the integration of research and education as an important part of science, and we hope we share the same philosophy with the referee and beyond. Every successful person has a painful story, and we are strong believers that all painful stories deserve successful endings if proper and persistent efforts are made. Please know that we are ready to do what is further required if given the second chance, and we hope our scientific responses prove that we are determined to make it so.

Minor/technical Changes

- P1 L3: Dimitri → Dimitrios as per request.
- P6 L195-197: The authors realized that removing the frozen fraction ≤ 0.05, accounting for less than 3% of pure water activation (see **Sect. 2.4**), as an artifact shifts our minimum detection to 0.006 L^{-1} for the current study. This detection limit shift has changed a few INP data (but not a substantial amount). The change has been reflected in **Figs. 1-3**, **S1-S2**, and **Table S4**.
- **Sect. 2.4**: Systematic and experimental uncertainties of WT-CRAFT and our experiments are clarified in more intuitive manner.

- **Sect. 2.6**: Identification of our samples for metagenomics is now provided. Note that the precipitation Sample# 50 (another hail/thunderstorm sample) was preserved only for metagenomics.
- **Fig. 2**: Replaced – all the data connecting lines are now removed to increase the visibility of data points.
- Former Fig. 4: Subdivided into two separate figures (**Figs. 4 and 5**) to clarify the associated discussion (new **Fig. 4**: our precipitation INP vs. previous precipitation INP & new **Fig. 5**: precipitation INP vs. local dust INP). All WT-CRAFT data were presented down to -25 °C.
- **Table S1**: Replaced – meteorological seasons are now used to categorize the sampling season instead of previously introduced arbitrary seasonal categories.
- Former Figs. 3, 6, and S3: Deleted as these figures were misleading/oversimplifying the relevant discussion.
- The reference sections have been updated for both main manuscript and SI. The abbreviation sections have been removed as they might not add much value.
- Cory et al. (2019b) and Rodriguez et al. (2020) are removed from the reference list and the main manuscript as Cory et al. (2019a) can represent a single good reference.
- A new reference (Markowicz and Chiliński, 2020) is added for showing an uncertainty of our PM measurements (see **Sect. 2.3**).
- A new acknowledgement is added for useful scientific discussion for the manuscript revision, "We also acknowledge Drs. Gourihar Kulkarni for useful discussions regarding implications of scavenging processes on our data."

References

Markowicz, K.M., and Chiliński, M.T.: Evaluation of two low-cost optical particle counters for the measurement of ambient aerosol scattering coefficient and Ångström exponent, Sensors, 20, 2617, 2020.

Vali, G.: Ice nucleation relevant to formation of hail, Stormy Weather Group, Ph.D. thesis, McGill University, Montreal, Quebec, Canada, available at https://central.bac-lac.gc.ca/.item?id=TC-QMM-73746&op=pdf&app=Library&oclc_number=894992919 (last accessed on December 21, 2020), 1968.