The importance of regional INP parametrizations focusing on the local aerosol sources

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INTRODUCTION

- Although the presence of ice in clouds is of high importance for the Earth's radiative balance, the hydrological cycle, and the atmospheric electrification, there are many uncertainties related to the spatial and temporal distribution of ice nucleating particles (INPs) [1,2].
- In-situ observations have been very useful in developing "global" INP parametrizations (e.g., [3] and [4]), currently used in different global climate models.
- There is an urgent need to develop regional parametrizations based on local measurements as the "global" parametrizations may not fully represent the regional aerosol physicochemical characteristics and their sources, especially in tropical latitudes where the available INP measurements is limited.

MAIN RESEARCH QUESTION How good is the "global" INP parametrization when trying to simulated local and regional TROPICAL phenomena?

METHODS

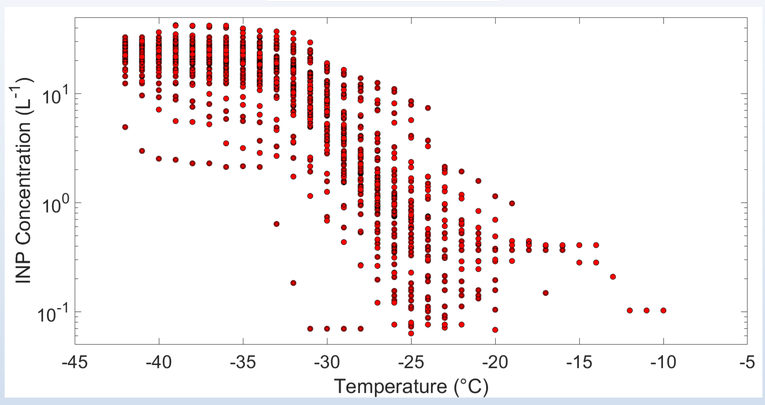

Figure 1. Ambient INP concentration measured along Mexico

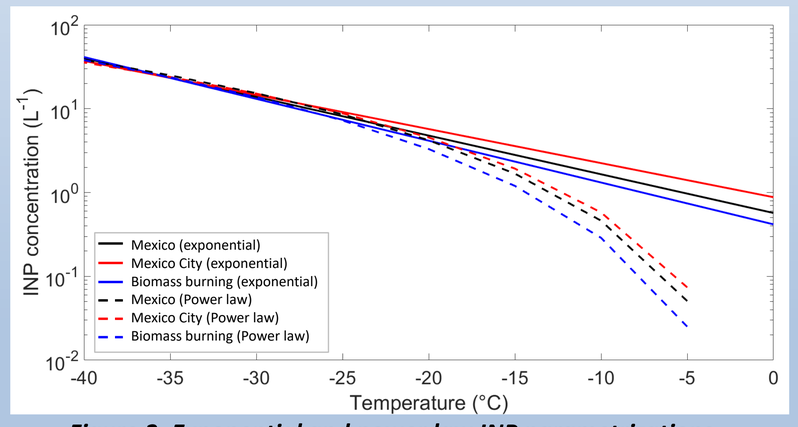

Figure 2. Exponential and power law INP parametrizations

WRF

CASE STUDY

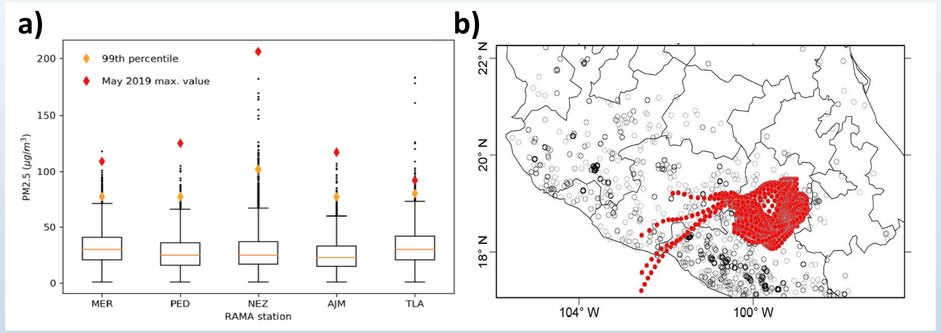

Figure 3. a) Box plots of $PM_{2.5}$ for May (2005–2019), indicating the 99th percentile values (yellow) and the maximum values observed during the heavy pollution event in May 2019 (red), and b) Hourly backward matrix trajectories from HYSPLIT initiated at 2200 UTC (16:00 LT) in Mexico City at 100 m (each dot corresponds to 1 h) [5]

Figure 4. Picture of the atypical hailstorm that took place in Mexico City on May 15, 2019 [6].

RESULTS

1. Observations vs. WRF

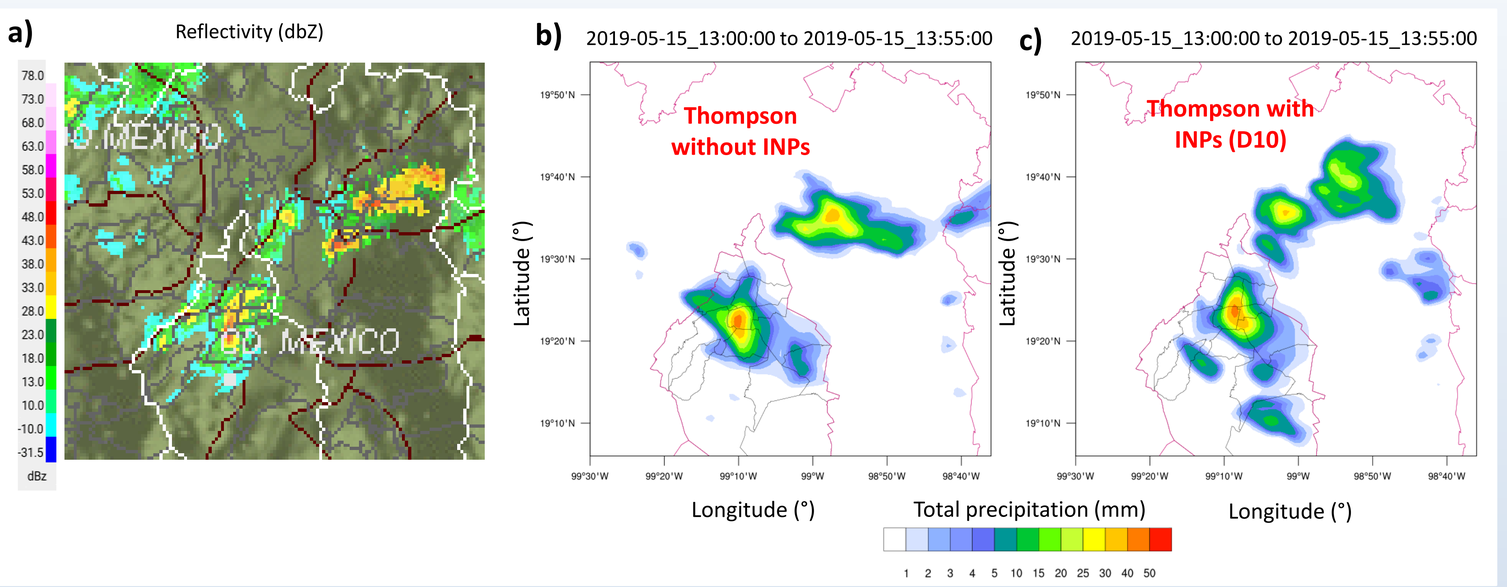

Figure 5. Precipitation distribution and intensity around Mexico City from a) observation and WRF simulations using the Thompson scheme b) without and c) with INPs (D10 parametrization)

2. The importance of INPs in graupel formation

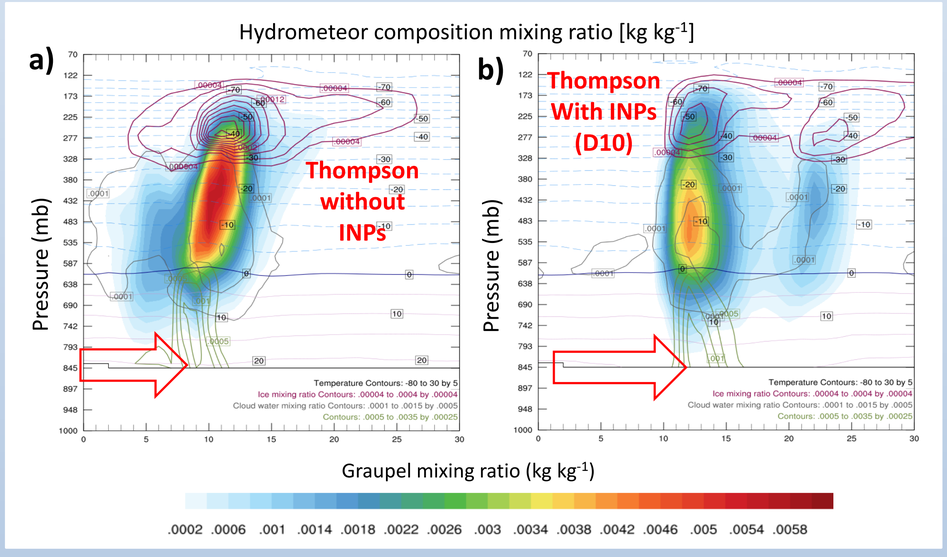

Figure 6. Vertical cross-section of graupel mixing ratio (shades) from the WRF simulations using the Thompson scheme a) without and b) with INPs (D10 parametrization).

3. The importance of local INP parametrizations

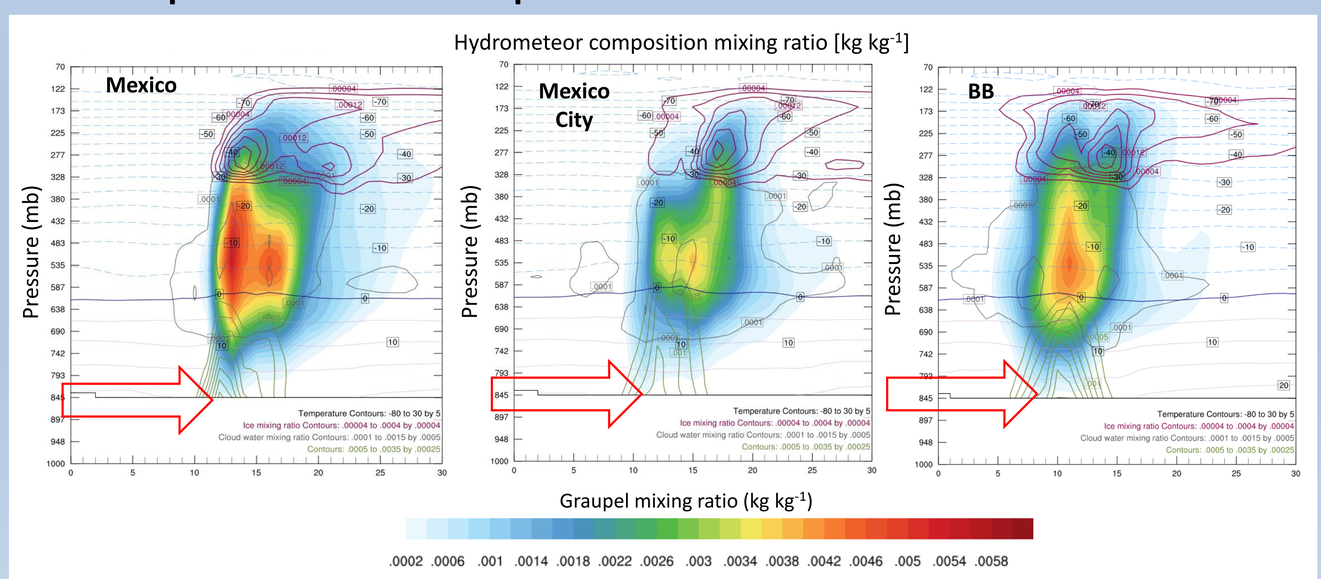

Figure 7. Vertical cross-section of the graupel mixing ratio from the WRF simulations using the Thompson scheme with a) Mexico, b) Mexico City, and c) Biomass burning INP parametrizations, respectively.

CONCLUSIONS

- Local ground-based INP measurements can improve the performance of the regional numerical models and can reduce uncertainties in simulating precipitation.
- There is an urgent need to develop region-specific INP parametrizations considering the different local mix of aerosol sources (Tropics ≠ Mid-latitude).
- Although urban INPs can influence the development of local extreme precipitation events, BB emissions can be a key player during the warm-dry season.

ACKNOWLEDGMENTS

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[1] Kanji et al. (2017). *Meteorological Monographs*, *58, 1.1-1.25;* **[2]** Burrows et al. (2022). *Reviews of Geophysics*, *60*, e2021RG000745; **[3]** DeMott et al. (2010). *Proceedings of the National Academy of Sciences*, 107 (25), 11217–11222; **[4]** DeMott et al. (2015). *Atmospheric Chemistry and Physics, 15*(1), 393–409; **[5]** Rios, Díaz-Esteban, and Raga (2023). *Science of the Total Environment*, 904, 166912; **[6]** Periodico Milenio (2015).