Evolution of the sub-micrometer aerosol size distributions measured in the Amazon rain forest during the wet season

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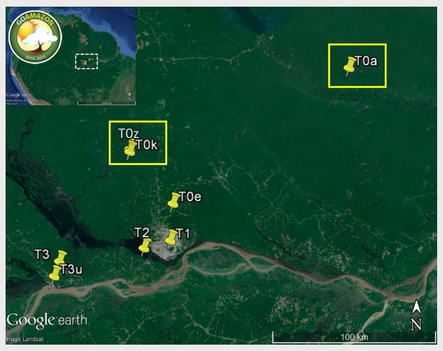
1. Introduction

- The impact of aerosol on cloud properties represents one of the largest uncertainties in computer simulations of climate change, in large part because of a poor understanding of aerosols characteristics under natural conditions that were prevalent during pre-industrial era;
- The Amazon rainforest is one of the few continental regions where aerosol properties and processes can be studied under near-natural conditions;
- We present aerosol size distribution and its evolution during the wet season in the Amazon basin using measurements at two background sites, the Amazon Tall Tower Observatory (ATTO) and the ZF2 site upwind of the Manaus city;
- The evolution of the aerosol size distributions under clean conditions is affected by precipitation and potentially the aqueous phase production of secondary organic aerosols.

2. Methods

Site Description:

- T0a: Amazon Tall Tower Observatory, ~ 150 km upwind of Manaus
- T0z: ZF2, ~ 70 km north of Manaus (upwind)

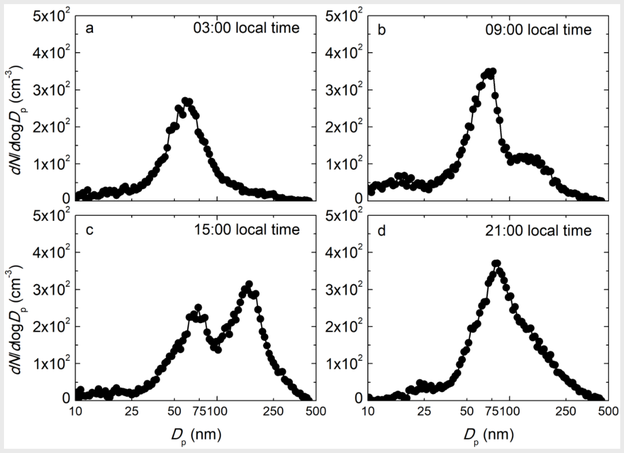


This study focuses on the aerosol size distribution evolution under clean conditions during the wet season:

- Wet season: few biomass burning, total aerosol number concentration ~ 600 cm^{-3}
- Criteria of "clean conditions": total aerosol number concentrations less than 450 cm^{-3}, black carbon (BC) concentrations lower than 25 ng m^{-3}, and CO mixing ratios less than 130 ppb.

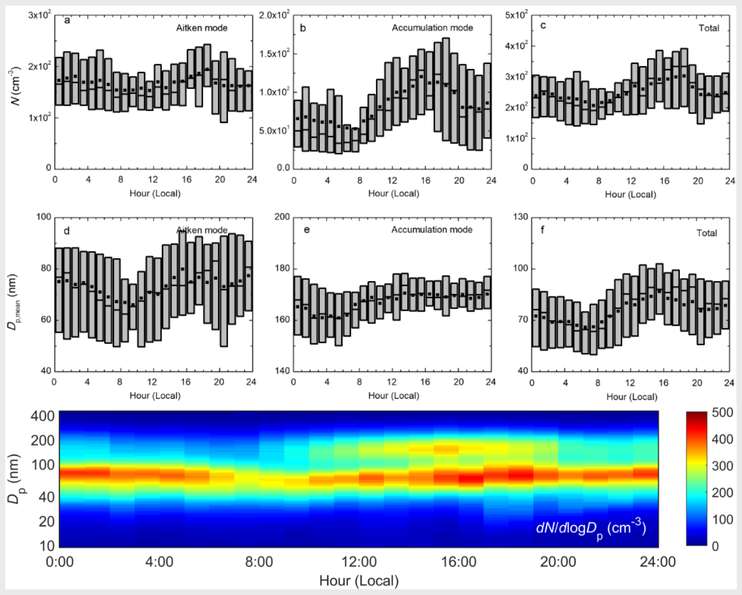
3. Results and Discussion

3.1. Representative aerosol size distributions



- Bi-modal aerosol size distributions were present in all studied days (54/54) in the wet season of 2014;
- The aerosol size distributions showed a Hoppel gap separating the Aitken and accumulation mode aerosols, demonstrating an influence of in-cloud processing on the aerosol particles;
- Accumulation mode aerosols increased during the daytime and decreased during the nighttime.

3.2. Diel Patterns of Aitken and Accumulation modes aerosols



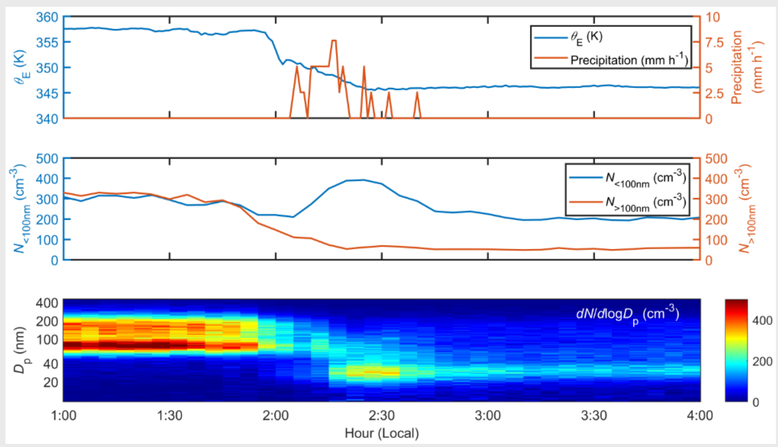
Aitken mode aerosols:

- Concentration remained relatively constant;
- Mean size increased during the daytime;

Accumulation mode aerosols:

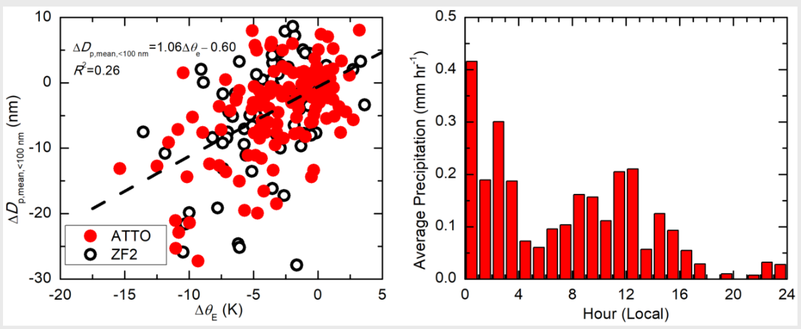
- Concentration increased during the daytime and decreased during the nighttime;
- Mean size increased during the daytime (suggesting the condensational growth);

3.3. Precipitation strongly influences the aerosol size distributions



Observations during precipitation:

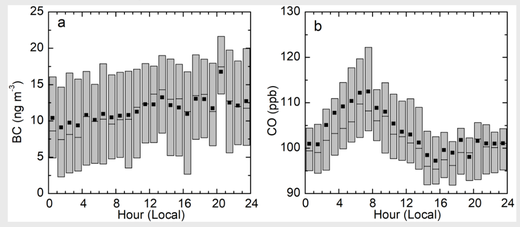
- Increase of the Aitken mode concentration due to convective downdrafts, bringing Aitken mode aerosols from the free troposphere;
- Washout of accumulation mode aerosols.



- The more decrease in the equivalent potential temperature, the more decrease in Aitken mode size;
- The decrease of the equivalent potential temperature is determined by the height of the free tropospheric air brought by convective downdraft;
- More precipitation between 0000 – 0400 LT, explaining the lower accumulation mode concentration during this time.

3.4. In-cloud processing may play a role in the evolution of aerosol size distributions

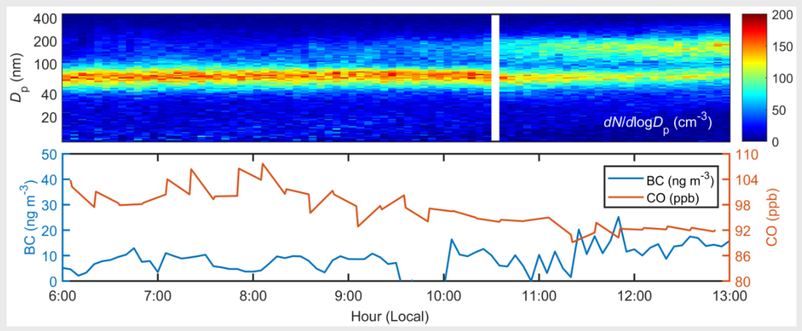
Under polluted conditions, the mixing of aerosols in the residual layer down to the surface could be identified by the increase of BC and CO;



Under clean conditions, minimal impact of pollution observed:

- BC concentrations remained relatively constant;
- Due to the formation of nocturnal boundary layer, CO released by soil accumulated overnight and dissipate during the daytime;
- No evidence for the direct emission of accumulation mode aerosols from the biosphere;
- The accumulation mode aerosols were unlikely grown by condensation, since continuous growth from Aitken mode to accumulation mode was not observed.

In-cloud processing as the potential source of accumulation mode aerosols during the daytime



Given the low SO_2 concentration under the natural conditions in the Amazon basin, the in-cloud processing of aerosol particles may be dominated by aqueous phase production of secondary organics from biogenic volatile organic compounds.

4. Summary

- This study analyzed the evolution of aerosol size distributions during the wet season under clean conditions in the Amazon basin;
- Precipitation introduced Aitken mode aerosols by downdraft and removed accumulation mode by washout;
- Given the low BC and CO concentrations under the clean conditions, the increase of the accumulation mode aerosol concentration during the daytime is likely caused by the in-cloud processing of aerosols.

5. References

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6. Acknowledgements

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