Lab and Field Testing of the Mist Chamber

Elizabeth B. Huddle[1], Katherine B. Beem[2], Jeffrey L. Collett, Jr.[2]
[1]University of Minnesota, Minneapolis, MN, [2]Colorado State University, Fort Collins, CO
Department of Atmospheric Science, Colorado State University, Fort Collins, CO

MOTIVATION

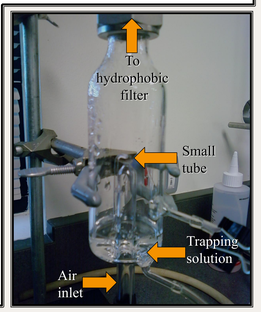
•Ammonia and nitric acid are important to measure because they can both react to become a particle. Particles can decrease visibility as well as have adverse health effects.
•Currently, denuders are being used to measure the concentration of atmospheric ammonia and nitric acid in the RoMANS II project. While these sampling instruments are quite efficient for collecting ammonia and nitric acid, they also are time and labor intensive.
•The mist chamber is an attractive alternative because it is simple to run, it is small in size, has a better time resolution and could potentially be automated.

OBJECTIVES

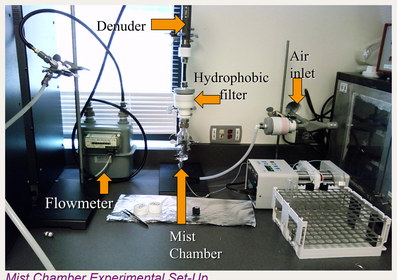
•Find the optimal running conditions of the mist chamber
•Sample ammonia and nitric acid in both the laboratory and field enviornment

DESCRIPTION OF A MIST CHAMBER[1]

•Trapping solution is pumped to the bottom of the mist chamber
•Air is pulled through a filter to remove particles and then through the larger entrance tube
•The air is pulled at a high enough rate so that the solution is forced into the small inner tube
•The solution in the small inner tube collides with the air, creating a fine mist
•The mist chamber collects water soluble gases from the air
•A hydrophobic filter prevents solution from escaping out of the top of the mist chamber



METHODS



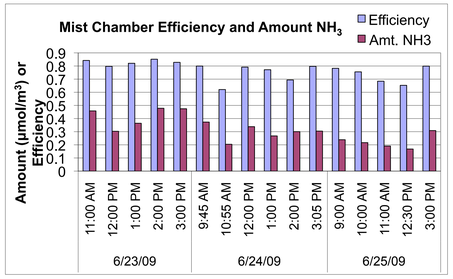
Mist Chamber Experimental Set-Up

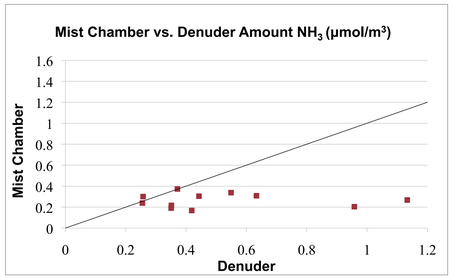
•After initial experimentation, it was determined that 10 mL of trapping solution would be used for the mist chamber
•For ammonia, the trapping solution used had a pH of about 2.00 and was made of HCl, DI water, and LiBr (to be used as an internal standard)
•For nitric acid, the trapping solution used was DI water with LiBr
•Sample times ranged from 20-90 minutes, with most samples being 60 minutes long
•Ion Chromatography was used to analyze the samples
•Efficiency was determined by connecting a denuder in series with the mist chamber

RESULTS- AMMONIA

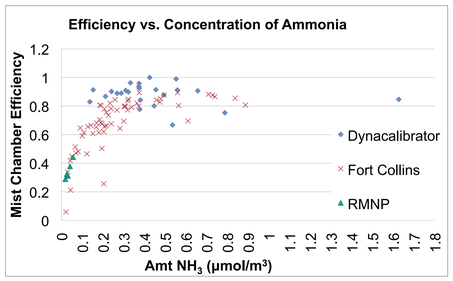
Ammonia
•The sampling time was originally 20 minutes, but was changed to 1 hour, which improved consistency among the data
•Variables such as pH, volume and temperature of the trapping solution were adjusted without a significant change in the efficiency of the mist chamber

•The efficiency of the mist chamber was in direct correlation with the concentration of ammonia sampled, which was a result that could not be explained



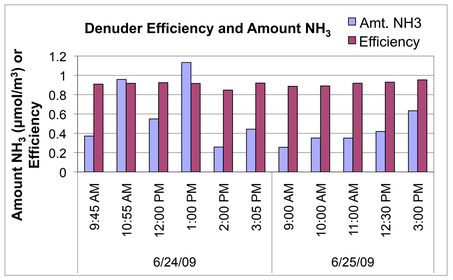


•The efficiency of the denuders was not dependent on concentration of ammonia

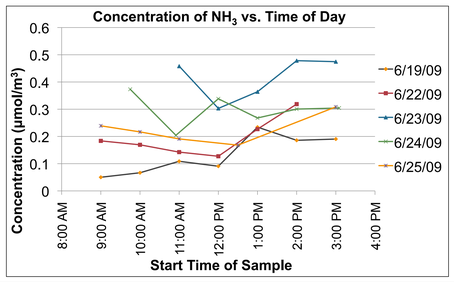


•It was believed that by monitoring the time of day that the samples were run, weather conditions could be compared to the ammonia concentrations in order to explain the variability in concentrations. More data must be reviewed on weather conditions before any conclusions can be made

•Denuders that were setup near the lab also measured the amount of ammonia, which was compared to the ammonia measured by the mist chamber. Most of the time the denuder collected a higher concentration of ammonia



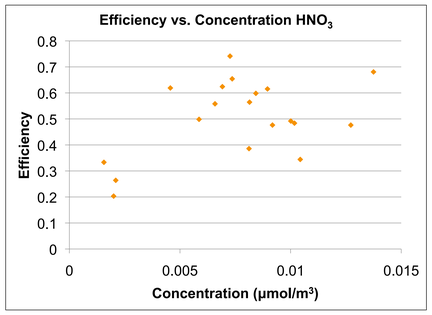
•The concentration of ammonia varied by location and method for sampling. The dynacalibrator (an instrument that generates ammonia in the lab) provided the highest concentration of ammonia, resulting in higher efficiencies than in the lab or field



RESULTS- NITRIC ACID

Nitric Acid

•Ambient nitric acid levels observed during testing was very low
•The low concentration of nitric acid measured in the lab was not directly correlated to the efficiency



CONCLUSIONS

•The mist chamber required less time and labor for preparations than the denuders but parameters must be better established for the mist chamber in order for it to be confidently deployed in the field
•Throughout this research, the mist chamber had lower efficiencies and was more inconsistent than denuders when sampling ammonia and nitric acid
•The mist chamber had low efficiencies when the concentration of ammonia was low but the same effect was not observed for nitric acid

FUTURE WORK

•More research should be done to determine why the mist chamber has a low efficiency especially at low concentrations
•It could be determined if all mist chambers have approximately the same efficiency by running two mist chambers simultaneously
•Sampling for a species that has previously been measured by a mist chamber with positive results, such as SO_2, would provide a good comparison of the efficiencies obtained by the mist chamber in this research

REFERENCES

1. Cofer, W.R., Collins, V.G., and Talbot, R.W., 1985: Improved Aqueous Scrubber for Collection of Soluble Atmospheric Trace Gases. *Environ. Sci. Technol.* **19**, 557-560.

9. ACKNOWLEGDGEMENTS

This work has been supported by the National Science Foundation Science and Technology Center for Multi-ScaleModeling of Atmospheric Processes, managed by Colorado State University under cooperative agreementNo. ATM-0425247.