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Atmospheric Measurement Techniques Discussions

Quantitative Chemical Assay of Nanogram-Level PM Using Aerosol Mass Spectrometry: Characterization of Particles Collected from Uncrewed Atmospheric Measurement Platforms

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Avenues for aerosol sampling: pros and cons

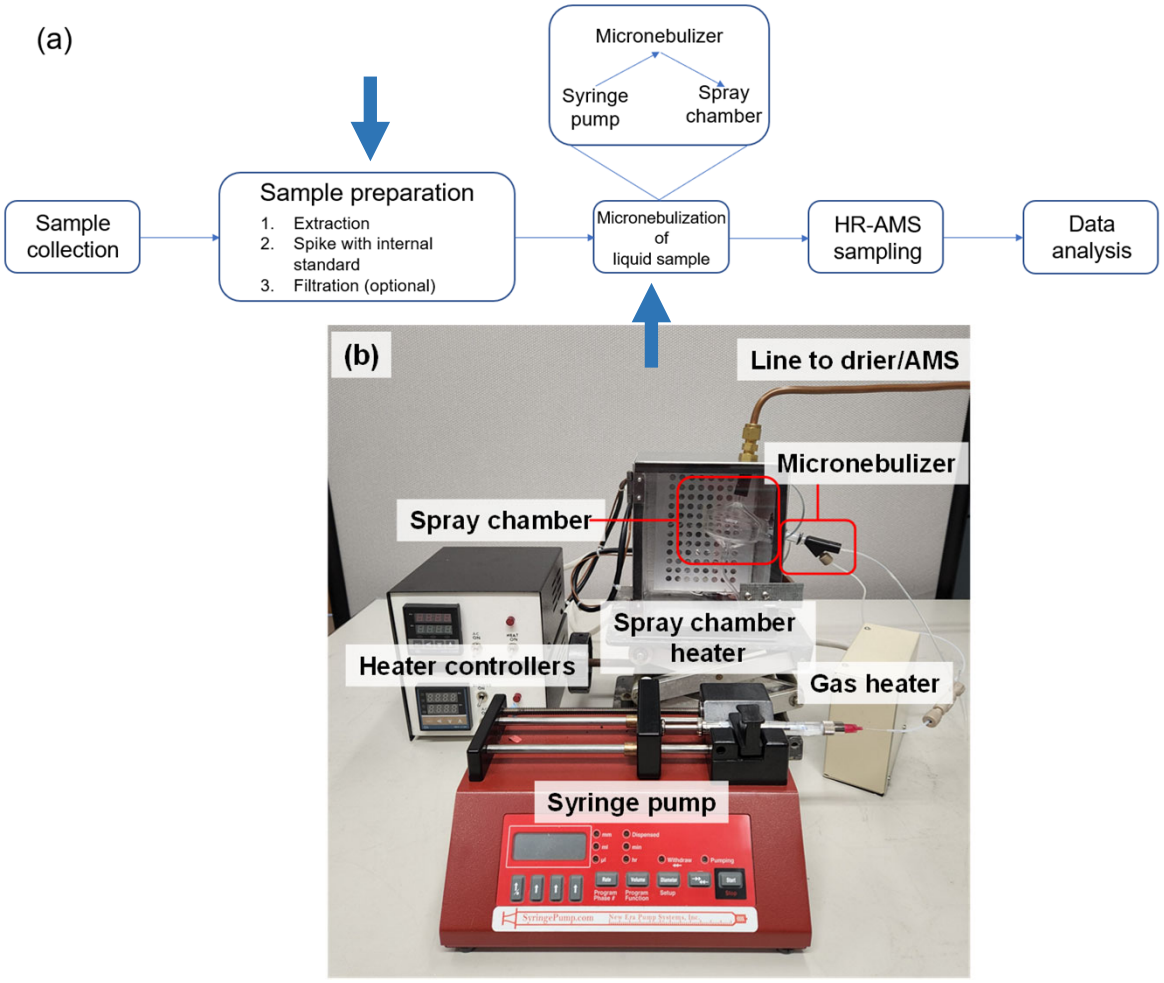
- Ground-based
- Traditional aircraft
- Uncrewed aerial systems (UAS) and tethered balloon systems (TBS)
  - Complementary & versatile
  - Payload restrictions, low air sampling flow rate → minuscule mass per sample
    - E.g., ambient PM = 10 μg m^{-3}, UAS sampler flow rate = 2.5 L min^{-1}

      → 6.7 hours of flight time would be needed to gather 10 μg of PM (for traditional analysis methods)

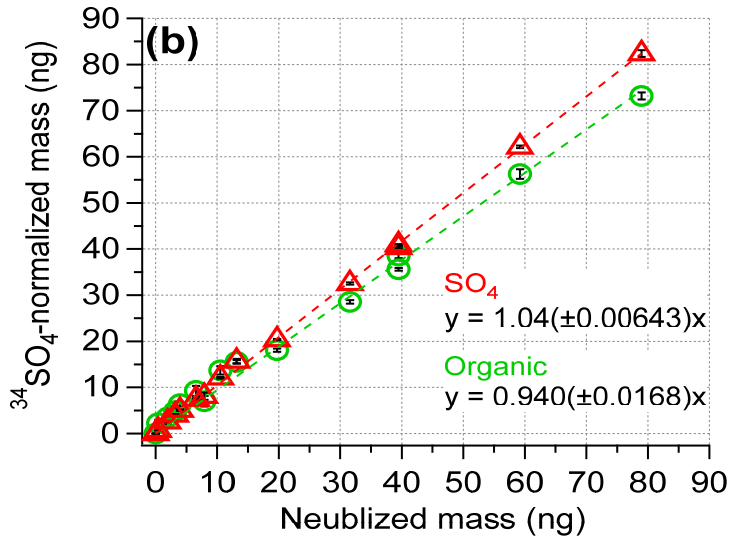
Objective:

1. Develop **a micronebulization Aerosol Mass Spectrometry (MN-AMS) technique** that combines isotopically-labelled internal standardization, micronebulization, and aerosol mass spectrometry for **quantitative** analysis of **nanogram-level** of PM
2. Application of MN-AMS to the analysis of UAS collected PM samples

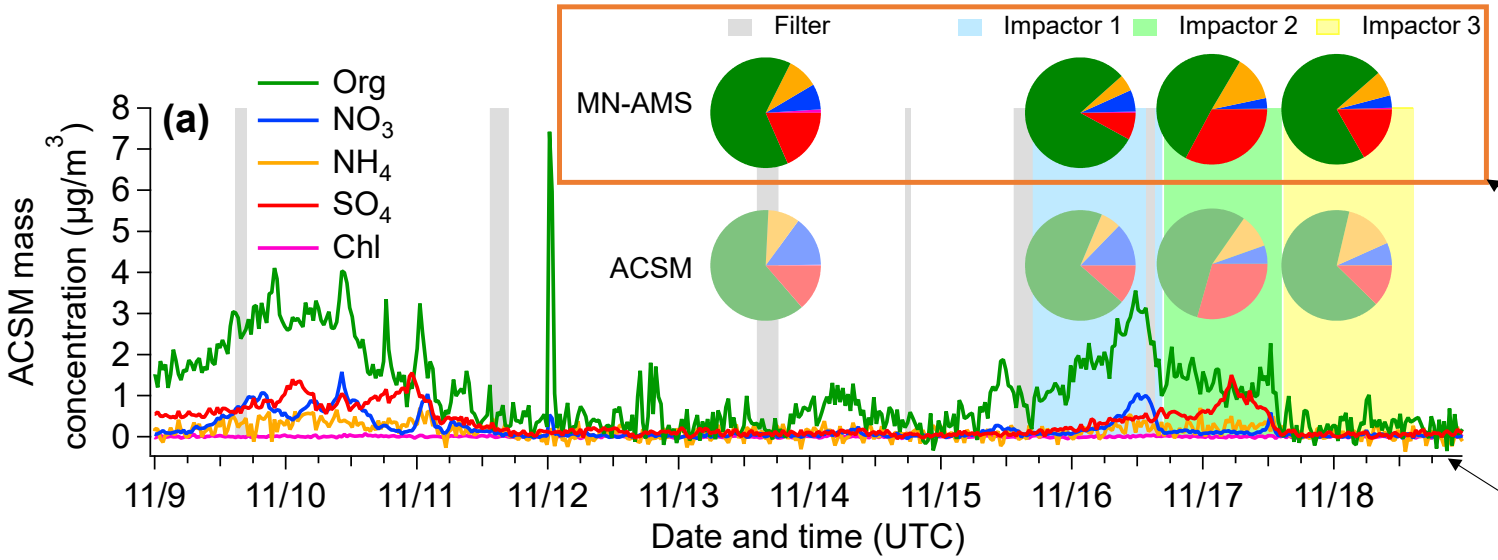
Micronebulization Aerosol Mass Spectrometry (MN-AMS)

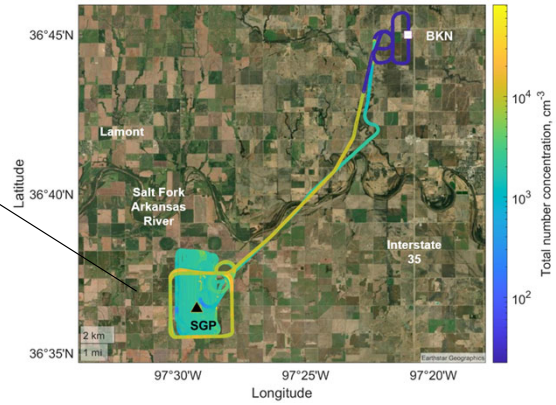


- Extraction
  - Ice bath sonication with methanol/H_2O
- Spike
  - $^{34}SO_4$ as an internal standard
- Internal standardization corrects for the non-linear behavior
  - Analytical recoveries are near 100 %



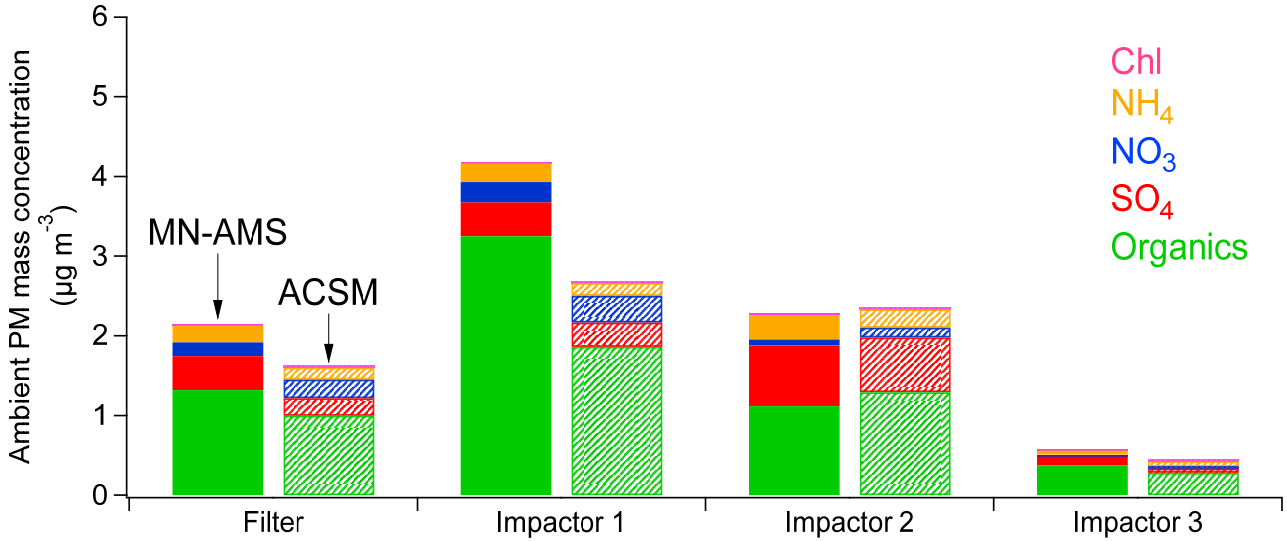
SGP samples: MN-AMS and ACSM comparison





- Co-located ACSM measurements allow for further method validation
- Bulk analysis of PM composition show similar results between the ACSM and MN-AMS

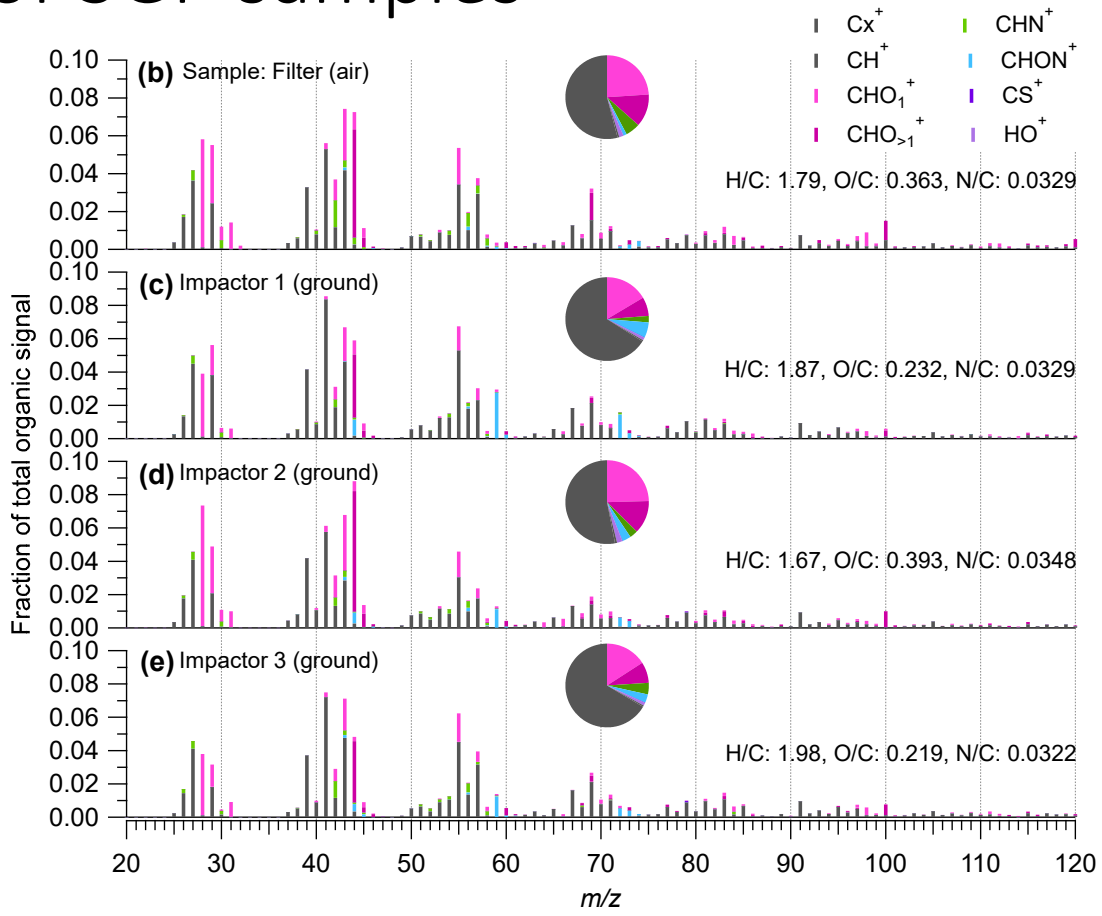
Quantification of SGP samples



- With isotopic internal standardization, the ambient PM mass concentration can be derived from the filter and impactor samples
- The offline MN-AMS measurements of ambient PM collected by UAS were within 20 % of those measured in real-time by the ACSM
- The time trend in ambient loadings measured by the ACSM is recaptured reasonably well by offline MN-AMS analysis

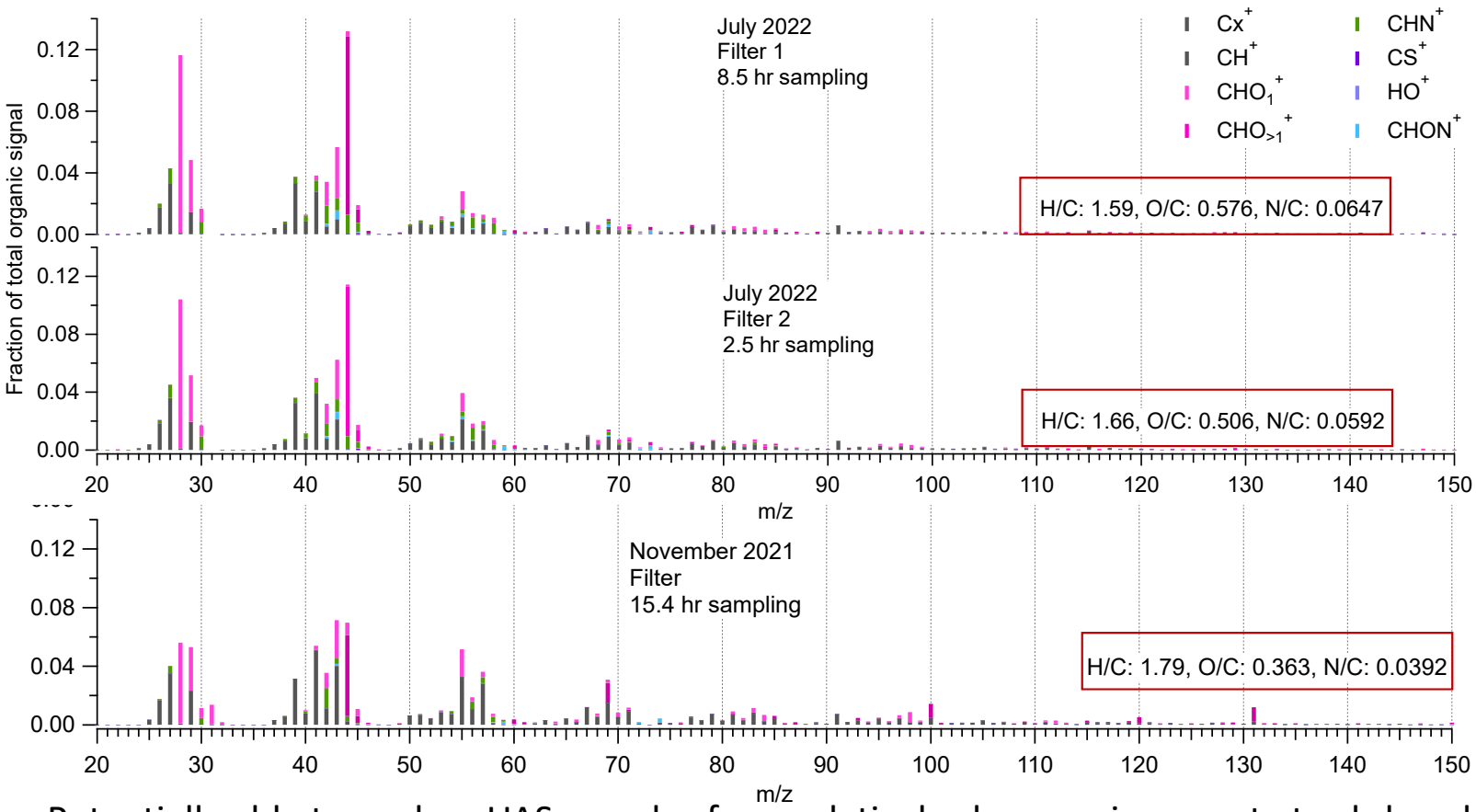
Chemical characteristics of SGP samples

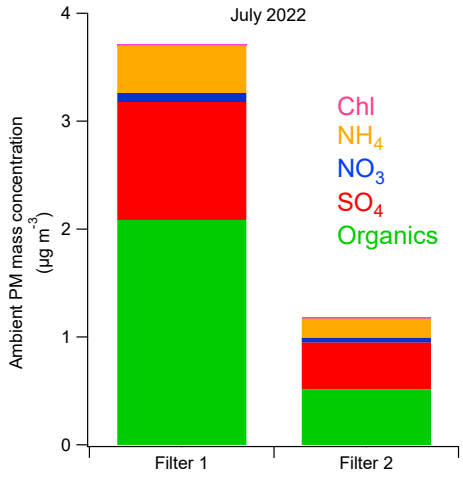
- MN-AMS provides high-resolution mass spectra of OA
- Mass spectral correlation with the corresponding ACSM data (UMR) was reasonable (r^2 ≥0.5)
- Nitrogen-containing organics were likely present in the SGP samples
  - Organonitrates were previously suspected at the SGP site[4]
  - Nitrogen-containing organics were additionally confirmed by SIMS measurements



(4) Parworth, C.; Fast, J.; Mei, F.; Shippert, T.; Sivaraman, C.; Tilp, A.; Watson, T.; Zhang, Q. Long-Term Measurements of Submicrometer Aerosol Chemistry at the Southern Great Plains (SGP) Using an Aerosol Chemical Speciation Monitor (ACSM). *Atmos. Environ.* **2015**, *106*, 43–55.

Chemical characteristics of SGP samples: July 22 vs. Nov. 21





- Potentially able to analyze UAS samples from relatively clean environment at sub-hourly resolution
- Ability to capture temporal variations in concentration & composition allows for aerosol source apportionment.