Transport of SARS-CoV-2 on particulate aerosols

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Introduction

- SARS-CoV-2 is known to be transmitted via aerosolized liquid droplets
- Microhabitats in dust and sediment can enhance the survival of pathogens and SARS-CoV-2 can survive for longer periods on surfaces like plastics
- Thus, we hypothesized that SARS-CoV-2 could be transported on particulate aerosols extending virus lifetimes in the atmosphere

Questions

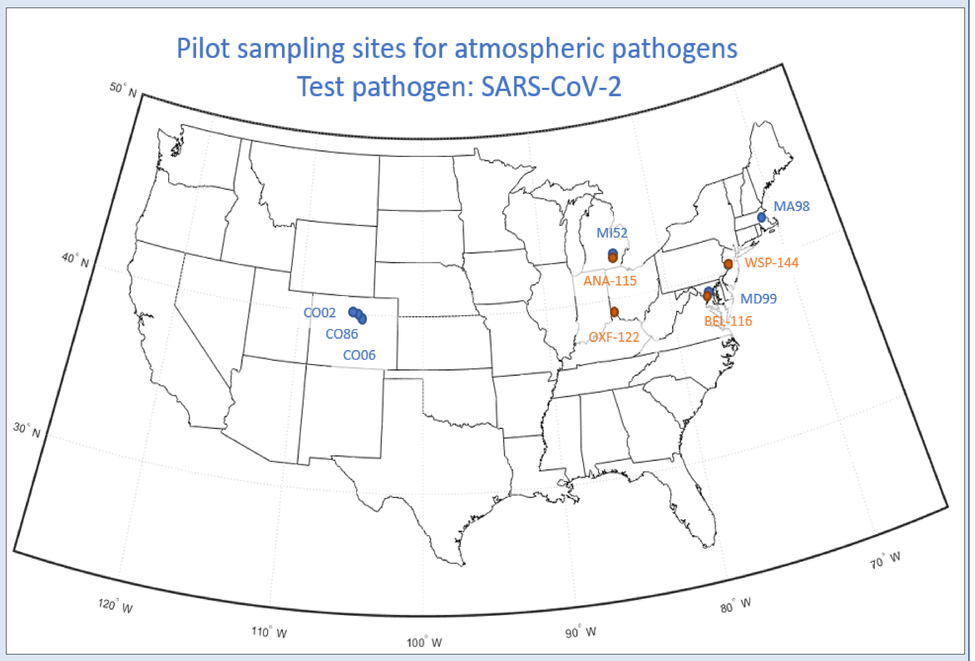
1. Can we measure SARS-CoV-2 in aerosols within U.S. cities?
2. Can we measure SARS-CoV-2 in aerosols from remote locations?
3. Does virus association with particles enhance survival?
4. What climate factors are associated with RNA detection in samples?
5. Are virus counts measurable in liquid aerosols above waste-water in treatment basins (high agitation and humidity)

Approach

SARS-CoV-2 RNA was quantified by RT-qPCR following disinfection, extraction, and purification. We measured samples from:

- NADP rain and particulate deposition samples
- IMPROVE PM_{10} Aerosol samples (Figure 1)
- Aerosolized water droplets inside a WWTP with known virus concentrations in treatment vats.

Figure 1. NADP and IMPROVE locations



Results

- Approximately 40% of the atmospheric samples containing particulates tested positive for virus RNA (Table 1)
- Results were more likely positive if holding times were low, but detectable virus occurred even after 20 days
- Linear models indicated positive results in NADP sites were associated with higher case counts, higher windspeeds, and lower sea-level pressure ($p<0.001$)
- CASTNET samples were more likely to be positive during weeks with lower wind speed
- We found no detectable RNA in the liquid droplets collected above WWTP treatment basins that contained SARS-CoV-2 virus

Table 1. Percentage of positive results from NADP and CASTNET deposition and aerosol samples

Location	Percentage
NADP	
Denver, CO	33%
Arvada, CO	0%
Ann Arbor, MI	22%
Washington D.C.	29%
New York, NY	50%
Boston, MA	25%
Lakewood, CO	100%
Niwot Ridge, CO	50%
CASTNET	
Trenton, NJ	42%
Annapolis, ND	33%
Ann Arbor, MI	25%
Oxford,OH	100%
Average	**42%**

Conclusions and Next Steps

Our data indicate a potential for SARS-CoV-2 virus transport on aerosols but has not identified whether this mechanism can lead to greater transmission rates. Interestingly, we did not measure virus RNA on water droplets alone, only when samples also contained particulates. Our next steps are to explicitly test the longevity of SARS-CoV-2 on different aerosolized substrates including clays, plastic, organic, water, and mixtures through controlled nebulization experiments.