Thermodynamic prediction of aerosol pH in the remote marine boundary layer of the Southern Ocean

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Introduction

- Aerosol acidity is a fundamental parameter of aqueous chemistry that impacts the lifetimes of pollutants, biogeochemical cycles, human health, and climate[1].
- Aerosol pH is difficult to constrain and challenging to measure directly[2].
- Aerosol acidity estimates from remote marine regions are particularly scarce.

Aim: To predict the pH of aerosols across a latitudinal transect of the Southern Ocean

Methods

- Major aerosol inorganic ion concentrations were measured:
  i) continuously in $PM_{2.5}$ using an Ambient Ion Monitor Ion Chromatograph
  ii) ~ daily in coarse and fine mode filter samples
- pH was estimated using a thermodynamic model (ISORROPIA-II) with inputs of measured relative humidity, temperature and inorganic aerosol species concentrations

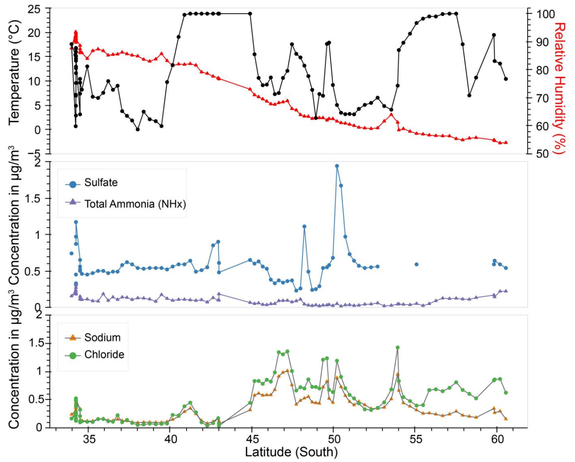


Fig.1. spatial series of meteorological variables(top), and aerosol species concentrations (middles & bottom)

A

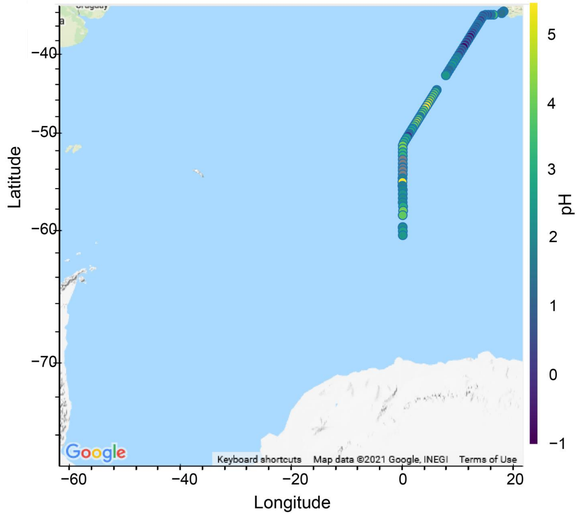
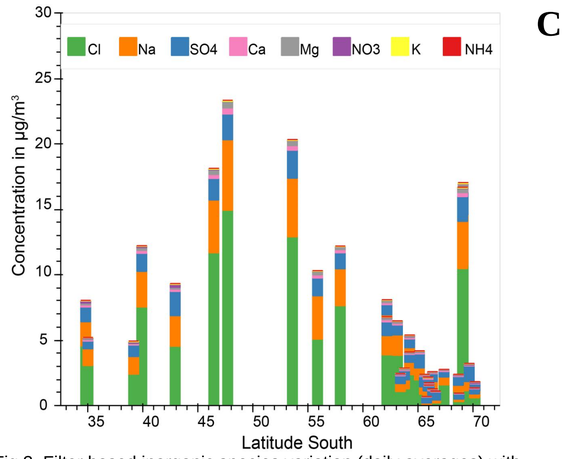


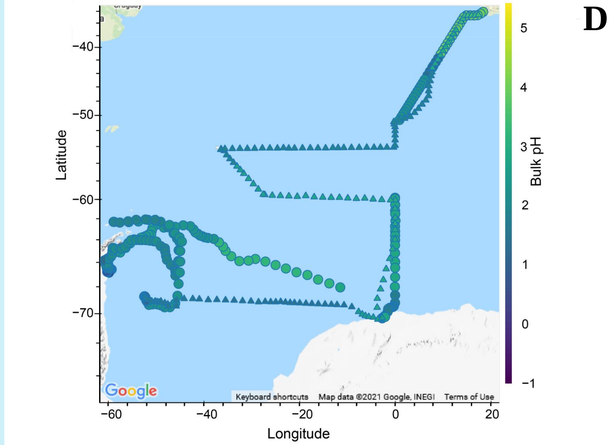
Fig.2. Aerosol pH (2 hourly averages) of $PM_{2.5}$ (AIM-IC data)

B



C

Fig.3. Filter based inorganic species variation (daily averages) with latitude (average collection)



D

Fig.4. Daily averages of bulk pH (filter samples). Circles represent the downward lag and triangles the return lag of the transect

Results & Discussion

A: High-resolution measurements highlight variability in aerosol inorganic concentrations across changing RH and declining temperatures

B: pH generally increases with latitude, likely due to increasing sea salt concentrations

C: Aerosol filter samples represent larger spatial and temporal scales

D: pH from aerosol filter samples is comparable to pH from continuous data

Preliminary conclusions:

- Aerosol pH is acidic in all samples
- Sea salt concentrations appear to be an important driver of the aerosol pH
- Bulk aerosol pH from filter samples is similar to pH from continuous data
- Currently exploring temperature and RH sensitivities and interesting excess chloride in some samples

References

- 1.Pye, Havala OT, et al. "The acidity of atmospheric particles and clouds." *Atmospheric chemistry and physics* 20.8 (2020): 4809-4888.
- 2.Hennigan, C. J., et al. "A critical evaluation of proxy methods used to estimate the acidity of atmospheric particles." *Atmospheric Chemistry and Physics* 15.5 (2015): 2775-2790.