Seasonal variability of submicron aerosol acidity at a coastal site in the Eastern Mediterranean

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Introduction

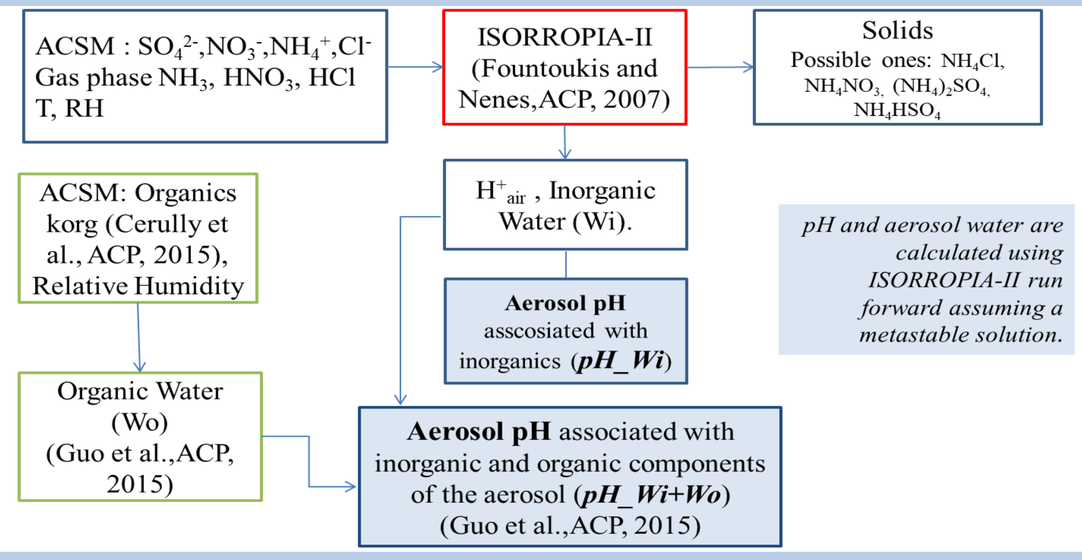
Importance: Aerosol pH effects on:
- chemical composition of atmospheric particles, including aerosol water
- gas-particle partitioning of semi-volatile gases
- solubility and concentration of toxic forms of trace metals
- Climate (Pye et al., ACP, 2020)

How is it determined?
- Direct measurements of particle pH: challenging
- Thermodynamic model calculations based on aerosol and air composition measurements: mostly used

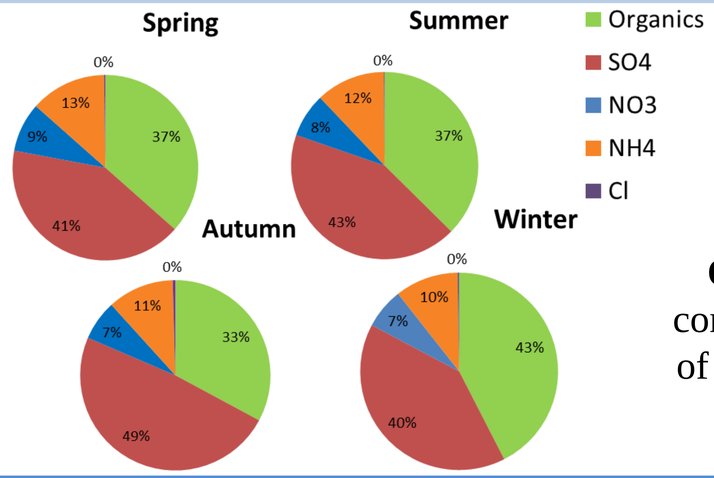
Aim of this study:
- Calculate the submicron aerosol water and pH in the area (Finokalia atmospheric observatory in the eastern Mediterranean)
- Examine the seasonality of the derived pH and its drivers

Measurement site:
Finokalia atmospheric observation station in Crete. Greece (35°20´N. 25°40´E; 250 m a.s.l.).
http://finokalia.chemistry.uoc.gr/

Methodology



Observations



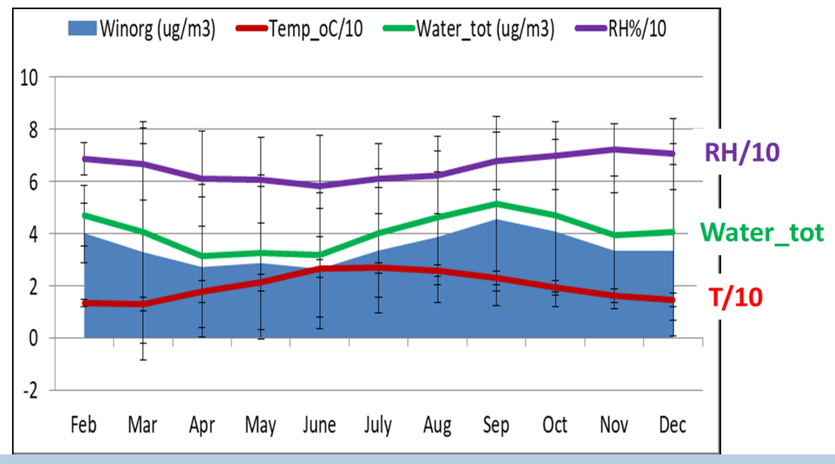
Data period: February to December 2014

Observations : Seasonal contribution to the PM_1 mass of each species. (ACSM data used in ISORROPIA-II)

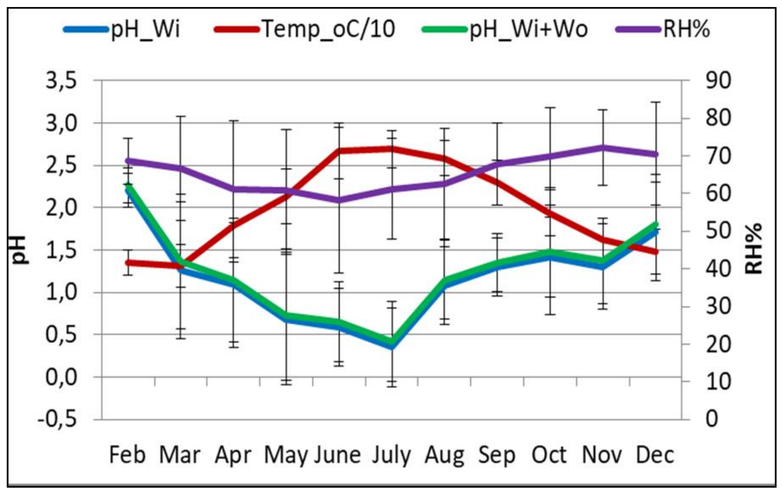
Model results-Seasonality-Aerosol Water

Wi (inorganic water)
Wo (organic water)
Water_tot = Wi+Wo

Wo is on average 11% to 19% of total water.



Model results - Seasonality - Aerosol pH



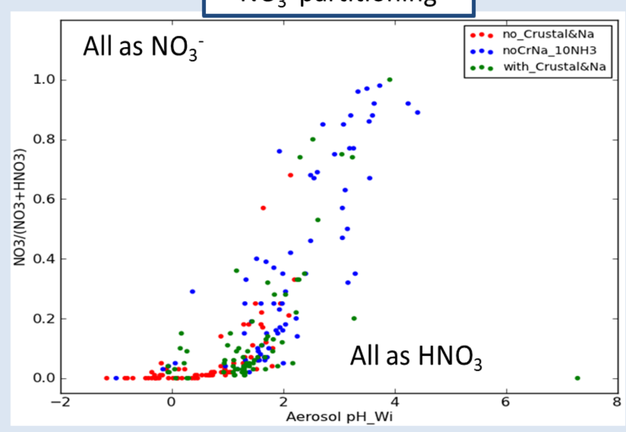
pH_Wi: calculated based on Wi
pH_Wi+Wo: calculated based on Wi+Wo

- ✓ **Accounting for organic water (Wo) increases the pH by 0.05 to 0.1 unit.**
- ✓ **Aerosol pH shows summertime minimum and wintertime maximum (1.8 pH unit difference).**

Model results-Sensitivity to crustals and NH_3

Sensitivity of pH to crustal elements and NH_3 levels

NO_3^- partitioning



PM_1 measurements including crustal species (K^+. Ca^{2+} . Mg^{2+}) and Na^+, at the site from February to December 2014 (70 days).
- ✓ average pH increase of 0.83 units was due to addition of crustal species and Na^+ followed by 0.08 increase in the partitioning of nitrate to the particulate phase.
- ✓ average pH increase of 1.46 units was due to addition of excess gas phase NH_3 followed by 0.3 increase in nitrate partitioning coefficient.

Conclusions

Submicron aerosol at Finokalia

- highly acidic with an average pH value of 1.09 ± 0.71
- Water associate with organics has a minor effect on the aerosol pH (average increase by 0.07 pH unit).
- Aerosol pH shows clear seasonality with the highest values in winter and the lowest in summer.
- Interpreting the crustal species in the aerosol pH prediction: average increase by 0.83 pH units accompanied by an increase in particle phase nitrate.

Acknowledgements

We acknowledge support of this work by the project "PANhellenic infrastructure for Atmospheric Composition and climatE chAnge" (MIS 5021516) which is implemented under the Action "Reinforcement of the Research and Innovation Infrastructure", funded by the Operational Programme "Competitiveness, Entrepreneurship and Innovation" (NSRF 2014-2020) and cofinanced by Greece and the European Union (European Regional Development Fund). https://panacea-ri.gr/

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