Bulk Aerosol Measurements at Mount Washington: Seasonal Cycles, Elevated Events, and Relationships to Air Mass Transport

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Twenty-four hour bulk aerosol samples have been collected at the summit of Mount Washington (1910 m), the highest peak in the northeast, since January 1999. The site is operated by AIRMAP, a University of New Hampshire air quality and climate program, and is part of an atmospheric observing network located in New Hampshire. This study examined the seasonal cycles, elevated concentration events, and the meteorology associated with high and low concentrations of the major ionic constituents.

The primary aerosol anion was sulfate (SO_4^{2-}) with ammonium (NH_4^+) as the principal cation. Aerosol nitrate (NO_3^-) concentrations were typically an order of magnitude lower than the NH_4^+ concentrations with the exception of elevated events in the cooler months (Figure 1c). Both aerosol SO_4^{2-} and NH_4^+ peaked during summer months, and the lowest concentrations occurred during winter (Figure 1a, b). There was a high median NO_3^- concentration during warmer months; however, there was a notable difference between elevated events during summer and those occurring during the cooler seasons. The dominant anion during summer events was almost exclusively SO_4^{2-}, but as SO_4^{2-} concentrations decreased during the cooler seasons, particulate NO_3^- made a larger contribution. The amplitude of the seasonal cycle at Mount Washington is likely exaggerated compared with surrounding lower elevation sites because of the harsh winter climate at this site. In addition, the site is within the mixed layer only on the warmest summer days, and under the influence of the free troposphere most of the year.

The seasonal relationship between NH_4^+ and SO_4^{2-} showed slopes ranging from 1.5 in summer to 2.1 in winter. This indicates that during warmer months a mixture of $(NH_4)_2SO_4$ and NH_4HSO_4 is present, while it is mainly the latter in winter. Adding NO_3^- to the regression indicated that this ion made a notable contribution mainly during winter and spring. During summer months the highest (95th percentile) concentrations of both aerosol SO_4^{2-} and NH_4^+ were associated with generally westerly and southwesterly transport. Winter elevated events of these species indicated similar transport and were accompanied by elevated aerosol NO_3^-. Elevated aerosol NO_3^- events during the cooler seasons were primarily associated with transport from the Midwest and coincided with warm periods in this region.

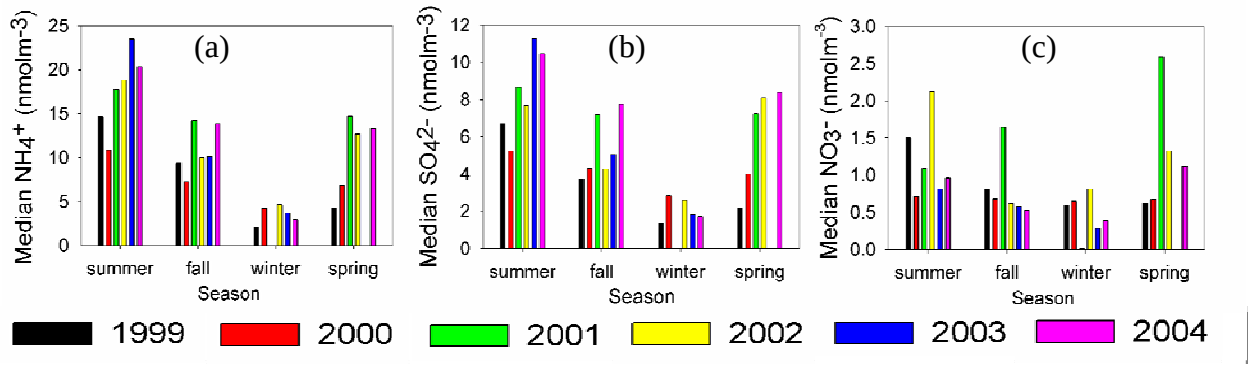

Figure 1. Median (a) NH_4^+, (b) SO_4^{2-}, and (c) NO_3^- as a function of year and season. Note that the scale is different for each plot. The four seasons are on the x-axis and the different colors indicate different years. The winter seasons are labeled by the January year. For example, winter 1999 includes January and February 1999, and winter 2000 includes December 1999, January 2000 and February 2000.