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Year-round observations of NO_x mixing ratios and fluxes above the coastal snow pack at Halley, Antarctica.

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Measurements of NO_x ($NO + NO_2$) concentrations at Halley (75^0S 26^0W) were carried out year-round *(January – December 2007)* for the first time, to provide us with an insight on its seasonal variability, relationship with various atmospheric parameters and its influence on surface ozone concentrations. Measurements were done at 7m above the surface snowpack, and for a few days during each season an additional inlet was placed at 0.1m to estimate the NO_x flux based on the flux-gradient method. Supporting measurements included 3-D wind vectors with a sonic anemometer, boundary layer depth with an acoustic SODAR, actinic fluxes with a spectrometer and meteorology.

The average ($\pm$ standard error) NO_x mixing ratios during summer months (Jan-Feb'07 & Nov-Dec'07) were 10.4($\pm$0.1) & 8.5($\pm$0.03) pptv, respectively, about 3-5 times greater than the spring (Mar-Apr'07) and autumn average (Aug-Sept-Oct'07) of 2.7 ($\pm$0.02) & 3.04 ($\pm$0.017) pptv. During winter (May-June-July'07) the average NO_x mixing ratio was below the detection limit of 5 pptv. A clear diurnal pattern in the NO_x concentration was detected from late spring (Oct) through the summer, with maxima occurring between 1700-1900 hrs LT. Generally, atmospheric vertical mixing dilutes snowpack emissions of NO_x, as indicated by the weak but significant negative correlation between NO_x mixing ratios and the turbulent diffusivity of heat (K_h) (r = -0.1291, $p<0.001$) for all months, except for March and April when it was positive (r = 0.085, $p<0.001$). Analysis of the wind speed and direction suggests that during March and April air masses originated for 45% and 18% of the time from the high plateau with wind speed greater than 5 ms^{-1}, unlike summer months when air masses were mostly of coastal origin. We discuss the possibility of NO_x from the high Antarctic plateau reaching the coast enabled through a combination of katabatic outflow and increased atmospheric lifetime under low-light conditions.

The average ($\pm$ standard error) NO_x flux was mostly positive (upward) and ranged from 0.07-5.45 x10^{12} molecule/m^2/sec with a maximum of 5.45x10^{12}($\pm$1.12x10^{12}) molecule/m^2/sec observed in early March. Maximum NO_x flux coincided with elevated NO_x mixing ratios which are associated with katabatic outflow of continental air. Surprisingly during the 21^{st} - 24^{th} February period most NO_x flux values were negative (towards the surface).

We discuss the seasonal variability of NO_x mixing ratios and its impact on ozone production with respect to atmospheric physical properties as well the strength of the photolytic snowpack source and compare to existing Antarctic observations from coastal and continental sites.