



## **Modes of temporal variability recorded in nitrate and accumulation records from six Greenland ice cores.**

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An analysis of the temporal variability of accumulation, nitrate concentration and nitrate flux from six ice cores covering the period 1794-1995 shows correlated co-variability of nitrate concentration on timescales greater than ten years and a 35% increase in average concentration during the latter 75 years. There are no clear co-varying trends in accumulation, though in some cases high frequency variability is highly correlated between sites. Annual nitrate fluxes show low-frequency trends driven by changes in concentration, while higher-frequency variability is driven by variability in the accumulation record. The changes in concentration yield a  $\sim 30\%$  increase in average flux ( $2.5$  to  $3.2 \mu\text{g m}^{-2} \text{ a}^{-1}$ ) and a  $\sim 11\%$  increase in variability during the last 75 years. Recent global decadal emissions of nitrate were compared to the ice core records. Trends in each of the records are highly correlated with the emissions dataset, with an average  $r$ -value of 0.93 for all six ice core records. A frequency analysis on the residuals of the accumulation records shows a component of the North Atlantic Oscillation (NAO) is anti-correlated to the accumulation records, yet there is some evidence of positive correlation in the concentration records from the western Greenland ice cores.