Connections between meteorology and chemistry in surface snow: Clark Glacier, McMurdo Dry Valleys, Antarctica

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Many studies have examined snow and ice chemistry in polar regions with the purpose of extending our knowledge of climate through the thousands of years captured in seasonal ice stratigraphy. Variation in major ions, stable isotope ratios, trapped gas composition, trace metal contents, and physical properties of the ice, among other studies, have provided information interpreted to yield a picture of the state of the atmosphere in the Holocene period. Sometimes, however, these studies are calibrated in the modern period against instrumental records not from the immediate vicinity of the site of the firn or ice core collected. In 2004-2005, a meteorology station was active on the surface of the Clark Glacier, collecting instrumental information for one full year on surface barometric pressure, temperature, wind speed and direction, and snow depth. In 2005, a snowpit was excavated and sampled directly below this meteorology station. Samples from this pit were analyzed for major ion composition using ion chromatography. The results demonstrate the precise correlations between the chemistry of the snow pack and the weather conditions active at the time of precipitation. Major ions are shown to react in a variable fashion, with some (Na+, Ca2+, Mg2+) demonstrating reaction to multiple individual snow deposition events, while MS- shows a more clearly annual signal, with only one peak shown for the period of meteorology collected. The stable isotopic record, meanwhile, appears to record the most recent year with a reasonable annual signal, but the signal becomes increasingly muted with increasing depth in the snowpack (also representing increasing time after deposition). These results confirm the potential for such records in snow and ice to record not only annual but potentially sub-annual time series in several chemical proxies related to climate study.