Ice Core Records of Late Holocene Volcanism: Contributions from the Greenland PARCA Cores

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Since the late 1960s when the first long cores were recovered from Greenland and Antarctica, polar firn and ice cores have provided unique details about the impacts of specific volcanic eruptions on the atmosphere's chemistry and on the climate at regional to global scales. In the last decade, ice core research has emphasized reconstruction of high-resolution (optimally annual) proxy histories for the latter part of the Holocene. This effort has lead to identification of a number of previously unrecognized explosive events and new details about the timing and nature of already well-known eruptions. In the last five years, a new suite of spatially distributed shallow to intermediate depth cores was collected in Greenland under the auspices of the Program for Arctic Regional Climate Assessment (PARCA). These records provide an unprecedented opportunity to assess local to regional variability of annual accumulation over Greenland as well as the annual character of the other important climate proxies such as insoluble dust, oxygen and hydrogen isotopic ratios, and numerous chemical species.

The PARCA cores are unique in their broad spatial distribution and accurate dating of annual layers using multiple seasonally varying indicators. Multiple, closely spaced cores were collected at a limited number of sites and demonstrate that high-frequency (e.g., annual) climate variability may be partially masked by glaciological noise. This becomes an important consideration when investigating volcanic events that may perturb atmospheric chemistry for as little as one or as long as four years. This paper examines the chemical and physical character of the ice containing the emissions from a number of well-known eruptions, including but not restricted to Coseguina, Tambora, the 1809 A.D. unknown event, and Laki. These analyses will be compared among the new PARCA cores, as well with existing Greenland and Antarctic volcanic histories. Due to their high temporal resolution, the PARCA cores also contribute to the continuing refinement of the timing of the arrival of volcanically-derived aerosols to the Greenland ice sheet. Unfortunately, human perturbation of the

atmospheric sulfate budget by burning fossil fuels now masks volcanically derived sulfate aerosol deposition over Greenland making assessment of 20th century volcanic emissions very problematic. Fortunately, sulfate background concentrations remain relatively unperturbed in the Southern Hemisphere atmosphere and thus, emissions from more recent eruptions may be evaluated with carefully sited cores from the Antarctic Ice Sheet.