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Comparison of the chemistry of two firn cores from Antarctica

Content

This study compares the chemistry (stable isotopes and ionic content) of two firn cores from sites under different environmental settings. These cores were retrieved during the 2004–2005 Brazilian/Chilean ITASE's traverse, one (IC-02) at 88°01'21,3"S; 82°04'21,7"W (altitude 2,621 m) in East Antarctica, the other (IC-05) at 82°30'30,8"S; 79°28'02,7"W (altitude 950m) in West Antarctica. Stable isotope data (δD and $\delta^{18}O$) were determined using a WS-CRDS Picarro®L2130i at the Centro Polar e Climático (CPC – UFRGS). The ionic data (Na⁺, Cl⁻, nssSO₄²⁻, MSA, and Mg²⁺) was obtained using two DX-500 Dionex Chromatographers at the Climate Change Institute (CCI – UMaine). Both cores were dated by counting the seasonal signal of isotope ratios and sodium concentration and by identifying volcanic peaks using the non-sea salt sulfate (nssSO₄²⁻) concentration peaks. The analysis encompasses 25 years of record (1978–2003). The IC-02 and the IC-05 cores have a mean annual accumulation of 0.25 and 0.35 m water equiv., respectively. The mean stable isotope ratio in the firn cores differs by a factor of approximately 1.3 (δD -371.99‰ and $\delta^{18}O$ -46.51‰ at the IC-02 versus -284.85‰ and -35.95‰ at the IC-05). The ionic concentrations also show a decreasing trend; at the IC-02, mean concentrations are Na⁺: 13.30 μg L⁻¹, Cl⁻: 34.86 μg L⁻¹, MSA: 9.28 μg L⁻¹, and Mg²⁺: 1.99 μg L⁻¹. At the IC-05, mean concentrations are Na⁺: 66.68 μg L⁻¹, Cl⁻: 135.84 μg L⁻¹, MSA: 17.98 μg L⁻¹, and Mg²⁺: 9.35 μg L⁻¹. At the IC-05, closer to the coast, all ions are in higher concentrations, particularly the Na⁺ (mean concentration five times higher than at the IC-02 core), indicating that more maritime aerosols contribute to the snow chemistry. The IC-05 Cl⁻/Na⁺ ratio (1.99) also denotes the marine aerosols. The Cl⁻/Na⁺ ratio in the IC-02 is approximately 2.77, showing a high input of chloride that is not related to marine aerosols. The same pattern stands out in Mg²⁺ data. In the IC-05, the Mg²⁺ has a correlation of 0.85 with Na⁺, indicating that most of its concentration is derived from sea salt spray; this correlation drops to 0.50 in the IC-02, indicating another source of Mg²⁺. Furthermore, the IC-02 data indicate a positive Cl⁻/Na⁺ ratio trend for the last 30 years, pointing out that more non-sea salt Cl⁻ is added to the Antarctic Plateau snow chemistry. This Cl⁻ input at the IC-02 shows no statistically significant correlation with nssSO₄²⁻ nor with MSA. The study concluded that sea salt predominantly dominates the IC-05 chemistry. Although the IC-02 is located in the Antarctic Plateau, there is a relatively high contribution of sea salts. Nevertheless, some ions such as Cl⁻ and Mg²⁺ have other sources that play an important role in the IC-02 chemistry.

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