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Stable-isotope ratios (δ18O and δD) in a firn core from West Antarctica

Content

A 22.48 m long firn core (BR-IC-4) was collected in the West Antarctic Ice Sheet (at 83°58'59.4" S, 80°07'01.4" W, 1295 m above the sea level) during the Austral summer of 2004–2005, as part of the Chilean-Brazilian ITASE (International Trans-Antarctic Expedition) traverse. The firn core had its hydrogen/deuterium (δD) and oxygen-18/oxygen-16 (δ18O) ratios determined, interpreted, and correlated to data previously obtained in the area, aiming to help reconstruct its paleoclimatic history. The isotopic composition (δD e δ18O) of 599 samples corresponding to the upper 12.98 m of the core, was determined by gas source mass spectrometry (IRMS) and cavity ring-down spectroscopy (CRDS) at the Climate Change Institute (University of Maine) and at the Glaciochemistry Laboratory of the Centro Polar e Climático (the Federal University of Rio Grande do Sul), respectively. Relative dating was based on the isotopic ratios and major ions (MS-, Na+, nssSO42-) and trace elements (Na, S, Sr) concentrations. The record covers approximately 13 years (from 1990 to 2003), showing a marked seasonal variability, with ionic parameters MS- (methylsulfonate) and nssSO42- (non-sea-salt sulfate) peaks in summer and Na+ maxima in the winter. A sulfur peak was identified in 1991 CE between September and November when plumes from Mount Pinatubo (Philippines) and Cerro Hudson (Chile) eruptions were recorded above the geographic South Pole. The mean accumulation rate of 0.48 ± 0.09 m water equiv. a-1 is relatively high for the geographic area and possibly results from snow drifting from nearby areas (there are ice glaze surfaces in other sites in the region). The stable isotope results are consistent with those found nearby by other studies, with δD varying between -367.90‰ and -256.30‰ (mean of -314.42 ± 19.01‰); and δ18O ranging from -44.96‰ to -35.08‰ (mean of -39.95 ± 2.05‰). The study of the backward trajectories (using the Hybrid Single-Particle Lagrangian Integrated Trajectory software – HYSPLIT) shows that the primary sources of local precipitation are the Bellingshausen and Weddell seas and the coast of Queen Maud Land. Deuterium excess values (mean 3.70 ± 1.54‰) indicate episodic intense oceanic evaporation and high relative humidity in the moisture sources because evaporation is more extensive in periods with low relative humidity, corresponding to a higher d. The IC-4 deuterium excess values are higher during winter months since the precipitation originated in more distant areas (the Weddell Sea and the Pacific Ocean) compared to summer months, in which the precipitation originates nearer the Antarctic coast, especially Queen Maud's Land.

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