

Controls on Water Stable Isotopes of an Antarctic Coastal Ice Core: A Case Study on the Hercules Névé, East Antarctica

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This study investigates the controls on water stable isotopes in an 80 m long ice core from Hercules Névé (HN), an East Antarctic coastal site situated approximately 80 km inland and at a height of more than 2800 m in the northern margin of the Transantarctic Mountains. HN site is advantageous for conducting research on regional reconstruction because of the high accumulation rate resulting from geographical features such as flatness, high elevation, and adjacency to the ocean. Water stable isotopes have provided information on the surrounding atmospheric conditions, ocean dynamics, and large-scale atmospheric circulation patterns. We intensively concentrated on the varied factors that impact the results of water stable isotopes, which are used in paleothermometry studies in polar regions.

We analyzed the water stable isotope of the HN firn core, which included a clear isotopic seasonal signal, allowing age dating spanning ~200 years. The study observed no spatial correlation between annual mean water isotopes and temperature around the study area. Other factors are likely to have influenced water stable isotopes. In addition, the reconstruction of temperature at this coastal site is expected to be difficult on an annual scale. A significant negative spatial correlation exists between yearly averages of water isotopes and sea ice concentration (SIC) covering the Ross Sea sector. The change in SIC leads to variability in air mass transport distance and the water stable isotope signal. Also, there is a positive correlation with geopotential height near the Amundsen-Ross Sea, indicating long-distance atmospheric circulation may act as a trigger for the changes in the ocean and atmospheric conditions near the HN site.

The findings highlight that the water stable isotopes of the coastal area have a large possibility of SIC contribution. The study suggests that atmospheric/ocean dynamics play a crucial role in determining water stable isotopes, and their influence on sea ice variability should be considered in future studies.