TRACER STUDIES OF THE ARCTIC FRESHWATER BUDGET

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1. Introduction

The freshwater lens covering the surface of the Arctic Ocean is roughly 50 to 150 meters thick and consists of river runoff, sea-ice meltwater, and low-salinity water of Pacific origin imported through Bering Strait. Whereas salinity data provide us with a good picture of the distribution and variability of the total freshwater contained in the Arctic Ocean, they cannot, in general, distinguish between the individual freshwater components. To obtain this information, measurements of additional water mass properties have to be performed.

The most promising variables for visualization and quantification of the individual freshwater components in the Arctic Ocean are the stable isotopes of water $^{1}H_{2}{}^{18}O$ and $^{1}H^{2}H^{16}O$ (HDO), dissolved inorganic carbonate, dissolved barium (Ba), and nutrients. These tracers have different sources and sinks in the Arctic Ocean. Therefore, they can be used, in combination, to identify the sources of the freshwater. Additionally, transient tracers allow us to determine the mean residence time of the freshwater. They can also be used to calibrate models used in studies of the Arctic freshwater balance.

In this chapter, we briefly outline the basic principles of the tracer method for studies of the Arctic freshwater balance, present results from field studies, and discuss a strategy for incorporating the tracer data into model studies. We briefly introduce stable isotopes of water, dissolved carbon, and barium as freshwater tracers, and we focus our discussion on the application of the stable isotopes of water because the spatial coverage of stable isotope data is better than that for other tracers and their integration into models

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is further along. However, the ultimate goal of tracer studies is to use them in an integrated fashion.

2. Principles

All components contributing to the freshwater of the Arctic Ocean by definition have salinities lower than that of the Atlantic water which is used here as reference salinity. River runoff and sea-ice meltwater have salinities of 0 and between 3 and 5, respectively. Although much saltier than river runoff and sea-ice meltwater, the

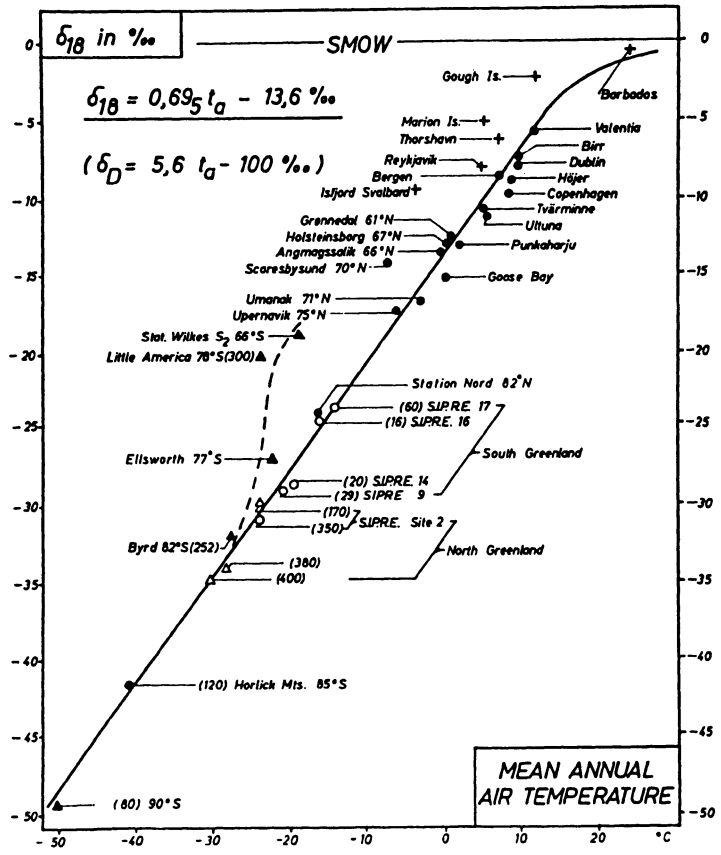

Figure 1: Plot of $\delta^{18}O$ for sites from a variety of latitudes (from Dansgaard, 1964). The $\delta^{18}O$ values are decreasing with increasing latitude (decreasing temperature). Typical values for high northern latitude sites are approximately –20‰.

Pacific inflow through Bering Strait with its average salinity of approximately 33 psu, about 2 psu lower than Atlantic water, represents a negative salt flux or a freshwater source. Salinity data have been used in past studies to estimate fluxes of the individual