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Freshwater transport through the Canadian archipelago

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The Arctic Ocean is connected to the Northwest Atlantic Ocean by three passages through the islands of the Canadian Archipelago. Flow through these passages accounts for about half of the freshwater leaving the Arctic Ocean, making it an important consideration in understanding and modelling the Arctic freshwater balance. Since 1998, an extensive array of instrumented moorings has been maintained across Barrow Strait, the widest of these 3 passages. Comprehensive measurements of current speed and direction, salinity, temperature and ice thickness have provided data to estimate volume, freshwater and heat transports through this connecting pathway. To accomplish this, specialized instrumentation has been developed to address unique aspects of the study location. Conventional compasses are unreliable at the site, because of its proximity to the north magnetic pole. To obtain accurate current direction measurements, a strategy that uses specialized instrumentation to cope with the small horizontal component of the earth's magnetic field has been developed and employed. Another challenge has been to obtain year-round, near-surface salinity measurements. The study area is ice-covered for 10 months of the year, with ice ridges presenting a hazard to conventional sub-surface instrumented moorings extending up into the top 30 m of the water column. Yet, it is in this upper layer that the fresh water from ice melt will be concentrated. To make the required measurements in this critical zone, the moored profiler "Icycler" has been developed and used to successfully collect daily year-round profiles to the under ice edge. Icycler consists of a winch in the main float of a mooring, which reels out an instrumented float once a day using a sonar to detect the depth of the ice, and a safe pay-out distance. When not profiling, the instrumented float is reeled in well below any danger of ice impact. The comprehensive measurements collected so far have been used to construct a 6 year time series of volume,

freshwater and heat transport through Barrow Strait. Besides a strong seasonal signal, the measurements also show large inter-annual variability. Freshwater export from the Arctic Ocean through Barrow Strait varies by as much as a factor of 2 from one year to the next. Given this large natural variability, detection of an increase in freshwater export into the North Atlantic due to accelerated melting of the Arctic ice pack is not possible from such a short record. But, our time series is getting long enough to explore connections between these measurements and other signals in the global climate system. We find that the inter-annual changes in freshwater transport through Barrow Strait appear to follow changes in the large scale atmospheric weather pattern referred to as the North Atlantic Oscillation (NAO), with the ocean transport lagging behind change in the NAO by about 8 months. Establishing and incorporating these types of connections into climate models will improve our capability for predicting global warming impacts.