Pacific Water Pathways through the Arctic Ocean

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The volume, characteristics and sources of freshwater circulating in the Arctic Ocean vary in time and are expected to change under a declining sea ice cover, influencing the physical environment and Arctic ecosystem. Relatively fresh (S = 32) Pacific Water, which enters the Arctic Ocean via the Bering Strait makes up a significant part of the liquid freshwater exiting the Arctic Ocean through Fram Strait. If transported to the Nordic Seas and North Atlantic via the East- and West Greenland Currents freshwater from the Pacific could have an effect on convection and dense water formation in those regions.

More than 30 repeated sections of nutrient measurements have been collected across Fram Strait between 1980 and 2018. The fraction of Pacific Origin Shelf Water along these repeated sections can be estimated from the ratio of nitrate to phosphate. The time-series of repeated Fram Strait sections indicates that the fraction of Pacific Origin Shelf Water passing out of the Arctic Ocean has changed significantly over the last 30 years. Pacific Origin Shelf Water fractions remained high from 1980 to 1998, but in 1999 the water mass almost disappeared from Fram Strait, reappearing only briefly from 2011 to 2012, when there was a peak in freshwater export though Fram Strait.

Several hypotheses suggest how variations in the large-scale atmospheric circulation over the Arctic Ocean may influence the transport and pathways of Pacific Water. Repeated sections across Fram Strait are compared with sea ice back trajectories and a simulated Pacific Water tracer in the NAOSIM numerical model. The simulated timing of periods with high and low Pacific Water abundance in Fram Strait is consistent with those observed. The model allows us to understand the causes of the high variability. A prominent role is played by the superposition of atmospheric sea level pressure modes that resemble the Arctic Oscillation and the status of the Beaufort High, respectively. The experiments help us to understand the interplay of large scale atmospheric forcing and the memory that is inherent in the concentration patterns of Pacific Water due to long transit time across the Arctic along changing pathways.