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The Arctic Mediterranean Sea - Deep convection, oceanic heat transport and freshwater

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The speculations about the driving forces behind the oceanic meridional circulation and the importance of the northward transports of oceanic heat for the ice conditions in the Arctic Ocean have a long history, but only after the Fram expedition 1893-1896 and from the studies by Nansen, Helland-Hansen and Sandström in the early 1900s did these speculations attain observational substance. In the late 1970s and onward these questions have again risen to prominence. A study of deep convection in the Greenland Sea, then assumed to drive the global thermohaline circulation, started with the Greenland Sea Project (GSP), while the investigation of the exchanges of volume and heat through Fram Strait had a more hesitant start in the Fram Strait Project (FSP). Not until 1997 with the EC project VEINS (Variation of Exchanges in the Northern Seas) was a mooring array deployed across Fram Strait. This array has been maintained and has measured the exchanges ever since. Eberhard Fahrbach was closely involved in these studies, as a secretary for the GSP and as the major driving force behind the Fram Strait array. Here we shall examine the legacy of these projects; How our understanding of these themes has evolved in recent years. After the 1980s no convective bottom water renewal has been observed in the Greenland Sea, and the Greenland Sea deep waters have gradually been replaced by warmer, more saline deep water from the Arctic Ocean passing through Fram Strait. Small-scale convective events penetrating deeper than 2500m but there less dense than their surroundings were, however, observed in the early 2000s. The Fram Strait exchanges have proven difficult to estimate due to strong variability, high barotropic and baroclinic eddy activity and short lateral coherence scales. The fact that the mass transports through Fram Strait do not balance complicates the assessment of the heat transport through Fram Strait into the Arctic Ocean and mass (volume) and salt (freshwater) balances for the entire Arctic Ocean are needed. The waters exiting the Arctic Ocean through Fram Strait are colder than those entering and with reasonable assumptions about the origin of the waters providing the net outflow it is possible to deduce the amount of the entering oceanic heat going to the atmosphere (>50%), to ice melt (20%). Almost all of this heat loss occurs in the Nansen Basin. The rest of the heat is used for heating the net outflow. It also becomes clear that freshwater, with its phase changes and its multiple transport pathways, plays a crucial role in the climate, not just of the Arctic Ocean but of the Arctic as a whole.