

Reviewer 2:

We want to thank the reviewer for spending additional time on our text and for spotting additional errors.

Major Complaints

We have collected our response to the three major complaints raised by the reviewer: The organization of the manuscript, the neglect to put the manuscript in the context of other existing reviews, and the omission of indigenous people's knowledge, in a couple of paragraphs added at the end of section 1 the introduction. These paragraphs are attached below. The smaller errors have been corrected.

The present review intends to give a comprehensive picture of the Arctic Mediterranean Sea, describing the processes and the water mass transformations in the different parts of the area and how these parts are connected by the circulation of the different waters. The narrative follows two tracks. The first is historical and describes how our knowledge of the geography, the hydrography and the ocean circulation has evolved through time. This approach continues to about 1980 and encompasses the knowledge provided by early summaries of the circulation in the Nordic Seas (Helland-Hansen and Nansen, 1909), the connections between the North Atlantic and the Nordic Seas (Helland-Hansen, 1912; Nansen, 1912; Nansen, 1913) and the early knowledge of the water masses and circulation in the Arctic Ocean (Nansen, 1902; Nansen, 1906; Timofeyev, 1960; Coachman and Aagaard, 1974).

After this focus shifts, and the narrative follows the Atlantic water as it enters the Arctic Ocean through Fram Strait and over the Barents Sea, and how it becomes transformed by the processes within the Arctic Ocean, especially by interactions with sea ice and with the freshwater input from the continents and from the Pacific inflow. The Atlantic water is transformed into both less dense water (outflow) and denser water (overflow) within the Arctic

Ocean and additional overflow water is formed in the Greenland Sea. The transformed waters eventually return to the subpolar gyre and the North Atlantic.

The review is primarily based on observations and their interpretations. The figures shown thus display mainly temperature and salinity profiles and TS diagrams and vertical temperature and salinity sections. This to show what the interpretations and discussions are based upon. The only schematics are presented in the last figure (24).

There are many reviews addressing the Arctic Mediterranean Sea, the Nordic sea and the Arctic Ocean. Coachman and Aagaard (1974) give a foundational synthesis of Arctic and subarctic hydrography, circulation, exchange passages, and sea-ice conditions based on the observational knowledge available in the early 1970s. It establishes the Arctic Ocean as a strongly stratified, relatively isolated basin connected to the Pacific and Atlantic through a few narrow gateways. It describes the importance of Bering Strait inflow, the Atlantic inflow via the Nordic Seas and Fram Strait, and the freshwater and ice export to the North Atlantic.

An early modern synthesis of the physical oceanography of the Nordic (or GIN) sea is provided by Hopkins (1991). It is the major physical-oceanography review of the Greenland, Iceland, and Norwegian Seas for the 1970s to the mid-1980s. It describes the basin hydrography, fronts, gyre circulation, the Atlantic Water inflow, the Arctic-origin outflow, deep convection, and sea-ice distribution and explains how the Nordic Seas transform northward-flowing Atlantic waters through cooling, mixing, and densification.

A summary of the pre-IPY (International Polar Year) 2007-2009 knowledge of Arctic water masses and pathways is given in Rudels (2015). It explains the layered structure: the polar mixed layer, the halocline, the Atlantic Water, and deep and bottom waters, and highlights dense-water formation on shelves, boundary current circulation and exchanges with the Nordic Seas and Pacific.

The reviews most akin to the present one are written by Rudels (2012), Rudels (2019), Timmermans and Marshall (2020), and Rudels and Carmack (2022). Rudels (2019) gives a

concentrated description of the Arctic Ocean circulation and water mass transformations, while Rudels (2012) covers more of the history of Arctic research. Timmermans and Marshall (2020) describe the dynamically distinct Arctic circulation: wind forcing, buoyancy forcing, topographic steering, eddies, and boundary currents. They emphasize how freshwater storage, sea-ice loss, and changing Atlantic or Pacific inflows may reshape stratification and circulation. Rudels and Carmack (2022) discuss the Atlantic and Pacific inflow branches, halocline formation, shelf contributions, and deep-water renewal, and stresses the controlling role of ridges, shelves, and narrow gateways in partitioning water masses among the Arctic basins.

Bluhm et al. (2015) compare the Eurasian and Amerasian basins, including their water-mass structures, circulation, ventilation, and connectivity and show how the warmer, saltier Atlantic influence is more direct in the Eurasian Basin, while the Canada Basin is more strongly influenced by freshwater accumulation and Pacific-origin waters. The review also connects basin-scale physical contrasts to ecosystems and biogeochemistry.

Bacon et al. (2022) concentrates on the Arctic Ocean boundary exchanges and describes the observational estimates of volume, heat, freshwater, and property exchanges through the Arctic gateways. It covers Fram Strait and the Barents Sea Opening in particular, making it directly relevant to the Arctic ocean–Nordic Seas exchange. It emphasizes that gateway fluxes, surface forcing, and storage changes together control Arctic water-mass transformation.

We have perhaps treated sea ice processes and the observed changes in the ice cover rather cavalierly, and we here refer the reader to Meier et al. (2014), which is a broad review of observed losses in Arctic sea-ice extent, thickness, age, and multiyear-ice coverage. It attributes the shift to coupled atmospheric, oceanic, and ice-albedo feedbacks, with summer melt increasingly sensitive to preconditioning. It also discusses implications for Arctic communities, ecosystems, shipping, resource activity, and weather and climate connections

The book by Rudels (2021) contains much of the topics discussed in our review, but it is a textbook, not a review, and contains more detailed descriptions of the circulation and the

active processes than are necessary to include in a review article. The book by Mills (2009) provides a very readable account of the history of the ocean sciences.

This review is, admittedly, focused on Western science, as based on the scientific method, and gives little recognition to indigenous contributions to exploration and ecological knowledge. There are two main reasons for this. First, it is beyond the scope of this review, and the authors lack the necessary expertise to do this complex subject justice. Second, the focus of this review is on the circulation and transformations of waters in the deep and offshore Arctic Mediterranean, and thus remote from the Arctic coastal regions where indigenous peoples travel, hunt and live. Regardless, there is much to learn from indigenous thinking as our global society addresses an uncertain future (cf. Berkes and Joly, 2001; Ford et al, 2010; Falardeau et al., 2019a, b; Huntington, et al., 2021). Indigenous knowledge resides in the holder's authority and is experiential and holistic and place-based (Gearheard, S., et al., 2006; Whiteman and Cooper, 2011; Fienup-Riordan and Carmack, 2011). Indigenous knowledge is not a single, uniform body of information, but is learned, practiced, and transmitted differently among distinct Arctic Indigenous Peoples; for reviews, see Eerkes-Medrano and Huntington (2021). Despite the above distinctions, there are key areas where complementarity exists (cf. Carmack and Macdonald, 2008). Intimate connections and dependence of snow and ice conditions can provide an early-warning system for climate and ecological change; one clear example is in documenting local observations based intergenerational knowledge and travel/hunting practice as records of environmental change (Krupnik and Jolly, 2002; Carmack, 2021). That the two-ways of knowing are jointly beneficial was demonstrated by comparison of remote sensing of sea ice and Inuit observations (Meier et al., 2006). Fienup-Riordan and Carmack showed the complementarity of broad spatial records (wind-generated ocean swell) and fine-scale knowledge of ice quality and currents (safety of travel over ice in coastal locations). We emphasize that the depth, breadth and sophistication of Indigenous Knowledge of what is Arctic equals that of Western science, and future avenues based on appropriate co-generation of knowledge offer a rich field of inquiry.