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Evaluation of the Polar Code in different environments and for different maritime activities in the two polar regions

Meric KARAHALIL[1*] & Burcu OZSOY[1,2]

[1] Istanbul Technical University, Maritime Faculty, Tuzla, Istanbul, Turkey;
[2] Scientific and Technological Research Council of Turkey (TUBITAK MAM), Polar Research Institute (KARE), Gebze, Istanbul, Turkey

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Abstract Because of the decrease in sea ice coverage, maritime activities in the polar regions have increased steadily over the years and several issues related to maritime activities have arisen. It is essential to understand these challenges because they could have serious political, environmental, and economic consequences. Although there are significant geographical and legal differences and differences in the types of activities between the Arctic and the Antarctic, a single International Maritime Organization Polar Code covers both regions. In this analysis, changes in polar regions are introduced, and the differences between the Arctic and Antarctic are discussed. The differences in maritime activities in the two polar regions are then discussed, and the Polar Code is evaluated in terms of these differences.

Keywords **polar regions, sea ice, maritime activities, Polar Code**

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1 Changes and differences in polar regions

Satellite observations have shown that the Arctic sea ice extent (SIE) has diminished by about three percent per decade since 1979, and models indicate that it will continue to decrease (Cavalieri and Parkinson, 2012; Overland and Wang, 2013; Rogers et al., 2013; Notz and Stroeve, 2018). The thickness and fraction of multi-year ice have also decreased (Kwok, 2018; Onarheim et al., 2018). In the 2020 season, Arctic SIE had a maximum of 15.05×10^6 km^2 in March and a minimum of 3.74×10^6 km^2 in September, which are respectively 2.51×10^6 km^2 and 0.59×10^6 km^2 below the 1981–2010 average minimum and maximum extents (NSIDC, 2019a). September has experienced the greatest declines thus far. Because of this decreasing trend, the duration of the melt season is lengthening. September has received the most attention because it is the month with the lowest SIE.

However, Antarctic SIE trends differ. The Antarctic annual average SIE reached a record high of 12.8×10^6 km^2 in 2014 but this was followed by a sharp decline to the lowest value of 10.7×10^6 km^2 in 2017 (Parkinson, 2019). In the 2019 season, the Antarctic SIE had a minimum of 2.66×10^6 km^2 in February and a maximum of 18.24×10^6 km^2 in September. These are respectively 0.40×10^6 km^2 and 0.24×10^6 km^2 below the 1981–2010 average minimum and maximum extents (NSIDC, 2019b).

The clearest difference between the Northern Hemisphere and Southern Hemisphere relates to their geographical conditions (Spindler, 1990; Maksym et al., 2012; Vaughan et al., 2013; Kern et al., 2016; Menne et al., 2018; Maksym, 2019; Parkinson, 2019). Because the Arctic

* Corresponding author, ORCID: 0000-0001-6196-2770, E-mail: merickrhll@gmail.com

Ocean is surrounded by land, the sea ice may remain trapped within it for several years, whereas the opposite condition occurs in the Antarctic. In addition, sea ice thickness varies considerably in the two regions. While the typical sea ice thickness of the Arctic is above 2 m, Antarctic sea ice is typically below 2 m. A large part of the Arctic Ocean comprises multiyear ice, most of which occurs as pack ice. The Antarctic mainly comprises seasonal ice that freezes and melts within a season, and it remains in summer only in a few coastal regions.

2 Maritime activities in polar regions and Polar Code implementation

The decreasing sea ice presents opportunities for maritime activities, especially in the Arctic. Potential Arctic sea routes are a new phase for international maritime transportation that supplies financial and time savings linked to the shorter distance between East Asia and Western Europe voyages (MARSH, 2014). In addition, the exploration and exploitation of huge oil and gas resources and the expansion of icebreaker fleets and investments in ice-class ships have released new opportunities for international operators. Although the transit numbers currently remain few, the number of operations has been increasing in the Arctic waters. The Arctic waters could see a boost in traffic with growth in natural resource extraction. For instance, there is an increasing amount of oil and gas transport traffic in the Barents Sea, tourism traffic in Svalbard, and local fishing in Canada's northern waters (Marchenko et al., 2016; Borch, 2018). Shipping will continue to increase as ice coverage decreases (Stephenson et al., 2013). Conversely, maritime activities in the Antarctic region involve cruise, fishing, research, and re-supply ships. Antarctic tourism and fishing are the only commercial activities formally recognized by all Antarctic Treaty members. Ships are not distributed uniformly. The northwest part of the Antarctic Peninsula and the Ross Sea experience the most ship traffic of all types. The Antarctic and Southern Ocean Coalition (ASOC) have expressed their concerns that the increasing number of vessels raises several environmental and maritime safety issues in the region (ASOC, 2008).

The maritime activities represent a threat to the sensitive polar ecosystems and the vulnerable marine wildlife and habitats (Ahyong et al., 2020). Moreover, the harshness of the polar environment presents significant risks to vessels. Thus, to take advantage of the commercial benefits, the risks and hazards of extreme circumstances of the polar regions should be understood (Ghosh and Rubly, 2015). Most casualties are related to sea ice, such as ice floe hits, and ships becoming trapped by ice, which demonstrates the real danger posed by sea ice to shipping (Marchenko, 2013).

The International Maritime Organization (IMO) was formed to legalize safety and pollution prevention measures for shipping in polar regions, and the International Code for Ships Operating in Polar Waters (the Polar Code) came into force on 1 January 2017 (IMO, 2017). It covers the full range of design, construction, equipment, operational, training, search and rescue, and environmental protection matters relevant to ships operating in the ocean surrounding the two poles. After years of debates and the implementation of a set of safety guidelines for these regions, the Polar Code has been improved with some changes in the safety guidelines (Brigham, 2014; Jensen, 2016). In the frame of maritime safety, sources of hazards are stated in the Polar Code as ice, low temperature, periods of darkness and daylight, remoteness, lack of accurate and complete hydrographic data and information, and lack of crew experience (IMO, 2017).

There is only one mandatory Polar Code for both polar regions, for which the boundaries have been set as beyond 60 degrees south and north latitudes. The boundaries of the Polar Code are therefore geographically limited. Moreover, considering the maritime traffic and SIE, the Polar Code's application boundary might be modified, especially in the Arctic (Karahalil et al., 2020). Ice information is essential for the safety of polar navigation. Detailed voyage plans should include the sea ice conditions to identify when it is unsafe to enter areas in which ice or icebergs are present and indicate safe passing distances and safe speeds in these regions. It is therefore necessary to improve the risk assessment tools, for use in each region. Moreover, obligatory sharing of cryosphere and weather observations from ships sailing in polar regions might be useful. The lack of infrastructure, the lack of accurate charting, and the harshness of the environment make emergency response and Search and Rescue (SAR) operations significantly more difficult in the Arctic and Antarctica. The Agreement on Cooperation on Aeronautical and Maritime Search and Rescue in the Arctic has been established by the member states of the Arctic Council on 12 May 2011. Therefore, there is good coverage by Arctic Countries for SAR operations in the Arctic Ocean. However, in Antarctica, the Council of Managers of National Antarctic Programs (COMNAP) are still working on improving SAR coordination and response. The Polar Code also includes SAR measures, but these could be more comprehensive. In addition, the Polar Code is mandatory for certain ships under the International Convention for Safety of Life at Sea (SOLAS) and the International Convention for the Prevention of Pollution from Ships (MARPOL). Nevertheless, SOLAS does not apply to ships of war and troopships, cargo ships of less than 500 t (gross tonnage), pleasure yachts not engaged in trade, wooden ships of primitive build, and fishing vessels that are not currently covered by the safety provisions of the Polar Code. Moreover, pollution of sea ice in the Arctic can be considerable because of the higher population in the Arctic region and the more intense ship traffic. Conversely, Antarctic sea ice can still be considered pristine. There was already in place pollution prevention measures for the

Antarctic, yet the second part of the Polar Code fails to introduce new mandatory ones. For instance, raw sewage discharge should have been banned.

3 Conclusion

As SIE decreases, the increasing number of ships raises the risks of maritime casualties. SIE and thickness are important factors for navigation as sea ice may damage the vessel's hull, propeller, and rudder under significant force. It is vital to evaluate maritime casualties for each polar region to better understand and assess future risks because the new routes and strategic, economic and environmental interests will motivate increased maritime activities.

Significant differences have been observed between the polar regions, which should be considered for the development of the Polar Code. Our analysis points to the need for separate revision of the mandatory Polar Code for each polar region. It could also be extended to include sea ice concentrations of 1/10 coverage or greater. Because of the differences in geographic and geopolitical conditions between the two polar regions, SAR measures should be considered separately within the Polar Code. Moreover, the inclusion of specific provisions regarding pollution in the Code could have tailored existing requirements to the individual needs of each region. In addition, the IMO is expected to develop Polar Code Phase II, which will address safety measures on ships not certified under the SOLAS Convention. However, no restrictive or voluntary arrangements have yet been issued for non-SOLAS ships. The relevant regulations should be implemented without delay. In addition, it is essential to train seafarers regarding ice formations and characteristics. Polar navigation training should include knowledge of different types of sea ice, ice navigation, vessel maneuverability in sea ice, and issues relating to ship stability. Therefore, the Polar Code should be improved, especially in terms of manning and training standards.

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