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Articles

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Abstracts

IMO's Concept of Marine Protected Area: In the Quest for "Additional Values" of Particularly Sensitive Sea Areas

Yasuhiko KAGAMI

In order to secure global common values, such as conservation of the ecosystem and biodiversity in the oceans, one effective measure is to designate protected areas around environmentally sensitive areas and to regulate international shipping there.

However, under current international law, coastal states cannot regulate international shipping without restriction; its navigational measures are subject to the jurisdictional framework set out by the United Nations Convention on the Law of the Sea (UNCLOS) and "IMO Conventions" such as SOLAS Convention and MARPOL73/78 and so on concluded under the auspices of the International Maritime Organization (IMO). However, these conventions were signed before conservation of the ecosystem and biodiversity became global common values and maintain a distance from area based regulations such as designating protected areas.

With this background, since the 1990s, IMO, the only competent international organization in the maritime area under UNCLOS, has developed Particularly Sensitive Sea Areas (PSSA), a kind of Marine Protected Area (MPA) concept.

PSSA attracts coastal states dissatisfied with the existing measures and is considered an alternative to obtain international approval for extraordinary navigational measures not based on existing conventions. On the other hand, states that are cautious toward such measures that exceed the jurisdictional framework set out by the UNCLOS or IMO Conventions, criticize PSSA practices. This antagonism has affected the IMO's MPA concept.

In this paper, PSSA practices over the past 20 years are examined, the additional values of PSSA are verified, problems of this concept are highlighted and improvement plans are shown. Thus, the spotlight will fall on the role of the IMO, "the unsung hero of our time" in the area of marine environmental protection.

Who Governs the Arctic Ocean? - A Reply from an International Law Perspective -

Yoshinobu Takei

Ongoing sea ice melting and the potential for increased anthropogenic activities in the Arctic Ocean have given rise to considerable discussions on Arctic Ocean governance. This article

addresses the issue from the perspective of international law. It first analyzes the current structure and issues of Arctic Ocean governance. Then, it analyzes the legal framework for the Arctic Ocean, focusing on navigation, fisheries, exploration and exploitation of non-living resources and marine scientific research. It also analyzes the recent developments as they relate to the issue of Arctic Ocean governance. The article concludes with some comments on the future of Arctic Ocean governance.

Keywords : the Arctic Council; the Arctic Ocean; governance; international law; law of the sea

Geopolitics in Asia and Japan's Maritime Strategy

Tetsuo Kotani

There are three strategic lines of communication that bring threat to Japan: the Indian Ocean, the Pacific Ocean, and the Eurasian landmass. Thanks to its insular position and the lack of China's maritime ambition, Japan enjoyed security from foreign threat until the mid-19th century. Faced with the threat from the Western powers, Japan developed geostrategy for survival. The Anglo-Japanese alliance and the Washington Treaty were strategic success as they increased security by controlling two of the three strategic lines of communication. On the other hand, the Tripartite Pact was a fatal error as it failed to control one of the three. The Tripartite Pact forced Imperial Japan to develop a full-fledged navy, which only invited hostility from the global naval powers. The U.S.-Japan alliance is the most successful one as it controls all the three lines of communication. Due to the geopolitical constrain, Japan will not seek a full-fledged navy. Despite growing Chinese maritime ambitions, the U.S.-Japan alliance will continue to be the best tool for Japanese maritime strategy. But the JMSDF needs to play greater role to supplement the relative decline of the U.S. sea power.

Keywords : Japan's maritime strategy, sea lines of communications, the Anglo-Japanese alliance, the Washington Naval Treaty, the U.S.-Japan alliance

Exchange of water and heat at latitude 6° N in the Bay of Bengal

Kazuyuki Maiwa

The seasonal variations of the vertical structure of temperature, salinity and geostrophic velocity at latitude 6° N in the Bay of Bengal have been investigated, using the temperature and salinity data obtained from XBT/XCTD measurements from September 2000 to October 2005 by the

cruises of the M/T KATORI. The results of past studies were confirmed by this study, that the variation of the thermal structure clearly shows that Rossby waves propagate westward at the depth of about 100m with the semiannual signal originated from the equator and that the effects of the local Ekman pumping change the amplitude of the signal. The variation of the salinity corresponded qualitatively with the variation of the rainfall. The seasonal variations of the geostrophic velocity relative to the depth of 400m and the volume transport show the contribution of the Southwest Monsoon Current (SMC) and the East India Coast Current (EICC) to the water exchange between the interior and the exterior of the Bay. West of longitude 85° E, the SMC carries the water from the exterior to the Bay during summer and the EICC to the exterior during winter. Both net volume and heat transports calculated by the geostrophic velocity at 6° N take their maxima in May. It turns out that the generation of cyclones in the Bay is restricted in the following two periods; May and October to January. The periods are almost consistent with the months with the positive heat transport except for the summer monsoon season. In the future studies, prediction and means of prevention will be discussed of disasters in the coastal countries around the Bay of Bengal, being based on the findings of this work with much deeper understanding of the feature.

IMO's Concept of Marine Protected Area:

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Yasuhiko Kagami*

Abstract

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Key words: The United Nations Convention on the Law of the Sea (UNCLOS), The International Maritime Organization (IMO), Marune Ecosystem, Marine Protected Area (MPA), Particularly Sensitive Sea Area (PSSA)

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Who Governs the Arctic Ocean?

- A Reply from an International Law Perspective -

Yoshinobu Takei [1]*

Abstract

Ongoing sea ice melting and the potential for increased anthropogenic activities in the Arctic Ocean have given rise to considerable discussions on Arctic Ocean governance. This article addresses the issue from the perspective of international law. It first analyzes the current structure and issues of Arctic Ocean governance. Then, it analyzes the legal framework for the Arctic Ocean, focusing on navigation, fisheries, exploration and exploitation of non-living resources and marine scientific research. It also analyzes the recent developments as they relate to the issue of Arctic Ocean governance. The article concludes with some comments on the future of Arctic Ocean governance.

Key words: the Arctic Council; the Arctic Ocean; governance; international law; law of the sea

1. Introduction

"Who Owns the Arctic?" – with this catchy title, Michael Byers, a renowned scholar of international law and politics, discussed sovereignty disputes in the Arctic and related issues in a book published in 2009.[2] In fact, potential conflicts relating to the Arctic have caught media's attention especially after Russia planted its flag on the North Pole;[3] the melting of sea ice in the Arctic Ocean has attracted increasing interests in enhanced anthropogenic activities in the Arctic Ocean, such as new navigational routes, untapped oil and gas fields, and increased fisheries and research activities. For example, the Arctic Marine Shipping Assessment (AMSA) predicts a potential for commercial navigation through three routes (the Northern Sea Route (NSR), the Northwest Passage and the trans-polar route) in the Arctic Ocean.[4] At the same time, concerns have been raised over the impacts to indigenous peoples living there and to the marine environment caused by, *inter alia*, the increased anthropogenic activities therein.

This article aims to consider issues relating to Arctic Ocean governance from the perspective of international law.[5] Put simply, the research question this article addresses is: "who governs the Arctic Ocean?" As the difference between the terms "own" and "govern" suggests, the article does not focus on the territorial and maritime boundary disputes; it rather focuses on the allocation of regulatory authority for particular activities and its interactions with discussions on the overall governance.

The article first considers how Arctic Ocean governance is currently pursued and

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what issues are relevant (Section 2). Following an overview of the existing governance structure for the Arctic Ocean, it discusses issues that are subject to intensive debates. Then, the article provides an overview of the legal framework applicable to the Arctic Ocean (Section 3). First, it describes the basic principles under the United Nations Convention on the Law of the Sea (LOSC),[6] including the allocation of jurisdiction in the oceans and seas, and other relevant principles of the law of the sea. It also briefly touches upon the boundary disputes among Arctic coastal states and possible methods of solution for these disputes. Second, it introduces the legal framework governing activities such as navigation, fisheries, exploration and exploitation of non-living resources and marine scientific research (MSR). On the basis of the analysis in the foregoing sections, it examines the recent and ongoing developments relating to the Arctic Ocean, in particular with a view to understanding trends in the shaping of the governance regime for the Arctic Ocean (Section 4). This article is concluded with some suggestions for future Arctic Ocean governance on the basis of the foregoing analyses (Section 5).

2. Arctic Ocean Governance

2-1 The Current Structure

Activities in the Arctic Ocean are governed by a complex mixture of international law and domestic legislation together with various kinds of institutions, involving diverse participants. The current state of Arctic Ocean governance may be viewed in the light of the following three elements: legal and policy instruments; international institutions; participants in governance.

Regarding legal and policy instruments, first and foremost, it is widely claimed that the Arctic Ocean is subject to the rules of the international law of the sea, as reflected in the LOSC, as other oceans and seas, despite the severe climate conditions and the existence of ice for most of the year. This proposition has been supported by the coastal states of the Arctic Ocean[7] and other states.[8] The LOSC, a Constitution for the Oceans, is the principal pillar of the legal regime governing activities in this region.[9]

In addition to the LOSC, there are a number of treaties, binding and non-binding instruments adopted at international organizations and domestic laws, regulations and policies that may have a bearing on Arctic Ocean governance. Among others, the Convention on Biological Diversity (CBD)[10] and the International Maritime Organization (IMO) instruments are significant in biodiversity conservation and navigation regulation, respectively.

In terms of institutions, there are inter-governmental institutions that may play a role in Arctic Ocean governance, including multilateral and bilateral inter-governmental organizations such as the North East Atlantic Fisheries Commission (NEAFC), the OSPAR Commission and the Russian-Norwegian Fisheries Commission, informal inter-governmental institutions without a formal organizational structure such as the Arctic Council, and *ad hoc* gatherings such as the conferences of Arctic coastal states at Ilulissat, Greenland, and Chelsea, Canada, in 2008 and 2010, respectively.

The Arctic Council was established by the eight Arctic states through the 1996 Ottawa Declaration.[11] It is the successor of the Arctic

Environmental Protection strategy (AEPS),[12] but its area of competence was expanded to include both environmental protection and sustainable development. Military security is explicitly excluded from the area of competence of the Arctic Council in the Ottawa Declaration. It does not take the form of an international organization; it does not have a permanent secretariat.[13] It rather intends to be a "high level forum", *inter alia*, to provide a means for promoting cooperation, coordination and interaction among the Arctic States, with the involvement of the Arctic indigenous communities and other Arctic inhabitants on common arctic issues, in particular issues of sustainable development and environmental protection in the Arctic. It has eight Arctic countries as members and indigenous peoples as permanent participants, as well as permanent and *ad hoc* observers.

Although the Arctic Council is a body dealing with the Arctic issues extensively, this does not mean other institutions are irrelevant.[14] Rather, international organizations such as the IMO and regional fisheries management organizations (RFMOs) and arrangements have the competence to regulate certain activities in the Arctic Ocean. Furthermore, international scientific organizations operating in the Arctic (e.g., the International Arctic Science Committee (IASC)) have contributed to the work of the Arctic Council and other works related to the Arctic Ocean. Technical organizations such as the International Association of Classification Societies (IACS) also play an important role as a source of reference in the technical knowledge aspect. The Conference of Parliamentarians of the Arctic Region, a parliamentary body comprising delegations appointed by the national parliaments of the Arctic states (eight Arctic states and the European Parliament), with the participation of Permanent Participants representing indigenous peoples, has also been involved in the discussion of Arctic governance through policy proposals.[15]

Potential participants in Arctic Ocean governance include Arctic coastal states, other Arctic states, non-Arctic states, international organizations and indigenous peoples. As elaborated in the next section, coastal and non-coastal states have different rights and obligations. International organizations and other, informal institutions have differing competences in accordance with their constitutive instruments.

An important characteristic of Arctic governance is the involvement of indigenous peoples. Under international law, certain categories of interests of indigenous peoples are recognized, but they are often implemented by sovereign states in their domestic legislation; indigenous peoples themselves do not possess the capacity to conclude treaties with states, nor do they acquire rights or assume obligations with effects in international law.[16] Under the domestic legal system of some countries like Canada, they are entitled to special legal claims domestically and may participate in decision-making. In the case of Greenland, the people of Greenland is recognized as a people in international law with the right of self-determination and in fact has been transferred competence from the Kingdom of Denmark in certain areas.[17] In the Arctic Council, where as stated below decision-shaping is pursued with the participation of all members and permanent participants, indigenous peoples' role is more significant than that in other

regions.[18]

2-2 Issues

There have been recurrent arguments that there should be a new comprehensive regime established for the Arctic Ocean.[19] These proposals are often modelled on the Antarctic Treaty System (ATS).[20]

The initiative to establish a comprehensive regime for the Arctic, however, has remained unsuccessful so far. This is partly because it has a geographic configuration quite different from that of Antarctica: Antarctica is a continent, remote from other continents and there are a handful of islands surrounding the Antarctic continent; the Arctic Ocean is a sea surrounded by the territories of five coastal states.[21]

Whereas the Antarctic Treaty sets out the basic principles of Antarctic governance, there is already a rather firmly established framework for the Arctic Ocean based on the law of the sea. One big difference from the Antarctic is that the Arctic hardly suffers overlapping territorial claims and it is hardly disputed that coastal states are entitled to maritime zones in the Arctic as provided for in the LOSC. If a new set of basic principles are established for the Arctic Ocean by virtue of an international instrument, whether binding or non-binding, it needs to justify a special treatment of the Arctic Ocean, excluding or substantially curtailing the application of the law of the sea. It is highly unlikely that this difficult task is performed with legitimacy in the international community.[22]

A separate yet related question is whether there should be a new approach to governing the Arctic Ocean, such as the integrated management of the Arctic Ocean or an ecosystem-based management, instead of the existing sectoral management systems. One area which certainly warrants the merits of the integrated nature of ocean management would be the protection of the marine environment and biodiversity from cumulative impacts arising out of activities such as navigation, fisheries and hydrocarbon resource development.

In addition, the presence of indigenous peoples is a factor which may suggest the need for a new approach to the management of the Arctic. In fact, the Arctic Council recognizes the involvement of the groups of indigenous peoples in its work. However, this does not in itself warrant a plea for the establishment of a new regime; instead, this may be a consideration in better implementing the existing regime.

Overall, the difference in geographical configuration and the existence of a legal framework based on the law of the sea render it unnecessary and unfeasible to consider establishing a totally new regime for the Arctic Ocean. But a need for the coordination of activities by different actors may be an element that should be taken into consideration in Arctic Ocean governance.

3. The Legal Framework for the Arctic Ocean

The LOSC provides a legal framework for all activities in the oceans and seas. Most of its provisions are relevant to the Arctic Ocean.[23] The coastal states have sovereignty over the territorial sea up to 12 nautical miles (NM) and internal waters landward of baselines. Seaward of the territorial sea, they may exercise jurisdiction over a certain category of activities in the contiguous zone (up to 24 NM from the

baselines), the EEZ (up to 200 NM from the baselines) and the continental shelf (up to 200 NM from the baselines or to the outer edge of the continental margin throughout the natural prolongation of the land territory, whichever more distant). The LOSC provides for the rights and obligations of states in each of the zones. Part XII of the LOSC provides for the protection of the marine environment in different maritime zones, including the provision of Article 197 on cooperation on a regional or global basis.

Some of the provisions may be limited in their application to the Arctic Ocean and a handful of other specific seas. First, the provisions concerning enclosed and semi-enclosed seas are applicable to the Arctic Ocean if this Ocean is recognized as a semi-enclosed sea.[24] They require cooperation among coastal states in the field of the exploration and exploitation of marine living resources, the protection and preservation of the marine environment, and scientific research policies.[25] Second, since some parts of the region concerned are ice-covered for most of the year, Article 234 concerning ice-covered areas may be applicable. Coastal states may exercise legislative and enforcement jurisdiction relating to pollution over areas within the limits of the EEZ in accordance with that article.[26]

There are a number of areas currently in dispute between the coastal states of the Arctic.[27] Furthermore, while sea-ice melting renders new areas of the Arctic Ocean susceptible to activities such as resource development, the possible areas of the continental shelf beyond 200 NM (hereinafter "outer continental shelf") still await delimitation among Arctic coastal states. There is no indication within the LOSC that the method of delimitation in the Arctic Ocean is any different from that used in other areas. In other words, delimitation shall be done in accordance with Articles 15, 74 and 83 of the LOSC. In practice, however, while some existing boundaries base themselves on the equidistance line,[28] existing or proposed boundaries in other areas are along the meridian lines.[29] The Russian claim to the outer continental shelf in the Arctic Ocean might suggest its intention to conclude delimitation agreements regarding the outer continental shelf with its neighbours along the meridian line, using the so-called sector principle.[30] If two states use the sector principle in the context of their outer continental shelf delimitation, it is not surprising if others follow, which might in turn influence the delimitation of the territorial sea and the EEZ in other regions.

Apart from the substantive rules mentioned above, the LOSC provides for the settlement of disputes, including compulsory dispute settlement procedures. However, certain categories of disputes specified in Article 297 are automatically made outside the scope of compulsory procedures entailing binding decisions. Cases involving military activities and disputes concerning maritime boundary delimitation may be optionally excluded from the compulsory dispute settlement procedures entailing binding decisions under Article 298.[31] All four parties to the LOSC among Arctic coastal states (i.e., Canada, Denmark, Norway and Russia) have declared not to accept an arbitral tribunal to be constituted in accordance with Annex VII of the LOSC for any category of the disputes specified in Article 298(1).[32] As neither Article 76 nor Article 121 is referred to in Article 298(1)(a), tribunals or

courts may have jurisdiction to entertain the cases relating to the delineation of the boundary between the continental shelf and the Area[33] but, in contentious cases, the question of *locus standi* would arise.[34] Apart from the LOSC, Canada, Denmark and Norway have declared their acceptance of compulsory jurisdiction of the International Court of Justice (ICJ) under Article 36(2) of its Statute.[35]

Besides the LOSC, there are a number of rules of international law in various fields that are applicable to the Arctic Ocean. The following sub-sections analyze the legal framework in the LOSC and other instruments for activities in four sectors which are expected to increase in the Arctic Ocean in the near future.[36]

3-1 Navigation

Under the LOSC, navigation is regulated in accordance with the classification of maritime zones. In internal waters, coastal states have wide discretion to control entrance of foreign ships.[37] In the territorial sea, while ships of all states enjoy the right of innocent passage, the coastal states concerned have jurisdiction to adopt laws and regulations concerning innocent passage.[38] Such laws and regulations are not applicable to the design, construction, manning or equipment of foreign ships unless they are giving effect to generally accepted international rules and standards (GAIRS).[39] If a strait is used for international navigation, ships enjoy the right of transit passage.[40] Beyond the territorial sea (i.e., in the EEZ and on the high seas), all ships enjoy the freedom of navigation.[41] Flag states shall effectively exercise jurisdiction and control over their ships in administrative, technical and social matters.[42] In so doing, they shall adopt measures necessary to ensure safety at sea, conforming to generally accepted international regulations, procedures and practices.[43] Regarding pollution from ships, flag states shall adopt laws and regulations for the prevention, reduction and control of pollution of the marine environment from their ships, at least having the same effect as that of generally accepted international rules and standards.[44] In areas under national jurisdiction, coastal states have legislative and enforcement jurisdiction over pollution from ships.[45] In particular, for the EEZ, coastal states may adopt laws and regulations concerning vessel-source pollution conforming to and giving effect to GAIRS, while enforcement jurisdiction is much limited in the EEZ compared with the territorial sea.[46]

Under the LOSC, the competent international organization (generally understood to mean the IMO) is expected to be a venue for establishing GAIRS regarding pollution from ships.[47] Key instruments developed through the IMO include the SOLAS Convention,[48] the MARPOL Convention[49] and the STCW Convention.[50]

In addition to the above-mentioned regulatory frameworks applicable globally, a need for special, stricter regulation specific to the Polar Regions, especially the Arctic Ocean, is widely recognized. For this reason, the IMO developed the guidelines for ships operating in Arctic ice-covered waters in 2002.[51] As discussed later, these guidelines were updated and extended to polar waters in 2009 and an initiative to develop a mandatory polar code was launched at the IMO.

Furthermore, the LOSC specifically provides that coastal states may adopt and enforce

laws and regulations to prevent, reduce and control marine pollution "within the limits of the [EEZ]" in ice-covered areas.[52] The geographical scope of this latter competence is not free from controversy: some argue that this is limited to the EEZ, thus excluding the territorial sea;[53] others argue that coastal states may take measures in the EEZ, the territorial sea and internal waters in accordance with Article 234.[54] Furthermore, even if agreement exists on the applicability of Article 234 to maritime areas landward of the EEZ, the relationship between Article 234 and Part III (on straits used for international navigation) of the LOSC is not clear. Commentators differ in their interpretations on whether the special competence of coastal states in ice-covered areas under Article 234 prevails over the right of transit passage in straits used for international navigation.[55] In addition, an issue would be whether coastal states may adopt laws and regulations in respect of issues other than marine environmental protection on the basis of this article.[56] Canada and Russia have adopted national legislation implementing Article 234, which will be discussed in the following paragraphs.[57]

On the one hand, Canada enacted the Canada Arctic Waters Pollution Prevention Act (AWPPA): in areas enclosed in the Act (i.e., internal waters, territorial sea and EEZ), it regulates shipping in accordance with the Act. When the Act was first enacted in 1970,[58] it generated protests from other states, but as the LOSC provides for the legislative and enforcement jurisdiction of coastal states in ice-covered areas within the limits of the EEZ in Article 234, the Act is considered to be in accordance with international law now, at least among parties to the LOSC.[59] Canada purports that the discharge standards provided by MARPOL 73/78 do not apply in its Arctic waters and the higher standards provided by the AWPPA instead apply.[60]

On the other hand, Russia argues that straits of the NSR are internal waters and it has the right to deny or control navigation of other states' ships there.[61] In fact, the 1998 Federal Act on the internal maritime waters, territorial sea and contiguous zone of the Russian Federation, in Article 14, describes the NSR as "including the Vilkitsky, Shokalshy, Dmitry Laptev and Sannikov straits", and all straits included here are enclosed within the internal waters by straight baselines.[62]

The USSR enacted a series of regulations on the NSR passage. The geographic scope of the regulation is vague, defined as "Northern Sea Route and adjacent areas" by Article 3 of the Edict of the Presidium of the U.S.S.R. Supreme Soviet of 26 November 1984 "On Intensifying Nature Protection in Areas of the Extreme North and Marine Areas Adjacent to the Northern Coast of the USSR" implemented by the Decree of 1 June 1990.[63] Some commentators have claimed that this definition would subject those areas of the high seas within the NSR to Russian coastal state jurisdiction and this would not be consistent with the LOSC.[64] In fact, some potential routes for the NSR pass through the high seas in part, although a considerable portion of such routes are within the EEZ.[65] Nevertheless, Russia has indicated that its NSR regulations apply within the limits of the EEZ.[66]

The 1990 Regulations provide for requirements to be satisfied by the vessels intending to use the NSR, including the

compulsory icebreaker-assisted pilotage in certain straits.[67] A possible area of controversy is the fact that higher fees for services are charged on foreign ships.[68]

Section 2 of the 1990 Regulations explains the rationale behind the regulation of navigation in the NSR. The phrases used in this section are substantially overlapping with Article 234 of the LOSC. In fact, a commentator interprets that Article 234 has been indicated by the USSR and Russia to be the basis of its domestic Arctic legislation.[69] A question would be whether or not the rules embodied in the regulations would be still valid after the sea ice conditions no longer meet the criteria of Article 234.

It is worth considering whether the national regulations for navigation of the Arctic waters are in line with the IMO Guidelines.[70] On the one hand, if Article 234 is not applicable to international straits and the Northwest Passage and/or the NSR are considered international straits, the coastal state may not impose additional requirements more stringent than the generally accepted international regulations, procedures and practices.[71] Then, Canadian and Russian regulations should be scrutinized in the light of the IMO Guidelines. On the other hand, if Article 234 is applicable to Arctic straits used for international navigation, the issue centres on how and to what extent national legislation can deviate from GAIRS. A commentator notes that "[…] special laws to be adopted by coastal States in accordance with Article 234 should neither contradict nor overlap with shipping rules and standards contained in SOLAS and MARPOL and other relevant IMO instruments".[72] In either case, however, Arctic coastal states may be able to use the IMO as a forum to legitimize their unilateral action as being in accordance with international law if they succeed in forming a united front by all five Arctic coastal states in future IMO discussions.

Apart from the above, navigational regulation may be put in place through the IMO for a particular region or part of it. Such mechanisms include: routeing systems (e.g., areas to be avoided) under the SOLAS Convention, special areas and emission control areas under the MARPOL Convention and the Particularly Sensitive Sea Area (PSSA). Under the SOLAS Convention, the IMO is "recognized as the only international body for developing guidelines, criteria and regulations on an international level for ships' routeing systems".[73] Under the MARPOL Convention, certain areas can be designated as special areas under Annexes I, II and V, in which the adoption of special mandatory methods for the prevention of sea pollution is required; similarly, certain areas can be designated as emission control areas where more stringent controls on SOx and/or NOx emissions are imposed.[74] In addition, on the request of a member state, the IMO may designate as a PSSA an area that needs special protection through action by the IMO because of their significance for recognized ecological or socio-economic or scientific reasons and which may be vulnerable to damage by international maritime activities.[75] So far, eleven areas have been designated as PSSAs.[76] If an area is approved as a PSSA, associated protective measures (APMs) can be taken to control the maritime activities in that area.[77] The Arctic Ocean has not yet been designated as an area to be avoided under the SOLAS Convention, a special area under the

MARPOL Convention or a PSSA.[78]

3-2 Fisheries

By virtue of sovereignty, coastal states may control fisheries within internal waters and the territorial sea. In the EEZ, coastal states have sovereign rights for living resources: they shall determine the total allowable catch (TAC) and, if the TAC is not exhausted by their own vessels, allocate surplus to other states.[79] For species shared among two or more coastal states, these coastal states shall cooperate.[80] For example, there is a potential for a shared stock (or stocks) in the EEZ of Canada, the Russian Federation and the United States in the Chukchi and Beaufort Seas in the sense of Article 63(1) of the LOSC.

On the continental shelf, coastal states have sovereign rights for the exploration and exploitation of sedentary species; they are entitled to determine how much to catch and whether or not to allocate surplus to foreign countries.[81]

On the high seas, all states have the right for their nationals to engage in fishing whereas high seas fishing states are obliged to take conservation and management measures and cooperate with other states.[82] If a stock straddles the high seas and the EEZ, high seas fishing states and a coastal state(s) shall cooperate.[83] For tuna and other highly migratory species listed in Annex I of the LOSC, coastal states in their migratory range and high seas fishing states shall cooperate.[84] The manner in which the provisions of the LOSC concerning straddling stocks and highly migratory fish stocks are implemented is given effect to by the provisions of the 1995 UN Fish Stocks Agreement,[85] the FAO Compliance Agreement[86] as well as RFMOs and arrangements.

In the Greenland, Norwegian and Barents Seas, two areas are beyond the jurisdiction of coastal States, i.e., the so-called Loophole in the Barents Sea and the so-called Banana Hole in the Norwegian Sea while other areas are subject to coastal State jurisdiction.[87] NEAFC is competent to regulate fisheries in the high seas part of the North Atlantic, including the Loophole and the Banana Hole. In practice, however, conservation and management measures of NEAFC are limited. In the Banana Hole, measures for spring spawning herring populations, which straddle between the high seas part and the coastal State maritime zones, are adopted by NEAFC only after the coastal States conclude an agreement to this end. In the Loophole, the two coastal States (Norway and Russia) largely control fisheries in the high seas part through allowing access to their EEZ fisheries, including the trilateral Agreement between Iceland, Norway and Russia and its bilateral protocols.[88]

Northward of the EEZ of the coastal States of the Arctic, there is a high seas area in the Central Arctic Ocean. On the Atlantic side, there are several fisheries regimes applicable to the Arctic. The text of the NEAFC Convention indicates that NEAFC is competent to regulate high seas fisheries in the Arctic Ocean between 42 W and 51 E.[89]

For anadromous stocks and catadromous species, LOSC provisions provide for the role of the state of origin and other states.[90] As for salmon, there is a specific multilateral regulatory regime called the North Atlantic Salmon Conservation Organization (NASCO), which covers the North Atlantic, arguably, including that part of the Central Arctic.

3-3 Non-living Resources

Coastal states have sovereignty/sovereign

rights to regulate the development of mineral and other non-living resources in internal waters, the territorial sea and the EEZ as well as on the continental shelf.[91] While all states enjoy the freedom of the high seas,[92] the International Seabed Authority regulates mineral resource development in the Area (i.e., beyond the outer limit of the continental shelf of any state).[93] The provisions of Part XII of the LOSC on protection and preservation of the marine environment include general provisions as well as specific provisions applicable to seabed activities.[94]

Apart from the regulation by national legislation, relevant global agreements such as the MARPOL Convention and the SOLAS Convention as well as bilateral and regional agreements are applicable.[95] The Arctic Council adopted the Arctic Offshore Oil and Gas Guidelines, last updated in April 2009. These guidelines are intended to be of use for offshore oil and gas activities during planning, exploration, development, production and decommissioning.[96]

3-4 Marine Scientific Research

The LOSC stipulates the right and obligation of coastal states and other states with respect to MSR in different maritime zones.[97] Whereas coastal states have the exclusive right to regulate MSR and hydrographic survey in internal waters and the territorial sea, they have the right to regulate MSR in the EEZ and on the continental shelf in accordance with the provisions of Article 246 of the LOSC. On the outer continental shelf, coastal states' discretionary power is further restricted.[98] On the high seas, all states enjoy the freedom of scientific research in accordance with Article 87. In the Area, all states and competent international organizations have the right to conduct MSR.[99]

While nothing indicates that the MSR regime contained in the LOSC is not applicable to the Arctic, there are uncertainties deriving from the complications specific to the Arctic Ocean, including the presence of sea ice (e.g., the legal status of research stations built on floating ice islands) and the application of the Treaty of Spitsbergen (e.g., Norway's competence to regulate MSR in maritime areas surrounding the Spitsbergen Archipelago).[100]

4. Recent and Ongoing Developments

There are several important recent developments and ongoing discussions that may shape the future of Arctic Ocean governance. These are as follows: the Search and Rescue Agreement and other developments within the Arctic Council, development of a mandatory polar code at the IMO, and fisheries management initiatives.

4-1 The Search and Rescue Agreement

As maritime navigation in the Arctic increases in the near future, there is an enhanced need for search and rescue (SAR) operations. The following paragraphs consider international legal rules concerning maritime search and rescue as well as recent developments in this field as they relate to the Arctic Ocean.

Under the LOSC, every coastal state shall promote the establishment, operation and maintenance of an adequate and effective SAR service and, where circumstances so require, by way of mutual regional arrangements cooperate with neighbouring states for this pur-

pose.[101]

In parallel with the Third United Nations Conference on Law of the Sea (UNCLOS III), the International Convention on Maritime Search and Rescue (SAR Convention) was adopted in 1979.[102] The Convention establishes an international system covering SAR operations, aimed at developing an international SAR plan so that the rescue of persons in distress at sea will be co-ordinated by a SAR organization and, when necessary, by cooperation between neighbouring SAR organizations. Parties are encouraged to enter into SAR agreements with neighbouring states involving the establishment of SAR regions, the pooling of facilities, establishment of common procedures, training and liaison visits. The Convention states that parties should take measures to expedite entry into its territorial waters of rescue units from other parties. Following the adoption of the Convention in 1979, the IMO Maritime Safety Committee divided the world's oceans into 13 search and rescue areas, in each of which the countries concerned have delimited search and rescue regions for which they are responsible. Parties accept responsibility for providing SAR services for a specific area.[103]

There were two search and rescue agreements in the Arctic: trilateral agreement among Russia, Canada and the United States; bilateral agreement between Norway and Russia for the Barents Sea.[104] Russia, Finland and Norway also signed a cooperation agreement about sea rescue and rescue operations in Murmansk, Lapland and the four most northerly counties in Norway.[105]

However, there was no framework agreement on search and rescue operations covering the entire Arctic Ocean. The need for such an agreement had been recognized by the Arctic coastal states as well as the Arctic Council.[106] At the ministerial meeting of the Arctic Council in Tromsø in 2009, ministers approved the establishment of a task force to develop and complete negotiation by the next Ministerial Meeting in 2011 of an international instrument on cooperation on search and rescue operations in the Arctic.[107]

During the five meetings of the task force, co-chaired by Russia and the United States, the eight Arctic states negotiated the agreement and the text was finalized at the Reykjavik meeting in December 2010. The Agreement was signed at the Ministerial Meeting held in Nuuk, Greenland, in May 2011.

The Agreement contains some important features. First, the Agreement divides the Arctic into several areas with a view to entrusting the *eight* Arctic states, rather than five coastal states, with the responsibility to conduct search and rescue operations in each of the areas. It is useful to see how the Arctic Ocean is divided therein although the Agreement explicitly states that the delimitation of SAR regions shall not prejudice the delimitation of any boundary between states or their sovereignty, sovereign rights or jurisdiction.[108]

Second, the Agreement stipulates procedures for request to enter the territory of another party for purposes of SAR operations.[109] An example for allowing other states' entry already exists in national legislation. For example, the 1998 Federal Act of the Russian Federation on internal maritime waters, territorial sea and contiguous zones in Article 16(2) provides for the permission of the entry into the territorial sea and internal waters by for-

eign ships for the purpose of searching for and rescuing persons in accordance with its legislation and treaties to which it is a party. Although the Arctic SAR Agreement does not explicitly oblige a requested party to permit entry, the 1979 SAR Convention provides that, unless otherwise agreed between the states concerned, a party should authorize immediate entry into or over its territorial sea or territory of rescue units of other parties for SAR operations.[110]

Apart from the content of the Agreement, it has three far-reaching implications for the Arctic Ocean governance in general. First, the Agreement is the first legally-binding instrument negotiated under the auspices of the Arctic Council. This is why discussions took place at the Senior Arctic Official (SAO) meeting in November 2009 whether to invite observers. Some SAOs stated that many countries both in Europe and other continents have interests and presence (for example research and shipping) in the Arctic and that perhaps the Arctic Council should not exclude parties that have legitimate interests from observing the Task Force. Other SAOs expressed doubts on the presence of observers at the intergovernmental negotiations between member states that would actually take place in the Task Force.[111]

In the end, the issue of observer presence was instructed to be decided at the first Task Force meeting. However, this does not eliminate future controversies. First, it remains to be seen whether and to what extent non-Arctic states would be involved in the future treaty-making under the auspices of the Arctic Council, especially on issues not limited to the interest of the Arctic states. Second, another question would be whether (and to what extent) to allow the involvement of indigenous peoples in treaty-making since the resultant agreement would eventually be concluded among governments.

Second, the Agreement is the first legally-binding instrument negotiated among the eight Arctic states.[112] In fact, the Agreement appears to allow only these eight states to become party to the Agreement.[113] This may not be satisfactory for non-Arctic states because, as noted in discussions on observers, non-Arctic states also have interests in SAR in the Arctic by virtue of their involvement in shipping and scientific activities. For example, the EU has suggested its willingness to contribute, through member states and the European Commission, to search and rescue operations in the Arctic.[114] The Arctic SAR Agreement stipulates that any party may seek cooperation with non-party states that may be able to contribute to the conduct of SAR operations.[115] It remains to be seen whether this provision will be implemented in a manner that satisfies other interested states.

Third, the adoption of the Agreement is part of the strengthening of the Arctic Council, as suggested by the Nuuk Ministerial Declaration.[116]

4-2 Other Developments within the Arctic Council

The Nuuk Ministerial Declaration decided to establish a task force to negotiate a new international instrument on marine pollution preparedness and response.[117] The negotiations will most likely be conducted with a view to developing an international agreement on a regional basis under Article 10 of the Interna-

tional Convention on Oil Pollution Preparedness, Response and Co-operation (OPRC).[118] It is not clear from the text of the Ministerial Declaration whether the resultant instrument will be a legally-binding instrument; but in any case such an option is not excluded. In fact, negotiations for the Arctic SAR Agreement were also started with the task of developing "an international instrument" as noted above.

In addition, the Nuuk Declaration decided that the permanent secretariat of the Arctic Council would be established in Tromsø by the beginning of the Canadian Chairmanship in 2013.[119]

These developments, together with other policy-related decisions within the Arctic Council, highlight the mainstreaming of the Arctic Council in policy discussions. This may be worrying for certain non-Arctic states because, as noted earlier, the Arctic Council is a body composed of eight member states from the Arctic and other states are only entitled to become observer.

In view of this strengthened role of the Arctic Council, the interest of other states to participate in the work of the Arctic Council as observer will undoubtedly increase in the future. The interest to become observer has been expressed by, *inter alia*, China, Japan, Republic of Korea and the European Union.

At the Nuuk Ministerial Meeting, the Arctic Council adopted "the criteria for admitting observers and role for their participation in the Arctic Council".[120] The criteria for admitting observers include the extent to which observers:

- Accept and support the objectives of the Arctic Council defined in the Ottawa declaration.
- Recognize Arctic States' sovereignty, sovereign rights and jurisdiction in the Arctic.
- Recognize that an extensive legal framework applies to the Arctic Ocean including, notably, the Law of the Sea, and that this framework provides a solid foundation for responsible management of this ocean.

[…]

- Have demonstrated their Arctic interests and expertise relevant to the work of the Arctic Council.
- Have demonstrated a concrete interest and ability to support the work of the Arctic Council, including through partnerships with member states and Permanent Participants bringing Arctic concerns to global decision making bodies.

These would virtually require potential candidates to recognize the *status quo* of Arctic Ocean governance through the Arctic Council, including the existing legal framework under the LOSC. The criteria would be discouraging to a call for a new comprehensive regime for the Arctic Ocean.

4-3 Development of a Polar Code at the IMO

As noted earlier, the IMO adopted the Guidelines specific to the Arctic Ocean in 2002. Since its 50th session in March 2007, the Sub-Committee on Ship Design and Equipment (DE Sub-Committee) worked on updating and revising them to be applicable also to the Antarctic.[121] IMO Assembly adopted the new Guidelines for ships operating in Polar waters in 2009.[122] The Guidelines provide for,

among others, construction, equipment, operational matters and environmental protection.

In relation to the Arctic, the Guidelines apply to the area as defined in section G-3.3, whose border is in many parts along 60°N but varies from 58°N to 67°03'9N in some areas. As far as the Arctic is concerned, they provide guidance for ships while engaged in international voyages in Arctic waters, the term "international voyages" in turn being defined in section G-3.14 as voyages in international waters, as defined in chapter I of the SOLAS Convention as amended, that is: "a voyage from a country to which the present Convention applies to a port outside such country, or conversely".[123] The Guidelines are not applicable to any warship, naval auxiliary, other vessels or aircraft owned or operated by a state and used, for the time being, only on government non-commercial service.[124]

One major difference from the 2002 Guidelines with respect to the Arctic is the expansion of scope from Arctic *ice-covered* waters to Arctic waters. The term "Ice-covered waters" is defined, for the purpose of the 2009 Guidelines, as "Polar waters where local ice conditions present a structural risk to a ship".[125] Whereas the extension of the scope of the Guidelines to include non ice-covered waters implies that almost all parts of the Northwest Passage and the NSR are subject to the Guidelines now, the requirement of "international voyages" for the application of the Guidelines means that some domestic voyages in the Arctic such as voyage between American ports using the Northwest Passage and voyage connecting Russian ports passing through the NSR are outside the scope of the present Guidelines.

The Guidelines stipulate that only those ships with a Polar Class designation or a comparable alternative standard of ice-strengthening appropriate to the anticipated ice conditions should operate in Polar ice-covered waters.[126] The Guidelines provide that all Polar Class ships should have double bottoms over the breadth and the length between forepeak and afterpeak bulkheads.[127]

As useful as they may be, the impact of the recommendatory Guidelines has been rather limited.[128] As some members of the IMO have urged that the Guidelines should be made mandatory as "Code", the item "Development of a mandatory Code for ships operating in polar waters" was assigned to the DE Sub-Committee.[129]

As it is still at an early stage in the development of the Code, it is difficult to speculate the final content of the Code. However, in any case, it will be consistent with the law of the sea and the Antarctic Treaty.[130] It was agreed to use the definition of the 2009 Polar Guidelines, including the definitions of Arctic and Antarctic waters for the time being.[131] While the Sub-Committee agreed that the question of addressing the societal differences between the Arctic and the Antarctic regions and how to address possible risks posed by Arctic shipping to indigenous peoples was outside the remit of the Sub-Committee, there were still discussions on the appropriateness of different requirements for Arctic and Antarctic areas.[132]

It is notable that the eight Arctic states are all supportive of the development of the polar code within the framework of the IMO. At the Ministerial Meeting in 2011, they recommended on an early completion of the drafting.[133]

This, however, does not mean that the

IMO is the only forum to develop regulations for navigation in the Arctic waters. As noted earlier, the coastal states may adopt and enforce specific rules under Article 234 of the LOSC. Recent initiatives at the domestic level in Canada and Russia are worth noting here.

First, Canada established a mandatory registration system for ships in the Canadian Arctic waters. The Northern Canada Vessel Traffic Services Zone Regulations formally established the Northern Canada Vessel Traffic Services (NORDREG) Zone and set out the requirements for vessels to report information prior to entering, while operating within and upon exiting the NORDREG Zone.[134] The reporting requirements are imposed only on certain categories of vessels; if a vessel is less than 300 GT operating independent of other vessels and carrying no pollutant or dangerous goods as cargo, the requirements do not apply.[135] There was some discussion on whether mandatory reporting should be required for all vessels, including small foreign flag adventure vessels, but taking into account the respect of the voluntary NORDREG Zone and of the mandatory Eastern Canada VTS zone as well as the aim to cover those vessels that pose the greatest risk to the marine environment, it was decided to confine the scope of regulations to specific vessels.[136]

Second, State Duma of the Russian Federation is considering the adoption of a new law with regard to navigation in the NSR. Presumably, the proposed new legislation is, at least partly, intended to update the 20-year old regulations in keeping with recent technological development in shipbuilding and shipping operations. Another possible reason for this initiative might be found in the intention on the part of State Duma to take the lead in policy discussions on the Arctic Ocean. Still another reason would be the proper implementation of LOSC Article 234 at the national level. Russia ratified the LOSC in 1997 and needs to fully adjust its domestic legislation to the rules provided by the LOSC. In any case, until the content of the proposed new law is revealed to the public, it is difficult to analyze the rationale for using “law” instead of “regulations”.

Interestingly, in the context of the development of a Polar Code, Russia indicated its preference to insert a provision on the relationship between national legislation applicable within the EEZ and the proposed Polar Code. It noted that the Canadian proposed draft paragraph 2.11 in DE 53/18/2 formulated the principle of priority of national regulations over the Code’s requirements but it was omitted in subsequent documents submitted to the DE Sub-Committee; Russia proposed retaining the Canadian proposed preambular paragraph in the proposed Code.[137]

4-4 Fisheries Management

Some of the fisheries management initiatives for the Arctic Ocean by coastal states should be noted in considering the issue of Arctic Ocean governance.

First, the United States have taken a number of steps to advance fisheries management in the Arctic. In 2008, Senate Joint Resolution 17 was signed by the President into law, which recommends the executive to initiate negotiations for the international management of Arctic fisheries.[138] Among other things, it stipulates that the United States should take the necessary steps with other *Arctic nations* to negotiate an agreement or agreements for managing migratory,

transboundary and straddling fish stocks in the Arctic Ocean and to establish a new international fisheries management organization or organizations for the region; the above-mentioned agreement or agreements to be negotiated should conform to the requirement of the UN Fish Stocks Agreement; and that until the agreement or agreements come into force and measures consistent with the UN Fish Stocks Agreement are in effect, the United States should support international efforts to halt the expansion of commercial fishing activities in the high seas of the Arctic Ocean.[139] In response, the State Department contacted other Arctic coastal states to work together for the conservation and management of shared stocks and is considering whether it would be desirable for a group of states with interests in present and future Arctic fisheries to adopt some form of general statement or declaration.[140] In addition, in 2009, the United States established the Arctic Fishery Management Plan (FMP) for part of the waters in the Chukchi and Beaufort Seas where the Untied States claim federal jurisdiction for fisheries management.[141] The FMP initially prohibits commercial fishing in the area concerned until sufficient information is available to support the sustainable management of a commercial fishery.[142]

Second, Norway and Russia are cooperating in fisheries management on the Atlantic side, especially in the Barents Sea. In their newly concluded delimitation treaty, they confirmed continued cooperation in fisheries matters, including through the existing mechanisms.[143] In addition, at the Joint Norwegian-Russian Federation Fisheries Commission in 2009, it was reportedly agreed to ask the International Council for the Exploration of the Sea (ICES) to prepare assessments on possible consequences of climate change for stocks managed by the Commission, including the distribution into the Central Arctic Ocean.[144] It remains to be seen whether the states concerned will seek to establish a regime similar to that for the so-called Loophole of the Barents Sea.

5. Conclusions

This article has examined the issues relating to Arctic Ocean governance. Section 2 described the characteristics of the Arctic Ocean governance structure by looking at the existing institutional arrangements and comparing the Arctic and the Antarctic. The findings include: the Arctic is already covered by an extensive international legal framework and a complex mixture of state and non-state actors, including various types of inter-governmental institutions; due to the difference from the Antarctic, it is unlikely that the Arctic will be governed by a system of legal and institutional arrangements similar to the ATS.

Section 3 articulated the legal framework for the Arctic Ocean, focusing on navigation, fisheries, non-living resources and MSR. As shown in detail there, the Arctic Ocean is subject to international law, in particular the law of the sea. The LOSC serves as the legal pillar for the Arctic Ocean, offering basic principles for the allocation of jurisdiction and the regulation of activities therein, with some elements specific to the Arctic Ocean. The analysis of the legal framework for activities in the Arctic Ocean (i.e., navigation, fisheries, non-living resources and MSR) shows that the competence to regulate activities in the Arctic Ocean is shared differently, depending on the sector. This implies that participation in the

work of the Arctic Council does not necessarily mean participation in Arctic governance *per se*. This makes a stark contrast with the ATS, where it is the starting point for interested states to become party to the Antarctic Treaty with a view to playing a role as a Consultative Party. Since substantive regulatory decision-making remains outside the Arctic Council, involvement of non-Arctic states will remain far more limited than that of non-claimants in the ATS.[145]

Section 4 looked into the recent developments concerning Arctic Ocean governance at the global, regional and national levels. The existing international legal framework, including the law of the sea, is gaining more and more importance in the Arctic Ocean governance discourse. This trend will be accelerated as it was recognized as part of the criteria for the observer status of the Arctic Council. Attempts to negotiate a new comprehensive treaty will be further discouraged.

The mainstreaming of the Arctic Council in the Arctic Ocean governance discourse is observed in various instances such as the negotiations of the Arctic SAR Agreement.[146] Therefore, while regulatory authority on substantive issues remains outside the Arctic Council as noted above, the Arctic Council will serve as the principal forum to shape the future of Arctic Ocean governance, including through coordination among different regulatory authorities.[147]

For the Arctic Council to continue advancing the Arctic Ocean governance agenda, it is essential that the Arctic Council maintains legitimacy for that function. In this regard, the adoption of criteria for admitting observers to the Arctic Council as well as the non-party provision of the Arctic SAR Agreement is a welcome achievement. However, their effective and adequate implementation would present a challenge to all stakeholders in Arctic Ocean governance. Furthermore, where the Arctic Council members wish to engage in discussions on Arctic Ocean governance having bearing on areas beyond their national jurisdiction (i.e., the high seas and the Area), they will be increasingly urged to adjust decision-making processes in a manner inclusive of non-Arctic states having a real interest.[148] Then, the real challenge would be how to strike a balance between coastal state interests and those of other states, including the interests of the international community as a whole.

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1 Research Associate, Netherlands Institute for the Law of the Sea (NILOS), School of Law, Utrecht University; formerly, Research Fellow, Ocean Policy Research Foundation. This article was originally submitted in June 2010; however, limited updates were provided at the end of May 2011.

2 M. Byers, *Who Owns the Arctic? Understanding Sovereignty Disputes in the North* (2009).

3 See, for example, BBC, "Russia plants flag under N Pole" (2 August 2007), available at <http://news.bbc.co.uk/2/hi/europe/6927395.stm> (last visited 20 May 2011). While the legal literature dealing with the Arctic Ocean has significantly increased after this incident, there were already a number of important contributions before that. See, e.g., A.G. Oude Elferink and D.R. Rothwell (eds.), *The Law of the Sea and Polar Maritime Delimitation and Jurisdiction* (2001).

4 Arctic Council, Arctic Marine Shipping Assessment 2009 Report, at p. 12.

5 The concept of "Arctic Ocean" is not understood in a uniform manner. In some cases, the term is used to refer to the maritime area north of the Arctic Circle, while a central area surrounding the North Pole is in some cases understood as the Arctic Ocean separately from associated seas such as the Kara Sea, the Barents Sea and the Norwegian Sea. Furthermore, as stated later, the IMO Polar Guidelines use different definitions for the area of their application. The term "Arctic Ocean governance" is used in this paper as the governance of both the

Arctic Ocean in a narrow sense and its associated seas.

[6] United Nations Convention on the Law of the Sea (LOSC), Montego Bay, 10 December 1982, entered into force 16 November 1994.

[7] E.g., Ilulissat Declaration, Ilulissat, Greenland, 28 May 2008.

[8] E.g., Commission of the European Communities, Communication from the Commission to the European Parliament and the Council, The European Union and the Arctic Region COM(2008) 763 final, 20.11.2008, at pp. 9-10; Council of the European Union, Council conclusions on Arctic issues, 2985th Foreign Affairs Council meeting, Brussels, 8 December 2009.

[9] But see D.M. Johnston, "The Future of the Arctic Ocean: Competing Domains of International Public Policy", 17 *Ocean Yearbook* (2003), at p. 597 note 4.

[10] Convention on Biological Diversity (CBD), Rio de Janeiro, 5 June 1992, entered into force 29 December 1993.

[11] Declaration on the Establishment of the Arctic Council, Ottawa, 19 September 1996.

[12] Arctic Environmental Protection Strategy (AEPS), Rovaniemi, 14 June 1991.

[13] Three Nordic countries decided to establish a secretariat in Norway for the period 2006-2013 under their chairmanships. Recently, the Nuuk Ministerial Meeting in 2011 decided to establish a permanent secretariat. On this issue, see sub-section 4.2 below.

[14] In fact, a limited role the Arctic Council plays has been pointed out by commentators. See, e.g., R. Huebert, "The Law of the Sea and the Arctic: An Unfulfilled Legacy", 18 *Ocean Yearbook* (2004), at pp. 213 and 218; D. VanderZwaag *et al.*, "The Arctic Environmental Protection Strategy, Arctic Council and Multilateral Environmental Initiatives: Tinkering while the Arctic Marine Environment Totters", in A.G. Oude Elferink and D.R. Rothwell (eds.), *The Law of the Sea and Polar Maritime Delimitation and Jurisdiction* (2001), at pp. 233-240; E.T. Bloom, "Establishment of the Arctic Council", 93 *American Journal of International Law* (1999), at pp. 719-720.

[15] See the website of Conference of Parliamentarians of the Arctic Region (CPAR), available at <http://www.arcticparl.org/> (last visited 26 May 2010).

[16] See P. Malanczuk, *Akehurst's Modern Introduction to International Law*, 7th edition (1997), at pp. 107-108.

[17] Competence in certain areas has been delegated from Denmark to the Greenland Home Rule Government, including mineral resource development and the capacity to negotiate and enter into agreement on issues under the competence of the Home Rule Government. However, defence and national security largely remain within the Danish government's competence. Act no. 473 of 12 June 2009, sections 1 and 11-12.

[18] Note that it was made clear in the Ottawa Declaration that "the use of the term "peoples" in [the Declaration] shall not be construed as having any implications as regard the rights which may attach to the term under international law".

[19] See, e.g., 6th Conference of Parliamentarians of the Arctic Region, Nuuk, Kalaallit Nunaat, Greenland, 3-6 September, Conference Statement, 5 September 2004, para. 39, asking the Standing Committee of Parliamentarians of the Arctic Region to "Consider possibilities to initiate a process which over time could lead to a binding legal regime for conservation and sustainable use of the Arctic and its marine environment". See also O.S. Stokke, "A Legal Regime for the Arctic?: Interplay with the Law of the Sea Convention", 31 *Marine Policy* (2007); H. Corell, "Reflections on the Possibilities and Limitations of a Binding Legal Regime for the Arctic", Seventh Conference of Parliamentarians of the Arctic Region, Kiruna, Sweden, 3 August 2006. On a proposal for a new treaty with a modest objective, see T. Koivurova and E.J. Molenaar, International Governance and Regulation of the Marine Arctic, A report prepared for the WWF International Arctic Programme (2010).

[20] Elements of the ATS include "the Antarctic Treaty, the measures in effect under that Treaty, its associated separate international instruments in force and the measures in effect under those instruments". Protocol on Environmental Protection to the Antarctic Treaty, Madrid, 4 October 1991, Article 1(e). At the core of the ATS are the Antarctic Treaty and various measures adopted by Antarctic Treaty Consultative Meetings (ATCMs). The Antarctic Treaty provides for, *inter alia*, international cooperation and "freezing" of territorial claims to Antarctica. Within the ATS, there are three main international agreements, namely, the Protocol on Environmental Protection to the Antarctic Treaty (Madrid Protocol), the Convention for the Conservation of Antarctic Seals, and the Convention on the Conservation of Antarctic Marine Living Resources (CCAMLR Convention). See Convention for the Conservation of Antarctic Seals, London, 1 June 1972, entered into force 11 March 1978; Convention on the Conservation of Antarctic Marine Living Resources, Canberra, 20 May 1980, entered into force 7 April 1982. The Madrid Protocol is open only to parties to the Antarctic Treaty. The latter two are independent of the Antarctic Treaty yet incorporate the essential elements of the Antarctic Treaty such as Article 4 on the legal

status of territorial claims. These agreements themselves are linked to each other: for example, the Madrid Protocol provides that Antarctic Specially Protected Areas (ASPAs) can be established in the marine area only with the consent of the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR). Protocol on Environmental Protection to the Antarctic Treaty, Annex V, Article 6(2).

[21] They are: Canada, Denmark (Greenland), Norway, the Russian Federation and the United States. Iceland has a tiny coastline on the Arctic Circle, but it is generally not considered to be an Arctic coastal state. Nevertheless, it claims that it is an Arctic coastal state. See Össur Skarphéðinsson, "Icelandic Perspectives on the Arctic", presented at Arctic Frontiers 2011: Arctic Tipping Points, Tromsø, Norway, 23-28 January 2011, pp. 5-6 and 9-10.

[22] But see Johnston, "The Future of the Arctic Ocean", at p. 614.

[23] The provisions concerning archipelagic waters do not currently apply to Arctic states. Iceland consists of islands, but has not declared archipelagic waters.

[24] On this point, there are opposing views. For a view supporting the characterization of the Arctic Ocean as a semi-enclosed sea, see, e.g., H. Corell, "Reflections on the Possibilities and Limitations of a Binding Legal Regime", 37 *Environmental Policy and Law* (2007), at p. 322. For a contrary view, see T.H. Heidar, "The Legal Regime of the Arctic Ocean", 69 *Zeitschrift fuẗr auslaẗndisches oẗffentliches Recht und Voĺkerrecht* (2009), at p. 636; A. Proelss and T. Mu̇ller, "The Legal Regime of the Arctic Ocean", 68 *Zeitschrift fuẗr auslaẗndisches oẗffentliches Recht und Voĺkerrecht* (2008), at p. 684. See also Koivurova and Molenaar, International Governance and Regulation of the Marine Arctic, at p. 67.

[25] LOSC, Article 123.

[26] This article will be dealt with in more detail in sub-section 3.1.

[27] Canada and the United States disagree on their maritime boundary for the territorial sea, the EEZ and the continental shelf in the Beaufort Sea. Canada and Denmark are in dispute over sovereignty over the Hans Island and its surrounding maritime areas. The United States and Russia have concluded a boundary delimitation agreement in 1990, but Russia has not yet ratified it. Norway and Russia recently signed a treaty covering maritime boundary delimitation as well as bilateral cooperation in fisheries and hydrocarbon management and they completed the internal ratification processes in February and April 2011, respectively. See Treaty between the Kingdom of Norway and the Russian Federation concerning Maritime Delimitation and Cooperation in the Barents Sea and the Arctic Ocean, Murmansk, 15 September 2010. In addition, Norway's sovereign right over maritime areas surrounding Spitsbergen and other islands of the Svalbard Archipelago is controversial. See Treaty concerning Spitsbergen, Paris, 9 February 1920, entered into force 14 August 1925, Articles 1-3.

[28] Boundaries between Denmark (Greenland), on the one hand, and Canada (westward of Greenland), Norway (Jan Mayen & Svalbard) and Iceland, respectively, on the other.

[29] United States – Russia; so-called "box" in the Svalbard Treaty; and the Canadian-claimed boundary between Canada and the United States.

[30] For a similar view, see T. Gorski, "A Note on Submarine Ridges and Elevations with Special Reference to the Russian Federation and the Arctic Ridges", 40 *Ocean Development and International Law* (2009), at pp. 57-58. As opposed to Antarctica, the sector principle has not been invoked widely in the context of the Arctic. Franckx observes that USSR/Russia and Canada have used the argument of the sector principle but it is not clear whether they maintain this. E. Franckx, *Maritime Claims in the Arctic: Canadian and Russian Perspectives* (1993).

[31] LOSC, Article 298(1)(a)-(b). Note that even if the state concerned has made a declaration in accordance with this article, boundary disputes without involving sovereignty or other rights over continental or insular land territory are subject to compulsory reference to conciliation.

[32] See Division for Ocean Affairs and the Law of the Sea, "Settlement of disputes mechanism, Recapitulative tables", <http://www.un.org/Depts/los/settlement_of_disputes/choice_procedure.htm> (last visited 20 April 2010).

[33] N. Klein, *Dispute Settlement in the UN Convention on the Law of the Sea* (2005), at p. 279.

[34] See L.D.M. Nelson, "The Settlement of Disputes Arising From Conflicting Outer Continental Shelf Claims", 24 *International Journal of Marine and Coastal Law* (2009), at p. 421.

[35] See International Court of Justice, "Declarations Recognizing the Jurisdiction of the Court as Compulsory", <http://www.icj-cij.org/jurisdiction/index.php?p1=5&p2=1&p3=3> (last visited 20 April 2010). Note that the scope of compulsory jurisdiction in the case of Canada and Norway would be severely curtailed by virtue of the limitations contained in their declarations.

[36] A drawback for this approach is the possible omission of cross-cutting issues such as marine biodiversity. Suffice it to state in the context of this study that the CBD as well as regional mechanisms such as the OSPAR Commission are relevant for

marine biodiversity conservation at the international level.

[37] R.R. Churchill and A.V. Lowe, *The Law of the Sea*, 3rd edition (1999), at pp. 61-62.

[38] LOSC, Articles 17 and 21.

[39] Ibid., Article 21(2).

[40] Ibid., Article 38.

[41] Ibid., Articles 58 and 87.

[42] Ibid., Article 94(1).

[43] Ibid., Article 94(3)-(5).

[44] Ibid., Article 211(2).

[45] See, e.g., Ibid., Articles 211 and 220.

[46] Ibid., Articles 211(5) and 220.

[47] S. Rosenne and A. Yankov (eds.), *United Nations Convention on the Law of the Sea 1982: A Commentary (Virginia Commentary)*, vol. IV (1991), at pp. 201-202. In the context of Article 94, see S.N. Nandan and S. Rosenne (eds.), *United Nations Convention on the Law of the Sea 1982: A Commentary (Virginia Commentary)*, vol. III (1995), at pp. 147-150.

[48] International Convention for the Safety of Life at Sea, London, 1 November 1974, in force 25 May 1980.

[49] International Convention for the Prevention of Pollution from Ships, London, 2 November 1973, as modified by the 1978 Protocol (London, 1 June 1978) and the 1997 Protocol (London, 26 September 1997) and regularly amended.

[50] International Convention on Standards of Training, Certification and Watchkeeping for Seafarers, London, 1 December 1978, in force 28 April 1984, as amended and modified by the 1995 Protocol.

[51] Guidelines for Ships Operating in Arctic Ice-Covered Waters, MSC/Circ.1056 & MEPC/Circ.399, 23 December 2002.

[52] LOSC, Article 234.

[53] E.g., A. Chircop, "The Growth of International Shipping in the Arctic: Is a Regulatory Review Timely?", 24 *International Journal of Marine and Coastal Law* (2009), at p. 371.

[54] E.g., D. Pharand, "The Arctic Waters and the Northwest Passage: A Final Revisit", 38 *Ocean Development and International Law* (2007), at p. 47. See also comments by Bernard Oxman in *Proceedings of the American Society of International Law*, vol. 82 (1988), pp. 333-334.

[55] For discussions, see R.D. Brubaker, *The Russian Arctic Straits* (2005); Byers, *Who Owns the Arctic?*, at pp. 47-48.

[56] Views supporting the coastal state right to prescribe on a wide range of issues on the basis of this article include: A. Blanco-Bazán, "Specific Regulations for Shipping and Environmental Protection in the Arctic: The Work of the International Maritime Organization", 24 *International Journal of Marine and Coastal Law* (2009), at p. 383. The contrary view, i.e., the right is limited to laws and regulations on marine environmental protection, include: Chircop, "The Growth of International Shipping in the Arctic", at pp. 371-372.

[57] For the laws and regulations of other coastal states (Denmark/Greenland, Norway and the United States), see, e.g., Ø. Jensen, The IMO Guidelines for Ships Operating in Arctic Ice-covered Waters: From Voluntary to Mandatory Tool for Navigation Safety and Environmental Protection? FNI Report 2/2007, March 2007, at pp. 7-8.

[58] At that time, the scope of the Act was limited to 100 NM from the baselines. It was extended to 200 NM in 2009. Bill C-3, An Act to amend the Arctic Waters Pollution Prevention Act, Royal Assented to 11 June 2009, entered into force 1 August 2009.

[59] See Rosenne and Yankov (eds.), *Virginia Commentary, vol. IV*, at p. 398 n. 7 and its accompanying text; Chircop, "The Growth of International Shipping in the Arctic", at p. 368. Article 234 does not apply to warships. See LOSC, Article 236.

[60] See the Canadian Government's declaration on acceding to MARPOL 73/78, cited in Chircop, "The Growth of International Shipping in the Arctic", at p. 369 n. 51. Nevertheless, in some respect, the Canadian standard appears lower than the MARPOL standard. For example, on the sewage discharge, see Chircop, "The Growth of International Shipping in the Arctic", at p. 375. Chircop comments that the Russian standard for vessel-source pollution is higher than the basic MARPOL norm. Chircop, "The Growth of International Shipping in the Arctic", at p. 370.

[61] For the route of the NSR, see L. Tymchenko, "The Northern Sea Route: Russian Management and Jurisdiction over Navigation in Arctic Seas", in A.G. Oude Elferink and D.R. Rothwell (eds.), *The Law of the Sea and Polar Maritime Delimitation and Jurisdiction* (2001), at pp. 269-271.

[62] See the map in Brubaker, *The Russian Arctic Straits*, at p. 8. See also the coordinates approved in 1985 available at the DOALOS database, <http://www.un.org/Depts/los/LEGISLATIONANDTREATIES/PDFFILES/RUS_1985_Declaration.pdf> (last visited 13 April 2010). If the area enclosed as internal waters in 1985 was not regarded as internal waters historically, the regime of innocent passage would apply.

[63] E. Franckx, "Nature Protection in the Arctic: Recent Soviet Legislation", 41 *International and Comparative Law Quarterly* (1992), at pp. 381-382.

[64] Ibid., at pp. 381-384; H. Kitagawa (ed.), *The Northern Sea Route: The shortest sea route linking East Asia and Europe* (2001), at p. 87. See also Tymchenko, "The Northern Sea Route", at pp. 283-284.

[65] See the map in Brubaker, *The Russian Arctic Straits*, at p. 7.
[66] DE 55/12/23, p. 2. Note, however, that specific reference to the NSR, as found in Article 14 of the above-mentioned 1998 Federal Act, is absent in the 1998 Act on the exclusive economic zone of the Russian Federation.
[67] Section 7.4.
[68] Chircop, "The Growth of International Shipping in the Arctic", at pp. 370-371.
[69] Brubaker, *The Russian Arctic Straits*, at p. 30.
[70] This issue becomes more important if a mandatory Polar Code is adopted at the IMO.
[71] Canada and the United States disagree whether the Northwest Passage is a strait used for international navigation. For an excellent summary of respective legal positions, see T.L. McDorman, *Salt Water Neighbors: International Ocean Law Relations between the United States and Canada* (2009), at pp. 232-245.
[72] Blanco-Bazán, "Specific Regulations for Shipping and Environmental Protection in the Arctic", at p. 384.
[73] SOLAS Convention, Regulation V/10(1). See also LOSC, Articles 22(3) and 41(4).
[74] The Antarctic area was already designated under Annexes I, II and V; the North American emission control area (which does not include the Arctic Ocean) was adopted in March 2010. See IMO, “Special Areas under MARPOL”, available at <http://www.imo.org/OurWork/Environment/PollutionPrevetion/SpecialAreasUnderMARPOL/Pages/Default.aspx> (last visited 23 May 2011).
[75] Note also that the IMO may, on the request of a state party, adopt special mandatory measures for the prevention of pollution within the limit of the EEZ of that state under Article 211(6) of the LOSC.
[76] See IMO, “Particularly Sensitive Sea Areas”, available at <http://www.imo.org/OurWork/Environment/PollutionPrevention/PSSAs/Pages/Default.aspx> (last visited 23 May 2011).
[77] APMs include designation of an area as a Special Area under the MARPOL Convention and adoption of ships’ routeing and reporting systems under the SOLAS Convention. Revised Guidelines for the Identification and Designation of Particularly Sensitive Sea Areas, Annex of IMO Resolution A.982(24), adopted on 1 December 2005, para. 6.1. In fact, at the time of designation of a PSSA, an APM must have been approved or adopted by the IMO. Revised PSSA Guidelines, para. 1.2.
[78] But some measures partly spill into the Arctic Circle. See Chircop, "The Growth of International Shipping in the Arctic", at p. 363.
[79] LOSC, Articles 61-62.
[80] Ibid., Article 63(1).
[81] Ibid., Article 77.
[82] Ibid., Articles 87 and 116-118.
[83] Ibid., Article 63(2).
[84] Ibid., Article 64.
[85] Agreement for the Implementation of the Provisions of the United Nations Convention on the Law of the Sea of 10 December 1982 relating to the Conservation and Management of Straddling Fish Stocks and Highly Migratory Fish Stocks (FSA), New York, 4 August 1995, entered into force 11 December 2001.
[86] Agreement to Promote Compliance with International Conservation and Management Measures by Fishing Vessels on the High Seas (FAO Compliance Agreement), Rome, approved by FAO Conference on 24 November 1993
[87] In addition to the EEZ adjacent to the mainland part of Norway, there are two 200 NM zones declared by Norway: the Fishery Protection Zone around Svalbard and the Fishery Zone around Jan Mayen. In the waters formerly disputed between Norway and Russia (“Grey Zone”), fisheries are regulated by a Joint Commission.
[88] R.R. Churchill, "The Barents Sea Loophole Agreement: A "Coastal State" Solution to a Straddling Stock Problem", 14 *International Journal of Marine and Coastal Law* (1999), at pp. 467-483. If species composition of the Barents Sea changes due to climate change and there are new fisheries, it could be argued that Iceland may fish for other species under these arrangements.
[89] Convention on Future Multilateral Co-operation in North-East Atlantic Fisheries, London, 18 November 1980, revised in 2006, Article 1(1). Uncertainty exists regarding the portion between 42 and 44 W because Article 1(2) of that Convention does not mention the Arctic Ocean in defining the Convention Area north of 59 N and between 44 W and 42 W.
[90] LOSC, Articles 66-67.
[91] It is conceivable that resource deposits are straddling maritime areas of two states. On the issue of transboundary oil and gas fields, the International Law Commission considered the feasibility to further study the issue but decided to discontinue its work in 2010. In addition, offshore hydrocarbon activities are regulated by the OSPAR Commission in the North-East Atlantic.
[92] LOSC, Article 87(1).
[93] Ibid., Part XI; Agreement relating to the Implementation of Part XI of the United Nations Convention on the Law of the Sea of 10 December 1982, New York, 28 July 1994, entered into force provisionally on 16 November 1994 and definitively on 28 July 1996.
[94] See, e.g., LOSC, Article 208.
[95] For an overview of such instruments relating to the

Arctic, see Koivurova and Molenaar, International Governance and Regulation of the Marine Arctic, at pp. 31-33.

96 Section 1.2 (Goals).

97 Especially, see LOSC, Articles 19(2), 21(1), 40, 87, 143, 245-246 and 256-257.

98 Ibid., Article 246(6).

99 Ibid., Articles 143 and 256.

100 For brief discussion, see Y. Takei, "Polar Complications in the Law of the Sea: A Case Study of the Regime for Research and Survey Activities in the Arctic Ocean", paper presented at the Sixth ABLOS Conference "Contentious Issues in UNCLOS – Surely Not?", Monaco, 25-27 October 2010, available at <http://www.gmat.unsw.edu.au/ablos/ABLOS10Folder/S3P2-P.pdf> (last visited 23 May 2011).

101 LOSC, Article 98(2).

102 International Convention on Maritime Search and Rescue, Hamburg, 27 April 1979, entered into force 22 June 1985, lastly amended in 2004. The SOLAS Convention also provides for SAR. See, e.g., SOLAS Convention, Annex, Chapter V, Regulation 33.

103 See IMO, International Convention on Maritime Search and Rescue (SAR), <http://www.imo.org/About/Conventions/ListOfConvetions/Pages/International-Convention-on-Maritime-Search-and-Rescue-(SAR).aspx> (last visited 20 June 2011).

104 Arctic Council, AMSA 2009 Report, at p. 172.

105 "Rescue agreement for Barents", SIKU CIRCUMPOLAR NEWS SERVICE, 7 September 2005, available at <http://www.sikunews.com/skriv_ut.html?catid=3&artid=464> (last visited 12 April 2010).

106 See, e.g., Ilulissat Declaration, para. 6.

107 Tromsø Declaration, on the occasion of the Sixth Ministerial Meeting of the Arctic Council, 29 April 2009, para. 8 of "Arctic Marine Environment". This commitment was reinforced at the Arctic Ocean Foreign Ministers' Meeting in Chelsea, Canada, in March 2010.

108 Agreement on Cooperation on Aeronautical and Maritime Search and Rescue in the Arctic (Arctic SAR Agreement), Nuuk, Greenland, 12 May 2011, Article 3(2) and Annex. Compare with other delimitation methods in the Arctic (e.g., five navigational areas established for the purpose of coordinating the broadcast of navigational warnings, as reproduced in IMO Doc. MSC.1/Circ.1310, p. 9) .

109 Ibid., Article 8.

110 1979 SAR Convention, Annex, Chapter 3 (3.1.2).

111 Arctic Council, Meeting of Senior Arctic Officials, Final Report, 12-13 November 2009, Copenhagen, at p. 6.

112 Senior Arctic Officials (SAO) Report to Ministers, Nuuk, Greenland, May 2011, at p. 5.

113 See Arctic SAR Agreement, Article 19.

114 Council of the European Union, Council conclusions on Arctic issues, 2985th Foreign Affairs Council meeting, Brussels, 8 December 2009, at para. 15.

115 Arctic SAR Agreement, Article 18.

116 Nuuk Declaration on the occasion of the Seventh Ministerial Meeting of the Arctic Council, Nuuk, Greenland, 12 May 2011, para. 1 of the Section "Strengthening the Arctic Council".

117 Ibid., para. 1 of the Section "Arctic marine environment".

118 Senior Arctic Officials (SAO) Report to Ministers, Nuuk, Greenland, May 2011, at pp. 6-7.

119 Nuuk Declaration, para. 3 of the Section "Strengthening the Arctic Council".

120 Ibid., para. 5 of the Section "Strengthening the Arctic Council". The SAO Report notes that the involvement of observers should enhance and complement the unique and critical role of Permanent Participants in the Arctic Council. Senior Arctic Officials (SAO) Report to Ministers, Nuuk, Greenland, May 2011, at p. 50 (Annex 1).

121 For criticisms on the 2002 Guidelines, see Arctic Council, AMSA 2009 Report, at p. 57; Chircop, "The Growth of International Shipping in the Arctic", at p. 373.

122 Resolution A.1024(26).

123 SOLAS Convention, Regulation I/2(d).

124 Guidelines for Ships Operating in Polar Waters, DE 52/WP.2, ANNEX 1 (2009), section 1.1.9. But the same paragraph provides that each State should ensure that such vessels or aircraft act in a manner consistent, so far as is reasonable and practicable, with the Guidelines.

125 Ibid., section G-3.5. In the 2002 Guidelines, part of the definition of the term "Arctic ice-covered waters" read "those waters […] *in which sea ice concentrations of 1/10 coverage or greater are present* and which pose a structural risk to ships" (emphasis added). 2002 Arctic Shipping Guidelines, section G-3.2.

126 2009 Polar Shipping Guidelines, section G-2.1. Compare with 2002 Arctic Shipping Guidelines, section G-2.

127 2009 Polar Shipping Guidelines, section 3.4.2. This text is identical to 2002 Arctic Shipping Guidelines, section 3.3.2. Note that the IMO was called by the XXVIIth Antarctic Treaty Consultative Meeting to draw attention to a specific environmental issue of whether full double-bottom construction would be necessary for ships operating in ice-covered waters of the Antarctic. Blanco-Bazán, "Specific Regulations for Shipping and Environmental Protection in the Arctic", at p. 386.

128 See, e.g., Jensen, The IMO Guidelines for Ships

Operating in Arctic Ice-covered Waters.

[129] Support for a mandatory code was also expressed by the ATCM XXXII in 2009 (Resolution 8) and the Arctic coastal states meeting held in Chelsea in 2010.

[130] See, e.g., DE 54/13/3, p. 2.

[131] See, e.g., DE 55/12, p. 2.

[132] See DE 54/23, pp. 24-25.

[133] Nuuk Declaration, para. 4 of the Section “Arctic marine environment”.

[134] Canada Gazette Part II, , Vol. 144, No. 13, 23 June 2010, at pp. 1161-1166.

[135] Ibid., at p. 1162 (Section 3).

[136] Ibid., at p. 1171.

[137] DE 55/12/23, p. 2.

[138] Senate Joint Resolution 17, directing the United States to initiate international discussions and take necessary steps with other nations to negotiate an agreement for managing migratory and transboundary fish stocks in the Arctic Ocean, available at <http://www.gpo.gov/fdsys/pkg/BILLS-110sjres17rcs/pdf/BILLS-110sjres17rcs.pdf> (last visited 24 May 2011).

[139] Paras 1, 2 and 4.

[140] U.S. Department of State, “Arctic”, available at <http://www.state.gov/g/oes/ocns/opa/arc/> (last visited 26 May 2011).

[141] NOAA, National Marine Fisheries Service, Alaska Regional Office, “Arctic Fisheries”, available at <http://www.alaskafisheries.noaa.gov/sustainablefisheries/arctic/> (last visited 24 May 2011).

[142] This unilaterally imposed moratorium was contested by Canada as it also claims part of the Beaufort Sea, as noted earlier. See, e.g., Canwest News Service, “Canada files protest over U.S. fishing ban in Arctic Ocean” (3 September 2009), available at <http://www.globalmontreal.com/canada+files+protest+over+fishing+arctic+ocean/1959503/story.html> (last visited 24 May 2011).
It was recently reported that Canada also banned fishing in the Beaufort Sea. CBC News, "Beaufort Sea commercial fishing banned" (15 April 2011), <http://www.cbc.ca/news/canada/north/story/2011/04/15/beaufort-sea-commercial-fishing-ban.html> (last visited 20 June 2011).

[143] 2010 Norwegian-Russian Maritime Delimitation and Cooperation Treaty, Annex I.

[144] Proceedings of the International Arctic Fisheries Symposium: Managing Resources for a Changing Arctic, 19-21 October 2009, Hotel Captain Cook, Anchorage, Alaska, February 2010, at p. 28.

[145] Under the ATS, non-claimants as well as claimants may participate in decision-making as long as they maintain the status of Antarctic Treaty Consultative Party (ATCP).

[146] At the same time, this means that the group of five Arctic coastal states does not play an essential role in Arctic Ocean governance even though some of the recent developments such as the establishment of the Arctic Regional Hydrographic Commission and the initiation of the biennial meeting of the parties to the 1973 Polar Bear Agreement were concerned with the five Arctic coastal states. This trend is also found in the reactions of some Arctic coastal states as well as those not invited to the Arctic coastal states foreign minister meeting in Chelsea in March 2010 when the meeting was convened by Canada.

[147] The need for coordination among regulatory authorities is widely recognized. See, e.g., Chircop, "The Growth of International Shipping in the Arctic", at p. 379. The integrated approach may mean different things to different people. For example, Tanaka argues that the concept operates at three levels: ecological, normative and implementation. See Y. Tanaka, "Zonal and Integrated Management Approaches to Ocean Governance: Reflections on a Dual Approach in International Law of the Sea", 19 *International Journal of Marine and Coastal Law* (2004).

[148] The concept “States having a real interest” was introduced in a high seas fisheries context through Article 8(3) of the UN Fish Stocks Agreement.

Geopolitics in Asia and Japan's Maritime Strategy

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Abstract

There are three strategic lines of communication that bring threat to Japan: the Indian Ocean, the Pacific Ocean, and the Eurasian landmass. Thanks to its insular position and the lack of China's maritime ambition, Japan enjoyed security from foreign threat until the mid-19th century. Faced with the threat from the Western powers, Japan developed geostrategy for survival. The Anglo-Japanese alliance and the Washington Treaty were strategic success as they increased security by controlling two of the three strategic lines of communication. On the other hand, the Tripartite Pact was a fatal error as it failed to control one of the three. The Tripartite Pact forced Imperial Japan to develop a full-fledged navy, which only invited hostility from the global naval powers. The U.S.-Japan alliance is the most successful one as it controls all the three lines of communication. Due to the geopolitical constrain, Japan will not seek a full-fledged navy. Despite growing Chinese maritime ambitions, the U.S.-Japan alliance will continue to be the best tool for Japanese maritime strategy. But the JMSDF needs to play greater role to supplement the relative decline of the U.S. sea power.

Key words: Japan's maritime strategy, sea lines of communications, the Anglo-Japanese alliance, the Washington Naval Treaty, the U.S.-Japan alliance

1. Introduction

The National Defense Program Guidelines (NDPG), approved by the Japanese government on December 17, 2010, provide guidance for defense policy and set the force structure for the next decade.[1] The document, reflecting the changing regional and global security environment, abandoned the long-held "static" defense posture and introduced a new concept of "dynamic defense" that envisions an increased operational level and tempo of the Japan Self-Defense Force (JSDF). Accordingly, the Japanese government has shifted its strategic focus from the north to the south to meet challenges from the rising China, especially, its growing naval power. The emphasis on the defense of the Ryukyu island chain and the plan to increase the submarine fleet from 16 to 22 reflected this strategic shift. Given the growing Chinese anti-access/area-denial (A2/AD) capabilities, the document also calls for strengthening partnerships with South Korea, Australia, India, ASEAN members, and NATO and to secure the maritime, space, and cyber commons.

Despite those new features in the NDPG, the essence of Japanese naval strategy remains intact.

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Japanese naval strategy is aimed at containing the naval reach of hostile Asian land powers within the marginal waters along the Japanese archipelago, thereby restricting their access to the open ocean. This is the only solution to Japan's geostrategic dilemma — allocation of naval assets for territorial security and sea lines of communication (SLOC) protection. Japan needs to keep the sea lanes open, especially to secure oil shipping from the Persian Gulf and the reinforcements of the U.S. military from continental United States in the event of a crisis. But it is nonsense if it is achieved at the expense of territorial security. By containing hostile Asia naval powers within its surrounding waters, Japan can achieve both territorial security and SLOC protection.

Japan has never adopted an official maritime or naval strategy since the end of World War II. So this paper is just an interpretation of Japan's postwar defense policies and force structures. Careful observation of Japan's defense policies leads to a conclusion that Japan's naval strategy is best described as that of reluctance. This is not to say that widespread pacifism in the postwar Japanese societies resulted in the reluctant naval strategy, but the geopolitical restrain is the primary reason Japan has refused an assertive naval strategy. The Pacific and Indian Oceans are a unified naval theater linked through the Straits of Malacca. If it is to take an assertive naval strategy, Japan needs to have a two-ocean navy. Japan simply cannot afford such an ambitious strategy. Japan instead decided to rely on U.S. naval power that has dominated the world's oceans to keep its sea lanes open. Japan has only reluctantly expanded its naval power to supplement the relative decline of U.S. naval power.

This paper begins with an overview of Japan's position in Asian geopolitics and then reviews the history of Japan's naval strategy. It also considers the lessons from the Pacific War, followed by an analysis of Japan's naval strategy after World War II. It finally considers the development of Japan's naval strategy after the Cold War and its implications for the future.

2. Japan in Asian Geopolitics

Geopolitics is an objective reality, independent of any state's wishes and interests. It is an environment within which states must act. Geopolitics is determined by the disposition of centers of economic and natural resources and by lines of communication. Theses two variables create a set of geopolitical constraints to the external affairs of states. If geopolitics is the setting in which states act, geostrategy is a description of where a state directs its power. Its primary variable is the state of border security. When its territorial security is in jeopardy, a state must concentrate its power to protect its borders, limiting its ability to project power to strategically important, but distant places and lines of communication. Geostrategy is not necessarily a reflection of geopolitical reality; it may be motivated by ideological, religious, and social factors or leader's personal preferences. In any case, geostrategy that not reflecting the underlying geopolitical reality leads to the decline of the power of a state.[2]

Since the Pacific Ocean is very vast, numerous islands have great implications for Asian geopolitics. Japanese archipelago constitutes part of the offshore island chain running off the Asian continent. This offshore

island chain creates a series of marginal seas along the Eurasian continent — including the Sea of Okhotsk, the Sea of Japan, the Yellow Sea, the East and South China Seas, and the Philippine Sea. Those marginal seas have contributed to the development of Europe and Asia by providing easy and cheap lines of communication between the two regions.[3] For land powers, the island chain is a double-edged sword. It can protect them from hostile maritime powers, while it blocks their access to the open ocean.[4]

The Kuroshio, or "Black Tide," is a strong current that begins off the east coast of Taiwan and runs northeastward past Japan. It was easy to sail with the strong current but difficult to sail against or across it with primitive seafaring craft. The Kuroshio brought peoples and their culture from the southern seas to Japan. Those peoples reached Japan for settlement, not for commerce. On the other hand, Japan sent envoys to China between 600 and 894 to introduce Chinese culture and technologies, but that was not a safe voyage. In those days, Southern part of China represented the limit of Japanese seafaring craft.[5] Japan later became notorious as the home of pirates after the 13th century. Those pirates were basically smugglers and established a market connecting Japan, China and Southeast Asia by the 16th century.[6]

Japan was free from foreign invasion for centuries. The continent opposite Japan posed no real threats at least until the mid-19th century. China, despite its 8,700-mile coastline and great navigable rivers running to the Pacific, remained a self-sufficient land power and showed little interest in maritime expansion with the exceptions of the Mongol and the Ming dynasties. The Mongols conducted seaborne invasion of Asian coastal regions and islands, including two unsuccessful invasions of Japan in 1274 and 1294.[7] In 1405, Zheng He, with his large heavily-armed ships, made his first of seven voyages that reached to Southeast Asia, the Indian Ocean and as west as the Horn of Africa. However, China's maritime ambition was short-lived because it was high cost low return. In addition, China could not pursue maritime ambition due to the constant pressure of the armed nomads across land borders. In other words, China's lack of maritime ambition protected Japan.[8]

As China turned away from the sea in the early 15th century, Western maritime powers reached Japan through the Indian Ocean. The "discovery" of the sea route to India opened the Indian Ocean as a corridor for the Western maritime powers to the Far East. "Southern barbarians," or Portuguese and Spanish missionaries and English and Dutch merchants, reached Japan bringing Western culture and technologies into Japan, which helped the unification of the country under a military leader, the Shogun Hideyoshi. After uniting his country, Hideyoshi tried to invade China via Korea twice in 1592 and 1597 only to be beaten by Chinese army and Korean navy. As they witnessed the Philippines falling into Iberian colonialism, the succeeding Tokugawa Shogunate chose to discourage foreign trade and exclude Western influence in 1640.[9] Under the closed door policy, the Shogunate ended construction of all oceangoing ships and any Japanese leaving or returning to Japan would receive death penalty.

In some sense, the closed-door policy was Japan's first but most reluctant form of maritime strategy. Faced with the first foreign threat, Japan voluntarily gave up trade routes that had already reached Southeast Asia and the Indian Ocean to seek internal security.[10] But this national isolation worked only because power projections capability of the Western powers was primitive. During the 250-year period of Japanese isolation, Western powers paved the corridor to the Far East by seizing trading stations around the Indian Ocean and then the South China Sea. Britain emerged from global wars as the dominant maritime power and founded a settlement in Singapore, the "Gibraltar of the East," in 1819.

While Britain was busy with Indian and Chinese affairs, Russians and Americans knocked at Japan's door. Russians moved across Siberia into the Amur River region and Alaska by the early 19th century and Russians and Japanese clashed over the Kuril Islands and Sakhalin. Rejected a request for trade to supply the expanding Russian settlements, the Russians raided Japanese villages in the northern islands in 1806 and 1807. Then Japanese writers warned that Russia posed the major threat to Japan.[11] On the other hand, American whaling fleet operating in the North Pacific off Hokkaido required coaling stations in Japan and better treatment of shipwrecked sailors by the Japanese. The acquisition of California made the United States a Pacific as well as Atlantic power. Also, projected transpacific steamship service using the great circle route between Shanghai and California required port privileges in Japan.[12]

Commodore Matthew Perry, commanding the U.S. East India Squadron, reached Japan in July 1853, and Perry's gunboat diplomacy with his "black ships" successfully opened Japan. The 1854 Treaty of Kanagawa opened the ports of Shimoda and Hakodate. The treaty privileges were soon extended for Russia and other Western powers. The unequal treaties and the arrival of Western military powers opened the eyes of the lower-ranking samurais, who developed a great enthusiasm for naval power. Those samurais abandoned xenophobia, introduced Western military technology and finally built a centralized state overthrowing the Shogun. Japan under the Meiji Restoration of 1868 immediately began industrialization and modernization under the slogan of "rich country, strong army."

The Western powers reached the Far East through the three strategic lines of communications through the Indian Ocean, the Eurasian landmass, and the Pacific Ocean. When it opened its door to the Western powers, Japan was part of the economic center in the Far East. The geopolitical requirement for Japan was therefore territorial security from foreign invasion through the three lines of communication, rather than the protection of trade routes. The Imperial Japan was to develop its geostrategy under this geopolitical setting. It is important to note, however, that both Russia and the United States needed to project naval power through the Indian Ocean until the construction of the Trans-Siberian Railway and the Panama Canal was completed in 1904 and 1914, respectively.

3. Maritime Strategy of Imperial Japan

The emergence of China as a naval power and the march of Russia toward ice-free ports were the major threats to the newly-founded Japan. Tokyo's national security strategy was — as an American advisor to the Japanese foreign service stated — to establish a defensive barrier along the archipelago off East Asia from the island of Sakhalin to Taiwan, while securing a beachhead in Manchuria and Korea.[13] Accordingly, Imperial Japanese Navy adopted A2/AD strategy in the western Pacific. But Imperial Japan's geostrategy changed under the Anglo-Japanese alliance, the Washington Treaty system, and then the Tripartite-Pact. Geostrategy under the first two was a success, while the one under the last was fatal.

In order to tie up the defensive barrier, Tokyo used Western gunboat diplomacy to assert its hegemony over Korea, "a dagger thrust the heart of Japan." The Sino-Japanese clash in Korea eventually led to the war of 1894-95 between the two countries. With its defeat of China, Japan seized Taiwan and the Pescadores and made Korea a virtual protectorate. Japan also obtained the Liaodong Peninsula, the Manchuria's outlet to the sea. But the European powers were concerned about Japanese seizing of Port Arthur on the tip of the Liaodong Peninsula. Under the threat of war from Russia as well as France and Germany, Japan was forced to return the Peninsula after all. Russia, now linking up the South Manchurian and Chinese Eastern Railways, seized Port Arthur in 1897 and finally occupied all three provinces of Manchuria in 1900.

Japan's unfinished task required a war with Russia, but Japan needed to protect its back from France, an ally of Russia. Then Japan sought an alliance with Britain. The Royal Navy with a global network of bases was more powerful than the fleets of France, Russia and Germany combined.[14] Given its alliance with Britain, Japan could expect at least British sabotage against hostile Western countries' sea lines of communications across the Indian Ocean.[15] In fact, Britain did not sell coal to Russia during the Russo-Japanese War. Where there were no friendly or neutral ports, the Russian Baltic Fleet needed to be refueled at sea directly from German colliers, which delayed the Fleet's arrival in the Far East. Admiral Togo's victory over the Baltic Fleet — after its 18,000-mile voyage — in the Battle of Tsushima led to the brokered Japanese victory over Russia. Under the auspices of U.S. President Theodore Roosevelt, Japan finally seized the southern half of Sakhalin and retained supremacy in southern Manchuria and entire Korea. Japan thus finalized the originally-designed defensive barrier.

The Anglo-Japanese alliance was a strategic success. As a result of the Russo-Japanese War, Japan emerged as a dominant naval power in the western Pacific. Japanese naval dominance was endorsed by British sea control of the Indian Ocean. However, among the three strategic routes leading to the Far East, the Pacific Ocean still remained open. As a result of the Spanish-American War, the United States obtained the Philippines, Guam, Hawaii, eastern Samoa and Wake Island in the Pacific to endorse the Open Door Policy in China. President Roosevelt brokered the peace at Portsmouth to restore a balance of power in

East Asia. Hysterical alarms over Japanese immigration on the American Pacific Coast, followed by the worldwide voyage of the Great White Fleet, triggered a war scare across the Pacific. Thereafter both Japanese and American navies began to regard each other as a hypothetical enemy.

Despite its strong position in Northeast Asia and newfound national pride, Japanese leaders were still moved by a combination of ambition and insecurity.[16] After 1905, Japan faced three strategic problems — Russian revenge, Chinese nationalism and the rising American maritime power across the Pacific.[17] The Imperial Japan then attempted to reinforce its influence in China, while preparing a war with the United States. The first Imperial Defense Strategy of 1907 allowed the army to pursue its forward position on the Asian continent, while allowing the navy to fulfill an "eight-eight fleet," consisting of eight dreadnought battleships and eight armored cruisers.[18] Taking the advantage of turmoil in China after the 1911 revolution and the breakout of the War in Europe, Japan seized the German territories of Qingdao on the tip of the Shandong Peninsula and the mid-Pacific islands of Micronesia, which lay athwart the U.S. lines of communication to the Philippines.

The United States directed its spear to the Anglo-Japanese alliance. Washington regarded the alliance as endorsing Japanese adventurism in China, while allowing Japan to threaten American sea lines of communication in the western Pacific. As long as the alliance remained, the United States would be forced to expand its navy vis-à-vis a joint Anglo-Japanese naval power.[19] Then the United States hosted the Washington Conference of 1921-1922 to create a multilateral framework to guarantee Chinese territorial integrity as well as to cap the naval arms race among the United States, Great Britain and Japan.

Japan received significant strategic benefit from the Washington agreements at the cost of the alliance with Britain. The Washington system blocked the two strategic routes across the Indian and Pacific Oceans not by force but by international law, or a treaty system. The status quo in the Pacific was to be maintained by arms control and non-fortification agreements. The capital ship tonnage ratio was set as 5:5:3 among the United States, Great Britain and Japan reflecting each country's geographical location. There was to be a ten-year holiday on capital ship building as well. The balance of power in China was also to be maintained. Thus Japan agreed to withdraw its forces from Siberia and northern Sakhalin and to return the Shandong Peninsula to China. Under the Washington system, Japan — at least temporarily — gave up the search for dominance in the Far East, although there remained in the Japanese Navy a sense of grievance against the inferior fleet ratio vis-à-vis the U.S. Navy.

Although the Washington Treaty system retained the balance of power in the western Pacific and improved U.S.-Japan relations, the strategic route across Eurasia remained open. The Soviet Union, which was not a party to the Washington system, did not seek to maintain the balance of power in Asia as well as in Europe. Instead the Communist regime at-

tempted to set the capitalist powers at odds to foster revolution while securing its two borders in Europe and Asia. Soviet military and ideological threat, coupled with the rise of Chinese nationalism and the onset of the Great Depression, undermined the moderate leaders in Japan who supported the Washington Treaty system while leading to the rise of militarism.[20]

The militant Japanese Army embraced the mission of blocking the Eurasian route with the establishment of a puppet regime in Manchuria in 1931 and, met by tenacious resistance from the Chinese Nationalist-Communist united front, expanded the theater of combat across coastal China. The Western powers continued to support Chiang Kai-shek through the supply routes from the South China Sea via British Hong Kong and French Indochina and from the Andaman Sea via British Burma. With regard to the Soviet threat, the Japanese Army took the initiative and concluded an anti-Comintern pact with Germany of 1936, although a Nazi-Soviet nonaggression pact of 1939 made this anti-Conmintern pact obsolete. Japan witnessed the advancement of Soviet armament in a quasi-war along the Manchurian border in 1939 and thereafter sought a nonaggression pact with the Soviet.

The Washington treaty system now provided no security to Japan. With the advance of aviation as well as the reinforcement of bases in Singapore and Hawaii, the Japanese Navy had concluded by 1934 that it had become difficult for the Japanese fleet to conduct attrition-interceptive operations in the western Pacific with the inferior fleet ratio.[21] Then the Japanese Navy, led by an anti-Washington system faction, withdrew from the naval arms limitation arrangements in order to construct a formidable fleet, especially the *Yamato*-class superbattleships. On the other hand, as relations with the United States deteriorated by the Army's advance into China, the Navy became more concerned about a possible shortage of petroleum for its fleet and its aircraft. In those days, Japan imported 80 % of oil products, 90 % of gasoline and 70% of scrap iron from the United States.[22]

With Nazi Germany not only having conquered most of continental Europe, but also giving a false impression of Britain facing imminent defeat, Tokyo interpreted the situation in Europe as a fundamental weakness of the western democracies and signed the Tripartite Pact of September 1940 with the other Axis powers. The purpose of the Pact was to deter the Americans from supporting Britain, thereby not only strengthening Germany's and Italy's North African and Mediterranean campaigns, but also weakening Great Britain's colonies in Southeast Asia in advance of a Japanese invasion. However, this Tripartite Pact turned out to be fatal to Japan's survival, as it did not block any of the three strategic routes. The Pact linked the ongoing war in Europe and a war in the Pacific, and the American and British navies rendered the high seas too dangerous for maritime trade. Berlin expected a coordinated attack with Japan on USSR but Tokyo needed to sign a Neutrality Pact with Moscow in April 1941 to secure Japan's back while moving southwards.

4. Lessons from the Pacific War

Japan, eyeing the resources in Dutch East Indies, had begun its southern expansion in 1939, filling the power vacuum in Southeast Asia resulted from the war in Europe. In response to Japan's advance into South French Indochina, from which Singapore was within Japanese aviation's reach, in the summer of 1941, the United States, coupled with Great Britain and Holland, imposed a trade embargo on Japan, thus shutting off the supply of oil from the United States, the Persian Gulf, and the East Indies.

Japan's strategy for the Pacific War was to establish a defense perimeter around its home islands and the Southern Resources Area, from Rangoon, through the East Indies, Rabaul, and the Gilberts and Marshalls to Wake, while inducing the United States to agree to negotiations. After a carrier attack on the U.S. Pacific Fleet at Pearl Harbor, Japan seized Guam, the Philippines, Hong Kong, Singapore, and Wake, and created the defense perimeter in 90 days. Japanese carrier force also raided the naval bases on Ceylon to discourage British forces in the eastern Indian Ocean. Due to Japanese control of the gates along the Indonesian archipelago, the British Pacific Fleet, formed in November 1944, needed to pass south of Australia to reach the Pacific theater — a route 7,500 miles longer than an approach through the Malacca Straits.[23]

However, there existed a wide gap in Japan's defense perimeter between the Kurils and Wake.[24] In the Battle of Midway, Japan lost four carriers, 322 aircraft and many irreplaceable first-line aviators. With the weakening of Japanese naval power, Japanese offensive ended; the Allied counteroffensive began.[25] The dual Allied advance through the Southern and Central Pacific gradually eroded the Japanese defense perimeter along the offshore island chain off east Eurasia. Only stray Japanese ships and submarines operated in the Indian Ocean for the rest of the war because the power center was in the Pacific.[26] After the seizure of the Marianas, U.S. bombers began fire raids on Japanese cities, while the Allied submarines and aircraft destructed the sea lines of communication between Japan and the South Resources Area and China.[27] Thus, the U.S. submarine campaign against Japanese sea lanes led to the collapse of Japanese economy as well as the difficulty in logistical support for the Imperial Japanese Army based overseas. Finally, the atomic bombing, coupled with the Soviet invasion of Manchuria, induced Japan to surrender.

What lesson should be learned from the Pacific War? The security of Singapore, an island on the tip of the Malay Peninsula, was a vital interest of the United States.[28] The United States was not ready for a war with Japan over Japanese aggression in China. But freedom of navigation in the maritime highway linking the Pacific and Indian Oceans was much more vital for the United States, when there was a risk that Japan might link up with Germany in the Indian Ocean. It is not an exaggeration to say that the United States prepared itself for the war with Japan over freedom of navigation in the maritime highway. The Allied Powers could isolate Japan by unrestricted submarine warfare but the Imperial Navy, preoccupied with the Mahanian

doctrine of “decisive battle,” prepared insufficiently for the commercial raid. The Pacific War also revealed that the Pacific is open-ended and provides highways for the direct confrontation of hostile powers.[29] Once it fell into the hands of hostile maritime powers, the offshore island chain in the western Pacific provided no barrier to Japan. Although Japan continued to control the gates to the Indian Ocean, it had little effect on the defense in the Pacific theater.

5. The Development of Japan’s Maritime Strategy during the Cold War

As a result of the Pacific War, Japan became totally unguarded. It lost the control of the offshore island chain, and its Army and Navy ceased to exist while the new constitution renounced war. Given the outbreak of the Cold War in Asia, however, the United States desired Japan to become an anti-communist ally and initiated a generous peace treaty between the Free World and Japan because the Japanese archipelago constituted part of strategic island chain for the West vis-à-vis the two communist giants, the Soviet Union and China. The U.S.-Japan alliance was another strategic success, as it blocked all the three strategic routes, while securing Japanese sea lines of communication. By providing bases to the U.S. military, Japan could expect U.S. extended deterrence and long-range SLOC protection, while the United States could enjoy strategic mobility in the Pacific.

Under the San Francisco Peace Treaty system, Japan enjoyed high economic growth for two decades, while heavily depending on the United States for national and sea lane security. The United States encouraged Japanese trade with Southeast Asia as the substitute for the traditional China market while reducing direct American aid.[30] Between the 1950s and the 1970s, Japan’s national energy consumption steadily increased. By the early 1970s, oil had supplied 80% of Japan’s energy needs and 80 % of it was imported from the Middle East.[31] Thus the maritime highway along Eurasia between the Middle East and Japan via Southeast Asia had become the lifeline of Japan.

The lessons from the Pacific War changed Japan’s naval doctrine. Japan’s national survival rests on unimpeded economic activities via sea lines of communication. The protections of sea lines of communication as well as the defense of surrounding waters became the two primary missions for the new Japanese navy, JMSDF. By 1971, Japan had adopted three mid-term defense procurement programs under which Japan developed a moderate naval force with minesweeping and anti-submarine warfare (ASW) capabilities as well as monitoring capabilities of the three Straits of Tsushima, Tsugaru and Soya, through which the Soviet fleet at Vladivostok had to pass to enter the open ocean.

However, the Indian Ocean, which had been an “American lake” since the end of World War II, ceased to be so just two decades after.[32] From 1967, British withdrawal from the east of Suez drew the Soviet Navy into the Indian Ocean, especially from Vladivostok. An increasing Soviet naval presence in the Indian Ocean threatened the vital oil shipping lanes of key U.S. allies, including Japan.[33] Given the

growing threat on its sea lanes, Japan needed to evolve its maritime strategy. In the process of developing the fourth defense program, there emerged two contrary visions for the postwar Japanese navy, based on the lessons from the Pacific War: an ocean-going navy and a limited, small navy.[34]

The first vision, representing the navy circles, assumed that a *guerre de course* was a more likely conflict in the western Pacific than a Soviet invasion against Japan.[35] With Japan's geography and lack of natural resources, Japan would maintain its economic role in the Pacific in wartime, but the U.S.-Japan security arrangements might not work in an attack on Japan's sea-lanes. So Japan would reduce its shipping and limit its operating areas to the seas between Japan and Indonesia, Australia, and the United States. Since Japan could not control the Indian Ocean, Japan would depend on oil from these three countries, especially Indonesia. To secure the sea area north of Indonesia, Japan would set a "Maritime Safety Zone" between two chains of islands: eastern one running from the Bonin Islands to the Marianas, and western one running from the Ryukyus to Borneo. Japan's monitoring Tsushima, Tsugaru, and Soya Straits with various ASW measures would also restrict the operations of Soviet submarines. Such measures would not bring a victory over the Soviet Union but at least keep Japan's sea-lane open while making the attack on Japan's sea-lanes too costly.

The other vision, representing civilian defense planners, regarded the desire of Japanese naval officers to secure Japan's sea-lanes as "unrealistic dream."[36] It would be "unauthorized" for the JMSDF to defend Japan's sea-lanes that extended throughout the Pacific and Indian Oceans. It would be "unrealistic" for Japan to obtain sufficient equipment for the mission such as ship sonar and torpedoes. Lastly, it would be "impossible" for Japan to defend its sea-lanes from the Soviet Union, which was estimated to have 120 submarines in the Pacific. Although Japan developed monitoring capability in Tsushima, Tsugaru, and Soya Straits, the capability would not be enough. Instead, Japan should have a small navy with an effective, limited capability against invasion, while providing full access to U.S. bases in Japan as well as monetary support to U.S. fleet operating in the Pacific Ocean.

James Auer, who observed the history of the JMSDF, concluded in 1971 that the Japanese government had made no decision between the two visions. The reason was the government's "non-policy stance in defense." The Japanese government had allowed civilian defense planners to pursue their vision of a limited force, the leadership of the JMSDF, supported by conservative politicians and businessmen, to pursue its goal of a blue-water navy, and the powerful Ministry of Finance (MOF) to preserve defense budget low.[37] As a result of the compromises of the three as well as interference from the opposition parties, the Japanese government had no clear defense strategy and the JMSDF had no clear missions.

Japan's maritime strategy turned out to be somewhere in between the two visions. Japan's maritime strategy was to promote U.S.-Japan

cooperation in sea control in Japan's surrounding seas to restrict the operations of the Soviet fleet from Vladivostok to the Indian as well as the Pacific Oceans.[38] The key enabler of the U.S.-Japan maritime strategy was the homeporting of a U.S. carrier task force in Yokosuka, Japan.[39] Instead of the fourth mid-term defense procurement program, Japan adopted its first longer-term NDPG in 1976. The NDPG provided certain level of standard force structure of the JSDF listed in its annex in order to deal with a "limited and small-scale aggression," while expected U.S. assistance in case of a larger attack. On the other hand, the United States expected more burden sharing with Japan to meet the growing Soviet military threat in the Far East. Thus both Tokyo and Washington had incentive to strengthen military-to-military cooperation. Then the maritime strategy was integrated into the U.S.-Japan security arrangement with the conclusion of the 1978 U.S.-Japan Defense Guidelines, which divided the labor between Japanese and U.S. forces (Japanese shield and U.S. spear).

At the same time, the U.S. Navy was developing an aggressive maritime strategy in which its fifteen carriers strike groups were instrumental.[40] The Soviet Union was reinforcing its forces in the Far East, both nuclear and conventional, with deploying 140 submarines, 100 surface ships and TU-22M *Backfire* bombers and SS-20 missiles, in an attempt to make the Sea of Okhotsk a "sanctuary" for its SSBNs. The U.S. Maritime Strategy, made public in 1986, envisioned, in case of war fighting, a massive naval offensive against Soviet forces on both side ends of Eurasia to reduce the threat against the NATO ground forces in the center front line in Europe.

An essential part of the U.S. and Japanese maritime strategies was to build a high-technology air defense and ASW network around the Japanese archipelago to threaten the Soviets a two-front war.[41] Accordingly, Tokyo announced in 1981 that Japan would defend its surrounding waters up to hundreds of miles (the Sea of Japan) and sea lines of communication up to 1,000 nautical miles ("north of the Philippines, west of Guam"). Japan's ASW and air-defense capabilities were to be great both in quality and quantity by the introduction of 100 P-3Cs, Harpoon and Sea Sparrow missiles, 200 F-15s, modern surface-to-air Patriot system, and short-range, early-warning aircraft. Japan also decided to introduce the *Aegis* air-defense system.[42]

Thus Japanese ASW/air-defense network augmented the U.S. carrier strike group based in Yokosuka, and virtually contained the Soviet fleet within the Sea of Japan, restricting Soviet operations in the Indian as well as in the Pacific. Japan achieved territorial security and SLOC protection only by concentrating on ASW and air defense in the northwestern Pacific. As Auer aptly described later, it was a "hidden success story" that contributed much to ending the Cold War.

6. Japan's Maritime Strategy and the Rise of Chinese Naval Power

With the demise of the Soviet Union, Japan's maritime strategy seemed obsolete. Japan could contribute to the security of the West because of its proximity to the Soviet

Union, but Japan was too self-restricted to contribute to the security in areas along its vital sea lanes. Criticized its “checkbook diplomacy” during the 1990-1991 Gulf Crisis and War, Japan began making contributions to international security by the dispatch of minesweepers to the Persian Gulf in 1991. Japan also participated in U.N. Peacekeeping Operations (PKOs) in Cambodia, Mozambique, Golan Heights, East Timor, and so on. After the September 11, 2001 terrorist attacks, Japan dispatched tankers to the Indian Ocean to support the U.S.-led maritime security operation. Japan also dispatched ground and air forces to Iraq, while actively supporting maritime security initiatives, such as the Proliferation Security Initiative. To meet piracy challenges in the Straits of Malacca, Japan has contributed to capacity-building of coast guards in Southeast Asia. Since March 2009, Japan has deployed destroyers and P-3Cs to the Gulf of Aden for counter-piracy operations. Thus Japan has contributed to the security in Southeast Asia and the Indian Ocean region to keep its sea lanes open.

However, the Cold War is not over in the Far East. North Korean missile and nuclear programs posed a serious threat to Japan in the 1990s. It turned out that North Korea continued nuclear programs in violation of the 1994 agreed framework and conducted a nuclear test in 2006. North Korea remains a major security concern for Japan with its nuclear weapons, missiles and spy boats. Cross-Taiwan Strait relationship was another security concern. In response to Chinese missile exercise to intimate Taiwan during its first-ever presidential election of March 1996, the United States sent two carrier battle groups in the vicinity of Taiwan, which reminded a possible Sino-U.S. confrontation over Taiwan. For those security concerns, Tokyo revised the 1976 NDPG in 1995 so that the JSDF could contribute more to regional and global security. Tokyo and Washington reaffirmed the importance of their alliance for the Asia-Pacific region in 1996 and revised the Defense Guidelines in 1997 so that Japan can provide logistical support for U.S. troops in “situations in areas surrounding Japan.” Tokyo also decided to introduce the sea-based missile defense system in 2003.

Given the diversified threats after the Cold War, Tokyo adopted a more active security policy with the National Defense Program Guidelines (NDPG) of 2004. Under the NDPG, Japanese naval power now assumes a wide variety of roles — from missile defense and counter-proliferation to disaster relief/humanitarian assistance — while promoting partnerships with nations along its vital sea lanes through confidence-building and capacity building. The 2004 NDPG also called for remote islands defense given the growing strategic importance of those islands. Due to those security concerns in the Far East, however, Japan’s naval activities beyond the Far East have restrictions.

China’s growing maritime ambition raises grave concern for Japan’s maritime security. China is also creating a wider strategic buffer in the western Pacific vis-à-vis U.S. Seventh Fleet. After the Philippines unwisely kicked out the U.S. Navy from Subic Bay in 1991, Beijing reasserted territorial claims in the East and South China Sea. Chinese strategy con-

ceived two “island chains” as China’s maritime defense barrier.[43] The “first island chain” along the Ryukyus, Taiwan, the Philippines, and Borneo is no more than 200 nautical miles from Chinese coast and, China has enhanced A2/AD capability up to the “first island chain by purchasing from Russia Su-30 ground-attack aircraft, *Kilo*-class attack submarines, *Sovremmeny*-class destroyers with SS-N-22 missiles — all of which the Soviet Union had developed to target U.S. carrier strike groups — spending some one billion dollars annually.[44] China is also introducing *Shang*-class ultra-quiet nuclear-powered attack submarines. Chinese navy has also expanded operational areas into the high seas toward the “second island chain” running along the Bonins and Marianas.[45] The 2009 Japanese defense white paper showed concern over Chinese naval activities in and around Japanese waters, especially in the East China Sea and the Philippine Sea. For instance, a Chinese nuclear submarine was detected submerged in Japanese territorial waters near Okinawa in November 2004. In October 2006, a *Shang*-class submarine surfaced in the vicinity of the USS *Kitty Hawk* off Okinawa. Chinese surface warships passed though the Tsugaru Strait and the Ryukyu Islands in October and November 2008, respectively[46].

China also persists in a series of excessive maritime claim — or a legal warfare — as a sea denial strategy, for example by requiring Chinese approval for innocent passage in the territorial seas by foreign warships or by failing to recognize the airspace above its Exclusive Economic Zones (EEZs) as international airspace.[47] China actively conducts scientific surveys in Japanese EEZs in the East China Sea and the Philippine Sea. Such activities reached a peak in 1999, and 33 Chinese survey ships were detected. Japan and China reached an agreement on prior notification regarding scientific surveys in the East China Sea in 2001, but Chinese unreported maritime surveys in Japanese EEZs still continue. China justifies its scientific survey in Japanese EEZ around Okinotorishima Island, located between Guam and Taiwan on the ground that the island is just a rock. China needs to map the sea bottom so that its submarines could intercept U.S. aircraft carriers in a Taiwan contingency.[48]

While widening buffer in the western Pacific, China is developing footholds (or “pearls”) along its sea lanes as the ones in Myanmar and Pakistan to ensure SLOC and energy security. This “String of Pearls” strategy of bases and diplomatic ties may not be guided by Beijing.[49] But it at least explains what China is doing in the Indian Ocean. The strategy, pressing on both sides of the Malacca Straits, is against strategic interests of Tokyo and Washington.[50] New Delhi is also concerned about this strategy as those “pearls” are sandwiching India.[51]

Today, the vibrant global economy heavily rests on free and fair access not only to the sea, but also to the air, space and cyberspace. The United States has guaranteed their free and fair use, and U.S. military operations also require stability in those global commons. On the other hand, globalization has proliferated advanced military technologies and doctrines around the world, and some states are acquir-

ing asymmetric weapons for a sudden attack against overwhelming U.S. military power. In the Western Pacific, China not only develops conventional weapons such as surface ships, 5th generation fighters, and aircraft carriers, but also acquiring asymmetric weapons such as anti-ship ballistic missiles, anti-satellite attack capabilities, advanced sea mines, and cyber and information warfare capabilities[52].

To meet those new challenges at sea, the JMSDF designed a new naval doctrine.[53] This document defines three objectives of JMSDF as 1) defending Japan's surrounding waters, 2) establishing freedom of the seas, and 3) building a stable security environment. The document assumes "engagement strategy" for peacetime and "contingency response strategy" for wartime. Engagement strategy is a strategy to build more advantageous security environment for Japan in peacetime, in order to prevent and deter the emergence of any defense situation. Response strategy concerns issues and policies to be taken when deterrence fails and threats reach Japan and aims to provide swift response to, and elimination of, threats against the nation. In peacetime and wartime, intense intelligence, surveillance, and reconnaissance (ISR) activities in the sea area connecting Tokyo, Guam, and Taiwan ("TGT Triangle") are critically important since most of Japanese merchant ships pass through this sea area. This sea area is also important as a maritime "bridgehead" for the reinforcements from continental United States. Engagement strategy aims to strengthen partnership with the United States and other like-minded nations to secure good order at sea in the TGT Triangle and the waters in Southeast Asia, South Asia, Oceania, and the Middle East. In terms of response strategy, the JMSDF strengthens ISR, especially ASW capability, to support the U.S. Navy's operations.

To meet the challenge of growing Chinese naval power, the Cold War maritime strategy is still relevant. U.S.-Japan combined naval power could be used to prevent Chinese naval power from reaching the Indian Ocean by restraining the Chinese fleet in the northwestern Pacific. Japan continues to host a *Nimitz*-class carrier, USS *George Washington* at Yokosuka. Although Japan's geographical position is less advantageous vis-à-vis China today than the Soviet Union during the Cold War, the 2010 NDPG properly shifted Japan's strategic focus from the north to the south, namely the Ryukyu island chain. Under the new NDPG, Japan will possess 48 destroyers, including 6 Aegis destroyers all capable of intercepting ballistic missiles and 4 13,500-ton "helicopter carriers," 22 submarines, 10 next generation ASW patrol aircraft (P-1), and 12 new fighters to reinforce sea control of the TGT Triangle. The JSDF will upgrade its ISR capabilities such as outer and cyber space situational awareness as well.

On the other hand, the JMSDF needs to continue global security activities, especially counter-piracy operations in the Gulf of Aden, to keep the global sea lanes open. But Japan's concern for its territorial security hinders contribution to SLOC security. For example, Japan dispatched an Aegis destroyer to the Indian Ocean in 2002 as part of its support for anti-terror operations at sea but it needed to send it back home to defend homeland from

intensified North Korean nuclear program. The growing Chinese naval power in the Western Pacific will further restrain Japanese naval contribution to the SLOC security. Although there is no hope of increase in defense budget, the JMSDF needs to develop a operational posture for rapid long distance deployment. For more efficient use of destroyers, all Japanese destroyers that formerly belonged to District Fleets now have come under the Escort Fleet, a sea-going element of the JMSDF Fleet, so that the JMSDF Fleet can be the force provider. The JMSDF is also strengthening partnership with the U.S. Navy and other like-minded navies of South Korea, Australia, India, ASEAN members, and EU/NATO.

7. Conclusion

There are three strategic lines of communication that bring threat to Japan: the Indian Ocean, the Pacific Ocean, and the Eurasian landmass. Thanks to its insular position and the lack of China's maritime ambition, Japan enjoyed security from foreign threat until the mid-19th century. Faced with the threat from the Western powers, Japan developed geostrategy for survival. The Anglo-Japanese alliance and the Washington Treaty were strategic success as they increased security by controlling two of the three strategic lines of communication. On the other hand, the Tripartite Pact was a fatal error as it failed to control one of the three. The Tripartite Pact forced Imperial Japan to develop a full-fledged navy, which only invited hostility from the global naval powers. The U.S.-Japan alliance is the most successful one as it controls all the three lines of communication. Due to the geopolitical constrain, Japan will not seek a full-fledged navy. The U.S.-Japan alliance will continue to be the best tool for Japanese maritime strategy, as any naval arms control regime is unrealistic under the current security environment.[54] But the JMSDF needs to play greater role to supplement the relative decline of the U.S. sea power.

Outbreak of piracy is a barometer of hegemonic power. History tells that piracy thrives when the power of a hegemon declines, and continues to flourish until addressed by another hegemonic power. Recent outbreak of piracy in Southeast Asia and then in the Horn of Africa indicates the relative decline of U.S. sea power. The United States still maintains the strongest navy in the world, but it now has only 282 ships compared with 6,678 in 1945 and 570 in 1990.[55] Given that maintaining one ship on station typically requires three ships — one on maintenance, one on training, and one on deployment — the U.S. Navy can never deploy more than 100 ships at sea at any given time, and these ships are spread all over the globe.[56] The U.S. Navy cannot secure the global SLOC alone any longer.

Under the U.S.-Japan alliance, the United States has provided extended deterrence and long-range sea-lane protection for Japan, while Japan has guaranteed U.S. regional presence and strategic mobility by providing bases for U.S. armed forces. This alliance structure is premised on U.S. hegemony. However, the United States is losing its dominance in the Pacific and Indian Oceans, although it is still an indispensable power. Japan is one of the primary beneficiaries of the free trade system under the U.S. leadership, and Japan needs to

contribute more to the maintenance of good order at sea with the United States.

The U.S. military faces a major basing disadvantage in the Western Pacific. U.S. major bases located in Japan and Guam are all under Chinese weapons systems. The development of Chinese asymmetric warfare capabilities has made those U.S. bases and forward-deployed forces more and more vulnerable. The 2010 Quadrennial Defense Review addresses this fact and the U.S. Navy and Air Force has already agreed to develop Air-Sea Battle concept to maintain conventional superiority, while defeating asymmetric warfare under anti-access security environment.[57]

In August 2009, Japan experienced its first real change of government when the Liberal Democratic Party (LDP), which had ruled the country since 1955, lost power. However, the new ruling party, the Democratic Party of Japan (DPJ), called for an "equal alliance" with the United States, and its naïve foreign policy has damaged the alliance, which formed the backbone of the country's global positioning for more than a half of a century, while making regional countries worried about the direction of Japan's foreign policy course. In the meantime, North Korea sank a South Korean warship in March 2010 and ten Chinese warships conducted a demonstration cruise in Japanese waters in April 2010. DPJ's mismanagement of the U.S.-Japan alliance fueled Chinese and Russian boldness as well. China reinforced its claim over the Japanese territory of Senkaku Islands in the East China Sea, while Russian President Dmitry Medvedev's visit to the Norther Territories, which has been illegally occupied by Russia since 1945.[58]

Since U.S. military dominance in the Western Pacific has been the key to stability and prosperity in the Asia-Pacific for decades, it is urgent to revamp the U.S.-Japan alliance. The primary objective of Japan's maritime strategy is the maintenance of military balance in the Western Pacific that favors the United States. Although they maintain leading-edge conventional military capabilities, Japan and the United States need to enhance its capability to defeat asymmetric threats. Japan needs to join the United States to develop the AirSea Battle concept, while taking measures to ensure free and fair access to the global commons.

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1 The English text of the NDPG will be available at the Ministry of Defense website, http://www.mod.go.jp/e/d_act/d_policy/national.html; the NDPG was first announced in 1976 and revised in 1995 and 2004.

2 For the definition of geopolitics and geostrategy, see Jakub J. Grygiel, *Great Powers and Geopolitical* Change (Baltimore: The Johns Hopkins University Press, 2006), especially Chapter 2.

3 Nicholas John Spykman, *The Geography of the Peace* (New York: Harcourt, Brace and Company, 1944), p. 24.

4 Robyn Lim, *The Geopolitics of East Asia: The Search for Equilibrium* (NY: Routledge, 2005), p. 7.

5 Yasunobu Somura, *Umino Seijigaku: Umiwa Dareno Monoka* [politics of the sea: who owes the sea?] (Tokyo: Chuo Koron Sha, 1988), pp. 3-9.

6 Ibid., pp. 18-20.

7 In 1274 and 1281, Kublai Khan, leading massive Mongolian expeditionary forces, attempted to invade Japan from the southern part of the Korean Peninsula, but the "divine wind" or *Kamikaze* scattered and sank much of the invasion fleet on both occasions.

8 Lim, *The Geopolitics of East Asia,* pp. 4-5.

9 Among the Western powers, only the Protestant Dutch were permitted to trade via a tiny island of Dejima in Nagasaki.

[10] Walter LaFeber, *The Clash: U.S.-Japan Relations throughout History* (New York: W.W. Norton & Company, 1997), p. 8.
[11] Lim, *The Geopolitics of East Asia,* p. 9.
[12] E.B. Potter, ed., *Sea Power: A Naval History*, 2nd ed. (Annapolis: United States Naval Institute, 1981), p. 164.
[13] Kiyoshi Ito, *Taiwan: Yonhyakunenno Rekishi to Tenbo* [Taiwan: 400-year history and prospects] (Tokyo: Chuo Koronsha, 1993), p. 65; the English translation of this book is available at http://www.china-institut.org/bibliothek/geschichte%20taiwans.pdf.
[14] Lim, *The Geopolitics of East Asia*, pp. 29.
[15] The Anglo-Japanese Treaty stated that if either country was attacked by another country, the co-signatory would maintain benevolent neutrality. If it was attacked by two or more countries, the co-signatory was committed to go to war on behalf of the ally.
[16] Kenneth B. Pyle, *Japan Rising: The Resurgence of Japanese Power and Purpose* (New York: Public Affairs, 2007), p. 96.
[17] Lim, *The Geopolitics of East Asia*, p. 38.
[18] Pyle, *Japan Rising*, p. 96.
[19] Sadao Asada, *From Mahan to Pearl Harbor: The Imperial Japanese Navy and the United States* (Annapolis, Naval Institute Press, 2006), p. 67.
[20] Lim, *The Geopolitics of East Asia*, p. 37.
[21] Asada, *From Mahan to Pearl Harbor*, p. 187.
[22] Waldo Heinrichs, *Threshold of War: Franklin D. Roosevelt and American Entry into World War II* (Oxford: Oxford University Press, 1988), p. 7.
[23] A.P.S. Bindra, "The Indian Ocean as Seen by an Indian," *U.S. Naval Institute Proceedings* (May 1970), p. 185.
[24] Potter, *Sea Power*, p. 293.
[25] Ibid., p. 301.
[26] Bindra, "The Indian Ocean," pp. 185 and 187.
[27] The Japanese merchant marine lost 8.1 million tons of vessels during the war, with submarines accounting for 4.9 million tons (60%) of the losses. U.S. submarines sank 700,000 tons of naval ships (about 30% of the total lost) including 8 aircraft carriers, 1 battleship and 11 cruisers.
[28] Lim, *The Geopolitics of East Asia*, p. 7.
[29] Bindra, "The Indian Ocean," p. 187.
[30] Michael Schaller, *Altered States: The United States and Japan since the Occupation* (New York: Oxford University Press, 1997), p. 49.
[31] Agency for Natural Resources and Energy, Ministry of Economy, Technology and Industry, *Energy in Japan 2006: Status and Policies* (March 2006), pp. 5 and 22.
[32] Bindra, "The Indian Ocean as Seen by an Indian," p. 200.
[33] Lim, *The Geopolitics of East Asia*, p. 109.
[34] James E. Auer, *The Postwar Rearmament of Japanese Maritime Forces, 1945-1971* (New York: Prager Publishers, 1973), p. 143.
[35] This view was typified by CDR Hideo Sekino (ret.). The "Sekino vision" was described in Auer, *The Postwar Rearmament*, pp. 139-143.
[36] This view was typified by Osamu Kaihara, a civil official in the Japan Defense Agency. The "Kaihara vision" was examined in Auer, *The Postwar Rearmament*, pp. 134-139.
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Exchange of water and heat at latitude 6° N in the Bay of Bengal

Kazuyuki Maiwa*

Abstract

The seasonal variations of the vertical structure of temperature, salinity and geostrophic velocity at latitude 6° N in the Bay of Bengal have been investigated, using the temperature and salinity data obtained from XBT/XCTD measurements from September 2000 to October 2005 by the cruises of the M/T KATORI. The results of past studies were confirmed by this study, that the variation of the thermal structure clearly shows that Rossby waves propagate westward at the depth of about 100m with the semiannual signal originated from the equator and that the effects of the local Ekman pumping change the amplitude of the signal. The variation of the salinity corresponded qualitatively with the variation of the rainfall. The seasonal variations of the geostrophic velocity relative to the depth of 400m and the volume transport show the contribution of the Southwest Monsoon Current (SMC) and the East India Coastal Current (EICC) to the water exchange between the interior and the exterior of the Bay. West of longitude 85° E, the SMC carries the water from the exterior to the Bay during summer and the EICC to the exterior during winter. Both net volume and heat transports calculated by the geostrophic velocity at 6° N take their maxima in May. It turns out that the generation of cyclones in the Bay is restricted in the following two periods; May and October to January. The periods are almost consistent with the months with the positive heat transport except for the summer monsoon season. In the future studies, prediction and means of prevention will be discussed of disasters in the coastal countries around the Bay of Bengal, being based on the findings of this work with much deeper understanding of the feature.

Key words: XBT/XCTD data, The Bay of Bengal, Monsoon, Southwest Monsoon Current, East India Coastal Current, Cyclones

1. Introduction

The Indian Ocean is geographically different from other oceans of the world. The Eurasian continent in the northern boundary causes seasonally reversing monsoonal winds north of about latitude 10° S. In boreal summer (winter), the winds are southwesterly (northeasterly), referred to as the Southwest Monsoon (the Northeast Monsoon) (Fig. 1). The winds are relatively weak in two transition periods (spring and autumn).

The wind system gives the dynamically complex circulation in the ocean. South of the Indian subcontinent, for example, the Southwest Monsoon Current (SMC) flows eastward in summer, while the Northeast Monsoon Current (NMC) flows westward in winter. Other current systems such as the

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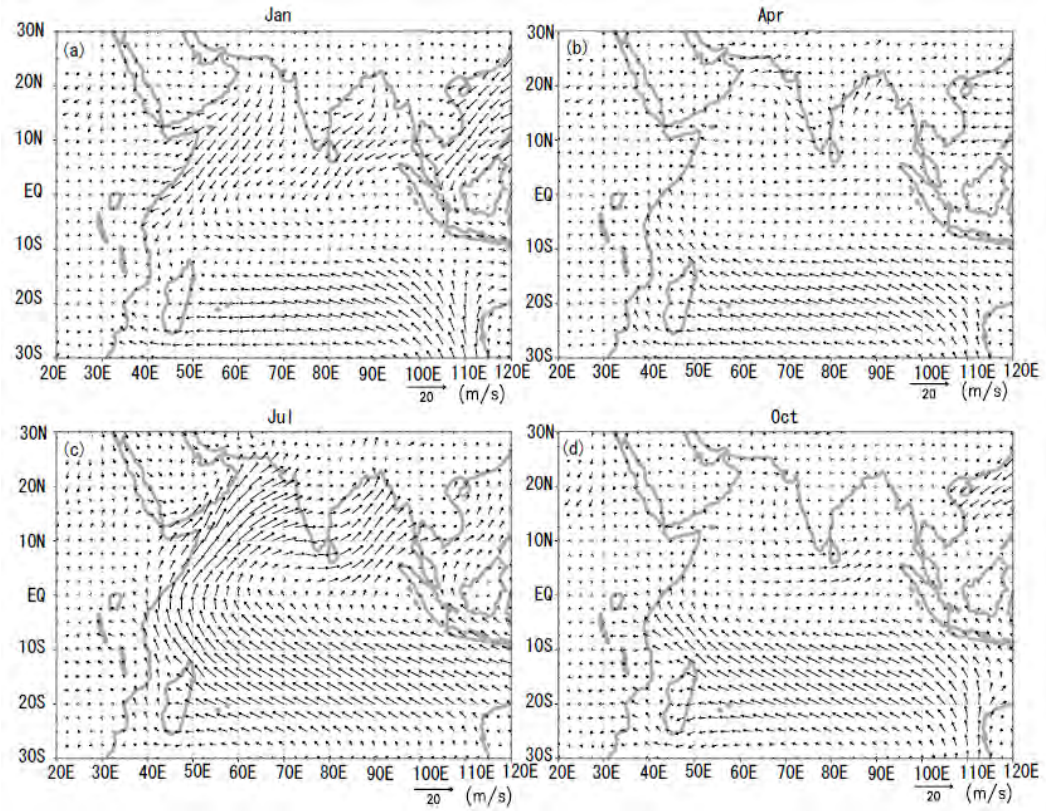

Figure 1: Monsoon wind fields for the Indian Ocean from the NCEP/NCAR reanalysis for a) January, b) April, c) July, d) October.

Somali Current off Somalia also change the direction due to the monsoon.

Other dynamical phenomena in the Indian Ocean are also unique. The schematic diagram (Fig. 2) shows topics of interest to researches in the Indian Ocean. In the equatorial region, strong eastward currents in the surface are excited as a direct response to switching the wind directions from easterly to westerly during the transition periods (Yoshida, 1959; Wyrtki, 1973; O'Brien and Hurlburt, 1974). They are normally called as (Yoshida-) Wyrtki Jets or Equatorial Jets. The speed of the currents exceeds 100cm/s and is somewhat higher in the autumn than in the spring (Schott and McCreary, 2001). The Indonesian Throughflows play a crucial role in exchanging water mass, heat and fresh water between the Pacific and the Indian Oceans and in the global thermohaline circulation. The Indian Ocean Dipole (IOD) has been recognised as a critical manifestation of the tropical air-sea coupled system (Saji et al, 1999, etc.). A positive event, the negative pole of the sea surface temperature anomaly in the east of the tropical Indian Oceans and the positive in the west, tends to generate a severe drought in the surrounding land areas in the east and a catastrophic flood in the west.

The latitude 6° N roughly divides the Indian Ocean into the two Seas. The Arabian Sea in the west undergoes remarkable changes of circulation patterns during both

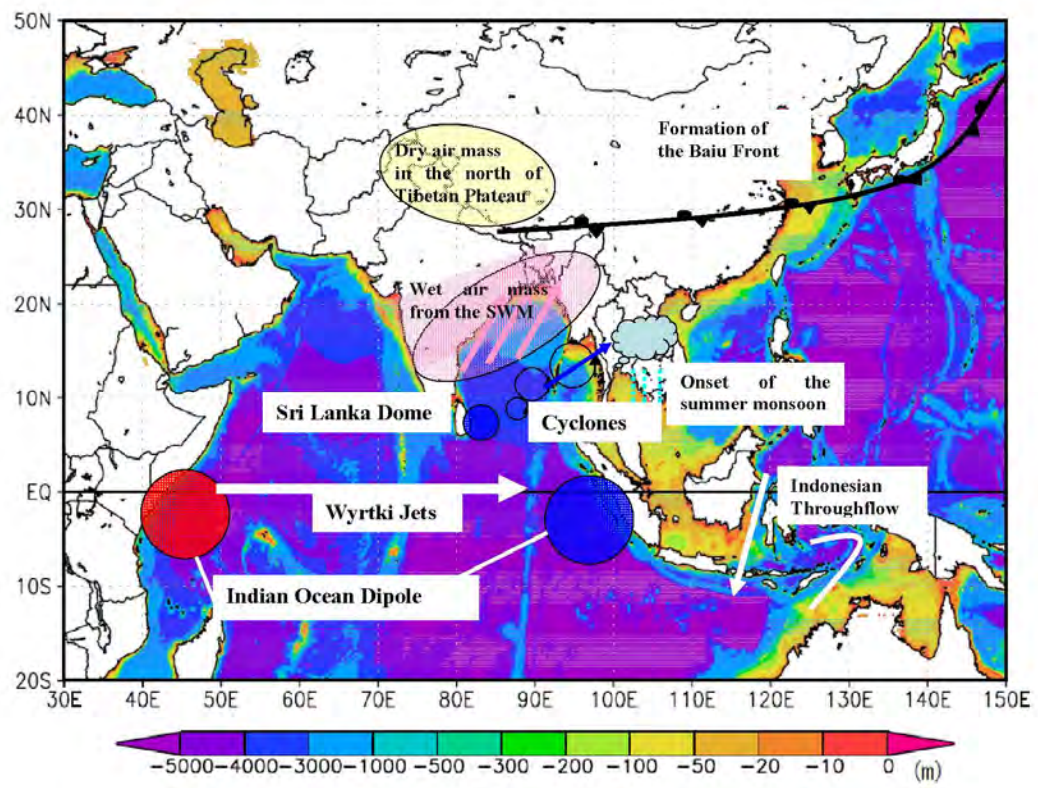

Figure 2: Schematic representation of the dynamical phenomena in the Indian Ocean together with topography.

monsoons and has relatively higher salinity than the Bay of Bengal because of the intense evaporation in the Arabian Sea and the immense quantities of fresh water by way of heavy precipitation as well as by river runoff in the Bay (Vinayachandran and Shetye, 1991).

The Bay is one of the most important and interesting research fields. Variability in the Bay due to the air-sea coupling has considerable impacts on peripheral countries and inhabitants there. An oceanic cold dome east of Sri Lanka is formed in response to the cyclonic wind-stress curl during the Southwest Monsoon (Vinayachandran and Yamagata, 1998). The dome potentially plays an important role in fisheries around Sri Lanka because it brings rich nutrients near the surface through upwelling (Vinayachandran et al., 2004). Cyclones generated in the Bay develop in the south east of the Bay or in the Andaman Sea and cause storm surges associated with coastal floods that constitute the world's foremost natural hazards (Murty et al., 1986). Additionally, latent heat release from the cyclones is considered as a trigger for the onset of the Asian summer monsoon (Orgill, 1967; Eguchi, 1996). The Baiu front is generated between wet air mass advected from the Bay and dry air mass above the Tibetan Plateau.

The large-scale circulation of the Bay and its western boundary current (the East Indian Coastal Current; EICC) has been researched from the ship-drift data and the data measured by the hydrographic survey on board (Legeckis, 1987; Shetye et al., 1991a,b, 1993, 1996; Murty et al., 1992; Suryanarayana et al., 1993). They showed the presence of a basin-scale gyral circulation and the EICC with seasonally reversing characteristics in its direction. Since TOPEX/Poseidon satellite with two radar altimeters and precise orbit determination systems was launched in 1992, analyses of the data obtained from the satellite refined the view of the circulation and the seasonal reversal of the EICC (Basu et al., 2000; Eigenheer and Quadfasel, 2000). The interest in the past studies has then been focused on the seasonal evolution and the driving mechanisms (Potemra et al., 1991; Yu et al., 1991; McCreary et al., 1993; 1996b; Shankar et al, 1996). They have discussed the roles of four mechanisms in the formation of the circulation and the EICC; 1) remote forcing from the equator, 2) alongshore winds adjacent to the northern and eastern coasts, 3) interior Ekman pumping and 4) local alongshore winds adjacent to the Indian and Sri Lankan coasts. In particular, McCreary et al. (1996b), extending a linear numerical model by Shankar et al. (1996), found the contributions of the mechanisms to the EICC to change along the coast and at the time of the year. For example, at 8° N during the summer monsoon, the large effect from the interior Ekman pumping contributes to reversing the direction of the EICC from north to south, compensating the effects of the local alongshore winds.

Exchange of water and heat between the interior and the exterior of the Bay is important for the dynamical phenomena in the Bay. Using XBT data and altimetry data from TOPEX/Poseidon, Vinayachandran et al. (1999) investigated the role of the SMC in the interbasin water exchange between the Bay and the Arabian Sea. In order to understand the interannual variability of the Bay, Yu (2003) examined the thermocline variability on seasonal timescales as the first step, using XBT data along 6° N.

In spite of many studies mentioned above, the subsurface variations have not been focused in terms of the water and heat exchanges between the interior and the exterior of the Bay. The subsurface variations are investigated in this study on a seasonal timescale using temperature and salinity profiles obtained from XBT/XCTD measurements on board of the commercial ship cruising in the mouth of the Bay. Being based on these data, the exchange of the water and heat are estimated.

2. Data and Data Processing

2.1 Data

At the 1758 locations in the Arabian Sea and along the mouth of the Bay of Bengal approximately at latitude 6° N, XBT/XCTD profiles had been observed by cooperative operation between Japan Meteorological Agency (JMA) and the Japan Agency for Marine-Earth Science and Technology (JAMSTEC), using the M/T KATORI, a tanker carrying oil from Persian Gulf countries to Japan, from September 2000 to October 2005. The profiles extended from about 100m to 1000m depth and the samplings were irregular in space and time. The distribution of data along the cruises in time and space is shown in Fig. 3.

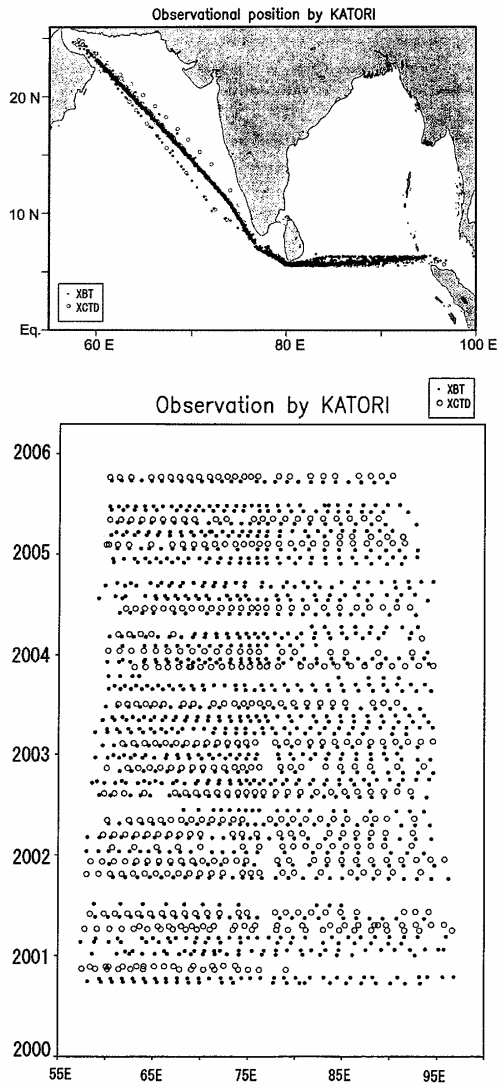

Figure 3: The distribution of data along the cruises in time and space.

The observed temperature, conductivity and estimated salinity, are stored at 1m depth. In order to remove abnormal profiles and detection error, a quick check by eye is applied for each temperature and salinity profile. The data are vertically averaged into bins of 10m. For the temperature, the data that have larger or smaller than three-standard-deviations (3σ) are also removed.

Climatological data of temperature and salinity from World Ocean Atlas 2009 ((WOA 09), Locarnini et al., 2009; Antonov et al., 2009) are utilised to estimate salinity profiles from XBT data and be compared with the observed data. The data are binned onto a one-degree grid in longitude and latitude.

2.2 Data Processing

In order to estimate the salinity from the XBT data, the following processing was carried out. The temperature and salinity data from the WOA09 are averaged spatially onto a box of 2.0° in longitude ×2.0° at the centre of latitude 6.5° N from longitude 80.5° E to 92.5° E. The spatially boxed data are linearly interpolated onto every 10m level in the vertical. The spline interpolation is performed to the boxed data in 0.1℃ intervals to the TS diagrams. Values of salinity are estimated by choosing values equivalent to temperatures from the XBT for each cruise, using the TS diagrams from the WOA09 data of each month and each box. For values of salinity that duplicate in a value of temperature at the process of the spline interpolation, the data are subjected to its depth.

These data together with the XCTD data are linearly interpolated onto the 1° grid. The space with continuously missing data over 2° are excluded from the interpolation. Three-point filter with weights, 0.5:1.0:0.5, is spatially applied to the gridded data (Yu, 2003). Monthly temperature and salinity sections are then constructed by averaging the data for each month.

3. Characteristics of temperature and salinity at latitude 6° N in the Bay

3.1 Annual mean

Figure 4 shows annual means of temperature and salinity structures in the upper 400m from the XBT/XCTD data averaged over the period of the observation and the WOA09 climatological annual mean (the average of five "decadal" climatologies for 1955-1964, 1965-1974, 1975-1984, 1985-1994 and 1995-2006). The temperature structure from the XBT/XCTD data well represents the one of the WOA09. The salinity structure is well reproduced by the XCTD data and estimated data using the temperature sections from the XBT data. Averaged differences in temperature and salinity over the section between the XBT/XCTD data and the WOA09 are about 0.21℃ and 3.2×10^{-2}psu, respectively. The maximum (minimum) difference between the data for temperature and salinity is about 1.24℃ (2.6×10^{-4}℃) at 82.5° E and the depth of 60m (85.5° E and the depth of 280m) and 0.35psu (9.9×10^{-5}psu) at 80.5° E and the depth of 30m (81.5° E and the sea surface). A layer on which temperature drastically changes at the depth exists around 100m. The isotherm of 28℃ in the west is shallower than in the east. The

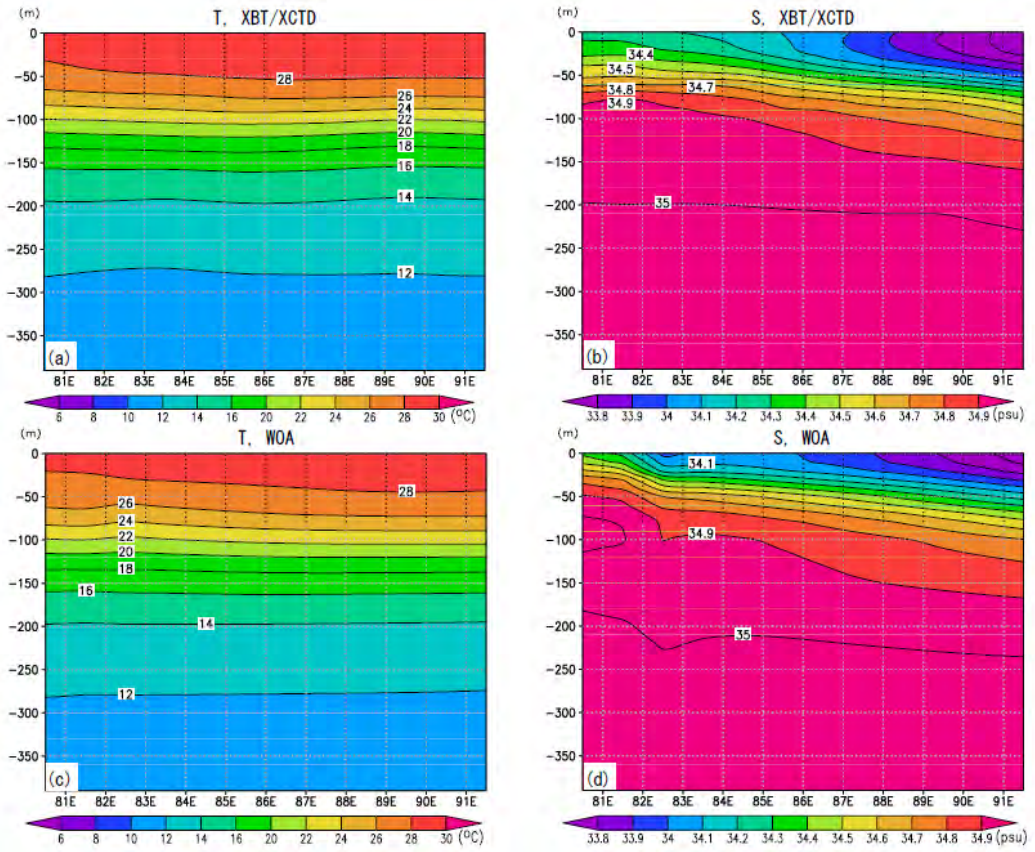

Figure 4: Annual mean of the vertical structures of temperature for a) the XBT/XCTD data and c) WOA2009 and salinity for b) the XCTD data and the estimated data from the XBT and d) WOA2009. The contour intervals are 2.0℃ for temperature and 0.1psu for salinity.

surface salinity in the east is lower than in the west. Figure 5a shows an annual mean of accumulated rainfall at 6° N, calculated from the satellite data of the Tropical Rainfall Measuring Mission (TRMM). The rainfall in the east of 85° E is higher than in the west. This is one of the possibilities that cause the salinity to lower in the western part of the Bay's mouth.

The temperature above the depth of about 100m of the XBT/XCTD data is higher than that of the data of the WOA09. This fact deserves some notice. The current warming trend in the global temperature will probably make the difference, as the WOA09 data is the average of the five "decadal" climatologies.

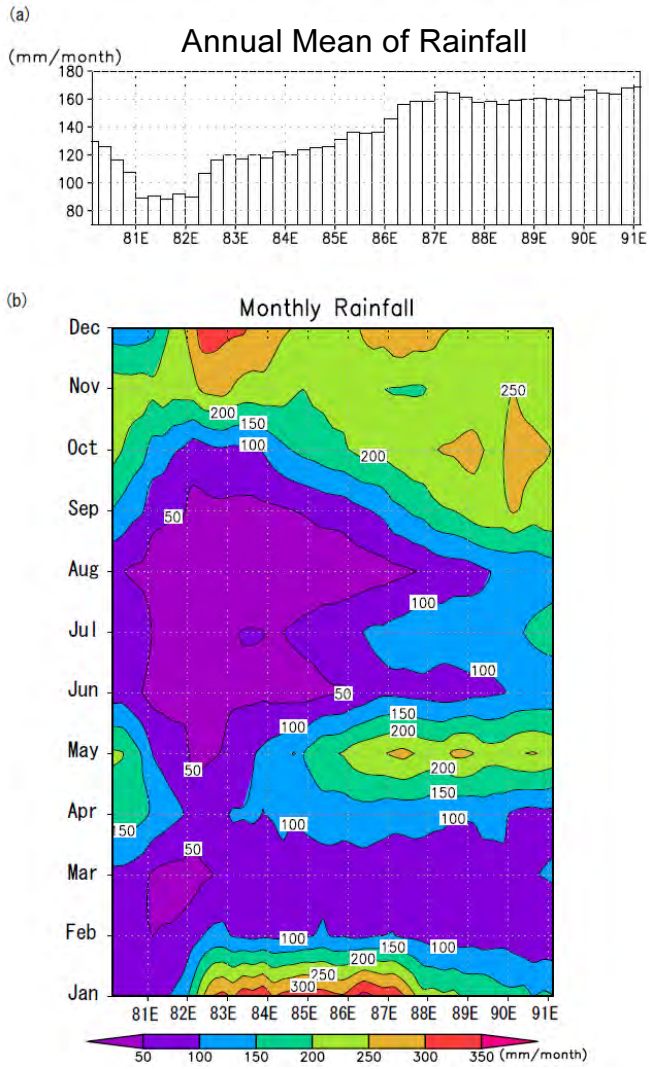

Figure 5: (a) Annual mean of the accumulated rainfall at 6° N and (b) the seasonal variation of the rainfall from satellite data of the Tropical Rainfall Measuring Mission (TRMM) (ci=50mm/month).

3.2 Seasonal variability

3.2.1 Temperature

Figure 6 shows a seasonal variation of the vertical temperature structures obtained from the XBT/XCTD data. Spatially averaged sea surface temperature (SST) does not generally change throughout the year and takes its maximum of about 29.94℃ in April and its minimum of 28.02 ℃ in August. The thermocline exists around 100m depth.

In order to verify the monthly data analysed from the XBT/XCTD and clarify the seasonal variations in the subsurface, seasonal anomalies of temperature were calculated by removing the annual mean, and investigated in comparison with the past studies. Figure 7 shows a seasonal variation of the anomalies. In May and November, positive anomalies between the depths of 100m and 150m at the eastern edge of the sections are observed. Subsequently, the anomalies propagate westward and their centres reach 85.5° E in July and January. Similarly, the negative anomalies in the east in February and September propagate to the west. The propagation speed is about 17cm/s, which is close to the non-dispersive phase speed of second baroclinic Rossby waves of 21cm/s estimated theoretically by Yang et al., (1998), while Yu (2003) estimated the speed

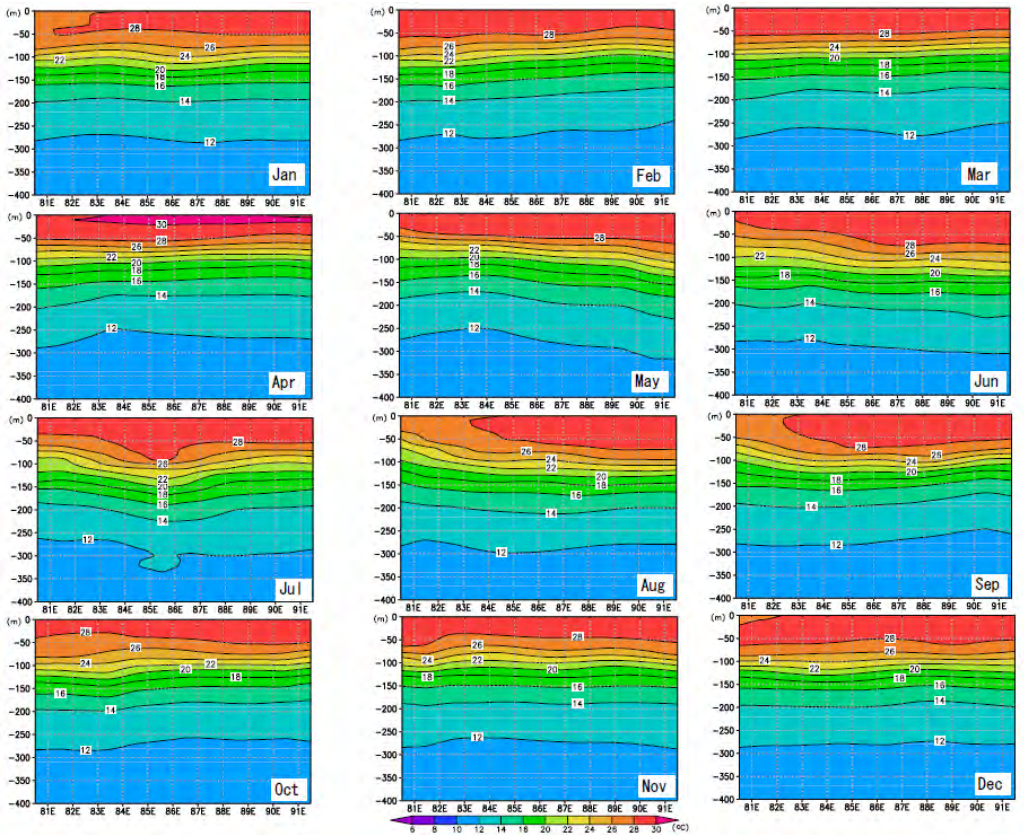

Figure 6: Seasonal variation of the temperature (ci=2.0℃).

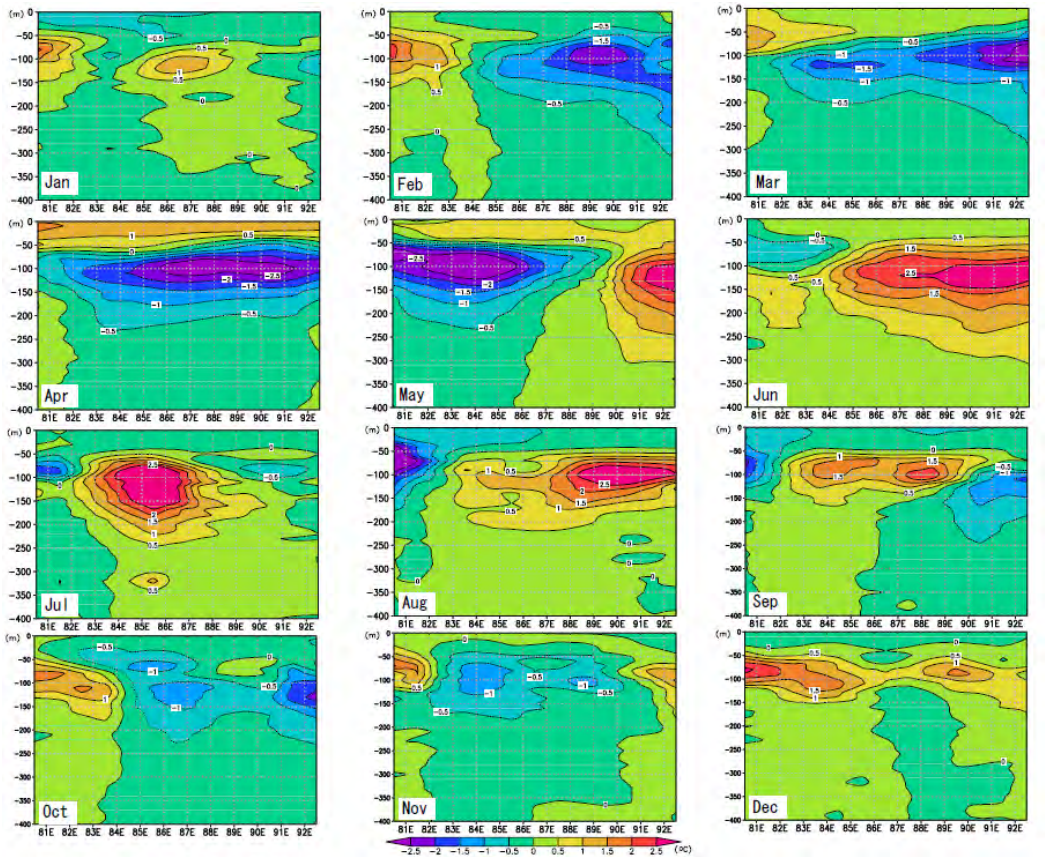

Figure 7: Seasonal variation of the temperature anomaly (ci=0.5℃).

of 24cm/s obtained from the different XBT data. As stated above, the propagation cycles with positive and negative subsurface temperature anomalies occur twice a year (semiannual periodicity). According to Yu (2003), the semiannual signal is originally excited in the equator and propagates eastward to the western coast of the Sumatra Island by equatorial Kelvin waves and northward along the Island by coastal Kelvin waves, and reaches the eastern boundary of the Bay. And then, the waves reflect from the boundary and propagate westward by Rossby waves. The Wyrtki jets play a significant role in the propagation of the waves in the equator. These waves affect the oceans as a remote forcing. The amplitude of the anomalies of the first cycle (February to July) is larger than the second one. Figure 8 shows the seasonal variation of the wind-stress curl ($\nabla \times \tau$) at 6° N in the Bay. The annual variability in the east of about 85° E suggests that the effect of the local Ekman pumping (upwelling in the positive curl and downwelling in the negative curl) contributes to the difference of the amplitude between the first and the second cycles.

Another positive anomaly at the centre of about 90° E and the depth of 100m in August is also a dynamical signal. The wind-stress curl

is negative between May and September (Fig. 8). When the signal from the equator propagates to the west of 85° E in August, the negative curl has the effect to descend the thermocline (downwelling) at the location by itself.

All the dynamical forcings here are associated with the changes of the wind directions due to the monsoon in the Indian Ocean. The results reconfirm the semiannual characteristics of the temperature anomalies along the mouth of the Bay from the data used in this study.

3.2.2 Salinity

Figure 9 shows a seasonal variation of the vertical salinity structures from the XCTD data and the estimated data from the XBT. The spatially averaged sea surface salinity (SSS) changes from 33.54psu in April to 34.44psu in August. The salinity above the depth of about 100m in the east is lower than in the west from June to December. Around the centre of the mouth of the Bay, the salinity above the depth of 50m is relatively low from January to May. A sharp pycnocline exists and deepens eastwards.

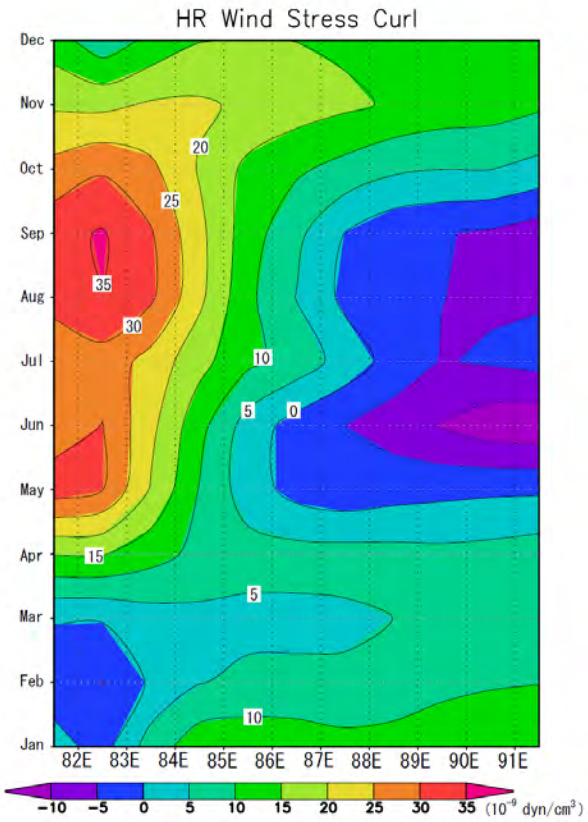

Figure 8: Seasonal variation of the wind-stress curl from Hellermann and Rosenstein wind-stress ($ci=5\times10^{-9}$dyn/cm^3).

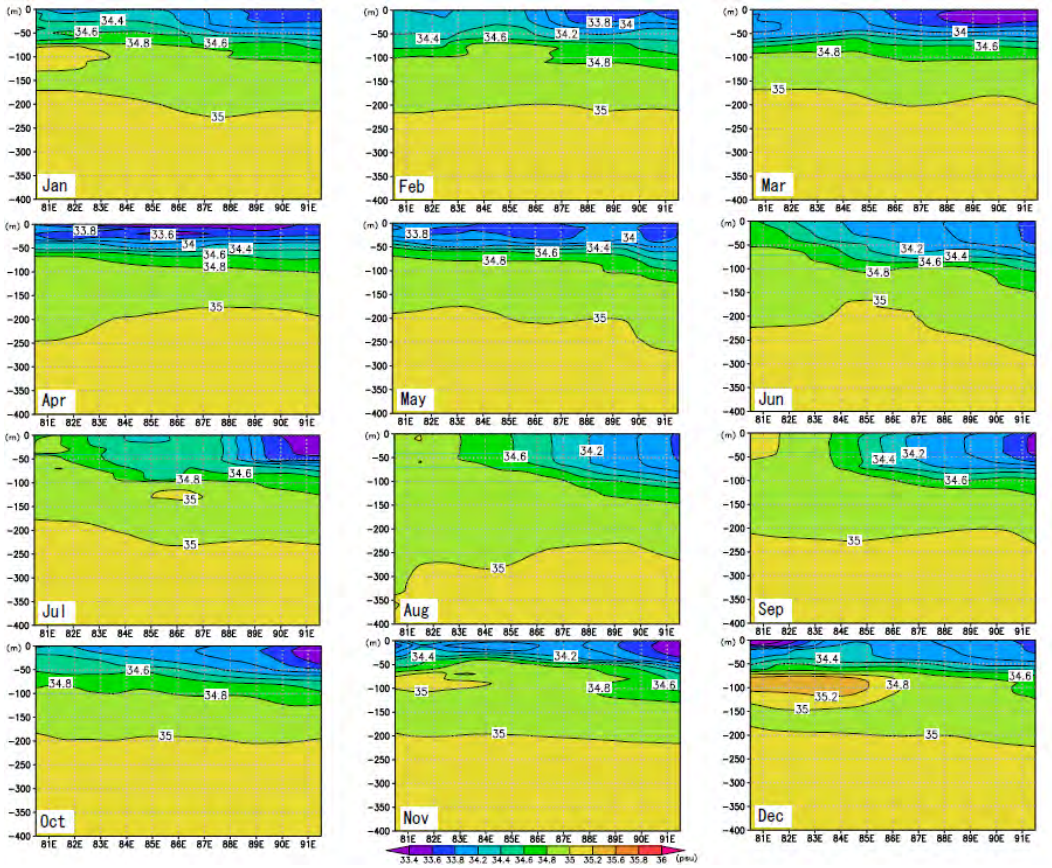

Figure 9: Seasonal variation of the salinity (ci=0.2psu).

Figure 5b shows monthly accumulated rainfall from the satellite data of the TRMM averaged over the observation period of the XBT/XCTD. The semiannual signal of the rainfall is clearly seen. The semiannual signal is the typical, monsoonal feature of the region near the equator on the African continent. It is of interest that the semiannual signal appears in the Indian Ocean where the annual signal dominates. The variation of the SSS qualitatively corresponds to that of the rainfall. For example, the SSS is lower in spring of the first rain season and higher in summer of the second dry season. However, the SSS variation cannot be quantitatively determined only by the rainfall. This will be discussed in the section 5.

It should be noted that, from November to January, high salinity over 35.0psu intrudes at the centre of the 100m depth in the west. This will be discussed in the following sections.

4. Volume and heat transports at latitude 6° N in the Bay

4.1 Geostrophic velocity

In order to investigate volume and heat transports at latitude 6° N in the Bay, the meridional geostrophic velocity was calculated

from the dynamic depth anomaly difference between a pair of grid points. The dynamic depth anomaly was calculated by integration of specific volume anomaly with respect to pressure levels, using density anomalies derived from the temperature and salinity data.

Figure 10a shows a vertical section of the geostrophic velocity in September 2000 (at the period of the cruise of kt01). For comparison, the surface currents derived from satellite data at the month from Ocean Surface Current Analysis (OSCAR), NOAA, are also shown in Fig. 10b. The geostrophic velocity at the surface well captures both the distribution and the magnitude on the figure.

A seasonal variation of the geostrophic velocity is demonstrated in Fig. 11. Strong currents over 0.1m/s are limited approximately within the depth of 200m, while currents are generally weak below the depth. From June to September, northward currents have large velocity in west of 85° E. The speed exceeds 0.3m/s at the sea

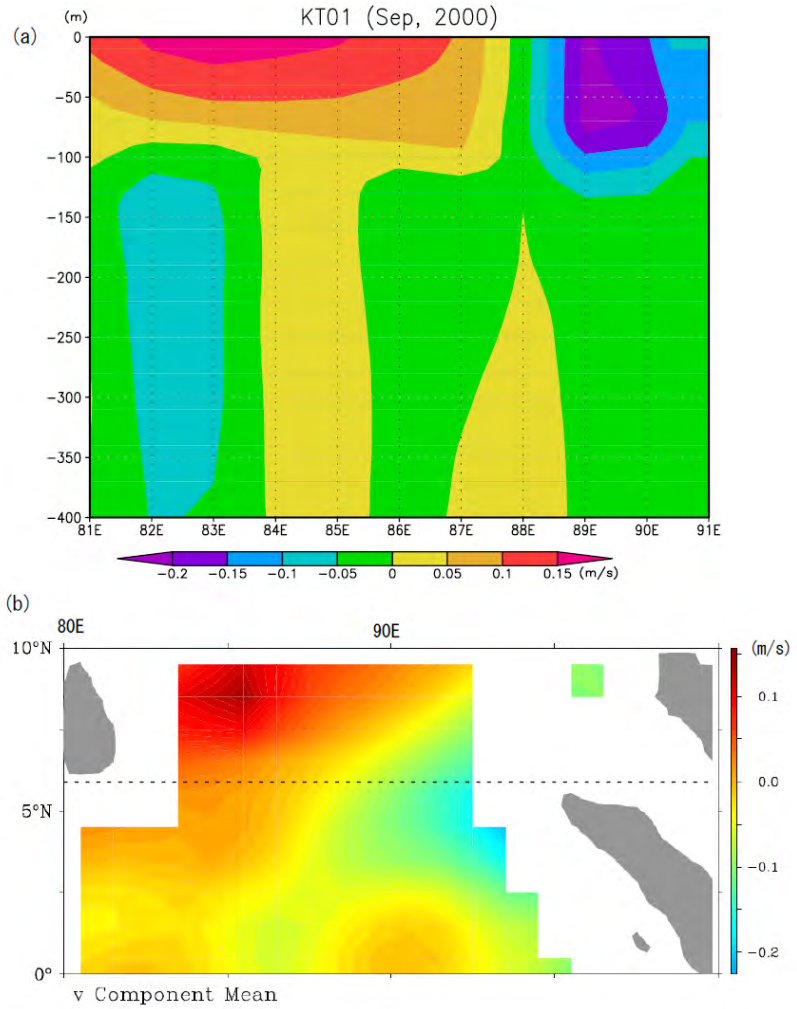

Figure 10: An example of (a) the geostrophic velocity (ci=0.05m/s) in September 2000 and (b) the surface currents derived from satellite data at the month from Ocean Surface Current Analysis (OSCAR), NOAA.

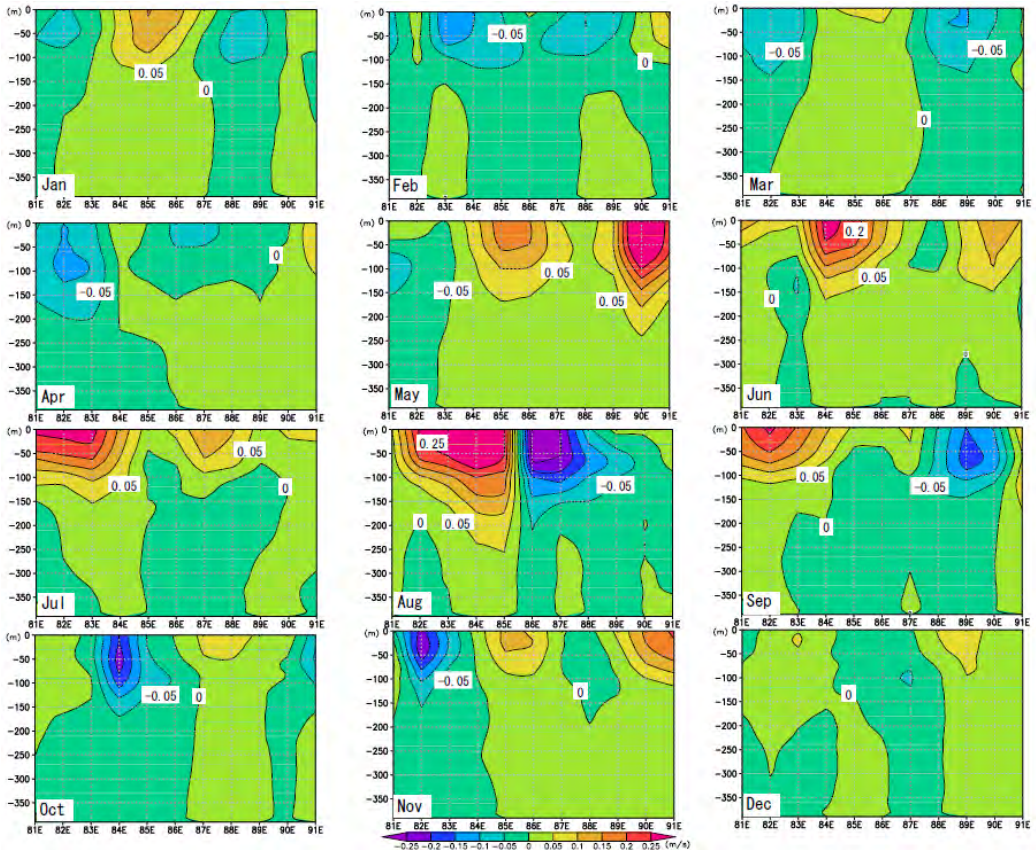

Figure 11: Seasonal variation of the geostrophic velocity (ci=0.05m/s).

surface and depth with the speed over 0.1m/s reaches about 170m in July. During summer, the SMC intrudes into the western Bay at the sea surface (Vinayachandran et al., 1999). The current brings relatively salty water from the Arabian Sea. The intrusion of the salty water is seen between June and September in Fig. 9. It should be noted that southward currents are strong in east of 85° E, whose maximum speed at the core is over 0.29m/s, which is seen in Figs. 5 and 7 of Vinayachandran et al. (1999). On the contrary, the currents in the west tend to be negative from November to April. According to McCreary et al. (1996b), forcings from local alongshore winds and Ekman pumping in the interior of the Bay cause southward surface flow along the eastern coast of India and Sri Lanka in winter.

A possible candidate that causes high salinity between the depths of 70m and 130m in the west in December (Fig. 9) is a northward flow between the depths of 60m and 180m near longitude 81° E. This flow is associated with a weak baroclinic structure there.

4.2 Volume transport

Figure 12a shows a seasonal variation of volume transport at 6° N derived from integration of the geostrophic velocity with respect to the depth as below,

$$\text{Volume Transport} = \int_{z=400\,m}^{z=0\,m} v_g \, dz \qquad (1)$$

where v_g is the geostrophic velocity and z the depth. Positive values indicate northward and negative southward. It takes the maximum of about 6.2Sv (Sverdrup: $10^6 m^3/s$) in 90° E in May and the minimum of -4.5Sv in 86° E in July. Annual variability is clearly seen in the west of 85° E, which is northward between May and September and southward between October to April. The northward transport in summer is particularly large in July and consistent with the intrusion of the SMC. On the other hand, the negative transport in winter is consistent with the direction of the EICC

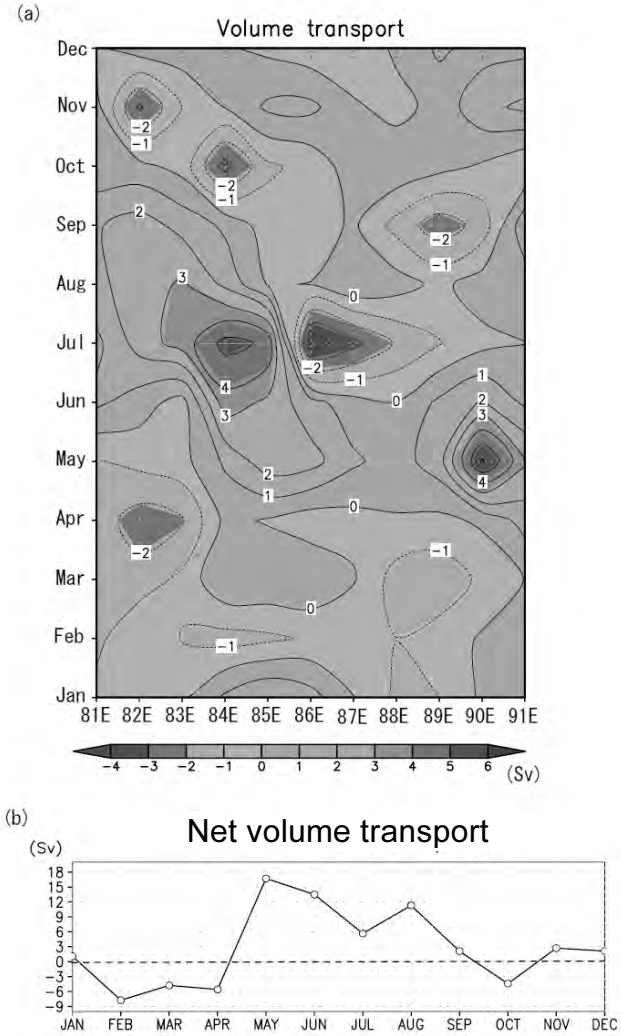

Figure 12: Seasonal variation of (a) the volume transport (ci=1.0Sv) at 6° N and (b) the net volume transport integrated along 6° N.

near the eastern coast of Sri Lanka. Note that the negative transport also appears in the east of the positive transport in July, which reflects the near-surface feature of the geostrophic velocity.

Figure 12b demonstrates the seasonal net volume transport integrated by the longitude. It varies from about -7.8Sv in February to 16.7Sv in May. The net transport throughout the year has positive (northward) value of about 32.6Sv. Interestingly, the northward transport does not take its maximum in summer when the SMC fully develops but in May when the current becomes northward in the region mostly as a whole.

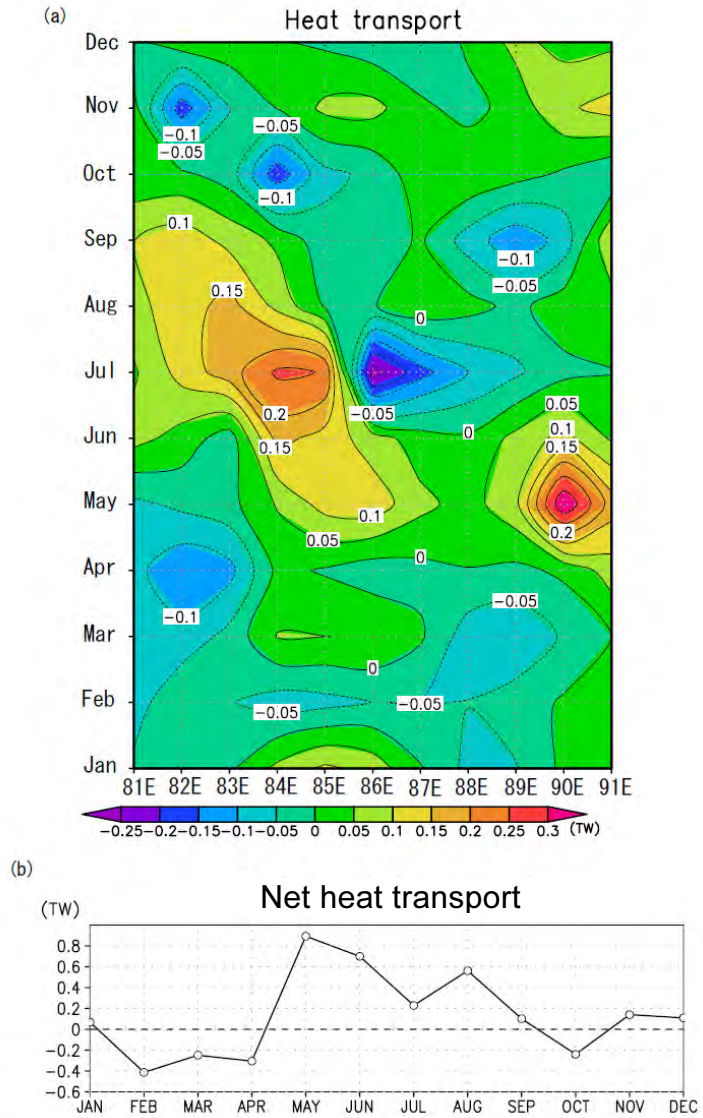

Figure 13: Seasonal variation of (a) the heat transport (ci=0.05TW) at 6° N and (b) the net heat transport integrated along 6° N.

4.3 Heat transport

In order to investigate the heat exchange at latitude 6° N, the heat transport is calculated as below,

$$\text{Heat Transport} = \rho C_p \iint \theta v_g \, dxdz \qquad (2)$$

where ρ is the density, C_p the specific heat capacity at constant pressure for water, θ the potential temperature, v_g the geostrophic velocity, x the longitude and z the depth. Figure 13a shows the seasonal variation of the heat transport at 6° N. Positive values indicate northward transport and negative southward. The variations are entirely similar to the volume transport. It takes the maximum of about 0.35TW. Annual variability is clearly seen in the west of 85° E, which is northward between May and September and southward between October to April.

Figure 13b demonstrates the seasonal net heat transport integrated by longitude. It varies from about -0.41TW in February to 0.89TW in May. The net transport throughout the year has positive (northward) value of about 1.6TW. The northward transport takes its maximum in May again when the current becomes northward in the region mostly as a whole. It should be noted that the component of the Ekman transport is not included in the above analyses, which is discussed in the following section.

5. Summary and discussion

The seasonal variations of the vertical structure of temperature, salinity and geostrophic velocity at latitude 6° N in the Bay of Bengal have been investigated, by the analyses of the data of the temperature and the salinity obtained from the XBT/XCTD measurements from September 2000 to October 2005 by the cruises with the M/T KATORI. In order to reproduce the salinity data from the XBT data, the TS diagrams from the WOA09 data were referred. The annual mean of both the temperature and the salinity section were well reproduced for the structures and the magnitude. The seasonal variation of the temperature well represents the dynamical features at 6° N in the Bay. Rossby waves propagate from the east to the west with the propagation speed of about 17cm/s that is close to the phase speed obtained by the other XBT data of Yu (2003) and the theoretical value of Yang et al. (1998). It is noticeable that Vinayachandran et al. (1999) also estimate the phase speed of 20.2cm/s, using the XBT data collected during 1985 to 1996. The semiannual signals of the waves as the remote effects from the equator were clearly seen. The local Ekman pumping has effects on the change for the amplitude of the semiannual signal. It is interesting that the variation of the rainfall has semiannual signals in the Indian Ocean while the signal is typical atmospheric response to the monsoon near the equator in the African continent. The seasonal variation of salinity is qualitatively similar to that of the accumulated rainfall. However, there are some differences of variations in locations and periods between the salinity and the rainfall. For example, the salinity around 81° E is relatively low in December, while the rainfall is low. In addition, the salinity in a month is not necessarily reproduced by mixing of the fresh water with the same amount of the rainfall in the month into the salinity in a previous month. The effect from river runoff is a possible candidate for the difference. The major rivers

that supply large amount of fresh water into the Bay are the Ganges and Brahmaputra rivers. The southward EICC in winter can advect the fresh water and result in the low salinity in the west of the Bay's mouth. The effects from intrusion of the Arabian Sea water are another possibility for the difference. Inclusion of these effects is the future tasks.

The seasonal variations of the geostrophic velocity relative to the depth of 400m and the volume transport show the water exchange between the interior and the exterior of the Bay due to the SMC and the EICC. West of 85° E, the SMC carries the water from the exterior to the Bay during summer and the EICC from the Bay to the exterior during winter. The depth of these currents extends up to about 170m in this analysis. The total transport obtained by the integration of the geostrophic velocity over the vertical section and longitude takes its maximum in May and its minimum in February. The net transport throughout the year was estimated to about +32.6Sv (northward). The seasonal variation of the heat transport is similar to that of the volume transport. The maximum also appears in May with 0.89TW and the minimum in February with -0.41TW. Figure 14a shows the number of the cyclones that have been generated in the Bay during September 2000 to August 2005, originated from the data of the Joint Typhoon Warning Center (JTWC) of the US navy. The averaged numbers for each month are also shown in Fig. 14b. The number of generation of the cyclones is large in May and October to January. The number almost corresponds with the period of the positive heat transport except for the summer monsoon season from June to September. In this study, however, the transports are derived from the integration of the geostrophic velocity and the component of the Ekman transport has been ignored. Figure 15a shows the seasonal variation of the Ekman transport integrated along the latitude 6° N in the Bay. Vertically averaged density for each grid point is used in the calculation. The annual

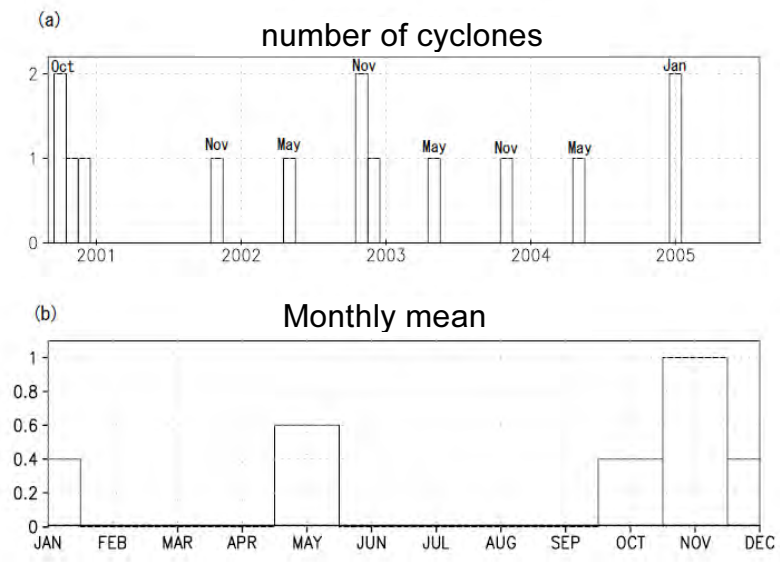

Figure 14: (a) The number of cyclones generated in the Bay of Bengal from September 2000 to August 2005 and (b) its monthly mean.

period is clearly seen, which is southward in the southwest monsoon (summer) and northward in the northeast monsoon (winter). The maximum and minimum are about 3.4Sv and -8.4Sv, respectively. The total transport of sum of the Ekman and geostrophic components are shown in Fig.15b. The relation of the generation of cyclones to the total transport is qualitatively similar to that to the heat transport. However, it is noteworthy that the net transport throughout the year is decreased to -2.0Sv from 32.6Sv by the geostrophic component. The components of Ekman transport should be included in the future work in detail.

Cyclones have huge impacts on the coastal countries in the periphery of the Bay. The results above indicate the relationship between the generation of cyclones and the heat exchange between the interior and the exterior of the Bay. However, in order to clarify the relation, the analyses on the interannual timescale are crucial. There is a limit to the data in this study to investigate the interannual variation, because of the missing data and limitation of the observation period. Vinayachandran et al. (1999) used the XBT data during 1985-1996 around about 6° N in the Bay, while Yu (2003) used the data from November 1987 to December 1999. In order to improve the analyses, these data, including the data in this study, must be unified. To understand the track of cyclones is also crucial for the adaptation to the disaster in the coastal countries. This problem should be solved in the future, for example, together with the analyses of sea surface fluxes. In this study, the characteristics of the water and heat exchanges at latitude 6° N in the Bay are shown on the seasonal timescale and the relation of the heat transport to the cyclones is indicated. On the basis of the results in this study and the forthcomings, the unified information enables us to predict the variations and adapt means to prevention of disasters around the Bay with much deeper understanding of the features.

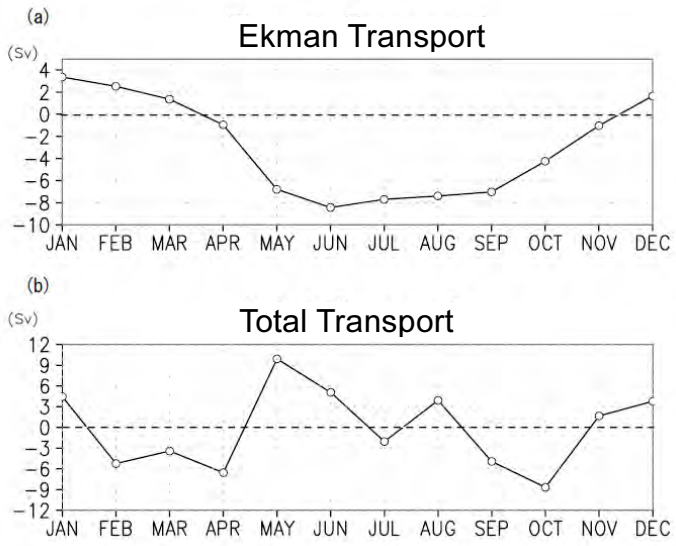

Figure 15: Seasonal variation of (a) the net Ekman transport integrated along 6° N and (b) the total net transport (sum of the Ekman and geostrophic components) at 6° N.

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