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Arctic Black Carbon from Shipping

A Club Approach to Climate-and-Trade Governance

By Thomas L. Brewer ICTSD Senior Fellow

ICTSD Global Platform on Climate Change, Trade and Sustainable Energy

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ICTSD welcomes feedback on this document. These can be forwarded to Ingrid Jegou, ijegou@ictsd.ch

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TABLE OF CONTENTS

LIST OF BOXES, FIGURES, TABLE AND MAPS

LIST OF ABBREVIATIONS

ABC	Arctic Black Carbon [agreement]
AC	Arctic Council
BC	Black Carbon
CBDR	common but differentiated responsibilities
CCAC	Climate and Clean Air Coalition to Reduce Short-Lived Climate Pollutants
CEM	Clean Energy Ministerial
CFCs	chlorofluorocarbons
CH4	methane
CO2	carbon dioxide
COP	Conference of the Parties to the UNFCCC
ECAs	Emission Control Areas
ECS	Energy Charter Secretariat
ECT	Energy Charter Treaty
EEDI	Energy Efficiency Design Index
EGA	Environmental Goods Agreement
EIA	Energy Information Administration [US]
EPA	Environmental Protection Agency [US]
GATS	General Agreement on Trade in Services
GATT	General Agreement on Tariffs and Trade
GHGs	Greenhouse gases
GTP	Global temperature [change] potential
GWP	Global warming potential
HFCs	Hydrofluorocarbons
IBRD	International Bank for Reconstruction and Development
ICAO	International Civil Aviation Organization
ICCT	International Council on Clean Transportation
ICS	International Chamber of Shipping
ICSID	International Centre for Settlement of Investment Disputes
ICTSD	International Centre for Trade and Sustainable Development
IEA	International Energy Agency
IGU	International Gas Union
IMF	International Monetary Fund
IMMA	International Maritime Methane Agreement
IMO	International Maritime Organization

ISO	International Organization for Standardization
ITA	Information Technology Agreement
LNG	Liquefied natural gas
MARPOL	International Convention for the Prevention of Pollution from Ships
MEF	Major Economies Forum on Energy and Climate
MEPC	Marine Environment Protection Committee of the IMO
NGO	Non-Governmental Organisation
NOx	Nitrogen oxides
OECD	Organisation for Economic Co-operation and Development
SEEMP	Ship Energy Efficiency Management Plan
SOLAS	International Convention for the Safety of Life at Sea
SOx	sulfur oxides
TBT	Technical Barriers to Trade Agreement
UNCLOS	UN Convention on the Law of the Sea
UNCTAD	UN Conference on Trade and Development
UNEP	UN Environment Programme
UNIPCC	UN Intergovernmental Panel on Climate Change
UNFCCC	UN Framework Convention on Climate Change
WEC	World Energy Council
WSC	World Shipping Council
WTO	World Trade Organization

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FOREWORD

The polar regions play a crucial role in regulating the earth's climate and are particularly vulnerable to the impacts of climate change. Arctic sea ice reflects 80 percent of the sun's rays that strike it into space and helps to stablise global temperatures. The polar regions are also the most sensitive to the impacts of climate change. Average air temperatures in the arctic have increased by over 5 degrees in the past hundred years largely due to human-induced greenhouse gas emissions some of which are also linked to energy, manufacturing and transport activity that is driven by international trade.

Tackling climate change will require a variety of measures to reduce emissions of greenhouse gases and pollutants at their source. Black carbon, commonly known as "soot", is a highly potent contributor to climate change; its global warming potential is hundreds-to-thousands of times greater than that of carbon dioxide. Black carbon emissions in the Arctic are particularly problematic as they reduce the "albedo effect", i.e. the reflection of sunlight back into the atmosphere. This in turn magnifies the global warming effect and contributes to sea level rise, ocean acidification and disruption of prevailing wind patterns and ocean currents in areas far beyond the Arctic region. In addition to being a major contributor to climate change, black carbon, which is a particulate matter and not a gas, also causes arctic ice-melt and has detrimental health and environmental effects.

Emissions of black carbon are closely related to international shipping, and thus to trade. Therefore, it is imperative to, as a matter of priority, identify and assess options for mitigating such emissions in the international maritime shipping sector. Emissions from the global shipping industry amount to around 1 billion tonnes a year, accounting for 3% of the world's total greenhouse gas (GHG) emissions. Without action, these emissions are expected to more than double by 2050, making it significantly harder to limit global warming to below 2 C by 2050. Whereas trade has important potential of contributing to both mitigation and adaptation to climate change, it is also necessary to address its direct climate impact in terms of transport.

Finding a solution locally to the case of soot from maritime shipping could be an option. In fact, contrary to carbon dioxide whose effects are global, soot emissions which occur in one distinct region could be reduced through for instance regulating and standards pertaining to ships operating in the region, and that region would benefit directly from the positive effects. This would thus reduce the free rider problem which is otherwise challenging to climate action, and instead create strong incentives for the concerned nations to take immediate action.

The Arctic region is controlled by a small number of countries, only eight, and the maritime shipping industry is a distinct sector. This would further constitute a case for finding a geographically limited, club-like solution, which should be politically more within reach than broad, multilateral, cross-sectoral options like the UNFCCC.

The international governance landscape in the intersection of trade, transport and climate change is indeed increasingly pluralistic, making it challenging to swiftly come up with concrete solutions. Although the multilateral institutional cores in the UNFCCC, WTO and IMO remain important for all three, there is a significant proliferation of institutional modalities in progress.

This paper addresses questions about how the problems related to black-carbon are being addressed or could be addressed within shipping sector. It examines available technologies and ongoing regulatory efforts, as well as regulatory gaps. Following this, it proposes an Agreement on Black Carbon (ABC) as a viable means for bridging such gaps. Such an agreement could be a club-like partnership, including both state- and non-state actors, with incentives and penalties for members, thereby ensuring that the problem caused by maritime shipping is effectively addressed. The paper also highlights the need to further ensure a coherent relationship of ABC with existing governance and institutional arrangements, including not only those governing climate change and shipping but also the trade regime-embodied in WTO rules and agreements.

Thomas L. Brewer is a Senior Fellow at the International Centre for Trade and Sustainable Development (ICTSD) in Geneva and focuses his research on the intersections of climate change issues with international trade, investment and technology transfer issues. He has numerous publications and was also a Lead Author of the chapter on International Cooperation in the IPCC report (AR5). He has had recurring short-term appointments as a Visiting Senior Research Fellow at Oxford University in the Smith School for Enterprise and the Environment, and he has been a Schöller Foundation Senior Research Fellow at Friedrich-Alexander University in Nuremberg, Germany. He is an Associate Fellow of the Centre for European Policy Studies (CEPS) in Brussels, and an emeritus faculty member of Georgetown University in Washington, DC. In addition, he has also consulted for World Bank, the United Nations Conference on Trade and Development (UNCTAD), and the Organisation for Economic Cooperation and Development (OECD).

This paper has the potential of informing and shaping future regulatory initiatives on black carbon and serving as a valuable reference for policymakers as well as other non-state actors and institutions involved with the issue. We hope that you will find the paper to be a thought-provoking, stimulating, and informative piece of reading material and that it proves useful for your work.

Ricardo Meléndez-Ortiz
Chief Executive, ICTSD

EXECUTIVE SUMMARY

International governance continues to become increasingly complex for climate change issues and trade issues as the institutional landscape for both has become more 'pluralistic'. Although the multilateral institutional cores in the United Nations Framework Convention on Climate Change and the World Trade Organization remain important for both, there is a significant proliferation of institutional modalities in progress. These changes pose distinctive international governance challenges where there are intersections of climate change and trade issues. Black carbon emissions in the Arctic region present such a challenge, and they need urgent action because of their global climate change consequences.

Black carbon issues were highlighted as pressing at the April 2015 Arctic Council Ministerial meeting. Interest was further heightened by the subsequent US government preliminary approval in May 2015 of permission for Shell to drill for oil in Arctic waters off the coast of Alaska. In yet another recent development, in May 2015, the International Maritime Organization decided not to adopt a greenhouse gas emissions target to be offered at the Paris COP-21 meeting in December.

Black carbon – which is commonly known as 'soot' – is a major contributor to climate change, as it ranks second or third after carbon dioxide in its total global contribution. Black carbon poses distinctive issues for international climate governance: it occurs as particulate matter, not as a gas; and it is short-lived, with an average life of about a week. Per tonne, it is a highly potent contributor to climate change; its 'global warming potential' is hundreds-to-thousands of times greater than that of carbon dioxide. Black carbon's impacts are not only global in scope, though; as an air pollutant, its detrimental impacts also include local and regional health and economic consequences.

The levels and impacts of black carbon in the Arctic region are under intense scrutiny from diverse perspectives, particularly because of the implications of the increasing and unexpectedly rapid pace of ice melt – to which black carbon is a principal contributor. This paper focuses on issues associated with black carbon emissions in international maritime shipping in the Arctic region. In particular, it addresses questions about the nature, magnitude and effects of black carbon emissions in the Arctic region by international shipping: What is the nature of the climate change issues posed by black carbon emissions in international maritime shipping in the Arctic? What are the sources of the emissions? How extensive are the emissions? What kinds of effects are there? Where do they occur?

Other questions concern the future: What are the prospects for future black carbon emissions in light of accelerating sea and glacial ice melt and the opening of new shipping lanes? What are the prospects for exploration and extraction of oil and gas in the region? Such prospects for the future are an important motivating consideration for this paper.

The paper addresses questions about how the problems are being addressed or could be addressed within the industry. There are technologies in existence and under development that can reduce black carbon emissions in maritime shipping. What are they? How available are they? The paper also addresses questions about the international institutional governance of black carbon in the Arctic. What is the relevant international institutional context? Which institutions are doing what? What are the institutional design issues and options for addressing climate change and trade issues related to Arctic black carbon more effectively? What institutional modalities are viable?

The analysis concludes that an Arctic Black Carbon (ABC) agreement is needed. The agreement can take the form of a club-like partnership of members of several existing international institutions and include non-state entities as well as governments and intergovernmental organisations. The partnership can involve commitments to limit black carbon emissions from international shipping in

the Arctic region and to undertake international technology transfer processes to facilitate emission reductions. The agreement could be consistent with both the UNFCCC and the WTO, but not involve either one directly in the agreement. An ABC agreement could build on the analytic and diplomatic work that is in progress in the Arctic Council, International Maritime Organization and under the Gothenburg Protocol.

The paper draws upon reports on black carbon issues – as documented in the body of the paper – by the Arctic Council, International Maritime Organization, Climate and Clean Air Coalition, International Council on Clean Transportation, Clean Air Task Force, Center for American Progress, UN Environment Programme, World Meteorological Organization, UN Economic Commission for Europe, US Environmental Protection Agency, Intergovernmental Panel on Climate Change and climate science journal articles. The paper places technical issues in the context of the increasingly pluralistic climate and trade ‘regime complexes’.

1. INTRODUCTION

Increasing concern about black carbon in the Arctic region is being driven by three ongoing developments:

- accumulating scientific evidence of the significance of its contribution to warming in the Arctic region, as well as local health and economic impacts;
- the prospect of increased emissions from maritime shipping as new Arctic sea lanes open because of rapid sea ice melt;
- increases in oil and gas exploration and extraction in the region.

Concern about these developments has prompted the Arctic Council (AC) and the International Maritime Organization (IMO) to put Arctic black carbon issues on their agendas, and both have initiated undertakings to address the problem.

1.1 Problem

Black carbon (BC) falling on ice and snow in the Arctic region reduces the albedo effect (i.e. the reflection of sunlight back into the atmosphere) and thereby contributes to global warming. The warming in turn causes the ongoing diminishment of the geographic extent and the thickness of sea ice and glacial ice in the region. This process has become a major concern among climate scientists and policymakers because of its wider effects, such as sea level rise, ocean acidification resulting from increased glacial melting and freshwater run-off, and disruption of prevailing wind patterns and ocean currents in areas beyond the Arctic region.

If the Arctic ice melt progresses and leads to the opening of new shipping lanes, the problem of black carbon emissions in the region will become more severe, unless mitigation measures are undertaken. Furthermore, because maritime black carbon emissions in the region will increase with increases in exploration and extraction of oil and gas, there will be yet further concern about the region's contribution to climate change.

1.2 Objective

The objective of the paper is to identify and assess options for mitigating black carbon emissions in the international maritime shipping sector in the Arctic region. The analysis includes studies and other activities to date in the industry and in international institutions, including the International Maritime Organization as well as the Arctic Council. The paper proposes the negotiation of an Arctic Black Carbon (ABC) agreement to address the problem. Both the Arctic Council and the International Maritime Organization have undertaken work programmes focused on black carbon issues, and an ABC agreement could expand on those efforts.

1.3 Organisation

Section 2 of the paper discusses the nature and magnitudes of black carbon as greenhouse particulate emissions, including comparisons with carbon dioxide and other greenhouse gases. The data and discussion are based on the latest reports of the United Nations Intergovernmental Panel on Climate Change (UNIPCC) and other recent studies about black carbon, as documented below. This section of the paper also discusses the sources and extent of BC emissions in international maritime shipping, including the prospects for increases in the Arctic region. Section 3 considers operational and currently available or soon-to-be-available technological solutions to mitigate maritime shipping BC emissions. Section 4 describes the international institutional context in which BC issues have emerged and the efforts thus far to address them. Section 5 proposes an Arctic Black Carbon agreement. Section 6 discusses additional key items for further consideration in policymaking and analysis. Annex A discusses definitions of the Arctic region, and Annex B presents a taxonomy and examples of club and non-club arrangements in international governance.

2. PROBLEM

2.1 Black Carbon as a Contributor to Climate Change

Black carbon is a highly potent source of climate change, and it poses global public goods problems like other sources such as carbon dioxide.[1] Black carbon is now recognized to be among the three most significant sources of contributions to climate change, along with carbon dioxide and methane. One recent study (Bond et al. 2013) has concluded that black carbon's total contribution is greater than methane's and about 55 per cent of that of carbon dioxide.

Black carbon – which is commonly known as 'soot' – has been defined by the IMO, as presented in Box 1.

Box 1. IMO definition of black carbon[a]

Black carbon is 'a distinct type of carbonaceous material, formed only in flames during combustion of carbon-based fuels' and [it is] distinguishable from other forms of 'carbon and carbon compounds contained in atmospheric aerosol' due to a unique combination of four physical properties:

1. It strongly absorbs visible light with a mass absorption cross section of at least $5m^2$g-1 at a wavelength of 550nm.
2. It is refractory; that is, it retains its basic form at very high temperatures, with vaporisation temperature near 4000K.
3. It is insoluble in water, in organic solvents including methanol and acetone, and in other components of atmospheric aerosol.
4. It exists as an aggregate of small carbon spherules.

[a] *Pending approval at IMO's Marine Environment Protection Committee in May 2015.*
Source: IMO (2015).

Estimates of the impacts of black carbon on climate change pose special measurement challenges, however, because it is particulate matter consisting of particles less than 2.5 millimetres across (Bowerman et al. 2013; Shoemaker et al. 2013). Black carbon is thus not a gas – and therefore *not* included among the standardized lists of widely recognized greenhouse *gases*.

Table 1 presents data from studies using time periods of 20 years and 100 years and indexes for global warming potential (GWP) and global temperature change potential (GTP). Both the 20-year and 100-year time periods are commonly used – with the former increasingly so for emissions with short-term lifetimes, such as black carbon. As for GWP and GTP, in addition to the many similarities between them, there are significant differences, as summarized in the notes to Table 1. For present purposes, we present both GWP and GTP in order to underscore the consistency in the basic patterns of the potency of black carbon as a greenhouse gas emission relative to carbon dioxide.

Table 1: Global warming potential of black carbon compared with carbon dioxide according to various estimates[a]

Type of emission	GWP[b] 20 years	GWP 100 years	GTP[b] 20 years	GTP 100 years
Carbon dioxide	1.0	1.0	1.0	1.0
Black carbon				
BC global[c]	3200 (270-6200)	900 (100-1700)	920 (95-2400)	130 (5-340)
BC global[d]	1600	460	470	64
BC four regions[e]	1200 (+/-720)	345 (+/-207)	420 (+/-190)	56 (+/-25)
BC global -radiation + albedo[f]	2900 (+/-1500)	830 (+/-440)	NA	NA

[a] *Methane (CH4) is also a potent and widespread short-lived GHG, with a GWP of 84 for 20 years and 28 for 100 years. Its median atmospheric lifetime is 12 years. Methane's total global warming impact, taking into account the quantity of emissions as well as its GWP per unit mass, is second to carbon dioxide among greenhouse gases. A sequel ICTSD paper (Brewer forthcoming) examines methane - and associated liquefied natural gas - climate change issues in international maritime shipping.*

[b] *'Whereas GWP integrates the effects up to a chosen time horizon (i.e., giving equal weight to all times up to the horizon and zero weight thereafter), the GTP gives the temperature just for one chosen year with no weight on years before or after' (UNIPCC 2013, Technical Summary: 58).*

Studies with original data:

[c] *Bond et al. (2013)*

[d] *Collins et al. (2013)*

[e] *Fuglestvedt et al. (2010). Includes aerosol-radiation interaction. Regions: East Asia, European Union + North Africa, North America, South Asia.*

[f] *Bond et al. (2013*

Source: Adapted from UNIPCC (2013), Table 8.A.6, p. 740. Also see UNIPCC (2009); UNFCCC (2014a).

There is a clear pattern in Table 1: Black carbon is much more potent than carbon dioxide per unit of mass – no matter which *indicator* is used (represented by columns in the table) and no matter which *data set* is used (rows in the table). Black carbon is on the order of at least tens of times higher and as much as thousands of times higher than carbon dioxide on these measures, according to the *median estimates*. Using the *extremes of the ranges of uncertainty*, the lowest ratio (100-year GTP) is 5, and the highest (20-year GWP) is 6,200. Comparisons of the 20-year and 100-year effects further confirm BC's status as a potent short-term contributor to climate change: its 20-year GWP is more than three times greater than its 100-year GWP, and its 20-year GTP is more than seven times greater than its 100-year GTP. In short, there is evidence that black carbon is much more potent per unit of mass than carbon dioxide and that it is especially potent in the short term.

Black carbon emissions pose localized health and agricultural productivity issues as well as globalized climate change issues. Black carbon particulates are a cause of lung disorders and other health problems, and they also cause damage to agricultural land (UNEP and WMO 2011; Shindell et al. 2012).

The health and air pollution effects, as well as important climate change effects, are more *localized and regionalized*, as compared with black carbon's globalized impacts on climate change. This difference means that the *political economy of BC is quite different from that of CO_2 in several respects*: the costs of BC emissions include the local economic costs of poor health, health care and reduced agricultural production, plus the human costs of premature deaths; and they are all localized and experienced in the relatively short term and medium term, as well as long term.

There are other issues about the impacts of black carbon, particularly over the long term (see Berntsen, Tanaka and Fuglestvedt 2010; Ramanathan and Xu 2010).

Of course, the impact of BC depends on the *quantity* of emissions as well as the potency per unit. An OECD (2015a; 2015b, Table 1) study estimated that international maritime freight shipping will increase from 60,053 billion tonne-kms in 2010 to 256,433 billion tonne-kms by 2050 – an increase of 327 per cent. Carbon dioxide emissions, according to the same study, will increase from 2.109 gigatonnes to 8.132 gigatonnes by 2050, an increase of 286 per cent. Of course such long-term projections are subject to much uncertainty and do not necessarily apply to maritime black carbon emissions, particularly those in the Arctic region. However, they are indicative of industry-wide trends of increasing volumes of traffic and greenhouse gas emissions. The next sections focus on the distinctive issues about the extent to which such trends may include Arctic region black carbon emissions.

2.2 Black Carbon in the Arctic Region

Black carbon is a distinctive climate change problem in the Arctic region (see Annex A for diverse definitions and related maps of the region). Of particular concern is the extent to which black carbon emitted from ships burning fossil fuels exacerbates the decline in the *albedo* effect of ice and snow – that is, soot from ships reduces the *reflective properties* of ice and snow. This particular regional phenomenon associated with BC, and the associated increases of ice melt in the region have significantly increased concern about black carbon issues in the region (Boone 2012; Rosenthal and Watson 2011; UNIPCC 2013 World Bank and ICCI 2013).

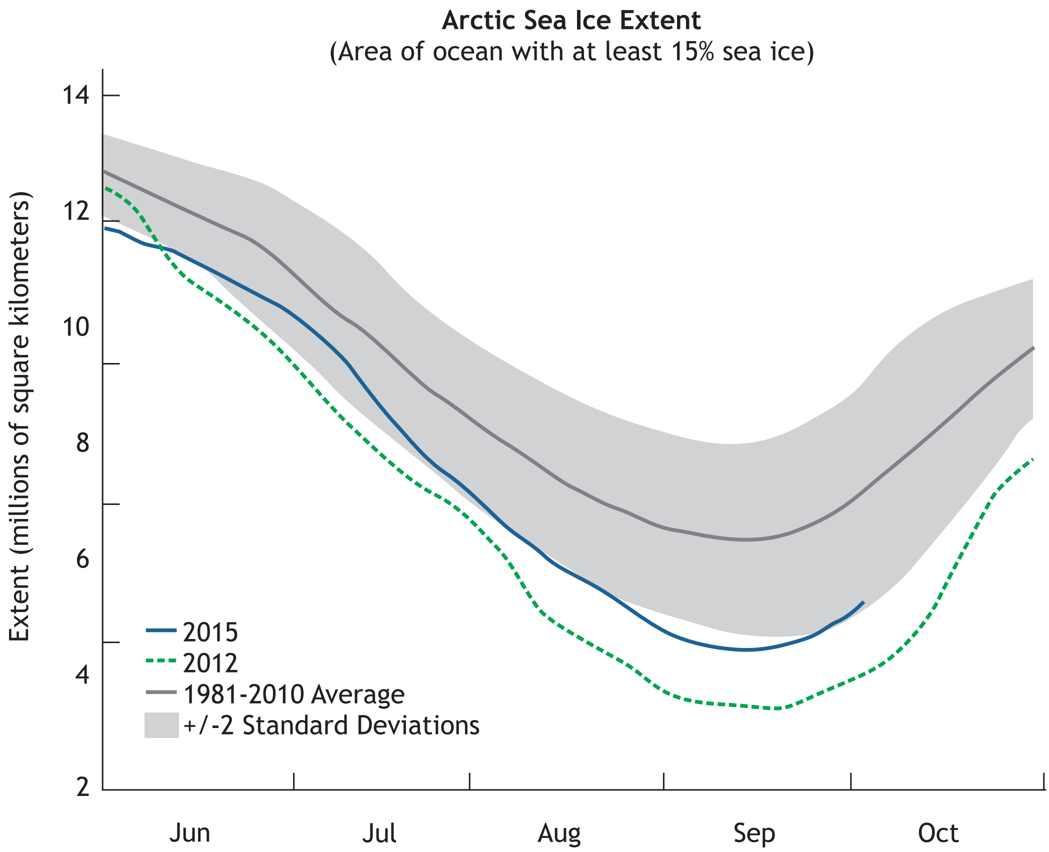
The extent of the sea ice melt is evident in Map 1, which depicts the much reduced size of Arctic sea ice as of 26 April 2015 compared with the median for the 30-year period 1981–2010.

Map 1. Changes over time in Arctic sea ice extent, as of 3 October 2015[a]

[a] The inner white area represents the ice on 3 October 2015; the orange line represents the median for 1981-2010. Source: National Snow and Ice Data Center (2015). Accessed at www.nsidc.org on 4 October 2015.

Each year, the area of ice reaches its maximum in February-March and then declines in April-May. The decreasing extent of recent years is evident in Figure 1, which shows the shift downward in the seasonal curve. The smaller extent in 2012 and 2015, compared with the median pattern for the1981-2010 period, during the several months starting in January is apparent.

Figure 1. Changes in Arctic ice melt, June-October



Source: National Snow and Ice Data Center (2015). Accessed at www.nsidc.org on 4 October 2015.

Evidence such as that shown in Map 1and Figure 1 has prompted increased concern about Arctic black carbon in several recent studies. The US Environmental Protection Agency (EPA) (2012) has summarized the scientific literature as follows:

> Studies have shown that BC has especially strong impacts in the Arctic, contributing to earlier spring melting and sea ice decline. All particle mixtures reaching the Arctic are a concern, because even emissions mixtures that contain more reflective (cooling) aerosols can lead to warming if they are darker than the underlying ice or snow. Studies indicate that the effect of BC on seasonal snow cover duration in some regions can be substantial, and that BC deposited on ice and snow will continue to have radiative effects as long as the BC remains exposed (until the snow melts away or fresh snow falls).

2.3 Black Carbon Emissions From International Maritime Shipping

The Arctic region issues specifically for maritime shipping[2] have been noted by the Arctic Council (2011a) as follows:

> Marine shipping in the Arctic region is … potentially high in its impact due to its proximity to Arctic snow and sea ice. Emissions from this sector may increase significantly due to increases in global marine shipping traffic, as well as a lower prevalence in summer sea ice cover. Marine shipping is also a significant source of the precursors [such as nitrous oxide] that lead to higher levels of local ozone, which impacts public health as well as the climate.

In 2004, about 6,000 ships were reported to be operating in the Arctic region (Arctic Council 2009: 72). Their total black carbon emissions were estimated to be 1,180 tonnes, which emanated from nine different categories of ships. More than 95% came from five categories: fishing vessels (31%), container ships (20%), general cargo (17%), passenger ships (10%), bulk carriers (10%) and tankers (8%) (Arctic Council 2009: 141, calculated from Table 8.2). There have been increases since then, overall and in key categories. For instance, there is evidence of increased cruise ship traffic in the region since 2010 (CBC News 2008; Judson 2010).There is satellite-based evidence of increasing maritime traffic in the northern sea routes (Northern Sea Route Information Office 2015).

The most important question, however, is how much and how fast shipping through the Arctic region will increase as the extent of sea ice melt progresses. Reports sponsored by the International Council on Clean Transportation (ICCT) (Azzara 2013; Azzara and Rutherford 2009; 2015; Azarra, Wang and Rutherford 2015) projected an increase in black carbon emissions of tonnes per year by 2025 by a *factor of 5 to 120*. The Norwegian Shipowners Association has similarly warned about increasing traffic in the next ten years (RTCC 2013). (Also see the variety of scenarios that are analysed in Arctic Council 2009; 2011b.)

In sum, there is already sufficient shipping traffic in the region to pose a variety of issues, including black carbon emissions issues; and the volume of the traffic is highly likely to increase over the next decade or so, and perhaps even much more beyond that (see especially Smith and Stephenson 2013).

3. TECHNOLOGICAL AND OPERATIONAL SOLUTIONS

In addition to reducing the volume of shipping traffic, there are technological and operational solutions to the problem (see Box 2). One estimate (IGSD 2008: 6 n85; also see IMO 2012a) is that reductions by as much as 90 per cent or more of maritime BC emissions could be achieved by a combination of the following technological and operational measures:

- Increased use of ultra-low sulfur diesel fuel, which has already reduced the rate of BC emissions per weight-distance unit.
- New fuel efficiency regulations, which have been promulgated by the IMO (noted in Section 4 below), are likely to do the same in the near future.
- Installation of new equipment such as particulate filters on diesel engines and scrubbers on smokestacks.
- Operational measures, including slower speeds in transit and the use of port-side electricity sources instead of on-board diesel-powered generators, can also reduce BC emissions.

In addition, the prospect of increasing use of liquefied natural gas (LNG) as a fuel could also reduce BC emissions. However, the potential for increased methane emissions from LNG as fuel or cargo is problematic, especially in view of methane's GWP of 84 at 20 years and 23 at 100 years (UNIPCC 2013). For further analysis of these methane issues, see two ICTSD papers (Brewer 2014a and forthcoming).

4. INTERNATIONAL INSTITUTIONAL CONTEXT

As one can see from the discussion in the previous sections, there has been much interest in black carbon among climate scientists. The literature reviews in the volumes of the UNIPCC Fifth Assessment Report published in 2013–14 include scores of references to refereed publications about black carbon (UNIPCC 2013; 2014a; 2014. Diplomats, however, have been less attentive to black carbon issues, at least until recent years. In particular, because it is not a gas, black carbon has been neglected in the multilateral climate change negotiating processes involving the Conferences of the Parties (COP) to the UN Framework Convention on Climate Change (UNFCCC), which explicitly focus on *gases* as sources of climate change. Thus, for instance, the 'Negotiating Text' of 12 February 2015 in the run-up to the Paris COP-21 meetings does not mention black carbon in its 86 pages of single-spaced text (UNFCCC 2015).

Black carbon, though, has been on the agendas of the Arctic Council, International Maritime Organization, Climate and Clean Air Coalition (CCAC) and work associated with the Gothenburg Protocol.

4.1 Arctic Council

The Arctic Council, which was established as an intergovernmental forum by the Ottawa Declaration of 1996, has eight member states: Canada, Denmark, Finland, Iceland, Norway, Russia, Sweden and the United States. There are six organisations serving as Permanent Representatives of indigenous peoples. Its observers include twelve states outside the Arctic region, nine intergovernmental and interparliamentary organisations and eleven non-governmental organisations (NGOs).

The Council's biannual ministerial meetings are high-level policymaking events, and the chair revolves among the national members on a two-year cycle corresponding to the ministerial meetings. In April 2015, the United States assumed the chair for the 2015–17 period.

Importantly, Council decisions are taken by consensus. Further, the Council does not implement its decisions collectively; it has no enforcement authority; and it has no programme budget. Implementation and financing of its programmes are undertaken by individual member states. Its mandate explicitly excludes military security issues. It is thus essentially a discussion forum, with a variety of working groups that produce studies about environmental and safety issues.

The current emphasis on climate change issues expands on several years of work by specialized task forces and expert groups (Arctic Council 2014). Its Task Force on Short-Lived Climate Forcers issued a series of findings and recommendations in 2011 (Arctic Council 2011c) that included a section on marine shipping (see Box 2).

Box 2. Excerpt from Recommendations of the Arctic Council Task Force on Short-Lived Climate Forcers

Measures to reduce black carbon from marine shipping in and near the Arctic could include Council-wide adoption of voluntary technical and non-technical measures, adoption of the proposed amendment of MARPOL Annex VI to establish an Energy Efficiency Design Index, and collaboration with IMO on certain other actions. Marine shipping in the region is [currently] a relatively small source of black carbon, but it is potentially high in impact due to its proximity to snow and ice, and may increase significantly due to projected increases in global ship traffic as well as decreases in summer sea ice cover.

Shipping is also a significant source of the precursors that lead to higher levels of local ozone, impacting health as well as climate. The Arctic Council nations comprise 90% of current shipping activities in the region; they therefore have a unique ability to influence the development of future black carbon emissions from this sector by enacting early voluntary measures and engaging in international regulatory regimes such as the IMO:

- voluntary measures by all eight Arctic Council nations to decrease black carbon emissions and encouragement of vessels (especially cruise ships) flagged in non-Arctic Council nations and operating in the Arctic to adopt these measures as well;
- support by all eight Arctic nations of the current IMO submission on black carbon by Norway, Sweden and the United States, which raised the importance of black carbon emissions from shipping on the Arctic climate and identified a range of technical and operational measures (e.g., speed reduction, improved engine tuning, energy efficiency enhancements, better fuel injection, or use of diesel particulate filters);
- adoption by all eight Arctic Council nations of the proposed amendment of MARPOL Annex VI to establish an Energy Efficiency Design Index for new ships; and
- ongoing provision of new scientific and technical developments to the IMO by AMAP [Arctic Monitoring and Assessment Programme] and other Arctic Council working groups, and vice versa.

Source: Arctic Council (2011c).

At its April 2015 Ministerial Meeting, the Council advanced the black carbon agenda by approving 'An Arctic Council Framework for Action' titled *Enhanced Black Carbon and Methane Emissions Reductions* (Arctic Council 2015; also see Arctic Council 2013; 2014). Accordingly,

Each Arctic State commits to:

- develop and improve emission inventories and emission projections for black carbon using, where possible, relevant guidelines from the Convention on Long-Range Transboundary Air Pollution (CLRTAP) and improve the quality and transparency of information related to emissions of black carbon;
- enhance expertise on the development of black carbon inventories, including estimation methodologies and emissions measurements, by working jointly through the Arctic Council and other appropriate bodies; …

The Arctic Council is thus becoming more attentive to climate change issues, including black carbon in particular. However, it will not be able to promulgate enforceable mandatory regulations unless it undergoes a dramatic transformation in its basic institutional nature – and there is no momentum for this to occur. For additional information on the Arctic Council and climate change issues in the Arctic region, see Griffith (2014), Lefton and Kelly (2014), Pincus and Ali (2015), Tarasaka and Clouser (2014) and Yeo (2015), as well as Arctic Council materials (2009; 2011a; 2011b; 2012; 2013 2015).

4.2 International Maritime Organization

As a sector-specific agency in the UN system, the International Maritime Organization has been granted specific mandates in two separate UN venues – in one to address international trade issues and in the other to address climate change issues.

The 1948 UN Maritime Conference in Geneva passed a convention to establish the Inter-Governmental Maritime Consultative Organisation; the convention entered into force in 1958; the name of the organisation was changed to International Maritime Organization in 1982 (IMO 2014a). Article 1(a) of the convention states the purposes of the organisation are:

> to provide machinery for cooperation among Governments in the field of governmental regulation and practices relating to technical matters of all kinds affecting shipping engaged in international trade; to encourage and facilitate the general adoption of the highest practicable standards in matters concerning maritime safety, efficiency of navigation and prevention and control of marine pollution from ships (IMO 2015b).

The IMO's mandate concerning climate change is embodied in Article 2 of the Kyoto Protocol of the UNFCCC: 'The Parties included in Annex I shall pursue limitation or reduction of emissions of greenhouse gases not controlled by the Montreal Protocol [on Ozone Depleting Substances] from … *marine bunker fuels*, working through … the International Maritime Organization ….' (emphasis added).

In short, the IMO as a specialized sectoral UN agency serves as a key international institution for both maritime shipping trade and climate change issues, thus supplanting and complementing, in some respects, the multilateral trade and climate change institutions.

The IMO currently has 170 member states and three associate members. In addition to the governments representing the 170 members, there are 63 intergovernmental organisation with cooperative agreements and 77 NGOs with consultative status (IMO 2014e). The European Commission has a cooperative agreement with the IMO, and nearly all of the individual member states of the European Union are members of the IMO. The NGOs with consultative status include a broad array of both industry groups (such as the World Shipping Council and the International Chamber of Shipping), environmental organisation (such as Friends of the Earth International) and technical organizations (such as the International Organization for Standardization). The IMO thus features not only a widely representative membership among countries, but also diverse intergovernmental and NGO participation, and industry-specific mandates within the UN system.

Black carbon has been on the agenda of the IMO for several years, but thus far it has only agreed on a definition of the term (as noted in Box 1).

The IMO has been working on an International Code for Ships Operating in Polar Waters (the Polar Code) to address safety and environmental issues in the Arctic and Antarctic regions (IMO 2014f). It was approved by the Marine Environment Protection Committee in October 2014 as amendments to the International Convention for the Prevention of Pollution from Ships (MARPOL), and it was approved by the Maritime Safety Committee in November 2014 as amendments to the International Convention for the Safety of Life at Sea, with entry into force on 1 January 2017 (IMO 2014g; 2014h). Although the Code does not include provisions concerning black carbon (Transport & Environment 2014), its adoption indicates a willingness to address Arctic-specific environmental issues.

The fuel efficiency regulations of the IMO are also relevant because they can reduce black carbon emissions, even though their direct objective is to reduce carbon dioxide emissions by increasing fuel efficiency. The fuel efficiency regulations are mandatory, tangible and in force, and will evolve over time (Hughes 2013; IMO 2011a; 2011b; 2011c; 2014b International Chamber of Shipping 2014: 2; ICCT 2011a; 2011b). The standards were adopted in July 2011 in the form of amendments to MARPOL.

The regulations include:

- the Energy Efficiency Design Index (EEDI) for *new* ships;
- the Ship Energy Efficiency Management Plan (SEEMP) for *all* ships; and
- guidelines concerning the method of calculation of the EEDI, the calculation of reference lines for use with the EEDI, survey and certification of the EEDI; and development of an SEEMP.

The potential CO^2 reductions resulting from the energy efficiency regulations have been estimated to be 151.5 million tonnes of CO^2 annually by 2020 and 330 million tonnes annually by 2030 (IMO 2011c; also see ICCT 2011b). Compared with business-as-usual, these would be reductions, respectively, of 13 per cent and 23 per cent by 2020 and 2030. The need for carbon dioxide emissions *targets* has been emphasized by Smith et al. (2015). Nevertheless, in any case, the extent to which efficiency regulations and targets for carbon dioxide emissions would reduce *black carbon* emissions, including those in or near the Arctic region, is not yet apparent.

Further, in May 2015, the IMO decided to remain focused on these efficiency measures and not to adopt a greenhouse gas emissions target to be offered at the Paris COP-21 meeting in December 2015. Though not specifically about black carbon or the Arctic region, the decision did indicate an absence of IMO momentum towards tangible progress focused *explicitly* on GHG emission issues.

There has been movement, however, in the form of regional Emission Control Areas (ECAs) regulating ships' emissions of sulphur oxide (SOx) and nitrogen oxide (NOx) (IMO 2012b; US EPA 2015). The ECAs have taken the legal form of Amendments to Annex VI of MARPOL and are thus officially designated areas and subject to IMO regulation. As of early 2015, there were four such areas in various states of implementation: North America (Canada, United States, French islands of Saint-Pierre and Miquelon), US Caribbean Sea (Puerto Rico and the US Virgin Islands), the Baltic Sea and the North Sea. The latter two, it should be noted, cover only SOx emissions. Possible ECAs have also been discussed for Norway, Japan and the Mediterranean.

4.3 Climate and Clean Air Coalition

The Climate and Clean Air Coalition has been created with a mandate to address issues concerning Short-Lived Climate Pollutants, including methane, black carbon and hydrofluorocarbons. Its membership consists of 39 countries, plus the European Commission. It also has 52 non-state partners, including the International Council on Clean Transportation, the World Health Organization and World Bank. Its relationship with the UN Environment Program provides it with an institutional place within the UN system. Its mandate includes the health effects of BC as well as the climate effects (CCAC 2014). The inauguration of the CCAC in 2012 – and the inclusion of black carbon on its agenda – occurred in the same year that black carbon was added to the agenda of the Gothenburg Protocol.

4.4 Gothenburg Protocol

The Gothenburg Protocol to Abate Acidification, Eutrophication and Ground-level Ozone, which was agreed in 1999, focuses on stationary sources (UNECE 1999). Revisions of the Protocol in 2012 explicitly included black carbon as a particulate matter to be reduced for climate change mitigation as well as health benefits (UNECE 2013 2015). The Protocol is thus an important development in international efforts to address black carbon issues, and it is an example of the incremental expansion of the original Protocol, which itself was one expansion among many to the 1979 Convention on Long-range Transboundary Air Pollution) (UNECE 1979). Two North American countries (Canada and the United States), 30 European countries plus the European Union as a regional entity have made commitments of varying percentage reductions in their small particulate emissions ($PM_{2.5}$), which include black carbon, by 2020 compared with 2005 levels. The commitments are considered binding and there are provisions for monitoring compliance.

4.5 International Organization for Standardization

The International Organization for Standardization (ISO) has 166 member countries and has published nearly 20,000 standards in diverse industries. It has overseen the development and registration of a wide variety of standards concerning both environmental issues in the ISO 14000 'environmental management' category, including ISO 14064-1:2006 ('greenhouse gases'). In conjunction with the IMO, the ISO has developed new standards for maritime transport relating to LNG in the context of 'energy management' – such as the ISO 50001 standards (ISO 2015).

The ISO has been recognized by the World Trade Organization (WTO) as a source of technically sound standards, and its role in developing standards helps to legitimize and perhaps shield some standards from challenges in the WTO Dispute Settlement system on the basis of the Technical Barriers to Trade agreement.

4.6 World Trade Organization

Among the more than 50 agreements within the WTO system, the General Agreement on Trade in Services (GATS) is one that clearly concerns maritime shipping. Any international maritime policies that might impinge on WTO non-discrimination principles of Most Favoured Nation or National Treatment could therefore be WTO-related issues.

The GATS includes members' Schedules of Specific Commitments concerning 'maritime transport services' (category 11.A). The subcategories of services covered are (a) passenger transportation, (b) freight transportation, (c) rental of vessels with crew, (d) maintenance and repair of vessels, (e) pushing and towing services, and (f) supporting services for maritime transport. Any of these could potentially be relevant to the international maritime shipping issues of special interest in this paper.

However, GATS Article XIV on 'General Exceptions' provides that

> Subject to the requirement that such measures are not applied in a manner which would constitute a means of arbitrary or unjustifiable discrimination between countries where like conditions prevail, or a disguised restriction on trade in services, nothing in this Agreement shall be construed to prevent the adoption or enforcement by any Member of measures: … (b) necessary to protect human, animal or plant life or health …

Article XXVI on 'Relationship with Other International Organizations' indicates that 'The General Council shall make appropriate arrangements for consultation and cooperation with the United Nations and its specialized agencies as well as with other intergovernmental organisations concerned with services' (WTO 2015a) There have been no WTO dispute cases involving international maritime shipping (WTO 2015b).

Since the IMO has on occasion asked the WTO secretariat for advice on the compatibility with WTO rules of IMO regulations under consideration, it is reasonable to suppose that IMO regulations concerning climate change issues that might be developed could be subjected to WTO secretariat scrutiny for their compatibility with WTO rules in order to reduce challenges in the WTO dispute settlement process.

Furthermore, in regard to the ISO, there has been a tradition in the WTO of recognizing the ISO as a source of legitimate international standards under the WTO Technical Barriers to Trade agreement when they form the basis of technical regulations adopted by WTO member states domestically. In short, it seems unlikely there would be WTO problems.

Additional information about the evolution of maritime shipping issues in the WTO is available in three extensive Background Notes by the Secretariat of the WTO (1998a; 2001; 2010a; also see WTO 1998b; 2010b; 2015c). Also see Karim and Deane (2014).

4.7 International Governance Challenges

The pluralism of the 'regime complex for climate change' (Keohane and Victor 2011) and the trade 'regime complex' is evident in the variety of institutions noted that have a mandate that puts or could put Arctic black carbon issues on their agendas. (For more on the number and diversity of climate change institutions, see UNIPCC 2014 ch. 13; Keohane and Victor 2011; and van Asselt 2014a; 2014b.)[3]

A central part of the international governance challenge, therefore, is to determine which one or more of these many possible institutions can contribute directly and constructively to international efforts to mitigate black carbon problems in the Arctic region, or at least be supportive of such efforts. The next section presents a proposal that takes into account that challenge.

5. ARCTIC BLACK CARBON AGREEMENT

An attractive option to address black carbon emissions in the arctic region is an agreement in the form of a club-like partnership.[4]

5.1 Club-Like Partnership

There is increasing interest in the possibility of creating international institutional arrangements with the features of 'clubs'. As defined in the political economy literature (e.g. Cornes and Sandler 1996), the benefits of clubs have two key features: they can be *shared among participants and excluded from non-participants*. In the context of climate change agreements, the development of club-like international agreements can thus incentivize *participation* and *compliance* (UNIPCC 2014: ch. 13; Victor 2015a; 2015b; also see DeSombre 2008, on clubs in shipping). As an international governance modality, such an arrangement has the advantages of deterring 'free riding' via non-participation and/or non-compliance. In short, countries or non-state actors that want to enjoy the benefits of the agreement must participate in it and comply with its rules.

Annex B provides a taxonomy of clubs and examples of them. It reflects two different uses of the club concept that are emerging among climate change specialists. One is based on the restrictive notion adopted above, where the roles of shareable and excludable benefits are central to the creation of incentives for participation and compliance. The other is based on the number of participants and distinguishes clubs from multilateral arrangements. The distinction between the two is important because some multilateral arrangements have the key features of clubs in the restrictive sense, despite their large size.

5.2 Elements

How, then, to apply these design guidelines to the international governance challenge at hand – namely the negotiation and operation of an Arctic Black Carbon agreement?

The benefits of *participation* need to be specified. There are many possibilities. An obvious one is the opportunity to operate in Arctic region waters. The agreement would provide that only ships meeting BC-related equipment and operational standards could operate in the Arctic region.[5] An international licence for Arctic operations by individual ships and ship owners-operators could be issued on the basis of certification of the required equipment being installed and properly maintained, as well as meeting operational standards. This would thus be a public–private sector partnership, in which individual ships, shipowners, ship operators, ship registry governments, all governments participating in the Arctic Council and other governments in the IMO would all be participants. Participation would be 'voluntary', but participation would be a precondition for a ship to operate in the Arctic region. A regulatory framework would be established within the IMO by the ABC agreement, in cooperation with other organisations as indicated below. The details of the division of labour among the organisations would be coordinated by the IMO.

The licensing requirement would be imposed on ships involved in oil or gas exploration or extraction activities as well as ships engaged in the transport of any goods or people and thus include all types of ships engaged in international commerce.

Another benefit that could be shared by participants in the agreement and excluded from non-participants would be a technology transfer agreement, whereby participants would be entitled to assistance in the acquisition of the required technology to meet participation and compliance criteria. The scope and funding levels of the programmes would of course be issues to be negotiated. These could be codified and monitored by the IMO with advice and operational support from a variety of organisations, as noted in Section 4.

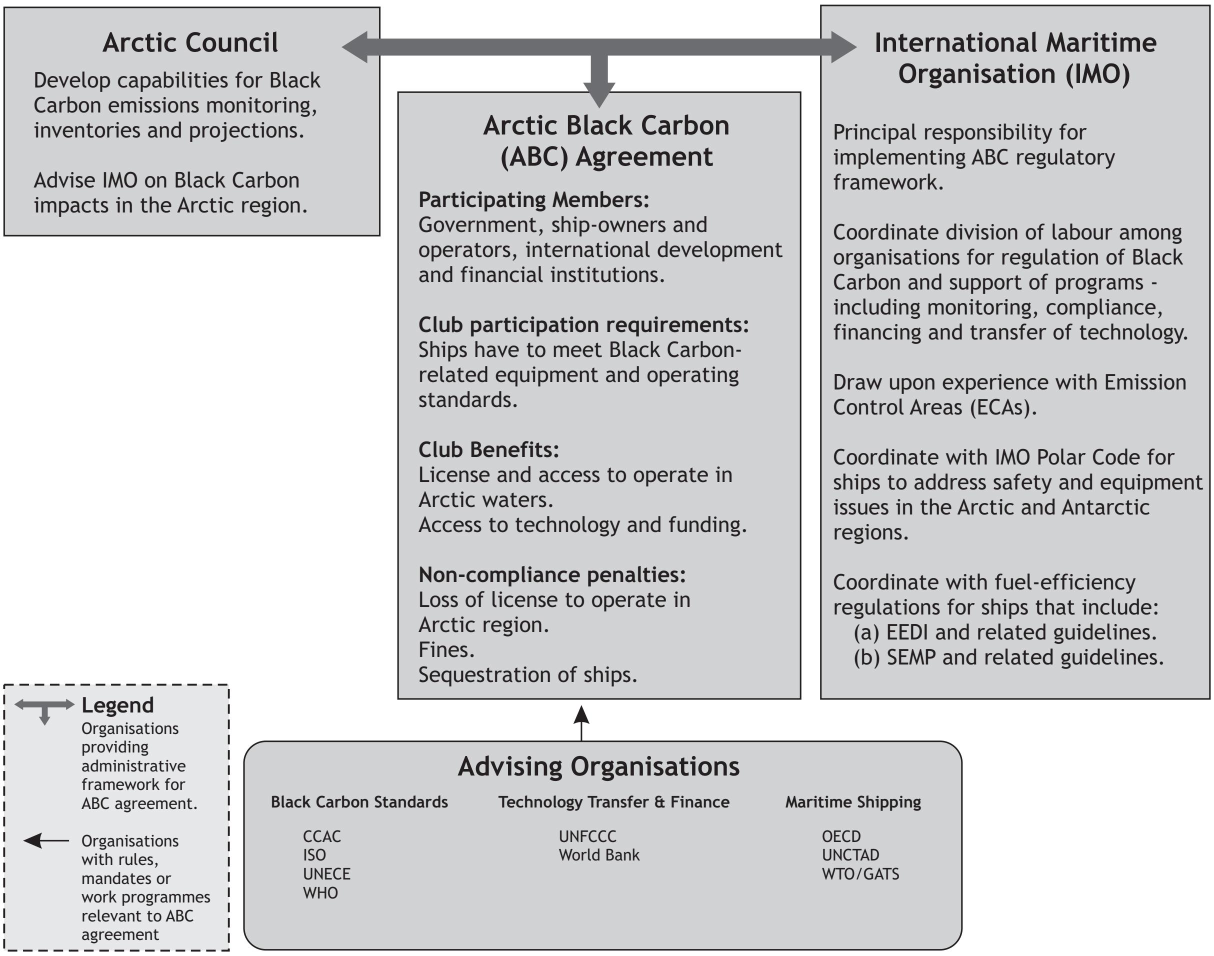
A *compliance* enforcement system would also be needed. There is already in place a worldwide, satellite-based, real-time tracking system that identifies individual ships, with their position, direction and speed . Any ship sailing into or through the Arctic region would be required to keep its transponder operating in order to be tracked. Failing to do so would result in a citation of the ship operator, with a substantial fine, embargo of the ship and cancellation of the operator's right to sail any ships in the Arctic region for a period of years. All licensed ships would be monitored for compliance with the equipment and operational standards.

Participation would be open to non-state entities such as ship owners and ship operators, as well as governments. International financial and development institutions such as the World Bank, regional development banks, UN Industrial Development Organization and UNCTAD could also participate, particularly in technology sharing programs.

Initiatives to address the climate change impacts of the international maritime industry should include the IMO as a central forum. In addition, there are many other activities in numerous organisations that already do or could interact with IMO activities.

The IMO should work directly with the Arctic Council, CCAC, ISO, UN Economic Commission for Europe, World Health Organization and other organisations to develop an Arctic Black Carbon agreement. This initiative should begin immediately in coordination with the US Arctic Council chairmanship, which has begun to focus on climate change issues during its two-year tenure from April 2015. See Figure 2.

Figure 2. Institutional Roles and Relationships for ABC Agreement



Source: Compiled by the author with the assistance of Mahesh Sugathan and James Hansen.

5.3 Other Organisations

Numerous other international organizations could provide formal or informal advice on a wide range of issues. Among them, the UN Framework Convention on Climate Change could provide input on international technology transfer issues, including how international maritime programmes relate to UNFCCC technology transfer activities. The OECD and UNCTAD also both have expertise on international maritime trade issues.

Several energy-focused organisations might also be able to advise on technical energy issues, including those associated with exploration and extraction of oil and gas reserves in the Arctic region. These include the International Energy Agency (IEA) and Energy Charter Treaty. In addition, other forums such as the Clean Energy Ministerial (CEM) and the World Energy Council – as well as the IEA – have expertise that is relevant to international technology transfer. Although each of these four institutionalized arrangements has expertise that is relevant to issues posed by black carbon emissions in the Arctic region, none of these has a mandate to regulate international maritime shipping or to regulate shipping or other activities in the Arctic region. Their potential contributions might thus be limited to relatively narrow technical issues rather than core substantive regulatory issues. Among economic development agencies, the World Bank could be particularly important in financing schemes.

6. ADDITIONAL POLICYMAKING AND ANALYTIC AGENDAS

The climate impacts of black carbon need more policymaking *action* than they have received thus far in the existing international institutional arrangements. This is not only the case for the Arctic region but also for black carbon emissions from international maritime shipping in *port areas*. As with Arctic black carbon, there are significant localized health and economic impacts of port area black carbon emissions, and of course there are also global climate change effects as well. Given the worldwide extent of the location of the relevant ports, this is clearly a problem needing serious attention from the IMO, with significant involvement of the CCAC because of its special focus on short-lived carbon pollutants including BC.

The potential for use of Emission Control Areas for the Arctic region – and port areas in other parts of the world – should be considered as a variation of the basic proposal for an Arctic Black Carbon agreement. The potential of ECAs as precedents and models for an ABC agreement needs more work that includes in part the experience to date with such regions for other types of air pollutants – namely emissions of sulphur oxide (SOx), nitrogen oxide (NOx) and particulate matter. Such zones presently only exist in North American and North European waters (IMO 2014h; US EPA 2010b).

The potential for cap-and-trade or other market-based arrangements to address GHG emission problems in international maritime shipping has been on the IMO agenda for several years, but without a resolution of the issues and without an action plan. The potential for BC to be included needs more serious attention. Measurement issues about the global warming potential of BC, however, may deter action, if there is any tangible movement on developing a cap-and-trade scheme that includes international maritime shipping.

The existence of a system of ship registration in countries other than the home country of the shipowner creates distinctive regulatory and related legal issues which are peculiar to international shipping. The implications of these arrangements for an ABC agreement clearly need detailed analysis.

WTO issues also need further analysis. Although countries' international maritime shipping policies have not been subjects of much concern within the WTO, any proposals for new regulations in the industry should be subject to careful analysis for their relationship to WTO GATS provisions and members' lists of specific commitments. Because of the complexities of including four different 'modes of supply' in the GATS and the highly uneven nature of participants' lists of commitments – uneven among participants and uneven across modes of supply – the interactions between the WTO GATS and any new international regulations of maritime shipping should be thoroughly vetted. This is also because any restrictions on shipping as envisaged by a black carbon agreement could impinge on unrestricted access to port services, for instance, offered by Arctic nations under the GATS.

Another area of international law requiring investigation is interactions between an ABC agreement and the United Nations Convention on the Law of the Sea (UNCLOS), which includes provisions concerning right of passage. A possible complication is that the US Senate has not ratified UNCLOS. In addition, the there will need to be clarification of the implications of distinctions among territorial waters, contiguous zones, exclusive economic zones and international waters – particularly as sea ice melt progresses and opens more areas to potential increases in international shipping activity. The development of scenarios and forecasting models (as in Smith and Stephenson 2013) will thus become even more useful and important.

Much more about technological and operational issues needs to be known, including especially from industry sources. There is much in the public domain on industry equipment manufacturers' web sites and in industry newsletters and journals – and much of the information is not only directly relevant but also ‘accessible’ to readers without engineering educations. Law firms with specialties in maritime issues provide public information about new regulations and the kinds of changes they require in equipment and operations.

Finally, the Arctic Council (2014; 2015e) has identified methane as well as black carbon as a significant threat in the Arctic region. This problem needs more attention, including within the broader context of worldwide emissions from prospective increases in liquefied natural gas as a fuel and a cargo in international maritime shipping (Brewer forthcoming).

ANNEX A: DEFINITIONS OF THE ARCTIC REGION

There are many definitions of the Arctic region – each developed by a different organisation for a different purpose. It has been remarked that

> The Arctic may be considered a single region, but it can be defined and delineated in many different ways. [Information available at portal.inter-map.com]. This theme introduces the different ways the Arctic can be and has been defined by different scholars and organizations, and the many ways that the 'Arctic boundary' can be drawn on the map. [The definitions] include environmental markers such as the treeline and 10°C July Isotherm, as well as definitions of the region created by processes of the Arctic Council. In order to establish the geographic limits of their work, the working groups of the Arctic Council began to create boundary lines on the circumpolar map that were relevant for their particular mandate. (Arctic Portal 2015; also see Østreng 2015)

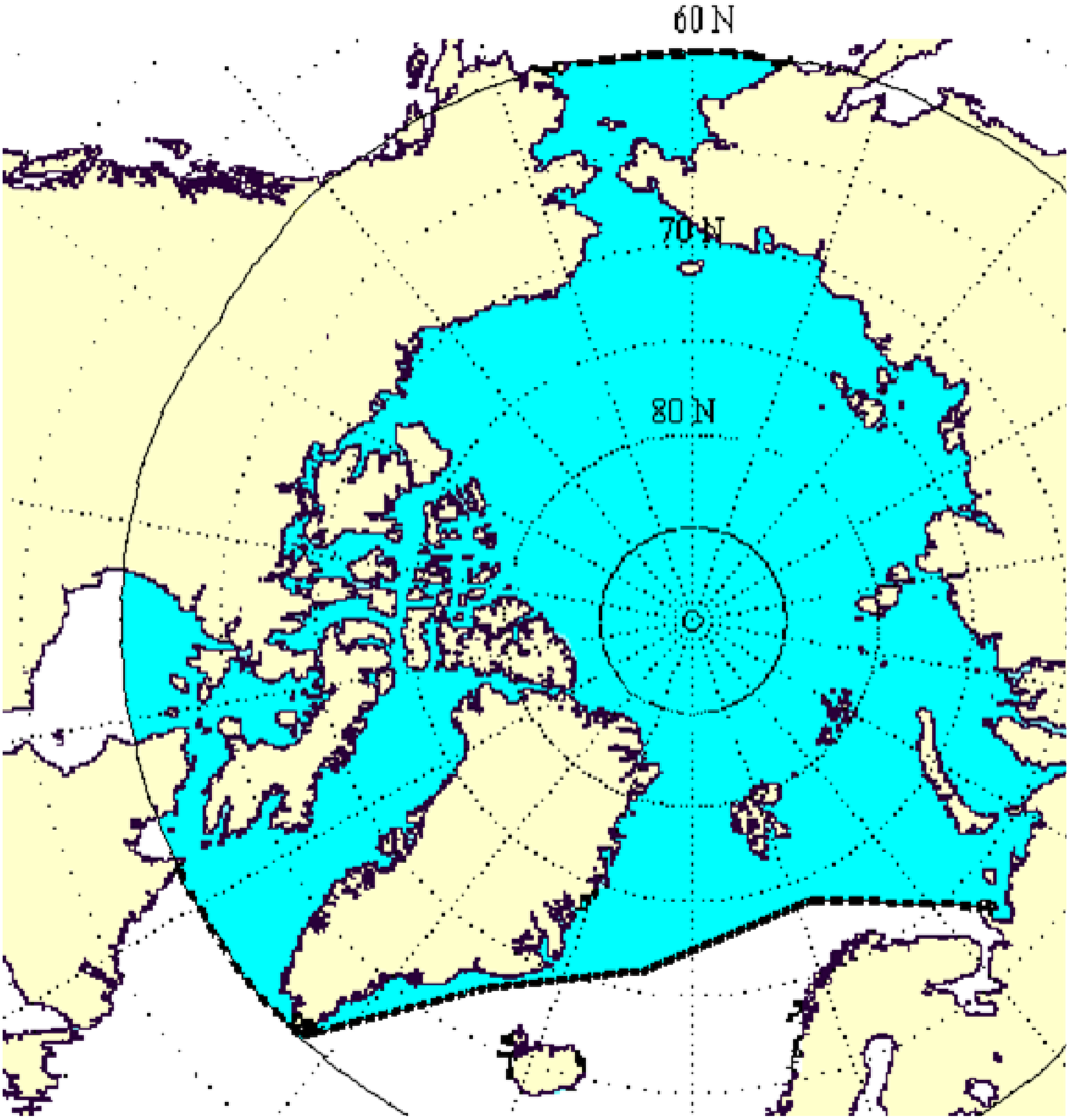
Maps A1 and A2 depict three of the definitions (for others see Arctic Portal 2015; Østreng 2015). Map A1 includes territories of the eight members of the Arctic Council and is a commonly used geographic definition of the Arctic region. It suffers, however, from not reflecting the common physical conditions that are often at the core of popular notions of the region, including in particular the temperature conditions. The same map thus also includes an 'isotherm' denoting the area where the average temperature is a given temperature during the warmest month of the year – in this instance, 10°C (50°F) for July.

Map A1. Arctic region defined in geographic and isotherm terms

The geographic area north of the Arctic Circle, represented by the thin broken line, includes territories of the eight national members of the Arctic Council: Canada, Denmark (including Greenland), Finland, Iceland, Norway, Russia, Sweden and the United States. The area inside the irregular solid thick line indicates the 10oC (50oF) isotherm for July – that is, the area where the average temperature is below that temperature.
Source: University of Texas Library , 'Arctic Region map'. Accessed at www.lib.utexas.edu on 28 April 2015.

Yet another possibility is to define the area in more functional terms in relation to a specific need. This has been the approach of the IMO, whose concern is the special challenges of the ice-bound region depicted in Map A2.

Map A2. IMO definition of the Arctic region



Source: IMO (2002) as reproduced in Østreng (2015). Accessed at www.arctis-search.com on 28 April 2015.

ANNEX B: TYPOLOGY AND EXAMPLES OF CLUBS AND NON–CLUBS IN INTERNATIONAL GOVERNANCE

This taxonomy was prompted by my presentation on an ABC agreement and presentations and discussions by others at a side event on Carbon Pricing, Technology Investment, and Trade at the International Scientific Conference on Our Common Future under Climate Change in Paris on 8 July 2015. The side event was organised by Climate Strategies, the Stanley Foundation, the Institute for Sustainable Development and International Relations (IDDRI) and ICTSD.

The taxonomy and lists of examples are preliminary representations from ongoing research on climate clubs (these are not intended to be comprehensive lists). There are other ways to distinguish among types of clubs (see especially Falkner 2015).

Note that it would be possible to combine the two criteria – benefits and size – in order to accommodate both the political economy literature that emphasizes the structure of benefits and much of the climate change discussion to date that emphasizes membership size. Accordingly, one could limit the notion of climate clubs to arrangements that have a relatively small number of participants (see Falkner 2015 for illustrative numbers) *and* have shareable and excludable benefits to encourage participation and compliance. The proposal for an Arctic Black Carbon agreement in this paper would meet both the size and benefits features.

Club concept focus	**Issue focus**	
	Climate and climate-friendly	**Non-climate**
Benefits: shareable and excludable[a]	ABC agreement proposal, as discussed in this paper	WTO[e] IMF[f] WORLD BANK[g] EUROZONE[h]
Size: non-multilateral	CCAC[b] EGA*[c] ITA*[d] MEF/CEM*[a]	Bilateral, regional, plurilateral, and other non-multilateral arrangements

[a] There are some ‘partial clubs’ – i.e. they have shareable and excludable benefits of *participation but not of compliance*. For instance, the Clean Energy Ministerial of the Major Economies *Forum has shareable membership benefits* consisting of international technological exchanges, but membership is *excludable* on the basis of market size or technological significance in clean energy. There are no provisions for *non-compliance*.

[b] Climate and Clean Air Coalition to Reduce Short-Lived Climate Pollutants

[c] Environmental Goods Agreement is a plurilateral negotiation in progress that is expected to be multilateralized within the WTO if/when the negotiations are completed. The goods whose tariffs are being negotiated include climate-friendly goods such as wind turbines.

[d] The Information Technology Agreement is a plurilateral agreement that has been multilateralized within the WTO. The goods whose tariffs have been reduced to zero include IT components for energy efficiency and other clean energy controls, as well as other climate-friendly goods.

[e] WTO membership (and the benefits thereof) requires that applicants’ policies qualify for *participation* in various specific agreements such as GATT, GATS and others (e.g. Russia and China), and *non-compliance* is penalized by enforced compensation of the ‘winner’ by the ‘loser’ in Dispute Settlement cases.

[f] IMF members have to contribute variable amounts for quotas in order to participate. Non-compliance in the form of ‘arrears’ on outstanding loans prevents further borrowing.

[g] World Bank Group consists of five organisations: the International Bank for Reconstruction and Development (IBRD), the International Development Association, the International Finance Corporation, the Multilateral Investment Guarantee Agency and the International Centre for Settlement of Investment Disputes (ICSID). The membership of the IBRD is 188; there are only 127 members of all five. The participation and compliance rules vary among the five organisations, but all have restricted participation on the basis of some criteria, such as paid-in capital (IBRD), and have rules about compliance, such as having to enforce arbitral awards (ICSID), and have to make annual contributions to participate and gain the benefits. Non-compliance in the form of ‘arrears’ on outstanding loans prevents further borrowing. Participation in the benefits of borrowing is also limited by ‘conditionality’ of loans.

[h] Eurozone members have to meet fiscal criteria to participate in the benefits of belonging to a single-currency zone. Members can be expelled for non-compliance (though the precise criteria may be ambiguous).

ENDNOTES

1 ‘Black carbon’ should not be confused with ‘carbon black’, which is used for instance to strengthen motor vehicle tyres and to make them and other products black. On the science and measurement of the climate change impacts of BC, see UNIPCC (2013), section 8.7; Kopp and Mauzerall (2010); and US EPA (2010a). On its sources, including maritime shipping, see Institute for Governance and Sustainable Development (IGSD) (2008; 2013); ICCT (2009; 2015) The Arctic Council (2011b; 2015), Frease (2012), Griffith (2014), Lefton and Kelly (2014), Pincus and Ali (2015) and Yeo (2015) focus on BC issues in the Arctic region.

2 For studies of the range of climate change problems – and types of greenhouse emissions – of interest in the international maritime industry, see Asariotis and Benamara (2012); Braithwaite and Drahos (2000), Cames et al. (2015), Chrysostomou and Vågslid (2012), Center for Climate and Energy Solutons (2014); Crist (2009; 2012), Culliname (2012); Dong (2014); ICCT (2007; 2011b; 2013a); Karim (2015); OECD (2009); UNFCCC (2014b) and Sarwar (2006). Numerous publications of the IMO are also important, including IMO (2011b; 2011c; 2011d; 2013a; 2013b; 2014c; 2014d). Also see UNCTAD (2014a; 2014b)Among greenhouse *gases, nitrous oxide* (NOx) is the third biggest contributor to global warming. However, in the maritime shipping sector, in particular, because of the relatively high ratio of NOx to CO_2 emissions of the industry and the location of most emissions in low NOx environments, and because of the cooling impact of NOx which breaks down methane in the atmosphere, the net climate change impact of NOx emissions in the industry is a cooling effect, not a warming effect (OECD 2009: 8–9). *Hydrofluorocarbons* (HFCs) were developed to replace chlorofluorocarbons (CFCs) as coolants in many applications including in international shipping in order to reduce the ozone-depleting effects of CFCs. The GWP of HFCs, however, is about 3,500 at 20 years and about 3000 at 100 years. *Sulfur oxide* (SOx) is often not included in lists of greenhouse gases, though it does have some direct and indirect warming and cooling effects and is a constituent of maritime emissions from diesel engines. (See, for instance, UNIPCC 2013; World Shipping Council 2014c.)

3 The pluralism and fragmentation of the international institutional landscape of climate change governance have been documented in detail by the literature reviewed by the UNIPCC (2014: ch. 13), Keohane and Victor (2011), van Asselt (2014a; 2014b), Moncel and van Asselt (2012), Bodansky, (2011), and Ostrom (2009). A large number of international forums have touched upon methane and/or black carbon and/or carbon dioxide emissions that have at least tangential relevance to the central climate change concerns of the international maritime shipping industry. They include the Clean Energy Ministerial, Energy Charter Treaty, G-7/G-8, G-20, Global Environment Facility, Global Methane Initiative, International Energy Agency, International Organization for Standardization, UN Development Programme, UN Environment Programme (UNEP), UN Industrial Development Organization and World Bank. However, none of them is focused on the issues of this paper.

4 The exclusionary nature of such arrangements is the basis for the nomenclature ‘club’. In order to give the institutional modality a more diplomatic and collaborative connotation, I have used the term ‘club-like partnership’. The intended purpose and design principles are the same as with ‘club’, despite the difference in semantics. The discussion here is an expansion based in part on Brewer (2015. There is a brief review of the literature about clubs and climate change institutional arrangements in UNIPCC (2014: ch. 13). There are important contributions by Victor (2011; 2015a; 2015b), Keohane and Victor (2011), Falkner (2015), Morgan, Messner and Schellnhuber (2014), Weischer, Morgan and Patel (2012), Andonova (2009), Babiker (2005), and Kolln and Prakash (2002). Several items in the

collection edited by de Coninck, Lorch and Sagar (2014) include references to clubs in the context of climate change issues – those by Garibaldi et al. (2014), Rossi (2014), and Brewer (2014b). There is a large collection of studies of compliance issues that are related to club goods in Brunnée, Doelle, Rajamani (2012).Also see, Cornes and Sandler (1996) and Sandler (1997) for introductions to key conceptual and empirical issues about club goods in general. See Keohane and Petsonk (2015) for climate clubs and the WTO.

5 Current shipping traffic uses mostly the Northern Sea route – which passes through Russian territorial/contiguous zone/exclusive economic zone waters - for a portion of the year. The Northwest Passage route – which passes through Canadian territorial/contiguous zone/ exclusive economic zone waters - is open less often. Both routes are projected to be open more often and for longer periods over the next several decades. By mid-century passage directly over the north pole may be feasible (Smith and Stephenson 2013). As noted in Annex A (Maps A1 and A2), there are several definitions of the 'Arctic region' and differences among them could come into play in delimiting the area covered by the regulations propose for the ABC agreement.

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