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Provision of Emission Control Area and the impact on shipping route choice and ship emissions

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ABSTRACT

This paper investigates the impacts of Emission Control Areas (ECAs) on aspects of global shipping. As the direction and degree of climate change have become increasingly well documented, emissions from ships have received more attention from the shipping industry. By using data for the Asia–Europe route, we model the route-choosing behaviour of liner shipping though possible ECA in the Mediterranean Sea. Our investigation reveals that, if an ECA is established, a considerable portion of ships will re-route around the ECA and regional emissions will be excessive under certain conditions. Small ships are more inclined to re-route than big ships. Therefore, despite the potential reduction of ship emissions in one area, our findings suggest that more internationally coordinating effort should be directed towards reducing ship emissions.

1. Introduction

The IMO (International Maritime Organization) have established measures on different issues. Current maritime emission regulations set limits for SO_x and NO_x for health and environmental reasons, and for CO_2 to mitigate global warming (Eide et al., 2013; Lindstad and Sandaas, 2014; Lindstad et al., 2015). One of IMO established measures is ECAs (Emission Control Areas). ECAs were first defined in Annex VI of the 1997 MARPOL (International Convention for the Prevention of Pollution from Ships) protocol, and came into effect in 2005. Emission requirements are much stricter in ECAs compared with outside such areas. Up to now, ECAs designated under MARPOL Annex VI for SO_x and particulate matter emission control include the Baltic Sea area, the North Sea area, the North American area and the Unites States Caribbean sea area. Among these ECAs, the North American area and the Unites States Caribbean sea area are also ECAs established for NO_x emission control (IMO, 2016). As regulators are determined to control ship emissions around populated cities, other areas are being considered to be added via the MARPOL protocol. Recently, the possible designation of the Mediterranean Sea as ECAs has been discussed (Panagakos et al., 2014).

It is confident that an ECA imposes limits on emissions which will definitely yield a reduction in emissions within the ECA. It will be beneficial if more quantitative analysis can be conducted on designating a new ECA by evaluating the ship emission reductions. Some previous studies have focused on regional ship emission reductions by ECAs: Poplawski et al. (2011) calculated ship emissions in Victoria, Canada; Schemban et al. (2012) investigated the influence of ship emissions

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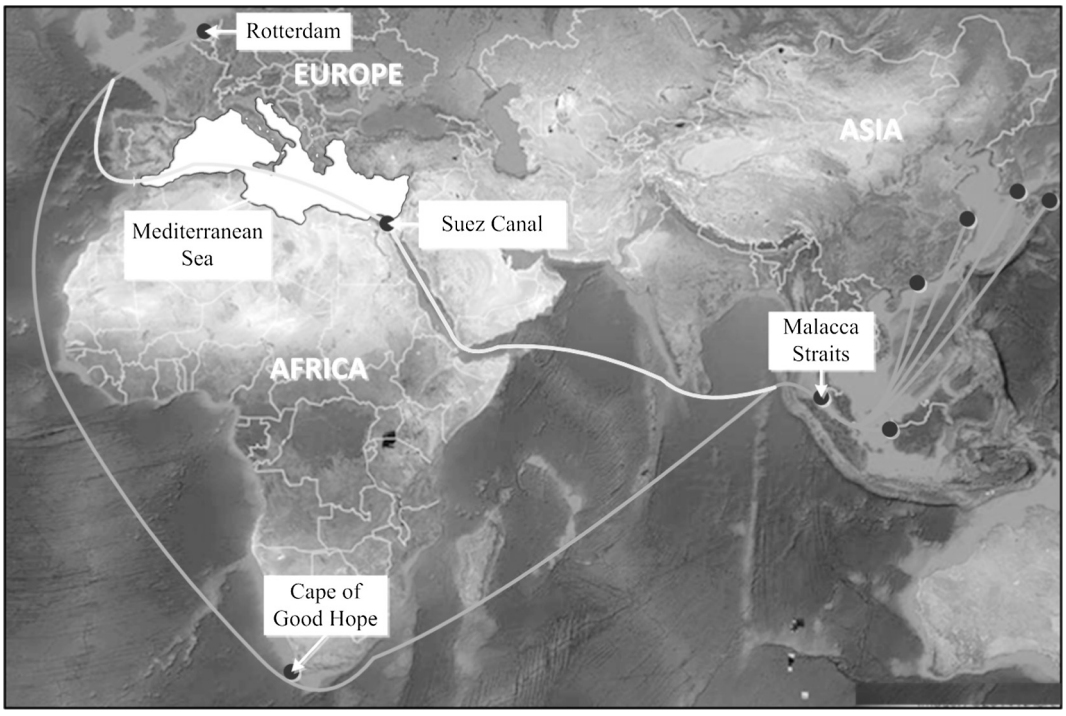

Fig. 1. Asia-Europe shipping routes.

on air quality in Mediterranean Sea harbours; and Chang et al. (2014) assessed the noxious gases of vessel operations in a potential ECA; Svindland (in press) presented SO_2 emission calculations of two container feeder vessels in a pre- and post ECA regulation setting. Those studies investigated the impact of ECAs by analysing changes (reductions) in shipping emissions. However, those studies focused on local harbours and ignored the influence of ship route change. With the establishment of new ECAs, ships' routing will change in response, and hence emission reductions should be adjusted according to the changes in ships' behaviour. Fagerholt et al. (2015) performed a computational study on shipping routes to evaluate possible impacts on sailing paths and speeds from the ECA regulations. The study showed that ship operators will often choose to sail longer distances to avoid sailing within ECAs. Therefore, it is important to conduct more studies on the shipping route configuration and associated implications under various ECA settings.

In 2014, the ECA Regulation Surcharge was implemented to the North American ECAs in the fixed amount per TEU. Although the ECA Regulation Surcharge is monitored and adjusted on a quarterly basis, the impact of this Surcharge has not been studied in the literature.

Seaborne trade between East Asia and Northern Europe can be made via the shipping routes via the Mediterranean Sea and the alternative via the Cape of Good Hope (Fig. 1). The establishment of ECAs means that all ocean-going vessels, if not using alternative fuels (methane, LNG, etc.) and/or abatement technologies, entering such areas would have to switch to low-sulphur fuel or pay an emission penalty. If emission standards in the Mediterranean Sea were to be controlled, the routes for shipping would likely be different. Currently, ships trading in designated ECAs have to use fuel oil on board with a sulphur content of no more than 0.10% from 1 January 2015, against the limit of 1.00% in effect up until 31 December 2014 (IMO, 2014).

Therefore, in the present study, we aims to contribute to ECA policy by modelling the possible effects of establishing an ECA in the Mediterranean Sea, with a focus on shipping route configuration and associated ship emissions along shipping routes. In Section 2 of the paper, we examine the literature on ship emissions, particularly those studies that have taken a modelling approach, and including with respect to ECAs. In Section 3 of the paper, we apply the Discrete Choice Model (DCM) to model the shipping route choice, including the process of setting modelling parameters. In Section 4, we present the results regarding route choice and corresponding emission reductions. Section 5 concludes the paper.

2. Literature review

The literature investigating ship emissions has focused on individual ships' emissions and the relationship of individual ships to the environment. Psaraftis and Kontovas (2010) studied various maritime policies on greenhouse gas emissions and discussed the ways of using reductions in steaming speed, changes in the number of ships in the fleet, and the use of in-

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