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Coastal exposure to oil spill impacts from the Finisterre Traffic Separation Scheme

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ABSTRACT

This study analyzes the coastal exposure to potential oil spills coming from the various corridors that constitute the Finisterre Traffic Separation Scheme (NW Iberia). A Lagrangian model was executed with results from a realistic configuration of an ocean model during 2012, validated here against High-Frequency (HF) radar-derived surface currents. Virtual particles were released each hour and followed during the next 4 days. A series of maps summarize which regions would be impacted and when. We have learnt, for example, that Cape Finisterre is the most affected area under a wide range of scenarios and that a sensitive area such as the National Park of the Atlantic Islands would require protective actions in less than 24 h if oil spills from the south eventually occurred. A complete analysis by corridor and during specific wind events is available through a web tool, which could be useful for decision makers in case of contingency.

1. Introduction

Thousands of tons of hydrocarbons are spilled to the global ocean each year, leading to a chronic pollution of our seas (GESAMP, 2007). Although large oils slicks coming from accidents of oil tankers and drilling platforms have usually received widespread media attention, spills from conventional maritime traffic are estimated to be three times larger (Oceana, 2005). Thus, tank washing or waste of bilge water largely contribute to this chronic pollution, which cause damage on both marine ecosystem and impact economic and recreational activities of the affected areas (EMSA, 2013).

Coastal pollution by hydrocarbons is a threat in the Euroregion Galicia (Spain) – North Portugal, where four of the 10 largest oil spills in Europe happened (ITOPF, 2013), the last one during the Prestige accident in 2002. The recurrence of maritime accidents in this area is related in one hand to the rough sea conditions during winter and on the other one to the intense maritime traffic. Shipping in the region is organized with the establishment of the Finisterre Traffic Separation Scheme (TSS), a group of corridors that separate northward from southward navigation but also ships transporting hazardous substances from those carrying conventional goods (Fig. 1). This is the second shipping corridor around the Iberian Peninsula in terms of traffic intensity, after the corridor in Gibraltar Strait that connects the Atlantic Ocean and the Mediterranean Sea. Navigation in the Finisterre TSS is from/to the British Channel to/from Gibraltar Strait, Africa and America. Thus, 42,354 ships communicated to national authorities during 2008 their passage through this TSS, and although the intensity of the traffic diminished after the 2008 economic crisis, the traffic reported in 2011 was still high, with a total of 38,946 ships (SASEMAR, 2011). More than 30% of these vessels transported substances classified as dangerous following the International Maritime Dangerous Goods Code of the International Maritime Organization (IMO). From mid-2002 to 2008, around 600 carriers with radioactive loads navigated through the Finisterre TSS (Suárez and Martínez, 2009). Moreover, part of this traffic puts in at the large ports of Vigo or A Coruña, the last one with an important transport of hydrocarbons – close to 7.5 Mt during 2011, the half of them crude oil (Coruña, 2012). From above, one can conclude that the coastal exposure to maritime pollution is large in this region, particularly to accidental or illegal oil spills, which lead it to be designated as Particularly Sensitive Sea Area (PSSA) by IMO in 2004.

To mitigate pollution generated by oil-spills, a strong effort has been carried out in last years to develop adequate contingency plans, particularly after the Prestige accident. These plans must include information about the vulnerability of the coastal environments,

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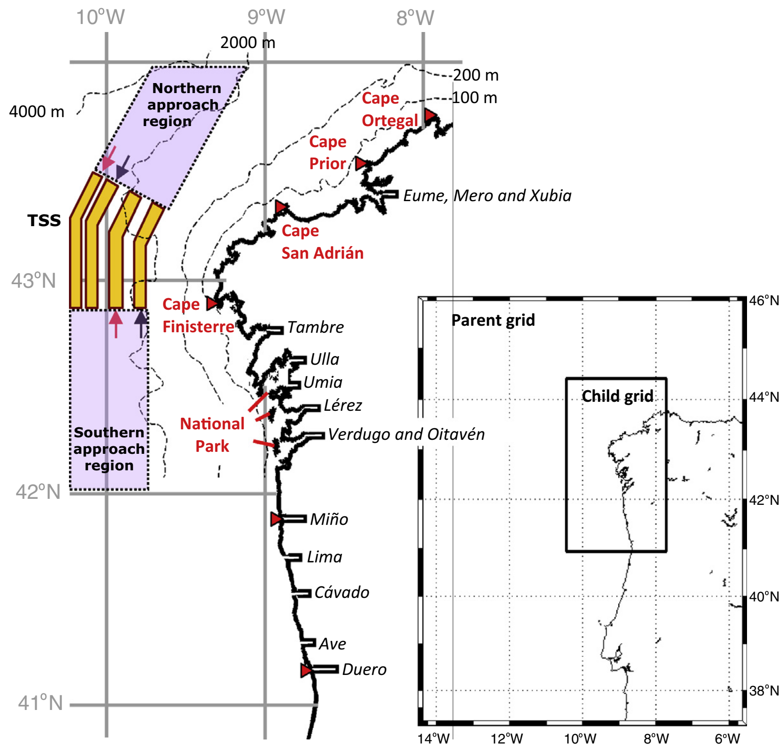

Fig. 1. Areas of the nested grids of the ocean model (right) and main geographic features in the child grid (left). The Finisterre Traffic Separation Scheme, river channels of the model configuration and the 100, 200, 2000 and 4000 m isobaths are also shown.

but also about the probability of the coast of being polluted by an oil spill, so that they may receive priority protection in case of emergency. The planners need to know, among other important questions, which regions will be impacted and their time of response by knowing the actual position of an eventual oil spill.

To help in the task, Lagrangian trajectory methods are a useful tool for the analysis of oil transport by tracking and ensemble of virtual particles over time (Viikmäe et al., 2013). The current strategy consists on coupling this tool with operational oceanographic currents, usually initialized with analyses fields and remote sensing data, and forced by atmospheric forecast models. A good example of the current state-of-the-art is the established operational system for oil spill predictions in the Mediterranean and Black Sea, where a Lagrangian model that predicts the transport, diffusion and spreading of oil spill is integrated with the MyOCEAN (http://www.myocean.eu/) regional and model Cyprus Coastal Ocean Forecasting and Observing System (CYCOFOS) downscaled forecasting products, contributing to the implementation of the Global Monitoring for Environment and Security (GMES) strategy (e.g., De Dominicis et al., 2013; Zodiatis et al., 2012).

In our area of interest (Fig. 1), Lagrangian models have been coupled to hydrodynamic and meteorological models (e.g., Abascal et al., 2010; Carracedo et al., 2006; Marta-Almeida et al., 2013; Montero et al., 2003; Sotillo et al., 2008) and in a lesser extent to High-Frequency (HF) radar data (e.g., Abascal et al., 2012). However, the most of these studies have been focused on simulating past events like the Prestige oil spill and/or on testing the reliability of the models during contingency exercises, with little focus on the coastal risk assessment.

A worth mentioning exception is the study of Abascal et al. (2010), where a 2D Lagrangian model in the region was forced by a combination of a re-analysis database of wind and waves consisting of 44-year hindcast and climatologic daily mean surface currents. However, as they conclude, these results could be improved by using a high resolution ocean model and taking into account the shipping routes. Allen-Perkins et al. (2012) took a more realistic approach during the development of the regional Galician contingency plan for marine pollution (CAMGAL). They studied the probability of coastal stranding of eventual oil spilled at the real position of vessels shipping in the area during 2010. For this task, a realistic ocean and meteorological model configurations were used.

The present study analyzes the exposure of the coast along the Euroregion Galicia (Spain) – North Portugal to potential oil spill impacts coming from the Finisterre TSS, the area with a higher probability of originating pollution in the region (Allen-Perkins et al., 2012). Here, we also include the analysis of the approach regions to the TSS during the navigation. The main contribution of this paper is the use of a realistic high resolution state-of-the-art ocean model configuration (5 times higher than that used by Allen-Perkins et al., 2012), maintained and executed in operational way in the frame of the Iberian Margin Ocean Observatory (RAIA; http://www.marnaraia.org). A 2D Lagrangian model is coupled to the results from the 3D ocean model configuration and is used to follow particles during the current temporal forecast horizon provided by the meteorological models of the Observatory, which is the temporal window managed by planners in case of contingency. The drift response to different wind events and the time spent to impact the coast is evaluated. Furthermore, surface currents used to force the Lagrangian model are compared with the HF radar data available in the region, demonstrating the reliability of these results for decision-makers.

2. Methods

2.1. The operational ocean model configuration

The ocean model configuration used is one of the several regional configurations available in the frame of the RAIA Ocean Observatory.