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Review

Current status of deepwater oil spill modelling in the Faroe-Shetland Channel, Northeast Atlantic, and future challenges

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ABSTRACT

As oil reserves in established basins become depleted, exploration and production moves towards relatively unexploited areas, such as deep waters off the continental shelf. The Faroe-Shetland Channel (FSC, NE Atlantic) and adjacent areas have been subject to increased focus by the oil industry. In addition to extreme depths, metocean conditions in this region characterise an environment with high waves and strong winds, strong currents, complex circulation patterns, sharp density gradients, and large small- and mesoscale variability. These conditions pose operational challenges to oil spill response and question the suitability of current oil spill modelling frameworks (oil spill models and their forcing data) to adequately simulate the behaviour of a potential oil spill in the area. This article reviews the state of knowledge relevant to deepwater oil spill modelling for the FSC area and identifies knowledge gaps and research priorities. Our analysis should be relevant to other areas of complex oceanography.

1. Introduction

1.1. Oil exploration and production west of the Shetland Islands

Oil production in deep water prospects west of Shetland (Fig. 1a) has taken place for over 20 years. The Schiehallion field (water depth 350–450 m) has been in operation since 1993, while the Foinaven field (400–600 m) started production in 1997. The search for new fields has consistently moved west towards deeper water and has led to oil exploration and discovery beyond the margins of the continental shelf, into the depths of the Faroe-Shetland Channel (FSC). For example, the Rosebank prospect (2008) is in 1100 m, the Cambo prospect (2009) in 1090 m and the North Uist prospect (2012) in just under 1300 m. This move towards deeper water exploration or production is not unique to this area. For example, in Europe similar patterns are evident on the Norwegian Continental Shelf, the Irish Atlantic Margin and nearby areas (e.g. Rockall Basin) and further afield (Eastern Mediterranean). Worldwide, Brazil, USA, Angola and Norway currently dominate deepwater production but new developments are expanding globally in all continents.

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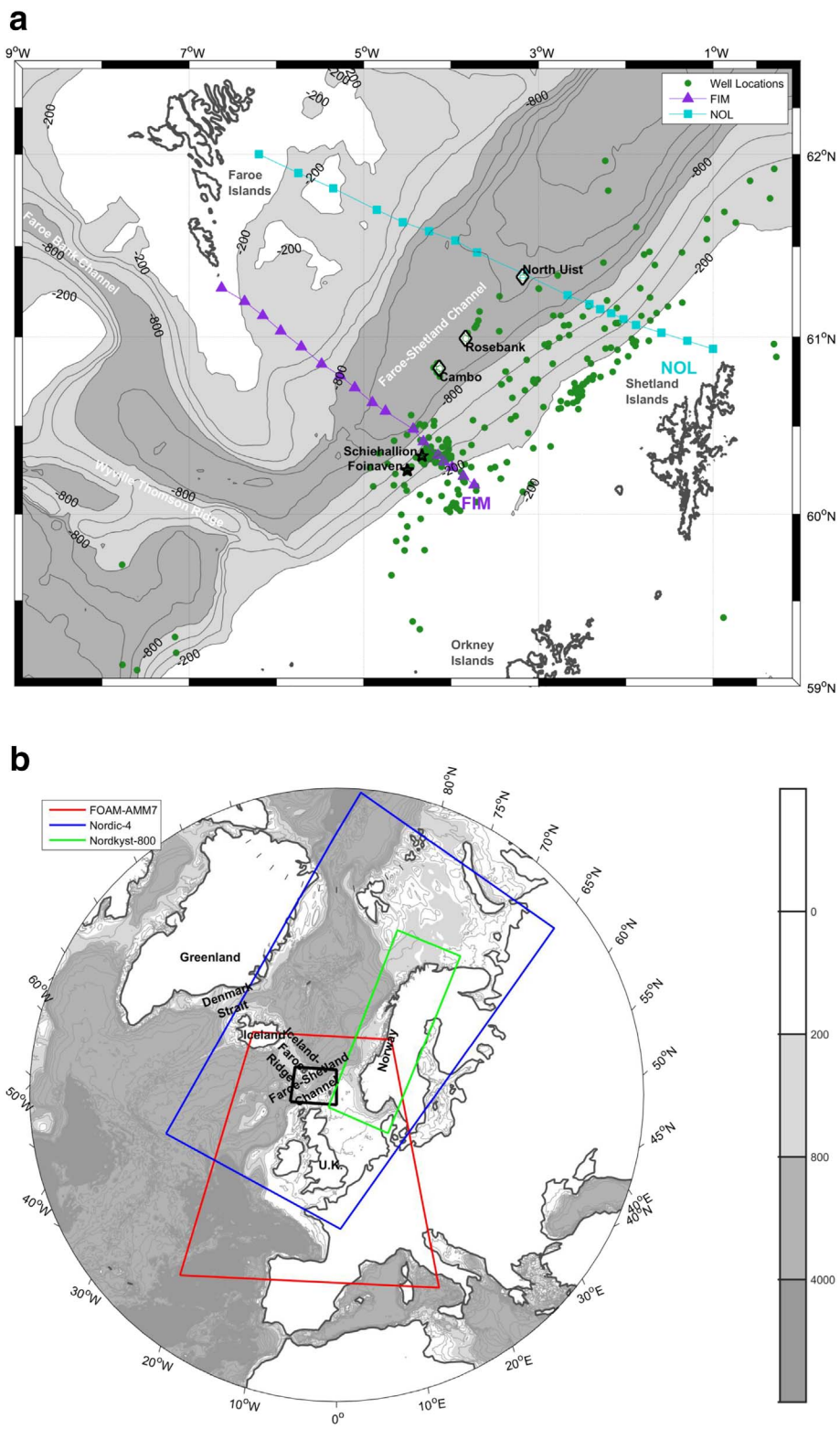

Fig. 1. a) map of the Faroe-Shetland Channel (FSC) showing the established monitoring lines, Fair Isle – Munken (FIM; stations are triangles) and Nolso - Flugga (NOL; stations are squares). Station numbering is incremental SE to NW. Green dots are wells drilled in the UKCS*, stars illustrate the location of key oil installations and rhomboids show the location of areas of exploration referred to in the text; b) general geographical location of the focus area (black polygon), also showing the domain of 3 hydrodynamic models (see legend) referred to in the text. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)
*Source: UK Oil & Gas Authority

1.2. Background to this study and research questions

On 20 April 2010, an explosion on the Deepwater Horizon (DWH) drilling rig initiated the catastrophic release of between 4 and 5 million barrels, or > 700,000 t (Crone and Tolstoy, 2010, Camilli et al., 2010, McNutt et al., 2012, Joye et al., 2016) of oil into the Gulf of Mexico over an 86 day period (e.g. see Cleveland, 2013) at an approximate water depth of 1500 m. Comparable to the Ixtoc I oil spill of 1979, DWH is considered to date the largest accidental release of oil into the marine environment (see Table I in Hoffman and Jennings, 2011).

The deeper waters west of Shetland represent the closest range of water depths to that of the DWH oil spill in the UK Continental Shelf (UKCS; those areas beyond the territorial sea over which the UK exercises sovereign rights over natural resources, not strictly speaking a continental shelf in geological terms). To put the FSC situation into context, using the figures provided by BP in the North Uist Exploration