DEVELOPMENT OF AN APPLICATION TO TRACK MISSING PERSONS AT SEA

Diego Pereiro, Kieran Lyons, Achref Othmani, Rob Fuller, Glenn Nolan, Tomasz Dabrowski

DEVELOPMENT OF AN APPLICATION TO TRACK MISSING PERSONS AT SEA

Diego Pereiro [(1)], Kieran Lyons [(1)], Achref Othmani [(1)], Rob Fuller [(2)], Glenn Nolan [(1)], Tomasz Dabrowski [(1)]

[(1)] Marine Institute, Rinville West, Rinville, Co. Galway; diego.pereiro@marine.ie

[(2)] Gno Beo Limited, 5 Woodlands Avenue, Renmore, Co. Galway

Abstract

Particle-tracking models can simulate the drift of floating objects in the ocean, and provide a valuable tool for search and rescue operations at sea. The choice of model parameters has a big impact on the prediction, and can greatly affect the success of the search and rescue operations. In particular, the way in which windage is introduced into the model largely determines the dispersion and final distribution of the numerical floats.

The Marine Institute has conducted several experiments with OpenDrift, which have proven to be useful to help in search and rescue operations and to investigate the important connection that exists between people missing from the coast of Ireland and being found on the Welsh coast. This has culminated in the implementation of a new version of an OpenDrift-based, web application called ADRIFT, which allows to select between a range of different objects with specific leeway properties.

Keywords: particle-tracking, search and rescue, windage, OpenDrift, ADRIFT

1. Introduction

Cases of people going missing in the sea require a rapid response in order to maximize the chances of succeeding in finding the body. A common approach consists of using a combination of ocean and atmospheric forecasts together with a particle-tracking model. Since a rapid response is necessary, an operational system is highly advisable, allowing end users to readily introduce the time and location where the person was last seen, run the particle-tracking simulation, and finally obtain a visualization of the prediction as a time-varying probability distribution, showing the areas where finding the person is most likely.

The prediction can be greatly influenced by the choice of model parameters. More specifically, the way in which windage is prescribed into the model largely affects the dispersion and final distribution of the numerical floats. Here, the term *windage* is used to refer to the drift caused by the direct effect of wind on the overwater section of a floating object.

One example of an operational system oriented to search and rescue operations, and providing a user-friendly interface to run particle-tracking simulations is ADRIFT, developed by the Marine Institute. The system is linked to 3-day ocean forecasts obtained from the operational, ROMS-based, hydrodynamic models run by the Marine Institute: the Northeast Atlantic model (NEATL, see Nagy *et al.*, 2020a), the Connemara model (Nagy *et al.*, 2020b) and the Galway Bay model (http://milas.marine.ie/thredds/catalog.html). Until recently, the associated particle-tracking model used in ADRIFT has been Ichthyop (Lett *et al.*, 2008). Latest developments include a replacement of Ichtyop with OpenDrift (Dagestad *et al.*, 2018), which offers a submodule specific for tracking different types of floating bodies, including missing persons.

This work presents this transition of the ADRIFT software, highlighting the importance of a proper windage parameterization when simulating the drift of missing persons at the ocean surface. Section 2 provides different experiments that demonstrate the role of windage when tracking floating bodies in the sea surface. Section 3 presents a brief summary of the tests carried out with OpenDrift in the Marine Institute so far. Finally, section 4 provides an overview of the new ADRIFT.

2. The importance of Windage

2.1 Experiments with drifters

A series of experiments with surface and fully submerged drifters were carried out in the waters west of Ireland in 2019. Surface drifters (iSPHERE), designed for oil spill contingency operations (Price *et al.*, 2006), consisted of a drifting sphere that sticks to the surface and is exposed to direct wind drag due to the equal cross-section areas between the air-water interface. On the other hand, fully submerged drifters (iSLDMB), had a cross-shaped drogue following the ocean current movement within the top 0.7 m of the water column, which minimizes the influence of winds and waves.

The paths followed by both groups of drifters were simulated using current fields from NEATL and ECMWF winds. Different wind drag coefficients were tested for each group, adding from 0% to 7% of the wind velocity to obtain the total float velocity. Particle-tracking model performance was assessed using the Liu and Weisberg (2011) skill score. Adding windage does not affect the ability of the model to track the iSLDMB drifters, but the performance is greatly affected when tracking the iSPHERE drifters: best results are obtained when a 2% wind drag coefficient is used (Figure 1). This experiment highlights the importance of considering the wind effect when tracking floating bodies in the ocean surface, such as missing persons.

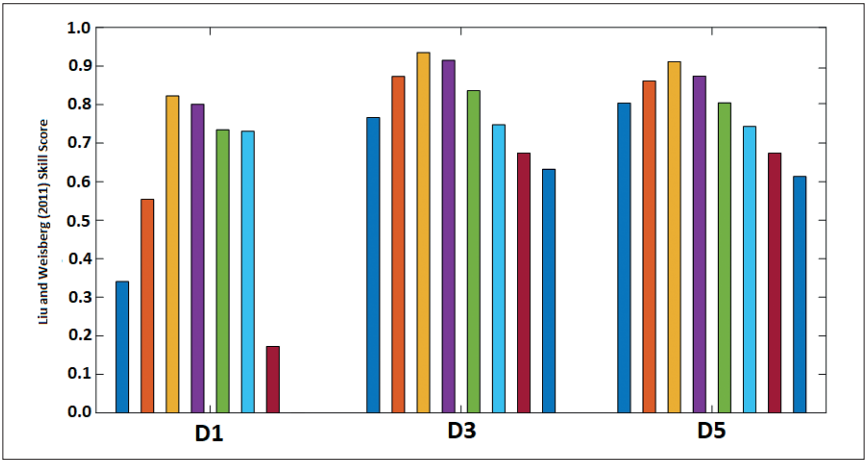

Fig. 1. Skill scores for the iSPHERE drifters (buoy deployments named here as D1, D3, D5). The wind drift-factor is varied between 0% and 7% at intervals of 1%.

2.2 The August-2020 Galway Bay case

Two people went paddle boarding at Furbo beach in the Galway Bay at 9 pm (BST) on the 12th of August 2020 and shortly after were swept out to sea by a northerly breeze. They were rescued on the 13th of August 2020 south of Inis Oirr Island at around 12:30 pm (BST).

The OpenDrift software was used with the Connemara model forecast and ECMWF winds to model the transport of the people in the water. The OpenDrift model has a leeway module for operational search and rescue. The distinguishing feature of this module is that there is a library of object classes, which have specific leeway, downwind, and crosswind coefficients. The user selects the object that is most pertinent to the current scenario and the simulation is carried out using the coefficients for that object.

A hundred numerical floats were released at Furbo Beach at 20:30 (UTC) on the 12th of August 2020 and they were tracked for 15 hours. A number of Leeway object classes were trialled to see which if any came close to matching the real-world scenario. Four examples are listed here: (1) person in water in unknown state; (2) person in water deceased; (3) surf board with person; (4) no-ballast life-raft without a drogue.

Figure 2 shows results of each of these experiments. For the person in water in unknown state (Figure 2a), the floats were soon scattered as the simulation developed. This is down to the large uncertainty associated with this object, since the person is in an unknown state. However, some floats almost arrived to Inis Oirr, in agreement with the observed trajectories. For the deceased person (Figure 2b), the particles were not as scattered and there is strong trend towards the west-southwest with quite a number

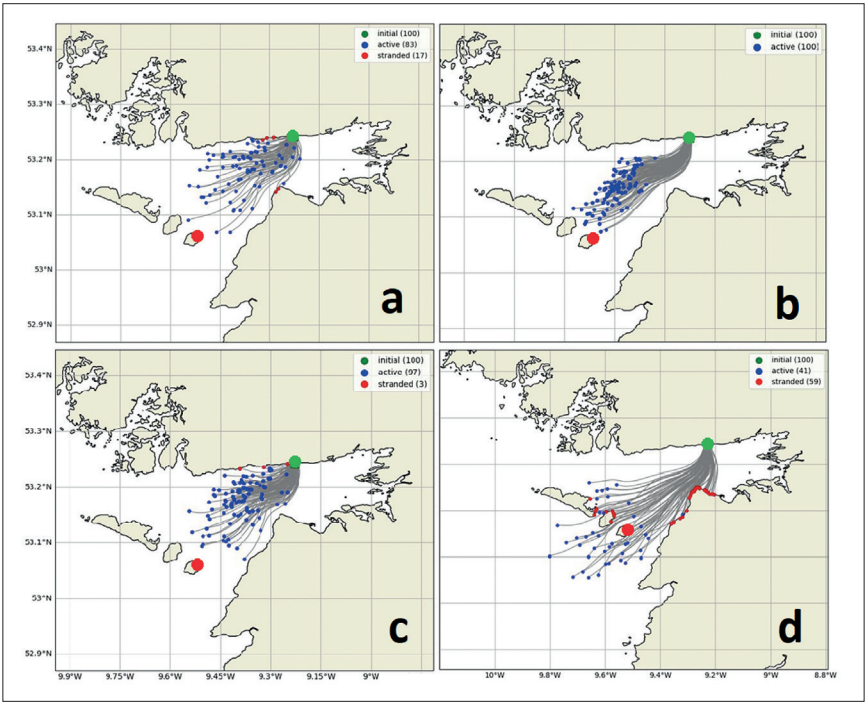

Fig. 2. August 2020 Galway Bay case OpenDrift trials. (a) person-in-water unknown state, (b) person-in-water deceased, (c) surf board with person, (d) no-ballast life-raft without drogue. Starting location (green circle) at Furbo beach and end location (red circle) at Inis Oirr Island are shown.

of particles apparently about to strand on the Aran Islands. For the surf board (Figure 2c), although some particles are heading for the area between Inis Oirr and the Clare coast, they have not travelled far enough in the allotted time. Finally, for the no-ballast life-raft (Figure 2d), this simulation comes closest to predicting the end position of the two people, with some floats stranding in the Aran Islands. Again, this set of experiments reveals the importance of selecting appropriate windage parameters when simulating the drift of floating bodies in the sea surface.

3. Recent Opendrift Test Cases

Since the August 2020 case, the Marine Institute has conducted several experiments with OpenDrift, which have proven to be useful to help in search and rescue operations around Ireland and to investigate the important connection that exists between people missing from the coast of Ireland and being found on the Welsh coast. In this

experiment, 100,000 floats were released at 20 sources along the eastern coast of Ireland at regular intervals between 01-January-2017 and 01-July-2019, and tracked used ECMWF winds and NEATL surface currents. It was found that, for a MP drowning at the east coast of Ireland and remaining in the surface of the ocean, there is a high probability that their body crosses the Irish Sea and arrives at the western shores of Great Britain. In particular, the Welsh regions of Gwynedd (probability of 12.80%) and Dyfed (probability of 5.36%) would be the most likely locations to find the body in Great Britain (Figure 3). On the other hand, the vast majority of the floats are washed ashore along the east coast of Ireland.

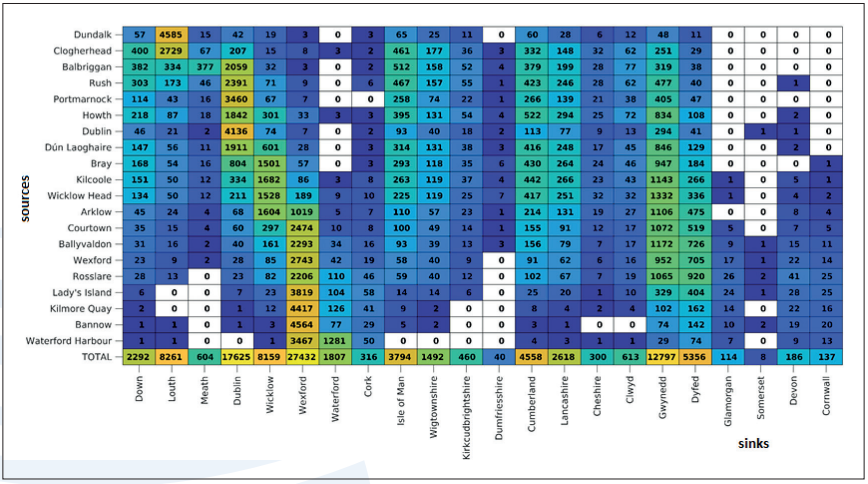

Fig. 3. Number of floats moving from sources (rows) to sinks (columns).

4. The New ADRIFT

After the experiments presented in Section 2 and the encouraging results from the test cases in Section 3, this has culminated in the implementation of a new version of an OpenDrift-based, web application called ADRIFT, which allows to select between a range of different objects with specific leeway properties. This software provides a user-friendly graphical interface which allows the user to rapidly run a particle-tracking simulation, and it is expected to help is search and rescue operations (Figure 4). The most important modifications with respect to the previous version of ADRIFT are: (a) inclusion of windage and (b) possibility to select among different object types with different windage parameters, including persons in water and several types of boats.

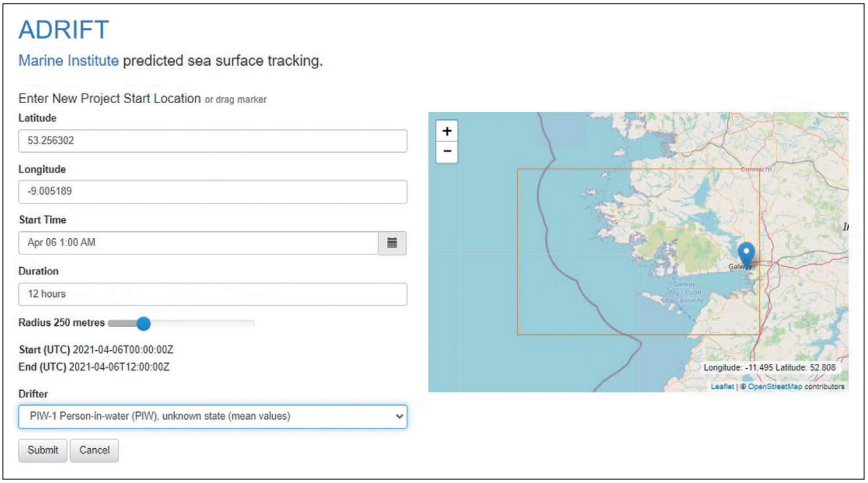

Fig. 4. Graphical interface of the new ADRIFT version. User can select starting position and time, duration of the simulation, initial dispersion radius and object type.

References

Dagestad, K.-F., Röhrs, J., Breivik, Ø., Ådlandsvik, B. (2018). OpenDrift v1.0: a generic framework for trajectory modelling. *Geoscientific Model Development*, 11, 1405-1420

Lett, C., Verley, P., Mullon, C., Parada, C., Brochier, T., Penven, P., Blanke, B. (2008). A lagrangian tool for modelling ichthyoplankton dynamics. *Environmental Modelling & Software*, 23 (9), 1210-1214.

Liu, Y., Weisberg, R.H. (2011). Evaluation of trajectory modelling in different dynamic regions using normalized cumulative Lagrangian separation. *Journal of Geophysical Research*, 116, C09013.

Nagy, H., Lyons, K., Nolan, G., Cure, M., Dabrowski, T. (2020a). A Regional Operational Model for the North East Atlantic: Model Configuration and Validation. *Journal of Marine Science and Engineering*, 8 (9), 673.

Nagy, H., Lyons, K., Dabrowski, T. (2020b). A Regional Operational and Storm Surge Model for the Galway Bay: Model Configuration and Validation. *Ocean Sciences Meeting* 2020. San Diego, CA, USA, 16-21 February 2020

Price, J. M., Reed, M., Howard, M. K., Johnson, W. R., Ji, Z.-G., Marshall, C. F., Guinasso N. L. Jr., Rainey, G. B. (2006). Preliminary assessment of an oil-spill trajectory model using satellite-tracked, oil-spill-simulating drifters. *Environmental Modelling & Software*, 21, 258–270.