

MASTS Small Grant Report – SG401 – May 2017

Does advection of harmful algae impact Shetland Aquaculture?

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Harmful algal blooms (HABs) composed of various genera of dinoflagellates and diatoms frequently disrupt shellfish aquaculture worldwide (Berdalet et al., 2016), including around the coasts of Scotland (Bresnan et al., 2021; Gianella et al., 2021; Martino et al., 2020). HABs are a particular threat in the Shetland Islands, where approximately 80% of the UK's *Mytilus edulis* are farmed and harvested (Martino et al., 2020).

Drifters were deployed from the RV Moder Dy into St Magnus Bay to assess the near shore performance of AMM15 around the Shetland Islands. The MASTS small grant #SG401 was used to purchase three SouthTEK Sensing Technologies Offshore Nomad drifters (<https://www.southteksl.com/index.php/products/offshore-nomad/drifter-offshore-nomad-detail>). A subscription to an Iridium Network was also purchased, which allowed transmission of positions around the Shetland Islands despite poor coverage of the GPRS mobile telephone network. Three additional drifters were purchased using a separate source of funds. Drifters were deployed in two separate experiments on the 30th of May 2018 and 4th of July 2018, during transects from the west of Shetland. Drifters were drogued at a depth of 10 m with SouthTEK SATIS drogues, which resemble holey-sock models (Niiler et al., 1995, 1987). Drogues were filled with water before deployment from the research vessel.

A particle tracking model was designed using current velocities from AMM15 (Graham et al., 2018). For these particle tracking models, current velocities were interpolated using gridded u and v vectors for the particular time step following previous literature (Jones et al., 2020). Particle tracking model simulations were initiated at the same time and location as drifter deployments. The starting location of particles was covered by evenly distributing 441 particles into an area limited by being 0.01° North and East of all sides of the location from where each drifter began responding from. The advection of the drifters was tracked for the entire period of their deployment, which was 473 hours from late May 2018 until mid-June 2018, and 132 hours during July 2018 (Figures 1 + 2; Table 1).

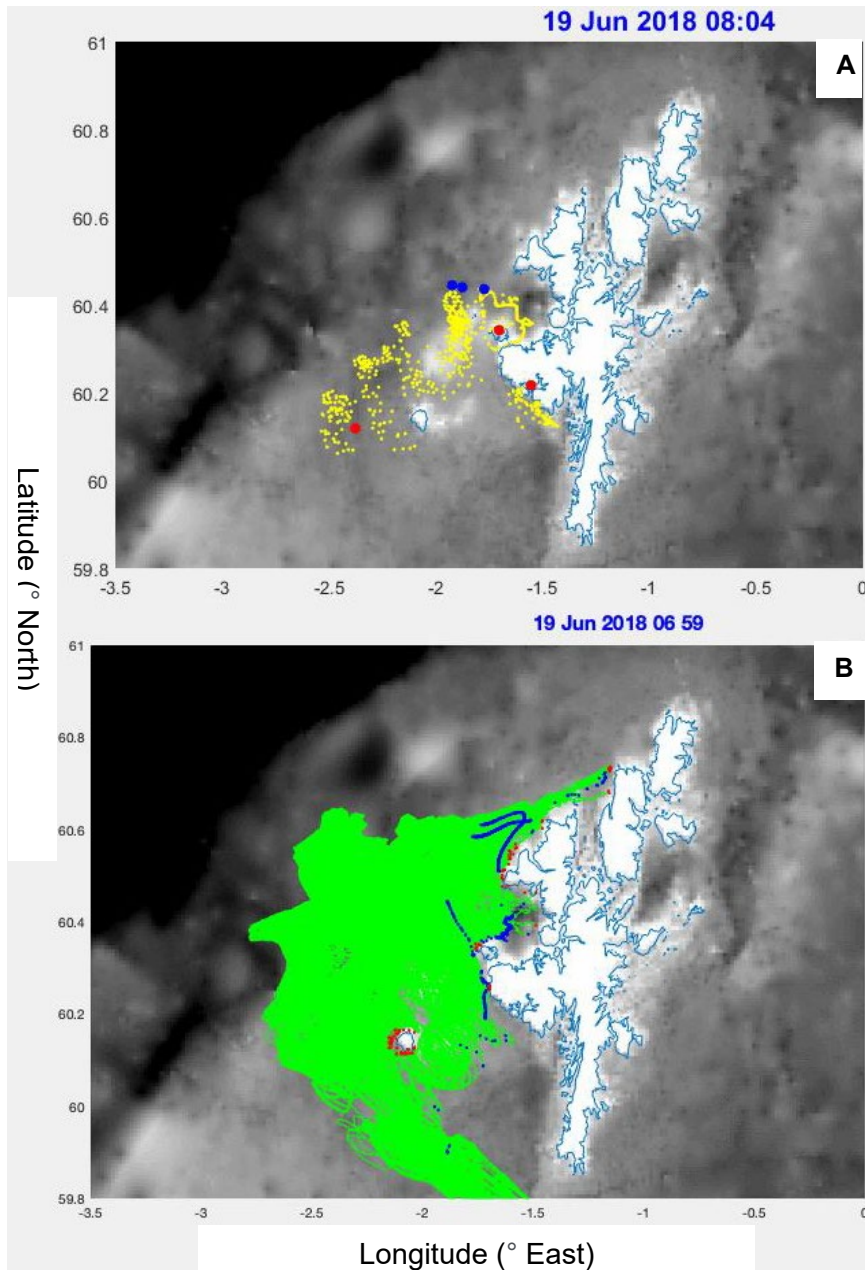


Figure 1 Results of model validation experiments which ran from 30th May until the 19th of June 2018 showing **A** drifter pathways after deployment west of Shetland and **B** Particles allowed to move under the influence of currents modelled by AMM15. Drifter tracks are displayed in yellow, the starting locations of drifters are blue, and end locations of drifters are red. Particle tracks are coloured green, the last location of particles are green and if particles have landed, they are coloured red.

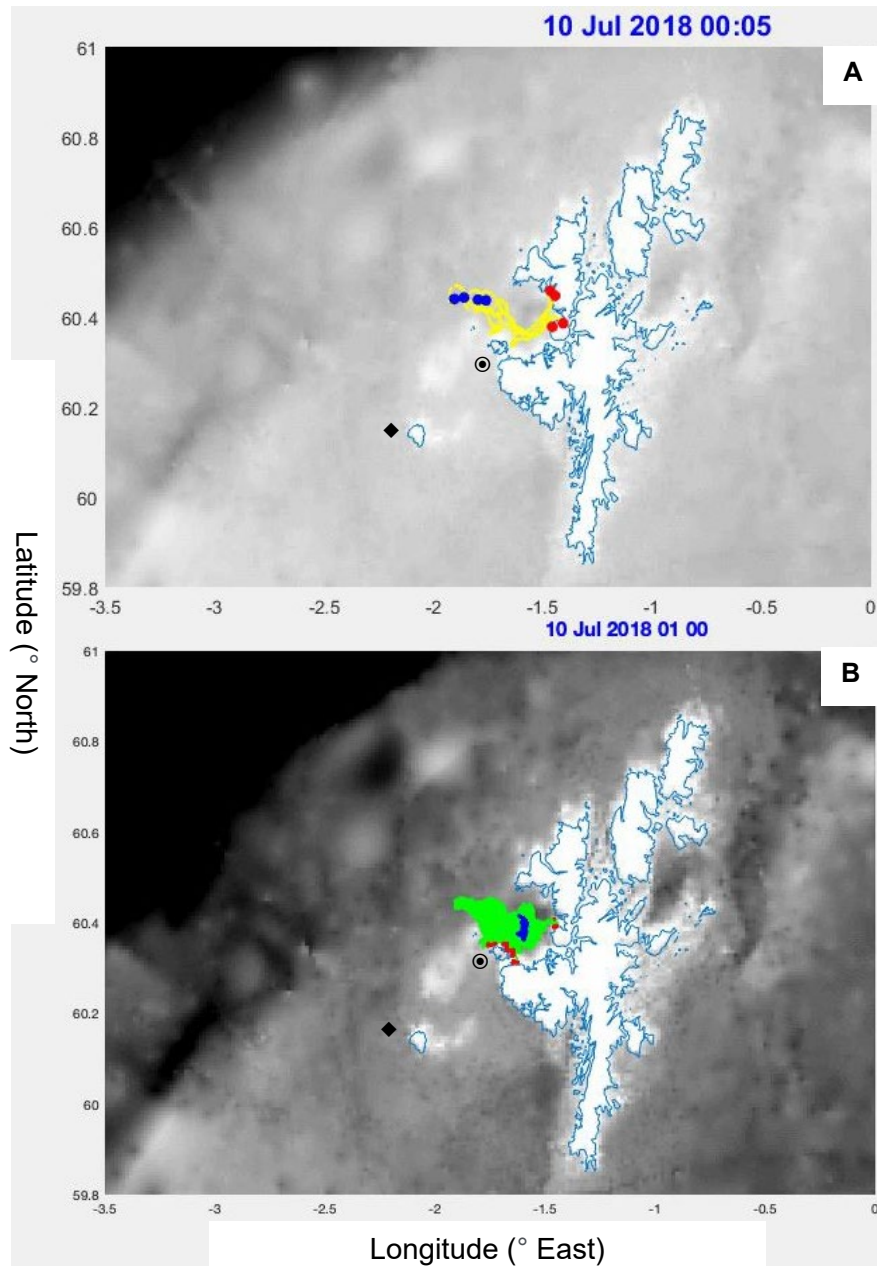


Figure 2 Results of model validation experiments which ran from 4th July until the 10th of July 2018 showing **A** drifter pathways after deployment west of Shetland and **B** Particles allowed to move under the influence of currents modelled by AMM15. Drifter tracks are displayed in yellow, the starting locations of drifters are blue, and end locations of drifters are red. The Island of Foula has been marked with the \blacklozenge symbol, and \odot marks the location of Papa Stour.

Table 1 Animations showing the tracks of drifters and particles under the influence of AMM15 in real time.

Dates of deployment	Drifters or particles under the influence of AMM15 currents	Link to animation
30 th May – 19 th June 2018	Drifters Particles	https://doi.org/10.6084/m9.figshare.16989304
4 th July – 10 th July 2018	Drifters Particles	

Pathways of modelled particles allowed to move along the ocean surface are similar to the pathways of drifters with 10 m drogues (Figure 1 + 2). From the end of May 2018 until mid—June, drifters moved away from the coast then back towards the coast where they eventually landed (Figure 1). At the beginning of July 2018 deployed drifters moved fairly steadily towards the coast of Shetland and landed in a voe after approximately a week (Figure 2).

Any model used to predict real-time events must be validated and have its skill assessed before meaningful conclusions can be made (Aleynik et al., 2016; De Mey-Frémaux et al., 2019; Giddings et al., 2014; Kurekin et al., 2014; Pinto et al., 2016). This is because without validation using collected data it is impossible to say how useful any model is, and its effectiveness to stakeholders will be unknown. Demonstrating that AMM15 output was comparable to tracks taken by drifters was an important part of my PhD and allowed more output from the model to be validated. A chapter my PhD thesis used output from particle tracking model simulations, and a paper is almost ready to be submitted to *Harmful Algae*. Thank you, MASTS, for providing this funding which made validating models near the Shetland coast possible.

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