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Ocean Science Discussions

Interactive comment on "Storm-driven across-shelf oceanic flows into coastal waters" *by* S. Jones et al.

S. Jones et al.

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>1. p.4, lines 121-122: Regarding "Gaps in positional data were linearly interpolated with a maximum gap size of 20 hours" - can you provide information on the extent of this?

Added clarification in text (p4 line 123); drifters were set to report position every 3 hours. While instances of a single position being missed were relatively frequent, longer gaps were rare.

>2. p.4, line 151: regarding the hindcast, in addition to citing Graham et al. (2018b), can you specify the period of hindcast, obviously covering August-December 2013.

Change made (p4 line 154).

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>3. 161-162: Regarding “The experiment was repeated 5 times resulting in a total of 200 unique particles being released from each location in Fig. 3a.”, how was each experiment different? Was this simply sampling a range of ‘random walks’?

That is correct, we re-ran the experiment several times to sample a range of diffusive random walks. Clarification added in text (p5 line 164).

>4. p.5, line 167: A few more details on the Lagrangian method would be appropriate.

Added more information as suggested (p5 lines 167 - 177). Details below.

> How do you interpolate in latitude and longitude to obtain model velocity at an arbitrary particle location?

The model velocity is obtained at the particle location by converting the model grid nodes into distance space and performing a bilinear interpolation (line 171).

> You refer to the model timestep Delta_t in Equation 1. How long is this? To which model do you refer? Noting previous reference to offline particle tracking and use of daily mean modelled velocities, does Delta_t = 1 day, or much shorter? If the latter, how do you interpolate in time?

We refer to the offline AMM15 output. Delta_t is thus 1 day or 86400 seconds in this context. We do not interpolate in time. See also response to Q. 6 regarding particle crashes.

>5. p.5, line 170: What is Delta_T? Presumably Delta_t?

Correct, modified in text for clarity (p5 line 170).

>6. p.5: Given the complexity of your study region, does the Lagrangian scheme involve any issues near bathymetry or coasts? Do particles “crash” into coasts or seabed if the timestep is too long?

Our primary interest was in the large-scale trends in the particle motion, particularly

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the contrast between summer and winter-storm shelf behaviour. While the Lagrangian scheme with a 1-day timestep does introduce cumulative errors leading to occasional terrain crashes, we do not consider this to impact our conclusions. Fig. 1 shows comparisons between particle tracks in daily mean modelled velocities and hourly modelled velocities. While there are differences between particle trajectories in hourly and daily flow fields, the regions swept by the particles are very similar. We therefore feel that daily flow fields are adequate for this study.

>7. p.5, lines 181-182: "We use only tracks from drifters drogued at 70 m as this enables a comparison between the behaviours of the autumn and winter groups." It is not clear to me what you mean - can you elaborate?

15 drifters were also released with drogues at 15 m depth, but these all moved on-shelf in August 2013 so would not contribute to an autumn–winter comparison. Modified text to clarify (p5 line 181).

>8. p.6, lines 203-204: Regarding ": : : the peak drifter speeds of 60 cm/s observed in this study suggest that oceanic water import via the AIC may briefly reach 0.48 Sv", how did you estimate this transport? Presumably by associating the speed with a crosssectional area? Can you provide some detail? Perhaps briefly reiterate the method of Porter et al. (2018)

Porter et al. (2018) estimated this transport using the cross-sectional area of the current core derived from glider sections. The T and S thresholds of Eastern North Atlantic Water during this period (10 – 10.5 °C, S >35.43) were chosen to represent the ingress of Atlantic water in the current. We assumed the same cross-sectional area but with revised average drifter speed to estimate the December transport. Added detail in text (p6 line 207-211).

>9. p.7, line 231: As you introduce the particle statistics and Figure 6, can you briefly explain the particle origin (%) diagnostic in the text, as you have in the figure caption? Also, in addition to Figures 6 and 7, could you also show the mean particle salinity, as

you have shown origin and age? Might this further confirm the pathway for high salinity water towards the Tiree Passage?

Added note in text clarifying particle origin diagnostic, as suggested (p7 line 242). We found that plotting average particle salinity did not provide additional insight to the existing particle origin percentage and particle age figures. The repeated particle releases over the 50-day period resulted in an approximate 50-day mean salinity over the region swept by the particles, but with unpredictable temporal aliasing. Close to the coast, salinity was also very dependent on the interaction between shelf currents and freshwater runoff, which may not be accurately resolved by the model. We considered that a more robust measure of model salinity was to report the arithmetic mean salinity of particles within the observation regions for August and December instead. This was added to the text (p10 line 347).

>10. p.7, line 240: Regarding the statement “While a minority of 20 m particles originated in the abyssal ocean”, do you mean that these particles upwelled from off the shelf? The abyssal ocean seems an exaggeration in this context

We intended to convey that the particles originated in deep water and crossed on-shelf, but without vertical displacement. We agree that ‘abyssal ocean’ infers they originated at depth so have modified the text (p7 line 250).

>11. p.7, lines 257-258: Regarding “the rapid (1-2 day) increase in currents in terms of the dynamic response to wind-induced pressure gradients”, I assume you mean geostrophic flows supported by a change in sea surface slope?

Yes, modified text to clarify (p8 line 268).

>12. p.8, first paragraph: Continuing this theme, you suggest rapid setup on a short barotropic adjustment time, perhaps disrupted by inertial effects, but what about Ekman dynamics? Might one expect a strong westerly wind to drive Ekman drift towards Northern Ireland, setting up local downwelling and a geostrophic jet to the west, in the

same sense as the AIC (or ICC in Fig. 1a)? Does this complement on-shelf oceanic flows?

We would expect Ekman drift to result in convergence at the Northern Irish coast which in stratified conditions would drive downwelling and depressed isopycnals. One would associate this density structure with a geostrophic jet to the east rather than to the west in the northern hemisphere? Such a density structure was observed in the AIC core by Porter et al., (2018) in July 2013 so we surmise that this process complements the on-shelf flow as suggested. Text added to acknowledge this feature (p8 line 284).

>13. p.9, lines 302-304: Regarding "between January and March coastal waters are cooler (6-8 _C) than the adjacent ocean (9-10 _C) so we would expect a similar event during this period to increase coastal water temperatures in western Scotland", is there evidence for this in the TPM temperature record?

We do see evidence of this effect, or example in winter 2008. See also figure supplied in response to R2 query, RE impact of storms on TPM long temperature time series. The warming associated with storms is seasonally dependent and more nuanced than salinity. Late season HSPs are sometimes associated with up to 0.5 °C of warming in the TPM time series. A note added to reflect this (p9 line 319).

References

Porter, M., Dale, A. C., Jones, S., Siemering, B. and Inall, M. E.: Cross-slope flow in the Atlantic Inflow Current driven by the on-shelf deflection of a slope current, Deep Sea Res. Part I Oceanogr. Res. Pap., 140, 173–185, doi:10.1016/J.DSR.2018.09.002, 2018.

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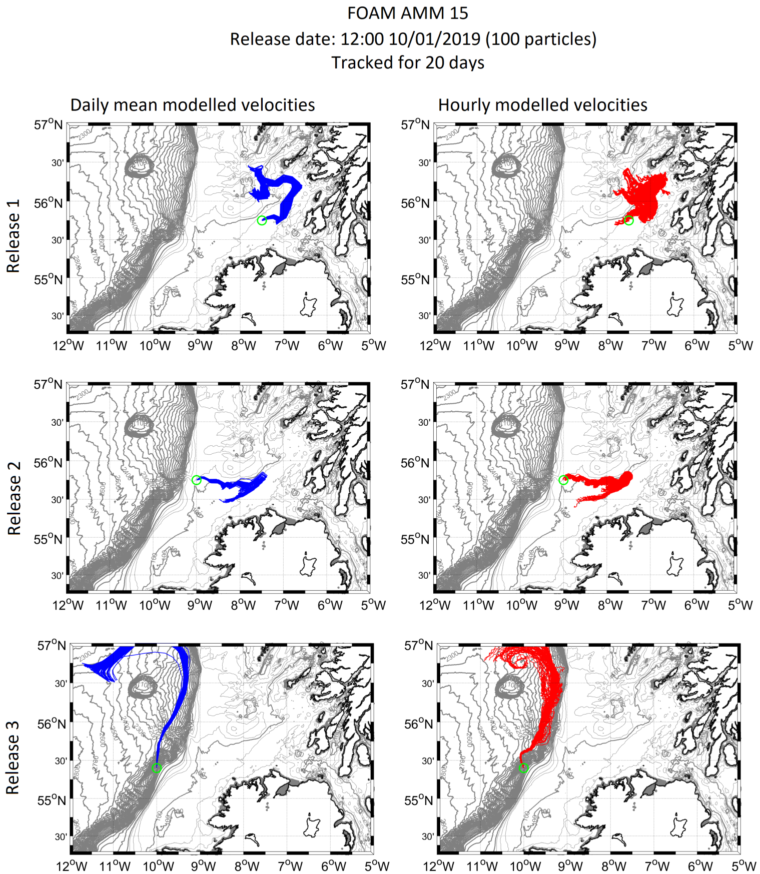

Fig. 1. Test particle releases into daily mean (left) and hourly (right) AMM15 model flow fields at 20 m depth.

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