General reply

We are very grateful to the constructive comments from the reviewers and Prof Woodworth and we thank them and Dr Williams as editor for their efforts. Our replies are included below in bold. We hope they are satisfactory and that the paper is now suitable for publication in OS.

RC1

I think the ms invokes an important issue on the estimation of tidal dissipation using an altimeter-based tidal product, which is widely used worldwide. In my view, the observations were designed with care and conclusions seems to have supported sufficiently by the text. I therefore think the ms would be considered for publication after making technical corrections shown below.

- **We thank the reviewer for their constructive comments and hope that they find the revised version of the manuscript suitable for publication.**

Specific issues:

P5L133 Table 2: M2 amp for Stn NE/TPXO (1.5m) is probably 1.15m.

- **Indeed, thank you for spotting. Corrected.**

P6L170 Fig.2(a) (this is just a comment and need not to response) In my view, the sea level (especially at site E) seems to show some asymmetric feature, i.e., shorter duration of flood. Is there any possible mechanism leading such a feature?

- **Yes, it is a tidal asymmetry due to frictional effects and represented by higher harmonics in the harmonic analysis.**

P7L178 (Fig.3 colour bar legend) I suggest modifying the legend from "current amplitude" to "corrent magnitude", as stated in the figure caption, to avoid a misunderstanding that the property is compiled solely by a single tidal constituent. For the Fig.3 caption, explanation for (a) and (b) is opposite.

- **Both issues have been corrected (see also the reply to Prof. Woodworth's short comment): "**The current magnitude (colour) and vectors at spring (a) and neap (b) flood tides from TPXO9. These are computed from the M2 and S2 constituents only. The white circle shows the location of Bardsey – note that it is not resolved in the TPXO9 data and has been added for visual purposes only.
- c) The magnitude of the tidal current during a spring-neap cycle in the Sound using the M2, S2, and M4 constituents in the TPXO9 data."**.**

P7L199-200 I could not follow how the two figures deltaH=0.07 and Uastro, sm=1.5m/s were deduced (using values in Fig2a?). Please add a brief explanation on this point.

- **This is indeed confusing and this paragraph has been rewritten in the light of the new far-field current calculations: "** This is illustrated in the TPXO9 spring and neap flood currents in Figure 4a-b, and the magnitude of the current in the Sound in Figure 4c. These currents are weaker than the far field estimate using Eq. (1) above. For spring tides, TPXO9 shows a current of up to 1.5 m s-1 in the Sound and 2.5 m s-1 in the far field, whereas the TG data and Eq. (1) comes out at 3.7 m s-1 from Eq. (1) for the spring tide far field (cf. Figures 3 and 4). For neaps the corresponding values are 0.6 m s-1 in the Sound and 1.5 m s-1 in the far field from TPXO9, and 3.0 m s-1 from the TG data and Eq. (1). The local sea-going experts (Colin Evans, pers. comm.) and the Admiralty chart for the Sound (Admiralty, 2017) state a current speed of up to 8 knots, or 4 m s-1, so TPXO9 underestimates the currents in the strait with a factor ~2.5, whereas the observations, even under the assumptions behind Eq. (1), get within 10%. One can argue that the sea-level difference along the strait will lead to an acceleration into the strait as well (see e.g., Stigebrandt, 1980), that could be added to the far field current. However, frictional effects will come into play and a large part of the along-strait sea level difference will be needed to overcome friction and form drag (Stigebrandt, 1980). In fact, of the 0.32 m GA sea-level difference between South and North Mainland (see Table 1), only 0.006 m is needed to accelerate the spring flow from 3.66 to 4 m s-1 in Eq (1). That means that almost the complete sea-level different along the strait is due to energy losses.**”**

P8L206-207 I suggest removing of a phrase "take the TPXO speed ... as North Mainland, and" to make the context clear. The assumption of using the u_sm was already applied to the discussions developed in the previous paragraph and probably need not to be repeated here.
This has also been rewritten using the new current estimates and the TPXO currents instead. The paregarph now read “To first order, dissipation can be computed from the TPXO9 speed and from the observed amplitude drop along the Sound by comparing the tidal energy flux, E_f, between the two locations. A decrease in the energy flux between two locations can be associated with local dissipation of tidal energy as the wave propagates them (see e.g., Green et al., 2008). The flux of tidal energy is given by (e.g., Phillips, 1977)

$$E_f = 0.5 c_g \rho g H^2 \qquad (3),$$

where H is again the tidal amplitude and $c_g = \sqrt{gh}$ is the speed of the tidal wave (*h* is the water depth in the Sound, taken to be 37 m), and ρ=1020 kg m-3 is a reference density. The dissipation, ε, is then the difference in energy flux between the two mainland TG locations, or $\varepsilon = 0.5 c_g \rho g (H_{SM}^2 - H_{NM}^2)$, taking c_g constant because h changes little between the TG locations. Using the TG amplitudes, the GA tide would then dissipate 119 kW m^{-1}. Over the 3.1 km width of the Sound, this integrates to 368 MW. The M2 tide contributes 31% of this, or 131 MW. This is approximately 0.06% of the total M_2 dissipation on the European shelf estimated from TPXO9 (see also Egbert and Ray, 2000), and is a reasonable estimate for such an energetic region. Note that this method is independent of the phases between the locations, nor does it depend on the phases between the amplitudes and currents.

The dissipation in a tidal stream can also be computed from $\varepsilon = \rho C_D |u|^3$, where Cd~0.0025 is a drag coefficient (Taylor, 1920). Using the TPXO9 current speed in the strait, assuming the Sound to be 3.1 km wide and 2 km long, the GA spring dissipation comes out as 35 MW (u-1.5 m s-1), and the M_2 dissipation (using a current speed of 1.2 m s-1) as 23 MW. This is a substantial underestimate (factors of 10 and more than 6, for the GA and M_2 tides, respectively), which again highlights the importance of resolving small-scale topography in local tidal energy estimates, and the use of direct observations in coastal areas to constrain any modelling effort. This dissipation here is only a small fraction of the European Shelf and coastline, and although the Bardsey tides are unusually energetic, underestimated local coastal energy dissipation may be substantial in the TPXO9 (and similar) data and numerical models.**”**

P8L228 I guess a factor of 0.5 is missing in the definition of the dissipation. In addition, please indicate the actual depth adopted when estimating the dissipation value.

- **See reply above – corrected.**

(comment, no need to response) I personally am interested in the impact of the Llyn Peninsula being tilted diagonally (toward NE and SW) against the axis of the Irish Sea and the difference between the main direction of the flood and ebb current around the island indicated, e.g., by Figs.2b and c. This is obviously beyond the range of the current study and looking forward investigating in a near future.

- **We agree, there’s a lot more to be done on this topic. Note, however that the tidal stream hits the island’s broadside (see Figure 1).**