

## ***Interactive comment on “Deep ocean exchange with west-European shelf seas” by J. M. Huthnance et al.***

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Received and published: 29 September 2009

We thank the referee for his constructive comments (shown in “quotes”).

“While we have substantial and improving quantitative knowledge of the way the deep ocean and shelf seas work, their mutual adjustment in the steep slope region is not well understood. In particular, the rates of exchange of properties across the slope remain largely undetermined, in spite of their critical importance and the fact that many of the mechanisms involved have long been known. This review by Huthnance and colleagues is a worthy attempt to summarise present knowledge for one of the better studied regions of the shelf edge and to divine the way ahead.”

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No response required.

“A strength of the paper is that it is a comprehensive catalogue of all the work on the European Shelf edge with an extensive reference list. The observational material is presented under (i) a review of previous work, (ii) a section on exchange processes and (iii) another summarising the exchange in sub-regions of the European shelf. The result is slightly repetitive and makes for a rather heavy read with few diagrams. It seems to me closely related to the previous, thorough process summary in Huthnance 95 which, for my money had a better structure.”

J. Klinck (referee) also comments on the structure; the suggestions are not entirely reconcilable. In view of the DEOS context of this paper aiming to inform on the west-European context, with different sectors having a different balance of processes, it seems appropriate to emphasise the specific sectors (in section 6) as suggested by J. Klinck (rather than the structure of Huthnance 95 which would suggest subsuming all in section 4). In revision, repetition has been minimised by a clear distinction between explaining processes in general (section 4) and putting all evaluation by region in section 6 (section 5 in revised version). We also recognize some common ground between the former sections 3 and 5 and have merged these to a combined section (3) on previous work and overall estimates of exchange. There are subsections (as each had implicitly before): (3a) observations and (3b) modelling. Regarding diagrams, we replace Figure 2 by “Schematic of stratification and cross-slope exchange processes” (more processes than in the original). We also introduce figures “Elements of shelf-sea carbon budget” and “Sea-surface temperature off Iberia”, the latter showing upwelled water and filaments.

“It is interesting to compare Table 1 of the current paper with Table 5 of Huthnance95 – a similar selection of candidate mechanisms with contributions of Order 1m<sup>2</sup>/s but only marginally more evidence constraining numerical values.”

We agree that there is a “similar selection of candidate mechanisms”. [This might be

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a lack of imagination, or a reflection that the issue is process evaluation rather than identification]. However, there is considerably more evidence than in Huthnance95: from LOIS-SES, OMEX, regional evaluations and models. We emphasise the purpose here, as the first comment of the Referee - to summarise present knowledge . . . and to divine the way ahead.

“The new feature of this paper which distinguishes it from the earlier one is the addition of the results of large scale modelling which seem to be the only way in which we might succeed in trying to quantify exchange. Unfortunately the modelling results are considered very briefly under “overall estimates” and are not directly compared with the inferences from observations. Table 1 gives transports  $m^2/s$  while the model results are shown in Sverdrups for sections of the shelf. It would be good to know the relative contributions of the different mechanisms if these can be teased out of the model results.”

There is some comparison between modelling and observational estimates in “Discussion”. This will be amplified by some further analysis of the estimates, distinguishing between summer and winter (in response to Referee 3) and different regions so that there are different balances of processes. Unfortunately, the relative contributions of different mechanisms cannot be inferred confidently from the model results hitherto. Future runs would be needed with finer resolution (for hitherto unresolved processes) and/or different elements of forcing (to separate processes). There is also a caveat as raised by Referee 3 that different process contributions are not necessarily additive; they may interact.

“My main suggestions for improvement would be: i) one or more illustrative cartoons of processes”

As above: we replace Figure 2 by “Schematic of stratification and cross-slope exchange processes” (more processes than in the original). We also introduce figures “Elements of shelf-sea carbon budget” and “Sea-surface temperature off Iberia”, the

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latter showing upwelled water and filaments.

“ii) a revised structure with less repetition”

As above: repetition has been minimised by a clear distinction between explaining processes in general (section 4) and putting all evaluation by region in section 6 (section 5 in revised version). Former sections 3 and 5 have been merged to a combined section (3) on previous work and overall estimates of exchange. There are subsections (as each had implicitly before): (3a) observations and (3b) modelling.

“iii) more emphasis on the modelling results and what can be inferred from them and how they compare with the few quantitative estimates from observations”

As in response to J. Klink regarding volume exchange, concentration of POM and balancing the PP budget, for the combined sectors from the Celtic Sea around the west of Britain to the North Sea, primary production is approximately balanced by respiration. We expect inputs to be approximately balanced by POM flux (concentration times volume exchange), neglecting burial. This comparison is made in the revised version albeit more detail is deferred to Wakelin et al. (in preparation). As in response to Referee 3, we will expand the modelling estimates to separate summer and winter for each modelling sector in figure 3; this will help comparison with some aspects of observations and processes which distinguish summer and winter. Inter-annual standard deviation will be added for the figure 3 model calculations of ocean-shelf fluxes.

“One small point that needs attention is the misleading statement at line 7 of p1068 that “Drifter observations : : demonstrates its (the slope current’s) dispersion ( Burrows et al. 1999)” In fact these observations measured dispersion in and on either side of the current and demonstrated that there is dispersion minimum in the slope current which was manifest in the persistence of drifters in the slope current once placed there.”

In the revised version this sentence is split to “Its spatial continuity is shown by drifter observations . . . (Pingree et al., 1999)” (not the point of contention) and the con-

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tentious element rephrased as follows in the W Scotland sector “Poleward along-slope flow, and some dispersion onto and away from the shelf around Scotland, were shown by . . . and drifters (Burrows et al., 1999)”. We disagree with the Referee in that the Burrows and Thorpe drifters, deployed in groups of 7 at 50m depth, did disperse laterally as follows:

Time / water depth (Winter, 200-400m; Summer, 200-400m; Winter, 500-700m; Summer, 500-700m)

Respective number onto shelf (4; 4; several initially but reverted to slope, 2 (just) later; 4).

However, we acknowledge that the original sentence was potentially misleading in suggesting that the slope current disperses on to the shelf.

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Interactive comment on Ocean Sci. Discuss., 6, 1061, 2009.