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Discussions

Interactive comment on "Modeling the effects of size on patch dynamics of an inert tracer" *by* P. Xiu and F. Chai

Anonymous Referee #1

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This paper considers the evolution of a passive tracer in a high-resolution ocean model. The tracer is released in a finite region and its subsequent distribution is analyzed. The influence of initial size of the tracer patch on the subsequent evolution is examined. The study is motivated by iron enrichment experiments. The key results of the paper concern the dilution rate of the tracer, for which two regimes are identified, one linear and one exponential.

With some additional work and more careful writing of the paper, I believe that this could be an interesting study, although the applicability of the results for iron enrichment experiments is limited by the use of a passive tracer. (Also, I'm not sure it is really true to say that the finite duration over which ships can observe the fertilized patch is the *main* difficulty in terms of extrapolating the results to regional and long-term impacts,

since there are other difficulties as well, see e.g. Boyd et al., 2007.)

The description of the simulation needs to be expanded - in particular with reference to the tracer. The details of the initialization are a little vague, and there is no explanation of the numerical diffusion acting on the tracer, nor the scheme used to evolve the tracer.

The tracer is normalized by the peak concentration at the end of the injection period and then the patch is defined as the region with concentration higher than 0.1. As noted by the authors, Law et al., 2006 (and other papers, e.g. Lee et al., 2009) use a value of 1/e instead. The reason for choosing 0.1 is not given. More crucially however, previous studies considered the evolution of the area within the contour c=m/e, where m is the peak concentration in each period, whereas instead here the contour is fixed at value 0.1. The results presented in this paper are interesting, but I think the distinction between the choice of the contemporaneous peak or initialization peak as the reference needs to be pointed out clearly since the results are quite different. Moreover, I think the paper would be strengthened, both in terms of clarity and impact, if the authors calculated the more standard area based on the contemporaneous peak and then discussed the behavior of both results in relation to the original Garrett description.

Throughout the description of the technique used, terms are introduced without being defined. For example, x, y, width, length.

The results find little difference in the strain rates for the different initial patch sizes for the first 32 days, but a difference in the dilution rate. I wonder, however, how much the dilution rate is influenced by the choice of 0.1? Looking at fig 1, it seems that for the larger initialization patches, a thin filament is pulled around an eddy during this time period and may be influencing the results: the result for a concentration value encompassing more of the tracer, e.g. 0.05, might give a result independent of initial patch size as for the strain rate.

It would be interesting to see the results for 2005 - at present they are only alluded to with statements like 'the dilution rates during the first stage are mostly higher than

zero', which hint that there is considerable variability. Indeed this is what I would expect for the smaller patches where a considerable difference in the initial evolution might be expected according to whether the initialization were within a coherent structure (i.e. an eddy) or not.

Indeed, overall, I would expect there to be essentially two regimes of behavior, one for initialization patches that are below the eddy scale and one for patches that are above.

Finally, the link with phytoplankton blooms is a little tenuous given the absence of biogeochemical processes. Even with very simplified representation of such processes, radically different behavior can be observed according to the size of the initialization patch (Neufeld and Haynes, 2002; see also Elliot and Chu, 2003). This should be noted in the final discussion and perhaps less emphasis should be given to iron fertilization experiments as motivation and more to passive tracer injection experiments.

Neufeld and Haynes, GRL, 10.1029/2001GL013667, 2002

Elliot and Chu, GRL, 10.1029/2002GL016255, 2003

Lee et al, JPO, 39, 894-914, 2009

Interactive comment on Ocean Sci. Discuss., 6, 1735, 2009.