21 August 2013

Response to Anonymous Referee #2 (OS-2012-77)

Matt, S., Fujimura, A., Soloviev, A., Rhee, S. H., and Romeiser, R.: Fine-scale features on the sea surface in SAR satellite imagery – Part 2: Numerical modeling, Ocean Sci. Discuss., 9, 2915-2950, doi:10.5194/osd-9-2915-2012, 2012.

We thank the referee for his comments, all of which have been addressed. Following the referee's advice, we combined several figures and removed others. We feel this helped improve the flow and logic of the paper. We also added explanations and references to the text as requested, and omitted parts that may have been unclear or superfluous.
During the course of the past year, we continued work on the use of computational fluid dynamics to model magnetic fields induced by fine-scale oceanic phenomena. This included comparing our modeling results to those from a traditional model, solving the integral equations, and which had previously been used to simulate ocean magnetic fields. As a result of this validation work, we improved the modeling approach used in this paper and updated the corresponding figures.

The answers to specific comments are outlined below:

1) ...companion paper... - it is a bad style to mention a paper which has not been accepted yet.

It is our understanding that it is common practice for journals to allow authors to refer to a companion paper in the same issue, when such papers are submitted together as "Part I" and "Part II". We understand that this has no bearing on the outcome of the respective reviews and may need to be modified in the final version.

2) Introduction should be more logical.

We revised the introduction to improve the logic and scientific language.

3) In particular, more logical connection between 2d and 3d paragraphs is needed.

We addressed this comment and improved the logic in this part of the introduction.

4) ...important practical applications... - wonder which ones.

We added an explanation, which describes the importance of the study.

5) ...interaction with ambient ... stratification... - First, stratification cannot interact with anything. Second, I cannot see the ways of a plume to interact with ambient waters except diffusion. Clarifications are needed. Third, stratification is just a density vertical gradient. Please use the term correctly.

We revised this section to clarify. It has been shown by other authors that gravity currents, such as surface buoyancy-driven currents, can interact with an ambient stratification (Baines, 2001; White and Helfrich, 2012). We added references to the text.

6) Buoyancy-driven surface currents, such as propagating river or rain-formed plumes... - Plumes are currents???

Gravity currents and surface buoyancy-driven currents are sometimes referred to as "plumes" in the oceanographic literature (for ex., Mediterranean Sea outflow plume, Columbia River plume, etc.). However, we concede that the terminology may be confusing and we removed the term "plume" from most of the manuscript.

7) These currents contribute to water mass exchange by horizontal advection and enhanced vertical mixing. - Any currents do that.

Gravity currents can lead to significantly enhanced vertical mixing (see, for example, Simpson, 1987). We added clarification and references to the text.

8) These buoyancy-driven flows are a type of organized structure that resembles a classical gravity current. - Now plume is a gradient current...

We added a clarification and references, explaining our use of the word "plume" in reference to a gravity (not "gradient") current. A classical gravity current is a flow driven by density differences. Such density-driven currents, e.g., river outflow plume, marginal sea outflows, smoke plumes, dust storms, among others, are common features in environmental fluid dynamics and have been well studied (see Simpson, 1987, for an extensive review).

9) Fujimura et al. (2011) showed that as in the case of the ship wake - Now all of the sudden there is a talk about ship wakes.

We clarified this sentence and paragraph.

10) Near-surface gravity currents may also interact with an ambient stratification in a resonant way, leading to a fragmentation of the near-surface plume - Again a mixture of everything.

We improved the language and clarified this section of the paper.

11) I would recommend to reduce the description of the first two models and at least briefly discuss M4S model.

As requested, we added a paragraph describing the radar model M4S.

12) The boundary conditions ... were set to periodic - What does exactly it mean?

We clarified the sentence.

11) Ship wakes - What exactly do you mean? What is a ship wake? How does it appear *into being? How does it evolve? What are its characteristics? What is its model approximation? How can they be seen in the fields of horizontal velocity and other parameters?*

We added a sentence to clarify and a corresponding reference (Pichel et al., 2004).

12) We found that cold subsurface water may be brought to the surface through the circulation in the ship wake - Wasn't that known before?

We are not familiar with any such study using computational fluid dynamics to study the sea surface signature of a ship wake in the presence of an ambient thermal stratification. We added explanation to the text to discuss that the signal we find is weak due to the small temperature gradient in our model, but qualitatively consistent with findings from in-situ measurements.

13) This sea surface signature in the temperature field may be detected by infrared sensors of the sea surface. - What kind of sensors?

Such a signal may be detected with high-resolution infrared cameras. We added an explanation to the text.

14) Figure 2 - What is the difference between upper and lower panels (visible one)? What is a red area in the center?

We added a sentence to the caption mentioning the low velocity area in the center of the figure, at mid-depth under the surface wake, which the reviewer refers to as "red area".

15) which is a proxy for a SAR image - Ship wakes in SAR imagery can look darker or brigther than the ambient water, can have one or two 'branches', can be visually displaced relative to the vessel. Which exactly case do you mean? By the way, if you considered those cases in the paper and explained the difference, it would be really an interesting research.

We explained in the text that in this work, we are considering the turbulent centerline wake only and that the radar model M4S had previously been used to study the Kelvin arms of ship wakes by Hennings et al. (1999).

16) In the case of a near-surface thermal stratification, the wake surface signature appears slightly wider and more pronounced than is the case without stratification (Fig. 4) - Wasn't that logical and expected? How could that be seen from Figure 4?

We combined Figures 3 and 4 to emphasize the difference. We agree with the reviewer that this result may have been expected and we merely report that the numerical model was able to reproduce this characteristic of a ship wake in stratified waters.

17) The model is initialized with a temperature anomaly in the near-surface layer, simulating a rain-formed plume - Why do you use temperature anomaly instead of salinity one???

They are completely different from an oceanographic point of view.

Our interest is in the behavior of a low-density buoyancy-driven current. In our case, temperature is used to create a density anomaly. The general behavior of this type of gravity current is the same whether the density anomaly is created by temperature or salinity. In fact, it is common in computational fluid dynamics to solve the relevant equations using the density anomaly only (see, for example, A. Scotti, "DNS of a gravity current propagating over a free-slip boundary", in: Direct and Large Eddy Simulation VII, Proceedings of the Seventh International ERCOFTAC Workshop on Direct and Large Eddy Simulation, V. Armenio, B. Geurts and J. Frölich eds., Springer-Verlag, 2010).

18) This parcel of low density water then propagates in the upper layer of the water column as a buoyancy-driven current. - Can't see any reasons for this structure to propagate.

We clarified this sentence and added a brief description of gravity currents to this section. We refer to Simpson (1987) for an extensive review of these types of flows.

19) A plume is a very stable structure in all the respects. And it is the LOW density plume! Is low density causing pressure on high density in Figure 7??

We added an explanation to the text clarifying that what we refer to as "plume", is in fact a buoyancy-driven surface current, which is a type of gravity current (see Simpson, 1987; Baines, 2001).

20) The flow exhibits features of a classic gravity current, including the gravity current head and a tail region, where Kelvin-Helmholtz overturns are apparent and contribute to mixing (Fig. 7). Strong statement. Any basements? In the caption of Figure 7 only internal waves are mentioned.

As stated above, we added a clearer description of the type of flow described in this figure. We also improved the figure caption.

21) This then leads to a resonant interaction between the internal waves and the nearsurface current, which results in a fragmentation of the low density plume. - Another not obvious statement.

We added references to support this statement (Simpson, 1987; Soloviev and Lukas, 1997, 2006; Nash and Moum, 2005; White and Helfrich, 2012).

22) The fragmentation becomes apparent as a banding pattern on the sea surface in the velocity field (Fig. 8). - What is that in Figure 8? The flow moves in the opposite directions?

We added text to this section to clarify what is shown in this figure. The flow is shown from the top, and as can be expected from the near-surface low-density anomaly, the density-driven dynamics generate two fronts moving in opposite directions.

23) Please try to cite only published works (not which ’in preparation’). For the key points of the work you would cite not only your own publications, but also someone’s else.

As requested, we removed the reference to a submitted paper and also added additional references.

24) ...lead to information... - strange phrase.

We reworded this phrase.

25) 2001; 2010 and some more cases - should be a comma instead of ;

We corrected this, where applicable.

26) An abbreviation ’SAR’ has been clarified twice.

We removed this redundancy.

27) rain-formed or rain formed? One consistent version is needed.

We corrected this oversight.

28) We argue... - not sure that it is what the authors meant.

We replaced this phrase with the perhaps more commonly used “we suggest”.

29) the article - usually this is referred to as a ’paper’.

We followed the reviewer’s suggestion and changed the wording.

30) All the variables used in the formulas should be explained.

We corrected this omission.

31) Some commas are missing.

We corrected grammar and punctuation, where applicable.

32) is concerned with - need to check.

We reworded this sentence.

33) Table 1 does not contain variable information and can be omitted.

We modified Table 1 to remove redundant information.

34) Figures 3-5 probably could be combined.

We combined Figures 3 and 4 as suggested and we agree that this improves the readability of the paper.

35) Figures 6 and 11 are not too informative and can be omitted or combined with others.

We followed the reviewer's advice and combined several figures to improve the flow of the paper.