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Interactive comment on "Vertical Structure of Ocean Surface Currents Under High Winds from Massive Arrays of Drifters" *by* John Lodise et al.

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Anonymous Referee #2 AC:We would also like to thank Referee #2 for his or her time and insight to the current manuscript

RC: The paper by Lodise et al concerns the behavior of undrogued and drogued so-called CARTHE drifters. I agree with Ref #1 that lack of structure is a major problem in this paper, it is surprisingly hard to follow the authors as they describe their methods and present their results. A few recent papers are lacking, although Ref #1 mentions that as well.

AC: References mentioned by Ref 1 have been added. Page 2, lines 24-29 Page 3, lines 3-10 Page 15, lines 24-27 Page 16, lines 3-9 Page 18, line 23

RC: What concerns me the most is the mix of tools used here in combination with a lack of uncertainty estimates: A coupled atmosphere-wave-ocean modeling system is used to provide the physical quantities needed to analyse the drift, but instead of using the ocean model results for the vaguely defined "pre-existing" circulation, the drifter trajectories are used to provide ocean circulation estimates that are later used in the analysis of the drifters themselves. Even though one can argue that the circulation estimates are independent of the drifter observations from the "high wind" periods later on, I still wonder how representative this "pre-existing circulation" is and feel uncomfortable about this circular use of the drifter data. Why discard the ocean model component entirely? Isn't the upper layer in the model even representative of the background circulation? If not, what is the point of the ocean coupling? And surely there are other ocean models that could be used, at least for comparison to the LAVA results?

AC:When compared to the LAVA velocity fields created using the CARTHE drifters, the surface velocity fields from the ocean circulation component of the UWIN-CM, qualitatively, do not agree (shown in the figures below). At the scales sampled by the drifters in this study, it becomes very difficult to model ocean circulation due to the lack of data to serve as initial conditions, especially in an area rich in frontal activity such as this. This has been tested in a number of previous papers (e.g. Chang et al., 2011; Taillandier et al., 2008), where drifter based LAVA fields were compared to model outputs and used to improve model performances. The drifters themselves would serve as the best validation for any ocean circulation model, therefore using the drifter data itself to come up with estimates of the regional circulation is expected to be more accurate. The model runs were performed during the LASER experiment not only to be used as a data set for later analysis, but also for operational procedures of the experiment itself. Even though the ocean circulation model doesn't seem to be representative of reality in this region, the wind and wave data from the other 2 model components perform well when compared to observational data.

REFERENCES: Chang, Y., D. Hammond, A. Haza, P. Hogan, H.S. Huntley, A.D. Kir-

wan, Jr, B.L. Lipphardt, Jr., V. Taillandier, A. Griffa, T.M. Ozgokmen, 2011. Enhanced Estimation of Sonobuoy Trajectories by Velocity Reconstruction With Near-Surface Drifters. Oc. Modelling, 36, 179-197 Taillandier, A. Griffa, P.M. Poulain, R. Signell, J. Chiggiato, S. Carniel, 2008. Variational analysis of drifter positions and model outputs for the reconstruction of surface currents in the Central Adriatic during fall 2002. J. Geophys. Res., 113, C04004, doi.1029/2007/JC004148

RC: The model coupling will also need to be better described: How is the coupling implemented? Are wave-dependent air-sea momentum fluxes part of the coupling (both to atmosphere and ocean) for instance? It is precisely in situations with rapidly changing weather conditions that these couplings become important (see Rohrs et al., Ocean Dyn., 2012, for estimates of wave dependent fluxes from directional wave rider data and an analysis of upper ocean drift relevant to the paper under review).

AC: The coupling implementation has been described in the manuscript. Page 7, lines 1-6

RC: Although it appears to be a good idea to split the upper ocean drift velocity into "wave", "wind" and "background" components, it really depends on the ability to delineate them, and I'm not entirely convinced in this case. The CARTHE drifters are influenced by the Stokes drift, how much of the LAVA circulation estimates still contain some Stokes drift despite making model based corrections etc.?

AC: The average Stokes drift during the selected hours over which the pre-existing circulation has been estimated using LAVA is 0.02 m/s and 0.04 m/s for the drogued and undrogued drifter cases, respectively. Due to the velocity spreading and averaging performed by LAVA, the uncertainty which arises from the Stokes drift component is small during these time periods. Page 10, lines 21-28

RC: I'm not sure what the authors should do to present a more convincing case, but I would at least need to see a much clearer presentation with more emphasis on the various potential sources of error in the estimates. Alternatives to the LAVA circulation

estimates should definitely be considered (and compared to the LAVA estimates). This work would constitute a major revision of the current manuscript.

AC: In addition, we have added 2 new figures (Figs 6 and 7) to make a more convincing case that the LAVA velocity fields are fair estimates of the pre-existing circulation by plotting the velocity fields on top of 2 consecutive 24-hour averages of SST data from AVISO. The first 24-hour averages for the SST span the time periods over which the high wind analysis windows are defined, where the second 24-hour periods, span the 24-hours following the high wind event. The structures seen in the SST fields line up very well with the LAVA velocity estimates of the pre-existing circulation and the second 24-hour period of SST shows qualitatively how much these structured changed during the high wind event. With these figures, we've hoped to have further convinced the reader that the estimates for the pre-existing regional circulation are adequate for our velocity deconstruction. Descriptions of these figures (6-7) and their implications can be found on: Page 10, lines 12-28 Page 12, lines 9-23 Page 16, lines 17-24

RC: Some minor comments: Eq. (1) isn't an average, "1/h" is lacking.

AC: You are correct. Thank you, the change has been made. Page 3, line 31

RC: A short description of the typical hydrographic structure of the upper ocean in the region (mixed layer depths, buoyancy frequencies, salinity/temperature profiles etc.) would be nice.

AC: A short description as well as a new figure (Fig. 2) has been added to describe the typical stratification and mixed layer depth in terms of temperature, salinity and potential density, in the presence of a typical frontal feature observed during the experiment. Page 7, lines 22-31.

RC: Please add some info about the spectral resolution in the wave model as well. Eq. (2) is not correct for a model with the limit at infinity, there is a cutoff frequency, and presumably a specific shape of the spectrum is assumed.

AC: Proper limits for the wavenumber have been assigned in Eq. (2), and concerns about the spectral resolution have been addressed. Page 6, lines 21-25

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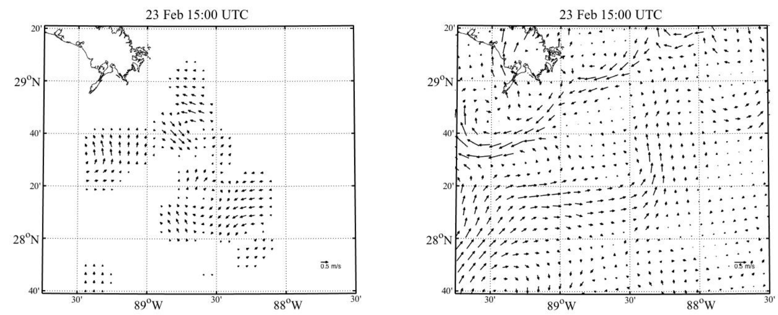

Fig. 1. Left: LAVA Drogued Velocity Field. Right: UWIN-CM Ocean Circulation at 0.5 m

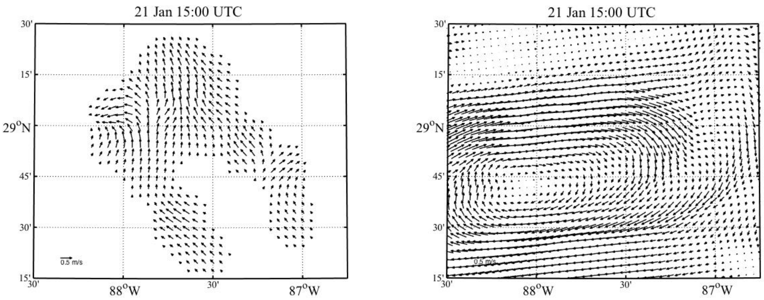

Fig. 2. Left: LAVA Drogued Velocity Field. Right: UWIN-CM Ocean Circulation at 0.5 m