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Interactive comment on "Observing and modeling currents on the continental slope: assimilation of high frequency radar currents and hydrography profiles" *by* A. K. Sperrevik et al.

Anonymous Referee #1

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This manuscript by Sperrevik et al. investigates the impact of assimilating high frequency (HF) radar-derived surface currents within primitive equation circulation model of the coastal ocean offshore Norway. The topic is of general interest to oceanographers, model developers, and coastal managers. Responding as effectively as possible to hazardous material spills, or to search-and-rescue events, is an important goal. For these reasons, the manuscript is appropriate for inclusion in this forum. Some critical aspects of the study configuration and results could, however, be better explained and in, at least, one area additional computations and their results should be included.

The chosen (ROMS) model is well documented in the literature and already implemented for the experiment area. The choice of assimilation schemes draws from a

much larger and less well tested set of options. The authors refer to several previous assimilation tests with HF radar-derived surface currents in paragraph 3 of the Introduction. They may want to consider adding a reference to the recent review paper by Paduan and Washburn (2013), which includes a longer discussion of recent assimilation attempts:

Paduan, J.D., and L. Washburn, 2013: High-frequency radar observations of ocean surface currents. Annu. Rev. Mar. Sci., 5, 115–136.

The linear adjoint model assimilation technique used here is not common and the paper would benefit from a more in depth discussion of how it compares to other techniques as well as the, apparently, severe limitations that are imposed by the high computational costs. In fact, the critical results of this work, as shown in the summary Figures 9 and 10, might be considered marginal or untrustworthy given that they are based on a single realization. Please speak to what would be required to run the assimilation test for the entire 3-month data availability period and do so if at all possible (i.e., with regular restarts, not for a single, 90-day prediction). If its not possible, it seems that one conclusion of this assessment is that the linear adjoint assimilation method is likely to be restricted to real-time applications and is not practical for use for multi-year re analysis studies of the type that would be beneficial to, for example biological connectively studies.

The entire section using the idealized channel model is of questionable added value, in my view. This may be because the description of the freely forced model is inadequate as is its justification as a viable ground truth in the situation being studied. The data locations diagram in Figure 5 is confusing with regard to the pseudo HF radar data locations. The caption refers to the total vector estimate locations from a two-site HF radar grid, but the data locations appear to follow the radial geometry of a single HF radar data set. Please clarify. Also, please clarify the domain used for the standard deviation computations in Tables 1 and 2. I assume that the results represent the standard deviations between the surface current (or temperature) at all model surface grid points across the entire domain, but it is not explained. Is that correct?

In both the idealized assimilation tests and those on the realistic model grid the surface current assimilation appears to provide better results than assimilation of CTD profiles of temperature and salinity. The authors state in both cases that this is evidence that the density of the CTD observations is too sparse. The CTD data locations are shown in Figure 5 for the idealized case but the locations are not shown for the realistic case. Are they the same? If not the should/must be shown. A broader discussion of this result is warranted beyond implicating the profile resolution, which appears to be fairly dense but limited in area in, at least, the idealized model case. It is just as likely that the results implicate ageostrophic forcing dominating the surface currents. Given the fact that the history of data assimilation over many decades in numerical weather prediction and more recently in numerical ocean prediction is one that favors integral data from density profiles over interface velocities.

The error covariance functions relating surface current and the model state variables is a critical component of any assimilation scheme. The authors here refer to the different error correlation length scales that were tested but they give no details. I assume that these were isotropic error covariance functions and were the same for velocity and temperature, but these details should be specified.

In the comparison of surface drifter trajectories with model-derived trajectories (Section 4.3.1) it is important that an additional result is computed and presented that compares the surface drifter velocities with the HF radar observations. This is necessary to bound the expectation of the assimilation tests and to establish the error levels in the HF radar observations beyond the simple geometric dilution of precision. Both Eulerian and Lagrangian comparisons of available drifter- and HF radar-derived velocities should be performed. In the former case, projection of the drifter-derived vector velocities into the radial velocity components facing the individual radar sites is the preferred approach and, if the angles occupied span a wide range, may provide some insight into azimuthal error biases in the individual radars as was shown in the error study of Paduan et al.

(2006):

Paduan, J.D., K.C. Kim, M.S. Cook, and F.P. Chavez, 2006: Calibration and validation of direction-finding high frequency radar ocean surface current observations. IEEE J. Oceanic Engin., 10.1109/JOE.2006.886195, 862-875.

Minor comments:

Page 15, line 24: the the is repeated

Page 16, line 26: too should be to

Page 17, line 22: thee should be the

Figures 9 and 10: Adding horizontal "zero" lines to the right-hand bias panels will make them more easily interpreted

Interactive comment on Ocean Sci. Discuss., 11, 1357, 2014.