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## ***Interactive comment on “The circulation of Icelandic waters – a modelling study” by K. Logemann et al.***

### **Anonymous Referee #1**

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Review of "The Circulation of Icelandic Waters - A Modeling Study", by K. Logemann, J. Olafsson, A. Snorrason, H. Haldimarsson, and G. Marteinsdottir

The authors combine a relatively high resolution regional ocean circulation model with assimilation of CTD data to simulate the currents and hydrography around Iceland for the period of 1992 to 2006. The model is forced with surface fluxes derived from NCEP atmospheric variables using bulk formulae, and river runoff. A detailed description of the resulting currents, and a broad comparison with observations, are given. Some sensitivity calculations are carried out in order to infer the driving mechanisms for various currents. Several new currents are identified and given names.

The primary focus of this paper is to try to produce the most realistic simulation of the ocean and describe the result. As best I can tell, the authors seem to be successful

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at that. However, the model does not really provide any definitive answers to dynamical questions about what determines aspects of the flow, such as volume fluxes, heat transport, etc. There is some attempt to infer dynamics through the sensitivity calculations, but I think the results are ambiguous for reasons detailed below. The discussion is quite descriptive and, I think, intended to provoke new analysis of observations and perhaps more focused dynamical studies. There is nothing obviously incorrect in the paper, but I see this largely as an editorial decision as to whether or not such model descriptions are useful. As an aside, I would prefer that new currents are identified and named based on observational evidence, not model results.

There are numerous aspects of the paper that need improvement. The model description is inadequate, the figures need improvement, and some of the analysis is misleading. Many of the references are in the gray literature and thus will not be accessible to many readers. If the editor feels that this sort of descriptive numerical oceanography will be of interest to the journal readership, it could be published subject to major revisions. Detailed comments follow.

(page 766, line 7) State where the Atlantic Water moved into the Nordic Seas.

(766, 13) volume flux volume flux

(766, 16) The Arctic Waters are also present north of the ridge to the west of Iceland.

(767, 12) What atmospheric processes? This statement is very unclear.

(769, 22) coastal

(770, 15) define  $d/dt$

(771, 1) What is the lower boundary condition for  $w$ ?

(771, 5)  $w(z=\text{zeta})$ ?

(772) An ice model is mentioned later, but there are no details. What are the dynamics and thermodynamics?

Section 2.2.1: How is a cell divided into 8 parts if each side is halved? Isn't that 4 sub-cells? How is it determined if finer resolution is required?

What is the topographic criteria? It would be clearer to show a contour plot of the horizontal grid spacing rather than the grid cells, I can not tell what the resolution is around Iceland. The axis labels are way too small on Fig. 2.

I do not understand the sentence beginning "By using a mix..."

(774,12) Does "this month" refer to days 1-30, or from the 15th of the previous month to the 15th of the current month?

(774,16) Why mention all the error terms (e.g.  $u$ ,  $v$ ,  $w$ , mixing coefficients) if only the heat flux terms are used (line 25)? How does one determine if the errors are due to advection or mixing? Does it matter? Are the corrected heat flux terms three dimensional? If so, it is misleading to call them a heat flux since this is generally taken to mean heat exchange with the atmosphere.

(775,2) Please show some measure of convergence. Is three iterations enough? The description of the correction term (lines 2-5) is very unclear, please expand.

(775,15) I assume some bulk formulae are used to get surface fluxes from atmospheric variables?

(776,11) How is the river runoff imposed on the model? Is there a volume flux at the coast? If so, provide details. How is this volume flux balanced over the whole domain? Is the model domain gaining volume or is it taken out of the domain somewhere?

(777,6) How large are the correction terms in the data assimilation compared to, say, the local surface fluxes or the nonlinear advection terms?

(778,5) Which tidal components were used in the model? Figure 5 (and vectors) is much too small to be useful.

(778,12) The assimilation of hydrography would be expected to improve the velocity

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field if the flow is near geostrophic, which it is, so this improvement is not surprising.

(778,25) I do not understand the sentence starting "Here, the temperature..."

(780,7) Please label or provide some guidance as to where these geographical features are.

(782, 9) I am not convinced the branching of the oNIIC is robust. This is especially a concern given the co-location of fronts with step changes in the model topography (most evident in Figs. 11 and 12).

(782, 17-25) The NIJ appears to be too deep in the model, the observations have it located over the 650 isobath. Also, the model shows an increase in westward transport as one moves to the east while the data show a significant decrease in westward transport. This is a major disagreement with the observations that needs to be made clear.

(783, 10) Should be Fig. 6?

(784, 9) To whom does "they" refer?

(784, 14) What does a 1 percent model error mean? I would be surprised if the model were within 1 percent of the observations. What are the error bars on the observations?

(784, 20) What is the correlation and significance between these two time series?

(785, 1-9) Lots of weakly supported speculation here.

Section 4: Why pick the 6 month period with the largest change in circulation to infer what is driving the mean circulation? This seems like just the wrong time period to focus on. What is the time scale for information to propagate from the edge of the circular perturbation region to the coast of Iceland? Just because you did not find a sensitivity in 6 months does not mean that there is no sensitivity, it may not have arrived yet. For example, it would be wrong to conclude that the wind stress curl in the eastern portion of a subtropical gyre has no influence on the western boundary current transport just

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because it takes some time (basin width / Rossby wave propagation speed) for the influence to get there. I am not convinced that the "no horizontal density gradient" calculations are useful. The real question is what determines the horizontal density gradients, the flow will adjust to the baroclinic shear. All these calculations tell us is whether the flow is baroclinic or barotropic.

(788,9-15) The vectors are too small to be useful. I do not believe these calculations are steady, or dissipation must be very large. It is surprising you do not connect the deep counter current with the NIJ, which is this model's version of the Vage et al. mechanism.

(791,4) What is "The theory of secondary circulation"? There is more than one.

(791,24) Was there a shelf in Fig 15? If so, its influence on the circulation was never discussed. I would expect a similar result with no shelf.

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Interactive comment on Ocean Sci. Discuss., 10, 763, 2013.

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