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Interactive comment on "A revised ocean glider concept to realize Stommel's vision and supplement Argo floats" *by* Erik M. Bruvik et al.

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Dear Editor and Referee #1,

below we offer a quick reply in order to facilitate discussion rather than a full answer to the review.

Reviewer #1(R#1) correctly points out that this is a somewhat unusual manuscript. This partially stems from the fact that we build on Stommel's vision for a global glider network. Stommel (1989) presented this vision as a short science fiction story. In our reappraisal we do take a less experimental approach genre-wise, even standard scientific we would argue, by first putting forward the equations for the energy consumption needed to propel/move the glider through the water. This equation (5) shows that a

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smaller and slower vehicle would consume less energy (to move through water). We then conduct some (simulation) experiments to show that a slow glider could indeed navigate the ocean in a meaningful way.

R#1 gives a good synopsis of the paper and we are thankful for his/her kind efforts with this unusual, but still comprehensible paper. From the point of understanding and appreciation of the text R#1 does raise relevant and substantial concerns. We find these to have two foci: A) Would/could it really work? Questions and doubts of technical feasibility. B) We do not properly address the total energy consumption of a complete glider with controllers and sensors.

Ideally, we would have a complete, actual vehicle to show for, but instead we are forced to make considerations about a future hypothetical glider. R#1 will certainly appreciate that the design of such a vehicle would require a substantial human and economic effort beyond our resources.

As far as concern A) is considered, let us put forward the following argument: both floats and gliders are already feasible technological facts. A hybrid of the two technologies, a slow glider or float-with-wings, seems doable as it might be thought of as a “mean” of the two classes of vehicles (this is of course a simplification). We are in the paper thus looking at a technological interpolation and not an a very speculative extrapolation.

R#1, for instance, expresses doubts that a small glider with a volume of 25L is technically possible. And we agree that present gliders indeed look compact and crammed enough already on the inside. Yet, Eq. (5) clearly shows that volume drives energy consumption. As energy considerations are of prime importance, we believe that vehicle volume must come down. And that this is not impossible if the glider was designed with this consideration in mind. This direction of development is necessary on the grounds of basic energy considerations. An example of a low volume vehicle is the SOLO-II float which has a volume of approximately 18L – in its previous techno-

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logical iteration, the SOLO-I float, it had a volume of 30L (see table on second slide of http://www.argo.ucsd.edu/AST13_SOLO-II_Status.pdf). Reduction of volume thus seem doable.

Further, R#1 raises concerns about the control of the vertical speed of our conceptual glider – especially at such low buoyancy as we prescribe (25 cc). In our work this is evaluated as continuous integrals and equations (Eq.(1) and Eq.(5)), clearly, a real glider must approximate this as discrete pumps(/bleeds). We believe this control problem to be solved in the implementation of floats as they also aim for a nearly constant vertical velocity and also operate at low buoyancies. As R#1 duly notes this and similar controls will have to be finer for a slow glider and is a step up in complexity of control compared to floats.

This brings us to issue B) – the control exercised and controller itself will require some energy. It will be very difficult for us to address this issue adequately as it is highly dependent on controller implementation and dynamics of the vehicle. Similarly, sensors may use more or less energy depending on configuration, implementation and sampling. We can thus not close the power budget as both R#1 and we would like.

It should be noted that we are not oblivious to the problem. In the paper we state that: "For the vision presented here, a power-hungry sensor must be avoided. This casts doubts whether a pumped C-T system could be employed on a slow glider."

Also, we do factor in energy consumed for heading control at a ball-park value of 1 kJ per dive/cycle. We do this since it is clear that the heading/attitude sensor will require energy and also energy for the control mechanism. This number is based on our experience with running endurance missions with the Seaglider. We may substantiate this with a power analysis/breakdown of an example low power Seaglider dive if R#1 wishes (?).

One should also consider and discuss some options for the glider technology in future. One option is to proceed with status quo: floats do Argo and glider missions continue to be more sporadic using 20 years old designs. Another option would be larger vehicles with more battery and more endurance. This could lead to designs which could require specialized equipment for launch and recovery – not a very feasible prospect. A third option would be to passively wait for leaps in battery technology, say, when batteries have improved 4-fold. We believe the novel concept proposed by us to be yet another prospective and more promising option than the aforementioned. The scientific community should know about this option and further discuss and elaborate on the concept.

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