Review of

“A revised ocean glider concept to realize Stommel’s vision and supplement Argo floats” by Erik M.Bruvik, Ilker Fer, Kjetil Vage, and Peter M. Haugan.

This manuscript goes back some 30 years, when Stommel presented his vision on how the world’s oceans could be sampled using a vast network of autonomous robots. The authors describe the extent to which this vision has materialised and what aspects have not been realised yet. The original concept consisted of gliding robotic underwater vehicles. The Argo program that uses vertically profiling floats. The underwater gliders that have been developed since then, never managed to get deployed in big numbers and on a global scale. The main hurdle is the limited endurance of gliders.

The authors look into the energy consumption of the underwater glider and make a case for a downscaled version of a glider, both in size and speed, that would give the glider the endurance required of the order of years, and add an active steering component to the device, which the floats, which operate in a Lagrangian fashion, lack. They simulate a hypothetical downscaled glider in some key parts of the worlds ocean, demonstrating the added value of a gliding float, which they call an Eulerian roaming float, compared to a Lagrangian float.

I enjoyed reading this manuscript. It is written in a well-structured way, and clearly presented. I don’t feel qualified to suggest alternatives for grammar and spelling issues, so I refrained from listing any. In any case, I think overall the manuscript is well-written.

After reading it, I was left a bit with a “So what?” feeling. I think this might be due to two things. The authors primarily look at the energy consumption required for propulsion, to argue that a horizontal speed of 13 cm s^{-1} would be sufficiently low to increase the endurance level of the (smaller) glider to the time scale of a year. The energy consumption by the sensors and controllers is marked as “beyond the scope of the research”. I think that this is in fact a very important aspect. And it may even be so, that the sensor/controller energy requirements are the limiting factor. The reason why I think this, is as follows. I must note that I am no expert on Argo floats, but it seems the expected life time of floats is some four years, where the primary limiting factor is depletion of the batteries. The standard cycle takes 10 days. A gliding float, would do a profile a day. Assuming that the float’s controller would go into a deep sleep during the drift-at-depth phase, then profiling every day would slash the endurance down to half a year. Of course it depends on how much batteries the device contains, but this makes me wonder. You do state that based on experience with a Seaglider, a cycle takes about 1 kJ for the electronics, which then would translate to 1/16 W, and could make the concept feasible. My experience is mainly with Slocum gliders, and, although the manufacturer has done a lot to reduce the power consumption of the electronics, a figure of 1-2 W is more appropriate. So clearly, sacrifices need to be made in terms what, how and how much is measured. Contrary to the Slocum glider, whose processor is effectively constantly running, a very low power system would sleep most of the time. The fact that going so slow requires only a small buoyancy drive, it also means that stratification may cause significant changes in the effective buoyancy drive, and as a consequence may require frequent monitoring of diving or climbing rates. A similar argument goes for keeping course. If the Seaglider is indeed so efficient (again, I am out of my comfort zone here), then simply reducing the buoyancy drive would allow for existing gliders to be used as described in the manuscript. Because this whole aspect is glossed over by saying beyond the scope of the manuscript, it does not really convince me.

Another aspect that does not convince me, because it is not properly addressed, (and I agree immediately that it is not so clear how this would be addressed properly) is, if it is at all possible to build a vehicle half the size that contains all the hardware needed to function **and** sufficient amount of batteries. If batteries is the limiting factor, a bigger glider may be more advantageous.

The final issue I have, is the costs of such a down sized glider. I reckon that a guide price of today's conventional glider glider is about $ 200k. To be deployed in thousands, the price must come down enormously. I am skeptical about the financial viability of the design, but I would loved to be proven wrong… Weirder things have happened though.

Sections 4.1-4.3 show the results of such a glider that is deployed in various parts of the world's oceans. Personally I felt that each case conveys more or less the same message, and the one case would be as good as any other. Like one float, one glider would not tell much about the state of the ocean, and the appeal is a large number of devices. I thought that focussing on one case, where you look at how the added information of a Eulerian-roaming device, as opposed to a Lagrangian device would give, would be more compelling.

I realise I sound a bit negative, and I also admit I also don't really know how you could factor in the issues I raised.

Detailed remarks

Below I list a number of remarks I made in the margin when reading the manuscript.

P1. L23: "in that sense fall short of realizing his vision", this sentence suggests that as long as it has wings, all is well. I think what you mean is that the dynamic positioning is what is failing.

P2. L4 "simpler", simpler than what? Also related to this paragraph is that "just adding wings to a float" in reality comes with a serious increase in the level of complexity.

P3. L16. This sentence initially confused me, but it made sense after I looked up some details of the Argo float. I think the words "pause" and "parking" in this context are not clear for someone who is not very familiar with how floats are typically operated.

p.6 L9 A considerable part of the lift is generated by the hull of the glider.

p.7. L14-16. (Related to the previous point) "… to compensate for …. smaller hull": this suggest that, at least for the Slocum gliders, the design of the wings (size/shape) is somehow optimized. I suspect it is not, as the leading principle in the design of the Slocum glider is easy construction and I don't think much thought has gone into the size of the wings.

p.8 L15. Here I thought is might be difficult to achieve gliding with just 25 g of buoyancy, because the effective buoyancy may change more than this in a stratified ocean, and using a vehicle that has not a compressibility that is exactly matching that of seawater. This requires frequently adjusting the buoyancy on both the down and up casts.
In my experience gliders typically reduce speed on both the down and up casts, due to stratification effects. You could, I suppose, store energy when reducing the volume on the own cast and releasing it again on the upcast, but still you will look at a hysteresis-like effect, and a much more technically complicated design (read: losing volume for batteries, increased costs).

p.11 L19 Here you say you set the glider's velocity vector. It is not clear to me where you specified the just that, the speed, or that you would specify the buoyancy of 25 cc. I guess you prescribed the speed. In that case, my previous point should some how be addressed. If you specified the buoyancy, I suggest you include a small discussion on how frequently the buoyancy needs to be changed, and what the energetic costs are.

p.14 L12. Here (and also in following paragraphs) you specify the energy consumption. I read this number as 691 cycles, at 1 cycle a day, using 1/16 W gives 2.9 MJ. Or is this computed using equation 5, taking into account the actual velocity the glider made, and stratification it faced, and the effort done to compensate for it? Also I think, this includes only the power required for propulsion. So what about the electronics?