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Ocean Science Discussions

Interactive comment on "Observations of brine plumes below Arctic sea ice" *by* Algot K. Peterson

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The manuscript looks at a subset of turbulence (via tried and tested TIC instrumentation) data from a well-studied but rich dataset and focuses on saline plumes beneath an Arctic ice floe. This is an intriguing dataset and analysis. I have no doubt that properly understanding the nature of the salt flux from these drainage channels and their influence on the upper water column is very important in getting the whole (Arctic) ice-ocean story right. Also this manuscript gives balanced weighting to the ocean and ice – which is not so common. I think this is a useful study.

My main comments/concerns/thoughts are: The setting is now framed nicely in the informative, if rather complex, figure 3. I think I've worked it all out. Should the triangles colour-code to the N2 profiles? Daily ticks (crosses) are hard to see. What are the dotted lines? Are the 3D view and bathymetry really required given that we are looking at the upper 1m and the ocean is $\sim$1000-2000m deep?

What I don't get is the TIC is fixed in the floe reference frame and these drainage channels don't particularly wander (yes/no?). How can we unpick variation in ice-ocean relative motion vs straight plume width? I think there is a component missing that could be accessed from the concurrent velocity data. Fig 5 helps with this.

The horizontal speed is correlated with the plume downward vertical velocity – this has me confused. If it's flowing horizontally faster wont the boundary-layer be more turbulent and tend to mix the plume before it arrives at the TIC?

Is it possible to take the vertical and horizontal velocities and back-trajectory to see where the plumes are actually coming from? Picking a mean horizontal speed of 0.15 m/s and taking a peak vertical velocity w' of -0.05 m/s so it will take 20 s for a "new" plume to get to the sensor suggesting a source radius of 3m. How many drainage centers are likely in this area?

Fig 5b is one of the cleanest results I've seen in boundary-layer observations. Despite this it seems to warrant only a few lines of text and no real exploration. It is really curious that the fast horizontal flow should generate the strongest vertical flows also.

Pg 13 line 25 doesn't make sense to me. I might have thought increased boundary-layer turbulence might have mixed the plume and reduced the peak in the plume by increasing the width.

Possible to look at the width of the plume as a function of velocity? It would seem so but I think this then reveals an issue in that the nice plume structure shown in Fig 4 is controlled by the horizontal velocity.

I believe a bit more connection to plume mechanics would help. There's a significant set of literature on this (e.g. reviewed by List 1982; Woods 2010). If Fig 4 is actually from a coherent plume structure then it would seem useful to reverse the plume equations to work out what is happening at the source? You have a width and a distance and a buoyancy anomaly? You could see if it is normal in a plume for the horizontal u' to be

greater than the w' (and the u' width seems greater?)?

Pg 9: line 8 “supercooled” – might be good to clarify that this is brine-induced supercooling and tied to the plume source, as opposed to pressure-induced supercooling that might be found in ice shelf affected waters. pg 15 line 10 “dissolve” not sure I'd use this term. They entrain and grow in scale but weaken in terms of buoyancy anomaly.

Does the paper address relevant scientific questions within the scope of OS? YES Does the paper present novel concepts, ideas, tools, or data? YES Are substantial conclusions reached? YES Are the scientific methods and assumptions valid and clearly outlined? YES Are the results sufficient to support the interpretations and conclusions? YES Is the description of experiments and calculations sufficiently complete and precise to allow their reproduction by fellow scientists (traceability of results)? YES Do the authors give proper credit to related work and clearly indicate their own new/original contribution? YES Does the title clearly reflect the contents of the paper? YES Does the abstract provide a concise and complete summary? YES Is the overall presentation well structured and clear? YES Is the language fluent and precise? YES Are mathematical formulae, symbols, abbreviations, and units correctly defined and used? YES Should any parts of the paper (text, formulae, figures, tables) be clarified, reduced, combined, or eliminated? NO Are the number and quality of references appropriate? Mostly Is the amount and quality of supplementary material appropriate? N/A

List, E.J., 1982. Turbulent jets and plumes. Annual review of fluid mechanics, 14(1), pp.189-212. Woods, A.W., 2010. Turbulent plumes in nature. Annual Review of Fluid Mechanics, 42, pp.391-412.

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