

Review of remotesensing-1563575:

An Algorithm to Transform Arctic SMAP-derived Skin Salinities into Bulk Surface Salinities

Authors: David Trossman and Eric Bayler

I cannot recommend the manuscript for publication, as I believe there is a serious flaw in the whole line of argumentation:

A). The authors observe and report biases between satellite (SMAP, SMOS) SSS and in-situ measurements in the polar oceans. They attribute these biases to the difference between skin salinity, as measured by the satellites and bulk salinity (at 5 m depth), as measured by the in-situ sensors. They then attempt to develop a correction algorithm for that difference. I do not see any convincing reason at all why the observed satellite – in-situ difference is caused by the vertical salinity stratification. In fact, there is a long list of possible systematic errors in the satellite salinity retrievals, which are much more likely causing these observed biases. For instance, in the order of my estimated importance:

1. Errors in the model for the electromagnetic permittivity (dielectric constant) of sea water, which governs the L-band emission from a flat ocean surface, and which plays a pivotal role in the satellite salinity retrievals.
2. Systematic errors in the ancillary wind fields or the wind roughness model that are used in the surface roughness correction of the SSS retrievals.
3. Systematic errors in the ancillary SST fields that are used in the SSS retrievals.
4. It is my understanding that the Version 5 of the JPL SMAP SSS and also the BEC SMOS SSS attempt to undertake a correction for sea-ice contamination. That is difficult to do as the ancillary sea-ice products that go into that correction are not accurate enough close to the sea-ice edge. That could easily result in over or under correction of the sea-ice contamination.
5. SMAP has the notorious problem of an emissive reflector (antenna dish), which has a strong seasonal signature. It is difficult to correct because it requires

accurate information of the physical temperature of the antenna dish, which is not available.

6. There could be issues with the reflected galactic radiation or sun glint. These effects need to be corrected for in the SSS retrievals, which could result in residual uncertainties.

7. Combinations of some or all of these.

The fact that the observed satellite – in-situ salinity differences exceed the reported errors in the satellite SSS data is not a valid argument, as this reported errors in the satellite SSS could easily (and I believe most likely does) underestimate the true error in the retrieved SSS.

One should note here that because of the low sensitivity of the L-band brightness temperature (TB) to salinity in cold water (1 K TB error = 4 psu SSS error), even small radiometric errors can lead to large errors in the observed SSS.

In order to assess the observed satellite – in-situ salinity differences, one would first need to exclude the aforementioned error sources, before considering attributing them to skin – bulk differences. That requires to look in detail into the geophysical signature of the observed biases (seasonal and zonal variations, differences between look direction, differences between ascending and descending swath). That is not a simple task.

A potential way to go about it is to look at satellite SSS retrievals from other algorithms (NASA/RSS SMAP SSS, LOCEAN SMOS SSS) and see if the observed biases are about the same as in the JPL SMAP or the BEC SMOS data. At least that would give a hint if the biases were caused by the SSS retrieval algorithm or not.

B) Looking at Figure 1, it appears that, on average, the satellite (skin) salinity is actual saltier than the in-situ (bulk) salinity. That is odd, as the mechanisms that could cause a mismatch between skin and bulk salinity (precipitation, river discharges, sea-ice melt) should make the skin salinity fresher. So, what mechanism could cause it getting saltier? Evaporation is a very unlikely candidate in polar regions.

This is another strong indication that the observed satellite - in-situ salinity differences are NOT caused by skin – bulk differences but rather point to deficiencies in the satellite SSS retrievals.

A couple minor issues that I observed:

C) The axes labels in Figure 1 are very small and thus illegible.

D) Table 1: I believe the unit for the gravitational acceleration g should be m s^{-2} .