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Interactive comment on "Freshwater in the Arctic Ocean 2010–2019" *by* Amy Solomon et al.

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This paper addresses a parameter that the authors call "Fresh water . . . in the ocean“. Instead of analysing observed salinity changes in the Arctic Ocean and concluding from these on possible causes like mixing with or advection of fresh or low salinity waters, the authors present a useless parameter, "freshwater in the ocean", and therefore the paper does not provide unique results.

In the framework of TEOS-10, freshwater (furtheron FW) content in the ocean is defined in a unique way as FW=1-SA with absolute salinity SA given in g/kg (IOC/SCOR/IAPSO 2010). That is, almost the entire mass of ocean water is freshwater. What the authors are presenting in this paper are, however, fractions of FW defined by a reference salinity which is an arbitrary parameter by definition.

They analyse time series of these FW content fractions. As comparisons of freshwa-

ter fractions in general, also the course of such FW fraction time series is arbitrary. The authors admit the arbitrariness of the FW fraction (line 57ff) and refer to Schauer and Losch (2019; US19 furtheron). US19 illustrate the severe consequences of this arbitrariness which, however, are ignored by Solomon et al.

Despite recognizing the arbitrariness of FW fraction terms and their comparisons, the authors apply the freshwater fraction concept because "oceanographers have long been accustomed to [its] use" (line 53) and for "traditional" reasons (lines 87-88). I don't consider "being accustomed" or "tradition" sound scientific categories - particularly not so, when scientific arguments speak against them.

Although Solomon et al. nowhere determine pure freshwater fluxes (volume/time) to the ocean, they claim in the introductary chapter that the determination of fluxes of pure freshwater requires a specific "scaled" salinity (lines 68-77). But also this claim is wrong. According to the Knudsen theorem fluxes of PURE freshwater into or out of the ocean, such as e.g. precipitation, can be determined independently of the choice of the reference salitity (Sref). Anyway, Solomon et al. don't compute fluxes of pure freshwater but the content of FW fractions and their variability.

Determining FW fraction content variability for a fixed ocean water volume remains ambiguous in the size but not in the sign. E.g. statements like in line 111, the FW increase being 25%, could as well be 15% or 35%, depending on the choice of Sref (see Table 1 in US19).

In their figures Fig. 2 and 3, however, Solomon et al. consider ocean volumes that are not fixed since they regard the upper layer down to a certain isohaline. The depth of the halocline can obviously vary. Calculating the content over a variable volume means, that also the sign of variation might change with changing Sref (see Fig. 4 of SL19; the formulation of varying volume is analogue to that of FW fraction transports through variable ocean currents.).

The authors could avoid all the ambiguity and arbitrariness of FW fractions and their temporal evolution if instead they showed integrated salinities over one or several fixed layers. They could discuss how the varying salinity relates to salt flux divergence (either due to vertical mixing or due to advective divergence) due to the different external pure FW or low (known) salinity water input. This discussion would be built on sound absolute quantities and would make this article a reliable resource for future reference.

References IOC/SCOR/IAPSO, 2010: The international thermodynamic equation of seawater – 2010: Calculation and use of thermodynamic properties. Intergovernmental Oceanographic Commission, Manuals and Guides 56, UNESCO, 196 pp.,http://www.teos-10.org/pubs/TEOS-10_Manual.pdf.

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