We thank all three anonymous reviewers and U. Schauer for reading this paper so carefully and providing such insightful comments. We have worked very hard to address your concerns as thoroughly as possible in the revised paper. In order to estimate to what extent the change in FWC outside of the Beaufort Gyre compensates for changes within the Beaufort Gyre in the 2010s, additional calculations were done with the ORAs to show FWC in the Beaufort Gyre and the rest of the Arctic, and with the satellite measurements below 82.5N. More details are provided about the data sources, and the satellite and in-situ FWC estimates are calculated more consistently. A spatial map of FWC from satellites is now included to compare the observational estimates more directly with the ORAs.

Our responses are shown with blue font below each comment.

Anonymous Referee #1

Major comments

1) The authors argue that the trend in Arctic freshwater content stabilized in the 2010s due to increased compensation between the Beaufort Gyre and the remaining Arctic. However, that is not immediately apparent in any of the figures. Only one of the reanalysis products presented in Figure 2 shows a compensating pattern in the freshwater anomaly, but it also does not reproduce the observed storage trends. The multi-model mean shows a small amount of compensation on the shelves, but it is not clear that this balances the large storage in the Beaufort Gyre. The fidelity of the reanalysis products, or what we can learn from them, is not really discussed in the text. From Figure 3 it appears that the freshwater content in the Beaufort Gyre stabilized in the 2010s, at the same time as the freshwater content of the full Arctic stabilized: no compensation is apparent in this figure.
It is correct to say that the reanalyses disagree on the extent and magnitude of trends outside the Beaufort Gyre. We have altered the maps in Figure 2 and now it is clearer that most of the products detect negative FWC trends along the Eurasian coastal seas. The magnitude of this trend is weak compared to the Beaufort freshening but nonetheless there is evidence of a slight compensation. Given that there is disagreement between models (Figure 2 time series of Beaufort and non-Beaufort FWC, for individual products), we have modified the text to express caution about making a definitive conclusion about the compensation.
2) The two time series presented in Figure 3 are from different data products and use different reference salinities. This is not justified or discussed in the text. Why not also show the Beaufort Gyre freshwater content from the hydrographic observations, as it is a subset of the full Arctic?
We address this issue by including the Arctic Ocean below 82.5N from satellites and use the same reference salinity of 35 for both satellite measurements and in-situ observations.
3) The definition of the study region varies throughout the manuscript, which makes it difficult to interpret the numbers that are presented. For example, at Line 88, the authors state “in this study, the reference salinity used is 34.8 psu and freshwater content is calculated over the area north of 70N”. However, in the Figure 3 caption a different domain and reference salinities are used. At Line 188, the authors give the impression that the Nordic Seas should be included in the analysis, but it is unclear that they have done this.
These lines have been removed to prevent confusion about the regions and techniques used in this study.
4) Runoff from the Greenland Ice Sheet has been considered in previous assessments, such Haine et al. 2015, Proshutinsky et al. 2015, so it is not particularly compelling to say that

this aspect has been overlooked previously. It is also not made clear how freshwater fluxes from Greenland enter the budget, since much of Greenland is to the south of the Arctic (Mediterranean).
It is true that the majority of the runoff from Greenland flows south, however, more than 40% of the Greenland ice sheet drains north of 79 degrees (Hill et al., 2018) where both solid and liquid runoff are expected to impact the Arctic Ocean basin more directly and we therefore consider it worthwhile to include and highlight in the paper. We therefore also update the work of previous studies to look at the change in the recent decade.
Ref: Hill, E. A., Carr, J. R., Stokes, C. R., and Gudmundsson, G. H.: Dynamic changes in outlet glaciers in northern Greenland from 1948 to 2015, The Cryosphere, 12, 3243–3263, https://doi.org/10.5194/tc-12-3243-2018, 2018.

5) In the abstract and the summary the authors state that the import of subpolar waters into the Arctic has increased, yet this is not discussed substantially in the manuscript.
The near-surface freshwater import from lower latitudes has increased through the Bering Strait, as stated in Section 2.5: "A recent study by Woodgate (2018) has shown that the Bering Strait exhibited a significant increase in volume and freshwater import to the Arctic between 2001 and 2014."
In regard to the Atlantic sector, Polyakov (2017) says that Atlantic Water layer has shoaled and is warmer, most likely because it is warming at its source. But true, not that more has been / is being imported into the Arctic. This has been corrected in the summary and abstract. Also, from L308 onwards we add, "In the Eurasian Basin, they relate the weakening stratification and enhanced sea ice melt, a process referred to as the Atlantification of the Arctic (Polyakov et al., 2017), to injection of (warmer) relatively salty water from the Barents Sea into the Eurasian Basin halocline, flowing at shallower depths. Although they do not show any clear link to the Fram Strait imports, they find a small but statistically significant correlation between observed salinity in the Eastern Eurasian Basin halocline and the northern Barents Sea upper water column. Thus, in agreement with the box model estimates of Tsubouchi et al. (2020), there appears to be no trend in volume fluxes at the boundaries, and no evidence for a dominant link between changes in the freshwater fluxes at the boundaries and changes in the upper Arctic Ocean."
New reference:
Tsubouchi, Takamasa, Kjetil Våge, Bogi Hansen, Karin Margretha H. Larsen, Svein Østerhus, Clare Johnson, Steingrímur Jónsson, and Héðinn Valdimarsson. "Increased ocean heat transport into the Nordic Seas and Arctic Ocean over the period 1993–2016." *Nature Climate Change* 11, no. 1 (2021): 21-26.
6) In general, it would be useful to include summary sentences at the end of each section.
Thank you for this suggestion. We have included summary sentences when appropriate.

Minor Comments

1) L26: You could specify "Arctic freshwater content" rather than "Arctic freshwater" here.
Done.
2) L41: This first sentence could be split into at least two.
Thank you, we think the sentence reads well as is.
3) L55: There may be a formatting issue here, but it seems S is being used for both salinity and salinity anomaly.
Salinity anomaly is now denoted with "δS".
4) L58: What do you mean by "verbal"?
The sentence has been changed to read, "...reference salinity and values attributed to it are not rigorously mathematically and physically defined."
5) L81: This clause is confusing, starting from "inverse imprint"

The sentence has been changed to read, “Is "ocean freshwater flux" purely a mirage, therefore? Forryan et al. (2019) pursue the surface freshwater flux approach, noting that (as is well known, e.g. Östlund and Hut, 1984) evaporation and freezing are distillation processes that leave behind a geochemical imprint via oxygen isotope anomalies on the affected freshwater in the sea ice and seawater. In the case of evaporation, distillation (here, isotopic fractionation) preferentially removes lighter oxygen isotopes from seawater, leaving behind in the seawater a proportion of heavier isotopes. The lighter isotopes that are now in the atmosphere return to the land or sea surface as precipitation. Those falling on land can (eventually) transfer from land to sea by river runoff or by other glacial processes, or by further cycles of evapo-transpiration and precipitation. For sea ice, the ice contains the lighter isotopes while heavier isotopes are contained in the brine that drains out of the ice during freezing, to re-enter the ocean. The isotopically-lighter meteoric fractions are used to quantify freshwater that originates from the atmosphere (directly or indirectly), and the isotopically-heavier fractions similarly quantify the signal of brine rejected from sea ice, and thereby the amount of ice formed from that seawater.”

6) L89: Can you comment a little bit more on why you choose 34.8 and how to interpret freshwater content and fluxes in this framework? Another significant freshwater framework that is missing in this discussion is that presented in Wijfells et al. 1992.
   The selection of the reference salinity (Sref=34.8) for the Beaufort Gyre region is in accordance with previous studies focusing on the freshwater content of the region (Proshutinsky et al., 2009). The same reference has been used in an earlier study to investigate the freshwater sinks and sources in the Arctic (Aagard and Carmack, 1989). The FWC anomalies estimated here is as a measure of the amount of liquid freshwater accumulated or lost from the water column column bounded by the 34.8 isohaline at depths. Note that there are other approaches used which are independent of a reference salinity, for example in Wijfells et al. (1992) where they focused on the global distribution of freshwater transport in the ocean based on the integration point (reference point) in the Bering Strait. It should be noted that all of these methods and the use of different reference salinities (for example Dickson et al., used Sref=35.2 to study inflowing Atlantic Water) have merits and limitations based on the choice of intent and application (Carmark et al., 2008).
   Carmack, E., F. McLaughlin, M. Yamamoto-Kawai, M. Itoh, K. Shimada, R. Krishfield, and A. Proshutinsky (2008), Freshwater storage in the Northern Ocean and the special role of the Beaufort Gyre, in Arctic- Subarctic Ocean Fluxes: Defining the Role of the Northern Seas in Cli- mate, edited by R. R. Dickson, J. Meincke, and P. Rhines, pp. 145–170, Springer, New York.
   Wijffels SE, Schmitt RW, Bryden HL, Stigebrandt A (1992) Transport of freshwater by the oceans, Journal of Physical Oceanography, 22, 155–162.
7) L167: Not sure this is a fair comparison, as Morison et al. 2007 present a very different time span. What is meant by “complex variability?”
   This refers to the interannual variability seen after 2007. The sentence is changed to “complex interannual variability”.
8) L173: Which “difference in annual cycle” are you referring to?
   This sentence has been removed.
9) L211: It is a bit confusing to include river discharge in this section after discussing river discharge in the previous section. Please clarify the links between these sections and which trends may be consistent between them. Boisvert et al. 2015, 2018 could also be referenced in this section.
   We think the reference to river runoff in Section 2.2 is required to show the relationship between the different freshwater sources. A reference to Boisvert et al. 2018 has been added.

10) L239: Could you clarify how sea ice age is converted into volume and how to interpret these results?
Sea-ice age can be related to thickness. Given the sea-ice concentration, you can estimate volume. Liu et al. (2020) states: "The relationship between ice age and ice thickness is first established for every month based on collocated ice age and ice thickness from submarine sonar data (1984–2000) and ICESat (2003–2008) and an empirical ice growth model."
Further, they use a satellite-based product providing sea-ice age, and "The ice age category represents how long in years the sea ice has existed since its first appearance, which is estimated through Lagrangian tracking of the ice from week to week using gridded ice motion vectors (Maslanik et al., 2007, 2011; Tschudi et al., 2019b)." Further details can be found in Liu et al.
11) L255: Spall 2019 "Dynamics and Thermodynamics of the Mean Transpolar Drift and Ice Thickness in the Arctic Ocean" may be a useful reference to include here.
Spall reference added.
12) L260: Typo, should read "on par"
Spelling corrected.
13) L265: Might add "before reaching the Transpolar Drift" to the end of the sentence.
The sentence has been modified as suggested.
14) L268: Please clarify this sentence. Does the decrease in sea ice extent cause a delay of freeze up?
Not necessarily. We modified the sentence as "Although the delay of freeze up during early winter, partly depending on the anomalies of oceanic and atmospheric circulations (e.g., Kodaira et al., 2020), would cause a delay of snow accumulation on sea ice, …"
Reference:
Kodaira, T., Waseda, T., Nose, T., and Inoue, J.: Record high Pacific Arctic seawater temperatures and delayed sea ice advance in response to episodic atmospheric blocking. Sci. Rep., 10, 20830, https://doi.org/10.1038/s41598-020-77488-y, 2020.
15) L272: Was the snow depth greater than the climatology? Please clarify this sentence.
The sentence was modified as: "In the Atlantic sector, precipitation associated with six major storm events in 2014/2015 during the N-ICE2015 field campaign (Merkouriadi et al., 2017) caused the snow depth to be substantially greater than climatology."
16) L299: In this section, you could also discuss the trends in Atlantic Water entering the Arctic as shown in Tsubouchi et al. 2020, for example.
From Tsubouchi et al. 2021 AW volume inflow does not have any significant trend.
We already discussed the trends in Atlantic Water when referring to Polyakov et al. (2020) L306, but the reviewer is right that more should be written and references are missing. We rephrased from L308 onwards: In the Eurasian Basin, they relate the weakening stratification and enhanced sea ice melt, a process referred to as the Atlantification of the Arctic (Polyakov et al., 2017), to injection of (warmer) relatively salty water from the Barents Sea into the Eurasian Basin halocline, flowing at shallower depths. They do not show any clear link to the Barents or Fram Strait imports. Thus, in agreement with the box model estimates of Tsubouchi et al. (2020), there appears to be no trend in volume fluxes at the boundaries, and no evidence for a dominant link between changes in the freshwater fluxes at the boundaries and changes in the upper Arctic Ocean.
New reference:
[Polyakov 2017 is already cited elsewhere in our manuscript]
Tsubouchi, Takamasa, Kjetil Våge, Bogi Hansen, Karin Margretha, H. Larsen, Svein Østerhus, Clare Johnson, Steingrímur Jónsson, and Héðinn Valdimarsson. "Increased

ocean heat transport into the Nordic Seas and Arctic Ocean over the period 1993–2016." Nature Climate Change 11, no. 1 (2021): 21-26.

17) L315: What is the "but" referring to here? Please rewrite this long sentence.
    The sentence has been rewritten to read,"...consisting mostly of the anticyclonic/convergent Beaufort Gyre and the cyclonic/divergent Transpolar Drift. The wind-driven circulation produces local accumulation or thinning of the surface layer..."
18) L316: Isn't the freshwater gradient in the Arctic caused by the difference in salinity between the Pacific and the Atlantic? It seems odd to credit the circulation with this gradient. Please clarify.
    Thank you for pointing out that this is unclear. In fact, there are different sources for fresh water in the Arctic, relative to the most saline input, from the Atlantic / Nordic Seas through the Fram Strait and the Barents Sea: continental runoff, precipitation and Pacific Water through the Bering Strait. Pacific Water has slightly lower salinity than Atlantic Water, whereas the other sources are pure fresh water. The different sources are described in detail in Section 2. The Arctic circulation redistributes that relatively fresh water in solid and liquid form on the large scale via the Transpolar Drift and the Beaufort Gyre. The cross-Arctic gradient from low fresh water north of the Fram Strait and the Barents Sea to high fresh water in the Canada Basin stems from all of these having a lower salinity than the saline inflow of modified Atlantic Water and being redistributed by circulation. This has been illustrated in various publications cited in our manuscript, e.g., in Section 3. Both, the sources/sinks of salinity (i.e., Pacific and Atlantic exchanges, along with the continental runoff, sea ice melt/formation and precipitation less evaporation fluxes) play a role in setting up the cross-Arctic freshwater gradients (Haine et al., 2015). However, the interior Arctic fresh water re-distribution is mostly controlled by the ocean large circulations and, specifically, by convergence of the fresh water in the Beaufort Gyre and corresponding fresh water divergence away from the Siberian shelves. We made the following clarification in the text: "Although, the exchanges with the Atlantic and Pacific influence the large scale salinity gradients across the Arctic Ocean (Polyakov et al., 2020), the combined effects of the density-driven and wind-driven circulations primarily drive a strong freshwater gradient through the Arctic, of up to 25 m freshwater equivalent (Rabe et al., 2011), with a maximum freshwater content in the Beaufort Gyre and a minimum in the Nansen Basin towards the Barents Sea."
19) L321: May want to swap word order to "yet unreached".
    The sentence has been modified as suggested.
20) L334: What is meant by more effective? Please explain and/or provide a reference.
    We have explained the statement and added more details and the reference: Preconditioning of the shelf waters due to the mixing with the upwelled Atlantic water also can result in the cold and saline cascading plumes (Luneva et al., 2020). Furthermore, cascading is becoming more common in the Arctic; it is more effective in mixing and ventilating upper and low intermediate Arctic waters than open ocean deep convection and can reach deep into the water column (e.g., Luneva et al., 2020).
    The sentence has been rephrased to clarify: "Furthermore, cascading is more effective in the highly stratified Arctic Ocean than open ocean deep convection in reaching deep into the water column."
21) L337: Please expand and clarify the synthesis of the Janout et al. 2017 study.
    The sentence has been changed to read, "From two expeditions in 2013 and 2014 and one year of mooring deployment in between, Janout et al. (2017) found a dual behaviour in Vilkitsky Trough, between the Kara and Laptev Sea: strong winds can cause an upward diversion of the along-slope freshwater transport onto the shelf; the addition of sea ice formation results in the formation of water with a higher density than that found at 3000 m, suggesting possible sinking of these waters to the Nansen basin."

Anonymous Referee #2

Comments:

1) My understanding is that the Beaufort Gyre is a part of the Amerasian Basin. The authors state otherwise (see abstract and ll 120-125).
Thank you for pointing this out. The abstract has been changed to read, "due to an increased compensation between a freshening of the Beaufort Gyre and a reduction in freshwater in the rest of the Arctic Ocean" and lines 120-125 have been changed to read, "However, this freshening is partly compensated by a reduction in freshwater in the rest of the Arctic Ocean".
2) Page 12, line 247. Should "Sea" start with lower case "s"?
Thank you but the spelling is correct.
3) I tend to disagree with the statement ll 309- 311 (p. 14) that Polyakov et al (2020) did not provide evidence for the link between the Barents Sea imports and salinity (freshwater) change in the halocline of the eastern Eurasian Basin. See their Fig 12, upper panel which compares salinity of the eastern Eurasian Basin with salinity from the northern Barents Sea (lagged, led by one year). The time series show statistically significant link. This, plus well-established pattern of the ocean circulation, provides reasonable evidence to state that changes in the eastern Eurasian Basin halocline show a fingerprint of changes in the upstream areas (notably northern Barents Sea). I suggest the authors modify this statement.
Polyakov et al. (2020) did show the timeseries of the salinity in the northern Barents Sea and in the Eastern Eurasian Basin (their Fig 12). They did show a correlation coefficient of 0.41 for the Barents Sea lagging by 1 yr and state that this correlation is significant (stating the way this was determined in their methods). They did not, however, show any relation (or lack thereof) to the Fram Strait inflow. We adjusted the text to reflect the fact:
"Although they do not show any clear link to the Fram Strait imports, they find a small but statistically significant correlation between observed salinity in the Eastern Eurasian Basin halocline and the northern Barents Sea upper water column."
4) P. 15, l. 323: Please define surface waters: this percentage depends heavily on the thickness of the layer.
This sentence has been changed to read, "On average, 10% of the Arctic surface waters are made up of meteoric waters (shallower than ~200 m depth; see Forryan et al. 2019, their figure 5b) and this number . . . ".
5) Same page, line 325. I tend to disagree with the statement that the wind is largely responsible for the subsurface horizontal redistribution of freshwater. If subsurface is defined as halocline, the circulation in the halocline is more like circulation in the Atlantic water layer and not the surface mixed layer. It is more complex and has a strong impact of topography and density.
The role of the wind and other components of the climate system is extensively discussed in this section. To avoid repetitions, we rephrased:
"The wind also contributes to vertical redistribution via wind-driven up and downwelling."

Anonymous Referee #3

General Comments:

1) Overall the paper seems incomplete and lacking in thoroughness.
   Thank you for this comment. We have worked very hard to include a more thorough analysis of Arctic Ocean FWC for the 2010s relative to the 2000s using ORAs, previous studies, in-situ and satellite measurements.
2) I found it hard to reconcile the time series of Beaufort Gyre and whole-basin FWC with prior studies, particularly over the major freshening event centered on 2005-2008. In Figure 3, the increases in FWC for the whole-basin and Beaufort Gyre are virtually the same. Nothing in the time series records for the reviewed processes is shown to explain this change. Other studies have found that the increase in FWC in the Beaufort Sea is offset by decrease in FWC in the rest of the Arctic Ocean to the extent that the increase in whole-basin FWC averages much less that Beaufort Sea FWC increase. Why is there this departure from past results? The authors don't recognize this question, and the author's FWC results are given with insufficient background on the hydrographic data distribution and details on the remote sensing to tell us.
   The timeseries of FWC for the whole basin to the 34 isohaline is extended from Rabe et al. (2014). Details of the mapping procedure and the distribution of hydrographic stations is given there until 2012. Further data is based on the data sources listed in Table 2 of the revised manuscript. We have added the table and a reference to Table 2 in the caption of Figure 3. The timeseries will be updated in the future by adding further data sources and published elsewhere.
   The two timeseries in Figure 3 do not show the same trend from 2002 to 2015, indicating that the remainder is contributed by the rest of the basin outside the Beaufort Gyre (BG). It is further clear that the Beaufort Gyre dominates the increase in FWC, even though a significant increase is seen also outside the BG.
   References:

   Rabe, Benjamin; Schauer, Ursula; Ober, Sven; Horn, Myriel; Hoppmann, Mario; Korhonen, Meri; Pisarev, Sergey; Hampe, Hendrik; Villacieros, Nicolas; Savy, Jean Philippe; Wisotzki, Andreas (2016): Physical oceanography during POLARSTERN cruise PS94 (ARK-XXIX/3). Alfred Wegener Institute, Helmholtz Centre for Polar and Marine Research, Bremerhaven, PANGAEA, https://doi.org/10.1594/PANGAEA.859558
   Roloff, Albrecht; Rabe, Benjamin; Kikuchi, Takashi; Wisotzki, Andreas (2015): Physical oceanography from 49 XCTD stations during POLARSTERN cruise PS87 (ARK-XXVIII/4). Alfred Wegener Institute, Helmholtz Centre for Polar and Marine Research, Bremerhaven, PANGAEA, https://doi.org/10.1594/PANGAEA.853770
   Vogt, Martin; Rabe, Benjamin; Kikuchi, Takashi; Wisotzki, Andreas (2015): Physical oceanography from 15 XCTD stations during POLARSTERN cruise PS86 (ARK-XXVIII/3 AURORA). Alfred Wegener Institute, Helmholtz Centre for Polar and Marine Research, Bremerhaven, PANGAEA, https://doi.org/10.1594/PANGAEA.853768

3) Further, no comparisons of hydrography-derived FWC with satellite-derived FWC are done for identical regions and identical times. Such comparisons could rule out issues due to using the different data types.
   We address this issue by including the Arctic Ocean below 82.5N from satellites and use the same reference salinity of 35 psu for both satellite measurements and in-situ observations. In this way we can compare the satellite measurements with the in-situ observations and ORAs.
4) I can't recommend publication without a clearer and more thorough evaluation of the data approaches, a more complete review of past interpretation of the 2005-2008 freshening and a stronger set of conclusions.

The revised paper now includes a more thorough evaluation of the different data approaches by calculating FWC from satellites using the same reference salinity as the in-situ estimate, as well as, by including a spatial map of (2010-2017) minus (2002-2010) FWC from satellites to compare directly with the ORA results. A more detailed discussion of freshwater from Greenland Ice Sheet discharge is now included in Section 2.4. The conclusions are now based on a more thorough evaluation of the ORAs, previous studies, and new estimates of FWC from in-situ and satellite measurements.

Specific Issues

1) Line 55 -It seems like this should read more like S)S'/Sref) where S'=S- Sref Line 85 - The Tsubouchi result is interesting. One might think the problem using a fixed reference salinity is dwarfed by the problem of hydrographic data coverage. The authors don't explain their remote sensing approach, but might be noteworthy if the remote sensing of FWC with ocean bottom pressure versus dynamic ocean topography is really a measure of steric pressure, which for the Arctic Ocean correlates well with FWC relative to a fixed Sref.
   Salinity anomaly is now denoted with "δS". We agree with the reviewer that the problem of using a fixed reference salinity is dwarfed by the lack of coverage in the hydrographic observations. We have included a detailed discussion of the remote sensing approach in Section 1.1.
2) Line 119 - One might add: For example, Rabe et al. (2011) and Morison et al. (2012) found that from the early to late 2000s, the increased deep basin freshwater content in the BG was largely balanced by a decrease in the rest of the Arctic Ocean.
   Thank you, this sentence has been added.
3) Lines 120-127 - The differences between the models is significant, especially in Fig. 2b. Is this caused by using S=34.8 as a lower bound for the integration. It seems like this would be a problem particularly if the distributions of Atlantic water on the shelves are different between the models.
   The reviewer is right to comment on the model disagreements outside of the Beaufort gyre. We agree that inconsistencies in the representation of the incoming Atlantic water *may* explain why there is little agreement on the Eurasian Basin freshwater changes yet strong agreement in the Beaufort Gyre (where the Atlantic water has less influence). In response to this and other comments, as well as to further analysis, we can no longer conclude that the Beaufort gyre freshening is being compensated by FWC decreasing elsewhere in the Arctic. Future work will be necessary to understand the model differences.
   Also, although nearly all the models show a freshening in the BG, many show no changes at all in the large regions of decreasing freshwater content described by Rabe et al. (2011) and Morison et al. (2012).
   These two referenced studies both identify "large regions of decreasing freshwater content" in the Eurasian basin observations specifically for the latter half of the 2010s*. Given their target period is different and shorter than ours, a direct comparison is difficult. We also note the two datasets used in (Rabe et al, 2011) do not agree on the FWC trend in the Eurasian Basin, with observations finding weaker FWC decrease than the model used. Therefore, it is difficult to suggest there was previous agreement on FWC trends outside of the Beaufort Gyre.
   Moreover, these two studies do not show data for FWC trends for the shelf regions on the Eurasian side of the Arctic Ocean. We have altered the scale in Figures 2b&c, which now show decreasing freshwater content in these shelf regions in all but one model. This decreasing trend is relatively weaker than the freshening of the Beaufort Gyre but is a

feature which the models agree mostly agree on. Morison et al. (2011) studied the trend in the latter half of the 2010s, using satellite and in-situ data and a reference salinity of 34.87. Rabe et al. (2011) meanwhile studied the latter half of the 2000s compared to the 1990s, using satellite and model data and a reference salinity of 34.

4) Line 145 - Measuring freshwater content change from altimetry and GRACE ocean bottom pressure was earlier described and validated with repeat hydrographic measurements by Morison et al. (2012)

   We thank the reviewer for pointing out the study by Morison et al., 2012. We have included this reference in the revised version of the manuscript. (Line 144-145). "The methodology which exploits the satellite derived ocean mass change and satellite altimeter data has been detailed in Gilles et al. (2012), Morison et al. (2012), and Armitage et al. (2016).

5) Lines 154-166 - Caption for Fig 3 says nothing about GRACE OBP. Was it used in Fig. 3 or not?

   Yes. We thank the reviewer for correcting the mistake in the figure caption. "Anomalies of freshwater content (in 10^3 km^3) in the Beaufort Gyre from satellite sea-surface height data analysis and **GRACE OBP data** (green) and in the whole Arctic Basin from objectively mapped in-situ hydrographic observations (blue).

6) Figure 3 and discussion of same - The BG record is said to be from altimetry and the whole basin is from hydrography. That's understandable given the time spans, but unfortunate. In recent years particularly, hydrography from the BG is plentiful but in situ observations, are few in the Amundsen, Nansen, and Makarov basins where we expect freshwater content has declined as BG FWC has increased. It would be helpful to compare satellite derived and hydrography derived FWC for identical BG and whole- basin regions to test the methodologies. It would also be illuminating to do the remote sensing comparisons over the whole basin including the Russian shelves where prior results and the modeling results of Figure 2 suggest decreased FWC acts to balance Beaufort Gyre FWC increase.

   As explained in the text (Section 1.1), the altimeter data is not readily available in ice-covered areas. We have added FWC for altimeter data below 82N. FWC for the whole basin is not advisable due to the large uncertainties associated with the altimeter data in polar region, especially above the latitude band of 82N resulting in the polar gap (see Figure 1 in Raj et al., 2020).

7) Figure 3. As stated above, his result, specifically the correlation of the increase in BG and whole-basin FWC from about 2004 to 2008, does not agree with the findings of Rabe et al. (2011) and certainly Morison et al. (2012) who found that the increase in BG freshwater over that time was largely compensated by decreasing trends in FWC in the Nansen, Amundsen, and Makarov basins, so much so that the whole deep basin average FWC trend could be accounted for by the loss in resident sea ice. In Fig. 3, the whole-basin FWC change around ~2007-08 seems biased by the relative lack of observations outside the Beaufort Gyre to look like the BG FWC change. The result would be more convincing if we were given information on spatial sampling and possible sampling biases. Also the same-area technique comparisons mentioned above might make the result more credible.

   Rabe et al. (2011) did not conclude that the FWC in different parts of the Arctic compensated around the middle of the 2010s. In fact, their Fig. 2 shows an increase in FCW inventories almost everywhere in the basin, between the time periods 1992-1999 and 2006-2008 (only JAS).

   Neither did they conclude that the increase in the FWC "could be accounted for by the loss in resident sea-ice". Sea-ice is potentially subject to enhanced melt but also decreased freeze-up and increased export. Rabe et al. (2011) only concluded that sea-ice melt and increased river water inflow partly caused the FWC changes, that were dominated by decreasing average salinity in the Polar Mixed Layer and Upper Halocline, rather than a change in the thickness of that layer. Please see Haine et al. (2015) for a complete review of the potential relation between liquid and solid FWC. Multiple "sources" of liquid FWC increase are mentioned there, including changes in Precipitation-Evaporation, sea-ice melt and changes in the imports / exports through the various Arctic gateways. The bottom line is that it's not possible to identify the single most significant source due to errors in the source data. The data coverage during 2007 and 2008 was particularly good across the whole Arctic basin, due to various IPY-related ship expeditions and deployments of autonomous ice-tethered CTD profilers. Please see Rabe et al. (2014) and Rabe et al. (2011) for a discussion of mapping errors related to data coverage.

8) Line 275 to 277. How does melt from Greenland get into the deep Arctic Basin? Virtually all the flow around Greenland is nominally southward, away from the Arctic Ocean.
   It is true that the majority of the runoff from Greenland flows south, however, more than 40% of the Greenland ice sheet drains north of 79 degrees (Hill et al., 2018) where both solid and liquid runoff are expected to impact the Arctic Ocean basin more directly and we therefore consider it worthwhile to include and highlight in the paper. We therefore also update the work of previous studies to look at the change in the recent decade. We have updated the Greenland ice sheet section to focus on the ice flux from this northern region in particular.
   Ref: Hill, E. A., Carr, J. R., Stokes, C. R., and Gudmundsson, G. H.: Dynamic changes in outlet glaciers in northern Greenland from 1948 to 2015, The Cryosphere, 12, 3243–3263, https://doi.org/10.5194/tc-12-3243-2018, 2018.
9) Line 278 - IMBIE?
   Added to line 278, “The Ice sheet Mass Balance Inter-comparison Exercise (IMBIE)...
10) Lines 320-322 - Eddy fluxes have little to do with stabilizing the BG. Rather the feed- back driven by the difference between surface geostrophic velocity and ice velocity balanced against dissipation by internal ice stress stabilizes the gyre at a time scale that is a small fraction of that due to eddy fluxes. See: Dewey, S., et al. (2018). Arctic ice-ocean coupling and gyre equilibration observed with remote sensing. Geophysical Research Letters, 45. https://doi.org/10.1002/2017GL076229.
   We added the reference suggested by the reviewer and rephrased our reference to Zhong et al. (2019):
   “Recent studies suggest that the Beaufort Gyre has stabilised or reached a new normal high-freshwater content state. Dewey et al. (2018) attributes this to a switch from a system driven by surface ice- and wind-stress that affects a passive ocean, to one where it is the ocean that drives the ice (often in the absence of wind). Zhong et al. (2019) in contrast attribute it to higher energy input to the ocean, and suggest that the transition is not complete, i.e. the Beaufort Gyre is not ”saturated” yet. Zhong et al. (2019) further concludes that the recent increase in cyclonic activity reduces this energy input, and hence should result in future decrease of freshwater stored in the Beaufort Gyre.”
11) Lines 325-327 – The authors had better define what they mean by upwelling. Some, as seemingly here, mean upwelling in terms of what happens at the coast or surface (anticyclonic means upwelling) and some define it by what happens to the pycnocline in the center of the gyre (anticyclonic = downwelling).
   Note that the first sentence has been modified in response to a comment by reviewer 2. We here meant coastal upwelling, as the reviewer noticed. We added this precision:
   “The wind also contributes to vertical redistribution via wind-driven <u>coastal</u> up and downwelling. On average, only the Laptev and Kara are dominated with downwelling; the rest of the Arctic, especially the Amerasian basin, is upwelling dominated (Williams and Carmack, 2015).”

Summary Section

1) I can agree that FWC content may have stabilized after 2010, but for reasons mentioned earlier, I don't think the changes in FWC 2005-2008 for the whole basin and the BG should be so similar.
   We have added a time series of satellite measurements in the Arctic Ocean below 82.5N, not including the Barents Sea because our methodology does not provide the best results in regions where the thermosteric component plays an important role in the steric sea level variability. Interestingly, these FWC estimates for the two regions produce similar FWC for 2005-2008. It is only after 2009 that these two time series diverge, indicating increased compensation after 2009.
2) I can believe the ice is more mobile in recent years, but I don't understand how Greenland melt has any effect on Arctic Ocean FWC.
   This is explained in detail in the response to Specific Comment #8 and in the revised paper Section 2.4. It is true that the majority of the runoff from Greenland flows south, however, more than 40% of the Greenland ice sheet drains north of 79 degrees (Hill et al., 2018) where both solid and liquid runoff are expected to impact the Arctic Ocean basin more directly and we therefore consider it worthwhile to include and highlight in the paper. We therefore also update the work of previous studies to look at the change in the recent decade. We have updated the Greenland ice sheet section to focus on the ice flux from this northern region in particular.
3) The paper does not cover regional variability very well.
   We address this issue by including satellite estimates of FWC in the Beaufort Gyre and the total Arctic below 82.5°N, and a spatial map of (2010-2017) minus (2002-2010) FWC from satellites.

Response to comment posted by Ursula Schauer:

We agree that it is necessary to use sound absolute quantities in scientific research and that there are ambiguities in using the freshwater fraction concept. However, we have already explicitly addressed SC1's point in our manuscript: we discuss the matter in the Introduction (LL 53-89), which includes reference to the reviewer's own 2019 publication. This is a review paper and most studies on this subject use the freshwater fraction concept, so we do the same in our manuscript when assessing these studies. Tesdal and Haine (JGR 2020, their section 2.3) confronted the same question and reached the same conclusion as us.