

Interactive comment on “Global sea level reconstruction for 1900–2015 reveals regional variability in ocean dynamics and an unprecedented long weakening in the Gulf Stream flow since the 1990s” by Tal Ezer and Sonke Dangendorf

Anonymous Referee #1

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Review of Ezer and Dangendorf, "Global sea level reconstruction for 1900-2015 reveals regional variability in ocean dynamics and an unprecedented long weakening in the Gulf Stream flow since the 1990s".

The paper creates two Gulf Stream proxies from a reconstructed sea level dataset (RecSL), compares these against observations (validation), and analyses for trends and relationship to coastal sea level.

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I think it's a great idea to analyse this dataset for these purposes. I found some of the validation very compelling and some unfulfilling. I thought the coastal sea level section was under-explored.

I found the structure confusing and suggest it could be rearranged so that validation is separate from the deeper investigation and implications.

This does require major work but, with this, the paper will make an interesting contribution to the literature.

Major comments:

I found the validation of the GS-SAB proxy very compelling (Fig 9b) but much less so the GS-MAB. The GS-MAB proxy as presented does not simply show strengthening/weakening and movement in the position of the GS or broadening of the GS is not considered. For the former, there are long datasets that could have been compared with e.g. Taylor et al. (1998) and Joyce et al. (2000). Better validation of this index and what it represents would make the conclusions more compelling.

The link to coastal sea level could be investigated further. How may your findings be useful for coastal management? I thought the closer correspondence of the index to the coastal sea level at modes of lower variability could be very important. Bingham and Hughes (2009) presented the idea of 1 Sv : 2 cm. How does your reconstruction relate to this? Could this be indicative of differing ocean processes being important in communicating offshore sea level changes to the coast on different timescales?

Structure: validation should precede the implications.

Minor comments:

177. How would differing modes, not captured in the satellite era, impact the reconstruction?

189-94, a map illustrating what you have done would be useful here. This would be

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beneficial to show the mean SSH from the reconstruction and to compare with the satellite ssh. This would give a better indication to the reader what has been used.

l167-169, you haven't shown us the path of the Gulf Stream. This could simply be a northward shift of the current. There are many papers on the GSNW that discuss this mode of variability. Also, you need to consider whether the GS is weakening or broadening (Dong et al., 2019 – which you cite). The GS could be just as strong but not as narrow.

l196-198, your reference list here is misleading. H&R (2004) showed a strengthening of the AMOC, Dong et al., only spoke of the GS.

This could be a useful indicator but isn't investigated sufficiently accurately.

Conflation of GS and AMOC.

l212-213, what method was used for calculating the degrees of freedom and correlation?

l281, is this your MAB GS proxy?

Fig. 9 b. I find this a very compelling figure.

More updated references for RAPID should be considered: Smeed et al., 2018: <https://agupubs.onlinelibrary.wiley.com/doi/full/10.1002/2017GL076350> Moat et al., 2020: <https://www.ocean-sci-discuss.net/os-2019-134/>

References:

Taylor, A. H., & Stephens, J. A. (1998). The North Atlantic Oscillation and the latitude of the Gulf Stream. *Tellus A*, 50(1), 134–142.

Joyce, T. M., Deser, C., & Spall, M. A. (2000). The relation between decadal variability of subtropical mode water and the North Atlantic Oscillation. *Journal of Climate*, 13(14), 2550–2569.

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Bingham, Rory J., and Chris W. Hughes. "Signature of the Atlantic meridional overturning circulation in sea level along the east coast of North America." *Geophysical Research Letters* 36.2 (2009).

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