

Interactive comment on “Increasing turbidity in the North Sea during the 20th century due to changing wave climate” by Robert J. Wilson and Michael R. Heath

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General comments The authors relate historical observations regarding water transparency (Secchi-disk depth) with calculations of shear bed stress based on model hindcast simulations. By this, they demonstrate that increased mobilization of suspended particulate matter is a major driver for the negative trend in transparency that was observed in the last century in the area of the North Sea. I really like the concept and the idea of the paper. Although the trend of decreasing overall transparency in the North Sea over the last century is already known (as the authors show well with their comprehensive literature review), the reasons and drivers remain largely speculative to

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date. In this respect the current work contributes to understand some of the underlying processes. However, in some cases, the conclusions drawn are not always supported clear enough by the data shown. In this respect, I would recommend improvement of the manuscript. Hopefully, the remarks and questions below are helpful in this context.

Introduction: As I understand the linear regression given in Håkanson (2006), it shows a linear relationship between the log values of SPM concentration and Secchi disk depth. Thus, changes in one parameter are transferred logarithmically to the other. Therefore, I would be careful with the “20 % increase in SPM” statement (also in the discussion), inasmuch as it is based on the average decrease in Secchi disk depth Capuzzo et al. found.

Methods: Page 3, Line 4: Does diffusivity play really a role in this context? If so, please elaborate a little bit more on that and/or give a citation. Page 3, Line 7: What is the rationale behind the 0.5 °C difference as threshold for a stratified water column? If this is a common value, please refer to the appropriate literature. Page 3, Line 27+: Could you explain why you are using two different datasets for calculating bed shear stress hindcasts? Wouldn't it be better to use the larger one in terms of being consistent in the data over the whole period (although missing the years 2011 to 2017)? Page 4, Line 26: What means “Core data analysis” in this context?

Results: Page 5, Line 8-9: From my point of view, the seasonal pattern is not readily visible in Figure 1 (right). Page 6, Line 3-4: That the relation is positive is not visible from the R^2 values given in Figure 2. Maybe refer also to Figure 3 at this point. Furthermore, I would soften the statement “across almost the entire study domain”, because even when the water column is mixed, there are some exceptions (as also stated by the authors). However, beside the two plume regions mentioned, also the English Channel, the Irish Sea, as well as the whole British east coast appear poorly impacted by the shear stress in terms of SPM. Page 7, Line 1-5: If the relation between shear bed stress and SPM is decoupled in the stratified season, what are then the drivers for the Secchi-disk decline in these months? Or is in this season also the decline in Secchi-

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disk depth lower? If so, the authors could refer to the appropriate literature or show the respective data. Page 7, Line 10+: Maybe incorporate the change in the trend into the main manuscript, as it is interesting and contributes to the whole story. Page 9: The authors emphasize the strong decline in Secchi-disk depth south of 53°N (Figure 4, right side), and explain it with an pronounced increase in shear stress across the region. However, according to the left side of the figure, I cannot see that the decrease in Secchi-disk depth at this point correlates to an increase in bed shear stress, which appears to be relatively small in this area (approx. 0-20%). However, as in this area the East Anglian plume as well as the plume of the Rhine is present, I would rather think that the decline in Secchi-disk depth here might be controlled by changes in e.g. river outflow (as stated by the authors before). Nevertheless, for the Northeastern part of the area (53-56°N, 4-8°E) the relationship appears to be valid, although the number of data points is comprehensively small.

Discussion: Page 10, Line 13-14: I think this statement is too strong. Instead I would claim that according to the data available shear bed stress is probably an important parameter in order to explain the transparency decrease in the last century. Page 11, Line 12-18: Maybe some of the discrepancies could also be explained by a seasonally variable contribution of the organic (e.g. phytoplankton) part of SPM. Turbidity is also influenced by the presence of pelagic phytoplankton.

Minor comments Page 3, Line 14-15: Check the brackets for the reference. Page 6, Line 1: “and SPM” after bed shear stress appears to be doubled. Page 7, Line 7: Maybe replace “bed shear stress and SPM” with “the two parameters” to avoid doubling of the terms with the begin of the sentence. Page 11, Line 9 + 13: “in situ” instead of “in-situ” Caption Figure 1: In the text is stated that the bed shear stress calculations are calculated after Soulsby & Clarke (2005), but in the caption stated Soulsby (2006). Please explain or correct. Caption Figure 4: “Century” or “century”; please keep consistent

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