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Discussions

Interactive comment on "Relations of physical and biogenic reworking of sandy sediments in the southeastern North Sea" *by* Knut Krämer et al.

Anonymous Referee #2

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This manuscript provides an interesting measurement of biological reworking of benthic sediments at six locations in the North Sea. The authors used DEM measurements with shear stress calculated from ADCP measurements to observe changes in the seabed morphology on very small scales. With shear stress below a critical erosion, these changes are attributed to biological reworking of sediments, and is quantified. These are interesting and novel measurements.

I found the explanation of physical processes and calculations to be over simplified and missing information. This analysis relies on all changes in the sediment mapped to be due to biogenic reworking when the bed shear stress is below a critical threshold, no discussion is present about the intermittency of sediment transport below a the critical shear stress. Equations demonstrating the physical methods as well as plots showing

these measurements would help to clarify the work done. I would also like to see plots of physical parameters: tides, waves (Hs, DPD) to put the short-term benthic lander measurements into an environmental context.

There is no discussion of error or uncertainty.

I found the manuscript disjointed - e.g. the biogenic reworking was compared to temperature, velocity, grain size, without any introduction to how these things influence reworking. The measurements are novel, but in this state the manuscript reads as a compilation of measurements instead of a strong scientific story.

Further line-by-line comments below:

pg 1, 8 - The measured biogenic reworking rates reach up to 14% of physically driven reworking via bedform migration.

Reword this sentence, I initially read it that the biogenic processes are driving bedform migration.

(!) 2, 17 - I don't like this....

pg3, 2 - What about the bed below 40m depth? Your measurements extend to 48m.

pg3, 5 - Morphological features at the deeper stations with weak bottom currents and beyond the reach of surface waves are of mostly of biogenic origin.

Is there a seasonality to the morphological features? I would expect that at least part of the year 40 m would not be below the depth where surface waves are felt.

pg3, 12-20 - I feel that this paragraph repeats some common assumptions about waves and wave-resuspension in shelf seas that require justification. Specifically, "Wave-induced shear stresses therefore usually do not reach supercritical conditions for sediment motion from late spring to early fall." Work in the much-deeper Celtic Sea by Thompson et al. (2017) showed persistent tidal resuspension, and of more importance here - showed wave orbital velocities at $\sim$100m depth even in August. If this work hinges on waves not being important to sediment movement in 20-40m in the North Sea in summer, analyses need to be present to show that this assumption is reasonable. The very basic rule-of-thumb is that if you assume linear waves, the wave will be 'felt' at the depth of half of the wavelength of the surface wave. From Grant and Madsen (1986): "The surface wave velocity and pressure fields penetrate to the seabed only in water depths less than about half their wavelength (e.g. Madsen 1976). For example, a 12-s wave, generally in the swell band, will penetrate to the bottom in 112 m of water or shallower, whereas a 6-s wave, typical of the wind-sea band, will penetrate to only 28 m or shallower." You can use

pg3, 26 - The activity and migration rate of ripples is mainly controlled by the magnitude of tidal flow, varying over the spring-neap cycle. Although they may not often become the dominant driver in ripple generation, the stirring effect of waves facilitates ripple migration.

This needs justification. Waves and currents both form ripples, and I'm not convinced from your previous paragraph that waves have been systematically discounted.

pg3, 28 - Citation? What about the relationship between mud content and ripples? E.g. Lichtman et al. 2018, Baas et al. 2013, 2016, Malarkey et al. 2015.

pg5, 3 - What is the formula used? I can't find reference to a critical shear stress equation from Soulsby (1997) used in Kramer and Winter (2016). Is the sediment distribution unimodal? A bimodal distribution can give you a nonsense d50, and might alter how sediments are mobilized (e.g. McCarron et al. 2019). Here you reference critical shear stress at tau_crit, but in the figures it is tau_cr, make it consistent.

pg5, 29 - How do you know you have caught all the organisms in your calculations?

pg7, 6 - Why wasn't there biogenic reworking in the other eight deployments?

pg7, 15 and elsewhere where values of R_bio are reported - What are the error bounds on these measurements?

pg7, 25 - Again, a qualitative assessment of waves vs. tidal suspension is missing. In Figure 5 waves are relevant. What were the oceanic conditions there compared to Figure 6? I would like to see figures of tides and waves instead of just text saying, "neap tide" or "wave action."

pg8, 2 - How do you know you masked correctly? Again, some calculations of the error in these values and in the approach is necessary.

pg8, 10-14 - Why isn't the sediment consolidated if the shear stresses are low? I would think this would be representative of a region with constant resuspension.

section 4.4 and pg12, 25- Why these parameters? Why not species composition, mud content, some metric of food availability? Are the currents the tidal currents? What about wave-induced currents? Your data show tidally variable conditions, please justify tidally averages here. Your figure 3 showed a period where ripples were obviously created, some the time variability in these measurements seems important, especially in u.

Pg. 17, Figure 1 caption: "Letters A-J" suggests these are inclusive of all letters, but C, D, H, and I are not present/used here. Rephrase: "The six stations with letters A, B, E, F, G, and J..."

Figures 4 - 8: I see here that your calculations of wave stress are indeed low except for one figure. In the introduction you discount waves as relevant, but it would be more appropriate to include their effects and show here in the results that in most cases wave-induced bed shear stress is very low. On that note, is there bias in the conditions of these measurements? I would assume limitations with the ship and cruise schedule probably biased toward calmer conditions.

The highest value of tau looks to be around 0.6 N/m2 so the axis doesn't need to go to 1 N/m2 - it creates empty space when better resolution of the figure would be nice. I think the purple is over the red line in most cases, but this is an inference. Please improve these plots so it is obvious what is being shown - i.e. it could be either the blue or red line that is hidden by the purple.

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