Dear Dr. Bagaev,

Thank you for your review of our manuscript. Please find in the following our responses to your comments. We repeated your comments in bold and you can find our response in italic.

1. Please specify what makes it possible to consider your model particles as microplastics. It might also be better to separate the description of the experiments from their interpretation and application to MPs transport prediction.
Our aim of this study is to investigate in how far the uncertainty in the representation of extreme storm events in metocean data for the Baltic Sea affects the uncertainty in the transport of sediment and MP. For this purpose, we simplified the representation of MP in the model. The idea of using a sediment transport model for transport simulations of MP is motivated by the cited studies. As a simplification, we assume that the plastic particles have a spherical shape and a density defined by the two high density plastic types (PVC and PET). Based on these simplifications, there is additional uncertainty in the transport simulation resulting, for example, from non-optimal settling velocities and critical shear-stresses, but this kind of uncertainty was not to be quantified in this study. We show different kinds of experiments, and some of the experiments are motivated by the outcome of another. For this reason, we decided to keep the description of an experiment and its interpretation closely together to allow the reader to follow this logic.

2. The conclusion made in the last sentence in Abstract is poorly linked to the aim of the study and was hard to understand. Please clarify.
If forecasting a storm event with a state-of-the-art weather model, the location and intensity of a storm system is affected by uncertainties which originate from uncertainties in the initial conditions, lateral boundary conditions and the model physics. The purpose of this study is to investigate if these uncertainties also affect the location of areas where material during/after the storm event is eroded/deposited, because in the different representations of the storm (ensemble members), its track varies in its position. The study indicates that the uncertainty in the storm representation is affecting the amount of transported material, but the location of erosional and depositional areas keeps nearly constant in the study area (changes only in size because of more or less erosion). This means that the model chain can be used in forecast mode to predict areas where erosion/deposition takes place. This allows for a strategic planning of measurement campaigns, because the model can be used to identify regions in which we should take samples. We will make this clearer.

3. Introduction, 2nd paragraph: again two poorly linked sentences. It is not clear how the models can complement field measurements.
As explained for the previous comment, the model chain allows for identifying regions in which erosion/deposition should take place. Our aim is not complementing the measurement campaigns, but to have a tool which can be used to identify sample regions beforehand. The proposed model helps to identify regions in which larger amounts of high-density MP is potentially deposited. This allows for a more specific planning of measurement campaigns.

4. 4th paragraph: too many assumptions made unexpectedly for the reader. Maybe there is a need for more references. New assumptions could be formulated in the Methods section. The interest of this study is not mentioned anywhere in Abstract.
We apply a simplification of a MP transport model to study the impact of the metocean uncertainty on the sediment and MP transport. Aim of this study is to investigate, whether this uncertainty affects the location of erosional and depositional areas. The application of the sediment transport model is motivated by the cited articles. We will make it clearer that the parameters for the MP transport are simplified and better motivate the purpose of the study, a decision support tool for measurement campaign planning.

5. Lack of references to existing models. For example: Ballent, A., Pando, S.,Purser, A., Juliano, M. F., and Thomsen, L.: Modelled transport of benthic ma-rine microplastic pollution in the Nazar Canyon, Biogeosciences, 10, 79577970, https://doi.org/10.5194/bg-10-7957-2013, 2013.Nicole Kowalski, Aurelia M. Reichardt, Joanna J. Waniek Sinking rates of microplasticsand potential implications of their alteration by physical, biological, and chemical-factors, Marine Pollution Bulletin, Volume 109, Issue 1, 2016, Pages 310-319, ISSN0025-326X, https://doi.org/10.1016/j.marpolbul.2016.05.064.A. Bagaev, A. Mizyuk, L. Khatmullina, I. Isachenko, I. Chubarenko, Anthropogenicfibres in the Baltic Sea water column: Field data,

laboratory and numerical testingof their motion, Science of The Total Environment, Volumes 599600, 2017, Pages560-571, ISSN 0048-9697, https://doi.org/10.1016/j.scitotenv.2017.04.185.If the transport of the MPs in the marine environment could not be investigated with the existing models, please explain.

The studies that we know so far use a deterministic representation of the metocean conditions for the transport simulations, i.e. they calculate MP transport under the assumption that the wind conditions were exactly known. They focus on parameters like the settling velocity, for example. These parameters for the transport model are simplified in our study, instead we use probabilistic metocean data. We mentioned in the conclusions that for a better prediction of the MP transport, we would have to improve the parameters for the MP transport model. The existing studies would also get an additional source of uncertainty if applying probabilistic instead of deterministc metocean data. We will add references to existing models and make the difference and the different focus to existing studies clearer.

6. Why exactly do you prefer to use the Eulerian approach?

The idea is to apply a sediment transport model, because these models are widely used in coastal engineering for example. The physics described by Eulerian and Lagrangian models is the same, the difference is just the numerical implementation. So when a sufficient spatial resolution / number of particles are used, it shouldn't make a difference which method is applied.

7. Both papers Khatmullina Isachenko and Waldschläger Schüttrumpf report settling velocities for still fresh water. Please explain the applicability of their results to salt (brackish) turbulent marine water. How exactly do you use those formulas for the settling velocity?

We use the Stokes formula as a simplification for the settling velocity. In an improved version of the model, the settling velocity could be represented by the mentioned articles. For example, we could use an ensemble approach based on different parameters to represent the uncertainty in the settling velocity, or define different fractions of the same plastic particle with different settling velocities based on the distribution of the particle shapes. A combination of the ensemble of metocean conditions with a representation of the uncertainty in the parameters for the MP transport (settling velocity, critical shear stress) would improve a forecast of MP transport processes.

8. You have not mentioned the values of critical sedimentation/resuspension shear stress and settling velocity for your particles. It might be useful for the future studies and the experiments reproduction.

These parameters do not have constant values since they depend on sea water viscosity. We, however, give example values for 10° C water in a new appendix section now.

9. It is important to explain why you use 10 and 330 mkm as the size of the particles, which is not common for MPs studies.

These diametres are motivated by a study for the North Sea (Stuparu et al., 2015). In this way we have MP particles which correspond to a relatively fine and coarse sediment fraction. We will include this information in the text.

10. Page 4: final paragraph - is really hard to understand. Please clarify.

The uncertainty of weather forecast originates in uncertainties in the initial conditions, the lateral boundary conditions and the representation of the model physics. For processes which cannot be explicitly resolved by the model resolution, parameterizations are used. We use stochastic perturbations of these parameterizations. The methods applied here are standard methods used at various operational forecast centres. The cited study tested to use initial conditions from an ensemble of data assimilation. In this way, the uncertainty in the initial conditions will lead to differences (spread) between the ensemble members already in the first model time steps. In the presented approach, it needs some time until the stochastic perturbations provoke differences in the members.

11. Page 9, line 19: findings indicate that bathymetry has predominant impact, how exactly do they do this? Is this statement somehow new compared to the results of Enders et al, 2019? I think that Fig. 13 might help you to highlight the new findings.

The motivation of this article is to investigate the impact of metocean uncertainty on the transport behaviour of MP. The finding in the presented study is related to this uncertainty, which is a result of the uncertainty *in the metocean data used to drive the sediment transport model.*

12. The authors found that with the decrease of MP density and size the ability of models to predict their transport decreases. I think this result is sufficiently supported by the experiments and should be stated more clearly! In fact you showed that small and light MPs (so called nanoplastics) are being driven by waves, while MPs (0.5-5mm) are affected by hydrodynamics.
The study focuses on the uncertainty in the MP transport provoked by the uncertainty in the representation of a storm in metocean data. We found a larger uncertainty for smaller and lighter material, which shows that an ensemble approach is getting more important if one is interested in smaller and/or lighter particles. The uncertainty in ocean currents and waves also differs with particle properties. A short-coming of this study is the fact that there are no stochastic perturbations of the model physics of the ocean model. For this reason, the uncertainty in the hydrodynamics might be underestimated.

13. Page 11, lines 1 and 2 seems too obvious.
Our statements show that if one is interested in the modelling of very light and/or very small material, the uncertainty in the metocean forcing of the transport model becomes more important. We do not know any study taking this kind of uncertainty into account.

14. Page 14, budget methods please explain, what do you mean? The whole paragraph looks unclear.
A budget method relates (a) input and (b) output of a quantity to (c) changes in its mass, e.g. inside an area of interest. If two of the three values are known, the third one can be determined. The purpose of our study is a potential support for the planning of measurement campaigns. To be able to create a map of the sea-floor with MP concentrations, a better knowledge of concentrations entering the Baltic Sea is necessary. We assume a homogeneous distribution over the sea-floor. This is sufficient to see where potential erosion and deposition could take place. For a more realistic simulation, knowledge about the amount of material inside the Baltic Sea would be necessary. Then, the model could run for a longer period, and should approximate the distribution on the sea-floor. The error in the approximation will be size- and density dependent.
15. Conclusion section too many repetitions with the Introduction and methods.
We will revise the conclusion section and remove repetitions.

16. Important, but somewhat discussionable is the idea regarding possible future application of the chain of models for MPs sink prediction. Your findings are based on the numerical experiments with the spectral wave model and GCM models with 1 nm grid, which might be ok for the sediments, but MPs distributions show high patchiness and probably high mesoscale variability. Which means that your models might require higher spatial resolution in order to be able to determine possible accumulation zones for the samples collection (since in situ samplings of bottom sediments for MPs are usually sparse and low in volume).
Our interest is a decision support for planning measurement campaigns. This is why we are interested in regions where large amounts of material is potentially deposited after a storm event. We think that for this purpose, the resolutions of the models are sufficient. We are also able to nest specific domains with higher resolutions into the existing models. For the western Baltic Sea, we tested setups with 600 m resolution for the wave and ocean models and 1.4 km for the atmospheric part.

1 Appendix A: Mathematical description of the particle sinking and erosion model

Sinking velocity of the particles is initially calculated by the Stokes formula,

$$w_{Stokes} = \frac{gD^2}{18\nu}\frac{\rho_p - \rho_w}{\rho_w} , \quad (1)$$

where g is the gravitational acceleration, D is the particle diameter, ν is the kinematic viscosity of water, and ρ_p and ρ_w are the densities of the particle and the water. To correct for larger particles whose sinking velocity would be overestimated by the Stokes formula, a Newtonian correction is applied by an iterative algorithm:

- A Reynolds number is calculated as $Re = 0.64 w_{sink} D/\nu$.
- A relative drag coefficient is derived from this Reynolds number as $C_D = 18.5/Re^{0.6}$ following Perry and Chilton as cited by[Khalaf, 2009].
- The updated velocity is calculated as $w_{sink} = \sqrt{\frac{4gD}{3C_D}\frac{\rho_p-\rho_w}{\rho_w}}$

which can be understood as a weighted geometric mean between the two velocities w_{Stokes} and ν/D. This correction makes large particles sink slower than the Stokes formula suggests. We, however, erroneously applied the correction also to the small particles where it resulted in an undesired upward correction. This has no effect on particle erosion but accelerates redeposition, which may even lead to an underestimation of the influence of meteorological uncertainty for the small particles in our study.

Erosion takes place when the actual shear stress exceeds the critical shear stress. To determine the critical shear stress, we follow the Shields curve in its version which was corrected by [Soulsby, 1997]. First, we calculate the dimensionless particle diameter D_*, which relates the particle diameter D to a viscosity-determined length scale, following [Rijn, 1984]:

$$D_* = \sqrt[3]{\frac{g}{\nu^2}\frac{\rho_p - \rho_w}{\rho_w}} D , \quad (2)$$

where ν is the kinematic viscosity of water, ρ_p is the particle density and ρ_w is the water density. Then we calculate the critical shields parameter for non-cohesive grains, θ_{cr} (also dimensionless), following [Soulsby, 1997] as cited by [Ziervogel and Bohling, 2003],

$$\theta_{cr} = \frac{0.3}{1 + 1.2D_*} + 0.055 * (1 - e^{-0.02D_*}) . \quad (3)$$

The critical shear stress can then be calculated as

$$\tau_{cr} = gD(\rho_p - \rho_w)\theta_{cr} . \quad (4)$$

The actual shear stress is calculated from the wave-induced and the current-induced shear stress, τ_w and τ_c. The current-induced shear stress itself, however, is also modified

diameter (μm)	density (kg m^{-3})	sinking velocity (mm s^{-1})	critical shear stress (N m^{-2})
10	1275	0.15	0.006210895
330	1275	8.14	0.045142586
10	1400	0.20	0.009277999
330	1400	10.98	0.062337737

Table 1: Sinking velocities and critical shear stress in the model at 10°C.

the wave field, as it changes the bottom drag coefficient according to the DATA2 formula given by [Soulsby, 1997],

$$\tau_m = \left(1 + 1.2\left(\frac{\tau_w}{\tau_c + \tau_w}\right)^{3.2}\right)\tau_c \, , \tag{5}$$

where τ_c is the shear stress induced by the current in the absence of waves. Both of them are combined depending on the angle α between currents and waves,

$$\tau^2 = \tau_w^2 + \tau_m^2 + 2\tau_w\tau_m\cos(\alpha) \, . \tag{6}$$

If the actual shear stress exceeds the critical one, the deposited material gets resuspended with first-order kinetics, i.e. proportional to its mass in the sediment pool.

The actual values for sinking velocities and critical stresses depend on temperature since it influences sea water viscosity. Values for 10°C are presented in Table 1.

References

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[Rijn, 1984] Rijn, L. C. v. (1984). Sediment transport, part II: suspended load transport. *Journal of hydraulic engineering*, 110(11):1613–1641. Publisher: American Society of Civil Engineers.

[Soulsby, 1997] Soulsby, R. (1997). *Dynamics of Marine Sands.* Thomas Telford Publishing, London.

[Ziervogel and Bohling, 2003] Ziervogel, K. and Bohling, B. (2003). Sedimentological parameters and erosion behaviour of submarine coastal sediments in the south-western Baltic Sea. *Geo-Marine Letters*, 23(1):43–52.