

## Answers to comments and questions from reviewer 1

**Comment 1: Line 572 There is undefined concern for wakes leading to suspension of deep sediments at 30m depth. This needs clarification related to the spatial area that would be affected compared to the width of the wake. Then consideration of how large this effect really is compared to tidal or other causes of sediment movement. This could be important for water clarity, organisms sensitive to sediments, etc, but seems unlikely in such a shallow area. Please make more clear.**

We acknowledge that there is a need to clarify that the resuspension observed in this study was due to the surface Kelvin wake, and as the focus of the study is the turbulent wake, the resuspension from the Kelvin wake is considered outside the scope of this paper. To address this comment, the section about resuspension has been clarified and the effects of the ship-induced turbidity has briefly been related to natural phenomena such as swells and waves (line 611-623 in the pdf).

**Comment 2: Figures 4 and 12 show wakes overlaid with the thermal observations of the water surface. Could the authors estimate the total percentage of area that is covered by wakes in the images? What percentage influence due these wakes have compared to the size of the water body? What is the net heat flux or turbulence changes based on the percentage area covered over a day?**

Regarding the total percentage of area covered by the wakes in the image, that number could be calculated. But, as discussed further in the answer to comment 5, there are still uncertainties in the understanding of the coupling between the observed satellite thermal wakes and the vertical distribution of the turbulent wake. However, we acknowledge the interest in giving an estimate of the scale of the impact of ship-induced turbulence. We therefore suggest adding a comparison between the estimated mechanical energy supplied by ship propulsion in the Baltic Sea, and the energy input by winds to the upper surface layer (line: 538-564 in the pdf). We hope that this addition will be satisfactory in contributing an estimation of the scale of the impact.

Moreover, the heat flux is not the main concern here even though we show SST, but the focus is the internal mixing and redistribution of water within the water column. The intense mixing that happens locally and centred in the ship lane region will have a different impact compared with the turbulence changes averaged over the entire area. We are highlighting the extremes and patchiness of the ocean landscape, how anthropogenic activities contributes to this patchiness, and the importance of being aware of these varying conditions within a region for sampling/monitoring and management purposes. We therefore argue that the relative energy input estimation is more adequate to include in this study than an estimate of the heat flux for the entire area.

**Comment 3: Lines 15-16 The authors propose there is a lack of field data on turbulent ship wakes, yet so much research is published on ship wakes, what is the real need?**

We acknowledge that a lot of knowledge exists on turbulent ship wakes under idealized circumstances. However, there is a lack of field data on real turbulent ship wakes in natural stratified water. This is explained in lines 74-88 and in Table 1.

**Comment 4: Line 18. Depth of 32 m ADCP placement in an area with a maximum depth of less than 200 m. This information places ship wakes penetrating to a depth of 18 m.**

We acknowledge that the water depth at the Gothenburg and Bornholm study sites has not been related to the characteristic water depth in the area of interest. To contextualise how well the depth of the study site represent the conditions in the major ship lanes in the Baltic Sea, we have added information about the Baltic Sea and Swedish Westcoast water depth in section 2.1 (line 121-126). The stratification and water depth has also been mentioned in section 3.3 (line 559-564), to further clarify and contextualise the results. Moreover, as clarified in the answer to comment 6, here the term “deep mixing” is related to previously reported mixing depths and the stratification depth. The term “deep mixing” indicating a mixing deep enough to reach to/across the thermocline, which will be clarified as suggested in the answer to comment 6.

**Comment 5: Line 25. Length of wake is median 13.7 km to 60 km. => maximum of 1.75 hour longevity. Median wake width was 157.5 m without accompanying depth. Usually the wake turbulence rises with the bubbles, leading to a wider, thinner wake influence.**

We acknowledge that we have not included a vertical estimate of the thermal wake. As we did not measure the vertical extent of the thermal wake, we chose not to include it. Nevertheless, we agree that the vertical extent of the thermal wake in the 157.5 m width cross section, probably is not uniform (see further discussion in the next paragraph). One possibility could have been to use the measurements for the turbulent wake to estimate the vertical extent of the thermal wake. We chose not to, as these two methods measure different things: the bubble cloud and turbulent kinetic energy dissipation rate gives a direct indication of the turbulence in the wake and the turbulent wake; the thermal wake is a proxy of the water mass that has been mixed and affected by the ship-induced turbulence and is hence a measure of the wake (but not the turbulence)(as discussed in line 510-519). These measurements give information about different things but are both related to the spatiotemporal extent of ship wakes. However, we will clarify this distinction in the abstract (line 19-21), and it is clarified in the discussion (Line 651-664).

Regarding the shape and vertical extent of the turbulent wake, there are several factors that can affect the “shape” of the wake: environmental conditions such as stratification, currents and waves, as well as vessel related information such as number and rotation direction of the propeller(s), speed and vessel manoeuvring. However, neither the individual nor combined effect of these factors have been well studied, and from the authors experience the one thing we do know is that the shape and extent of the turbulent wake shows large variations. Therefore, we have refrained from general statements or assumptions regarding the vertical distribution of the thermal wake. However, we acknowledge the need for this knowledge, and it is the focus of the follow-up study to this first mapping of the spatiotemporal extent of ship wakes. Still, based on our current knowledge, and the observations made in this study, we suggest addressing this comment by further clarifying the different type of information we get from the thermal and turbulent wake observations, and explain why there is no vertical estimate for the thermal wake.

**Comment 6: Line 552 "deepest wake greater than 15 m" which is listed as "deep vertical mixing" for the Baltic Sea.**

We acknowledge that “deep mixing” is an expression that needs further clarification and contextualisation. In this context, the term “deep” was used in relation to previously reported mixing depths and in relation to the seasonal stratification depth. To address this comment, we have specified the specific depth instead of using the term “deep”. To contextualise how this depth relates to the depth and stratification depth in the ship lanes in the Baltic Sea, we have also added information about the general bathymetry and stratification depth. Regarding the comment for Line 552 (now line: 588), what was written was “depths greater than 15 m”, and not “deepest wake greater than 15 m”. However, there was clearly a need to clarify the meaning of “deep”, and we hope the suggested changes addresses the concern in a satisfactory way.

**Grammatical corrections:**

**The word "it" requires an antecedent noun, but is used without in the paper. The writing would be more clear if this was corrected, particularly to stop starting a sentence with the word "it". Lines 352, 469 – the sentences starts with the undefined word "it", while is 15 other occurrences, the words "it is" could be removed and the sentence made more clear. Line 391 – what does "it" mean in this sentence? Line 565 "though it is difficult" What is difficult? Line 351 – Reference Error.**

We would like to thank reviewer 1 for the overall constructive feedback and the suggested grammatical corrections. The use of the word “it” has been reviewed throughout the paper and exchanged/removed where appropriate. The other grammatical corrections have also been amended.