
Reviewer 2

This study examines the effects of sea surface temperature (SST) warming and urbanisation on typhoon hazards and risks in Shanghai, a city often prone to their effects. This is done by comparing WRF experiments with uniform SST warming and land use change for five recent damaging typhoons. The results show that typhoons increase in size with warming SSTs, making their associated wind and rainfall more hazardous. However, increases in urbanisation has little effect on the synoptic evolution of the typhoon, instead increasing the local rainfall due to increased surface roughness and moisture convergence. Overall, this manuscript is very well written, succinct, and easy to follow. The methodology, results, and discussions are all sound, and there is clear impact and relevance to disaster management. There is also a good discussion of the limitations and avenues for future research. I recommend this paper for publication after minor revisions addressing the following comments.

Reply: Thank you for reviewing our manuscript and for your constructive comments. We have addressed the specific points you raised, as detailed below. We hope that our responses and revisions satisfactorily address your concerns.

Reviewer Comment 2.1 — The authors suggest that a southward shift of tracks due to the Fujiwhara effect may reduce cyclone impacts in Shanghai. However, the case studies selected were only ones that impacted Shanghai to begin with. Is it possible that typhoons that would normally make landfall north of Shanghai will now directly hit Shanghai, resulting in greater effects? Some further discussion of this, particularly around lines 262-263, may be beneficial.

Reply: Yes, our results indicate that a southward shift in typhoon tracks under higher SSTs could increase the risk to Shanghai in two distinct ways. First, typhoons that would previously have passed north of Shanghai may now make direct landfall on the city, increasing wind and rainfall hazards. Second, even if typhoons that would have directly impacted Shanghai now shift southward, the increased size and intensity of these typhoons may still subject Shanghai to severe impacts, such as flooding and storm surges. We will extend the discussion around lines 262-263 to clarify these two scenarios and highlight that the overall risk to Shanghai may rise due to both potential changes in typhoon track and intensity.

Reviewer Comment 2.2 — Figure 9 presents differences between CTR and U3km for In-fa, however this seems to be largely a null result (i.e. no significant changes). Meanwhile, Figure S5 presents results that show substantial differences between the simulations, and these are discussed in the text. Because of this, I would suggest moving Fig S5 into the main body of the text, and Fig 9 into supplementary material. Some of the colour maps used in figures could be improved. Notably, a blue-red diverging colour map is frequently used where a sequential colour map would be more suitable. This applies to Figs 3, 5, 6, 8, 9, S1, S2 and S4.

Reply: Thank you for your suggestion. We will consider swapping Figure 9 with Figure S5 as suggested. In addition, we will evaluate and revise the color scheme in the other figures.

Reviewer Comment 2.3 — A study by Yin et al. (2021) has previously the effects of SST warming on typhoon hazards in Shanghai and could be included in the discussions. Yin, K., Xu,

S., Zhao, Q., Zhang, N. and Li, M., 2021. Effects of sea surface warming and sea-level rise on tropical cyclone and inundation modeling at Shanghai coast. *Natural hazards*, 109(1), pp.755-784.

Reply: We appreciate you bringing this paper to our attention. We will incorporate the reference in the revised manuscript.

Reviewer Comment 2.4 — L11-12: "...and their dynamic systems" is unclear. What specifically does this refer to?

Reply: Thank you for pointing this out. We will change "TC sizes and its dynamic systems" to "TC sizes and intensity".

Reviewer Comment 2.5 — L44: change to "there is not much evidence that supports..."

Reply: Will be revised. Thank you.

Reviewer Comment 2.6 — L92-93: given that all TCs analysed here are from 2018 onward, you could just say the temporal resolution is 3 hrs.

Reply: Will be corrected as suggested.

Reviewer Comment 2.7 — L98: MODIS should be defined.

Reply: Will be corrected as suggested.

Reviewer Comment 2.8 — L104-105: WSM and MM5 should be defined.

Reply: Will be corrected as suggested.

Reviewer Comment 2.9 — Fig S1 caption: "temporary" should be "temporal".

Reply: Will be corrected as suggested.

Reviewer Comment 2.10 — L128: "radius" or "distance" is perhaps more suitable than "buffer".

Reply: We will changed it to "distance". Thank you.

Reviewer Comment 2.11 — L142: I'm not sure that a percentage bias is appropriate for MSLP here, given it tends to only vary between approx. 950-1050 hPa.

Reply: Thank you for your comment. The bias here is calculated as the relative difference between the simulated SLP_{min} (CTL) and the observed SLP_{min} . Although the range of SLP_{min} is relatively small, we believe that the percentage bias still provides a useful quantitative measure.

Reviewer Comment 2.12 — L143: I don't think "climate dynamics" is suitable here since this isn't a climate study. Consider replacing this part with something like "the tracks and intensities are well simulated, including an increase in SLP_{min} as the TCs move over land".

Reply: Thank you for your suggestions. We will revise this sentence.

Reviewer Comment 2.13 — Fig 3: the red contour showing Shanghai is a little difficult to see. Consider changing this to a different colour or otherwise making it clearer. Also relevant for Figs 8 and 9, where the red line overlies red shading.

Reply: The contour lines will be revised to make them more visible.

Reviewer Comment 2.14 — L159: it may be convenient to redefine the variables for the reader.

Reply: We will revise it as suggested. Thank you.

Reviewer Comment 2.15 — L163: “exposure” could be changed to “exposure time” etc. to specify this paragraph is referring to the time of the cyclone.

Reply: Will be revised. Thank you.

Reviewer Comment 2.16 — L168-169: The first sentence here feels like it should belong in the previous paragraph, otherwise it could be removed.

Reply: We will remove it, as suggested.

Reviewer Comment 2.17 — L178: Are the quantities shown in Fig 6 averaged over the Shanghai domain, or are these values at a single grid point?

Reply: In Figure 6, the values correspond to the maximum rainfall intensity and maximum 10-m wind speed averaged over all time steps, with the maxima identified within the Shanghai domain at each time step. We will clarify this better in the figure’s caption.

Reviewer Comment 2.18 — L187-188: I recommend changing the words “positive/negative effect” to remove any connotations. Something simple like “can increase/decrease” may work. Also see L198.

Reply: We will consider revising the text. Thank you.

Reviewer Comment 2.19 — L210-211: “equivalent in intensity” is only really true for SST2 and SST3 experiments.

Reply: Thank you for pointing this out. We will clarify in the revised manuscript that “equivalent in intensity” applies specifically to the SST2 and SST3 experiments at 2021-07-26 0600 UTC. Moreover, in the CTR and SST1 experiments, the two typhoons reach comparable intensities at later times. For instance, in the CTR case, the two TCs exhibit similar intensity at 2021-07-27 0600 UTC.

Reviewer Comment 2.20 — L213-214: does In-fa actually move southward/southwestward, or is it just that its northward propagation is slowed?

Reply: We confirm that Typhoon In-fa moved in a southward/southwestward direction, which is clearly illustrated in Figure 4b.

Reviewer Comment 2.21 — L225: change to “Typhoons in the Northern Hemisphere have been found to normally move northward...”

Reply: Will will revise as suggested.

Reviewer Comment 2.22 — L225-231: It also appears that raising SSTs allows the model to spin up TCs more frequently and rapidly, potentially leading to more double (or more) TC activity events and hence more common Fujiwhara effects. Has this been observed in recent decades? Some further discussion could be beneficial.

Reply: Thank you for raising this important point. We have clarified that the mechanism discussed in our manuscript applies specifically to cases in which binary TCs are already present. Warming SST primarily intensifies the existing two typhoons and their interactions. We did not find evidence in our simulations or in recent literature that increased SST necessarily leads to a higher frequency of binary TC events. However, in light of the large number of two-typhoon cases in the WNP region (60.6%), we anticipate an increase in the southward movement of typhoon trajectories in this region in the future.

Reviewer Comment 2.23 — L238: should this be “water vapour content”?

Reply: Indeed, we will revise it.

Reviewer Comment 2.24 — L243: the authors for the references here should be outside the brackets.

Reply: Thank you for noticing this.

Reviewer Comment 2.25 — L266: should this “warmer SST” related to El Nino be specific to the central/east Pacific?

Reply: Thank you for pointing this out. We will specify the sentence to the western North Pacific (WNP) region.