Response to the first reviewers' comments (RC1) on the paper "*Modeling interactions between tides, storm surges, and river discharges in the Kapuas River delta*".

We want to thank the reviewer for taking the time to review our paper. Their comment has been beneficial and helped us to improve the manuscript. In what follows, the reviewer's comments are presented in bold-italic type, our response in roman type, and modification in color in the main text.

Page 2, 63: can better represent.
Response: The suggestion has been followed.

Page 5: Tidal forcing: The source of the tidal signal at the open boundary is missing. How many harmonics did you use?
Response: The source of the tidal signal at the open boundary is added. The number of harmonics constituents is 15, i.e., M2, S2, K1, O1, N2, P1, K2, Q1, 2N2, MF, MM, M4, MS4, MN4, and S1. We added sentences as follows in the last paragraph of page 5:

"At the open boundaries in the ocean, we prescribe tidal elevation and current of 15 harmonics from the global tides model dataset, the OSU TPXO Tide Models/TPXO9-atlas (Egbert and Erofeeva, 2002). We also retrieve global ocean circulation from HYCOM (Chassignet et al., 2007) at these boundaries".

Wind forcing: The link/source to/of the observed wind velocity is missing. By the way, at which height are the wind data provided by ERA5 and meteorological station?
Response:
The source of observed wind data is now added. Both wind data are measured and modeled at 10 m above the surface. The paragraph is updated as follows:

The wind velocity and the atmospheric pressure data are the ERA5 reanalyzes dataset obtained from the European Canter for Medium-Range Weather Forecast (ECMWF). The data have a spatial resolution of 31 km (Hersbach et al., 2020), while the temporal resolution is hourly and available at 137 vertical levels (0 to 80 km from the surface). But, here, we only selected and used the data that represented wind at the surface. Unfortunately, compared with observational data from the Stasiun Klimatologi Mempawah (http://iklim.kalbar.bmkg.go.id), measured at 10 m above the surface, there are clear difference in amplitude. The observed wind velocity is more significant than the wind velocity from ERA5 during a wind surge (Fig. 4). Therefore, in the case study, we adjust the magnitude of the wind input data (ERA5) during the wind surge event. We multiplied the wind magnitude with a ratio between both peaks (the observed and ERA5 data).

River forcing: Not clear when the observational data are available and for which rivers. Please, clarify.

Response:

The Kapuas River discharge that is available now was observed in the middle stream at Sanggau (about 284 km from the river mouth) from November 2013 to May 2015 (Kästner et al., 2018). On the other hand, the available water level data is observed by Pontianak Maritime Meteorological Station in Pontianak (20 km from the Kapuas Kecil river mouth, the second largest distributary of the Kapuas river). The data is measured hourly from 2010-2012 for only half-days (from 7 a.m. to 7 p.m.). Then, from 2012-2015 they observed the data for 15 hours (from 7 a.m. to 10 p.m.). Finally, from 2016 until now, they observed the hourly data in full days (24 times per day). Unfortunately, in our case study, in which the flood event occurred in December 2018, we don't have the observational data for the discharge, so that we replace it with the output of global discharge data, GFMS (Wu et al., 2014). We implemented sensitivity analysis to evaluate the accuracy of this GMFS's output for the Kapuas River.

Setup: If it is possible, please, create a Table, where you describe all experiments (discharge rate, wind forcing).

Response: The suggestion has been followed. We add a table in the Appendix section.

Table A3. Scenarios used to force the model

Scenario	Duration of simulation	Wind Speed (ms^{-1})	Wind Direction (°)	Pressure (kPa)	Discharge Kapuas (m^3s^{-1})	Discharge Landak (m^3s^{-1})	Tidal Range (m)
Discharge1	1 month	2 - 8	0 – 360	100.5 - 101.5	3×10^3	300	1.8
Discharge2	1 month	2 - 8	0 – 360	100.5 - 101.5	5×10^3	300	1.8
Discharge3	1 month	2 - 8	0 – 360	100.5 - 101.5	7×10^3	300	1.8
Discharge4	1 month	2 – 8	0 – 360	100.5 - 101.5	9×10^3	300	1.8
Wind_1x	1 month	2 – 8	0 – 360	100.5 - 101.5	3×10^3	300	1.8
Wind_1.5x	1 month	3 – 12	0 – 360	100.5 - 101.5	3×10^3	300	1.8
Wind_2x	1 month	4 – 16	0 – 360	100.5 - 101.5	3×10^3	300	1.8
Wind_2.5x	1 month	5 – 20	0 – 360	100.5 - 101.5	3×10^3	300	1.8
Wind_3x	1 month	6 - 24	0 – 360	100.5 - 101.5	3×10^3	300	1.8
Wind_4x	1 month	8 - 32	0 – 360	100.5 - 101.5	3×10^3	300	1.8
Wind_5x	1 month	10 - 40	0 – 360	100.5 - 101.5	3×10^3	300	1.8
Case Study	1 month	2 – 21	0 – 360	100.5 - 101.5	3.3×10^3 – 5×10^3	250-700	1.8

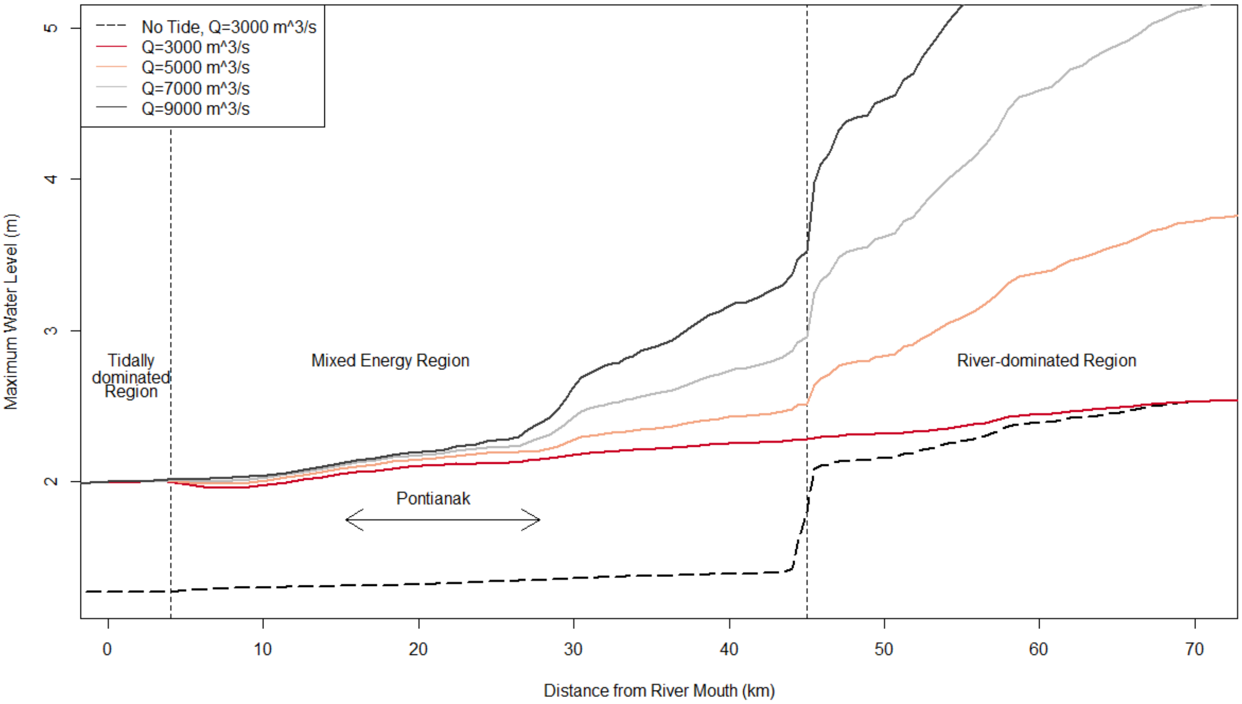
Page 6, 165: What about P1 harmonic? It should be important for the area. Please, give some information about higher harmonics – MO3 and MK3, they would show how well your wetting/drying scheme is working.

Response: The suggestion has been followed. We involved P1, MO3, and MK3 constituents in the tidal analysis. As a result, the contribution of the P1 constituent is significant, while the contribution of MO3 and MK3 constituents is relatively weak. The corresponding figure (Fig. 6 and 7), table (Table A1 and A2), and paragraph (in section 3.1 model validation) have been updated.

Page 6, 180-189: Please, provide the coordinates of the stations.
Response: The coordinates have been added.

Page 7, 195-206: I doubt very much about MXVL analysis and zones defining procedure, especially if we consider mixed energy region. Such behavior of MXWL may signalize about larger river bed area and not about tidal impact. You can, for example, find a difference between MXVL and mean level within the tidal cycle at each location. If this difference is small, it means that the behavior of MXVL can be largely explained by a variation in river bed area. Another strategy is to run experiment with only river forcing and then find a difference between MXVL levels in experiments with tidal and river forcing and with only river forcing.

Response: As suggested, we run experiments only with river forcing (without tidal forcing). We also extended our MXWL analysis area to more upstream. The result is added in Figure 8, as follows:



This result shows the impact of tidal and river discharge interaction on maximum water level along the river. Using the "no tide" scenario, we can see clearly that the maximum water level gradually decreases with a gentle slope in the mixed-energy zone. However, compared to the "Q=3000 m^3/s" scenario, we can see that the MXWL profile is more dynamic when tides are imposed in the simulation. Therefore, it supports the analysis that we mentioned in the paragraph. Based on the figure, we also modified the frontier between mix-energy and river-dominated regions to about 46 km from the river mouth.

Page 8, 253: 'we simulated it but did not show the result here' -> 'not shown'
Response: The suggestion has been followed.

Figure 5: DISCHARGE-> Discharge. The axis font size is too small. 'Note that the Kapuas …. discharge.' – I would remove this sentence from the caption.

Response: The figure has been updated and the suggestion has been followed.

Figure 7: The phases and amplitudes diverge larger from the observational data than they do at the river mouth. What do you think is major reason for that?

Response:

The first reason may be because the propagation of tidal waves upstream is modified by riverbanks width convergence and depth difference (Guo et al., 2014). There is also an influence of the backwater at the observation point within the city (Kästner et al., 2019). Therefore, the amplitude and phase of the tide's constituents are modified. Regarding the bathymetry, the depth of the Kapuas Kecil river mouth is very shallow, while in Pontianak, it is five-fold deeper. Next, it may also be due to asymmetric tides as the impact of the interaction between tidal with river flow (Parker, 1991). As we simulated, the observation point is located in the mixed energy region where tidal and discharge interact in linear and non-linear ways. This interaction may generate other constituents that override and decrease the amplitude and phase of constituents in the river mouth.

Tables A1, A2: The ->the, 'Mouth'->'mouth'. Please, add P1, MO3, MK3. Please, add coordinates of the stations.

Response: The suggestion has been followed. The additional tidal constituents (P1, MO3, and MK3) and the coordinates have been added.

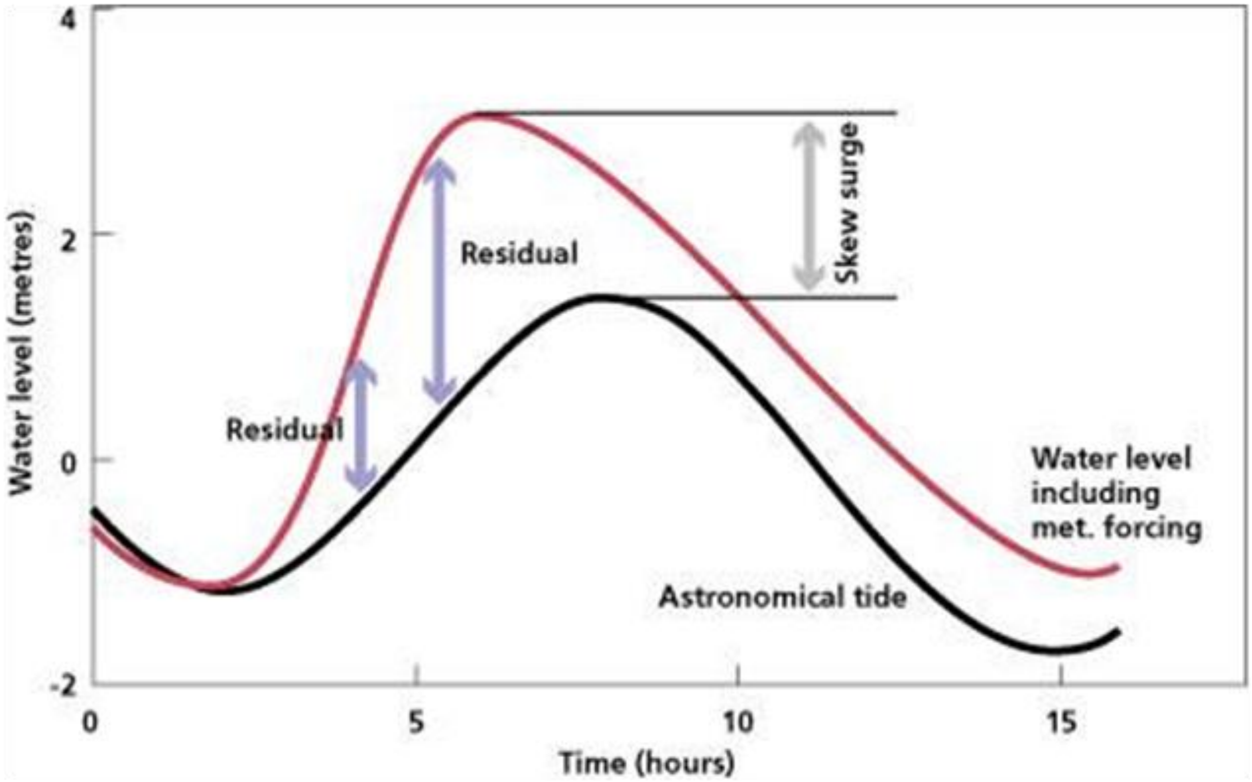
Figure 8: I think should be re-drawn, see the comments above.

Response: The suggestion has been followed. Figure has been updated.

Figure 9: Honestly, I do not understand the dynamical processes behind such a variation in MXVL in first zone (0-4km) within different wind scenarios. It looks artificial. Can you give some explanation? I think it would be very helpful and also add a value to the paper, if you include the maps for each wind scenario for the considered area. You can show the MXWL (within the tidal cycle) difference for the run with wind and tidal+river forcing and with only tidal+river forcing.

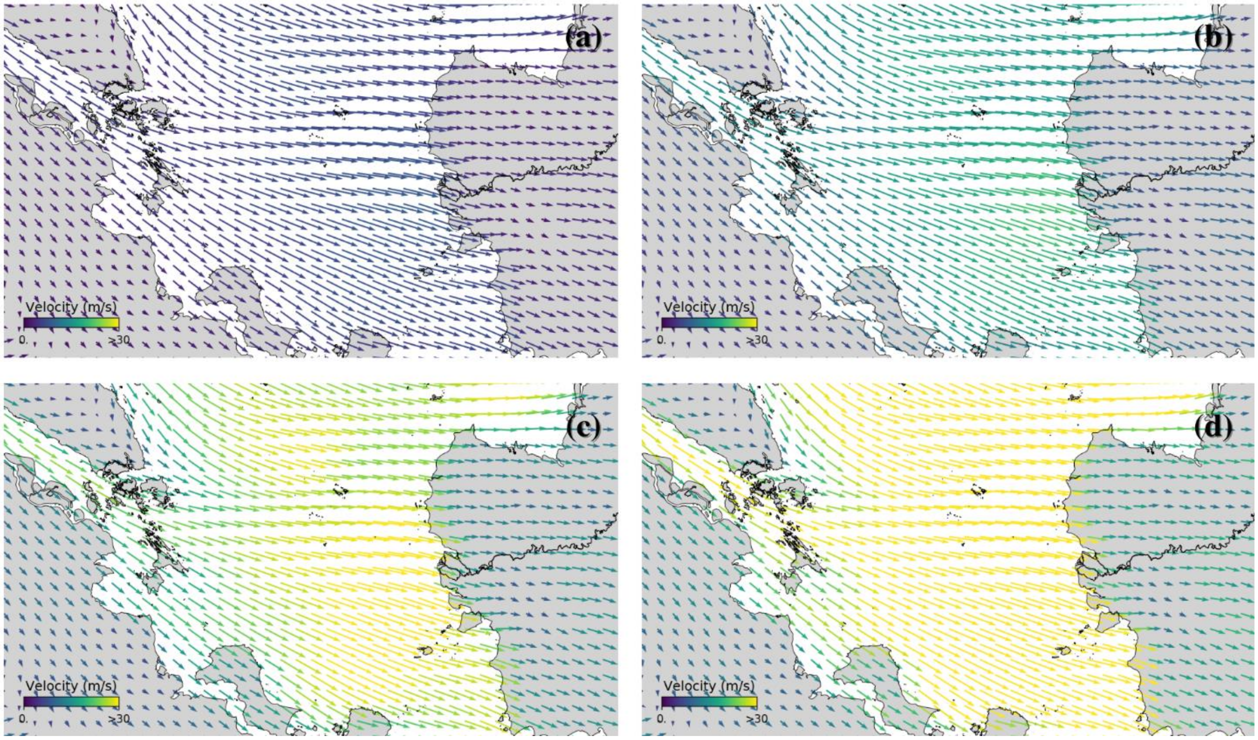
Response:

The maximum water level in this zone is the sum of the highest amplitude within the tide cycle and the skew surge. The skew surge represents how high the sea level rises from its expected tide level due to gradient pressure and wind stress. Since the coastal area is shallow, the stronger the wind, the higher the skew surges possibly generated due to interaction between the tide and the surge component (Santamaria-Aguilar and Vafeidis, 2018). The scenario we used in this simulation is the worst scenario of wind, which blows from the ocean to the land.



Schematic of a skew surge (The National Oceanography Centre, 2021)

Following your suggestion, the following figure has been added to the manuscript. It depicts wind direction and magnitude over the domain for (a) scenario Wind × 1, (b) scenario wind × 2.5, (c) scenario wind × 4, and (d) scenario wind × 5.



We then added the MXWL profile without wind stress in Figure 10, which depicts wind surge effects on the maximum water level (MXWL) along the river.

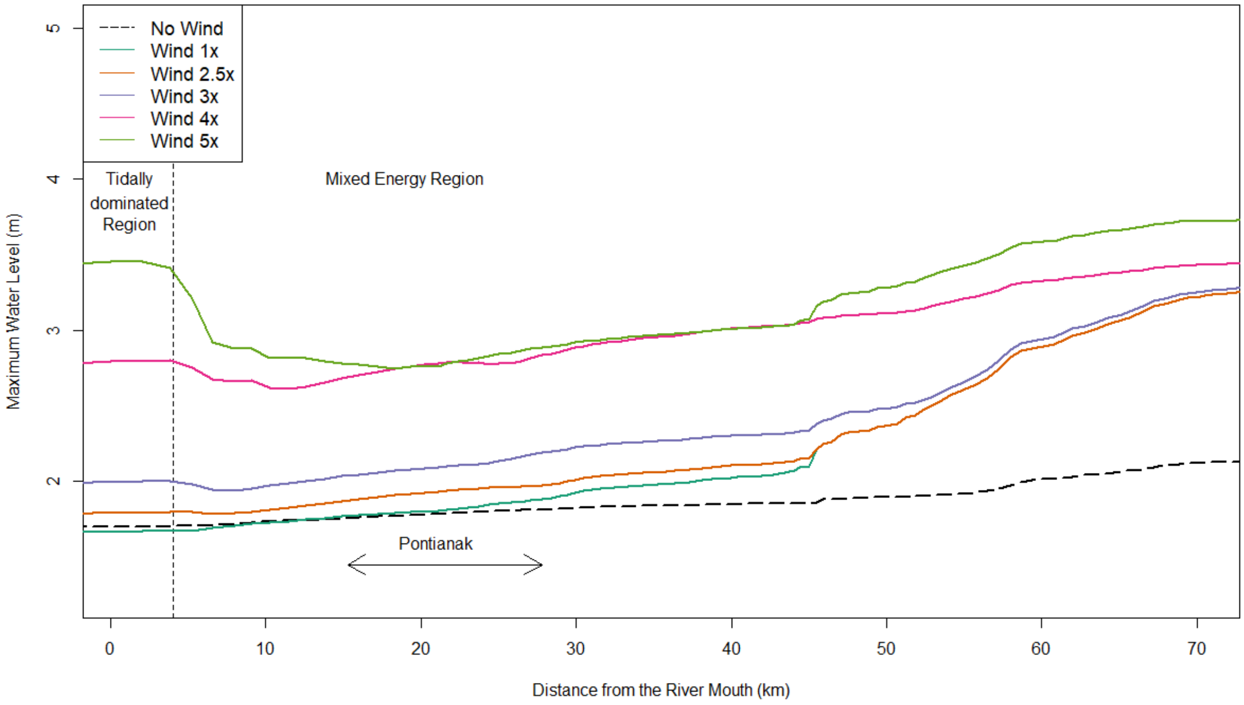
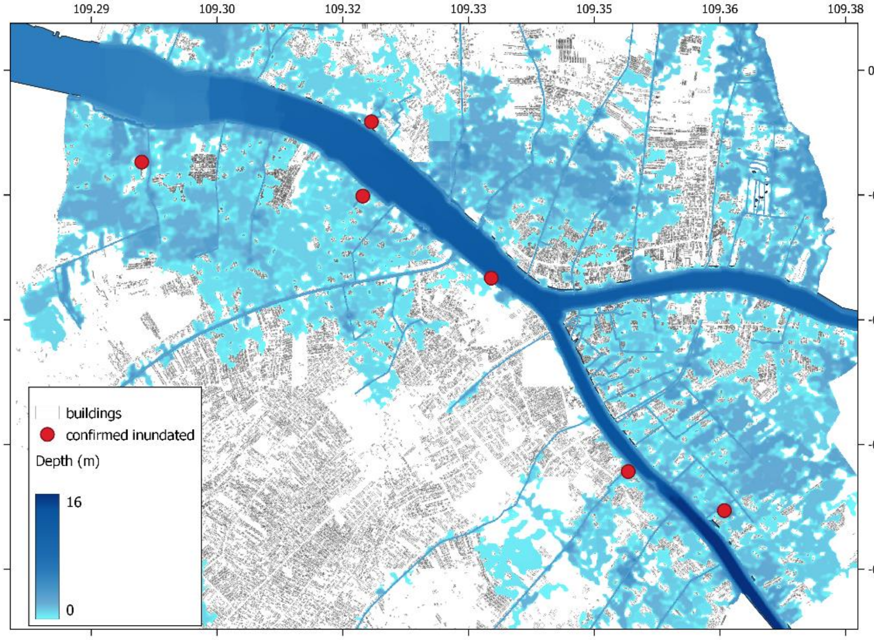


Figure 12: The axis font is hard to read, it is too small. Just a curiosity: what will be with the results, if you decrease 2 times h*?

Response:

The figure has been updated. We used h* to define an area becomes wet or dry in our momentum equation. We have re-run the simulation using h* = 0.1 m. Since we re-ran the model using a higher resolution of DEM and a higher mesh resolution in the case study, the city's canals can now be depicted by the model. Consequently, the inundated area extent is changing.



Reference

Chassignet, E. P., Hurlburt, H. E., Smedstad, O. M., Halliwell, G. R., Hogan, P. J., Wallcraft, A. J., Baraille, R., and Bleck, R.: The HYCOM (HYbrid Coordinate Ocean Model) data assimilative system, J. Mar. Syst., 65, 60–83, https://doi.org/10.1016/J.JMARSYS.2005.09.016, 2007.

Egbert, G. D. and Erofeeva, S. Y.: Efficient inverse modeling of barotropic ocean tides, J. Atmos. Ocean. Technol., 19, 183–204, 2002.

Guo, L., Van Der Wegen, M., Roelvin, J. A., and He, Q.: The role of river flow and tidal asymmetry on 1-D estuarine morphodynamics, J. Geophys. Res. Earth Surf., 119, 2315–2334, https://doi.org/10.1002/2014JF003110, 2014.

Hersbach, H., Bell, B., Berrisford, P., Hirahara, S., Horányi, A., Muñoz-Sabater, J., Nicolas, J., Peubey, C., Radu, R., Schepers, D., Simmons, A., Soci, C., Abdalla, S., Abellan, X., Balsamo, G., Bechtold, P., Biavati, G., Bidlot, J., Bonavita, M., Chiara, G., Dahlgren, P., Dee, D., Diamantakis, M., Dragani, R., Flemming, J., Forbes, R., Fuentes, M., Geer, A., Haimberger, L., Healy, S., Hogan, R. J., Hólm, E., Janisková, M., Keeley, S., Laloyaux, P., Lopez, P., Lupu, C., Radnoti, G., Rosnay, P., Rozum, I., Vamborg, F., Villaume, S., and Thépaut, J.: The ERA5 global reanalysis, Q. J. R. Meteorol. Soc., 146, 1999–2049, https://doi.org/10.1002/qj.3803, 2020.

Kästner, K., Hoitink, A. J. F., Torfs, P. J. J. F., Vermeulen, B., Ningsih, N. S., and Pramulya, M.: Prerequisites for Accurate Monitoring of River Discharge Based on Fixed-Location Velocity Measurements, Water Resour. Res., 54, 1058–1076, https://doi.org/10.1002/2017WR020990, 2018.

Kästner, K., Hoitink, A. J. F., Torfs, P. J. J. F., Deleersnijder, E., and Ningsih, N. S.: Propagation of tides along a river with a sloping bed, J. Fluid Mech., 872, 39–73, https://doi.org/10.1017/JFM.2019.331, 2019.

Parker, B. B.: Tidal hydrodynamics, J. Wiley, New York, 883 pp., 1991.

Santamaria-Aguilar, S. and Vafeidis, A. T.: Are Extreme Skew Surges Independent of High Water Levels in a Mixed Semidiurnal Tidal Regime?, J. Geophys. Res. Ocean., 123, 8877–8886, https://doi.org/10.1029/2018JC014282, 2018.

The National Oceanography Centre, Skew surge: https://ntslf.org/storm-surges/skew-surges, last access: 25 December 2021.

Wu, H., Adler, R. F., Tian, Y., Huffman, G. J., Li, H., and Wang, J.: Real-time global flood estimation using satellite-based precipitation and a coupled land surface and routing model, Water Resour. Res., 50, 2693–2717, https://doi.org/10.1002/2013WR014710, 2014.