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Improved storm surge modelling using the new ERA5 climate reanalysis

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Storm surges are one of the costliest hazards of tropical and extratropical cyclones, and are driven by low atmospheric pressure and strong winds. This type of coastal hazard can have significant socio-economic impacts in densely populated and low-lying coastal areas. Recent examples of such coastal disasters include Hurricanes Irma and Sandy which made landfall in the U.S., Typhoon Fitow in eastern China and extratropical cyclone Xaver that affected Northern Europe. Each of these storms caused storm surges of >3 m with many casualties and high economic losses, exceeding 65 billion U.S. Dollars for Hurricanes Sandy and Irma, as a result.

To effectively protect coastal communities from flooding, information on coastal flooding is needed. With quickly increasing computational capabilities, hydrodynamic models, such as the Global Tide and Surge Model (GTSM), have become important tools for coastal risk assessments. Previous studies have reported that the coarse resolution of ECMWF's ERA-Interim climate reanalysis (0.75°, 6h) results in an underestimation of tropical cyclone induced storm surges (Muis et al., 2016; Schenkel & Hart, 2012; Vousdoukas et al., 2018). Recently, ECMWF replaced ERA-Interim with the new ERA5 reanalysis dataset (0.25°, 1h). Here, we force GTSM with wind speed and atmospheric pressure from ERA-Interim and ERA5 to quantify the improvement in storm surge modelling resulting from this meteorological forcing upgrade. We focus on four tropical and three extratropical cyclone case studies.

Preliminary results show that the performance of GTSM improves significantly when forced with ERA5 over ERA-Interim. For Hurricane Irma R^2 increases from 0.41 with ERA-Interim to 0.76 with ERA5. Furthermore the maximum modelled surge height at Everglades City (FL) increases from 0.7 m with ERA-Interim to 2.4 m with ERA5 while the maximum observed surge height is 2.6 m. This is due to the fact that tropical cyclones are better represented by ERA5's higher horizontal and temporal resolution. For extratropical cyclones we observe a slightly better representation of the air pressure and wind fields in ERA5 compared to ERA-Interim, while the simulated storm surges do not show any significant differences. To conclude, our results show that the new ERA5 dataset results in large improvements in global storm surge modelling with major implications for coastal risk assessments.