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Storm surge and extreme river discharge: a compound event analysis using ensemble impact modeling

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Every winter deep low-pressure systems passing over Western Europe provide conditions where the coastal North Sea reaches storm-surge level. The accompanying frontal systems lead to large rainfall amounts, which can result in river discharges exceeding critical thresholds. The risk of disruptive societal impact increases strongly if river runoff and storm-surge peak near-simultaneously. Existing studies suggest that no such relation is present at time lags shorter than six days. These results, however, were based on relatively coarse resolution ($\sim$150km) meteorological forcing, impact-proxies, or statistical techniques. Therefore, here we re-investigate the possibility of finding near-simultaneous storm surge and extreme river discharge. Using the output of a high-resolution (0.11°/12 km) regional climate model ($RACMO_2$) in ensemble mode (16x50 years) we drive the storm surge model (WAQUA/DCSMv5) and two hydrological river-discharge models (SPHY and HBV-96). Due in part to the large natural variability in the duration of floods, we find that the probability for finding extreme river discharge and storm surge conditions are up to four times higher (than random chance) for a broad range of time lags (-2 to 10 days, depending on exact threshold). This includes the more probable occurrence of near-simultaneous compound surge x discharge events.