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Projecting Changes in the Drivers of Compound Flooding in Europe Using CMIP6 Models

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When different flooding drivers co-occur, they can cause compound floods. Despite the potential impact of compound flooding, few studies have projected how the joint probability of flooding drivers may change. Furthermore, existing projections are based on only 5 to 6 climate model simulations because flooding drivers such as storm surges and river run-off need to be simulated offline using computationally expensive hydrodynamic and hydrological models. Here, we use a large ensemble of simulations from the Coupled Model Intercomparison Project 6 to project changes in the joint probability of extreme storm surges and precipitation in Europe under a medium and high emissions scenario. To compute storm surges for so many simulations, we apply a statistical storm surge model trained with tide gauge observations and atmospheric forcing from the ERA5 reanalysis. We find that the joint probability of extreme storm surges and precipitation will increase in the northwest and decrease in most of the southwest of Europe. On average, the absolute magnitude of these changes is 36% to 49% by 2080, depending on the scenario. We show that due to internal climate variability and inter-model differences, projections based on small climate model ensembles can differ qualitatively depending on the specific simulations included. Therefore, our results provide a more robust and less uncertain representation of changes in the potential for compound flooding in Europe than previous projections.