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Integrated extreme sea level events in the Mediterranean coast of Spain

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Coastal areas are one of the most vulnerable regions to climate change given their high exposure to the increasingly frequent extreme sea level (ESL) events and the high population density with around 680 million people (approximately 10% of the world's population) residing at less than 10 m above sea level and projected to reach more than one billion by 2050 (IPCC, 2019).

Extreme sea level events include the combination of mean sea level, tides, surges and waves set-up. These events that historically occurred once per century are projected to become at least an annual occurrence at most parts of the world during the 21st century. Therefore, a crucial step towards coastal planning and adaption is the understanding of the drivers and impacts of ESL events (Hinkel et al., 2019).

Flooding and extreme events in river mouths and their adjacent coastline have a complex nature with oceanic and fluvial processes taking place. Their analysis requires, therefore, the consideration of several physical variables that play a role in water levels such as precipitation, waves, storm surge, and tides. In a climate change scenario, the effects of sea level rise and storminess changes must also be accounted for. The contribution of different processes to ESL events has often been analyzed independently given the difficulty to predict their combined effects.

This work focuses on the analysis of ESL events due to the combination of sea level rise, extreme waves, storm surges, tides and river flows in a climate change scenario, following:

- Projections of wave variables for an ensemble of EURO-CORDEX RCMs under RCP8.5 using WavewatchIII v5.16 (Besio et al., 2019). Wave propagation of local hydrodynamic processes and storm surge with Delft3D.
- Projections of river flow using a physical-based and distributed hydrological model under the same runs as the wave climate.
- Joint statistical characterization of local waves and river flows and long-term temporal variability based on the methodology of Lira-Loarca et al. (2020).
- Analysis of compound extreme sea level and flooding events.

The methodology is applied to a case study in the coast of Granada (Spain) where severe flood events have occurred in recent years. The results highlight the need for an integrated approach encompassing the relevant components of water levels, and specifically sea level rise and waves and the differences in the temporal variability of the significant wave height in a climate change scenario.

References:

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