Abstract

Changes in both global and regional mean sea level, and changes in the magnitude of extreme flood heights, are the result of a combination of several distinct contributions most, but not all, of which are associated with climate change. These contributions include effects in the solid earth, gravity field, changes in ocean mass due to ice-loss from ice sheets and glaciers, thermal expansion, alterations in ocean circulation driven by climate change and changing freshwater fluxes, and the intensity of storm surges. Due to the diverse range of models required to simulate these systems, the contributions to sea-level change have usually been discussed in isolation rather than in one self-consistent assessment. Focusing on the coastline of North-West Europe, we consider all the processes mentioned above and their relative impact on 21st century regional mean sea levels and the 50-year return flood height. As far as possible our projections of change are derived from process-based models forced by the A1B emissions scenario to provide a self-consistent comparison of the contributions. We address uncertainty by considering both a mid-range and an illustrative high-end combination of the different components.

For our mid-range ice-loss scenario we find that thermal expansion of seawater is the dominant contributor to change in North-West European sea level by 2100. However, the projected contribution to extreme sea level, due to changes in storminess alone, is in some places significant and comparable to the global mean contribution of thermal expansion. For example, under the A1B emissions scenario, by 2100, change in storminess contributes around 15 cm to the increase in projected height of the 50-year storm surge on the west coast of the Jutland Peninsula, compared with a contribution of around 22 cm due to thermal expansion. An illustrative combination of our high-end projections suggests increases in the 50-year return level of 86 cm at Sheerness, 95 cm at Roscoff, 106 cm at Esbjerg, and 67cm at Bergen. The notable regional differences between these locations arise primarily from differences in the rates of vertical land movement and changes in storminess.