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Studying extreme coastal precipitation events with the new LES model ATHAM-Fluidity

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Coastal communities are among the most vulnerable to extreme flooding events due to the combined risks of heavy precipitation, storm surges, high river levels and likely future sea level rises. Developing robust early warning prediction systems for such events is therefore of utmost importance. Whilst mesoscale and global atmospheric models may be able to reliably predict the onset of large-scale storms, the resolutions at which they operate limits their ability to capture potentially important regional variations in flood severity due to (for example) local terrain effects.

As part of the ongoing EU-FP7 PEARL project (Preparing for Extreme And Rare events in coastaL regions), the high-resolution large-eddy simulation (LES) atmospheric model 'ATHAM-Fluidity' is under continued development, with the purpose of dynamically downscaling these larger-scale models and thus providing more detailed precipitation maps at specific sites of interest. This finite-element model employs a fully unstructured tetrahedral grid that is not only able to capture detailed (static) variations in terrain height, but can also dynamically adapt during the simulation to concentrate resolution in regions where it is most needed.

A key aim of this work is to assess whether the ability to resolve down into the turbulence length-scales, as well as capture any steep local topographical variations, can lead to a significant improvement in predictive skill of flood risk at the neighbourhood scale. To this end, we perform simulations of two historical coastal flooding events at two separate PEARL case study sites and compare model output against observational data. The first case study site, Greve in Denmark, is characterised by fairly low-lying land, whilst the second case study site, Rethymno in Crete, is situated close to steep inland mountainous terrain. Within PEARL's wider integrated modelling framework, model output from this latter case in particular will provide important input data to the precipitation run-off modellers in determining flood risk downstream of the inland catchment areas.