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The benefits of unstructured grids for wave modelling in semi-enclosed domains

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Traditionally wave modelling has used a sequence of nested meshes to obtain high resolution wave fields near the coast. This supposes an uncertain error due to internal boundary conditions and physics at multiple scales. Both may distort the wave energy balance and for winds blowing from land there is the additional difficulty of wave trains travelling towards the offshore being hindered by the intermediate domain boundaries. Unstructured grids avoid multiple meshes and thus the problem of internal boundary conditions but may result in inconsistent fluxes of wave energy among cells, depending on mesh size and shape. This may distort the wave energy balance.

Here we analyse high resolution wave simulations for a full meteorological year where high resolution meteorological models were available in a domain off the Catalan coast. This coastal case presents sharp gradients in bathymetry and orography and therefore correspondingly sharp variations in the wind and wave fields.

We have carried out simulations with SWAN using a traditional nested sequence and a regional unstructured grid with varying resolution depending on a) distance to the coast line and b) gradients in bottom topography (as a proxy of associated gradients in wind and wave fields). Also a local unstructured grid covering the Catalan coast and nested to a regular system is included in the comparison. We are interpreting the results depending on the directional sector for the wind field since that determines fetch length, suitability of generation and dissipation terms in the wave model and compatibility with mesh size and shape.

The obtained simulations are being compared to wave observations from buoys near the coast and remote sensing data all over the Western Mediterranean Sea. Additionally some test have been carried out in order to analyse the computational time required for each alternative, showing an important reduction when working with the regional unstructured grid.