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Regularising subgrid scale information in the next generation of ocean models

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A consideration of stabilisation techniques is essential in ocean model development if finite element-based models are to correctly model ocean processes over a wide-range of scales. Careful application of these techniques can significantly increase flexibility of models and allow meshes to become highly anisotropic. This enables the model to capture a wider range of ocean phenomena and thus reduce the number of parameterisations required, bringing us a more physically realistic solution.

The next generation of ocean models employ unstructured meshes and anisotropic adaptivity to gain a greater degree of flexibility. These however, also introduce erroneous artefacts into the solution, when for example a process becomes unresolvable due to an adaptive mesh change or advection into a coarser resolution of mesh in the domain. The suppression of these effects, caused by spatial and temporal variations in mesh size, is one of the key roles stabilisation can play.

In this presentation, we will discuss a range of stabilisation techniques suitable for application in ocean modelling. We will compare traditional schemes such as Petrov-Galerkin and Galerkin least-squares with more recently developed schemes derived from subgrid scale modelling concepts for advection-diffusion processes. With a focus on consistent and residual-free schemes we will discuss the application of the variational multiscale method, residual-free bubble function enrichment and sub-element Green's function ideas in our aim to capture the important subgrid scale information.

In combination with adaptive methods, stabilising techniques are key to the development of next generation ocean models. In particular, these ideas are critical if we are to achieve our aim of extending models, such as the Imperial College Ocean Model, to the global-scale.