An eddy-permitting finite-element model for the North Atlantic

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A 3D finite-element primitive-equation ocean model (FEOM) based on tetrahedron partitioning of the computational domain is developed (Danilov et al., 2004). Due to flexibiity in mesh refinement the FEOM provides a tool for modelling the influence of small scale phenomena unresolved by current climate models on large scale ocean circulation.

The model is applied to simulate the North Atlantic thermohaline circulation at eddy-permitting resolution (0.2°–2°). It relies on a horizontally refined mesh in regions of steep topography and allows the sloping bottom to be represented within the z-coordinate vertical discretization, similar to the so called shaved cell approach (Fig. 1). It is the first time this approach is used to model large-scale ocean circulation.

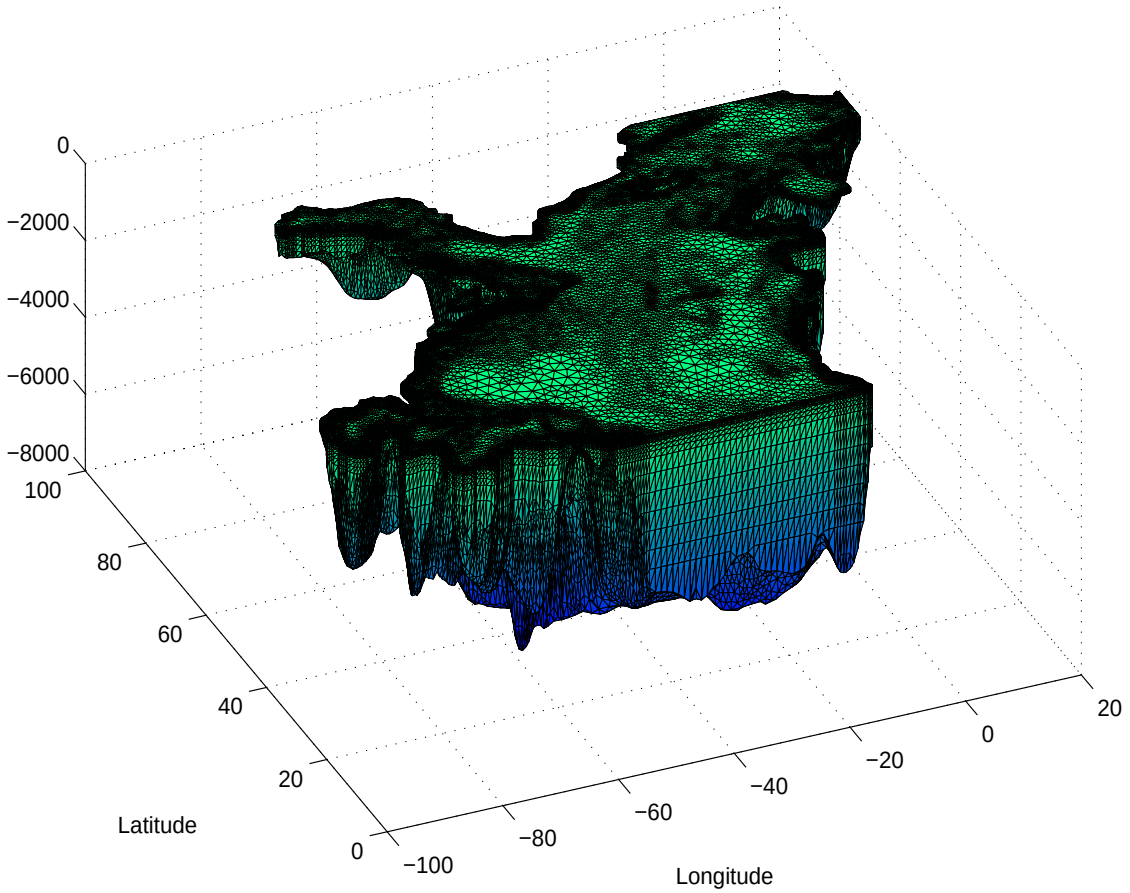

Figure 1: 3D mesh

The FEOM performance in the North Atlantic was compared with that of other models in existence. The meridional overturturning circulation and heat transport are in good agreement with those produced by the DYNAMO project models (Willebrand et al., 2001). The maximum overturning cell is 15.5 Sv and its position is almost identical to that obtained in a $1/10^0$ simulation (Smith et al., 2000). The maximum heat transport is around 1 PW which is in agreement with other models.

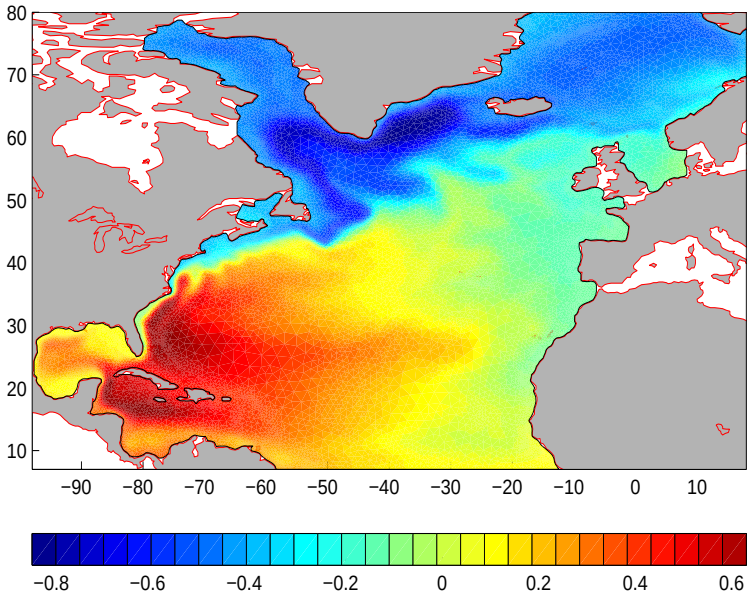

Figure 2: Mean SSH (m).

The mean sea surface height demonstrates the presence of the Gulf Stream recirculation reproduced only by the ISOPYCNIC model of DYNAMO (Fig. 2). When restoring of tracers is applied in the Bay of Cadiz, the model is able to develop the Azores Current of sufficient strength, comparable to that of ISOPYCNIC and maintain the Mediterranean salinity tongue. The annual mean transports of the Gulf Stream and Deep Western Boundary Current at 27°N are of 37 Sv and 17 Sv with core velocities of about 1 m/s and 12 cm/s respectively.

References

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