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Continuous linear and nonconforming discretizations of horizontal velocity in FEOM: Assessing effects of stabilization

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In a search for a robust and efficient algorithm suitable for simulating large-scale ocean circulation on unstructured meshes the performance of continuous linear and nonconforming types of discretization of horizontal velocity is analyzed. The basic version of Finite Element Ocean circulation Model (FEOM) works with continuous linear representation of horizontal velocity and elevation. This type of discretization stores model fields in the most economical way but is prone to pressure modes and thus requires stabilization. To assess the effects of stabilization, a version of the code with the same functionality, but nonconforming representation of the horizontal velocity is used. It does not require stabilization but uses three times more degrees of freedom to store the velocity.

By running several test cases it is shown that the stabilization introduces frictional effects at free-slip boundaries while in other cases (including no-slip boundaries) its influence can be kept at a small level by tuning the stabilization strength. Both versions of the code are nearly equal in terms of CPU time. The numerical advantages of the absence of stabilization in the nonconforming code are hidden behind the increased number of operations needed to manipulate velocity arrays of larger size. It is concluded that both versions are equally suitable for numerical ocean modeling.