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Investigation of model capability in capturing vertical coastal processes: A case study in the Adriatic Sea

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Coastal horizontal and vertical processes play an important role in ocean dynamics. Being the interface between land and sea, they are strongly influenced by winds, river inputs, tides, heat and water fluxes, topographic features, as well as human activities. In this work we perform a set of simulations using two different models, SHYFEM and MITgcm, each employing very different numerical approaches (finite elements and finite volume respectively). This allows us to access their capability to capture a number of coastal processes, specifically considering the role of upwelling and downwelling in the Northern Adriatic Sea. We focus on the Adriatic as its topography, having a very shallow northern basin becoming deeper towards the south, as well as the local atmospheric conditions and its large number of freshwater sources (about a third of the entire Mediterranean), make it prone to dense water events, when cold north-easterly winter winds induce dense water formation in the shallow northern coastal shelf. These extreme dense water events have many complex influences and thus are particularly challenging to understand and model, though their impact on the wider ocean circulation has made them an important topic of research. In this study we focus on one particularly strong dense water formation event that occurred in the beginning of 2012. This serves as an interesting test case to assess both the models strengths and weaknesses, while giving an opportunity to understand how these events affect coastal upwelling and downwelling processes. Using the two very different models we examine the impact of different resolutions (horizontal and vertical), different preconditionings as well as assessing the importance of non-hydrostatic dynamics, in order to identify the crucial model characteristics needed to best reproduce coastal processes.