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The sea ice component of MUSE, the unstructured-mesh global ocean model of CMCC

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The rapidly evolving sea ice cover requires novel modeling approaches and mathematical techniques to accurately simulate the sea ice dynamics, thermodynamics, and its interactions with the atmosphere and ocean at varying spatiotemporal resolutions. In this context, the CMCC is developing the Multiscale Unstructured model for Simulating the Earth's water environment (MUSE), a novel global ocean-sea ice model on unstructured meshes.

MUSE employs a finite-element numerical discretization on unstructured meshes, aiming at offering flexibility in simulating the global ocean for various applications, ranging from physical process understanding to operational sea ice predictions. The ongoing implementation of the sea ice component utilizes the traditional continuous sea ice formulation and the 2+1 split assumption, meaning that the sea ice dynamics and advection are solved for horizontal motions while the thermodynamics and radiative processes are parameterized at the subgrid scale.

MUSE employs a modified elastic-viscous-plastic (mEVP) solver for the sea ice dynamics and a Flux Corrected Transport (FCT) advection scheme, alongside the state-of-the-art column physics package "Icepack" maintained by the CICE consortium.

Here, we describe the global implementation of the sea ice component in MUSE and its coupling with the ocean. We present the resulting representation of vertical thermodynamic processes and horizontal dynamics of sea ice.