Inclusion of explicit tidal motions in ocean simulations of the North Atlantic at unprecedently high resolution.

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Basin to global submesoscale-permitting simulations of the ocean circulation down to the kilometric grid scale has recently been made technically achievable thanks to the continuous increase in performance capabilities of supercomputers. Data from this type of simulations, provided they realistically represent oceanic motions at fine scale, can be used for preparing satellite observation missions and for guiding the design of the next generation operational systems. Yet, due to the computational costs of these simulations, it remains highly challenging to perform sensitivity experiments/analysis. Moreover, the relative scarcity of observational data available at scales ~10 km makes it challenging to assess how realistic these simulations are.

The ability of these submesoscale permitting models to realistically simulate tides and internal tides remains to be addressed. In particular, there is a need to document the impact of including tidal forcing in these models, and to understand more precisely how tidal motions affects both large and fine scale flow properties.

Here, we report on the first multiyear-long sensitivity twin experiment performed with a basin-scale model at kilometric resolution for assessing the impact of the explicit representation of tides: a simulation performed with tidal motion and the other without. This twin experiment has been designed in preparation for the upcoming SWOT satellite altimetry mission. Our model, eNATL60, is a basin-scale configuration of NEMO (Nucleus for European Modeling of the Ocean) that spans the North Atlantic from about 6°N up to the polar circle, and fully includes the Gulf of Mexico, the Mediterranean Sea, and the Black Sea. The horizontal grid resolution is about 1/60° while the vertical dimension is discretized along 300 levels, for a complete computational domain of 10 billion points. With a numerical domain made of 6.3 billion compute points, the NEMO-eNATL60 model requires a minimum of 30 TB of memory; it has been running on MareNostrum IV at BSC on 18000 cores in parallel at a progression speed of about 50 minutes for one simulated model day. Our twin experiment has generated a total of 1.8 PB of data.

Our assessment of the simulated surface dynamics in eNATL60 against high resolution observation products (high resolution altimetry, ship-born thermosalinographs, mooring data) shows the skill of the model in capturing oceanic flow properties (including tidal motions) at scale down to the model *effective resolution* (~10 km). The response of the kinetic energy cascade towards fine scale, as well as the properties of sea surface height and temperature, to the tidal forcing is assessed by means of spectral analysis.