Analysis of the dynamical downscaling in an ocean model of the Gulf of Lion-Balearic-sea region: What is the spin-up time?

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Abstract

The Operational Oceanography Service of the Catalan Institute of Research for the Governance of the Sea (ICATMAR) is developing a prediction system of the essential ocean variables (3D temperature, 3D salinity, 3D ocean currents and sea surface height) in the marine area extending from the Gulf o Lions in the north, to the Gulf of Valencia in the south, including the Balearic Islands. The model resolution is about 800m (1/128°), using as initial and boundary conditions the MedSea Physics Analysis and Forecast Copernicus Marine Service (CMEMS) product with a resolution of 4km (0.042°).

The procedure of driving a high-resolution model from information of a coarser resolution parent model is known as dynamical downscaling and it is one of the common approaches to solve small-scale ocean features for specific areas. Using this methodology, a spin-up time is required for the higher resolution model to achieve its own numerical and physical stability and to develop the finer circulation structure. The ICATMAR pre-operational forecasting system is using 7 days of model initialization for 3 days of forecasting, being this a standard scheme in coastal/regional operational oceanography services.

In the framework of the AquaINFRA project, we investigate what is the actual spin-up time in our regional setting. We consider one-month simulations in the four seasons of a year, performed with two different ocean models: MITgcm and CROCO. Both models are applied to the same domain and have the same resolution, parent model and atmospheric forcings, the ERA5 hourly product. The dynamical downscaling of the models is analysed using the spatial distribution of the singularity exponents and the singularity spectra [1–4]. Figure 1 shows maps of the singularity exponents of the MITgcm modelled sea surface temperature, for the first day of the simulation and after 3 and 7 days. Results show, for both models, that a spin-up of 7 days is enough for the downscaled fields to be statistically stable at the surface, but not for fields in deeper layers.

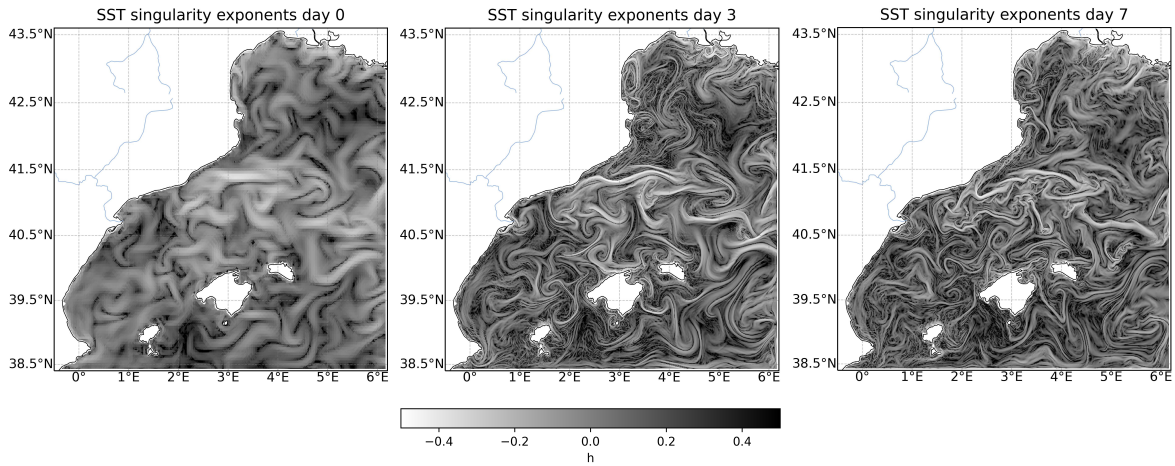

Figure 1: Singularity exponents of the Sea Surface Temperature of July 2022 simulated with a 800m resolution model of the Gulf of Lions-Balearics sea region. From left to right: At time 0 of the simulation (initial conditions from MedSea, 1st of July 2022), after 3 days (4th of July 2022), after 7 days (8th of July 2022).

References

[1] A. Turiel, C.J. Pérez-Vicente, J. Grazzini *Numerical methods for the estimation of multifractal singularity spectra on sampled data: A comparative study*, Journal of Computational Physics, 216(1), pp. 362–390, 2006.

[2] A. Turiel, H. Yahia, C. J. Pérez-Vicente *Microcanonical multifractal formalism—a geometrical approach to multifractal systems: Part I. Singularity analysis*, Journal of Physics A: Mathematical and Theoretical, 41(1), pp. 015501-015536, 2008.

[3] J. Isern-Fontanet, A. Turiel *On the Connection between Intermittency and Dissipation in Ocean Turbulence: A Multifractal Approach*, Journal of Physical Oceanography, 51(8), pp. 2639–2653, 2021.

[4] J. Isern-Fontanet, X. Capet, A. Turiel, E. Olmedo, C. González-Haro *On the seasonal cycle of the statistical properties of sea surface*, Geophysical Research Letters, 49(8), e2022GL098038, 2022.