Exploring eddy-rich ocean models and surrogate initialisation techniques for medium-range coupled numerical weather prediction

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Context, scope and methods

- ECMWF responsible for delivering the European Commission's **Extreme Digital Twin** (EDT), providing global km-scale pre-operational weather forecasts.
- IFS (atm. model) base running at 4.4km **coupled to NEMO**.
- NEMO3.4-LIM2 ORCA025 for now, with ORAS5 initial conditions (3D-VAR ocean analysis).
- Moving to **NEMO4.0-SI3 eORCA12** (~8km), with fitting ocean initial conditions (ICs).
- Investigating **two ocean-only preconditioning methods** as eORCA12-ready alternatives to data assimilation for generating ocean ICs.

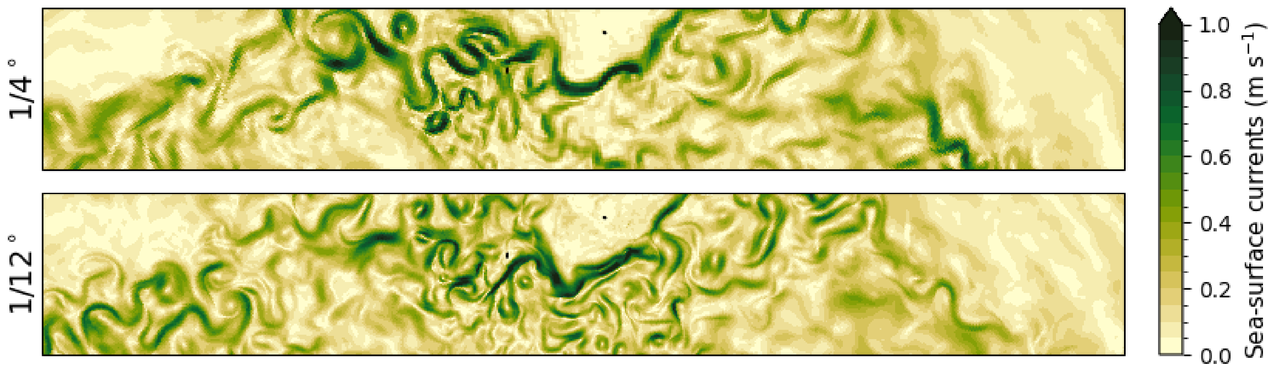


Fig. 1*: Snapshot of daily surface current velocities in coupled forecasts with NEMO at 1/4º and 1/12º (resp. top and bottom).*

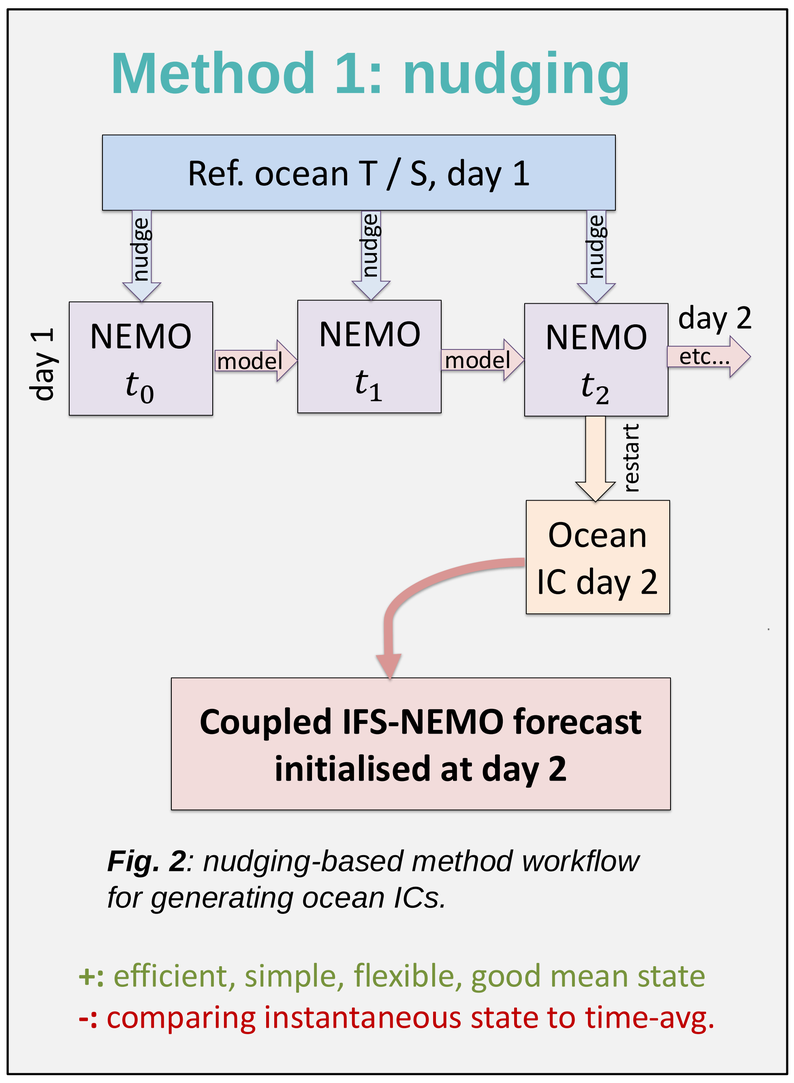


Fig. 2*: nudging-based method workflow for generating ocean ICs.*

+: efficient, simple, flexible, good mean state
-: comparing instantaneous state to time-avg.

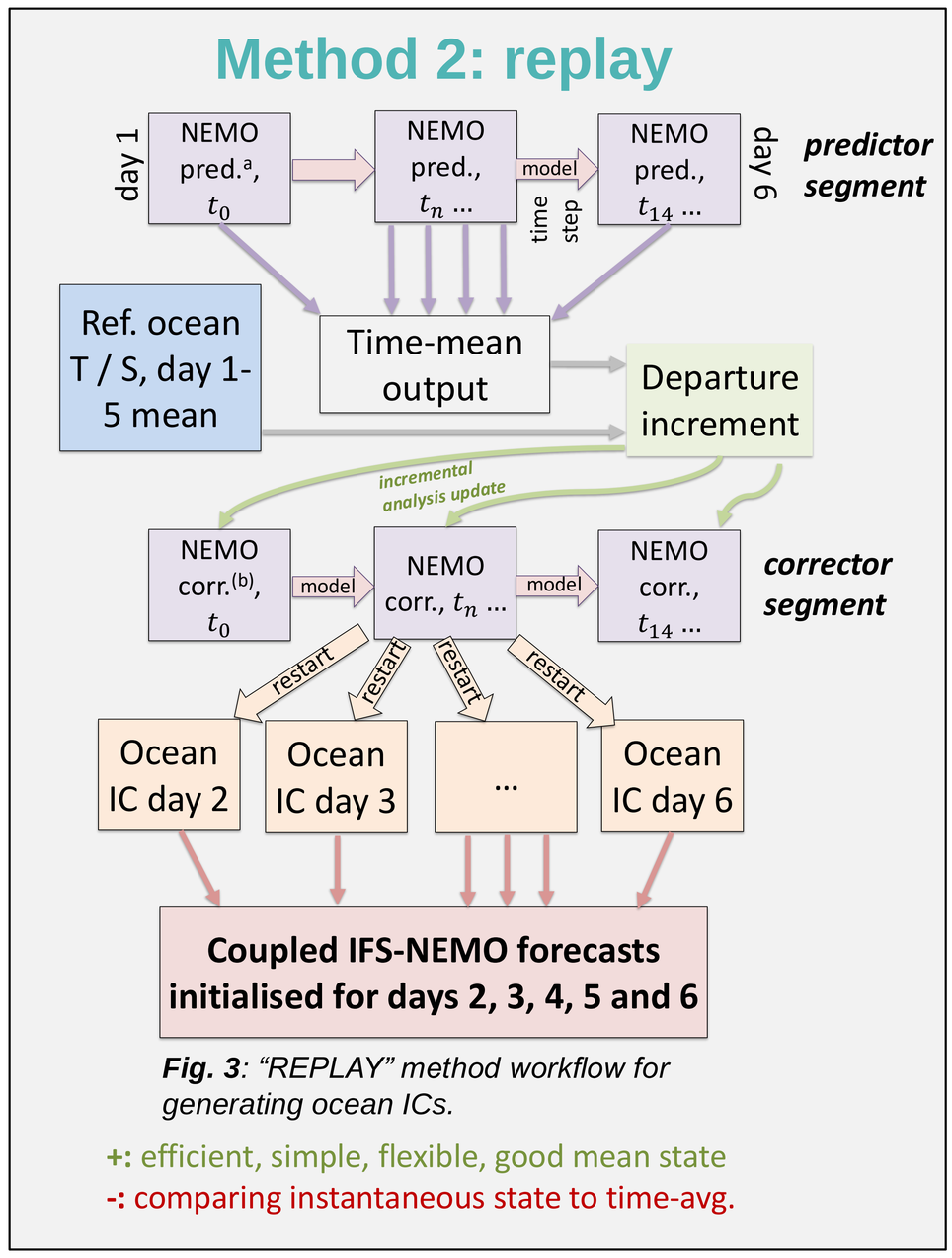
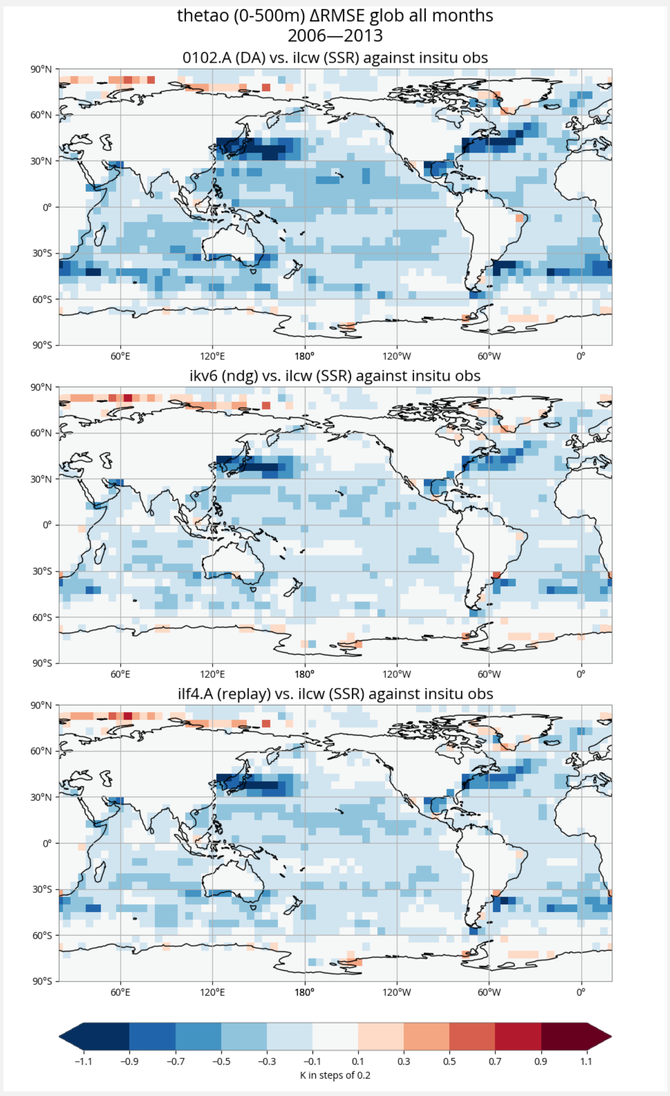


Fig. 3*: "REPLAY" method workflow for generating ocean ICs.*

+: efficient, simple, flexible, good mean state
-: comparing instantaneous state to time-avg.

Mean oceanic state in pre-runs



- Best performance obtained with data assimilation (as expected).
- Most of the skill obtained from data assimilation can be **reproduced via simple nudging and/or replay**.
- Replay **slightly** less biased than nudging (few percents).

Fig. 4*: 2006 – 2013 differences in RMSE for the ORAS6 analysis (top), nudging (middle) and replay (bottom) based analogues, all with respect to simple surface relaxation on SST (blue = good).*

Results from coupled forecasts

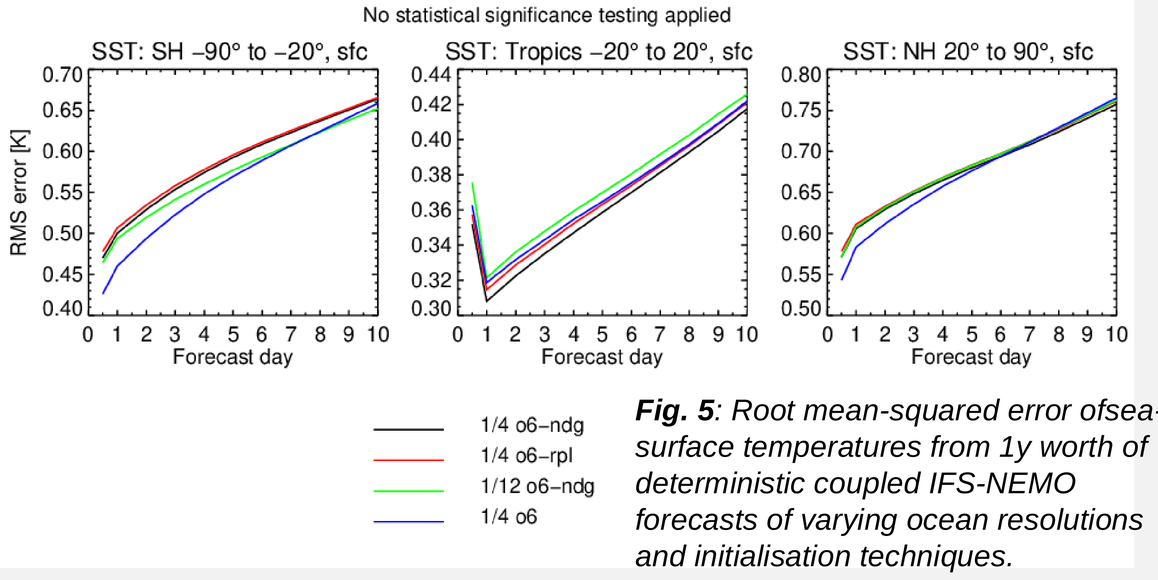


Fig. 5*: Root mean-squared error ofsea-surface temperatures from 1y worth of deterministic coupled IFS-NEMO forecasts of varying ocean resolutions and initialisation techniques.*

- Method offers **viable alternative** for initializing forecasts at nonstandard resolutions.
- Work in progress on **replay with 1/12º ocean**.

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