Analog forecasting (AnDA) and large-ensemble ocean simulations to improve satellite-derived gridded products

Yicun Zhen, Pierre Tandeo, Stéphanie Leroux, Julien Le Sommer, Pierre Ailliot, Ronan Fablet, Bertrand Chapron, Cédric Herzet, Thierry Penduff, Jacques Verron, et al.

To cite this version:

Yicun Zhen, Pierre Tandeo, Stéphanie Leroux, Julien Le Sommer, Pierre Ailliot, et al.. Analog forecasting (AnDA) and large-ensemble ocean simulations to improve satellite-derived gridded products. OceanPredict ’19 - GODAE OceanView Symposium, May 2019, Halifax, Canada. pp.1. hal-02156704

HAL Id: hal-02156704
https://hal-imt-atlantique.archives-ouvertes.fr/hal-02156704
Submitted on 14 Jun 2019

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L’archive ouverte pluridisciplinaire HAL, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d’enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.
Analog forecasting (AnDA) and large-ensemble ocean simulations to improve satellite-derived gridded products.

Authors:
Yicun Zhen
Pierre Tandeo (P.I.)
Stéphanie Leroux
Julien Le Sommer
Pierre Ailliot
Ronan Fablet
Bertrand Chapron
Cédric Herzet
Thierry Penduff
Jacques Verron
Sammy Metref

Context & Approach:
- Investigate AnDA as an alternative, data-driven method to interpolate along-track satellite altimetry data (CMEMS-3DA project).

• Approach: Twin experiment based on the OCCIPUT large-ensemble global ocean simulation.

- The OCCIPUT dataset:
  • 50 members x 20 years of daily SSH at 1/4° resolution (e.g. Penduff et al., 2014; Bessières et al., 2017).
  • Member #1 of the ensemble is taken as the truth.
  • Along-track AVISO-like pseudo-observations are extracted from this truth for 2004.
  • The 49 members and 19 years left are used as the historical catalog.

• Goal:
  • Reconstruct AVISO-like gridded products from along-track SSH.
  • Compare AnDA with Optimal Interpolation methods.

Analog Data Assimilation
AnDA (e.g., Lguensat & Tandeo., 2017).

- Analog forecasting + Ensemble Kalman filter analysis
- Data-driven approach where the analogs are searched via k-th nearest neighbours algorithm in a historical catalog.
- AnDA can be seen as an Optimal Interpolation with a physically-constrained covariance structure.
- In this project, AnDA performs the analog search in the EOF space.

Application to Lorenz-63:
- AnDA outperforms OI because:
  • It uses past trajectories to produce realistic reconstructions.
  • It uses an adaptive covariance structure (i.e. AnDA “knows” when the reanalysis is good or less good).

Application to the reconstruction of gridded SSH

Example results from a Twin Experiment in the Gulf of Mexico region:

• AnDA is able to capture high-frequency SSH signals better than OI (e.g. Florida coastal waves).
• AnDA produces realistic SSH trajectories, with a reconstructed variance less sensitive to observational sampling than OI.
• AnDA is significantly dependent on the catalog (its size, resolution, realism, etc.).

Further work is on-going to investigate how AnDA behaves in a “cousin” experiment (pseudo-obs. taken from a higher-resolution simulation than the OCCIPUT catalog) and with real observations.

Conclusions: