OceanPredict '19
GODAE OceanView Symposium | 6-10 May 2019 Halifax, Canada
Advancing the science and application of ocean predictions

Theme 4: Data Assimilation

Session 2: Variational, ensemble and hybrid methods in ocean data assimilation II

Abstract ID: 3607555

Assimilation of sea-ice concentration into a multi-category sea-ice model using an Ensemble Kalman Filter

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The future global forecast system of Mercator Ocean International, to be released by 2022, is being configured with a multi-category sea-ice model and ensemble based data assimilation method. In a multi-category sea-ice model the ice at each grid point is characterized by a finite number of sea-ice categories that are defined by classes of thickness. This means that the ice concentration in a grid point is the sum of the concentrations of each category and the sea-ice volume per unit area is the weighted mean of the ice thickness for each category where the weights are the sea-ice concentration of the corresponding category. The most important impact on the assimilation system of using such a multi-category model is the need to control the sea ice concentration and sea ice volume for each category, which are the prognostic variables, with observations of total concentration, which is a diagnostic variable. This means that we need somehow to find a sea-ice thickness distribution with the correct mean and the correct weights/concentrations without any information about its distribution. The big issue is that changes in the distribution of sea ice concentration will potentially change the total sea ice volume as well as the ice thermodynamics properties leading to bad short term forecast as well as non realistic long term trends.

In this work, the problem of assimilating sea ice concentration into a multi-category model is addressed by using ensemble methods along with stochastic perturbations of some model parameters. More specifically, the Global configuration eORCA025 is used to create an ensemble simulation. Each member is initialized from fields issued from a deterministic simulation and then atmospheric forcing fields, ice-strength concentration parameter, ice-ocean drag and the ocean state equation are modeled by an auto-regressive process with mean (mode in the case of Gamma process) equal to the parameter used in the deterministic simulation. Then an Ensemble Kalman Filter (EnKF) is used to constrain sea-ice concentration and sea-ice volume for each category. The ensembles of model simulations are compared against independent sea-ice concentration product and non-assimilated sea-ice thickness. Deterministic metrics such as bias and rms errors as well as probabilistic metrics such as rank histogram and spread/error relationship are produced for each data set.

Keywords: DA - Ensemble data assimilation, DA - Background and observation error covariances, DA - Estimates of probabilities, DA - Smoother/smoothing in data assimilation, Systems - Ocean Prediction Systems types (forecasting, analysis, scales, assessment, regions, ecosystem, ice, wave, etc.)

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Abstract ID: 3550628

Efficient Ensemble-Based Data Assimilation for High-Dimensional Models with the Parallel Data Assimilation Framework PDAF

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Discussed is how we can build a data-assimilative model by augmenting a forecast model by data assimilation functionality for efficient ensemble data assimilation. The implementation strategy uses a direct connection between a coupled simulation model and ensemble data assimilation software provided by the open-source Parallel Data Assimilation Framework (PDAF, http://pdaf.awi.de), which also provides fully-implemented and parallelized ensemble filters and smoothers. The combination of a model with PDAF yields a data assimilation program with high flexibility and parallel scalability with only small changes to the model. The direct connection is obtained by first extending the source code of the coupled model so that it is able to run an ensemble of model states, which is also usable for ensemble forecasting. In addition, a filtering step is added using a combination of in-memory access and parallel communication to create an online-coupled ensemble assimilation program. The direct connection avoids the common need to stop and restart a whole forecast model to perform the assimilation of observations in the analysis step of ensemble-based filter methods like ensemble Kalman or particle filters. Instead, the analysis step is performed in between time steps and is independent of the actual model coupler. This strategy can be applied with forced uncoupled models or coupled Earth system models, where it even allows for cross-domain data assimilation. The structure, features and performance of the data assimilation systems is discussed on the example of the ocean circulation models MITgcm and NEMO.

Keywords: DA - Ensemble data assimilation, DA - Performance and cost of data assimilation, DA - Smoother/smoothing in data assimilation, DA - Data assimilation applications,

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Abstract ID: 3566007

Development of a global ocean ensemble data assimilation and prediction system at the Met Office

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Development work is underway at the Met Office to produce a global ocean ensemble forecasting system. Using the Met Office Forecasting Ocean Assimilation Model (FOAM) as its basis, the ensemble system consists of 36 realisations of the NEMO Vn3.6 ocean model in a 1/4 degree global configuration, with sea ice capability provided by the CICE model. Each ensemble member is driven by external forcing taken from an associated member of the Met Office Global and Regional Ensemble Prediction System Global (MOGREPS-G). MOGREPS-G is a well-established system that provides a realistic ensemble of atmospheric conditions over the globe. Initial condition perturbations are applied to each ocean ensemble member through data assimilation of perturbed observations. Perturbed physical parameterisations are also being investigated. At present, each member of the ensemble uses a 3DVar-FGAT (First Guess at Appropriate Time) scheme to assimilate Sea Surface Temperature (SST), Sea Surface Height (SSH), sea ice, temperature profile and salinity profile observations. However, the ultimate aim is to switch to using a 3DVar hybrid scheme. Preliminary work to assess the use of the ensemble in the data assimilation will be presented by Lea et al. In this presentation, we discuss the ensemble system, its forcing and the applied perturbations. Results from an extended run of the system are presented, with an assessment of the mean state and ensemble spread shown.

Keywords: DA - Ensemble data assimilation, DA - Hybrid data assimilation, Systems - Implementation of Ocean Prediction Systems, Systems - Probabilistic forecasting,

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Abstract ID: 3594011

Initial experiences in using ensemble information in data assimilation with the Met Office ocean forecasting (FOAM) system

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A global ocean ensemble system is in development at the Met Office. The system uses NEMOVAR a variational data assimilation (DA) with background error covariances modelled using a multivariate balance operator and a diffusion-based correlation operator. Each ensemble member runs the 3D-Var FGAT data assimilation independently. The details of this system including how the ensemble is generated and an assessment of the ensemble performance will be described in a separate presentation by While et al. Here we focus instead on some preliminary assessments of the options to use the ensemble information from that system in the DA. This takes advantage of the hybrid ensemble capabilities of NEMOVAR. Various aspects of ensemble DA will be assessed in the context of the FOAM system including the impact of the number of ensemble members used, the localisation needed, the best level of hybridisation between the modelled error covariances and ensemble based error covariances.

Keywords: DA - Ensemble data assimilation, DA - Hybrid data assimilation, DA - Variational data assimilation, ,

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