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Bias correction with Data Assimilation

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With this work, we aim at developping a new method of bias correction using data assimilation. This method is based on the stochastic forcing of a model to correct bias.

First, through a preliminary run, we estimate the bias of the model and its possible sources. Then, we establish a forcing term which is directly added inside the model's equations. We create an ensemble of runs and consider the forcing term as a control variable during the assimilation of observations. We then use this analysed forcing term to correct the bias of the model. Since the forcing is added inside the model, it acts as a source term, unlike external forcings such as wind.

This procedure has been developed and successfully tested with a twin experiment on a Lorenz 95 model. Indeed, we were able to estimate and recover an artificial bias that had been added into the model. This bias had a spatial structure and was constant through time. The mean and behaviour of the corrected model corresponded to those the reference model.

It is currently being applied and tested on the sea ice ocean NEMO LIM model, which is used in the PredAntar project. NEMO LIM is a global and low resolution (2 degrees) coupled model (hydrodynamic model and sea ice model) with long time steps allowing simulations over several decades. Due to its low resolution, the model is subject to bias in area where strong currents are present. We aim at correcting this bias by using perturbed current fields from higher resolution models and randomly generated perturbations.

The random perturbations need to be constrained in order to respect the physical properties of the ocean, and not create unwanted phenomena. To construct those random perturbations, we first create a random field with the Diva tool (Data-Interpolating Variational Analysis). Using a cost function, this tool penalizes abrupt variations in the field, while using a custom correlation length. It also decouples disconnected areas based on topography. Then, we filter the field to smoothen it and remove small scale variations. We use this field as a random stream function, and take its derivatives to get zonal and meridional velocity fields. We also constrain the stream function along the coasts in order not to have currents perpendicular to the coast.

The randomly generated stochastic forcing are then directly injected into the NEMO LIM model's equations in order to force the model at each timestep, and not only during the assimilation step. The first results on a twin experiment with the NEMO LIM model will be presented.