Optimal adjustment of the atmospheric forcing parameters of ocean models derived from ERAinterim Reanalysis using sea surface temperature data assimilation in long term (1989-2007) simulations of the global ocean circulation.

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Near surface variables (air temperature and humidity, wind velocity, downward radiations and precipitations) from atmospheric reanalyses are commonly used as surface boundary conditions in ocean general circulation models that carry out operational forecasts, ocean reanalyses, or hindcast simulations of the recent ocean variability (the last 50 years). However, these variables are characterized by large uncertainties at global scale. For example, the use of two different databases to compute the mean ocean-atmosphere net heat flux can lead to discrepancies of the order of at least 10 W/m², when the signal of a global warming of the world ocean corresponds to a value of 0,5 W/m². On the other hand, sea surface temperature (SST) is more accurately observed from space than most near surface atmospheric variables or air-sea fluxes. However, this observed variable, intrinsically linked to air-sea exchanges, is not involved in the boundary conditions of ocean general circulation models except when explicitly assimilated. In brief, models do not benefit in their forcing from one of the best observed ocean surface variable.

The objective of this research is to constrain (within observation-based air-sea flux uncertainties) the surface forcing function of an ocean model (e.g. surface atmospheric input variables from atmospheric reanalysis) by using a methodology based on advanced statistical assimilation methods (Ensemble Kalman Filter) to take into account SST satellite observations. In other words, this work aims to take advantage of an ocean model to correct near surface atmospheric variables benefiting from their consistency with ocean surface dynamics. This work presents the originality to be carried out in a realistic case, with real SST observations assimilated in realistic global ocean model simulations.

In the present study, the aim is to estimate a set of corrections for the atmospheric input data of the ERAinterim reanalysis for the period from 1989 to 2007. We use a sequential method based on the SEEK filter, with an ensemble experiment (of 200 members) to evaluate the impact of uncertain atmospheric forcing on the ocean state. The control vector is extended to correct forcing parameters (air temperature, air humidity, downward longwave and shortwave radiations, precipitation, components of the wind vector). Over experiments of one month duration, we assimilate observed monthly SST products (Hurrel, 2008) and SSS seasonal climatology data (Levitus, 1994), to obtain monthly corrections that we can use later in a free run model. Each one month experiment is independent, and we don't apply estimated corrections to the model state. This work is carried out with a global configuration of the NEMO model, at a 2° resolution.

The results obtained for every month of the period between 1989 and 2007 show that the estimated parameters directly used in the model (in independent monthly runs) has the same type of impact on the SST than the analysis itself. This first result shows that it is possible to isolate the forcing errors impact in the ocean model in order to estimate consistent atmospheric variables corrections. On a global scale, a set of optimal flux corrections is computed that leads to a better agreement between the SST produced by a free (no assimilation) model run and SST observations over a long time period (1989-2007). Moreover, for the whole reanalysis period, the objective corrections obtained with this method are comparable, for the net heat flux, to empirical corrections applied in the past to produce better forcing (DFS4). Our corrections tend to equilibrate the net heat flux balance at the global scale, and to remove the potentially unrealistic negative trend (leading to ocean cooling) in the ERAinterim net heat flux over the whole time period. More specifically in the intertropical band, we reduce the warm bias of ERAinterim data mostly modifying th latent heat flux by wind velocity intensification. It is thus interesting to note that the wind velocity correction (+0,5m/s) leads to values comparable to QUICKSCAT radiometer winds. The objective nature of the method makes it possible to learn more about the partitioning of the corrections between all the components of the net heat flux, consistently with the ocean dynamics.

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