RESPONSE OF THE UPPER OCEAN TO ATMOSPHERIC FORCING UNCERTAINTIES IN A NORTH ATLANTIC OGCM: A STOCHASTIC APPROACH

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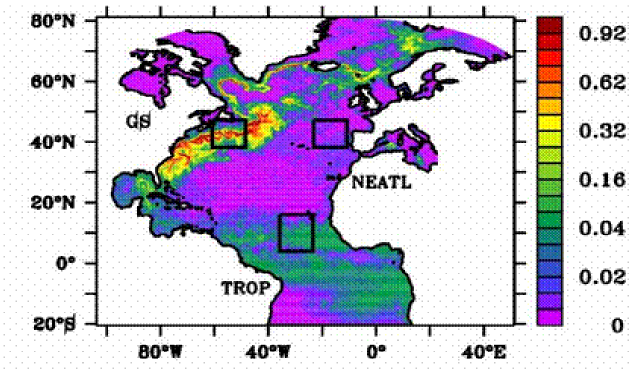
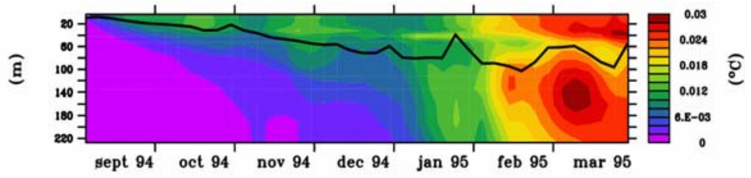


Ensemble spread in SST (in °C) in March.

The knowledge of model errors is necessary for the evaluation of the degree of realism of a simulation. Besides, data assimilation or state estimation methods require the specification of model errors. The latter arise from various sources. Uncertainties in the atmospheric forcing are expected to have significant impact at different space and time scales and many questions arise on the induced ocean response (e.g. how deep is the impact in the water column?) This study aims at answering some of these questions in the context of eddy-permitting modeling in the North Atlantic. The objective is to explore the model errors in surface layers and at monthly time scales due to uncertainties in the atmospheric fields. We use a stochastic approach: an ensemble of 50 simulations is generated by perturbing randomly the atmospheric forcing fields. The model sensitivity to the perturbations is then characterized from the ensemble statistics, mainly the ensemble spread (variance). The period of study is Sep. 1994 – Mar. 1995. The OGCM is NEMO in the 'NATL4' configuration (North Atlantic, 1/4° resolution) developed by the DRAKKAR project.



Ensemble spread (in °C) of the mean T in the GS region as a function of time and depth. Black curve: mixed-layer depth.

The analysis of the ensemble spread in temperature (T) led us to define three different areas characterized by different regimes and by distinct sensitivities to the atmospheric perturbations: in the Gulf Stream region (GS), in the North-East Atlantic (NEATL) and in the northern tropics (TROP). In each zone, we analyze the ensemble spread in T as a function of time and depth. We suggest three mechanisms that could lead to the observed responses at the time scales of interest: 1/ vertical diffusion, 2/ effect of mesoscale activity and 3/ horizontal advection. The vertical diffusion leads to a penetration of the spread from the surface to depth that is linked to the seasonal deepening of the mixed-layer. Mesoscale activity induces some spread in the ensemble because of the decorrelation of eddies and meanders between the different runs. The depth penetration of the spread is then linked to the vertical structure of the mesoscale signals. Horizontal advection by the mean currents is essentially zonal in the areas of interest (Gulf Stream and NECC/NEUC in the tropics). It tends to advect eastward some signal created upstream from mesoscale activity. The effect of advection leads to a complex vertical structure due to the vertical structure of the velocity field itself as well as to the interplay between the time scales of the currents variability and of the mesoscale decorrelation.

Reference: Lucas M., N. Ayoub, B. Barnier, T. Penduff and P. De Mey, 2008: 'Stochastic study of the temperature response of the upper ocean to uncertainties in the atmospheric forcing in an Atlantic OGCM', *Ocean Modelling*, Vol.20, 1, pp. 90-113 doi: 10.1016/j.ocemod.2007.07.006.

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