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THE IMPACT OF OCEAN INITIALIZATION FOR SST PREDICTIONS OVER THE TROPICAL OCEANS

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Introduction

At present, sea surface temperature (SST) influence in climate is unquestionable. Therefore a good SST representation by numerical ocean models is crucial for climatic studies.

Most of the surface ocean circulation is wind-driven, so when reliable wind stresses are used to force an ocean general circulation model, a good representation of the surface currents is expected. In the case of the SST simulation, besides the wind stresses, it is also necessary the addition of heat fluxes in the ocean-atmosphere interface.

All numerical ocean model solutions are only an approximation of the real ocean state. There are computational truncation and round off errors. Additionally, due to the discretization of the model ocean, some parameterizations are used to represent sub-grid processes and turbulence. For this reason, even if the model starts from a realistic state, after some time there is a deviation from the expected ocean state. To correct this problem, there are techniques to include observed data into the model, forcing the solution to be as close as possible to reality.

In this work, an ocean general circulation model is used to simulate the mean SST in November 2004 over the tropical oceans. Two experiments are compared; in the first one, no data assimilation is considered. The second one uses as initial condition for the 1^{st} of November 2004 an ocean state which includes observed data. The results are compared to observed SST data. The objective is to investigate to what extent ocean data assimilation contributes to SST prediction in the tropics.

Model settings and data

Ocean Model. The model used is the Modular Ocean Model (MOM), from the Geophysical Fluid Dynamics Laboratory, version 3.

Ocean grid. The ocean area is the global tropical ocean (180^{o}W – 180^{o}E, 40^{o}S – 40^{o}N). The longitudinal spacing is 1.5 degrees, and the latitudinal spacing is 0.5 degrees between 10^{o}N – 10^{o}S, decreasing to 3 degrees between 10^{o} and 40^{o} of latitude (see the upper part of Figure 1). In the vertical coordinate, 20 vertical levels were adopted, 7 of them in the first 100 m, spaced by 15 m.

Spin-up process. To obtain initial conditions for the 1^{st} of November 2004, the model was integrated for 30 years from Levitus climatology, forced by climatological wind stress from the ECMWF analysis (Trenberth et al., 1989), climatological solar radiation from Oberhuber (1988), and surface heat flux parameterized according to Rosati and Miyakoda (1988) bulk formulas. After this period, the model was forced by monthly means of wind stress from the NCEP/NCAR reanalysis (Kalnay et al., 1996) for the period January 1971 to October 2004.

Experiments. Two one-month experiments were done. In the first one (the "spin-up IC" experiment), the model ran from the ocean state obtained using the methodology described above. In the second experiment (the "observed IC" experiment), the initial condition was replaced by another one from a different model experiment, which considered ocean temperature and salinity data assimilation (Ben Kirtman, person. comm., 2005). This initial condition was interpolated to the model grid. Both experiments were

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forced by November 2004 NCEP/NCAR wind stresses. The SST simulated by each experiment were compared to the ERSST data ("Extended Reconstruction of SST", Smith and Reynolds, 2004).

Results

Figure 1 shows two maps related to the differences between the observed SST (ERSST) and the SST generated by each MOM experiment in November. When both maps are compared, in some areas near the continents (e.g. North and South America, Australia, South Africa), the "observed IC" experiment presents fewer difference contours, meaning that the SST simulated is closer to the ERSST. In the Tropical Pacific, the "observed IC" experiment also presents better results, because a smaller difference area is noticed. However, in the Tropical Atlantic, the maps show that both experiments presented almost the same deviation from the ERSST; little gain is obtained using initial condition based on observed data in this case. The reason for this result over the tropical Atlantic may be an indication of the importance of 1-D surface heat fluxes to control SST variability, as suggested from observational investigation (Foltz, Grodsky et al.).

Summary and Conclusion

As shown in the SST difference ma
inclusion of observed ocean data in the
condition can correct systematic erro
deviations of the model during the first
of forecast, leading to resultant SST cl
observed ones. This fact is noticed mos
tropical oceans. On the other hand, the
the model on reproducing SST in the T
Atlantic, a region known by low
predictability, the resulting SST field is
the same regardless of the initial co
used.

Current thinking suggests that
horizontal and vertical resolution can be
SST simulation (e.g. Giarolla et al. 20
the next step of this work will inclu
increasing of horizontal and vertical resolutions of the model.

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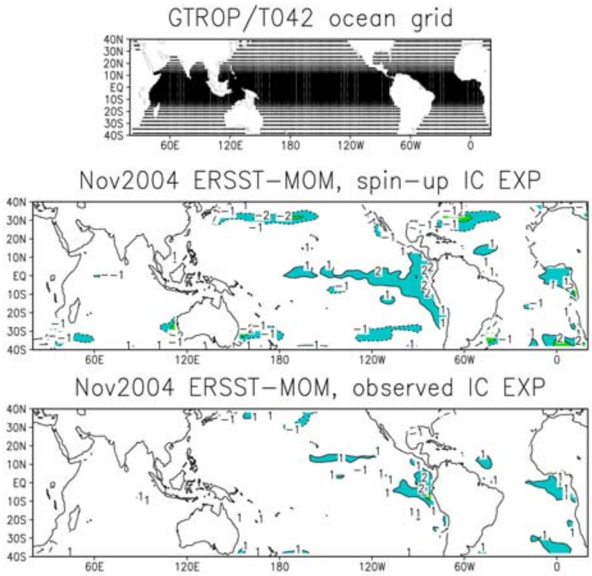

Figure 1: The ocean model horizontal grid (upper), and maps representing the difference, in degrees celsius, between observed SST (ERSST) and the MOM simulated SST in the "spin-up IC" (middle) and "observed IC" (lower) experiments.