PRELIMINARY RESULTS OF COAWST MODELING SYSTEM FOR RIO GRANDE DO SUL STATE – BRAZIL, AND CENTRAL REGION OF SOUTH ATLANTIC OCEAN

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RESUMO

Several ocean and atmospheric numerical models have been developed to improve forecasting accuracy and dynamical understanding. However, most of these models are not coupled. A two-way, coupled ocean-atmosphere-wave-sediment transport modeling system named COAWST is used and compared to an uncoupled atmospheric model. The COAWST system has ROMS as the ocean component, WRF as the atmosphere component, SWAN as the wave component, and the CSTMS as the sediment modeling component. This poster will show the preliminary results using COAWST with only WRF and ROMS. Theses models exchange Sea Surface Temperature (SST), 10m surface winds (U10m,V10m), surface atmospheric pressure (Patm), relative humidity (RH), surface air temperature (Tair), precipitation, cloud fraction, and shortwave (swrad) and longwave (lwrad) heat flux components. The experiment's study area is from 24°S to 42°S and from 65°W to 20°W, covering the Brazilian state of Rio Grande do Sul, Uruguay, part of Argentina, and part of the south Atlantic Ocean. The ROMS grid resolution is 1/6° and WRF is 17 km. Two experiments were conducted, one with ROMS and WRF coupled (COAWST) and the other with only the atmospheric model. The simulation is from December 13th, 1979 to March 1st, 1980. The results of COAWST were compared with WRF during a frontal system that occurred on February 2nd, 1980. COAWST shows a more intense frontal system with a more intense cyclone, higher temperature gradients, and higher fluxes of latent and sensible heat than the standalone WRF. Because of the higher resolution of the ROMS grid, more detailed patterns are captured and transmitted to the atmosphere through the sensible and latent fluxes. Thus, COAWST was able to simulate a frontal system more intense than standalone WRF. Observational data and further analysis are required to evaluate the effects of coupling against the standalone simulation. Also, it may be necessary to run simulations for longer periods.

INTRODUCTION

Several oceanic and atmospheric numerical models have been developed with the aim to improve knowledge of the dynamics of each system and obtain better forecasting. However most of these models are used separately, with no feedbacks between them. But using coupled models, this feedback occurs one or two-way. In this way, high resolution patterns of the atmosphere and ocean are considered in the boundary conditions of each model, allowing further studies on the effects of the atmosphere over the ocean, and vice versa. In this context, it is being developed the Coupled Ocean-Atmosphere-Wave-Sediment Transport Modeling System (COAWST) (WARNER et al., 2010). This work has the objective of evaluate the impact of COAWST system for the Rio Grande do Sul state, Brazil, and part of Atlantic Ocean.

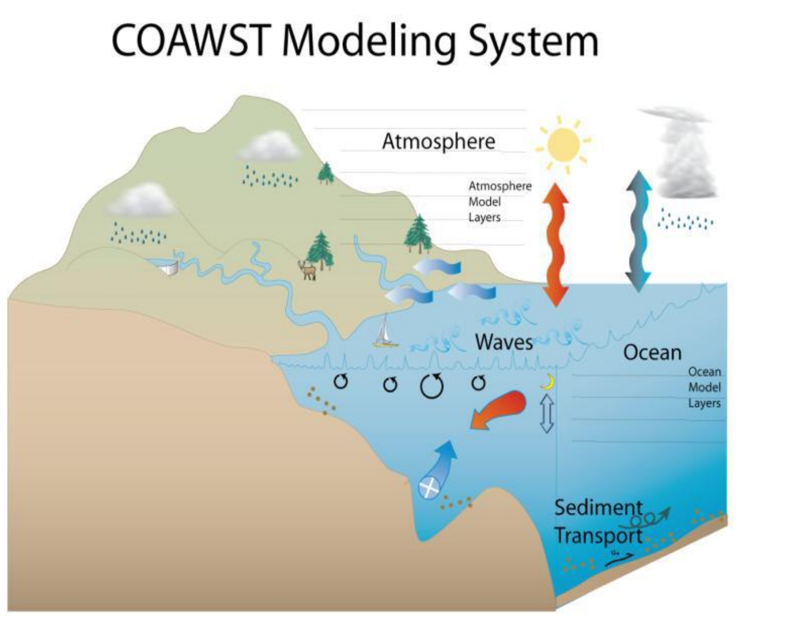

Figure 1: COAWST Modeling System and its atmospheric, oceanic, wave ans sediment transport components.
Warner et al. 2010

DATA

The study area is shown in Figure 3, which comprises the region from 26°S to 40°S and from 25°W to 60°W , covering the part of South America (AS) and the Atlantic Ocean. The WRF model was configured with horizontal resolution of 17 km and 28 vertical levels. It was used as the initial and boundary atmospheric condition the data from NCEP FNL Operational Global Analysis (http://dss.ucar.edu/datasets/ds083.2/), with horizontal resolution of 1°x1° and temporal resolution of 6h. The ocean grid has horizontal resolution of 1/6 ° and 40 vertical levels. The initial and boundary conditions are obtained from the project Simple Ocean Data Assimilation (SODA) (CARTON and Giese, 2008), with a horizontal resolution of 0.25° x0.4 ° lat-lon, with 40 vertical levels. The frequency of communication between the models was 10 minutes. The experiments were initialized on December 13, 1979 and run until March 1, 1980, with output every 12 hours.

METHODOLOGY

The modeling system COAWST (Figure 2) is composed of the atmospheric model Weather Research and Forecasting (WRF) (SKAMAROCK et al., 2005), the Regional Oceanographic Modeling System (ROMS) (SHCHEPETKIN and McWilliams, 2005), the Simulating WAves Nearshore (SWAN) (BOOIJ et al., 1999) and the model of the Community sediment transport Modeling Project (CSTM) (Warner et al. 2008). This system allows the exchange of information between the models mentioned with a frequency adjustable by the user. The communication between the models is done by Model Coupling Toolkit (MCT) (Larson et al. 2004; Jacob et al. 2005). The ocean model provides to WRF the sea surface temperature (SST) and the to SWAN bathymetry (bath), free surface elevation (η) and surface currents (u_s;v_s). The WRF provides to ROMS 10m surface winds (U_{wind}, V_{wind}), atmospheric pressure (P_{atm}), relative humidity (RH), surface air temperature (T_{air}), cloud fraction (cloud), precipitation (rain), longwave (LW_{rad}) and shortwave (SW_{rad}) net heat fluxes, and to SWAN, ROMS provides U_{wind} e V_{wind}. The wave model provides to WRF and ROMS significant wave height (H_{wave}) and wave length (L_{wave}). SWAN still provides to ROMS wave direction (D_{wave}), surface and bottom periods (T_{surf}, T_{bott}), percent wave reaking (Q_b), wave energy dissipation (W_{dissip}) and the bottom orbital velocity (U_b). The sediment model is fully coupled to the ROMS, with its routines integrated into the ROMS, it is not

In this poster its shown preliminary results of the implementation of COAWST system in the cluster from Federal University of Rio Grande do Sul. In order to evaluate the system in a simpler way, increasing the complexity according to results obtained were conducted two experiments. One with only WRF model and another experiment with WRF model coupled to ROMS model (COAWST).

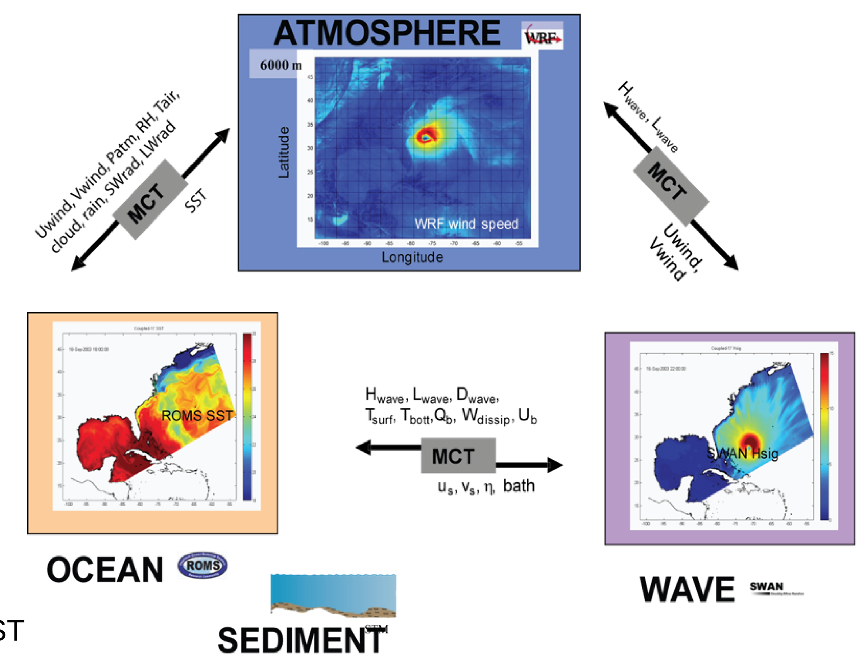

Figure 2: Data fields exchange between each model in COAWST system.
http://woodshole.er.usgs.gov/operations/modeling/COAWST/index.html

PRELIMINARY RESULTS

Figure 3 shows sea level atmospheric pressure (hPa) (SLP), Temperature at 2m (° C), sea surface temperature (SST) (° C), Latent and Sensible heat flux (W/m²), Precipitation (mm) and Relative humidity at 2m (%) at 00UTC February 2nd, 1980. In the SLP field from COAWST experiment is observed a low pressure system centered at 37°S 33°W, associated with a cold front extended to the coast of the State of Santa Catarina. In experiment WRF, the cyclone is more southerly than in COAWST experiment, and less intense. The air temperature gradient due the cold front is higher in the COAWST experiment too. These results are associated with higher values of sensible and latent heat flux, as can be seen on the figure 3. During almost all simulation, COAWST experiment estimate higher values of sensible and latent heat fluxes than WRF experiment.

This is caused by the SST estimated by ROMS model, that is hotter than SST used as boundary condition used in WRF. Another observation to be made is the more detailed patterns of SST in the Atlantic Ocean simulated by ROMS in COAWST experiment, seen in Figure 3. This result is seen throughout the entire simulation period (figures not shown), as expected, since with a finer grid, ROMS model is able to simulate the smaller scale phenomena in the ocean, thus transferring that detailed information to atmosphere. This is one of the biggest advantages in coupled modeling system. Because events not simulated by the boundary conditions can be included.

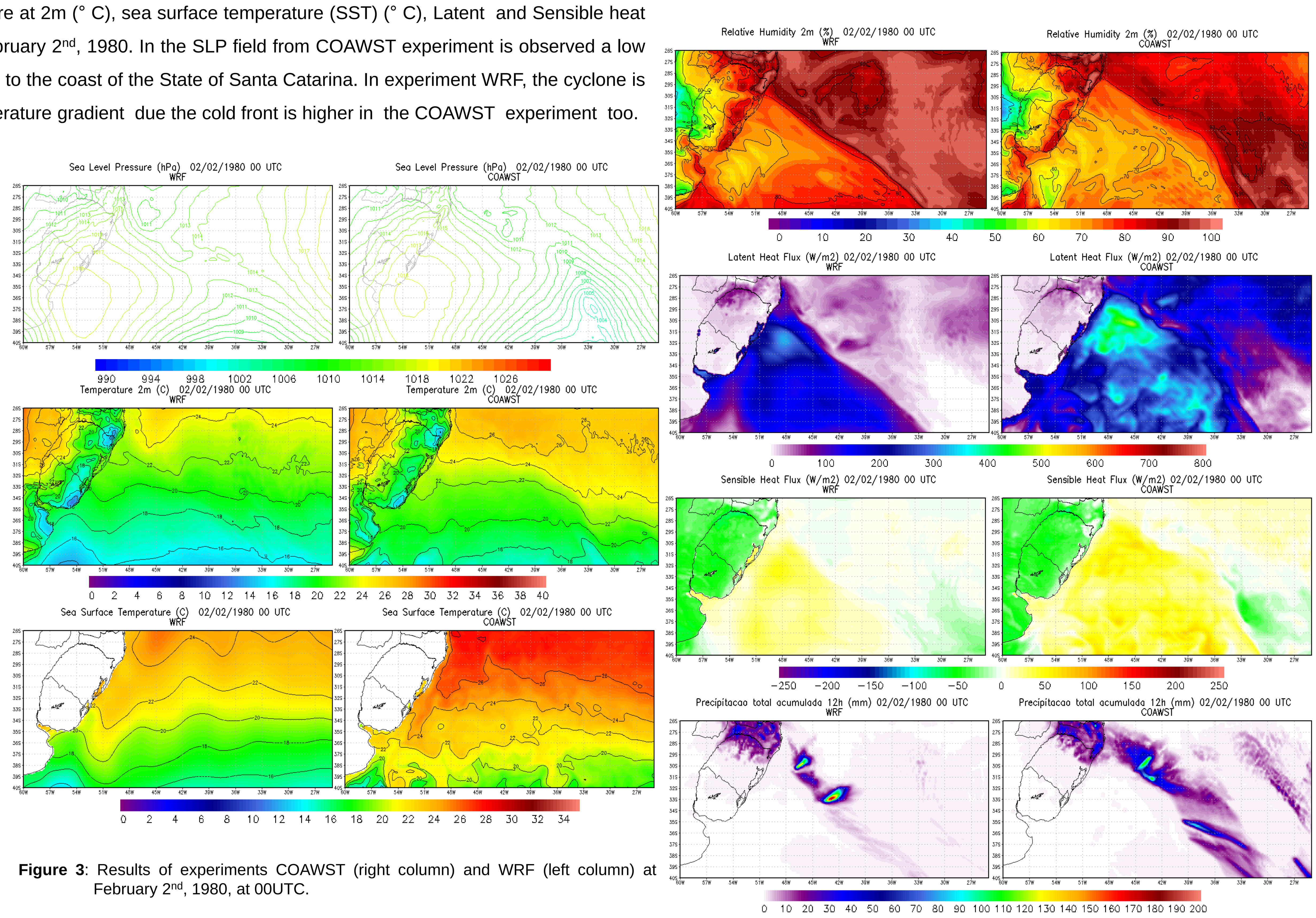

Figure 3: Results of experiments COAWST (right column) and WRF (left column) at February 2nd, 1980, at 00UTC.

CONCLUSIONS

The COAWST modeling system proved capable of simulating a frontal system, transferring information between the oceanic and atmospheric models every 10 minutes. The ROMS model estimate higher SST than SST in boundary condition used in the WRF experiment, leading to higher values of latent and sensible heat flux. The system COAWST remained stable during the simulated period, showing no outliers during simulation. But it is necessary to compare the observed data to analyze the results presented COAWST closer to reality than the WRF model.

OUTLOOK

This work is part of SIMTECO project, fostered by FINEP. We intend to perform longer simulations, using all modules of the system and validate against observed data, and them obtain a complete forecasting system of atmospheric, oceanic and wave state.

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