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INTERACTIONS BETWEEN THE GEM ATMOSPHERIC MODEL AND AN ICE-OCEAN MODEL OF THE GULF OF ST. LAWRENCE

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1. INTRODUCTION

*This poster presents experiments in which the Canadian operational GEM atmospheric model (Côté et al., 1998) is coupled to the ice-ocean Gulf of St. Lawrence model developed at l'Institue Maurice-Lamontagne by Saucier et al. (2002). A storm event from March 1997 is simulated and it is shown that the two-way interaction between the atmosphere and the ocean surface is important for accurately forecasting air temperature and sensible heat fluxes near the coasts.

Section 2 describes the experimental set-up, results are presented in section 3, and section 4 consists of a concluding discussion.

2. DESCRIPTION OF THE EXPERIMENT

Surface conditions between March 13 and 15, 1997 are simulated using two different treatments of the Gulf of St. Lawrence in the GEM model. In the first simulation, which will be referred to as uncoupled, GEM uses a fixed ocean boundary layer derived from operational analyses. In the second simulation, at each time step (600 s), GEM is coupled interactively with the ice-ocean model that provides the sea surface temperature, ice surface temperature, and dynamic ice conditions. The atmospheric forcing that is provided to the ice-ocean model includes wind, air temperature, cloud cover, and moisture. For this preliminary experiment, sea surface heat fluxes were calculated separately by both the GEM model and the ice-ocean model, and were reasonably consistent.

3. PRELIMINARY RESULTS

Strong northwesterly winds produced significant ice drifts between March 13 and 15, 1997, creating areas of open water along the northern coast of the Gulf of St. Lawrence. The modeled ice concentration from the coupled simulation after 48 h faithfully reproduced the observed ice patterns (result not shown). Since sea surface water temperature is considerably warmer than the atmosphere in winter, areas of open water are expected to transfer significant amounts of sensible heat to the atmosphere, particularly if the winds are strong. In our case, the heat is transported roughly from the northwest to the southeast over the Magdalen Islands. Fig. 1 compares the observed and modeled surface air temperature for 46 coastal locations around the Gulf of St. Lawrence. The temperatures produced by the uncoupled (dashed) simulation are colder than those produced by the coupled (solid) simulation. The mean error of the surface air temperatures produced by the coupled simulation at these locations is a factor of 10 smaller than that produced by the uncoupled simulation. Compared with its original uncoupled setup, the GEM model with a dynamic ice cover gives more accurate air temperature forecasts for

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71% of the 46 stations. In the coupled simulation, the feedback from the increased air temperature over the gulf is important near marginal ice areas, considerably affecting the sensible heat flux computed by the ice-ocean model, with a suggested over-estimation in the uncoupled simulation due to its colder air temperature.

4. CONCLUDING DISCUSSION

In this preliminary experiment, it was found that the interactive coupling of the GEM model and the ice-ocean model can give significant improvements in forecasts of surface air temperature around the Gulf of St. Lawrence during times of rapid change in ice cover. The warmer air temperatures also had a strong impact on the simulation produced by the ice-ocean model. These are important results that raise questions about the original flux parameterizations used in the uncoupled models, and the impact of using separate atmosphere and ocean components for meteorological and climate studies in the Gulf of St. Lawrence. More detailed results on this atmosphere-ocean interaction study will be presented in the poster at the conference.

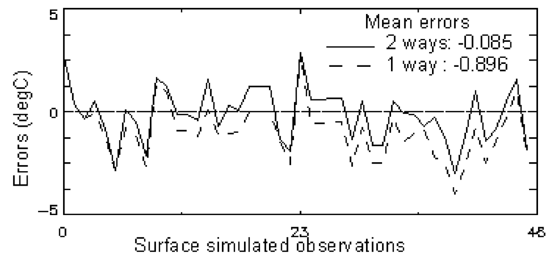

Fig. 1 Errors in simulated observations for surface temperatures (degC). 24 hours forecast valid at 00 UTC 14 March. Solid and dashed lines represent respectively the coupled and uncoupled simulations. The mean error of the coupled simulation is smaller (factor 10). The uncoupled simulation is colder.

REFERENCES

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