8.2 VERIFICATION OF REAL-TIME NON-HYDROSTATIC ETA MODEL FORECASTS FOR SOUTHERN NEW ENGLAND

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1. INTRODUCTION

The National Ocean Service's (NOS) Coast Survey Development Laboratory has implemented NOAA's Local Analysis and Prediction System (LAPS) for the Narragansett Bay and adjacent coastal waters. The LAPS implementation is part of a 3-year project funded by the National Oceanographic Partnership Program (NOPP) and lead by the University of Rhode Island and Drexel University. The LAPS analyses and forecasts will be used as surface forcing by a real-time oceanographic prediction system being developed for the Bay and adjacent waters by project partner Applied Science Associates, Inc. The forecast model used in LAPS is a workstation version of the non-hydrostatic Eta mesoscale prediction model released by the National Weather Service (NWS)/National Centers for Environmental Prediction's (NCEP) Environmental Modeling Center in April 2001.

The purpose of this paper is discuss a preliminary verification of the surface forecasts over the Narragansett Bay Watershed region in Southern New England from the workstation Eta model.

2. NON-HYDROSTATIC WORKSTATON ETA MODEL

The workstation version of the non-hydrostatic Eta model was implemented in NOS's Coast Survey Development Laboratory on an SGI Origin 2000 workstation (8 processors) in the Fall of 2001. The grid domain covers the Southern New England and adjacent coastal waters. The model is run once a day on a 0000 UTC forecast cycle out to 24 hours. A description of the version implemented at NOS is given below.

2.1 *Grid Configuration*

The model has a horizontal resolution of approximately 4 km and 38 vertical sigma levels, because the use of the eta coordinates generated unrealistic wind fields.

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The model's original NCEP 2 minute land/water mask for the domain was replaced with a higher resolution 30 second mask. Additional manual editing was done to improve representations of bays and sounds.

2.2 *Parameterizations*

The model uses a variety of parameterization schemes. The Mellor-Yamada (1982) level 2.5 turbulence closure scheme is used for parameterizing vertical turbulence exchange. For precipitation, two schemes are used. The Betts-Miller-Janjic cumulus parameterization scheme developed by Betts and Miller (1986) and refined by Janjic' (1994) is used for calculation of convective precipitation. For grid-scale precipitation, an explicit cloud water parameterization scheme (Zhao et al. 1991) is used. The cloud water parameterization scheme takes into account the physical processes of evaporation, condensation, melting, freezing, sublimation, and deposition, which occur in the atmosphere. Radiation processes are parameterized using the NOAA/Geophysical Fluid Dynamics Laboratory radiation package. A 4-layer soil model is used for soil temperature and moisture calculations. The model takes into account soil and vegetation types, and green vegetation fraction.

2.3 *Initialization*

The initial conditions are based on the analysis from NCEP's Eta Data Assimilation System (EDAS) valid at 0000 UTC. The lateral boundary conditions are obtained from the 3 hourly forecasts from the 0000 UTC forecast cycle of NCEP's operational Eta-12km mesoscale model. In both cases, the EDAS and Eta-12 model output is obtained from the NWS's AWIPS 32km resolution dissemination grid.

Sea surface temperatures (SST) for the oceans and the Great Lakes are based on NCEP's daily, real-time, global, 0.5 deg resolution SST analysis. The daily sea surface temperature product is produced on a half-degree (latitude, longitude) grid, with an optimum interpolation analysis of the most recent 24-hour buoy, ship and satellite SST data. Snow and sea ice cover is based on NESDIS' daily 23-km analysis. The initial snow depth is defined by the daily 47-km resolution U.S. Air Force U.S. snow depth analysis. If the NESDIS analysis has snow cover, but the U.S. Air Force analysis does not, then a default snow depth of 2 inches is assigned.

2.4 Forecast Fields

The Eta model output has similar fields as those from the operational Eta model at NCEP. However, for this NOPP project, the focus is on variables required for defining surface boundary conditions for the numerical ocean model. These include surface air and dew point temperatures, wind velocity, total cloud cover, total precipitation, evaporation, sensible and latent heat fluxes, and short- and long-wave radiation. An example of the sensible flux field is shown in Fig. 1. The sharp difference between sea and land fluxes over the Narragansett Bay is well described by the model.

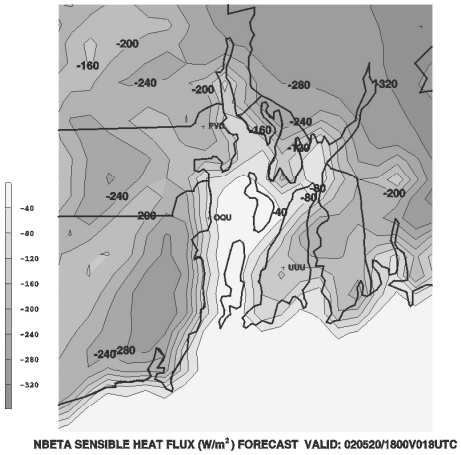

Fig. 1: Example of the 18-h forecast of sensible heat flux over Narragansett Bay and adjacent waters. Also depicted are the locations of selected observing stations: Providence T.F. Green State Airport (PVD); Quonset State Point (OQU); and Newport State Airport (UUU).

3. PRELIMINARY EVALUATION

A comparison of Eta model forecasts to different types of observational networks is being performed. Time series for surface temperature, dew point, wind speed and direction from the model are compared to those of NOS Physical Oceanographic Real-Time System (PORTS) stations in Narragansett Bay and weather stations in southern New England. Also, the surface fields are compared with the LAPS analysis, as well as with the operational NCEP Eta model (12 km resolution).

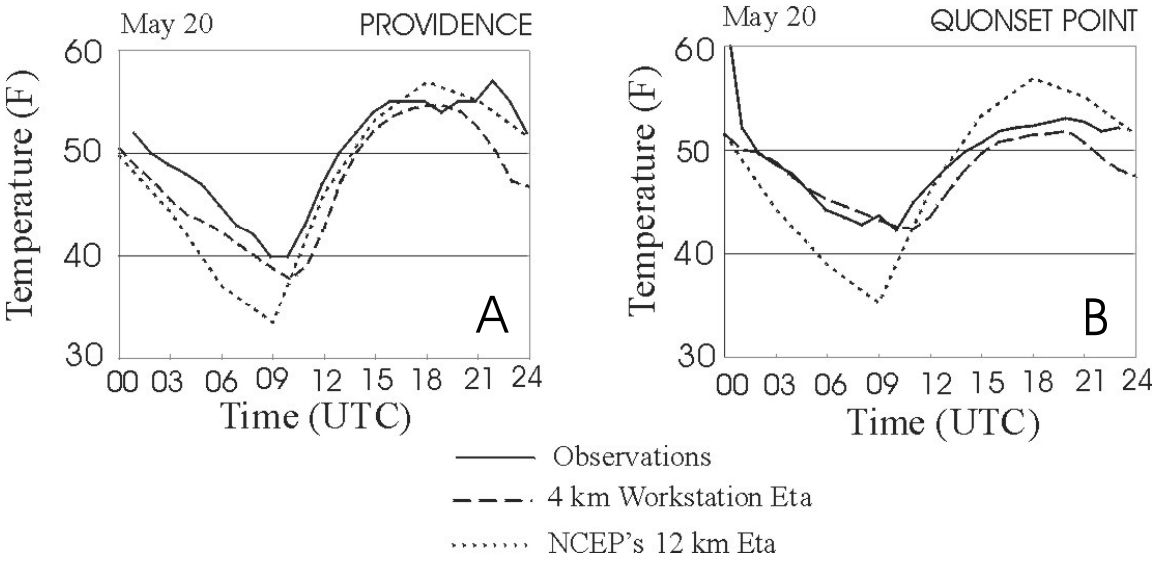

Fig. 2: Hourly surface air temperature forecasts for May 20, 2002 from the workstation Eta model at Providence T.F. Green State Airport automated surface observing system (ASOS) Station (A), and Quonset Point NOS PORTS Station (B). Also depicted are observations and 3 hourly forecasts from the Eta-12 model valid at the same time.

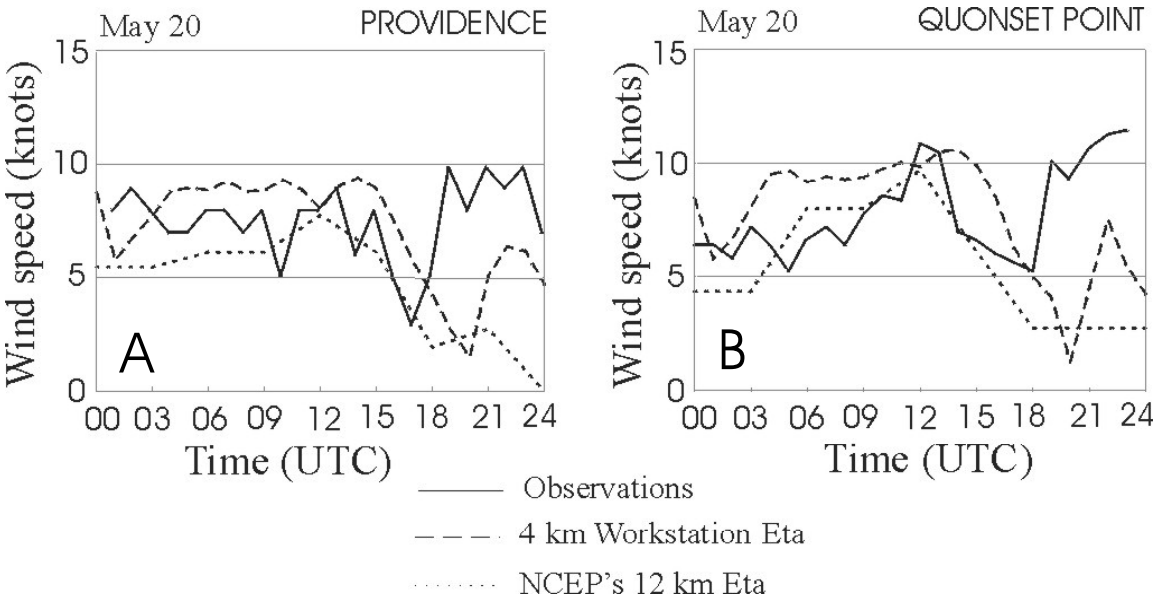

Fig. 3: Same as Fig. 2, except for surface wind forecasts.

Time series shown in Figs. 2 & 3 correspond to two closely located stations (4 km distance). One of the stations (Providence) is located over the land, and the other one (Quonset Point) is located over the water. As the time series show, the maximum observed day temperature (solid lines) was about 57°F over the land and about 53°F over the water. Eta 4 km depicts this difference relatively well whereas the Eta-12 demonstrates almost the same temperatures at both stations (i.e. Eta-12 doesn't resolve the water). The wind speed comparison for these two stations shows relatively good prediction by both Eta-4 and Eta-12 during the first 18 hours. Neither Eta-12 nor Eta-4 predict the speed increase during the last 6 hours of the forecast although the Eta-4 does show increasing wind between 20 and 22 hours of the forecast.

For verification of spatial distribution of forecast fields, the LAPS analysis is used. Fig. 4 shows the comparison between Eta-12 (available through AWIPS 32 km grid), Eta-4 and LAPS analysis. The surface temperature from Eta-4 demonstrates large variability, mainly following the topography. This is in good agreement with the LAPS analysis. Also, there is a sharp zone between land and sea in Eta-4. Eta-12 temperature is much smoother, not showing the topographic details and the land-water contrast.

The LAPS wind analysis (Fig. 4) depicts NE wind over the sea, and NW winds over southern New England. Along the RI and CT coasts, Eta-4 predicted a turning of the surface winds to a southerly direction (Fig 4b), which is seen in the LAPS analysis (Fig. 4f). Taking into account that there was no strong synoptic flow, this situation could be related as a weak sea breeze, although the temperature differences were not very strong. Both models predict the zone of weak winds, but Eta-4 was better in predicting a wind shift to a southerly direction at several grid points over the coast.

4. SUMMARY AND PLANS

The workstation version of the non-hydrostatic Eta model has been implemented at NOS at horizontal resolution of 4 km with 38 vertical sigma levels. The original 2 minute resolution land/water mask was replaced with greater resolution 30 second data. Additional manual editing of the land/water mask was done to improve the representation of Narragansett Bay and other bays and sounds in the region. The Eta model is run once a day out to 24 hours to provide surface forcing for a real-time numerical ocean model for the Narragansett Bay and adjacent coastal waters.

A comparison between Eta 4 km model, observations from different sources and the LAPS analysis shows relatively good agreement between forecasts and observations. Land-sea differences are well described, although in some synoptic situations the predicted values may not match the observations. Further testing of model parameterization schemes and their appropriateness for very high resolutions, as well as using a local analysis for initial conditions, are planned. Also, a comparison to more mesonet stations and upper-air profiles from radiosondes is planned.

5. ACKNOWLEDGMENTS

The project is funded by a grant from the National Oceanographic Partnership Program. Thanks to Matt Pyle of NCEP for his advice in setting up the workstation Eta model at NOS.

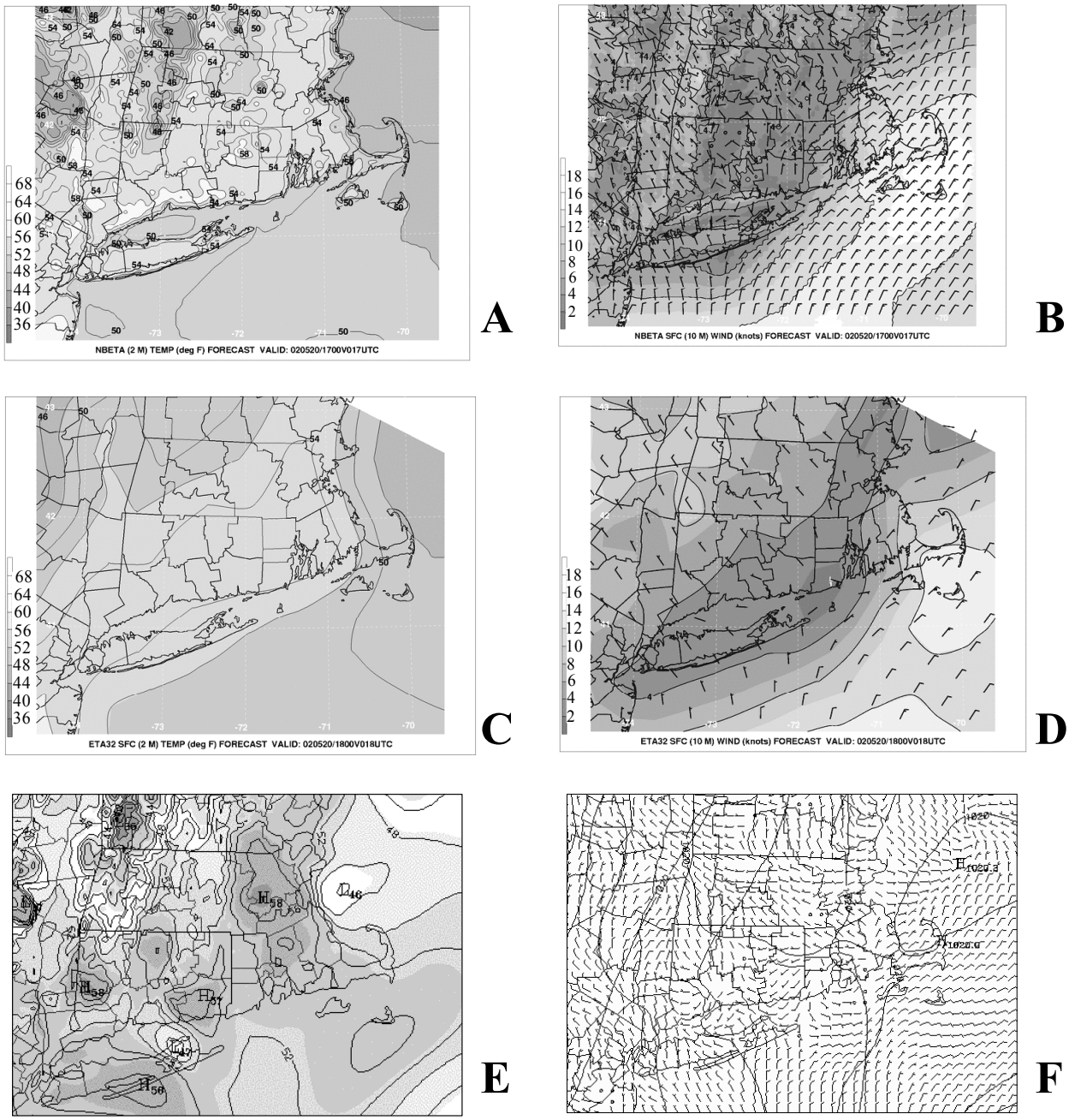

Fig. 4: Surface air temperature and winds for 17 UTC May 20, 2002: Eta-4 forecast (A, B); LAPS analysis (E, F); and for 18 UTC May 20, 2002: Eta-12 forecast (C, D).

6. REFERENCES

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