OPERATIONAL NUMERICAL WEATHER PREDICTION ON THE CYBER 205 AT THE NATIONAL METEOROLOGICAL CENTER

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The Development Division of the National Meteorological Center (NMC) has the responsibility of maintaining and developing the numerical weather forecasting systems of the center. Because of the mission of NMC these products must be produced reliably and on time twice daily free of surprises for forecasters. Personnel of Development Division are in a rather unique situation. We must develop new advanced techniques for numerical analysis and prediction utilizing current state-of-the-art techniques, and implement them in an operational fashion without damaging the operations of the center.

In the past, modifications have been made to the operational job suite without adequate testing and evaluation because computational resources were not available to produce enough case studies for evaluation. Hopefully, with the computational speeds and resources now available from the Cyber 205, Development Division Personnel will be able to introduce advanced analysis and prediction techniques into the operational job suite without disrupting the daily schedule.

The operational job suite prior to the installation of the Cyber 205 contained four major components: 1. A barotropic numerical model extending over the Northern Hemisphere giving forecasters an early look at the new synoptic situation immediately after data collection at the start of the twice daily operational cycle. 2. A Limited Fine Mesh (LFM) primitive equation numerical model extending over the North American continent. The LFM is started about 1 hour 45 minutes after data collection producing numerical guidance for use by forecasters when they make their 12 to 48 hour forecasts. 3. A global primitive equation numerical model using a spectral representation to produce numerical guidance for use by forecasters in the 2 to 5 day range. This model is started at about 4 hours after each twice daily collection of atmospheric data. 4. A global data assimilation cycle is started about 10 hours after data collection and is used to produce the first guess fields for the next synoptic cycle. The data assimilation cycle consists of an optimum interpolation analysis and a global spectral model which are used to produce two six hour analysis/forecast cycles. In addition to these four major components, a Moveable Fine Mesh model is available when needed to produce forecasts of hurricane movement. The hurricane model has the capability to move with the hurricane as it forecasts the storm track for periods of 48 hours.

The operational implementation of these analysis/forecast systems on the Cyber 205 will have to proceed in a careful controlled manner so that daily production schedules are maintained. For this reason, each component of the operational suite must be carefully evaluated and tested after conversion to the Cyber 205. All components of the present system scheduled for implementation on the Cyber 205 will be converted in their present form with the current resolution and numerics in order to evaluate their performance in a parallel fashion. After about a month of successful parallel tests the component will become operational on the Cyber 205.

The National Weather Service received their Cyber 205 in May of 1983 and the first operational product appeared on August 30, 1983. The LFM was successfully implemented on the Cyber 205 and has been producing numerical guidance twice a day since that time. The final version of the LFM computer program that was implemented takes about 75 seconds of CPU time to produce a 48 hour forecast. This is about 15 times faster than the IBM/195 version of the same model. The LFM is a grid-point model containing 7 layers with 53 x 45 grid points in each layer. Five prognostic variables (pressure, temperature, moisture, and two components of wind speed) are specified at each of the 16,695 grid points. The primitive equations are solved in finite difference form for each of the prognostic variables and then advanced forward in time with an explicit

time step. Nine 400 second time steps are required for each hour of model integration which yields a total of 432 explicit time steps to produce a 48 hour prediction.

The conversion of the LFM computer code to the Cyber 205 was accomplished in about 1.5 months by a skilled meteorologist/programmer. The 2.0 FORTRAN compiler was used to produce a half precision version without resorting to Q8 special calls. The data structure of the original version of the model was changed extensively to take advantage of long vector lengths. Minimal vectorization of the radiation and moist physics was achieved with use of the vector WHERE statement.

Operational use of the Cyber 205 has shown that the system is certainly reliable and capable of achieving vendor advertised CPU speeds. With this new resource the National Weather Service should be able to improve most aspects of numerical weather prediction systems including the prediction of major precipitation events. With the increase in computing power, the National Weather Service will be able to run operational numerical guidance systems with improved analysis methods, improved model physics and increased mathematical accuracy.