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C O N T E N T S

AMERICAN REVOLUTION BICENTENNIAL 1776-1976

ABBREVIATIONS AND ACRONYMS

ABL	Atmospheric Boundary Layer
AMS	American Meteorological Society
ATA	Air Transport Association
BUV	Backscatter Ultraviolet
CDC	Control Data Corporation
CPU	Central Processing Unit
DFI	Digital Facsimile Interface
DGTS	Digital Graphics Transmission System
DST	Data Systems Test
FAXX	Automated Facsimile Transmission System
GATE	GARP Atlantic Tropical Experiment
GFDL	Geophysical Fluid Dynamics Laboratory
GISS	Goddard Institute for Space Studies
IBM	International Business Machines
ITPR	Infrared Temperature Profile Radiometer
LFM	Limited-area Fine-mesh Model
NASA	National Aeronautics and Space Administration
NCAR	National Center for Atmospheric Research
NESS	National Environmental Satellite Service
NMC	National Meteorological Center
NOAA	National Oceanic and Atmospheric Administration
NWP	Numerical Weather Prediction
NWS	National Weather Service
PBL	Planetary Boundary Layer
PE	Primitive Equation
RAOB	Radiosonde Observation
VTPR	Vertical Temperature Profile Radiometer
WMO	World Meteorological Organization
3L GLOBAL	Three-layer Global Model
8L GLOBAL	Eight-layer Global Model
6L PE	Six-layer Primitive Equation Model

PREFACE

At its sixth session, the WMO Commission for Atmospheric Sciences proposed that progress reports on numerical weather prediction be submitted to the Secretary-General on an annual basis. The Executive Committee subsequently adopted this recommendation and incorporated it into their resolutions.

In response to this resolution, the National Meteorological Center will issue an annual report on its NWP activities early in the first part of each year, in time to reach the Secretary-General by 1 March. Consequently, the NMC Semiannual NWP Activities Report will cease with this issue.

The new annual reports will receive the same distribution that the semiannual reports received in the past.

I. INTRODUCTION

This report summarizes the Numerical Weather Prediction activities of the National Meteorological Center for the second half of 1974.

A major effort in converting computer programs from the triple CDC 6600 system to the dual IBM 360/195 system continued. By December, most of this conversion was completed and the work on optimizing the codes was underway.

The major changes made in the operational numerical forecasting system with the conversion to the IBM 360/195 were:

(1) The Cressman analysis technique and the Shuman-Hovermale six-layer model were removed from the "Final" cycle (data cut-off 10 hours after 1200 GMT) on September 18, 1974. The Flattery spectral analysis technique and the Stackpole eight-layer primitive equation model with a $2\frac{1}{2}^{\circ}$ latitude-longitude global grid were implemented. This new system was implemented twice per day, 10 hours after 0000 and 1200 GMT.

(2) On September 18, 1974, the Flattery analysis method was also implemented into the twice-per-day "Operational" cycle (data cut-offs 3 hours and 20 minutes after 0000 and 1200 GMT).

A major objective in 1975 is the implementation of a version of the Stackpole eight-layer model into the Operational cycle.

The following is a brief description of the NMC operational numerical weather prediction system. The four basic cycles, RADAT, LFM, Operational, and Final, were run daily from 0000 and 1200 GMT data times.

RADAT. The RADAT cycle was initiated 1 hour and 30 minutes after data time. It consisted of the Cressman-type analysis method and the filtered barotropic model with long-wave stabilization control. The nonlinear balance equation was used. The 500-mb forecasts contained terrain and skin friction effects estimated from a 850-500 mb thickness forecast made simultaneously. The integration domain was the 1977-point octagon with the 381-km grid interval on the polar stereographic projection (true at 60°N). Forecasts were made to 48 hours. This system was the same as used in 1973, except that by early October 1974 it was running on the IBM 360/195 with the Flattery analysis system.

LFM. The LFM cycle began 2 hours after observation time. It was essentially the same as the one used in 1973. Its basic characteristics were:

- Cressman-type analysis system;
- Initially, the rotational wind component was obtained from the analyzed wind field and the divergent component was obtained from the 12-hr forecast made in the previous Operational cycle;

- Forecast model was the modified version of the 6L PE;
- Area domain was North America;
- Grid was 53 x 45 and grid interval was 190.5 km at 60°N on the polar stereographic projection;
- Leapfrog time differencing with the invariant form of Shuman's semimomentum horizontal differencing;
- Forecast length was 24 hours;
- Lateral boundary condition incorporated the use of smoothed tendencies of the 12- to 36-hr forecasts of the 6L PE made in previous Operational cycle;
- Model design incorporates the effects of mountains, moisture, radiation, skin friction, sensible heat exchange over oceans, and convection.

Operational. The Operational cycle was begun 3 hours and 20 minutes after observation time. Until September 18, 1974, the system was the same as that used in 1973. It was basically similar to the LFM system but the 6L PE covered a hemispheric 65 x 65 grid domain with a 381-km grid distance. A "wall" lateral boundary condition was used. Forecasts were made to 84 hours from 0000 GMT data and 48 hours from 1200 GMT data. As part of NMC's 5-day forecast program, these forecasts were extended barotropically to 156 hours at 0000 GMT and to 96 hours at 1200 GMT. The Reed model (1963, NMC Technical Memorandum No. 26) was used to produce a 1000-500 mb thickness prediction from 84 to 156 hours at the 0000 GMT cycle. After September 18, 1974, the Flattery global analysis technique replaced the Cressman analysis system.

Final. The Final cycle was begun 10 hours after observation time. Prior to September 18, 1974, the cycle was run with 0000 GMT data only and the 6L PE was integrated to 12 hours to produce the first guess for the analysis in the following cycle. The 6L PE model of the Operational system was used in the 1200 GMT cycle to produce the first guess for the 0000 GMT analyses. After this date, the Flattery analysis program and the Stackpole 8L GLOBAL model on a $2\frac{1}{2}^{\circ}$ latitude-longitude grid were used twice each day to bring late arriving data into the NMC numerical operational system.

II. DEVELOPMENT DIVISION

A. Global Modeling Branch

1. 8L GLOBAL Model Becomes Operational

During the second half of the year, the 2.5° 8L GLOBAL model became operational in NMC's Final run, i.e., 10 hours after the data's synoptic time. Transition to operational status entailed many operational-type alterations to codes as well as these model changes: the incorporation of winter and summer albedos; employment of the 50-mb wind analysis as the initial conditions for the constant potential temperature layer; resolving an error that manifested itself as a forecast of excessive heights at the pole point.

At year's end, intermittent parallel tests of the 2.5° and 2° versions were underway with the 2° running as a hemispheric model.

(Stackpole)

2. Damping 8L GLOBAL Model Gravitational Oscillations

Experiments with a number of methods of specifying the initial divergence in the 8L GLOBAL model (NWP Activities, First Half of 1974, Chapter II, Section A, Part 2) have been completed. None of the static methods either significantly improved the forecast skill or suppressed the gravitational oscillations. Use of a dynamic initialization, consisting of 12 hours backward, followed by 12 hours forward integration, with the 8L GLOBAL model did succeed in suppressing the gravitational oscillations. However, no improvement in verification error was noted in the forecast from this initialization.

A report on these experiments is under preparation.

(Dey, McPherson, and Brown)

3. Mountain Flow

The usefulness and practicability of calculating the vertical fluxes of heat and momentum due to "sub-grid scale" mountains by gravity waves is under investigation. (Collins)

4. Global Energy Diagnostics

A program has been implemented that calculates various energy-related quantities twice daily from the final global Flattery analyses. These data are soon to be archived for long-term use.

Using the energy program, a comparison of the conventional and Flattery analyses shows general agreement. Noted differences are under investigation.

A more general code, which will use sigma-level forecast data as input, is being developed to calculate energies and conversions. This code will be used to diagnose the 8L GLOBAL. (Collins and Miller)

5. Convective Parameterization

A convective parameterization scheme for the 8L HEM model is being coded and debugged. The method estimates the contribution of deep convective activity to total precipitation and large-scale tendencies of temperature, moisture, and wind. (Hirano)

6. 3L GLOBAL Forecast Model

Experiments with the approximate three layers of equal mass version of the 3L GLOBAL model show an acceptable exchange between kinetic and potential energy and conservation of total energy. However, kinetic energy grows rapidly to 96 hours at the expense of potential energy. By including a dissipation term of the form

$$D = K|\nabla^2 u|\nabla^2 u$$

applied to the wind, potential temperature, and moisture, the growth in kinetic energy is greatly impeded and total energy is still essentially conserved. This latter is true for a calculation to 8 days that includes minor effects (surface drag, heating and evaporation over the ocean, radiation, latent heating, and moist convective adjustment) as well as for a calculation to 8 days with no minor effects.

Several forecasts were calculated using December 1974 initial data. These calculations all became unstable between 60 and 96 hours. It is possible that this instability resulted when the mountain regions were not smoothed exactly as they had been for earlier, stabler forecast calculations to 8 days. In a subsequent calculation, this instability difficulty was circumvented by simply reducing the Antarctic heights to .6 of their real value before smoothing. Additional experiments, including smoothing and adjustment of Antarctic heights, will be made.

Tapes of the December 1974 2.5° global analyses for 0000 and 1200 GMT have been saved. These data sets will be employed in calculating experimental forecasts with both the 3L GLOBAL and 8L GLOBAL models for verification and comparison. (Vanderman)

B. Regional Modeling Branch

1. Hurricane Modeling

Work over the period can be divided into four major categories: (1) code optimization, (2) development work on moisture and wind analysis techniques, (3) model sensitivity experiments with idealized data, and (4) programming to permit experiments with operational data sets. Brief descriptions of each follow in the above order.

Improvements in the CPU speed of the code have been gained through various types of changes--some designed to take advantage of the high-speed buffer capabilities of the 360/195, but others simply more efficient algorithms requiring fewer operations or fewer fetches of data from core memory. The wall clock time of the code has been reduced essentially to that of the CPU time through use of a two-disk two-drum configuration that utilizes four separate channels. The sum result of these improvements is that the forecast code now runs 30 to 40 times faster than the atmosphere and can meet operational timing requirements. We are presently exploring two additional, promising options that could bring the speed to 60 or 80 times that of the atmosphere.

Means to provide moisture and wind analyses more detailed than those available in the NMC global system are being explored and tested. The moisture improvements involve a detailed treatment of surface observations extended through the upper layers. The wind analysis technique involves vorticity as its basic variable and is designed to account for rawinsonde and all supplemental data without introducing spurious divergent components. Results of tests with these approaches will be summarized in the next semiannual report.

Sensitivity experiments with the moving three-dimensional grid have continued to reveal minor inconsistencies between the forecast and initialization codes and have been most useful in this respect. No serious oscillations now result from the vortex initialization procedure and, given constant large-scale conditions (moisture, sea-surface temperature, steering flow, etc.), vortices move steadily (with minor observations due to asymmetries and the B-effect) with long term central pressure variability of only several mb.

In the final category, coding has been completed to transfer data from the global, operational analyses and forecasts to fields formated in strips in the model coordinate system. These fields are utilized for boundary conditions, as well as for large-scale initial conditions. Forecasts carried out several hundred time steps from these fields exhibit no noisy behavior beyond that existing in current NMC operational models.

(Hovermale, Chu, Marks, Jones, and Scolnik)

2. Nested Grids (see also 6. below)

The wind and relative humidity analyses of data in Hurricane HILDA on September 30, 1974, have been completed. The grid points data read from these analyses are being now used to define an initial balanced state for the six-level nested grid primitive equation hurricane model.

A divergent barotropic primitive equation model incorporating two mutually interacting nested grids was integrated to 24 hours. Some small-scale irregularities developed during the time integration in the fine mesh. The amplitudes of these spurious waves, however, remain small. No explicit smoothing or diffusion was used in this integration to damp these waves. This nested grid technique, therefore, appears suitable for use in the mesoscale prediction models. It is now planned to test a scheme to incorporate a moving fine mesh embedded in a coarse mesh with this model. (Mathur)

3. Semi-implicit Model

The NMC six-layer primitive equation model has been adapted for semi-implicit time integration. Earlier difficulties using orography (NMC Activities Report, First Half of 1974) have been overcome by revising the manner in which the tropospheric pressure gradient is decomposed into explicit and implicit components. A moisture variable and physical processes such as surface friction, solar heating, long-wave cooling and latent-heat release, have all been incorporated in the same manner as in the operational model.

Successful 48-hour forecasts have been achieved using a 1-hour time step. The semi-implicit model has a grid length twice that of the operational model. Comparisons with an explicit version of the new model with a 15-minute time step show differences of less than 20 meters in the forecast 500-mb heights. In the one test case, precipitation patterns at 48 hours were quite similar.

The semi-implicit model is presently being converted for use on the IBM 360/195 machine. (Campana)

4. Planetary Boundary Layer Model

The results of experimental testing of the PBL model have been published in NOAA Technical Memorandum NWS NMC-55. The conversion of the PBL model for the IBM 360/195 computer was initiated and subsequently completed to an extent which will allow for quasi-real-time checkout runs prior to operational implementation. (Polger)

5. The Limited-area Fine-mesh Model (LFM)

The LFM initialization and forecast codes have been converted to run on the IBM 360/195 computer. These programs have replaced the CDC 6600 versions in NMC operational production. The forecast length has been extended to 36 hours by using a divergence damping term in the calculation of the time tendency of the horizontal wind components. Basically, this is a viscosity term and it is applied only at points near the boundary. Its purpose is to suppress erroneous gravitational oscillations. (Newell)

6. Hemispheric Nested Grid Model

This model uses three grids of different resolution on a Northern Hemisphere stereographic projection. The coarsest grid (A) extends slightly into the Southern Hemisphere. The intermediate grid (B) is rectangular in outline with twice the resolution of A and centered at an arbitrary location within A. The fine grid (C) is also rectangular in outline with twice the resolution of B and centered at an arbitrary location within B. All grids have the same vertical structure, patterned after the energy-conserving sigma-coordinate layer equations of Arakawa. The program and code treat the number of layers and their locations in sigma as flexible, with flexibility also programmed for the resolution of grid A and the horizontal dimensions and locations of B and C.

These three grids are forecast "simultaneously"; each grid interacts with its neighbor at essentially every time step. A configuration, in which the fine grid has an areal extent almost equal to the present LFM but with twice the present LFM resolution (i.e., with Δx about 100 km), is estimated to require about 7 minutes computation time (optimized) per 24-hour forecast for each vertical level involved. An 8-level 24-hour forecast will, therefore, require almost 1 hour of 360/195 time. As a candidate for operational implementation then, this model should be considered as potentially replacing both the present LFM and operational hemispheric PE. (Phillips and Campana)

7. A One-Dimensional Unsteady Boundary Layer Model

The development of a one-dimensional Atmospheric Boundary Layer (ABL) model, which is going to be forced by an LFM model in the way suggested by Gutman, has started. The turbulent diffusion is introduced by means of a turbulent energy equation. Also included are moisture-condensation, radiation, and heat transfer from the ground. When the code on the IBM 360/195 is running, tests will be performed with real data. Special attention must, however, be given to initial data and initialization procedures to allow the model to be run operationally (in Sweden). There is no good balance equation for the ABL. (Bodin)

C. Upper Air Branch

1. Analysis of Stratospheric Data

a. Comparison of satellite data with radiosonde data

Studies of variability of satellite data in comparison with neighboring radiosonde data are being conducted. New consideration is being given to the inclusion of satellite-derived temperatures or heights in the stratospheric analysis series. (Laver and Finger)

b. Rocketsonde-satellite comparisons

United States rocket stations have been scheduling meteorological rocketsonde launches to coincide with NOAA satellite overpasses. The radiances computed from the in situ temperature measurements are compared with the satellite radiance measurements in the tropospheric and stratospheric channels. Preliminary results from comparisons for NOAA 3 indicate a correlation between biases in the radiance measurements and biases in temperature retrievals. Results obtained from previous rocket-radiosonde comparisons with Nimbus 5 have shown that this type of program can contribute significantly to improve satellite temperature derivations. A comparison program for the NOAA 4 operational sounders, launched November 1974, is being initiated. (Gelman, Miller, and Finger)

c. International rocketsonde comparisons

A paper describing results from recent international rocketsonde comparison tests has been submitted for publication in the Journal of the Atmospheric Sciences. Comparison of temperature and wind data obtained by the five different rocketsonde systems allowed adjustments to be derived, leading to more meaningful depiction of stratospheric-mesospheric circulation. (Finger and Gelman)

d. Rocketsonde data exchange and analysis

Rocketsonde data exchange with the Soviet Union continues. These data are used on a continuing basis in weekly synoptic analyses at the 5-, 2-, and 0.4-mb levels and in weekly meridional cross sections. (Finger, Gelman, McInturff, and Nagatani)

e. Automation of 5-, 2-, and 0.4-mb maps

Utilizing VTPR data, first-guess height fields are being obtained on a weekly basis for 5- and 2-mb charts together with a first-guess temperature field at 2 mb. Rocketsonde data have been introduced in experiments, but a technique is being developed to give more weight to rocketsonde winds in the height analyses.
(Nagatani, Laver, and Finger)

f. Backscatter-ultraviolet ozone studies

BUV data are being used in ozone transport studies, interhemispheric comparisons, studying properties during sudden warming phenomena, and in determining effects of nuclear-weapons tests on ozone in the stratosphere. (Miller, with personnel from NASA/Goddard)

g. Evaluation of forecast fields for the SST

In preparation for the spring 1975 proving flights of the Concorde between New York and London, NMC's 150- and 100-mb forecasts are being evaluated. (Laver and McInturff)

2. Research on Atmospheric Circulation

a. Stratospheric warmings and polar vortex breakdown

A brief paper comparing simulated and observed features of the stratospheric warming phenomenon was presented at the AMS Conference on the Upper Atmosphere (Atlanta, September 30-October 4). The papers presented at the conference have been submitted for publication in the Journal of the Atmospheric Sciences. (Quiroz, Miller, and Nagatani)

b. Global energy program

A program to compute several terms of the global energy balance is being written to run off the operational global analysis. The program is in the checkout stage. (Miller and Collins)

3. Quality Control

a. Improvements in Raob Deficiency Advisories

The programs producing Raob Deficiency Advisories have been modified to provide more detailed information on discrepancies in operational data received by NMC. The teletype advisories now will indicate the levels and parameters in error as well as other problems with incomplete and nonreceived reports. Efforts are underway to begin transmission of the advisories on circuits leading to NWS upper air units and other Region IV locations requesting them. (Thomas)

b. Operational data from mini-computerized stations

Preliminary studies have begun to evaluate the quality and availability of Raob data from stations equipped with mini-computers. Evaluations will be made of the volume of data automatically processed by NMC from stations before and after being equipped with the minis. Initial indications show that the data base at NMC's initial analysis deadlines has not improved significantly in the first 6 months of mini-computer use. (Thomas)

c. Comparison of Raob data available to major processing centers

A coordinated investigation was undertaken to evaluate the Raob data received and processed by four weather centers within the conterminous United States--Washington, Carswell, Omaha, and Monterey. It was found that each of the centers received and processed approximately the same reports at a given date and time. Specific losses of data differed from center to center, however. An NMC Office Note has been drafted providing details of this study. (Thomas)

D. Data Assimilation Branch

1. Data Impact Tests

a. A special ITPR impact test was run in August. Using full-scan Nimbus 5 data for April 1973 and regression-derived VTPR soundings for the same period, a 5-day analysis-forecast cycle was run using surface reports and satellite data only. The purpose of the test was to determine the extent to which satellite temperature retrievals, with a well-defined surface reference level, are capable of defining the large-scale mass and wind fields when assimilated into a forecast model over a period of 5 days. The DST analysis/forecast system (the Flattery spectral analysis scheme and 8L GLOBAL forecast model operating in a 6-hour cycle) was used. The analysis began from a bad first guess (using coefficients valid for 23 June). Surface data and satellite data were assimilated in 6-hour intervals over the 5-day period.

The resulting analyses are being compared with the NMC operational analyses for the same time period. Results are not yet complete; however, it appears that the satellite data, after about 2 days of assimilation, produced a reasonably good approximation to the "true" upper level height fields over the Northern Hemisphere. In a root-mean-square sense, the "accuracy" of the satellite-based analyses appears to be roughly comparable to a typical NMC 36-hour forecast. A report on this test is being prepared in collaboration with K. Hayden of NESS.

(Bonner, van Haaren, and O'Neil)

b. Work continued on the comparison of ITPR and radiosonde cross sections. Analyses are being made by hand of temperature, potential temperature, D values, and geostrophic winds in three cases where Nimbus 5 soundings and radiosonde soundings are located along nearly the same vertical plane. (Lemar)

c. A limited evaluation of the SMS winds generated by the University of Wisconsin McIDAS system during a special 5-day test period (see Section 2) was begun. Winds are being analyzed by hand and by a computer analysis program developed by A. Thomasell of NESS. Computer analyses are being produced at "high" and "low" levels--using Wisconsin winds only, NESS winds only, and Wisconsin plus NESS winds. The aim is to examine differences between NESS and Wisconsin winds and to determine the extent to which the Wisconsin winds, which will be part of the DST data sets, provide additional information beyond what is available from conventional reports and NESS-derived cloud-tracked winds. (Lemar and Bonner)

2. Data Archiving

A data archiving program in support of GATE was carried out from June 15 to September 23. Level II tapes were produced each day containing:

- conventional data received over the Global Telecommunications System by H+10;
- VTPR data and SMS satellite winds;
- Nimbus 5 retrievals produced by NASA/GISS.

Copies of these tapes were mailed daily to GISS, CEDDA, and GFDL. (Chiusano)

At the request of GFDL, daily sea surface temperature fields were generated from the NESS-archived data for the GATE period. Fields were written in standard DST Level III format and mailed to GFDL for use in GATE research. (Chiusano)

Special data processing procedures were established for handling the University of Wisconsin cloud-tracked winds. Winds derived from SMA-A picture triplets near 1200 and 1800 GMT were transmitted to GISS and then to NMC via the NESS-GISS data point where they were written on tape in DST Level II format. The purpose of the test was primarily to examine the procedures for producing, transmitting, and archiving these winds within the operational deadlines established for the DATA Systems Test.
(Desmarais, Chiusano, and O'Neil)

3. Data Assimilation

a. A series of experiments in assimilating real VTPR data with a primitive equation barotropic model were completed. Several insertion techniques were examined, as a part of the planning and design of a global data assimilation system suitable for operational usage. The following conclusions were reached:

(1) If asynoptic observations of the mass field are inserted, the motion field must be adjusted correspondingly at the time of insertion via some simplified dynamic constraint if the impact of the observations is to be retained;

(2) Given such an adjustment, any of the commonly used damping integration methods will effectively suppress residual gravitational noise, with no clear indication of superior performance of any of several methods tested;

(3) "Repeated insertion" methods, in which data are inserted at several successive time steps in an effort to reinforce the model's "memory" are not useful. (McPherson and Kistler)

b. Global Assimilation System

Coding is underway on an experimental assimilation system based on the NMC 8L GLOBAL model, and incorporating the conclusions of the preliminary experiments. This version will have 5^{o} resolution and will use a time filter to damp gravity wave noise resulting from insertion. Temperature and surface pressure data will be inserted at 3-hour intervals via a successive-correction to the motion field poleward of 20^{o}. Experiments will be conducted with forward integration only, and with cycling forward and backward over a 12-hour interval containing the data.
(Kistler, Gordon, and McPherson)

c. Optimum Interpolation Objective Analysis

The Cressman successive-correction objective analysis method currently being used in the experimental global assimilation system will utlimately be replaced with a new local objective analysis method which incorporates the statistical optimum interpolation principles of Gandin. This new method is currently being designed and coding is expected to commence shortly. The scheme will analyze directly to model sigma surfaces (or any desired analysis output surface) from observations distributed in three dimensions. The analysis will be multivariate; that is, it will analyze temperature and horizontal wind component fields simultaneously--with the thermal wind relationship used as a weak constraint. Additionally, the analysis scheme will make allownace for the various error levels of this heterogeneous observational data in a rational and systematic way in producing the final analysis. (Bergman)

III. AUTOMATION DIVISION

A. Meteorological Techniques Branch

1. Objective Analysis

a. The LFM analyses were reprogrammed and implemented during this period. These analyses run two times during each cycle. The 12-hour 6L PE forecast fields from the preceding cycle provide the first guess fields for the LFM analyses.

A global analysis/forecast cycle was also incorporated into the operations during this period. Global analyses are run three times during each cycle. The first guess for these analyses is obtained by "analyzing" the 12-hour forecast parameters of the 8L GLOBAL (height, wind, and relative humidity) from the previous cycle. This procedure transforms the 12-hour forecast fields into spectral representations, producing the guess coefficients for the ensuing global analysis.

The linkage between the 8L GLOBAL forecasts and the analyses for the barotropic and 6L PE model occurs through these "guess coefficients." Backup has been provided for utilizing 24-hour forecasts in case a cycle is unavoidably lost.

The development of several support programs for the implementation of the above analyses includes an analysis-post-processor program for transposing spectral representations of the global analyses to the 6L PE, Tropical, LFM, and Southern Hemisphere polar grids.

b. Several support programs for the implementation of the analyses referred to in (a) above were also completed:

(1) Analysis post-processors for transposing the spectral representation of the global analyses to the 6L PE grid, the tropical grid, the LFM grid, and a Southern Hemisphere polar grid.

(2) Pre-analysis processors for preparing observational data for the LFM analysis programs.

(3) Data listing programs for the upper air files.

(4) Program for obtaining LFM guess fields by interpolating from the 6L PE forecast fields.

(5) Program to form fields of forecast height and temperature tendencies for use in the asynoptic correction for VTPR soundings.

(6) Program which performs vertical consistency checks on the height, temperature, and wind data obtained from conventional upper air observing stations.

2. Report Processing

a. Agriculture, crops, climate

The initial phase of outputting temperature and precipitation summaries for the World Agricultural Weather Watch has been programmed.

Coordinating and implementing some of the immediate requirements for the Large Area Crop Inventory Experiment (LACIE) has been done. This is a joint investigation involving the Department of Agriculture, the Department of Commerce, and the National Aeronautics and Space Administration.

3. Miscellaneous Activities

a. Coarse mesh grid point analyses

The CDC 6600 version of the coarse mesh grid point type analyses of surface, upper air, and moisture parameters has been reprogrammed for possible experimental use on the IBM 360/195 system. The tropopause analysis will also be converted in the next period.

B. Services and Applications Branch

1. Programming Support Section

The second half of 1974 was devoted almost exclusively to continuing the reprogramming of CDC 6600 operational programs for the IBM 360/195.

a. Forecast models

(1) The 6L PE forecast code is being modified to optimize its running on the IBM 360/195 computing system. The disk I/O has been changed to attain direct core to disk data transfer. These changes are being merged into a module which will allow testing in an operational environment.

(2) Both the Barotropic Mesh Model and the Barotropic Extension have been converted and are running operationally on the IBM 360/195. The stability of the Barotropic Extension has been improved by providing the model with more carefully prepared drag coefficients and pressure at the ground arrays.

(3) The Reed 1000-mb forecast program and the post-processors for both the Barotropic Extension and Reed model also have been converted for the 360/195 and are now operational.

b. Transmissions

(1) The format of teletype bulletins to be transmitted through the NMC's IBM 360/40 system via the IBM 360/195 has been redefined.

Special subroutines were written to assist the programmer in this area. Conversions of codes which produce the teletype bulletins for the forecasts of the 6L PE and the LFM models were completed by the end of 1974. A special transmission for the GATE project was completed and in operation on June 25, 1974.

(2) The Air Transport Association (ATA) transmission, which supports aviation operations, was totally redesigned in anticipation of a proposed new output format. The conversion to the new format is expected to be during the first half of 1975.

c. Other projects

(1) The conversion of the Air Pollution Potential package to the IBM 360/195 has been completed and is operational. However, extensive modifications to eliminate sections no longer required to add new specifications and to streamline its operations are scheduled.

(2) Snow Cover and Sea Surface Temperatures for the NMC 65x65 Cartesian grid and the 2.5x2.5 degree longitude/latitude grid are operational on the 360/195.

(3) The 8L GLOBAL post processor has been checked out on the new computer, but some changes are being made to handle Fourier smoothing of the forecast fields. Also, experiments are being conducted to determine the need for more palative smoothing techniques for output products.

(4) Work has begun in conjunction with personnel from the National Center for Atmospheric Research (NCAR) to make operational a program to predict severe winds in the Boulder, Colorado, area.

(5) A program to mesh Northern and Southern Hemisphere analyses and forecasts has been written and is being tested. The Southern Hemisphere portion of the grid is derived from the 8L GLOBAL model.

(6) Programs to produce both height and pressure change fields for the RADAT and operational job streams were completed.

(7) Programs for updating the Surface and Upper Air Dictionaries have been converted to the 360/195.

2. Graphics Support Section

a. Reprogramming. As basic routines were gradually debugged during the second half of 1974, and became more reliable, programming the higher-level applications programs could advance. During this period, basic routines were modified and updated frequently and intermediate level routines were developed to meet the requirements of the applications programs as they developed.

The largest graphics program still remaining to be converted is the MERC program which does the aviation forecasts for the Tropics, and this is now in the process of being reprogrammed.

b. Operational modules reprogrammed during this period:

FDFAX.....plots winds aloft and temperature forecasts over the United States.

POPFAX....displays the Probability of Precipitation.

MAX/MIN FAX...displays the Max/Min Temperatures.

WAVFAX....displays the ocean forecasts of waves and swell.

TRAFAX....displays the Three-dimensional Trajectory Forecasts.

MIAFAX....displays Miami NHC charts.

PEPFAX....a gigantic display code which combines the functions which had been performed by five separate modules on the CDC 6600, namely:

(a) PEPFAX...Northern Hemisphere analyses and forecasts on 1/40M scale;

(b) LFMFAX...LFM model output at 1/25M scale;

(c) PFAX.....Aviation forecast charts for Northern Hemisphere at 1/40M scale;

(d) PLOTFAX..North American sectional analyses at 1/20M scale (contour lines only, no plotted data yet);

(e) UABPLOT..Stratospheric analyses at 1/40M scale (contour lines only, no plotted data yet).

The total number of maps now generated by PEPFAX under its various guides every day is:

DFI maps generated at 0000 GMT	143
DFI maps generated at 1200 GMT	145
Charts displayed locally on Varian	288
Charts scheduled for transmission	257

c. Observational data-plotting routines are being tested for addition to PLOTFAX and UABFAX.

d. OEPWND, an operational program that generates transmissions of mean winds, was also reprogrammed during this period.

e. Digital graphics transmission system

The NMC FAXX stores digital packed maps until scheduled transmission time, when a Digital Facsimile Interface converts the digital data to analog form for transmission on the appropriate facsimile circuit.

In addition to the routine function above, computer graphic systems are being developed which will enable manually prepared charts to be inputted into the FAXX system from remote sites.

The system, designated Digital Graphics Transmission System (DGTS) utilizes Alden Digitizers, Varian plotters, and minicomputers in addition to the main computer. This infusion of digitized manual charts has increased the daily facsimile workload substantially.

IV. MACHINE PERFORMANCE AND UTILIZATION

A. IBM 360/30G

1. 360/30 Profile Released: Leased IBM 2803 Tape Control
IBM 2816 Tape Switch

Added: Purchased IBM 2803 Tape Control
IBM 2816 Tape Switch

2. Utilization (Av. mo.) - 124 hours . . . . Total 741 hours

B. IBM 360/40GF

1. 360/40 #1 Profile Added: Purchased Interdata 50 Minicomputer

2. Utilization (Av. mo.) - 732 hours . . . . Total 4,389 hours

C. IBM 360/40GF

1. 360/40 #2 Profile Released: IBM 2701 TX Control

2. Utilization (Av. mo.) - 727 hours . . . . Total 4,359 hours

D. IBM 360/40GF

1. 360/40 #3 Profile Added: Interdata 50 Minicomputer

2. Utilization (Av. mo.) - 731 hours . . . . Total 4,387 hours

V. DISTRIBUTION OF PRODUCTS

NMC originates about 810 separate teletypewriter bulletins each day for transmission over NWS, U.S. Navy, and ATA teletypewriter service. The following table shows the additional NMC daily facsimile transmissions:

Recipient	Number of Transmissions
National Facsimile Network (NAFAX) WFX1234	88
Aviation Meteorological Facsimile Service (NAMFAX) GF10201	155
Navy Facsimile Network: 70S537	24
GS18204	75
Air Force Facsimile Network: GF20309	43
GF10814	75
RAFAX	14
International Facsimile Network (Bracknell, England) . . .	33
Russian Facsimile Network	21
Forecast Office Facsimile Network (FOFAX): Circuit #10206	50
#10207	50
#10208	51
Caribbean Radio GF10204	23
Tropical Analysis Network (TROPAN) GF10209	13
Suitland-Honolulu Circuit GFA10211	57
Suitland-Redwood City, CA GF10205	13

VI. FORECAST VERIFICATIONS--MONTHLY MEANS FOR 1974

A. NMC Grid Area (1,977 Grid Points)

	24 hours					36 hours								48 hours				
	PE MODEL			PERS		PE MODEL			PERS		BAROTROPIC			PE MODEL			PERS	
	R	H	W	H	W	R	H	W	H	W	R	H	W	R	H	W	H	W
200 mb																		
July	.76	132	20.3	199	26.2	.75	177	23.6	261	31.0				.77	191	24.3	290	33.0
Sep.	.79	143	20.1	227	27.5	.81	176	22.5	291	32.0				.79	212	25.0	328	34.7
Nov.	.80	176	22.1	273	30.2	.82	205	25.0	340	35.5				.79	250	27.6	376	37.3
300 mb																		
July	.78	124	17.2	198	24.3	.79	158	20.0	255	28.8				.79	181	21.3	289	31.3
Sep.	.82	132	17.9	233	27.3	.84	161	20.1	293	31.6				.81	199	22.8	332	34.5
Nov.	.83	172	20.7	298	33.6	.84	202	23.7	365	38.6				.81	244	26.4	400	40.4
500 mb																		
July	.72	97	12.7	134	16.6	.76	118	14.1	174	19.6	.67	130	15.5	.75	138	15.1	200	21.4
Sep.	.77	102	13.0	155	18.2	.80	120	14.0	196	20.9	.70	143	15.9	.78	145	15.8	223	22.8
Nov.	.80	129	15.0	203	22.7	.83	145	16.4	251	26.2	.72	178	19.0	.80	174	18.1	276	27.6
850 mb																		
July	.67	84	10.2	96	11.2	.69	101	11.3	125	13.6				.70	116	12.0	144	14.6
Sep.	.73	87	10.8	113	12.7	.76	102	11.6	139	14.7				.74	118	12.9	157	15.7
Nov.	.78	106	13.5	147	15.2	.82	114	14.2	181	17.4				.79	137	15.2	198	18.2
1000 mb																		
July	.66	85	11.9	97	12.8	.67	106	13.0	127	15.2				.69	120	13.9	142	16.1
Sep.	.75	90	12.6	122	14.8	.75	110	13.5	151	17.0				.75	123	14.8	167	18.0
Nov.	.81	111	15.3	171	18.3	.83	125	16.5	208	20.9				.80	149	17.8	224	21.5

B. North America--Area 1 (195 Grid Points)

	24 hours					36 hours								48 hours				
	PE MODEL			PERS		PE MODEL			PERS		BAROTROPIC			PE MODEL			PERS	
	R	H	W	H	W	R	H	W	H	W	R	H	W	R	H	W	H	W
200 mb																		
July	.85	99	14.7	192	23.7	.83	135	17.6	251	29.2				.84	151	19.7	285	32.1
Sep.	.83	116	16.2	213	24.7	.81	160	18.8	278	29.8				.80	196	22.9	334	34.2
Nov.	.91	137	19.6	336	39.3	.89	190	24.3	420	46.8				.85	245	29.6	472	50.4
300 mb																		
July	.86	94	13.4	194	23.6	.85	127	15.9	251	28.5				.85	146	18.5	287	31.8
Sep.	.89	104	14.7	236	26.9	.87	148	18.2	304	32.5				.85	184	21.8	357	36.6
Nov.	.91	155	21.3	386	46.7	.90	198	25.4	467	54.1				.86	251	30.5	510	56.5
500 mb																		
July	.83	68	9.0	126	14.6	.83	90	10.4	165	18.0	.75	104	11.9	.83	104	12.5	191	20.3
Sep.	.87	76	10.6	155	17.4	.87	97	12.2	198	20.7	.76	131	14.3	.85	122	14.7	230	23.2
Nov.	.89	117	15.1	258	30.8	.89	143	17.5	315	36.2	.82	179	21.3	.86	172	20.2	343	37.8
850 mb																		
July	.77	60	7.6	93	10.1	.79	78	8.5	123	13.0				.75	97	10.1	138	13.8
Sep.	.81	69	9.5	109	12.6	.83	81	10.3	135	14.8				.76	103	12.0	146	15.4
Nov.	.84	86	11.3	154	17.0	.85	103	12.7	191	20.5				.83	117	14.1	206	21.3
1000 mb																		
July	.75	67	9.6	95	11.5	.79	83	10.4	127	14.5				.75	104	12.3	140	15.4
Sep.	.80	81	12.3	130	16.2	.83	94	13.3	162	19.1				.78	116	15.1	173	19.8
Nov.	.84	98	13.6	179	20.7	.86	114	15.4	219	24.5				.82	133	17.5	230	24.7

C. Europe--Area 3 (143 Grid Points)

	24 hours					36 hours								48 hours				
	PE MODEL			PERS		PE MODEL			PERS		BAROTROPIC			PE MODEL			PERS	
	R	H	W	H	W	R	H	W	H	W	R	H	W	R	H	W	H	W
200 mb																		
July	.84	115	14.3	218	24.4	.80	164	17.8	274	28.9				.80	186	19.8	306	30.8
Sep.	.85	149	17.0	284	30.0	.84	191	21.0	346	34.5				.80	248	25.1	390	36.3
Nov.	.83	160	18.0	283	29.3	.83	196	21.3	350	34.6				.80	232	24.1	386	36.4
300 mb																		
July	.86	125	15.0	252	28.4	.83	165	18.2	313	33.2				.81	199	21.2	349	35.7
Sep.	.88	146	17.3	315	33.9	.85	197	21.9	374	37.9				.81	250	26.0	417	39.8
Nov.	.86	169	19.3	331	35.5	.84	215	23.0	402	40.6				.81	257	26.5	442	42.7
500 mb																		
July	.82	88	9.6	158	17.2	.80	118	11.6	202	20.6	.76	130	13.3	.78	143	13.4	229	22.4
Sep.	.85	104	11.7	200	21.0	.84	136	14.1	244	23.9	.76	162	16.0	.81	166	16.7	273	25.2
Nov.	.84	123	13.2	225	23.3	.82	157	15.9	278	27.1	.75	185	18.5	.80	186	18.3	311	29.0
850 mb																		
July	.77	65	6.8	102	10.0	.76	84	8.2	129	12.1				.72	102	9.4	146	13.2
Sep.	.82	81	8.6	139	13.7	.81	103	10.3	167	15.3				.76	124	12.1	184	15.9
Nov.	.81	93	9.4	156	14.7	.80	115	11.5	195	17.1				.76	141	13.4	217	18.1
1000 mb																		
July	.73	69	7.5	100	10.0	.74	84	8.8	124	11.9				.70	104	10.1	140	12.9
Sep.	.82	84	9.3	148	14.9	.81	105	11.0	174	16.3				.76	128	13.0	188	16.9
Nov.	.83	94	10.4	173	16.7	.81	123	12.7	210	18.8				.77	153	14.9	236	20.2

D. Asia--Area 4 (275 Grid Points)

	24 hours					36 hours								48 hours				
	PE MODEL			PERS		PE MODEL			PERS		BAROTROPIC			PE MODEL			PERS	
	R	H	W	H	W	R	H	W	H	W	R	H	W	R	H	W	H	W
200 mb																		
July	.71	132	17.9	182	23.6	.70	174	21.0	236	28.4				.74	183	22.5	266	31.5
Sep.	.76	144	18.4	202	25.6	.78	174	21.8	257	30.2				.78	204	23.8	294	33.6
Nov.	.77	183	22.3	250	27.3	.82	193	24.2	308	32.2				.78	238	27.4	333	32.8
300 mb																		
July	.72	112	14.7	158	20.5	.77	132	16.7	204	24.6				.79	146	18.3	234	27.5
Sep.	.80	124	16.1	198	25.5	.84	144	18.7	255	30.3				.82	177	21.3	290	33.7
Nov.	.84	159	19.3	280	31.2	.86	177	22.1	337	35.7				.84	211	24.4	364	36.6
500 mb																		
July	.69	82	10.7	104	13.7	.77	90	11.8	136	16.5	.62	108	12.9	.78	98	12.7	154	18.3
Sep.	.77	92	11.8	131	16.8	.83	99	12.7	167	19.9	.69	124	13.8	.80	123	14.3	189	22.0
Nov.	.83	117	13.6	195	22.0	.87	121	15.1	234	24.9	.62	184	17.8	.85	138	16.4	253	25.6
850 mb																		
July	.56	80	9.8	71	9.7	.59	94	10.7	92	11.6				.67	96	11.5	106	12.8
Sep.	.70	81	10.4	92	11.4	.73	93	11.4	115	13.2				.75	105	12.3	128	14.6
Nov.	.77	104	13.0	138	14.1	.82	106	13.6	165	15.8				.80	121	15.0	176	16.3
1000 mb																		
July	.53	87	12.0	78	11.7	.55	105	13.1	104	14.1				.63	106	14.1	112	14.9
Sep.	.71	85	11.4	102	13.1	.71	105	13.2	130	15.6				.74	114	14.4	142	16.9
Nov.	.81	112	15.0	168	17.6	.84	125	17.0	202	19.8				.81	143	18.9	212	20.0

R	Correlation coefficient of forecast and actual height change
H	Root-mean-square deviation of height in feet
W	Root-mean-square vector geostrophic wind error in knots
PE MODEL	Operational six-layer primitive equation baroclinic forecast model
PERS	Persistence forecast
BAROTROPIC	Operational barotropic forecast model

VII. PERSONNEL CHANGES

A. Development Division

New Employees:

Stephen H. Scolnik,	Meteorologist, Regional Modeling Branch	7/74
Mukut B. Mathur	" " " "	11/74

B. Automation Division

New Employees:

Robert A. Jirsek,	Meteorologist, Graphics Support Section	8/74
Robert P. Hollern,	Mathematician, Programming Support Section	9/74

Separation:

Arthur F. Wick, Mathematician, Resignation 8/74

C. Forecast Division

New Employee:

William P. Moore, Super. Meteorologist, Aviation Weather Branch 12/74

Separations:

Loyal P. Stark,	Meteorologist,	Retirement	7/74
Sydney Levitus,	"	Transferred to GFDL	11/74
Billy C. Williams,	"	" " Central Region	12/74
Paul J. Dallavalle,	"	" " SDO	12/74
Olin R. Houston,	Super. Meteorologist,	Retirement	12/74