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Numerical Weather Prediction Activities

National Meteorological Center

First Half 1974

U.S. DEPARTMENT OF COMMERCE · National Oceanic and Atmospheric Administration · National Weather Service

UNITED STATES DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
NATIONAL WEATHER SERVICE

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C O N T E N T S

ABBREVIATIONS AND ACRONYMS

AFOS	Automation of Field Operations and Services
AMS	American Meteorological Society
APP	Air Pollution Potential
ATA	Air Transport Association
ATS	Applications Technology Satellite
BUV	Backscatter Ultraviolet
CDC	Control Data Corporation
CIMO	Committee for Instruments and Methods of Observations
CPU	Central Processing Unit
CRT	Cathode Ray Tube
DFI	Digital Facsimile Interface
DGTS	Digital Graphics Transmission System
DST	Data Systems Test
ERL	Environmental Research Laboratories
FAXX	Automated Facsimile Transmission System
GATE	GARP Atlantic Tropical Experiment
GFDL	Geophysical Fluid Dynamics Laboratory
GISS	Goddard Institute for Space Studies
GOES	Geostationary Operational Environmental Satellite
IBM	International Business Machines
IAMAP	International Association of Meteorology & Atmos. Physics
IUGG	International Union of Geodesy and Geophysics
ITPR	Infrared Temperature Profile Radiometer
JAS	Journal of Atmospheric Sciences
LFM	Limited-area Fine-mesh Model
MOS	Model Output Statistics
MSL	Meteorological Satellite Laboratory
NASA	National Aeronautics and Space Administration
NCAR	National Center for Atmospheric Research
NCC	National Climatic Center
NESS	National Environmental Satellite Service
NHRL	National Hurricane Research Laboratory
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
RAWARC	Radar Warning and Reporting Circuit
TDL	Techniques Development Laboratory
UCLA	University of California in Los Angeles
UPI	United Press International
VTPR	Vertical Temperature Profile Radiometer
WPM	Words Per Minute
WWB	World Weather Building
3L GLOBAL	Three-layer Global Model
8L GLOBAL	Eight-layer Global Model
8L HEM	Eight-layer Hemispheric Model
6L PE	Six-layer Primitive Equation Model

I. INTRODUCTION

This report summarizes the NWP activities of the NMC for the first half of 1974. The major event of this period was the installation of the NOAA dual IBM 360/195 computer system. The first computer was installed in November 1973 and the second was installed in February 1974. A large portion of the NMC effort has been directed at the conversion of computer codes from the CDC 6600 system to the IBM 360/195 system. The descriptions of the ongoing work contained herein largely reflect this conversion effort.

NMC plans to modify its operational model system to one which best utilizes the increased computer power brought about by the acquisition of the dual IBM 360/195 system. It was not possible to schedule this immediately following the acquisition date since sufficient computer check-out time for development and testing was unavailable. Therefore, it was decided that the modeling system--which was operational on the CDC 6600 system--first be converted to the new computer system. Then after sufficient test and evaluation, a new operational model configuration would replace the old one.

On January 23, 1974, the 6L PE model with the 381-km grid distance was declared operational on the IBM 360/195. The major change in the model was the change to a 65 x 65 grid from the 53 x 57 array to allow for less boundary contamination in the forecasts in lower latitudes. The equator is an inscribed circle of this grid.

The 8L GLOBAL with the spectral analysis method was implemented into a quasi-operational mode in March 1974 (see II. A. 1. herein). It was run on a real-time basis but did not interact with the operational system. This new global system is intended to be used at H+10 hours to incorporate the later arriving data at NMC into the earlier operational analysis-forecast systems. It can also serve to provide the first estimates needed for the retrieval of the satellite radiance data. The spectral analysis system is intended to be used for the earlier primary forecast times for the hemispheric systems. However, the 8L HEM will remain in a research state until test and evaluation results reflect its superiority. Until that time, the 6L PE, or a higher spatial resolution version thereof, will serve operationally in the H+3:15 cut-off system.

It is intended that the 6-layer LFM model continue to run at the H+2 cut-off, but on the IBM 360/195. No major modification is planned for the objective analysis technique for this system. However, with computer programming optimization, it is planned that the new spectral analysis technique and the 6L PE will also be run at this time. This will provide for earlier MOS guidance, developed for the 6L PE by the TDL of the NWS. By running the LFM immediately following the 6L PE, it will be possible to have more accurate lateral boundary conditions than are presently used. (Presently, time-smoothed forecast changes from the previous 12-hr cycle are used.) This model configuration will also form the basis for testing the two model grids in a nested framework--i.e., with two-way interactions.

II. DEVELOPMENT DIVISION

A. Global Modeling Branch

1. 8L GLOBAL Model

The principal effort of the period was the optimization of the experimental 8L GLOBAL model code. The task is virtually completed, as the model now runs at a speed of 10 seconds per time step (1 minute per forecast hour for the 2.5° global grid - 11,020 grid points per horizontal field) on the IBM 360/195. Work is nearing completion to further optimize some of the input/output sections. A ratio of machine central processor time to wall clock time of 85 to 90 percent is anticipated.

In conjunction with the Automation Division, the model has run routinely on a twice-per-day schedule since March 15, 1974. It was also run routinely as part of the DST conducted by the Data Assimilation Branch. During these runs, a number of numerical and programming difficulties came to light which were corrected.

One of these problems necessitated a revision of the method of calculation of mandatory level heights given the layer temperature and pressures. This has been described in NMC Office Note No. 97.

2. Damping 8L GLOBAL Model Gravitational Oscillations

A number of methods of suppressing the gravitational oscillations found in the 8L GLOBAL Model (see NWP Activities, First Half 1973, Chapter III, Section C) are being investigated. All methods under consideration which are operationally feasible require the solution to the Poisson equation on the sphere. An improved solution has been obtained which is more compatible with the differencing system used in the prediction model. To test it, an analyzed wind field was decomposed into its rotational and divergent components and then reconstructed. The difference between the reconstructed and original wind fields was analyzed. The improved solution contained a root-mean-square error of 1 $cm \cdot sec^{-1}$ with the largest grid-point errors of 5 $cm \cdot sec^{-1}$ near the poles.

This method of solution is being used in a series of experimental forecasts in which:

a. The analyzed wind field is replaced by the reconstructed wind field.

b. The analyzed wind divergence is replaced by the 12-hour forecast divergence.

c. The analyzed surface pressure tendency is set to zero.

d. The analyzed surface pressure tendency is replaced by the 12-hour forecast surface pressure tendency.

e. Both the analyzed wind divergence and surface pressure tendency are replaced by the 12-hour forecast values.

f. The analyzed mass tendencies in each σ-domain are set to zero.

g. The analyzed mass tendencies in each σ-domain are replaced by the 12-hour forecast values.

h. The analyzed wind divergence and mass tendencies in each σ-domain are replaced by the 12-hour forecast values.

Preliminary results indicate that several of these methods are beneficial in the first several hours of the forecast and make some improvements in the resulting 12-hour forecasts. The most promising methods will be further pursued for possible operational implementation.

(Dey, Brown, and McPherson)

3. Vertically Integrated Model

Since April 1, 1974, the Vertically Integrated Model (Monthly Weather Review, December 1973) has been running operationally on the CDC 6600. Input to the model consists of 48-hour 6L PE forecast fields of air temperatures, dew point temperatures, and sea level pressure. Output from the model consists of forecasts of daily precipitation amounts for 2 days beyond the initial time. Currently, these forecasts are being evaluated for possible use in extended-range forecasting.

4. Spectral Methods

The machine program to convert the Hough function analysis to spherical harmonic expansions has been completed. NMC Office Note No. 95 describes the transformation. Experiments with various fast Fourier transform methods were conducted to determine optimum codes. Subroutines for converting gridded fields to spherical harmonics (and the reverse) have been developed for use in prediction models. (Sela)

5. Mountain Flow

The theoretical study of the flow of air over mountains, resulting in flow reversals, has been completed. The results are reported in *On the contributions of nonlinearity and nonhydrostatic accelerations to low-level contrary flow over mountains*, Ph.D. dissertation, University of Chicago, by William Collins. Three two-dimensional numerical models developed for this study may have further application. They may be described as (1) nonlinear hydrostatic, (2) linear nonhydrostatic, and (3) nonlinear anelastic.

The nonlinear hydrostatic model has been used to study the impact of local fine-mesh calculations for improving forecasts in mountainous terrain. The method relies upon a linearization of the additional contribution of the fine-mesh mountains.

A three-dimensional linearized nonhydrostatic model has been developed for the study of terrain effects. Of major interest is the manner in which air traverses the mountain--partially over, and partially around. The objective is to have a theoretical basis for more accurate specification of low-level winds in operational forecast models. This project is still in the development stage. (Collins)

6. Global Energy Diagnostics

Under study and development is a program to calculate energy forms appropriate to the 8L GLOBAL model. Calculations are planned both on sigma and pressure surfaces. (Collins, Miller, and Ships)

7. Cumulus Parameterization

A method of parameterizing the effects of small-scale convection suitable for the temperate as well as tropical regions of the globe is under development. (Hirano)

8. 3L GLOBAL PE Forecast Model

Recent 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, their sum. 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) and for a calculation to 8 days with no minor effects.

Future plans include calculating forecasts with this model using current data and verification of these forecasts. (Vanderman)

B. Regional Modeling Branch

1. General

A meeting of the Committee on Operational Hurricane Modeling was held at NMC on February 28. A summary of the meeting was prepared for limited distribution.

Seminars on mesoscale modeling were presented in June by Professor R. Anthes of Pennsylvania State University and Professor C. Kreitzberg of Drexel University.

2. Hurricane Modeling

a. A major activity during the winter involved spin-up experiments with a two-dimensional model. Results comparable to those presented in the literature were reproduced on a 30-km grid. Thereafter, experiments were conducted on a 60-km grid to determine what alterations in parameterization would be required to achieve acceptable solutions for our operationally oriented problem. Variations in eddy viscosity and in lateral and lower boundary conditions were tested, and a steady solution achieved that compared favorably to the atmosphere and other 2-D solutions. The larger grid increment, however, produced a magnified horizontal scale--a problem we expect to live with until higher resolutions are practical.

Parallel experiments with a three-dimensional counterpart have revealed essentially the same results with the exception that solutions in the vicinity of the vortex center show departures. This is felt to be primarily a problem related to necessary variances in the finite difference equations. Asymmetries of any importance do not develop in 48 hours when initial data reflect symmetric conditions.

While testing will continue with these spin-up experiments, the code is now further modified to the point where temporal boundaries and a movable grid are working options. Preliminary short runs to 12 hours indicate that vortices move in a predictable fashion for simple zonal flows with no vertical shear. However, further testing is required to verify code integrity with these more complex manipulations.

The analysis-initialization scheme reported earlier (NWP Activities, Second Half of 1973) is still in a general stage of code development. Acceptable analyses of geopotential heights, temperatures, and Montgomery stream function have been obtained on isentropic surfaces, but further evaluation of the results is required. Work is continuing on a moisture analysis and results have reached the point where they can be judged on a meteorological basis. (Hovermale, Chu, Marks, and Scofield)

b. A six-level nested-grid hurricane model was coded. The total forecast area is nearly a 2600-km square. The aircraft reconnaissance data for Hilda (1964) and analyses of these data by NHRL have been received and will be used to define an initial state. The computer code for the six-level model is written in such a way that the area of integration can be located in the region of any storm with little effort. The model will be later used to study the development of other hurricanes.

A divergent barotropic PE model incorporating two mutually interactive nested grids similar to those used in an earlier four-level hurricane model was coded. A 12-hour integration, utilizing a large-amplitude sinusoidal perturbation on a basic current as the initial state, was carried out. Results show that the potential vorticity following a particle is nearly conserved across the interface of the coarse and fine mesh. No smoothing is used. Further tests are planned. A scheme to incorporate a moving fine mesh, embedded in a coarse mesh, will also be tested using this model.

The paper entitled *A multiple-grid primitive equation model to simulate the development of an asymmetric hurricane* (Isbell 1964) appeared in March 1974 issue of JAS. A paper entitled *Development of banded structure in a numerically simulated hurricane* was submitted to JAS. (Mathur)

3. Semi-Implicit Model

Results of early experimentation have been published in NOAA Technical Memorandum NWS NMC-54. Current research has centered on the problem of incorporating orography into the semi-implicit model. Erroneous features of meteorological scale appear stationary over the mountains and become more intense with time. Various diagnostic experiments are still being made but no definitive reasons for the difficulty have been found. Changes in model formulation may have to be made, if the semi-implicit technique is to be successfully used at NMC.

A PE barotropic semi-implicit model with orography seems to have none of the above-mentioned mountain problems. (Campana)

4. Planetary Boundary Layer Model

The experimental testing of the PBL model was completed and the results presented at the AMS Conference on Weather Forecasting and Analysis, March 1974, and submitted for publication as a NOAA Technical Memorandum. It is planned to convert the PBL model for the IBM 360/195 and to run the model as part of the operational cycle. (Polger)

5. Conversion of Operational Models

The operation of the 6L PE model was transferred from the CDC 6600 computer to the IBM 360/195 computer at 1200 GMT January 23, 1974. Work continues on the conversion of the new computer code to accept the Flattery spectral analysis scheme operationally.

The conversion of most components of the LFM model from the CDC 6600 computer to the IBM 360/195 computer is complete. A period of operating the converted code and comparing it to the present operational LFM model will precede operational implementation on the IBM 360/195 computer. The converted version of the LFM model will be designed to run to 36 hours compared to the present 24-hour limit.

(Howcroft, Campana, Polger, Carlton, and Gordon)

C. Data Assimilation Branch

1. Data Impact Tests

The planned impact test with Nimbus 5 soundings was postponed because of the need to concentrate on establishing archiving procedures for the DST.

We began to examine the ability of Nimbus 5 soundings to define baroclinic zones and jet maxima by comparing ITPR-only and radiosonde-only cross sections. Seven cases are being examined in which Nimbus 5 reports lie along lines with radiosonde data. (Lemar)

An NMC Office Note is being prepared describing an attempt to estimate the errors in VTPR retrievals from the variances of rawinsonde and satellite measurements over the North Atlantic. A second Office Note in preparation examines the effects of correlated errors in estimating a "true" value from a linear combination of a forecast, VTPR, and radiosonde observations. (Bergman and Bonner)

2. Data Archiving

A full-scale end-to-end test of the DST archiving system was conducted in May. Level II tapes containing

- conventional data received over the global telecommunication system

- VTPR data and ATS satellite winds

- Nimbus 5 retrievals produced at GISS, New York

were written on tape in standard format, and tapes were mailed daily to users at GISS, GFDL, UCLA, and NCAR. Global analyses were produced from these tapes--using the 8L GLOBAL model with a 2.5^{o} horizontal mesh and the Flattery spectral analysis scheme operating in a 6-hour analysis-forecast cycle. Tapes containing grid point values of heights, temperatures, winds, and humidities were produced each day from 00 and 12 GMT analyses. Tapes were mailed routinely to designated DST users. The aim of the test was primarily to test Level II and Level III archiving procedures; however, data are being used in preliminary studies of data assimilation techniques and atmospheric predictability at GISS.

Results of this test will be analyzed this summer. Analysis procedures will be revised and retested in October in preparation for the first DST period, which is expected to begin in January 1975. (Desmarais and O'Neil)

3. Data Assimilation

The use of a numerical prediction model as an integrator of asynoptic observations requires that special procedures be devised to insert the data into the model. We have conducted experiments in which a PE barotropic model is "corrected" by inserting observations of 500-mb height as calculated from real VTPR soundings. Three important elements of any assimilation procedure have been examined: a damping integration method; simultaneous adjustment of the motion field using observed gradients of the mass field; and repeated use of each observation. A fourth element, a local objective analysis procedure, was retained without change through all experiments.

Assimilations with and without local balancing of the motion field from observed mass gradients indicate very strongly the need for such balancing to accelerate the adjustment of the model to the inserted data. Analysis of the remaining experiments is not complete, but preliminary indications are that repeated insertion is necessary to ensure that the resulting analyzed fields fit the observations both in space and in time. The experiments with different time integration methods indicate no clear performance superiority, which suggests that selection of a method may depend on other factors--such as economy.

These studies are forerunners of assimilation experiments with the NMC 8L GLOBAL model. A global data set for a 5-day period from December 1973 has been prepared, including conventional as well as satellite-derived data. It is anticipated that the experiments will begin as soon as the 5^{o} version of the model has been converted to the IBM 360/195. (McPherson and Kistler)

D. Upper Air Branch

1. Analysis of Stratospheric Data

a. Comparison of satellite data with radiosonde data

Monthly summaries of comparisons of VTPR-derived temperature data with mandatory-level radiosonde information have been derived and attached to the NMC Newsletter. (Laver and Finger)

b. Rocketsonde-satellite comparisons

United States rocket stations have been scheduling meteorological rocketsonde launches to coincide with NOAA-3 satellite overpasses. The radiances computed from the observed temperatures are compared with those actually observed in all channels and the results will be analyzed with special consideration to possible cloud contamination. Results obtained from previous rocket comparisons with Nimbus 5 have shown that this type of program can contribute significantly to improve satellite temperature derivations. (Gelman, Finger, and Miller)

c. International rocket comparisons

The second phase of the CIMO meteorological rocketsonde intercomparisons took place at the Guiana Space Center, French Guiana, during late September 1973. France, the United Kingdom, the Soviet Union, and the United States participated. Comparisons have been made of temperature and wind data obtained by the four different rocketsonde systems over the altitude range 25-70 km. Adjustments to temperature reported by the various sensors are being derived for use in high-level map analyses. (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 radiance data, experimental work is being done to automate first guess height and temperature fields for upper stratosphere analysis. A feasibility study introducing rocketsonde data for final analysis will follow. (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)

2. Research on Atmospheric Circulations

a. Major stratospheric warmings (Northern Hemisphere)

A paper surveying recent warming cases (1969-74) has been submitted for publication (Quiroz), and a comparison of observed features with the results of dynamical simulations has been undertaken. (Quiroz, Miller, and Nagatani)

b. Stratospheric warmings (Southern Hemisphere)

A detailed observational study was completed for publication in <u>Proceedings of IUGG IAMAP International Conference, Melbourne, 1974</u>. The systematic, quasi-periodic development of minor warmings under highly baroclinic conditions was noted. A polar vortex breakdown was not observed in 1969-73 in the Southern Hemisphere. (Quiroz)

c. Determination of stratopause heights and temperatures

Stratopause heights are determined as functions of time and of latitude along the meridians 70°W and 70°E. Results should provide significant checks on theoretical models. (McInturff)

d. Energy studies

Interhemispheric energy exchanges, low latitude-high latitude interactions, stratospheric-tropospheric interactions, and tropical mixed Rossby-gravity wave modes are studied in an effort to understand the variability of the atmosphere. (Miller, with personnel of (MSL/NESS, ERL, and Development Division)

3. Quality Control

a. Journal of quality control

A journal for quality control within NWS will contain information based on over 5 years of research, objective investigation, and experience concerning data deficiencies, their causes and effects. (Thomas and Finger)

b. Investigation of February 8, 1974, snowstorm in Washington, D.C.

Convincing evidence has been found to indicate that absences of key RAOB data from certain east coast stations may have had a bearing on the accuracy of NMC prognoses prior to the February snowstorm. The required data have been obtained and will be included in a reanalysis of the synoptic situation prior to the storm to determine what effect the addition of the data eventually has on the objective prognoses. (Thomas)

c. Quality control of AFOS

Experimental quality control programs are being written for testing on the NOVA-20 computer. Some aspects will be designed to evaluate data availability and accuracy, to apply some measure of control and correction of discrepancies, and to alert human monitors to suspicious data. Output of statistical tabulations are planned as a by-product of the programs. (Thomas)

III. AUTOMATION DIVISION

A. Meteorological Techniques Branch

During this period, efforts included program conversion for the IBM 360/195 and maintenance of observation data processors on the IBM 360/40.

1. Conversion

a. Reprogramming of the global analysis has been accomplished. Twelve levels of heights and winds, six levels of moisture, and four levels of temperature are analyzed routinely in 6 minutes CPU time. A typical analysis run processes about 7000 reports. Since both surface and upper air reports of all types are analyzed simultaneously, the procedure can properly be called three-dimensional. (Newell and Chase)

b. The global analysis preprocessor for observational data is ready to accept 'GOES' observations. (Chase)

c. Work continues on the global analysis post-processor to prepare 65 x 65 grid fields for the Northern Hemisphere and 73 x 23 grid fields for the Tropics from the analysis spectral coefficients. (Chase and Newell)

d. Preanalysis processor programs for the fine mesh (LFM) analysis are about ready for implementation in July. (Costello)

e. Reprogramming of the LFM surface, upper air, and moisture analyses for the IBM 360/195 is underway. The tropopause analysis for the LFM model is completed. (Costello, Nierow, and McDonell)

f. Reprogramming the surface, upper air, and aircraft data processors for the IBM 360/195 is continuing. (Webber, Byle, and Fleming)

g. Networks are being established on the IBM 360/195 to run operationally the 6L PE model and return the forecast files back to the CDC 6600 for post-processing. (Irwin)

2. Maintenance of Machine-Processed Observations

a. To support data assimilation tests and the GATE project, substantial revisions were made to our data processors on the IBM 360/40. We intend to be able to process, store, and dump 00 and 12 GMT upper air observations for an 18-hour period and 06 and 18 GMT observations for an 11-hour period. (Webber and Thompson)

b. Dropsonde data are now being incorporated into our automated data base. (Webber)

B. Services and Applications Branch

1. Programming Support Section

The reprogramming of CDC 6600 operational programs to the IBM 360/195 continues to be the high priority project of the section. Several persons have received additional training in the use of the IBM 360 Job Control Language. The programs being converted can be divided into three categories: forecast models, transmissions, and support programs.

a. Forecast models

The 6L PE model has been running in operational mode on the IBM 360/195 since January 1974, but it is continuing to undergo extensive modifications to improve its running time and to link in with the new NMC Production Package currently being developed. The LFM model is being converted by members of the Development Division with assistance from the Programming Support Section. The Mesh Model is approximately two-thirds checked out on the IBM 360/195. The conversion of the Barotropic Model has been started. (Carlton and Helmick)

b. Transmissions

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; they are: a character converter, a line builder, and a line blocker. Conversions of codes which produce the teletype bulletins for the forecasts of the 6L PE and the LFM models are expected to be completed by the end of 1974. A special transmission for the GATE project was completed and in operation June 25, 1974.
(Allard, Raymond, Townshend, and Steinborn)

c. Other projects

The APP package is in the first phase of conversion to the IBM 360/195. Snow cover for the $2\frac{1}{2}^{o}$ longitude/latitude grid (147, 37) for Northern and Southern Hemispheres has been running operationally on the IBM 360/195 since mid-April. A 2^{o} version is being tested, and a version to produce snow cover on the 65 x 65 6L PE grid is being programmed. The reprogramming of the H+2 operational system is underway. The balance equation code is in a test mode. A general grid printing program for the 6L PE has been operational since March. In addition, the generalized post-processor for the 8L GLOBAL model has been converted. Further work is required on the eight-layer processor to decrease the computer running time. The 2.5^{o} sea surface temperature program has been modified to produce 2^{o} Northern and Southern Hemisphere fields. (Finnican, McClees, Helmick, and Boczenowski)

The operational programs remaining on the CDC 6600 still require occasional program modifications to handle maintenance and upgrading. The modifications for this period include changes to pick up additional relative humidity fields, reprogramming to allow use of IBM 360/40-CDC 6600 interface, and incorporation of new stations in the surface and upper air automatic data processing dictionaries.
(Steinborn, Allard, and Townshend)

2. Graphics Support Section

The Graphics Support Section has been working on two major projects: reprogramming the operational map-generating programs from the CDC 6600 to the IBM 360/195, and developing the DGTS which will enable charts to be transmitted in a digital mode between the computer center in Suitland and sites remote from the center (such as the World Weather Building).
(Bedient, Shimomura, Schnurr, Hopkins, Brinkley, Dent, and Nathan)

a. Reprogramming

The reprogramming project has advanced to the point where the basic graphics subroutines which draw isolines and print characters on a geographical background are nearly completed. However, much remains to be done in the various operational applications. These applications programs have the logic which handles the grid-point data fields, labels the isolines and centers; reads, sorts, thins, and plots data at stations; titles the maps; adds facsimile transmission control information; and finally calls upon the basic graphics subroutines to integrate all the information into the resulting digital packed scan-line format map. Work is now in progress on the program to portray the numerical model forecasts on a Northern Hemispheric polar stereographic projection.

b. Digital graphics transmission system

The NMC FAXX accepts digital packed maps and stores them on disk storage; at the scheduled transmission times, it transmits the maps by fetching the digital map information, unpacking it, and sending it to one of 12 DFI ports in small increments. The DFI converts digital data to analog form for transmission on the appropriate facsimile circuit. A second function of FAXX is to produce maps for local use. This is done by sending the digital map information from disk storage to the Interdata minicomputer which drives a Varian electrostatic plotter.

Two more functions for FAXX are now being developed in the minicomputer-based DGTS which will become an integral part of the FAXX system. One function is to provide computer graphics to a remote site, and the other is to enable manually prepared charts to be input into the FAXX system from a remote site for subsequent transmission on the facsimile circuits. At a remote site, there will be a terminal consisting of an Alden digitizer for scanning manually prepared maps for transmission, a Varian plotter for producing maps transmitted from the central computer site, and a minicomputer which controls both of these devices. The terminal is connected via high speed communications circuits to the Terminal Controller minicomputer at Suitland and the controller is connected to the FAXX main computer.

The equipment for the DGTS has been assembled, and the hardware and the computer programs (written with the assistance of members of the Information Processing Branch) are being tested by transmitting test charts to and from a terminal. Programming the minicomputers and the FAXX main computer to handle the remote terminal traffic in an operation mode is now in progress. The user requirements for digitizing manually drawn charts have been analyzed, and the schedules and controls necessary for the computer to recognize each manual chart and automatically transmit them are now being prepared.

The additonal workload of approximately 200 facsimile transmissions per day made from the manual charts digitized into the FAXX system would exceed the capabilities of the main FAXX computer in its present configuration. Reducing the load on the IBM 360/40 computer will be accomplished by the following strategy:

(1) Increase the record size and change the packing algorithm of all digital map information. This entails modifications to

all operational map generating programs presently on the CDC 6600 in addition to changes throughout the FAXX system. These modifications are now being checked out.

(2) Move some of the DFI workload onto a minicomputer. The digital-to-facsimile conversion will be performed in a minicomputer interface which was designed locally by personnel in the Electronic Equipment Branch in collaboration with the Graphics Support Section. All the pieces necessary for replacing one DFI unit's function with this minicomputer and interface are not yet on hand, and the programming for using the device still remains to be done.

C. Information Processing Branch

1. Air Transport Association

a. On February 12, 1974, we initiated an amendment capability for the ATA digital wind forecasts. The amendments are manually entered on a CRT tube by a meteorologist or aide and 'sent' to the IBM 360/40 where they are automatically processed and transmitted.

One to 15 amendment messages are entered on the CRT, each one in the form of a four-sided latitude-longitude polygon area. Changes can be made to any or all of the millibar levels and to any or all of the four time periods. The parameters changed are any or all of the following: wind speed, wind direction, and temperature.

b. On March 7, 1974, Japan Air Lines became the 13th polled user of the ATA winds.

2. Automation of Field Operations and Services

Several new codes have been written and old ones revised to support NMC's participation in the AFOS program. Among the new codes that have been checked out are the following:

a. A code to format required messages in the AFOS format complete with the required header and record size.

b. A code to load and maintain on the IBM 360/40 the various jobs required by the Interdata minicomputer. One or more of these jobs, when loaded into this minicomputer, will control the actual communications with the AFOS line.

c. A code (currently running operationally) to break down various bulletins of observational data (climate, synoptic, upper air, etc.) into their component individual observations and store them into separate data bases.

d. A code which generates AFOS messages from all of the raw data bases (hourlies, FT's, etc.).

Other actions to support AFOS include the design, implementation, and maintenance programs to accommodate AFOS.

3. Interdata 50 Minicomputers

A vast amount of time has been spent in building and checking out the basic software system and in designing, optimizing, and checking out the various communication software packages to run in these minicomputers. One important aim has been to permit the simultaneous operation of Alden digitizers and Varian recorders via two 50-kilobit full duplex circuits. The implementation of these circuits is required to support the final move to the WWB. These software packages are also designed to support the communications with the AFOS line with minimal adaptation.

4. Miscellaneous Line Changes

a. In March 1974, we added the UPI as the fifth user on our shared 1050-wpm line. Since then, we have gradually been escalating the amount of data we send them to an eventual total of 2-3 hours work per day.

b. Also in March, at the rate of one line per week, we helped upgrade the three 75 wpm RAWARC lines to 100-wpm operation.

c. We helped set up a special 1050-wpm line to an Inktronic printer in the WWB and successfully demonstrated our ability to supply that printer with all the information required to support the Forecast Division charting operation.

d. In late April 1974, we deleted the 1050-wpm Honolulu line in favor of three 100-wpm Honolulu receive lines.

e. At the end of May 1974, we implemented a new full duplex Mexican 100-wpm circuit.

f. We successfully checked out with the Bureau of Land Reclamation a new high speed procedure to allow the handling of three distant terminals on a polled basis.

5. Bulletin Directory

a. Normal maintenance included some 6000 additions, deletions, and changes.

b. At the end of March 1974, we implemented a major change to accommodate Tokyo's switchover to WMO catalog numbers.

6. Revisions

Codes to handle additional or changing requirements have been revised. These revisions include the addition of 12 new international transmission bulletins and a program to decode hourly observations and store them in a data base. (Brandis, Carpenter, Lish, and McDaniel)

D. Operations Branch

1. There has been continued maintenance of NMC's Operating System on the CDC 6600, including modifications adjunct to meshing the IBM 360/195 system into our operational stream and adjustments to assist the release of one CDC 6600 system. (Fuller)

2. Data Management Section

Current automated archives originally intended for NCC and NCAR have been expanded to provide permanent in-house data sets. Archive data sets for NCC and NCAR are now current, and new data are provided to these centers 2 to 3 weeks following the end of each month. (Gelhard)

Reprogramming the 36-day random-access file of analysis, 6L PE, LFM, and barotropic forecast data for the IBM 360/195 is near completion. A 31-day sequential tape file of all basic data, analysis, forecasts, and sigma fields of the 6L PE and LFM is being constructed.

Data are also being provided to the following facilities: Fleet Numerical Weather Facility, UCLA Dept. of Meteorology, Scripps Institute of Oceanography, Fisheries Research Board of Canada, Portuguese Meteorological Service, and GISS.

E. Electronic Equipment Branch

Two additional minicomputers (to total six) have been ordered. One will be used as a communications front-end for IBM 360/40 System #2, and the other will front-end the IBM 360/40 System #1 for bisynchronous high-speed circuits and for the start/stop circuits.

These systems will be described fully in the next semiannual activities report.

IV. MACHINE PERFORMANCE AND UTILIZATION

A. Machine Use

1.	IBM 360/30G	633 hours
2.	IBM 360/40GF - #1	4,351 "
3.	IBM 360/40GF - #2	4,220 "
4.	IBM 360/40G - #3	4,305 "

B. Profile Changes

1.	IBM 360/30G	Released	two IBM 2311 Model 1 Disk Drives
2.	IBM 360/40GF - #1	"	one IBM 2841 " " " Storage Control
		Added	two Memorex 660 Disk Drives
3.	IBM 360/40GF - #2	"	one IBM 2914 Model 1 Switch Unit
4.	IBM 360/40G - #3	"	two Memorex 660 Disk Drives

V. DISTRIBUTION OF PRODUCTS

As of June 22, NMC was originating about 810 separate teletypewriter bulletins each day for transmission over NWS, U.S. Navy, U.S. Air Force, 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
Circuit #10207 .	50
Circuit #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																		
Jan.	.76	203	28.2	292	36.5	.75	261	32.5	362	41.3				.72	318	36.0	405	42.8
Mar.	.80	188	25.9	302	36.6	.81	237	29.4	391	43.3				.81	273	31.6	443	46.2
May	.80	151	22.6	244	31.7	.81	188	25.7	314	36.9				.79	221	27.7	344	39.0
300 mb																		
Jan.	.83	177	24.3	309	37.4	.81	229	28.5	477	42.0				.77	291	32.3	419	43.7
Mar.	.86	167	22.5	325	37.5	.86	214	26.4	410	44.2				.85	253	29.2	465	47.6
May	.84	144	20.2	263	32.1	.84	182	23.4	334	37.5				.82	216	25.9	369	39.7
500 mb																		
Jan.	.82	131	17.5	222	26.9	.81	168	20.2	272	30.2	.64	219	23.6	.75	220	23.3	304	31.5
Mar.	.84	128	16.3	234	26.6	.85	161	19.0	295	31.2	.69	212	22.2	.83	193	21.0	334	33.4
May	.82	107	14.3	185	22.1	.83	134	16.7	237	25.8	.71	162	18.2	.81	158	18.1	265	27.3
850 mb																		
Jan.	.78	109	14.5	156	17.5	.75	141	17.1	187	19.6				.69	181	19.3	206	20.1
Mar.	.80	108	13.4	161	17.3	.80	134	15.8	203	20.1				.78	158	16.8	229	21.3
May	.78	86	11.4	129	14.4	.79	107	13.1	165	16.9				.78	121	13.9	184	17.6
1000 mb																		
Jan.	.79	114	16.0	164	19.8	.76	150	19.5	197	22.2				.69	192	21.7	215	22.6
Mar.	.82	109	14.9	172	20.0	.81	136	17.6	215	23.0				.79	164	19.0	239	24.0
May	.78	89	12.8	134	16.3	.77	115	14.7	170	18.9				.77	128	15.8	185	19.4

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																		
Jan.	.79	167	21.7	312	33.2	.75	219	25.4	394	38.9				.69	288	29.8	448	41.8
Mar.	.90	134	19.6	309	34.5	.88	181	23.4	395	41.1				.85	246	27.3	456	45.6
May	.87	120	18.5	248	31.2	.85	170	22.8	325	37.6				.81	211	26.1	362	40.1
300 mb																		
Jan.	.86	153	20.1	344	38.3	.82	207	24.6	421	43.4				.76	273	29.6	470	46.4
Mar.	.93	135	18.7	377	41.8	.91	185	23.4	464	48.7				.88	249	28.3	524	52.8
May	.89	122	17.9	277	34.3	.86	174	23.0	355	41.2				.82	216	25.9	388	42.8
500 mb																		
Jan.	.87	106	13.8	238	26.3	.82	146	16.9	287	29.5	.69	208	20.5	.77	189	20.5	319	31.4
Mar.	.91	102	13.8	262	28.1	.91	136	16.4	329	33.5	.79	208	21.0	.87	182	20.1	368	35.9
May	.87	85	12.1	178	22.0	.84	120	15.2	227	26.3	.74	142	16.9	.80	146	17.2	246	27.0
850 mb																		
Jan.	.83	85	10.6	147	16.0	.78	113	13.1	166	17.3				.71	140	15.3	176	17.4
Mar.	.85	85	10.8	166	17.9	.86	100	12.5	203	20.7				.81	127	14.8	221	21.6
May	.78	72	9.2	113	13.9	.76	93	11.5	140	16.6				.73	110	12.9	145	16.0
1000 mb																		
Jan.	.84	98	13.6	163	19.1	.80	128	16.7	185	20.9				.71	161	19.3	193	21.0
Mar.	.86	99	13.3	188	21.5	.88	113	15.3	228	24.8				.83	142	18.0	240	25.3
May	.77	79	11.2	119	15.4	.76	100	13.6	146	18.2				.72	120	15.2	149	17.4

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																		
Jan.	.86	158	17.1	320	32.3	.83	210	20.8	383	36.3				.78	263	24.4	411	37.6
Mar.	.84	161	17.9	304	29.1	.83	207	21.9	386	35.2				.79	267	25.4	439	38.2
May	.84	121	14.2	231	24.4	.84	158	18.3	303	30.3				.83	188	19.7	342	32.0
300 mb																		
Jan.	.89	165	18.7	374	39.8	.86	218	23.2	434	44.0				.79	277	27.5	460	44.7
Mar.	.87	167	18.2	348	35.2	.85	219	23.2	436	41.9				.81	283	27.7	492	45.9
May	.89	133	15.7	295	31.9	.88	177	20.4	381	39.1				.86	214	23.1	434	42.3
500 mb																		
Jan.	.87	125	13.3	262	27.1	.84	166	16.8	310	30.6	.72	214	19.6	.77	215	19.8	336	31.5
Mar.	.85	123	12.6	246	24.2	.85	160	16.0	312	29.0	.70	211	19.3	.80	212	19.4	352	31.9
May	.88	94	10.4	202	21.0	.88	125	13.6	265	26.1	.77	167	16.3	.86	156	15.6	309	29.0
850 mb																		
Jan.	.83	104	9.9	189	17.6	.78	135	12.5	220	19.2				.71	175	14.9	240	19.8
Mar.	.77	102	8.9	154	14.2	.77	126	11.5	196	17.4				.71	168	13.5	223	19.0
May	.84	72	7.4	133	12.5	.84	92	9.0	174	15.7				.82	117	10.8	203	17.5
1000 mb																		
Jan.	.82	110	10.4	191	18.3	.78	143	13.1	227	19.8				.69	188	15.9	245	20.0
Mar.	.78	98	9.1	149	14.2	.77	124	11.8	187	17.2				.70	165	13.9	212	18.7
May	.82	73	7.8	131	12.6	.83	91	9.6	169	15.6				.81	115	11.5	194	17.0

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																		
Jan.	.67	204	25.2	239	29.7	.65	259	29.3	295	34.0				.62	312	32.9	327	35.8
Mar.	.83	160	20.9	272	30.8	.79	233	24.2	358	36.8				.82	254	27.0	405	40.4
May	.80	158	21.4	261	32.9	.83	183	23.1	325	37.3				.81	222	27.0	374	41.9
300 mb																		
Jan.	.80	158	20.6	251	31.5	.75	216	24.9	309	36.0				.71	275	29.3	343	38.3
Mar.	.87	142	18.5	287	33.1	.82	213	22.2	367	38.9				.83	238	25.3	417	42.6
May	.85	145	19.8	280	34.8	.86	170	21.7	340	39.3				.85	206	25.3	385	42.9
500 mb																		
Jan.	.79	113	14.1	173	21.7	.77	143	16.2	211	24.6	.53	200	20.3	.72	189	19.4	238	26.8
Mar.	.84	103	12.8	191	21.9	.79	154	15.1	241	25.5	.55	199	19.2	.80	168	16.8	275	27.9
May	.85	99	12.9	186	22.9	.86	114	14.4	224	25.9	.74	151	16.4	.84	141	16.8	251	27.7
850 mb																		
Jan.	.65	107	15.0	111	13.2	.64	135	16.7	134	15.1				.59	172	18.7	147	16.0
Mar.	.77	102	13.4	141	15.3	.72	141	16.2	179	17.7				.73	151	16.8	200	19.0
May	.80	86	11.9	132	15.4	.78	112	14.6	159	17.4				.78	119	15.1	174	18.4
1000 mb																		
Jan.	.68	118	16.0	124	16.1	.68	148	19.1	153	18.6				.63	184	21.1	166	19.5
Mar.	.83	97	13.4	163	18.5	.81	130	16.3	206	21.5				.79	155	18.5	232	22.9
May	.82	91	12.1	146	17.6	.75	130	15.5	178	20.0				.78	133	16.9	188	20.5

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:

Alvin J. Miller, Research Meteorologist, Upper Air Branch
Joyce A. Peters, Secretary " " "

Transfers:

Keith W. Johnson, Research Meteorologist, " " " to NESS
Louise T. McDonald, Secretary " " " to NRL
Roderick A. Scofield, Res. Meteorologist, Regional Modeling Branch to NESS.
Joseph Ships, Technical Assistant, to Forecast Division.

B. Automation Division

New Employees:

Dean F. Dubofsky, Mathematician, Operations Branch
Arthur F. Wick, Jr., " Services & Applications Branch
Stephen T. Rich, Meteorologist, Meteorological Techniques Branch
Lawrence E. Sager, " " " "

Transfer:

Frederick S. Zbar, Meteorologist, to OMO, Office of Associate Director.

C. Forecast Division

New Employees:

Paul F. Carpenter, Meteorologist, Surface Analysis Branch
Richard D. Thomas, " " " "
Gerald G. Rigdon " " " "
Sydney Levitus, " " " "
Charles L. Vlcek, " " " "
Robert N. Klein, " " " "
John R. Leathers, " " " "
Wallace G. Haggard, " Aviation Weather "
Robert H. Hopkins, " " " "
Robert Kuessner, " " " "
Felix E. Henderson, Jr. " " " "
Francis D. Hughes, " Basic " "
H. Michael Mogil, " " " "
Robert C. Richey, " " " "
Mary C. Newton, " " " "
John V. Wright, " Quantitative Precip. Branch

Transfers:

Holbrook Landers,	Meteorologist,	to	Southern Region
Ernest J. Perfrement,	"	"	" "
William M. L. Briggs,	"	"	Central "
Barry Lee Kercher,	"	"	Environmental Data Service
Cosmo D. Fornaro,	"	"	SDO
Earl W. Estelle, Super.	"	"	Weather Analysis & Prediction Div.

Retirement:

George S. Templeton, Supervisory Meteorologist.