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Numerical Weather Prediction Activities

National Meteorological Center

Second Half 1973

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NATIONAL WEATHER SERVICE

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SECOND HALF OF 1973

CONTENTS

ABBREVIATIONS AND ACRONYMS

AD	Automation Division
ADP	Automated Data Processing
AERINC	Aeronautics Incorporated
AFTN	Aeronautical Fixed Telecommunications Network
APP	Air Pollution Potential
AR	Attention Routine
ASP	Asymmetric Multiprocessing System
ATA	Air Transport Association
CDC	Control Data Corporation
CRT	Cathode Ray Tube
DATAC	Data Acquisition Division (NWS)
DFI	Digital Facsimile Interface
DOS	Disk Operating System
DST	Data Systems Test
EAI	Electronic Associates Inc.
EOF	End of File
FAA	Federal Aviation Administration
FOFAX	Forecast Office Facsimile Network
FT	Terminal Forecast
GFDL	Geophysical Fluid Dynamics Laboratory
GISS	Goddard Institute for Space Studies
IBM	International Business Machines
I/O	Input/Output
ITPR	Infrared Temperature Profile Radiometer
JAM	Journal of Applied Meteorology
JAS	Journal of Atmospheric Sciences
LFM	Limited-area Fine-mesh Model
NAMFAX	National and Aviation Meteorological Facsimile Network
NASA	National Aeronautics and Space Administration
NCAR	National Center for Atmospheric Research
NEMS	Nimbus E Microwave Spectrometer
NESS	National Environmental Satellite Service
NHC	National Hurricane Center
NMC	National Meteorological Center
NOAA	National Oceanic and Atmospheric Administration
NRC	National Records Center
NWP	Numerical Weather Prediction
NWS	National Weather Service

OS	Operating System
PBL	Planetary Boundary Layer
PE	Primitive Equation
RAWARC	Radar Warning and Reporting Circuit
RMB	Regional Modeling Branch
RMS	Root Mean Square
SAB	Services and Applications Branch
SCR	Selective Chopper Radiometer
SIRS	Satellite Infrared Spectrometer
TDL	Techniques Development Laboratory, NWS
UAB	Upper Air Branch
VTPR	Vertical Temperature Profile Radiometer
WMO	World Meteorological Organization
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 second half of 1973. There were no significant changes made to the operational models during this period. Major efforts are being directed toward converting the operational programs to the new IBM 360/195 computer system acquired by NOAA.

Preliminary activities in the new hurricane modeling project are given in Section III. B. 3. Results of the first VTPR test are discussed in Section III. C. 1. During the latter half of the period, units of NMC moved to new quarters in the World Weather Building (WWB). These included the Office of the Director, Development Division, and portions of Automation Division. The Forecast Division will be moving to the WWB during the spring.

II. THE NMC OPERATIONAL MODELING SYSTEM FOR 1973

The following is a brief summary of the numerical model configuration which was in operational use at NMC during 1973. Each system was run daily from both the 0000 GMT and 1200 GMT data bases.

At 1 hour and 30 minutes after data time, the barotropic system was initiated. This is a filtered model with planetary wave stabilization control. A fourth-order-accurate finite-difference Jacobian is incorporated and a 1-hour time step is used. Effects of mountains and skin friction are included. A 850-500 mb thickness forecast was made simultaneously to obtain a more accurate estimate of these effects on the 500-mb barotropic forecast. The integration domain is the familiar 1977-point octagon with a 381-km grid distance on the polar stereographic projection, true at 60°N. Forecasts were run to 48 hours.

At 2 hours after data time, the LFM system was initiated. This is essentially the Shuman-Hovermale 6L PE model (F. G. Shuman and J. Hovermale, 1968, JAM, Vol. 7, No. 4) applied to a North American area. The grid distance of the 53 x 57 grid was 190.5 km on the stereographic projection and the time step was 6 minutes. The lateral boundary condition was changed from a time-invariant one to one which incorporated smoothed tendencies obtained from the 12- to 36-hr forecasts of the 6L PE made at the previous cycle 12 hours before. These tendencies and those of the LFM model are blended on the three outermost boundary rows of grid points. At the same time that the lateral boundary condition was changed, the 53 x 57 grid was reduced to a 53 x 45 grid by eliminating the 12 northernmost grid rows. This cut 10 minutes off the running time without a noticeable deterioration of the forecast skill over the conterminous United States. All forecasts were run to 24 hours. About 1 hour of CDC 6600 computer time is now required for each forecast. A leapfrog differencing system with the invariant form of Shuman's semimomentum horizontal differencing system was used.

At 3 hours and 20 minutes after the 0000 GMT and 1200 GMT data times, the coarse-mesh version of the Shuman-Hovermale (6L PE) model was initiated. Here, the 53 x 57 grid with the 381 km grid distance on the polar stereographic projection is used. A free-slip, thermally-insulated wall condition is used at the lateral boundaries. As with the LFM model, the 6L PE incorporates a simulation for the effect of (1) mountains, (2) skin friction, (3) short- and long-wave radiation, (4) sensible heat exchange over the oceans, (5) convection, and (6) precipitation. Moisture is treated as a thermodynamically active variable. By a three-point time averaging of the pressure-gradient terms in the momentum equations of the 6L PE and suitable controls of the computational mode, a 20-minute time step was used in the invariant formulation of the semimomentum finite-difference system. Forecasts were run to 84 hours from the 0000 GMT data. Runs to 48 hours were made from the 1200 GMT data. The 84-hour 500-mb forecasts made from 0000 GMT data were extended to 156 hours with the filtered, divergent barotropic model. Similarly, the 48-hour 500-mb forecasts made from the 1200 GMT data were extended barotropically to 96 hours. Given the 500-mb barotropic forecasts from 84 to 156 hours at the 0000 GMT cycle, the Reed model (1963, NMC Technical Memorandum No. 26) was used to obtain 1000-500 mb thickness predictions for use in forecasting surface maximum and minimum temperatures. All the extended runs are used primarily for guidance for NMC's 5-day forecast program.

The initial analysis technique for all numerical systems was the Cressman successive approximation method (J. E. McDonell, notes on "Operational Objective Analysis Procedures" prepared for the NWS Advanced Prediction Techniques Course, September 1973). It was used to analyze the geopotential heights and temperatures at the 850-, 700-, and 500-mb levels on the 1977-point grid for the barotropic run 1 hour and 30 minutes after data times. It was also used at the 0000 GMT and 1200 GMT data times for the LFM and 6L PE grids at the 2-hour and 3-hour-and-20-minutes data cut-off times. Geopotential heights, temperatures, and winds were analyzed at all mandatory pressure levels from 850 mb to 100 mb. Sea-level pressure, surface temperature, and tropopause pressure were also analyzed. Moisture was analyzed in the three lowest sigma layers of the models. Geopotential height and temperature analyses were made later in the day for display purposes from the 1200 GMT data at 70 and 50 mb. The same parameters were also analyzed at 30 and 10 mb once a day combining the 0000 GMT and 1200 GMT data.

The initialization for the model runs made 1 hour and 30 minutes after data times consisted of the mass-wind relationship as specified by the nonlinear balance equation.

The initialization procedure for the PE models consisted of the following:

After specifying the sigma-coordinate system from the mountain heights and the constant pressure and tropopause analyses, the analyzed geopotential heights and winds were interpolated from the pressure surfaces to the sigma surfaces. The divergent component of the wind field is replaced with the 12-hour forecast component made from the previous 6L PE cycle. In the case of the LFM, this estimate of the initial divergent wind component also comes from the 12-hour forecast of the 6L PE made 12 hours earlier. The rotational wind component was the objectively analyzed one, not that obtained from the balance equation.

III. DEVELOPMENT DIVISION

A. Global Modeling Branch

1. 8L HEM and 8L GLOBAL Development

The principal effort in terms of time consumed has been the conversion of the programs to the IBM 360/195 computer. This has involved not only changes of syntax but substantial reprogramming to take as much advantage as possible of the high-speed features of the machine. The goal is a running time of 20 minutes for a 48-hour 2.5° grid-mesh single-hemisphere 8-layer forecast and 40 minutes for the 8L GLOBAL, since the latter covers twice the area. The value of 20 minutes is based on the timing achieved by IBM during their contract proposal stage.

NMC Office Note 90 was prepared describing the basic physics and structure of the 8L GLOBAL and 8L HEM models. (Stackpole)

2. 3L GLOBAL PE Forecast Model

Experiments in the study of energy changes in a sigma vertical coordinate PE model using the 3L GLOBAL model have progressed. In calculating the pressure force and vertical advection terms, a number of different formulations of the finite-difference equations have been employed. These include reduction of the pressure-force terms to the calculation of the gradient of geopotential on a pressure surface, conversion of the model to approximate three layers of equal mass, and altering the vertical advection terms from mass weighting to another form known to conserve energy exchanges between the boundary layer and the layer above. A completely acceptable exchange between kinetic and potential energies has not resulted from any of these experiments. The study will continue. (Vanderman)

3. Damping 8L GLOBAL Model Gravitational Oscillations

Large amplitude gravitational oscillations with periods of 2 to 3 hours, 5 to 6 hours, and 8 to 10 hours have been noted in the 8L GLOBAL model, see NWP Activities, First Half 1973, Chapter III, Section C. Experiments with methods to damp these oscillations are being conducted along the following lines:

a. Divergence damping

Experiments with the special viscosity term, which damps only divergence (Shuman, NMC Office Note 32), illustrated two problems with the method: for all but rather small values of the viscosity coefficient, precipitation was reduced and the flow in mountainous regions was undesirably altered (McPherson and Stackpole, NMC Office Note 83). Two approaches toward alleviation of these problems are planned. In the first, only the vertical mean divergence in each sigma domain will be damped; while in the second, the divergence damper will be restricted to sigma domains above the tropopause. Preliminary results with the latter approach indicate some success in terms of the variables having smoother time series graphs and improved verification scores.
(Dey, Kistler, and McPherson)

b. Removing the initial vertical mean divergence

Based on evidence that the noise consists essentially of external gravity waves, it is planned to remove the vertical mean divergence from the initial fields. The solution of a Poisson equation is necessary to accomplish this. A method which obtains a direct solution of a Poisson equation was tested and found unsuitable for our purpose. A solution by relaxation has been written and is being checked out.
(Dey, Kistler, and McPherson)

c. Investigating Flattery's global analysis method

In theory, Flattery's global analysis method provides gravity wave-free initial data provided a wind law is satisfied. In practice, however, it has been decided not to require that this wind law be satisfied. Experiments are being planned to investigate the effect of requiring the wind law to be satisfied on the gravitational noise in the subsequent 8L GLOBAL model forecasts. (Dey and McPherson)

4. PE Model Initialization

The results of experiments designed to selectively remove gravity waves from a PE model, see NWP Activities, First Half 1973, Chapter III, Section A, indicate that such an approach is not mathematically feasible. Attention has therefore turned toward approximate methods of accomplishing this goal. The methods presently under investigation are divergence damping and removal of the vertical mean divergence from the initial data, and are reported on elsewhere in this section. (Dey)

5. Vertically Integrated Model

Experiments have been carried out with the vertically integrated model which now includes diabatic heating and a moisture equation. A detailed report on the formulation and results is now being prepared.
(Bostelman)

6. Spectral Methods

Hough function analysis is converted to spherical harmonic representation of the height and wind fields directly from the series expressions of the eigenfunctions used in Flattery's global analysis. (Sela)

7. Mountain Flow

Work continues on projects begun in the first half of 1973. (Collins)

8. Cumulus Convection

A method for parameterizing cumulus convection has been outlined. Conceptual aspects of the scheme and details of its formulation are now being discussed. (Hirano)

B. Regional Modeling Branch

1. General

All four new staff members assigned to work on the development of a new, higher resolution model suitable for application to the prediction of hurricanes had arrived by July 9. In addition, Dr. Mukut Mathur, a National Research Council Research Associate and an expert in hurricane modeling, joined the Division on August 1. Dr. Banner Miller, NHC, visited the project in August. Dr. Richard Anthes, Pennsylvania State University, briefed us on his recent work on hurricane model data dependence in September.

Mr. J. Howcroft worked with Dr. G. Kontarev, USSR Academy of Science, in carrying out a comparison of the LFM and a version of G. I. Marchuk's implicit model. Dr. Kontarev presented two seminars on Marchuk's method in October. Recent work on the semi-implicit method used in England was discussed by Dr. Alan Gadd in September.

A paper on quasi-static models was presented before a symposium on mesometeorology at GFDL in November. A working group on mesometeorological planning met at the WWB in November. The National Academy of Sciences Panel on short-term forecasting was briefed on the activity of the RMB in December. Planning for the new IBM 360/195 operational forecasting system continued with renewed emphasis during November and December. (Gerrity)

2. Operational Models

The operational 6L PE model has been converted to operate on the newly-acquired NOAA IBM 360/195 computer. In the conversion process, several changes have been made. The grid has been expanded from one containing 53 x 57 points to 65 x 65 points. The grid interval has not been changed, the grid has just been extended to include the Equator and thereby move the lateral boundaries further from the regions of principal forecast interest.

In addition, the time step has reverted back to 10 minutes from the 20-minute step now used operationally. The longer time step was introduced originally to save computing time and was not intended to improve the model's meteorological performance. This modification is being dropped now to make our total conversion effort more efficient--in that many of the 6L PE routines can now be used in the scheduled conversion of the LFM model.

NMC plans to eventually use analyses obtained from the Flattery spectral analysis scheme for input to the 6L PE on the IBM 360/195. Until that scheme is adopted operationally, the present grid-point analyses will be smoothly expanded from the NMC 1977-point octagon into the inter-boundary region of the 65 x 65 grid.

The converted model has been operating since mid-December on the IBM 360/195 and its forecasts to 48 hours have been compared with operational ones. The differences are minimal and the conversion appears to have been successful. Consequently, operation of the 6L PE will be transferred from the CDC 6600 computer to the IBM 360/195 as soon as the latter is considered sufficiently reliable. Work is now proceeding to optimize the new computer code. (Howcroft, Gordon, and Carlton)

3. Hurricane Modeling

a. Development work directed toward the goal of improved prediction of hurricane movement and precipitation was initiated at the start of the period. The operating model, as it is now planned, will be applicable to significant precipitation systems of extra-tropical nature as well as those characteristic of the deep Tropics.

The model has several characteristics that are intended to make it more flexible for operational purposes and more useful for short-range forecasting. These include time-dependent boundaries, a movable grid, initialization procedures based directly on the finite-difference prediction equations, cumulus parameterization, and refined analyses.

Regarding this final point, it should be pointed out that we shall be attacking two rather diverse analysis problems. In data-poor regions, where interest will focus primarily around intense tropical systems, analysis-initialization procedures will necessarily involve the use of modeled vortices anchored by reconnaissance and satellite data. It is possible that certain manual input will be required before automated techniques can prove reliable. On the other hand, when the model is used to forecast storms over continental areas, the analysis-initialization approach will rely more heavily on conventional techniques like those currently employed in NMC operational models. One major modification to the conventional scheme is planned, however: the fine-scale extrapolation of data on potential temperature surfaces for the primary purpose of improved definition of frontal structures.

To date we have programmed and successfully run on the IBM 360/195 codes simulating symmetric and asymmetric vortices. Further testing is planned to study the detailed interactions of the large-scale dynamics with various parameterizations, while concurrently effort is underway to mesh the boundaries with forecasts from larger-scale models.

Preliminary design of the analysis-initialization system has been completed and codes are in the early stages of check-out.
(Hovermale, Marks, Chu, and Scofield)

b. Further experimentations with the four-level fine-mesh multiple-grid PE model, to investigate the importance of convective vs. nonconvective release of latent heat and surface friction in the development of simulated hurricanes, were carried out. A paper describing the simulation of Isbell 1964 will appear in the March issue of JAS. The relative importance of convective vs. nonconvective heating in the development of simulated hurricanes and mesoscale features is presented in another paper (to be submitted to JAS). A barotropic model is currently used to test a scheme to incorporate a moving fine mesh in a nested grid system. (Mathur)

c. PBL model

The implementation of a PBL model at NMC on an experimental basis began during the fall of 1972. Twenty-four hour forecasts from the model were distributed to components of NMC as well as field and research offices of NWS for evaluation.

The initial verification shows that the PBL model has skill in forecasting ceiling/visibility combinations, areas of severe weather, rain vs. snow delineation, and temperature changes over the eastern two-thirds of the United States. The model does not perform well over the western mountains or during the summer months.

Improved forecasts are likely through improved analysis and modeling techniques. The evaluations will be used to provide guidance for further development efforts and the implementation of PBL forecasts within the NMC operational program. (Polger)

d. Semi-implicit model

The operational Shuman-Hovermale 6L PE model has been successfully adapted for semi-implicit integration (NWP Activities, First Half 1973). This new model is less complex than the operational one from the standpoints of grid structure and physics. Results of the early experiments (48-hr forecasts) have been submitted to NOAA for publication as a Technical Memorandum.

Current research has been in several areas. The difficulty with the computational cap has been solved by varying its formulation from adiabatic and isentropic to homogeneous and incompressible--density rather than potential temperature is kept constant in time. Testing has begun on lateral boundary conditions for a fine-mesh semi-implicit model--specifying (everywhere) the normal wind component from a previously run coarse-mesh version and using fine-mesh temperature and tangential wind values at outflow points and coarse-mesh values at inflow points. Preliminary tests with orography have been unsuccessful. Experimentation with spatial filters is promising. (Campana)

C. Data Assimilation Branch

1. Data Impact Test

a. VTPR test

A study report was prepared for NASA, describing results of the VTPR test conducted last spring (see NWP Activities, First Half 1973). Despite the presence of about 100 VTPR reports in each operational analysis, differences between analyses with and without VTPR data were small--even over the Pacific where VTPR soundings are now the principal source of temperature data. Predictions to 48 hours from both sets of analyses were verified and compared on 9 forecast days. Root-mean-square errors and S1 scores showed a slight improvement in skill over North America for forecasts using VTPR and conventional data compared to those based on conventional data only. No improvement was noted for VTPR-based forecasts over Europe, the Eastern Atlantic, and Eastern Pacific. A major problem with VTPR data appears to be that good retrievals are not available in critical locations. We are examining this question further by studying the distributions of actual and potential retrievals in the vicinity of large-scale cyclones.

b. Nimbus 5 test

In the original ITPR-SCR-NEMS test (see NWP Activities, First Half 1973), many Nimbus 5 soundings were erroneously rejected as incomplete. We decided, therefore, to redo the test--using the latest retrievals of observations from NESS during the 5-day full-scan period in April. Results of this experiment will be evaluated early in 1974.

c. Second VTPR test

The planned retest of VTPR is being delayed until implementation of the 8L HEM model and until further improvements can be made in VTPR retrieval and quality control procedures.

2. Data Archiving

Further plans have been made for archiving of Level II and Level III data for selected periods during the DST. The analysis/forecast cycle required for producing Level III data (gridded initial state parameter) will now be run on the NOAA IBM 360/195. Simulated Level II data tapes have been produced and mailed to users. A 3-day end-to-end test of the entire archiving operation was conducted in December. For this test only, analyses and forecasts were made on the GISS machine. A 15-day archiving test operation--run entirely at NMC--is scheduled for March 1974.

3. Data Assimilation Studies

a. Next operational system

The system as described in NMC Office Note 80 will be used in the DST Level III archiving system. Continuing research on appropriate initialization procedures is described in Section A. 4.

b. Noise analysis

Gravitational noise components in the 8L GLOBAL forecasts were isolated by the application of a powerful time filter to a 24-hour forecast, thus producing 12-hour forecast fields relatively uncontaminated by oscillations with periods of 10 hours and less. Differences between the time-filtered fields and their unfiltered counterparts yielded some insight as to the magnitude and character of the noise. Differences in wind and temperature fields were small--less than 2 m sec^{-1} and 0.5^{o} in an RMS sense--and devoid of any recognizable pattern. Height differences were also small--less than 10 m (RMS)--but showed a very large-scale latitudinal pattern. Verification of filtered and unfiltered fields against radiosonde observations indicated that the filter effected less than a 10 percent reduction in the height errors of 12-hour forecasts.

A complete description is being prepared as an NMC Office Note.

c. Assimilation with real data

Experiments in quasi-continuous four-dimensional assimilation of real atmospheric data have begun. The vehicle is a PE barotropic model, integrated either explicitly or semi-implicitly. One set of experiments is designed to further explore the feasibility of the semi-implicit integration method. Another set is intended to test insertion methods which may be used in assimilation experiments with the 8L GLOBAL model.

The first experiment will be a continuing 5-day integration of the model, begun from an operational analysis, to test the insertion of NOAA 2 and Nimbus E temperature observations. The data will be incorporated indirectly at 3-hour intervals by means of a local analysis procedure.

Results will be evaluated by comparison against an equivalent of the operational 12-hour cycle. Forecasts will be made from both assimilated and operational initial states, and compared with respect to accuracy and noise content.

Subsequent experiments will test improved procedures for inserting the observations into the model and for accelerating the adjustment between mass and motion fields.

D. Upper Air Branch

1. Analysis of Stratospheric Data

a. Comparison of satellite data with radiosonde data

Continuing studies of compatibility of satellite-derived temperature data with mandatory-level radiosonde information at all levels have been widely disseminated to interested scientists in NESS, NWS, and NASA. Summaries have been attached monthly to the NMC Newsletter. Comparisons of Nimbus 5 information with radiosondes are also being made. (Johnson, Finger, Gelman, and Laver)

b. Rocketsonde-satellite comparisons

The UAB has been coordinating a cooperative effort between U.S. rocket stations and Nimbus 5 and NOAA 2 experimenters. Approximately 250 rocketsondes have been launched in conjunction with satellite overpasses from January to August 1973. The rocketsonde-radiosonde temperature profiles have been assembled and placed on computer punch cards. These were made available to the satellite experimenters (ITPR, SCR, NEMS, and VTPR) for further calculations. The data supplied to NESS to date have provided a basis for adjusting the weighting functions for ITPR and SCR, which improved the compatibility between satellite and rocketsonde radiosonde temperature profiles. (Gelman and Finger)

c. Southern Hemisphere temperature analysis

The 14-level Southern Hemisphere temperature analysis continues to be modified as various problems are discovered. At present, Hough-function analyses are not used. NESS programmers are assuming responsibility for conversion to the IBM 360/195. (Johnson)

d. Thickness specification

Relationships between radiance and stratospheric layer thicknesses have been tested using NOAA 2 VTPR and Nimbus 5 SCR-observed radiances. Thickness fields derived from analyzed radiance maps continue to be used for constructing hemispheric synoptic maps above the 10-mb level. Applicability of relationships in the Southern Hemisphere has been verified in comparisons with Antarctic rocket data. (Quiroz and Gelman)

e. Rocketsonde data exchange and analysis

The United States and the Soviet Union continue to exchange meteorological rocket data for special interhemispheric stratospheric and mesospheric studies. On a reimbursable basis, NMC performs research for the United States. Weekly synoptic analyses at the 5-, 2-, and 0.4-mb levels are being performed using all available rocketsonde, radiosonde, and satellite data. Meridional cross-sections for the Western Rocket Network are being done weekly, with minimal time lag, on the basis of preliminary reports. Final meridional cross-sections for both Eastern and Western Hemispheres are also being drawn; these are based on published data.

(Finger, Gelman, McInturff, Nagatani, and Laver)

2. Research on Stratospheric Circulation

a. Study of critical-layer theory

An empirical study of the potential vorticity budget during stratospheric warmings continues. The effects of cooling and warming due to radiative absorption and emission by O_3, CO_2 and other important sources of diabatic heating are being entered into the budget.

b. Southern Hemisphere warmings

Antarctic warmings, which may serve as a "control" in testing baroclinic instability as a mechanism for the breakdown of the polar vortex, are also being studied with the aid of satellite data.

c. Comparative study of stratospheric warmings

All the stratospheric warmings known since 1952 are being studied in terms of their scope, length of duration, intensity, movement, and possible cause (with special reference to tropospheric influences). At present, only statistics already available are being used, but more will be generated as required to yield a synoptic model of the phenomenon.

(McInturff, Laver, and Nagatani)

3. Quality Control

a. Compilation of information on upper air programs in WMO countries

A considerable amount of detailed information concerning the upper air program at individual stations in several WMO member countries was received from the President of the Commission for Instruments and Methods of Observation of the WMO. This information was synthesized and distributed to interested offices. In cooperation with the Services and Applications Branch of NMC's Automation Division, an effort is now being made to store the information for computer processing and periodic updating. (Thomas)

b. Tape-slide presentation of quality control of data

In collaboration with DATAC in the Office of Meteorological Operations of the NWS, a tape-slide presentation is being prepared on the subject of quality control. It illustrates the flow of data from the source through the final processing system of a user. Specific examples of the effects that data deficiencies have on automated data processing can thus be shown. Plans call for distribution of this package to each NWS Regional Headquarters for further presentation at the field stations and possibly in selected technical training courses. The package should be ready for field distribution by early 1974. (Thomas)

IV. AUTOMATION DIVISION

A. Meteorological Techniques Branch

1. Objective Analysis

a. The report-checking sections of the operational coarse-mesh and fine-mesh analysis programs were reworked to use the flags now available from the preanalysis processor vertical consistency check (see A. 2. b). In general, those observations which have not passed the checks are rechecked using tighter toss-out limits than for those which have passed the checks. Additionally, very lenient limits are now used for any data the monitoring analyst has designated to be retained. (Zbar)

b. Most of the global analysis subroutines have been converted from the CDC 6600 computer to the IBM 360/195 computer. The individual subroutines are being made into an analysis package and being checked out on a test case. (Newell)

c. The global analysis preprocessor (which prepares the observational data for analysis) and the global forecast preprocessor (which prepares the forecast data for analysis) have been converted to the IBM 360/195 computer. Work continues on the global analysis post-processor programs which utilize the coefficients determined by the global analysis to output parameters at geographical locations such as grid points. In particular, the grids required for operational use are emphasized. (Chase)

d. The preanalysis processor for the fine-mesh analysis programs (surface, upper air, moisture, and tropopause) is being converted to run on the IBM 360/195 computer. (Costello)

2. Machine-processed Observations

a. By coordinating with the NWS Communications Division's Presentation and Display Branch, about 160 surface airway observations (SA's over the U.S.) are being encoded into synoptic code format and then processed into the synoptic report data base. In general, the SA's are those which do not transmit SM's and they were selected to improve the spatial distribution of the reporting SM's and the available SA's. (Fleming and Irwin)

b. Vertical consistency checks are now being applied to constant-pressure heights, temperatures, winds, and to significant-level temperatures before they enter the CDC 6600 data base. Flags are set to indicate the results of these tests, but in most cases the original values are not altered. The use of these flags by the analysis programs is described in Section A. 1. a. (Costello and Newell)

c. The upper air dictionary for the IBM 360/40 was reorganized and implemented. This is the version to be used on the IBM 360/195, since it allows some error-checking procedures to be performed. Considerable improvement in our upper air report processing capability has resulted. (Webber and Thompson)

d. The aircraft processor which handles reports from the AERINC circuit was enlarged to process reports from New York and San Juan; it also was modified to prepare rejected reports for transmission to San Francisco. (Byle)

e. Programs are underway which will permit data to be extracted from the teletype lines and processed into a 2311 disk file, accessible by both the IBM 360/195 and IBM 360/40 systems. Tape backup for this procedure is being prepared and auxiliary programs to aid in diagnosing problems are being written. Initial work also has started on the surface and aircraft processors to be run on the IBM 360/195. (Byle)

f. Work on the IBM 360/40 upper air processors is underway which will allow those programs to run on the IBM 360/195. The data sets have been created and initialized, and the upper air dictionary formatted. An I/O package has been written and the conversion of the report processors is in progress. (Webber)

3. NMC-NHC Activities

a. Use of the CRT's in Miami has been expanded so that in addition to using it as a backup input system for operational programs, it is now used for sending the military hurricane advisory via teletype. The advantage of this is that the basic advisory format is always available and the necessary modifications can be made more efficiently.

b. Special NHC low-level satellite wind information, which hopefully will be useful to NMC's hurricane project, has been made available to that group.

c. Conversion of NHC's operational programs to run on the IBM 360/195 is underway. (Zbar)

4. Miscellaneous Programs

a. Aviation digital forecasts

The changes in the transmission preparation described in NWP Activities, First Half 1973, Chapter IV, Section A. 5. b) have resulted in a 50-percent reduction in running time on the CDC 6600 and a reduced loading time into the IBM 360/40 from 15 minutes to 4 minutes. These factors have been responsible for an earlier start-up of the transmission of between 30 and 60 minutes.

Low-level forecasts were added to the data base for the Western North Pacific, South Africa, and South American areas, and some unused high-level bulletins were eliminated. (Irwin)

b. Automated surface plotting

An experimental 1:5 million surface chart has been produced for which a character set for displaying the current weather (ww) symbols was developed. (Irwin and Nathan)

c. Support programs

The following routines have been written for the IBM 360/195 and are available for use:

Data field packers, unpackers, and checkers (W3AIØØ, W3AIØ1, W3AIØ7, W3AI12, W3AI13, and W3AQØ5).

Date and time conversion routines (DATDAY, SECOND, DATIM1, DATIM2) and central processor timer routines (STIMER and TTIMER).

Routine to acquire the GO-Step parameter field (PARMF).

Routine to provide dumps by program and subprogram names as well as registers and control blocks (SDUMP). (Chase)

Assistance was given to Western Region in converting their probability of precipitation forecast program to run on the CDC 6600 computer. This program is currently running experimentally twice per day and the results are being mailed to Western Region for evaluation of the forecasts. Mr. Glenn Rasch of Western Region spent most of one week at NMC working on this project. (Kneer, McDonell, and Costello)

B. Services and Applications Branch

The activities of the Branch for this period have been concentrated in two major areas: (1) The Programming Support Section is deeply involved in program rewrite or modification for the initial 360/195 operational package which is planned for implementation in early 1974; (2) the Graphics Support Section has been immersed in 6600 programming to upgrade the automated facsimile transmission system and in the implementation of new computer graphics packages.

With the move to its most pleasant new quarters in the WWB, the SAB along with the rest of the AD has been adjusting to operating via terminals--the 3780 and 2922 into the IBM 360/195 and the U200 into the CDC 6600. This has been a rather trying experience since the initial terminal operations have left much to be desired.

A committee has been established to coordinate the conversion effort for NMC's operational programs. (Fuller, Irwin, Loman, and McDonell)

In addition, IBM personnel are assisting in the development of procedures for an efficient way to monitor the operational programs and are available in matters requiring consultation.

1. Programming Support Section

The Section has been exposed to the initial training classes available on conversion to the IBM 360/195. This was preliminary to the task of converting the CDC 6600 operational programs and library subroutines to the IBM 360/195. All personnel are at various stages of converting routines with which they are familiar. Program testing was moved from the IBM 360/158 site at IBM's downtown Data Center in Washington, D.C., to NOAA's initial IBM 360/195 at FOB-4 in mid-October 1973. Program upgrading is continuing on some CDC 6600 programs.

a. The following CDC 6600 programs are being converted to the IBM 360/195:

(1) 8-layer PE Post-processor, and PPMAPS (Helmick)

(2) 6L PE (10-minute time step), 65 x 65 grid (Howcroft, Gordon, and Carlton)

(3) Snow coverage on $2\frac{1}{2}^{\circ}$ lat/lon grid, and wind speed and direction routines (McClees)

(4) FOUS (SPAR) transmission, 65 x 65 grid (Gordon)

(5) Date/time check for operational programs (Steinborn)

(6) Indexing subroutines, 9-point smoother, grid prints from PE sigma data (Finnican)

(7) Titling subroutine--W3FP02 (Tyler and Starosta)

(8) Random access routines for binary data sets--
W3FK00 (R. Jones on loan from OPS. Br.)

(9) ADP report handlers--W3A102 thru W3A104, and
W3A117 (Allard)

b. In order to implement an initial operational package on the IBM 360/195, it was necessary to write several routines for loading and retrieving data files and transferring them from one machine to the other. The CDC 6600 programs to write input data for the IBM 360/195 have been completed. (Starosta)

The IBM 360/195 routines to capture the forecast files from the 6L PE for dumping into the CDC 6600 have also been completed. (Jones)

c. A program is being written for the IBM 360/195 which will manage a reference library of WMO stations (Chapter III. D. 3. a). The library will contain the following pertinent information about each station:

(1) Location, manpower hours, observation schedules

(2) Types of equipment

(3) Observational procedures

(4) Coding and transmission procedures

(5) Data accuracies (Nathan)

d. CDC 6600 program maintenance and upgrading included a modification to the APP program which eliminates the use of the 12-hour old 36-hour and 48-hour forecast files. (Helmick)

e. The never-ending Upper Air and Surface Dictionary changes were processed several times this period. (Townshend)

f. Several transmission routines were rewritten to facilitate use of the interface "black box" between the CDC 6600 disk and the IBM 360/40 disk. These routines include LBUREC/PRUREC, FSNT5, and FUXN229. (Raymond and Starosta)

g. Changes to the program which produces a set of SIRS bulletins for NESS were completed. These changes included programming a second file of Clear Radiance data (see <u>NWP Activities, First Half 1973</u>). (Steinborn)

2. Graphic Support Section

a. Automated facsimile transmission system

On July 5, 1973, a new version of the automated facsimile transmission system was made operational using the IBM 360/40 computer which had been acquired for this purpose. This system change entailed extensive modifications to computer programs in both the CDC 6600 graphics-generating programs and in the IBM 360 automated transmission system. The resulting increase in the capacity of the system permitted the addition of automated charts to the daily schedule of facsimile transmissions. Over the succeeding weeks, this increased capacity was utilized by the inauguration of the NAMFAX circuit with its 78 automated charts per day and by the conversion of those charts previously generated on the mechanical "curve-follower" plotter to the automated system, which numbered 50 charts per day on the military circuit, 18 charts on the Russian circuit, 30 charts on FOFAX, together with minor additions to the other circuits. (Bedient, Schnurr, and Hopkins)

b. New computer graphics packages

(1) The program to display the UAB's stratospheric analyses together with plotted observations was completed and put into operation on September 13, 1973. (Schnurr and Shimomura)

(2) The following display packages for TDL products were prepared in cooperation with TDL personnel and were installed in the NMC operations in September and October for facsimile transmissions: (a) the ocean forecasts of wind wave, sea swell, and sea height; (b) the 3-dimensional Trajectory Model forecasts; and (c) the Subsynoptic Update Model's short-range forecasts of sea-level pressure and precipitation. (Schnurr and Shimomura)

(3) The 8L GLOBAL display program was revised for more efficient operation and also to produce the additional Varian charts of the 12-hour forecasts for the Southern Hemisphere. (Schnurr)

c. Reprogramming for the IBM 360/195

Reprogramming from the CDC 6600 to the IBM 360/195 of the operational graphics programs which generate the automated facsimile charts and local Varian charts has just begun. A survey of the existing CDC 6600 graphics programs yields the following statistics concerning the scope of this reprogramming project:

Total number of individual statements of coding	45,755
Statements in COMPASS assembly language: (26 percent of the total)	11,816
Statements in FORTRAN: (74 percent of the total)	33,939
Total number of separate program modules:	90
Modules in COMPASS	11
Modules in FORTRAN	79

Of the 90 program modules, 11 are main programs which have a total of 23,573 FORTRAN statements (which is 69 percent of the FORTRAN statements), and the remaining 68 FORTRAN subroutines total 10,356 statements.

C. Information Processing Branch

1. Air Transport Association

At the end of June, ATA magnetic tapes were generated on the CDC 6600 and prepared for the first time in long record format (1280 character records). This significantly improved our performance in two ways:

a. The tapes became available earlier (close to 6 hours after observations)

b. The tape processing time was reduced from about 15 to 4 minutes.

The net result was 1/2 to 1 hour earlier startup of the ATA transmission to the 12 airline terminals currently on this network. Comparable speeded-up tape backup remains available on the DOS 360/40.

In October, the high-level files (150 mb) were dropped from the ATA transmission. At the request of the Lockheed Terminal, the following low-level files were added to the ATA transmission in December: Western North Pacific, South Africa, and South America.

2. Gander

In September, the long record format for the digital wind forecast to Canada (Gander transmission) was implemented, thereby significantly reducing the time required for their telephone dial-up transmission.

3. Service C

A major innovation took place in mid-July as the FAA in Kansas City took over the responsibility for disseminating via the 2400 baud hi-speed link to us, the data we formerly picked up on the six low-speed SVC C circuits (upper air, synoptics, etc.). Several codes were modified at NMC to accommodate this change. These SVC C lines were turned down at the end of July as problems incident to such a switchover gradually became ironed out. Since that time, however, there have been intermittent returns to the SVC C lines when it became apparent that Kansas City could not supply all the data as quickly as it had previously been received.

4. Aeronautical Fixed Telecommunications Network

In mid-July, the low-speed line 22--a transmit line to the AFTN switch at Kansas City--was turned up. This change coincided with the introduction of a new code to supply AFTN headings on FTUS bulletins for Kansas City.

5. Radar Reporting and Warming Coordination System

In early September, we implemented a procedure to turn up low-speed lines automatically to eliminate the necessity for operator intervention. This was particularly important with the five RAWARC lines which go down frequently and need to be brought up promptly.

6. IBM 360/40-CDC 6600 Interface

In early October, the 2701 interface between the CDC 6600 and the IBM 360/40 computers was successfully put into operation. This permitted many of the magnetic tapes coming up from the CDC 6600 via the long line to be dropped.

7. Upper Air Format

In early November, the new operational code DPSD to dump radar digital data on magnetic tape once a day for TDL was installed, and about the same time a new local upper air format was implemented. Many codes had to be changed to synchronize with it.

8. Miscellaneous

Other codes that were implemented included:

a. DUCE - a code to exercise and checkout the auto-dial feature of the Memorex 1270

b. Codes to display the CCAP switching directory on the CRT's

c. Routines to provide the FAA at Kansas City with a FT Summary twice a day, and to generate FT bulletins to Canada, Hawaii, and Alaska.

D. Operations Branch

1. Assistance with changes in facsimile products included:

a. Implementation of direct data interface between IBM 360/40 and CDC 6600.

b. Implementation of automated schedule of output to permanent files.

2. Continued routine maintenance of CDC 6600 programs, including changes effected to enable the IBM 7094 to be dropped. Attended classes in OS and ASP for IBM 360/195.

3. The following additional entries were added to the DOS AR for operational use:

a. UCS - print buffer for 1403 can now be loaded by typing UCS. This eliminates the need for reading of control card with UCS options.

b. PAKI or T - marker bit is set 'on' or 'off' for 2701 Interface with CDC 6600. This allows for tape backup for fax map packing if interface is not available for computer to computer data transfer. Marker bits are stored on 101 and tested by both system #2 and #4.

c. PD - decimal tapes to printer (double space) using the AR entry. (Double EOF's ends printing.)

d. PS - decimal tapes to printer (single space) using the AR entry. (Double EOF's ends printing.)

4. Date and time update was added to IBM 360 system #4 DOS so that an automatic system update is made at 2400 GMT. Since there is limited access to tape controllers for clock read, system date and time is checked for month, day, year, and time. Updated data and time is then typed on the 1052 keyboard typewriter.

5. Batched - Job multiprogramming, foreground processing option was added to DOS. This allows for the full utilization of the system's multiprogramming capabilities. The linkage editor can now execute in a foreground partition similar to that of background, providing enough main storage is available. This option gave the system #2 operator more frequent opportunities for the running of programmers checkout jobs that required 1AX disks.

6. Changes were made to DOS so that the new INTF program could be made operational on System #2. Assistance in job checkout was made available during CDC 6600 system time.

7. Allied Chemical BICOMP program was tested and changes were made to source programs for smoother job operation. The REMCOM terminal was used for receiving and transmitting data via the MEMOREX 1270 Terminal Control Unit and the System 360/30. System checkout to the New York site is scheduled at a later date.

8. CLIMATE monthly mean program was made operational with the departure of the IBM 7094/II. A number of upper air data problems have caused some loss of data and job restarts. Backup procedures are available so that all failures can be corrected before transmission time.

9. Data Management Section

a. Thirty-six day rotating disk file of basic data and selected forecast fields are generated for Long Range Prediction Group, and for verification by various groups.

b. Report files

Upper air ADP report files (ADPUPA, UPABDG, STRSOB, AIRCFT) are now being maintained in triplicate with a copy to NRC, Asheville; NCAR in Boulder, and one for in-house use. Data through August 1973 has been supplied to users. Ultimate goal is to supply data with 1-month lag.

c. Gridded data files

Gridded basic data files from operational and final analyses and a few selected PE forecasts are being collected into one file per 12-hour cycle, operation and distribution of these data is the same as ADP report files (b. above).

d. Polar coordinate daily sea-level pressure, 700-mb height and 700-mb temp files, continuous from January 1, 1947, are being archived. Tapes are now being updated from the 36-day rotating disk file, eliminating the need for card files.

e. Polar coordinate monthly sea-level pressure and 700-mb height files are maintained for the Long Range Prediction Group in both calendar-month summaries and midmonth summaries.

f. LFM data files

A 36-day rotating disk file to contain basic data and forecast fields from the LFM has been nearly completed but not implemented.

g. All elements of the operational data base have been converted from CDC 6600 format to IBM 360/195 format.

h. Completed subroutines to convert field data from the CDC 6600 to IBM 360/195 format and vice versa.

E. Electronic Equipment Branch

1. Mini-computers

Four Interdata mini-computers that will be used to (a) front-end the Graphic 360 system, the CCAP 360 system, and to (b) operate as remote terminals outputting to the digital graphic recorders and receiving digital weather charts via the digitizer into our graphic system, have been delivered.

The mini-computer systems have undergone modifications which upgraded them, with the intent of getting maximum speed in data transfer and maximum efficiency in the internal processing.

a. The graphic system will operate basically in the following manner

Weather charts will be generated in the CDC 6600-IBM 360/195 environment and transmitted to our disk-stored data base on our IBM 360/40 graphic system. At scheduled times, they will be called up and transmitted via the Interdata front-end mini-computer over two full-duplex 50.0 kb lines to the remote Interdata mini's at the WWB. The remote mini's will unpack the data and output weather charts on the newly-acquired Varian Statos 31 electrostatic recorders.

Charts that will be hand-drawn at the WWB will be placed in the digitizer and converted to digital information, a form that the remote mini can pack and transmit back over the 50.5 kb lines via the front-end mini into our 360 graphic system.

b. The CCAP Interdata front-end will be used to interface out high-speed data circuits and low-speed back channels to the 360 communications computer, making a more efficient communications system by replacing adapters in the IBM 2701's and 2703.

2. The four EAI Data Plotters that have carried the bulk of the computer prepared charts the past 10 years have finally been phased out. The Interdata Model 4 and Varian Statos 5 electrostatic recorder had taken over the complete operation of outputting in-house computer weather charts, but will be replaced by the Model 50 mini-computers and the Varian Statos 31 recorders.

The Data Plotters have been in use 24 hours a day for so long a time that the mechanical parts were really in bad need of replacement, and due to the age of the machines most parts could not be purchased. Many parts were handmade and required expert handling for the past few years to keep the plotters operational. Needless to say, we were not sorry to see them go.

3. Current Projects

a. A complete digital to amplitude modulated output board has been designed and will be installed in the mini-computer to output facsimile to users in the field from a mini-computer, and consequently will replace one line in the DFI. The board will be programmable for three different carrier frequencies, three different speeds, and a variety of codes that have to be transmitted preceding the chart data.

Also on the board, we will be able to program circuits to transmit to the DACOM unit. All of these circuit designs have been completed and are in the process of being assembled and built.

b. A circuit board for the mini-computer has been designed but not yet assembled, which will receive live facsimile directly from the incoming fax lines. These would then be converted to digital form and passed to the mini-computer to be packed and sent to our 360 graphic data base.

c. We have already designed, built, and operationally checked out the interface to input manually-prepared charts into our graphic data base via the digitizer, remote mini-computer, hi-speed circuits, and front-end mini-computer to the 360.

V. MACHINE PERFORMANCE AND UTILIZATION

A. Machine Use

1.	IBM 360/30G	881 hours
2.	IBM 360/40GF - #1	4,386 "
3.	IBM 360/40GF - #2	4,300 "
4.	IBM 360/40G - #3	4,389 "
5.	CDC 6600, NOAA	2,495 "

B. Profile Changes

1. IBM 7094-II - Released 9/73 (all 729 MTU kept in NOAA)
2. All others - No changes.

VI. FORECAST VERIFICATIONS--MONTHLY MEANS FOR 1973

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																		
Jul.	.75	131	19.2	194	24.9	.76	167	22.1	252	29.1				.76	192	24.3	279	31.2
Sep.	.85	133	19.8	253	29.8	.85	169	23.3	320	34.9				.83	204	26.3	362	37.7
Nov.	.84	169	23.8	306	36.0	.84	215	28.4	383	41.9				.82	262	31.3	431	44.3
300 mb																		
Jul.	.79	121	16.5	196	23.7	.80	153	18.9	253	28.2				.79	180	21.2	285	30.6
Sep.	.87	127	17.0	261	29.4	.87	162	20.3	329	34.6				.85	194	23.1	374	37.8
Nov.	.87	161	21.3	333	37.7	.87	207	26.0	410	43.4				.84	261	29.5	461	46.2
500 mb																		
Jul.	.75	91	11.8	134	16.2	.77	115	13.4	174	19.3	.65	130	14.9	.76	134	14.8	198	20.8
Sep.	.83	95	12.2	173	19.9	.84	120	14.4	219	23.4	.70	163	17.0	.82	141	16.1	251	25.4
Nov.	.85	121	15.1	230	26.0	.85	155	17.9	285	29.9	.72	198	21.1	.82	192	20.4	322	32.1
850 mb																		
Jul.	.69	78	10.4	94	10.9	.70	97	12.2	122	13.0				.73	105	12.5	139	13.9
Sep.	.81	78	10.3	126	13.7	.80	99	12.1	158	16.0				.79	113	13.0	176	16.8
Nov.	.82	98	12.4	159	16.8	.80	130	14.6	196	19.1				.78	153	16.3	218	20.3
1000 mb																		
Jul.	.71	74	11.0	96	12.5	.70	98	12.7	124	14.4				.72	107	13.6	138	15.3
Sep.	.82	77	11.0	129	15.4	.80	102	13.1	161	17.8				.79	116	14.2	175	18.2
Nov.	.83	100	13.5	169	19.0	.80	137	15.9	207	21.3				.78	162	18.2	229	22.4

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																		
Jul.	.84	99	14.1	192	23.3	.84	129	17.2	248	28.9				.83	156	19.7	286	31.9
Sep.	.88	113	15.7	252	29.7	.88	146	19.3	321	34.9				.82	192	24.4	363	38.4
Nov.	.90	138	19.1	340	38.4	.88	183	23.6	420	44.3				.82	242	28.2	468	46.9
300 mb																		
Jul.	.85	101	13.6	200	23.8	.85	128	16.0	256	28.9				.84	154	18.9	297	32.4
Sep.	.88	124	15.8	273	31.7	.88	157	19.6	348	37.5				.84	196	24.0	391	40.6
Nov.	.92	141	18.9	381	44.2	.89	194	24.6	460	49.3				.83	258	30.1	508	52.0
500 mb																		
Jul.	.85	68	9.0	135	15.4	.86	88	10.8	177	19.0	.79	103	11.7	.84	107	12.8	205	21.0
Sep.	.89	83	10.8	190	21.1	.89	106	13.4	248	25.8	.78	164	17.2	.85	134	16.3	281	28.1
Nov.	.91	99	13.1	248	28.4	.88	132	16.2	305	32.4	.71	206	21.9	.83	172	19.5	333	34.0
850 mb																		
Jul.	.79	60	7.5	93	10.2	.83	68	8.6	126	13.0				.84	77	10.0	142	13.9
Sep.	.84	71	8.8	127	13.4	.85	85	10.3	164	16.2				.80	105	12.1	177	16.4
Nov.	.88	74	10.0	155	16.8	.84	102	12.5	189	19.3				.81	124	14.7	202	19.7
1000 mb																		
Jul.	.76	66	8.8	94	11.6	.82	74	10.1	124	14.0				.81	85	11.9	139	15.0
Sep.	.85	76	10.3	138	15.6	.85	96	12.8	176	19.4				.81	116	14.1	189	19.5
Nov.	.87	86	12.3	167	19.2	.84	115	14.9	203	21.6				.81	141	17.6	218	22.3

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																		
Jul.	.81	121	14.0	201	21.5	.81	157	17.1	262	26.4				.82	176	19.3	305	29.2
Sep.	.88	129	15.7	291	29.8	.88	170	18.7	369	35.0				.86	218	23.7	440	40.2
Nov.	.89	137	15.9	313	30.8	.88	184	19.7	394	36.9				.85	236	23.8	453	40.5
300 mb																		
Jul.	.84	121	14.0	223	24.0	.84	157	17.6	290	29.8				.84	184	20.2	337	33.0
Sep.	.89	136	15.7	313	32.6	.88	185	20.0	397	38.6				.86	234	24.7	470	43.8
Nov.	.90	157	17.3	372	37.2	.88	214	22.4	458	43.5				.85	272	27.0	519	47.0
500 mb																		
Jul.	.82	88	9.4	152	15.7	.81	122	11.9	201	19.7	.72	142	14.0	.81	142	13.6	234	21.7
Sep.	.86	98	10.8	197	20.7	.83	136	13.7	250	24.5	.78	161	16.2	.82	165	16.5	294	27.4
Nov.	.88	120	12.3	260	25.5	.87	157	15.5	324	30.0	.76	203	19.3	.84	193	18.8	366	32.6
850 mb																		
Jul.	.79	61	6.2	97	9.4	.79	81	7.7	128	11.7				.79	94	8.9	150	13.1
Sep.	.86	72	7.6	144	13.9	.84	99	9.7	179	16.4				.80	124	11.9	205	18.1
Nov.	.89	92	9.0	198	17.8	.88	115	11.5	243	20.4				.85	140	13.8	267	21.7
1000 mb																		
Jul.	.80	56	6.3	94	9.2	.79	75	7.7	122	11.4				.76	93	9.1	141	12.6
Sep.	.85	72	7.7	141	13.6	.83	98	9.9	169	15.6				.78	124	12.2	193	17.2
Nov.	.88	104	9.9	212	19.2	.87	133	13.2	257	21.7				.84	162	15.7	281	22.9

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

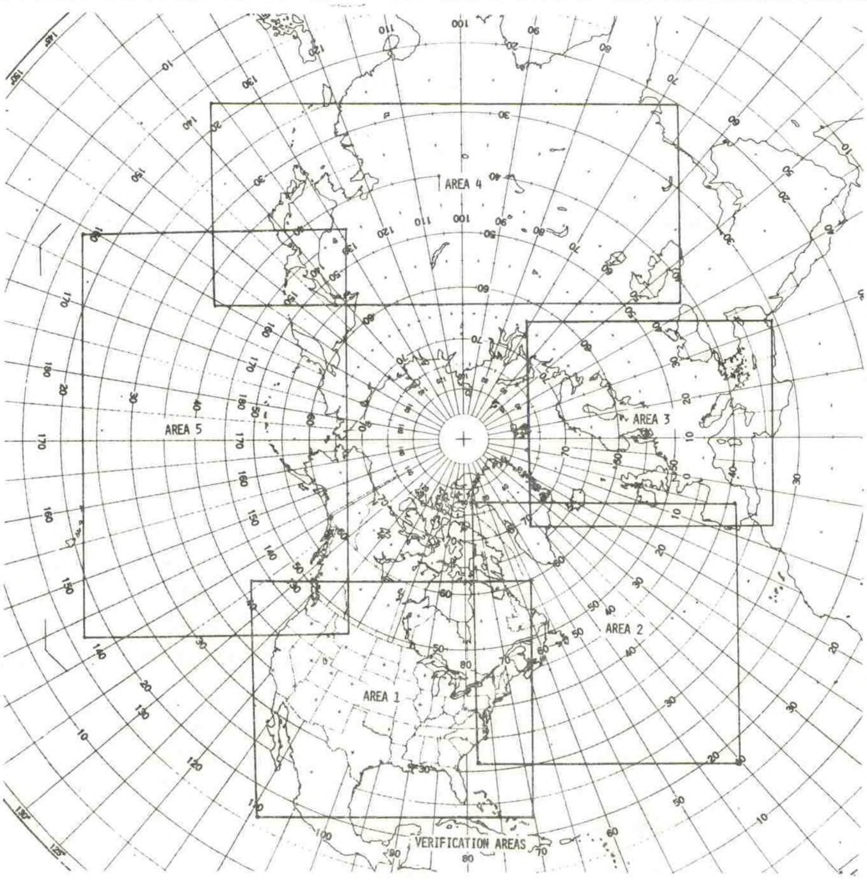
	24 hours					36 hours								48 hours				
	PE MODEL			PERS		PE MODEL			PERS		BAROTROPIC			PE MODEL			PERS	
	R	H	W	H	W	R	H	W	H	W	R	H	W	R	H	W	H	W
200 mb																		
Jul.	.76	134	17.4	207	25.7	.75	172	21.0	261	30.5				.72	208	23.6	290	32.9
Sep.	.84	131	17.7	247	29.2	.84	166	21.6	308	35.3				.82	208	25.0	347	37.8
Nov.	.88	146	20.9	305	33.8	.86	204	26.7	384	40.1				.85	237	29.6	428	42.6
300 mb																		
Jul.	.76	116	14.9	182	23.2	.78	143	17.0	228	27.4				.76	170	19.5	255	29.8
Sep.	.87	117	15.7	250	29.6	.87	151	19.3	305	34.8				.85	182	22.3	342	37.3
Nov.	.93	132	19.4	351	38.7	.90	186	24.5	428	44.7				.88	222	27.6	469	46.9
500 mb																		
Jul.	.75	76	10.1	112	14.5	.77	91	11.7	143	17.2	.60	108	13.0	.76	112	13.1	159	18.4
Sep.	.85	76	10.5	151	18.5	.86	95	12.3	186	21.7	.72	127	14.8	.83	118	14.2	206	23.0
Nov.	.92	92	12.9	238	26.7	.90	123	15.5	288	30.1	.68	210	20.3	.89	148	17.6	320	32.2
850 mb																		
Jul.	.64	86	13.0	86	10.5	.64	112	15.3	112	12.6				.70	110	14.5	124	13.7
Sep.	.78	77	11.9	110	12.8	.75	101	13.8	134	14.7				.76	111	13.8	143	15.4
Nov.	.82	88	13.1	136	14.8	.80	115	15.3	161	16.5				.79	131	15.6	178	17.2
1000 mb																		
Jul.	.67	78	11.0	93	11.8	.60	116	13.2	121	14.5				.70	114	13.9	133	15.5
Sep.	.80	73	10.8	117	14.2	.73	106	13.1	144	16.6				.75	115	14.2	149	16.8
Nov.	.86	88	12.2	156	17.3	.81	129	15.2	186	19.6				.78	151	17.2	201	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. DISTRIBUTION OF PRODUCTS

As of December 22, NMC was originating about 810 separate teletypewriter bulletins each day for transmission over NWS, U.S. Navy, U.S. Air Force, and Air Transport Association teletypewriter service. The following table shows the additional NMC daily facsimile transmissions:

Recipient	Number of Transmissions
National Facsimile Network (NAFAX)	52
Aviation Meteorological Facsimile Service (AMFAX)	43
Navy Facsimile Network: 70S537	29
GS18204	67
Air Force Facsimile Network: GF20309	50
GF10814	58
RAFAX	14
International Facsimile Network (Offenbach, Germany)	31
Russian Facsimile Network	21
Forecast Office Facsimile Network (FOFAX): Circuit #10206	59
Circuit #10207	59
Circuit #10208	59
Caribbean Radio	19
Tropical Analysis Network (TROPAN)	39
Suitland-Honolulu Circuit	54



VIII. PERSONNEL CHANGES

A. Development Division

The following joined the staff during this reporting period:

1. Roland T. Chu, Research Meteorologist, Regional Modeling Br.
2. Mark J. Rozwodoski, Mathematician, Global Modeling Br.
3. Robert E. Kistler, Research Meteorologist, Data Assimilation Br.
4. Kay Anne Weinstein, Secretary, Data Assimilation Br.

B. Forecast Division

The following joined the staff during this reporting period:

1. Charles T. Gadsen, Jr., Meteorologist, Aviation Weather Br.
2. Patrick J. Burek, Meteorologist, transferred from Automation Division to Aviation Weather Br.
3. Paul J. Dallavalle, Meteorologist, Surface Analysis Br.
4. Carl E. Weinbrecht, Meteorologist, Surface Analysis Br.
5. Billy Charles Williams, Meteorologist, Surface Analysis Br.

The following left the staff during this reporting period:

1. William A. Rammer, Meteorologist, transferred to Western Region.
2. Paul Jacobs, Meteorologist, transferred to Weather Analysis & Prediction Division, NWS.
3. Charles W. Vore, Meteorologist, retired.
4. John C. Hurley, Meteorologist, retired.

The following internal changes were made during this period:

1. Earl W. Estelle, Meteorologist, reassigned as Chief, Quantitative Precipitation Br.
2. James F. O'Connor, Meteorologist, reassigned as Deputy Chief, Forecast Division.

C. Long Range Prediction Group

Maurice P. Coleman, Secretary, joined Long Range Prediction Group.

D. Automation Division

The following joined the staff during the reporting period:

1. Joel Nathan, Mathematician, Services & Applications Br.
2. Alan Nierow, Meteorologist, Meteorological Techniques Br.

Arthur R. Kneer, Mathematician, Chief of Services & Applications Br. transferred to Office of Management & Computer Systems, NOAA.

IX. PUBLICATIONS BY NMC PERSONNEL

Finger, F. G., K. W. Johnson, M. E. Gelman, and R. M. McInturff, "Compatibility of Radiosonde and Nimbus-4 SIRS Derived Data at Stratospheric Constant-Pressure Surfaces," Monthly Weather Review, Vol. 101, No. 3, March 1973, pp. 244-251.

____________________, "Compatibility of Satellite-Derived Stratospheric Temperatures and Observed Radiances with Data from Radiosondes and Rocketsondes," published in Proceedings of the International Symposium on Meteorological Satellites, May 21-24, 1973, Paris, France.

Gerrity, J. J., Jr., "Numerical Advection Experiments with Higher Order, Accurate, Semimomentum Approximations," Monthly Weather Review, Vol. 101, No. 3, March 1973, pp. 231-234.

**Neiburger, M., **J. Edinger, W. D. Bonner, "Understanding Our Atmospheric Environment," W. H. Freeman and Co., San Francisco, Cal., 1973.

Quiroz, R. S., and *R. M. Henry, "Stratospheric Cooling and Perturbation of the Meridional Flow During the Solar Eclipse of 7 March 1970," Journal of the Atmospheric Sciences, Vol. 30, No. 3, April 1973, pp. 480-488.

__________, +M. P. Weinreb, and +D. Q. Wark, "Operational Radiance Maps of the Stratosphere, with Preliminary Results of a Major Stratospheric Warming." Paper H.5, 16th COSPAR Meeting (Konstanz, Germany, May 1973).

__________, "The Abnormal Stratosphere Studied with the Aid of Satellite Radiation Measurements." AIAA Paper No. 73-493, presented at AIAA/AMS International Conference on the Environmental Impact of Aerospace Operations in the High Atmosphere, Denver, Colorado, June 11-13, 1973.

Sela, J., and W. Bostelman, "A Vertically Integrated Primitive-Equation Model," Monthly Weather Review, Vol. 101, No. 12, December 1973, pp. 871-876.

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* Staff Member, NASA

\+ Staff Member, NESS

** Dept. of Meteorology, University of California at Los Angeles

Technical Memoranda

#52 "Toward Developing a Quality Control System for Rawinsonde Reports" F. G. Finger and A. R. Thomas

53 "A Semi-Implicit Version of The Shuman-Hovermale Model" J. P. Gerrity, Jr., R. D. McPherson, and S. Scolnik

Office Notes

#81 "Damping Properties of the Implicit-Backward Integration Method" R. D. McPherson

82 "Derivation of the RSG Criterion with Nonlinear Equations and a Restricted Spectrum" F. G. Shuman

83 "Noise Suppression in the Eight-Layer Global Model" R. D. McPherson and J. D. Stackpole

84 "Labels for NMC 360/195 Data Fields" Automation Division Staff

85 "NMC 360/195 Data Sets" Automation Division Staff

86 "A Comparison of Explicit and Implicit Integration Schemes in Four-Dimensional Data Assimilation" R. D. McPherson

87 "On Map Projections for Numerical Weather Prediction" J. P. Gerrity, Jr.

88 "The Formulation of the Autobarotropic Layer in the 'New LFM' Model" J. P. Gerrity, Jr.

89 "Vertical Differencing and Conservation (Revised)" J. A. Brown, Jr.

90 "The NMC 8-layer Global and Hemispheric Primitive Equation Models (8L GLOPEP & 8L HEMPEP) on a Longitude-Latitude (λ-ϕ) Grid" J. D. Stackpole

29 NMC Format for Observational Data (updated version of September 1969 edition) Automation Division Staff