Numerical Weather Prediction Activities

National Meteorological Center
Second Half 1972

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C O N T E N T S

ABBREVIATIONS AND ACRONYMS

AD	Automation Division
AERINC	Aeronautics Incorporated
AFOS	Automation of Field Operations and Services
AMFAX	Aviation Meteorological Facsimile Service
ATA	Air Transport Association
ATOLL	Analysis of Tropical Oceanic Lower Layer
CDC	Control Data Corporation
CRT	Cathode Ray Tube
DD	Development Division
DFI	Digital Facsimile Interface
DIGIFAX	Digital Facsimile
DOS	Disk Operating System
EEB	Electronic Equipment Branch
EWFB	Extended Weather Forecast Branch
EFD	Extended Forecast Division
FAXX	Facsimile
FOFAX	Forecast Office Facsimile Network
IBM	International Business Machines
ITPR	Infrared Temperature Profile Radiometer
LFM	Limited-Area Fine-Mesh Model
NAFAX	National Facsimile Network
NEMS	Nimbus E Microwave Spectrometer
NESS	National Environmental Satellite Service
NMC	National Meteorological Center
NOAA	National Oceanic and Atmospheric Administration
NWP	Numerical Weather Prediction
NWS	National Weather Service
NHC	National Hurricane Center
OB	Operations Branch
PBL	Planetary Boundary Layer
PE	Primitive Equation
PEATMOS	Primitive Equation and Trajectory Model Output Statistics
POP	Probability of Precipitation
RGT	Remote Graphics Terminals
RMS	Root-Mean-Square

Abbreviations and
Acronyms (continued)

SATRH	Saturation Relative Humidity
SCR	Selective Chopper Radiometer
SIRS	Satellite Infrared Spectrometer
SSWFC	Severe Storm Warning Forecast Center
TROPAN	Tropical Analysis Network
UAB	Upper Air Branch
VTPR	Vertical Temperature Profile Radiometer
WMO	World Meteorological Organization
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 numerical weather prediction (NWP) activities of the National Meteorological Center (NMC) for the second half of 1972. High points of the period included (1) the establishment of the Data Assimilation Branch, Development Division, to study four-dimensional data assimilation, (2) the planetary boundary layer (PBL) model running experimentally once a day 7 days a week to 24 hours, (3) a global analysis and 12-hr forecast system running twice a day at 10 hours after data time, and (4) the incorporation of satellite vertical temperature profile radiometer (VTPR) data into the operations on December 19, 1972. There were no changes made to the operational six-layer primitive equation (6L PE) model during the period. Also included in this report are summaries of recent developments in data automation and verification statistics for the 6L PE model.

II. REVISIONS IN OPERATIONAL PROGRAMS

New Procedure Introduced into the Limited-area Fine-mesh Model (LFM)

The LFM program contains the parameter SATRH (saturation relative humidity) that controls the onset of the precipitation process in the model. When the LFM was made operational in September 1971, SATRH had been set at 90 percent so that the process was begun when the model relative humidity was at that value. In monitoring the performance of the LFM during its first year, a definite trend toward overforecasting measurable precipitation was noted as fall turned to winter. In an attempt to control this bias, SATRH was adjusted upward and a value of 97 percent was used from February through May. By the latter part of that period, it was apparent that the model was too dry and SATRH was returned to 90 percent during the summer.

Based on the experience gained from the LFM during its first year, a seasonal variation of SATRH has been programmed into the model. The parameter is set at 96 percent from November 20 through March 20, and at 90 percent from May 20 through September 20. SATRH varies linearly and is rounded to the nearest whole percent during the spring and fall adjustment periods. This change was made in the operational program on October 18, 1972, and is described in *NWS Technical Procedures Bulletin No. 79*. (Howcroft)

III. DEVELOPMENT DIVISION

A. Spectral Analysis

Global analyses are now produced twice daily with a truncation of wave No. 24 in longitude, using seven vertical functions of pressure and 24 Hough functions (of latitude). Starting in September, daily Varian charts of 1000-, 500-, and 300-mb Northern Hemisphere analyses and daily verification statistics for 70 Northern Hemisphere stations are being produced to aid in further evaluation. These indicate that the Hough analyses are approximately equivalent to those produced by the present operational code in their fitting of height and wind observations. Thickness temperatures, obtained from the geopotential height analyses, verify with higher RMS differences than the operational temperature analyses, but with lower RMS differences than the latter after they have been initialized.

In mid-November, the use of persistence as a first guess was eliminated and a 12-hour eight-layer global forecast was substituted. At the same time, VTPR data became available on an operational basis. These events have presumably resulted in substantial improvement in the analyses for the Southern Hemisphere.

A series of 48-hour forecasts using the spectral analyses as initial conditions has been made with the operational six-layer model (6L PE). A significant difference between the operational analysis and the Hough analysis is that the latter supplies information over the full 53 by 57 point rectangle upon which the 6L PE forecast is run, thus totally eliminating any requirement to expand the data from the NMC 1977 point octagon. Thus, not only is the expansion with its related problems avoided, but "real" (information containing) data are made available to the 6L PE model over its entire domain of calculation. These forecasts are still under evaluation, but initial statistical results indicate little or no difference between these forecasts and those made operationally. The tests were made using the operational moisture analyses. A further series of tests will be made using spectral moisture analyses, as well as mass and velocity analyses. The analyses have also served as initial conditions for test forecasts using the new eight-layer hemispheric model.
(Flattery, Stackpole, Johnson, and Goddard)

B. Continued Development of Eight-Layer Hemispheric Model (8L HEM)

The principal advance was the elimination of the serious net cooling alluded to in previous reports. This was accomplished by redefining the long wave emissivities appropriately. They are now based on the calculations of P. M. Kuhn (JAM, Vol. 2, p. 368, 1963) rather than those of C. D. Rogers used heretofore. Also the emissivity of cloudy layers was reduced to 50 percent of a black body. Weekly forecasts to 84 hours are being performed and evaluated. (Stackpole)

C. Global (Grid Point) Forecast Models

1. Conversion of the 8L HEM to a Global (8L GLOBAL) Model

The 8L HEM code was successfully modified to run on the full sphere. Computer limitations forced a reduction in the resolution from 2.5° to a 5° longitude-latitude grid. This allowed for an increase in the time-step length to 20 minutes. On November 21, the 8L GLOBAL model commenced to run operationally twice per day with its 12-hour forecasts serving as first guess fields for the regular Hough function analyses (see III. A.). The performance of this system, both in its cycling aspects and in occasional forecasts to 48 hours, is being evaluated. Investigations are planned of its usefulness in four-dimensional data assimilation and in furnishing the first guess of temperature in the radiance-to-temperature inversion of the VTPR measurements. (Stackpole)

2. Global Three-Layer (3L GLOBAL) Primitive Equation Forecast Model

The 3L GLOBAL model has been modified successfully to provide for the following:

a. Three layers of moisture

b. Precipitation

c. Latent heat

d. Radiation involving moisture parameterized as clouds

e. Convective adjustment

f. Heating of boundary layer over the oceans

g. Evaporation into the boundary layer over the oceans

h. Surface drag in the boundary layer.

This model has been test run from 0000 GMT June 4, 1970, initial data out to 95 hours in two ways: (1) with all the above-listed effects and (2) with none of these effects. Results, in the form of heights, streams, precipitation, and some temperatures and winds, were printed on polar stereographic projections for the two hemispheres and the Mercator projection for the tropical belt at 24-hour intervals through 72 hours. Some surprising and interesting comparisons between the two sets of forecasts can be made. Noteworthy were the one-for-one relations in the development and translation of most systems.

The model was employed in calculating forecasts once daily to 72 hours from 1200 GMT analyses for the period of the Apollo 17 mission. Forecast maps at the 24-hour time intervals were supplied directly to the Spaceflight Meteorology Group, NWS, who have primary responsibility for forecast support to NASA space missions. Their main interest in these forecasts concerned reentry of Apollo 17 and the splashdown area in the Southern Hemisphere 350 miles southeast of Samoa.

The forecast calculations to 72 hours were stable; however, there was a steady gain in kinetic energy throughout the forecast period. By 72 hours, the kinetic energy was approximately 80 percent greater than at the initial time--which reflects an average increase in wind speed of approximately 33 percent. This was evident in the increased circulation of individual systems. Although the cyclones and anticyclones over-developed, their translation generally verified well. As a result, the forecasts were of considerable value to users.

More recently, experiments have been conducted in attempts to determine the cause(s) of the increase of kinetic energy in the model. Most of the obvious causes have been tested and eliminated as possibilities. The most likely culprit, now being formulated for testing, is the vertical averaging in the pressure force terms. The fact that the two upper layers of this particular model are relatively thick may be involved also. There is considerable disagreement as to how the pressure force terms should be formulated in a primitive equation baroclinic model. There may be no exact or precise formulation--a best should exist and hopefully will be discovered. (Vanderman)

D. Limited-Area Fine-Mesh Model (LFM)

1. Decrease in Forecast Area

The LFM is operated in a very time-tight operational schedule. If delays occur anywhere in the system, the usual result is that the LFM run is terminated to prevent delay in the coarse-mesh PE run, which is still the primary source of the NMC numerical guidance material. During the past 4 months, one in nine (11 percent) of the LFM operational runs has been either cancelled or ended prematurely before reaching the 24-hour forecast. One way to increase the reliability of receipt of the LFM is to decrease its running time in order to provide some small margin for delays. Several experiments have been made in which the LFM has been operated on a grid of 53 by 45 points, rather than the operational 53 by 57 grid.

The 12 rows of data at the top of the grid, those over the polar areas, are not used in the integrations. In this test mode, the clock time required for the model was reduced by about 12 to 15 minutes in the test runs. The resulting forecasts differ somewhat in detail when compared with the operational LFM forecasts, but there is little to choose from in terms of forecast quality between the test runs on the truncated grid and the operational runs, which were made on the 53 by 57 grid.

2. Live Boundaries

As a corollary to the work with the truncated grid for the LFM, experiments with "live" (temporally variable) boundaries have been run. Truncating the grid resulted in freeing enough extended core storage in the computer to make room for the additional data needed. As structured in the present operational version of the LFM, boundary values are taken from a fine-mesh analysis and are kept temporarily invariant during the forecast. The calculated tendencies are reduced by two-thirds and one-third at the penultimate and antepenultimate grid rows respectively. In these first experiments with live boundaries, the 6L PE forecasts made during the operational cycle 12 hours previous to the LFM runs were used to provide appropriate boundary values for the LFM. Forecast tendencies interpolated from the 6L PE were used to update the boundary values during the LFM run at the ultimate grid row and were blended with the truncated tendencies at the next two inner rows. The 12- and 24-hour forecasts from these runs were subjectively verified against similar ones from the LFM operational model. The runs were for the most part of comparable quality, but there were areas in which the experimental forecasts displayed some improvement. (Howcroft)

E. A New Numerical Forecast System

A visit was made to the Dynamical Prediction Research Unit at the Canadian Meteorological Center in Montreal. André Robert and his colleagues briefed us on the performance of their semi-implicit model.

The checkout of a hemispheric version of our new model was continued during this period. Problem areas which have been identified principally involve the initialization of analysis data for the model and the formulation of boundary conditions. At this time, the model has been integrated to 48 hours based upon one real data case, but neither orography nor diabatic effects were included. (Campana and Gerrity)

F. Planetary Boundary Layer Model (PBL)

The third phase of the PBL project began during this period. The third phase had been designated the objective test and evaluation phase of the PBL.

The development effort during this period was primarily in the area of refinement of the products to be produced by the PBL and the subsequent real-time testing. The output, which is recorded directly on microfilm, includes the following charts over the area of integration at the initial time, 12- and 24-hours:

1. Mean relative humidity (50-1600 m) and precipitation type when the mean relative humidity is predicted to exceed 70 percent (this is not a prediction of precipitation)

2. Mean relative humidity (50-300 m), vertical velocity and temperature at 300 meters

3. Mean relative humidity (600-1600 m), vertical velocity and temperature at 1600 meters

4. Wind speed and direction at 50 meters and surface temperature

5. Best lifted index and total-total index

6. Multiple freezing levels

7. Mixing height and total wind speed

8. Relative concentrations of pollutants

9. Fire weather burning index.

In addition, time cross-sections depicting wind speed and direction, relative humidity, temperature, and multiple freezing levels at hourly intervals have been produced from gridpoints near several major cities.

The PBL has been operating on an experimental basis since October 2, 1972. The forecasts, which are based on 0000 GMT data, are distributed to the Forecast Division of the NMC for evaluation. Time cross-sections are being transmitted daily by facsimile to five cities for evaluation.

The PBL analysis routine has been modified to increase the amount of detail in the vertical temperature and humidity structure. Because the PBL forecast is verified against the analysis, the analysis must be able to duplicate the observed sounding by linearly interpolating, to the data point, the parameters at the four surrounding gridpoints. This was accomplished by using a block function on the final scan and smoothing the fields to eliminate the resulting step discontinuities.

(Polger and Jones)

G. Primitive Equation Model Initialization

The initialization method being investigated involves using a PE forecast model from which gravity waves have been removed. (See Numerical Weather Prediction Activities, First Half 1972, Chapter III, Section I.) As originally formulated, a term $-\vec{\nabla}A$ was added to the horizontal equation of momentum. The necessary fourth equation was provided by assuming that the total derivative of horizontal divergence with respect to time vanishes. This resulted in an elliptic diagnostic equation for A.

It has been found necessary to revise the original model by using a different fourth equation, resulting in a new second-order, linear diagnostic equation for A. However, the new diagnostic equation is nearly everywhere hyperbolic for typical real data.

A matrix inversion technique was used to solve the second-order, linear partial differential equation. Four tests were made in which the equation was everywhere elliptic, everywhere parabolic or degenerate, everywhere hyperbolic, and a mixed situation. A Dirichlet boundary condition was used for these tests. In each case, a solution was obtained. The four cases are now being repeated using a Neumann boundary condition. (Dey)

H. Vertically Integrated PE Model

A running version of the model is now available. Compatible surface pressure and topography are obtained hydrostatically, and no initialization is necessary if the initial surface pressure is held constant throughout the integration. A time average of the first few hours may serve as initial data in the variable pressure case. The eddies are computed from a prescribed temperature profile and wind law. This work is being documented and will include results for ten 72-hour forecasts. A comparison with the barotropic is also made.

Studies of spectral methods continue.

A paper on a solution of a system of Helmholtz equations has been published in Monthly Weather Review, Vol. 100, No. 8, August 1972, pp. 644-645. (Sela and Bostelman)

I. Mountain Waves

Two numerical models, a nonlinear hydrostatic model and a nonhydrostatic linear model, were used to determine separately the effects of nonlinearity and nonhydrostatic accelerations upon the formation of overturning to the lee of the model mountains. A detailed account of this work is given in the paper "On the Contributions of Nonlinearity and Nonhydrostatic Accelerations to Low-level Critical Flow Over Mountains" (to be published). These effects will be investigated in combination in a nonlinear anelastic model coded during this period. (Collins)

J. Data Assimilation Branch

A new group, the Data Assimilation Branch, has been formed with responsibility for developing methods for assimilating asynoptic data and for conducting tests of the impact of new satellite data upon operational analyses and forecasts. Efforts will be directed both towards improving the operational use of new types of data and fulfilling the NMC commitments to the Global Atmospheric Research Program (GARP). Commitments include the production of Level III analyses data sets for selected periods during the Data Systems Test and for the First GARP Global Experiment.

Formed in late 1972 under contract with the National Aeronautics and Space Administration, work thus far has centered on developing plans for a series of data impact tests. In general, the impact of new data will be tested by comparing parallel analyses and forecasts made with and without these data. Operational or A-mode forecasts, made at NMC, will include all data available to the operational system. B-mode forecasts made at Goddard Institute for Space Studies, New York, will use the same analysis and forecast model. However, the data set to be tested will be added to the B mode if it is an experimental system, withheld from the B mode if the system is operational. The first such test, in which temperatures and heights from NOAA-2 (VTPR data) are withheld from the B mode, is scheduled to begin in March 1973.

K. Upper Air Branch (UAB)

1. Analysis of Stratospheric Data

a. Stratospheric synoptic analysis

Minor changes in the stratospheric analysis program (Northern Hemisphere heights and temperature fields at 70, 50, 30, and 10 mb) have been introduced as necessary. Various display techniques for analyzed fields have been completed. Monthly archive tapes including daily (1200 GMT) fields, monthly means and standard deviations of daily values from monthly means are being prepared beginning with October 1972. The Height Index Parameter and Temperature Index Parameter are being routinely calculated. (Johnson and Laver)

b. Comparison of satellite data with radiosonde data

A comprehensive effort is continuing to determine compatibility of satellite derived temperature and height data with radiosonde data at stratospheric levels. Results of evaluating SIRS-B compatibility will appear in the Monthly Weather Review in early 1973. Data from the recently launched VTPR on NOAA-2 as well as from the Infrared Temperature Profile Radiometer (ITPR), the Selective Chopper Radiometer (SCR) and the Nimbus E Microwave Spectrometer (NEMS) on Nimbus 5 are being scrutinized. (Finger, Johnson, Gelman, McInturff, and Laver)

c. Improved first guess for SIRS retrievals

A statistical regression technique for obtaining a first-guess temperature profile at high stratospheric levels that was developed in cooperation with the National Environmental Satellite Service (NESS) for use in the SIRS-B retrieval process has been adapted for use with the VTPR. (Gelman and Miller)

d. Southern Hemisphere temperature analysis

A 14-level temperature analysis program for the Southern Hemisphere has been supplied to NESS for providing first-guess information for operational retrievals of the VTPR. (Johnson)

e. Thickness specification

The relationship between radiance (as measured by SIRS and SCR) and the thickness of stratospheric layers with lower boundaries at 100 to 10 mb has been investigated (Monthly Weather Review, Vol. 100, Nov. 1972). Layers exhibiting optimal thickness-radiance correlation (to 0.98) have been identified, and a technique has been developed for using measured radiances to specify hemispheric thickness fields which, by addition to the lower boundary height field, give synoptic maps at heights above the 10-mb level. (Quiroz and Gelman)

f. Rocketsonde data exchange and analysis

Since January 1972, the United States and the Soviet Union have been exchanging meteorological rocket data for special inter-hemispheric stratospheric and mesospheric studies. On a reimbursable basis, NMC will perform 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 data. Final meridional cross-sections for both Eastern and Western Hemispheres are also being drawn; these are based on published data. (Finger, Gelman, and McInturff)

g. First guess for ITPR retrievals

A large sample of rocket-raob soundings has been selected for the development of regression equations to provide first-guess temperature profiles for ITPR remote soundings. Simulated NESS retrievals based on the "minimum-information solution" and on the above first-guess profiles show generally small departures from the observed profiles below the 1-mb level, even in most stratospheric warming situations. Work will continue in support of NESS.

(Quiroz, Johnson, and Gelman)

2. Research on Stratospheric Circulation

a. Baroclinic instability forced from below

A two-level model has been developed that allows us to examine the effect of vertical flux of eddy kinetic energy by the pressure-work term at the boundaries on the baroclinic instability of the layer. Preliminary results indicate a marked increase in baroclinic instability even with zero convergence of eddy kinetic energy. A paper co-authored with David Rodenhuis of the University of Maryland has been submitted to the Monthly Weather Review. (Miller and Johnson)

b. Empirical study of critical-layer theory

A pilot study of quasi-geostrophic potential vorticity transport, before and during stratospheric warming episodes, indicates that significant generation of potential vorticity occurs in the initial stages of stratospheric warmings. This generation of potential vorticity is related to a critical layer or layers. Further numerical studies are underway. A paper will be presented at the American Meteorological Society meeting in January 1973. (Johnson)

c. Investigations of the quasi-biennial oscillation

Autocorrelation techniques have been employed to investigate changes in the quasi-biennial oscillation of the equatorial stratosphere. Analytic relations between phase-speeds and periods of the temperature- and wind-components have been deduced and compared with actual observations; these results are being published in the November 1972 issue of the Monthly Weather Review (Vol. 100). (McInturff and Miller)

3. Quality Control

a. Compilation of information on upper air programs in World Meteorological Organization (WMO) countries

A considerable amount of detailed information concerning the upper air programs at individual stations in several World Meteorological Organization (WMO) member countries has been received from the President of the Commission for Instruments and Methods of Observation of the WMO. This information will be synthesized and, if possible, published as a reference work. The work will continue into early 1973. (Thomas)

b. Tape-slide presentation of quality control of data

In collaboration with the Data Acquisition Division in the Office of Meteorological Operations of the National Weather Service (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. (Thomas)

c. Statistical summaries

The monthly summaries showing the percentage of rawinsonde data processed by NMC from each station in the world have been discontinued. In their place, a weekly and monthly summary of the number of reports processed from North American stations is being distributed. The new information will be available to field officers much sooner than the old type summaries were. (Thomas)

d. Study of day-night humidity differences

Research continues in order to learn the effects of radiation on upper air humidity measurements. Daily comparisons of the day-night differences of mixing ratios vs solar elevation angles and other likely relationships are being made for each station in the world. This allows a determination to be made of the radiation effects on each type of instrument. (Finger, Johnson, McInturff and Thomas)

e. Review of UAB quality control program

A synopsis of 4 years of quality control projects and their effects on NWP activities has been written for publication. The review describes procedures used to improve the quality of operational rawinsonde data and illustrates the measure of success attained with each major undertaking. Publication in early 1973 is anticipated.

(Finger and Thomas)

IV. AUTOMATION DIVISION (AD)

A. Meteorological Techniques Branch

1. Objective Analysis

a. The 300-mb and 200-mb analyses for national facsimile (NAFAX) charts, N30, N93 and N31, N94 respectively, were switched from the IBM 7094 computer to the CDC 6600 system beginning 1200 GMT September 27, 1972. These charts are prepared from the observational data used in the analyses for the LFM package. (AD Staff)

b. Two errors were discovered and corrected in both the fine-mesh and coarse-mesh operational analysis programs. During most of November 1972, these codes were running in a state of partial repair as the problem was being solved and were corrected by December 4, 1972. The first error was the incorrect use of the map scale factor in one term of the equations used to generate the gradient winds for use as a first guess in the wind analysis. The second error was found to be a sign change and switching of two terms in the ageostrophic correction of the winds used during the height analyses. The net effect upon the analysis of the first error appeared as an overly large reduction in the guess wind speeds along the axis of troughs (over North America particularly), resulting in the tossing out of reasonable wind observations. The second error had the effect of improperly deriving height gradients from the wind reports for use in the height analyses. (Zbar and Burek)

c. Both the fine-mesh and coarse-mesh analysis codes have been extensively revised to optimize space and time requirements. The errors mentioned in A.1.b. have been corrected in these updated codes, and implementation of the new codes will be accomplished in January 1973. (Burek)

d. The toss-out criteria used in the sea-level pressure analysis have been made stricter in order to eliminate problems caused by erroneous data. For this purpose, two reports are said to be neighbors if they lie within 170 nautical miles of each other. A report without neighbors is considered isolated. An isolated ship report is deleted from the analysis if its pressure differs from the guess by more than 6 mb. Other isolated reports are not used if they differ from the guess by more than 12 mb. A report which is not isolated is tossed, if it differs from the guess by more than 10 mb and if its error differs from the average error of its neighbors by more than 8 mb. (Newell)

e. In the preparation of a numerical tropical analysis of a level in the atmosphere, four passes are made through the observations; at which time the Cressman weighting function is used to adjust the guess field grid point data to the observations. Recently, the technique was modified to introduce an elliptical weighting function on the second, third and fourth passes through the observations. This was accomplished by multiplying the Cressman weighting function (W_c) by an elliptical weighting factor (W_e), derived from stream-function values from the preceding scan. This has the effect of giving more weight to observations upstream and downstream from a grid point, than those lateral to the flow. The equation expressing this new weight (W_e) is given below:

$$W_e = 1 - \frac{|\psi_o - \psi_g|}{\Delta\psi}$$

where ψ_o = stream function value at location of observation in meters

ψ_g = stream function value at grid point being adjusted in meters

$\Delta\psi$ = empirical values determined by experimentation in meters.

Following are the values of $\Delta\psi$ for one grid interval (5^o longitude at the equator) for the constant pressure levels and wind speeds corresponding to the $\Delta\psi$ values:

Levels mb	$\Delta\psi$ meters	$V_{\Delta\psi}$ mps
850	50.21	8.55
700	67.78	11.54
500	84.35	14.36
300	123.00	20.94
250	123.00	20.94
200	123.00	20.94

Note: Stream-function values referred to are actually scaled values in meters obtained by multiplying the true values by $\overline{f}/g$, where $\overline{f}$ is the Coriolis parameter at 45°N latitude and g is the gravitational acceleration. (Irwin)

f. Procedures have been established with the Analysis Branch of NESS (NESS/AB) to provide NMC with surface bogus reports based upon satellite cloud picture interpretations. Surface bogus reports have been prepared with selected present weather, total sky cover, low and/or middle cloud type, and cloud base parameters which, when interpreted by the moisture analysis preprocessors, will provide estimates of mean relative humidity for the boundary and the lowest tropospheric layers of the NMC 6L PE and LFM models. Over oceanic areas, where conventional surface or upper air reports are not available, the relative humidity analysis program will use the latest 12-hr forecasts; however, since NESS/AB has access to the 12-hr forecasts, RH estimates can be made from satellite photos and compared to the forecasts for agreement. If disagreement is noted, NESS/AB will specify surface bogus reports to introduce the desired relative humidity estimates. This procedure has been in effect since mid-July. (Desmarais)

g. The preanalysis processor code has been modified to honor requests for the deletion of data which, in the judgment of the monitoring analyst, would have detrimental effects on the resulting analyses if allowed to remain in the analysis data base. (Costello)

2. Updating Asynoptic Reports

The report summarizing the tests conducted to evaluate methods for updating asynoptic data (NWP Activities, NMC, First Half, 1972) has been published as NOAA Technical Memorandum NWS NMC-51, "Updating Asynoptic Data for Use in Objective Analyses." (Desmarais)

3. Machine-processed Observations

a. The implementation of the programs related to processing synoptic surface reports was accomplished to utilize the storage capacities of the IBM 360 system disks. This freed one-half disk pack for other uses. (Fleming)

b. A program to process the aircraft reports received from Aeronautics Incorporated in Cedar Rapids, Iowa, has been written. This program formats the reports for transmission and replaces the older method of manually preparing these bulletins. (Byle)

c. The programs involved in processing aircraft reports were altered in order to accommodate the new WMO aircraft report which became effective December 7, 1972. (Byle and Webber)

d. The implementation of the programs related to processing the upper air reports was accomplished to utilize the storage capacities of the IBM 360 system disks. This change allows reports for both 0000 GMT and 1200 GMT to reside in disk storage simultaneously. Additional work was done on the aircraft processors to reduce the running time required to prepare the reports for the CDC 6600 computer. (Webber)

e. A program was implemented on the CDC 6600 computer system which logs the receipt or nonreceipt of a number of parameters for each upper air station in the dictionary. From this logged information, other programs were written which prepare summaries showing (a) the receipt or nonreceipt of stations, and (b) the receipt or nonreceipt of individual parameters for all stations for any selected time period up to 31 days. (Costello)

4. NMC-NHC Activities

A new tropical analysis (ATOLL) was constructed and became semioperational (once a day) to replace a hand-drawn chart produced at the National Hurricane Center (NHC). It is at present under evaluation.

Research continues on time-dependent boundary conditions and their effect upon two simple filtered barotropic models. One of the models is currently used for hurricane forecasting by NHC, and it is hoped that the model's forecast accuracy may be favorably affected. The other is run on an area which duplicates NMC's limited-area fine-mesh model.

The Varian minicomputer has been delivered to NHC and is being set up and checked out to serve as a link between NMC and NHC. Eventually, this machine will be processing NMC's data base as well as serving as a unit to receive high quality map transmissions. (Zbar)

5. Miscellaneous Programs

a. Vertical consistency check-heights and temperatures

A program to detect errors in radiosonde data by use of the hydrostatic equation was completed and should be implemented early in the next reporting period. (Costello)

b. Vertical consistency check-winds

A procedure has been developed which examines radiosonde wind reports and marks the mandatory level winds as either passed or failed according to criteria of vertical consistency. Each mandatory level wind is tested against gross speed limits, against the winds by height, and against the tropopause wind reports. Depending upon the results of these tests, a decision may be made that a given mandatory level wind should be marked as passed or failed. As a final step, these mandatory level winds which have been judged to pass are used to decide the marking for those mandatory winds for which no marking has yet been decided. The purpose of this marking system is to provide guidance to those programs which use the mandatory level winds. This procedure will be implemented at the same time as 5.a. (Newell)

c. Data format check

Occasionally, NMC has lost data during the transfer process from the IBM 360 to the CDC 6600-- owing to incorrect data format or magnetic tape parity error. When either condition occurred, the data processors which unblock and unpack formatted surface and upper air reports could not correctly handle some of the bad data and, as a result, would have to give up processing the remainder of the bad data block. In one instance, the problems occurred early in a data block and 10 radiosonde reports were lost for use in the LFM analyses.

To minimize the data losses under these circumstances, a routine was included in the NMC data-loading programs to preprocess and to edit all data blocks. The routine checks for format and blocking errors, and if errors are found, removes the fragmented report from the data block. This preprocessing routine became operational on November 29, 1972.

(Desmarais)

d. Verification of operational wind and temperature forecasts and analyses

The existing program, which uses radiosonde reports to verify the wind and temperature forecasts at several isobaric levels, has been modified by the addition of 35 more stations at which the verification is performed and by the inclusion of the 150-mb level. The new stations were chosen from Europe and Asia, in order to obtain a more representative compiling from the Northern Hemisphere.

After a preliminary check to eliminate gross errors in the observations, the verification procedure matches each wind and temperature report against the forecast value obtained by interpolating from the grid-point values to the station. Statistics of the errors in the wind and temperature analyses and forecasts are computed at 104 stations and at seven isobaric levels between 850 and 150 mb inclusive. The results of the verifications are used to monitor the quality of the analyses and forecasts. (Newell)

e. Tropical analysis display

The current procedure prepares the facsimile display at a 1:40 million scale and then transmits this information, so that the receiver obtains a 1:20 million scaled chart. To improve this display, programming was completed which generates 1:20 million scale in the first place. The additional computer expense for this procedure is about 1.5 minutes of CDC 6600 processor time and is awaiting improved running times in other analysis programs before being implemented. The new displays will be for the 700- and 250-mb levels and will have streamlines, isotachs, and plotted observational data. This program also is being used to experiment with the plotting of surface observations for the Southern Hemisphere. (Irwin)

f. Flight planning output

The program which prepares the forecast parameters for use in machine flight planning was completed for the CDC 6600 computer, reducing further our dependence on the IBM 7094 system. Additional programming is underway to prepare the formats required for transmission in order to reduce the computing chore that is currently done on the IBM 360 system. This should result in earlier transmissions of these data than is the case at the present time.

Procedures have been designed to receive Air Force Global Weather Central's forecasts to be utilized as flight planning transmissions during emergency conditions. (Irwin)

g. Several reruns of analyses and forecasts (LFM and 6L PE) for the Agnes storm of June 1972 were made, using corrected versions of the analysis programs. The results were evaluated by the NMC Office of the Director. (McDonell)

6. VTPR Data

NOAA's environmental satellite, NOAA II, was launched October 15 and is currently operational. Among the several radiometers on board, the satellite carries a VTPR which measures infrared energy from the earth's atmosphere, cloud tops, or earth's surface. These measurements provide information on the temperature and total moisture content in the atmospheric column observed beneath the satellite. From these data, additional calculations are made by NESS to determine geopotential heights at various pressure levels.

NESS processes the VTPR data as soon as they are acquired from the satellite, which has an orbital period of about 115 minutes. VTPR-derived constant pressure heights and temperatures are available for NMC use in objective analysis programs, but before these data can be used operationally certain evaluations are required. Automated Analysis Branch (AAB) is responsible for NMC quality control of all data allowed to enter the analysis programs and, accordingly, must have access to these VTPR data in a time frame which will permit AAB personnel to evaluate and to deny any or all data from entering the analyses. Currently, VTPR data dumps are accomplished at approximately 0+45, 2+15, and 8+00 hours after NMC cycle times of 0000 and 1200 GMT. VTPR data are loaded into NOAA's CDC 6600 computer assigned for NMC's operational run from magnetic tape provided by NESS. As soon as the data are loaded, a printed listing of all VTPR soundings collected (beginning at 1801 GMT for the 0000 GMT cycle, or 0601 GMT for the 1200 GMT cycle) is made available to AAB. In addition, 300-mb VTPR heights and temperatures are Varian-plotted along with corresponding NMC 300-mb 12-hr forecast height and temperature isopleths. These listings and Varian maps are usually available within 15 minutes after VTPR dump time for AAB evaluations. A communications link has been established from AAB, through the Sander's cathode ray tube (CRT), to a disk file on NMC's IBM 360 computer. The file contains monitoring requests which are honored by preanalysis processing codes executed on the CDC 6600 at scheduled data dump times from the IBM 360 data base. By inserting proper entries into this disk file, AAB is able to eliminate any particular VTPR height or temperature, a complete sounding, or a sequence of VTPR soundings. The 0+45 dump provides data for ingestion into the RADAT analysis which uses a 1+25 data dump, and into the LFM analysis which uses a 2+00 data dump. The 2+15 VTPR dump is used to supply data for the operational (3+25) analysis. This lead time gives AAB about one hour to evaluate the RADAT analysis just completed and any additional VTPR soundings. The VTPR data dump at 8+00 after cycle time should contain all VTPR soundings, valid within 6 hours of the synoptic time, for a final analysis. VTPR heights and temperatures are updated or backdated to synoptic time with a tendency method which uses NMC's 12-hour forecast changes from forecast hour 6 to forecast hour 18. The tendency fields are generated at the beginning of each cycle and reside in the NMC guess file on the CDC 6600. Since routine forecasts are not made above 100 mb, high-level data are not updated or backdated.

VTPR data were used in the 1200 GMT final analyses beginning December 5. The VTPR data have been used in the NMC operational system since 1200 GMT December 19, 1972. (Desmarais)

B. Services and Applications Branch

1. Programming Support Section

a. Forecast data being transmitted twice daily to the Bureau of Reclamation will be changed early in the next period, such that the 12-hour forecast data will come from the LFM while the 24-hour forecast data will be from the 6L PE. With this change, Reclamation will receive 704 LFM grid points covering North America. The 6L PE forecast will be interpolated to the LFM grid before being transmitted. (Allard)

b. NMC began transmitting extended period forecast data to the Canadian Meteorological Service on December 5. These data are being transmitted in the proposed WMO Grid Code. (Allard)

c. An all FORTRAN version of the 6L PE is being compiled to facilitate the developmental work being done on the forecast model. (Carlton)

d. Packing subroutines used by the operational programs are being modified to compute and check the sum of the data being handled. When incorporated in NMC's operations, these routines will ensure the correctness of data being transferred between storage media. (Carlton)

e. Subroutines written early in the CDC 6600 conversion effort are being inspected for areas where optimization can be realized or generality increased. (Finnican)

f. The Barotropic Model occasionally experiences computational instability at isolated grid points in forecasts beyond 120 hours. A change has been proposed, and will go into operation shortly, to impose a stricter vorticity control and at the same time recompute the stream function field when vorticity values exceed certain limits. (Helmick)

g. The CDC 6600 program of the Barotropic Mesh Model was changed in the first week of November to correct a problem whereby the vorticity pattern tended to diminish in intensity as the forecast hour increased. (Helmick)

2. Graphics Support Section

a. Computer graphics projects

The following automated maps were programmed by this Section and put into the NMC operations during this half year:

(1) RADAT 4-panel 500-mb height/vorticity display. This is an elaborate system involving several jobs on the CDC 6600 generating individual hemisphere maps, which are subsequently sectioned and composed on the IBM 360 into one 4-panel facsimile chart. Provisions were made for missing panels, substituting a map background with a "Not available" message for the missing portion. This project was completed and put into operation on September 13.

(2) The 500-mb analysis with plotted data. Effective 1200 GMT September 27, the 12-hr height change was added to the plotting model of the 500-mb analysis chart which had been started earlier in the year.

(3) VTPR plotted chart. A program was written to plot VTPR data on the first-guess 300-mb height and temperature chart for use by the monitoring analyst.

(4) Twelve-hr upper wind prognosis. On September 27, a new version of the upper wind prognosis 8-panel facsimile chart was initiated with a plotting model, which has winds depicted by barbs and flags on a shaft in place of the printed wind direction and speed.

(5) Primitive Equation and Trajectory Model Output Statistics (PEATMOS) Probability of Precipitation (POP) chart. The automated PEATMOS POP facsimile chart was made operational on 1200 GMT December 13. This display package required approximately 3 months to prepare--beginning with generating the appropriate map background, then smoothing the given grid point data, modifying the contouring program to draw lines only within the irregular boundary enclosing the 48 States, adapting contour-labeling routines to also work in the irregular boundary, thinning the contour labels to eliminate overprinting, titling the maps, and preparing the operational controls.

(6) Effective November 1, the following list of automated Northern Hemisphere charts began scheduled facsimile transmissions, replacing maps formerly generated by the IBM 7094 curve-follower program:

Facsimile Slot No.		
N032	Analyzed	500-mb height/temperature
N035, N099	36-hr forecast	500-mb height/wind
N065, N126	36-hr forecast	300-mb height/wind
N037, N101	48-hr forecast	500-mb height/vorticity
N067, N110	72-hr forecast	500-mb height/vorticity

Facsimile Slot No.		
N004 (4-panel)	24-hr forecast	850-mb height/thickness, 700-, 300-, 200-mb height/wind
N046 (2-panel)	24-hr forecast	850-mb height/thickness, 700-mb height/wind
N036, N100 (4-panel)	Initial, 12, 24, 36-hr	500-mb height/vorticity
N043, N106 (4-panel) F045C, F107C	Initial, 12, 24, 36-hr	Relative humidity, vertical velocity

The current summary of automated Digital-Facsimile charts (193/day) in the transmission schedule is:

40 charts on NAFAX
8 charts on FOFAX
42 charts on AMFAX
41 charts on HONOLULU
15 charts on CARIBBEAN
17 charts on OFFENBACH
30 charts on MIAMI

For local use, we display approximately 242 charts per day on the Varian.
(Shimomura, Schnurr, and Dent)

b. Compressed data format for digitized maps

The digitized maps, as they are output from the CDC 6600, are in a compressed scan-line format where the data compression uses an 8-bit format. However, for some applications, a 6-bit format is desirable so this option has been programmed and plans are to convert all the maps to this format. The applications for which this 6-bit format are being tested are:

(1) for map transmissions to the Remote Graphics Terminals located in Miami and Kansas City,

(2) for graphics display on the FR80 film processor, and

(3) for sending the digital maps through the interface connecting the CDC 6600 disk to the IBM 360 disk. (Bedient and Schnurr)

c. Digital facsimile system

The following modifications were made to the IBM 360 facsimile program during the reporting period:

(1) Simultaneous transmissions on eight facsimile circuits versus four in the previous version are now possible. Each of the eight Digital Facsimile Interface (DFI) ports has been assigned its own facsimile circuit, thus providing greater flexibility in scheduling transmissions and in operating procedures.

(2) The provision to transmit coded information required to trigger the Mode and Message Selection System (MOMSS) receivers attached to any facsimile circuit has been added.

(3) A second Memorex disk drive has been added to provide double the capacity for storage of packed maps for local display and for transmission via the DFI. (Hopkins)

d. Remote graphics system

There are two remote graphics terminals (RGT), one located at NHC, Miami, Florida,and the other at Severe Storm Warning Forecast Center (SSWFC) Kansas City, Missouri, connected to the NMC computer. An RGT consists of a Varian 620L minicomputer, a Statos V electrostatic recorder, and at least one magnetic tape unit.

The following activities were carried out to make the systems operational:

(1) Programs were designed for the purpose of receiving NMC maps in digital packed form via a 4800 baud, full-duplex, telephone circuit. The maps are written on magnetic tape and are displayed on the Statos V recorder off-line following the transmission.

(2) IBM 360 and Interdata programs were written which transmit NMC digital packed maps from the IBM 360 facsimile program overlay area through the Interdata minicomputer to either of the two RGTs.

(3) Construction of a multiprogrammed, real-time operating system for the Interdata Model 4 computer was begun to facilitate simultaneous transmissions to the Miami RGT, the Kansas City RGT, and local graphics recorders, with provisions for future transmissions to the circuits, which will relate to the Automation of Field Operations and Services (AFOS), Federal Aviation Administration circuits, and other special purpose circuits.

(4) Several visits were made to NHC and SSWFC to install and make operational the Remote Graphics software designed for the reception of NMC products, to install the Varian Master Operating System, and to train the programmers in the use and maintenance of the system. (Hopkins)

e. Alaskan winds-aloft and temperature forecast (FDAK1)

The FDAK1 teletype bulletin for Alaska was changed on the 1200 GMT run of July 25 with the addition of the 24-hr forecast period from the 6L PE model. At the same time, the bulletin prepared from the earlier barotropic cycle was discontinued. (Shimomura)

C. Information Processing Branch

1. The following changes were made in relation to the bulletin directory:

a. In August, the directory of all the bulletins passing through our communication system was completely rewritten into a single index switching directory. This allows the switching of bulletins by the new five digit WMO catalog numbers, as well as the current four-digit domestic catalog numbers and PSS00 numbers.

b. A newly received WMO directory is now in the process of being merged into the current directory.

c. A method was implemented to switch bulletins from our tech control CRT by catalog numbers.

2. The latest of the 2400 baud bisynchronous circuits to go into operation is the Washington-Bracknell leg of the WMO main trunk circuit. It became pseudo-operational in November and is currently running in parallel with the Offenbach circuit, which it should replace sometime next year. Facsimile switching tests are under way with provisional operation scheduled for mid-January 1973.

3. In November, the IBM 360 communication system began decoding reports (normally, this system handles bulletins only). We now produce and maintain a data base of aviation weather on a swinging disk, thus making it available to both operational IBM 360 systems.

4. A program was written for the communications computer that encodes aviation bulletins from the new data base tailored to individual user requirements. These bulletins include the following:

Hourly bulletins - SAUS 1-22 KWBC
Scans - SCAN 1-22 KWBC
Reports - UBUS 1 (Nine of them--according to area, within area by State and within State alphabetically by station)

5. Changes were made in various codes to accommodate a new larger entry dictionary to show what type of reports were received for each station and whether any CRT changes were necessary for decoding.

6. Changes in the CRT display packages included extension of the U.S. coverage programs to indicate the source of each type of report displayed, and the Automated Analysis Branch was given the capability to pass additional data (bogus, deletions, etc.) to the CDC 6600 to aid in upper air, surface, and hurricane analyses.

7. Two low-speed ASCII lines (150 words per minute) were added. One is used essentially to print out pertinent information on transmitted bulletins (for monitoring purposes). The other is intended to pass ship data between Suitland and San Francisco (not yet operational). Codes were revised to allow for identification of these incoming bulletins and for formatting and queuing of output bulletins.

8. In September, transmission of 150-mb data for the North America, North Atlantic, and Eastern North Pacific areas, as part of the Air Transport (ATA) commitment, was begun. Our operational procedures were also tightened up by eliminating most required manual operator interventions in favor of automatic handling. At the request of ATA users, one automatic retrieval pass after the transmission of all middle-level data and before the shipment of low-and high-level data was introduced.

9. In December, coding was added to handle the switchover from the IBM 7094 to the CDC 6600 generated transmission tapes. At the current time, only the Air Force "paper doll" transmissions are still being generated on the IBM 7094.

10. A vastly improved two-priority queuing scheme involving several codes was implemented for the transmission of weather bulletins.

11. Codes were written to provide statistics for the Tokyo and Offenbach circuits.

12. A very useful debugging code was written to allow the printout of any part of a full core dump while the communication system is in normal operation. These dumps are written on disk upon machine restarts. (Staff)

D. Operations Branch (OB)

With the demise of the Extended Forecast Division (EFD), Data Management Section came into existence--staffed by most of the members of EFD's Computer Applications Section. The new section will retain some responsibility for maintenance of guidance programs for Extended Weather Forecast Branch (EWFB), Forecast Division, while assuming additional responsibility for OB functions.

1. All of EWFB's operational programs were converted from the IBM 7094 to the CDC 6600 by October 1972. (Staff)

2. A disk "data bank" of observed and forecast data for a 36-day period is now operational. The contents of these files are described in NMC Office Note 79. A similar file of analyses and forecasts from the LFM is being developed for verification and experimentation. (Hiland)

3. A variation of the FAX-VARIAN code was implemented to provide automatic transmission of extended range products on the Offenbach circuit. (Jones and Schnurr)

4. A basic data archiving system has been developed to provide automatic selection and stacking of the grid data and upper air reports to be archived at the National Climatic Center, Asheville, North Carolina, and the National Center for Atmospheric Research, Boulder, Colorado. (Gelhard and Quinn)

5. Operating techniques were established involving implementation of new programs and revisions to existing programs. The activities between programming branches and the operators' section were coordinated, implementing changes when warranted.

6. The IBM 7094 job monitor was maintained for operations. Job documentation was provided for the IBM 7094, 360's, and the CDC 6600.

7. The following operational programs were written:

Code to print the upper air and surface dumps used on the CDC 6600.
Code for tape copying in the surface archive program.
Code to provide operator work schedules.
Code for computer accounting.
Code to dump a decimal tape on the IBM 360.

8. Monthly climate mean program was completed as far as existing data allowed. With a need for a full month of data, this program was set aside until a conversion from the simulation of a small disk pack to the complete use of the larger disk pack was completed. Work has once again been started on this project.

9. Systems Modifications on the IBM 360's

a. Work has been done on Disk Operating System (DOS) Release #26 and tested on System #2. This new release had a number of modifications by IBM which required program changes and adjustments to fit our operational needs. An error was found in the linkage editor when an operational program was catalogued to the system library. This has been corrected by IBM and the new DOS release should be in use on System #2 in the near future.

b. DOS Core Image Library on System #3 has been relocated to accommodate new operational programs. This DOS system is now a two-disk system with work files, Private Relocatable and Source Statement Libraries on a second pack. DOS on System #3 uses the small 2311 disk drives, which necessitated the above.

c. Program modifications have been made to the DOS attention routine, so that the computer operator can now start operational programs through the 1052 typewriter keyboard. This eliminates having to use the interrupt button when a job is to be called by job SKP. Along with this option, the operator can now zero any job chain that is running or start a new job chain. This allows for a smoother flow of operational jobs during critical time periods of data collection.

E. Electronic Equipment Branch (EEB)

1. A hardware problem that had existed in the IBM 360/30 system when non-IBM devices were installed on the system was finally resolved in September. The problem resulted in failure of automated charts during transmission. Any one of the devices could have caused the malfunction. With the collaboration of members of the EEB staff, Sanders Corporation and Data Recall Corporation, the malfunction was resolved. The problem was determined to be in the Sanders CRT display 731 unit, which was corrected by an on-site modification.

2. The third DFI was delivered to NMC in August 1972. The unit arrived in an inoperable state, requiring many man-hours in locating and correcting the problems. The unit was then modified to bring it up to the operational level of DFI #1 and #2.

3. The three DFI's underwent major changes in regard to the number of 8-bit bytes they could receive from the IBM 360 during one request cycle time. In order to accomplish this, the clock time of each DFI was doubled and the buffer size in the DFI's was then increased from four 8-bit bytes to eight 8-bit bytes per request. This change greatly reduced the time the computer spent communicating with the DFI's over the multiplex channel, enabling the computer to handle jobs being run in the background mode.

4. The Interdata Model 4 minicomputer is being modified to operate as the interface between NMC's facsimile computer and the Miami and Kansas City terminals. This task is in addition to its original purpose of interfacing between the IBM 360 and the Varian recorder which generated weather charts for in-house use. The following equipment was purchased and is being installed to upgrade the system: additional 8K of memory, a second selector channel, and two 201 full-duplex circuits for interfacing to Miami and Kansas City.

5. The Miami facsimile and data terminal is now installed and operational. E. Hopkins and L.T. Tyree travelled to Miami to install and check out the system, both hardware and software.

6. The Kansas City facsimile and data terminal has been installed and is operational. E. Hopkins and R. Haas went to Kansas City to check out and put their system into operation. Both Miami and Kansas City systems are awaiting the addition of an IBM 360/40 at NMC. In addition, the modifications to the Interdata minicomputer have to be completed.

(Staff)

V FORECAST VERIFICATIONS--MONTHLY MEANS FOR 1972

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

	24 hours					36 hours								48 hours				
	PE MODEL			PERS		PE MODEL			PERS		BAROTROPIC			PE MODEL			PERS	
	R	H	W	H	W	R	H	W	H	W	R	H	W	R	H	W	H	W
200 mb																		
July	.72	140	19.7	197	24.8	.72	183	23.2	253	29.0				.73	208	25.6	286	31.7
Sep.	.81	142	18.9	243	27.9	.82	183	22.3	314	33.4				.81	214	24.8	353	36.1
Nov.	.85	162	21.0	307	34.4	.84	205	25.0	369	39.3				.80	244	28.1	390	39.6
300 mb																		
July	.75	129	17.3	192	23.2	.77	162	20.0	246	27.4				.76	189	22.3	278	30.1
Sep.	.84	138	17.2	252	28.2	.84	176	20.5	320	33.4				.82	207	23.1	361	36.2
Nov.	.88	155	19.5	326	36.4	.86	199	23.7	388	41.3				.83	239	27.0	408	41.5
500 mb																		
July	.71	96	11.8	132	15.6	.71	119	13.5	170	18.5	.63	134	15.1	.74	137	15.1	193	20.2
Sep.	.79	100	12.0	173	19.1	.82	126	14.2	222	22.6	.78	137	14.9	.81	150	16.1	252	24.7
Nov.	.86	113	13.5	224	25.1	.82	146	16.5	271	28.8	(not available)			.81	177	18.9	288	29.2
850 mb																		
July	.66	80	10.6	92	10.8	.66	101	12.4	118	12.7				.69	110	13.3	134	13.7
Sep.	.80	78	10.4	124	13.5	.80	99	12.2	158	15.9				.80	112	13.2	178	17.0
Nov.	.85	89	11.1	161	17.1	.80	131	14.4	204	20.3				.79	140	15.2	210	19.8
1000 mb																		
July	.68	84	12.8	111	15.4	.69	97	12.6	126	15.3				.68	120	15.7	148	18.0
Sep.	.80	80	11.8	129	16.0	.79	104	13.4	163	18.4				.79	118	14.9	182	19.3
Nov.	.81	107	13.3	182	20.1	.81	133	15.5	211	22.0				.76	163	18.1	227	22.7

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

	24 hours					36 hours								48 hours				
	PE MODEL			PERS		PE MODEL			PERS		BAROTROPIC			PE MODEL			PERS	
	R	H	W	H	W	R	H	W	H	W	R	H	W	R	H	W	H	W
200 mb																		
July	.84	101	14.5	185	23.3	.82	133	17.3	237	27.8				.83	153	20.0	278	31.0
Sep.	.87	121	16.1	258	29.2	.85	169	19.9	322	34.4				.82	208	24.6	359	37.8
Nov.	.87	141	18.7	287	35.1	.83	199	24.5	344	40.0				.77	259	29.4	369	40.4
300 mb																		
July	.84	102	13.6	190	23.7	.84	129	16.2	241	28.5				.84	149	18.6	276	31.2
Sep.	.89	128	16.1	286	31.8	.86	175	20.2	343	36.4				.82	218	24.9	381	39.7
Nov.	.91	141	19.2	336	42.0	.86	198	25.0	398	47.7				.81	258	30.2	421	47.5
500 mb																		
July	.84	66	8.7	124	15.1	.85	83	10.4	161	18.4	.73	106	12.6	.84	97	12.0	183	20.0
Sep.	.87	86	10.6	184	20.1	.84	120	13.4	227	23.3	.82	124	14.0	.82	145	16.4	252	25.4
Nov.	.90	99	13.0	235	28.9	.86	139	16.9	282	33.1	(not available)			.82	178	20.3	304	33.5
850 mb																		
July	.75	60	7.7	90	10.5	.80	73	9.3	115	12.8				.76	80	10.4	123	12.9
Sep.	.86	70	8.4	139	14.8	.84	91	10.6	168	17.0				.79	108	12.6	179	17.4
Nov.	.88	72	9.1	156	18.2	.85	99	12.1	194	21.5				.81	121	14.0	202	21.1
1000 mb																		
July	.73	68	8.9	95	11.6	.79	75	10.3	114	13.3				.74	90	12.1	122	13.8
Sep.	.86	79	10.3	152	17.5	.84	101	12.7	184	20.0				.78	121	14.8	192	20.0
Nov.	.82	94	12.3	176	20.7	.82	116	14.7	210	23.9				.76	147	17.7	219	23.7

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

	24 hours					36 hours								48 hours				
	PE MODEL			PERS		PE MODEL			PERS		BAROTROPIC			PE MODEL			PERS	
	R	H	W	H	W	R	H	W	H	W	R	H	W	R	H	W	H	W
200 mb																		
July	.78	127	15.1	214	22.5	.74	175	19.4	273	27.4				.77	195	21.4	316	29.9
Sep.	.85	145	15.9	280	27.6	.85	178	19.5	359	33.4				.82	225	22.9	410	37.0
Nov.	.91	151	17.0	384	36.7	.91	188	20.0	468	41.9				.86	241	24.4	503	43.2
300 mb																		
July	.82	128	14.7	234	24.3	.81	168	18.1	297	29.4				.82	196	21.1	346	32.9
Sep.	.86	153	16.2	311	30.7	.87	188	20.1	400	37.6				.84	240	24.1	461	42.0
Nov.	.92	163	18.0	423	41.8	.90	209	22.0	501	46.4				.86	264	26.8	536	47.9
500 mb																		
July	.82	88	9.4	159	15.8	.81	118	11.7	207	19.6	.72	141	13.9	.81	136	13.6	241	21.9
Sep.	.85	110	11.3	212	20.1	.85	139	14.1	278	25.1	.80	160	15.3	.82	174	16.7	322	27.9
Nov.	.89	120	12.7	277	27.4	.88	154	15.5	333	30.6	(not available)			.85	191	18.6	362	32.0
850 mb																		
July	.75	67	6.3	100	9.0	.76	86	7.7	129	11.1				.78	93	8.7	147	12.3
Sep.	.83	75	7.8	139	12.1	.84	95	9.6	181	14.8				.81	119	11.4	207	16.4
Nov.	.89	84	8.7	189	17.1	.85	123	11.6	237	19.9				.83	139	13.3	258	20.9
1000 mb																		
July	.78	60	6.2	100	8.7	.79	76	7.2	121	10.1				.77	92	8.9	140	11.5
Sep.	.83	73	7.7	135	12.2	.83	95	9.7	175	14.8				.80	118	11.5	199	16.2
Nov.	.83	105	10.2	205	18.4	.84	124	12.3	241	20.6				.80	157	14.9	269	22.0

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																		
July	.74	147	19.0	210	25.9	.76	179	22.9	266	30.7				.74	212	25.8	302	33.9
Sep.	.82	133	17.3	240	28.1	.84	162	20.7	305	33.6				.82	194	23.3	350	37.0
Nov.	.88	150	19.5	317	34.4	.88	187	23.6	389	39.3				.86	216	26.0	419	40.6
300 mb																		
July	.73	127	17.1	186	24.0	.79	150	19.4	238	28.6				.77	175	21.7	268	31.5
Sep.	.84	124	16.1	238	28.3	.85	152	19.1	301	33.6				.84	179	21.4	344	36.7
Nov.	.91	143	18.2	351	39.2	.91	176	21.7	420	43.8				.88	211	24.9	443	44.5
500 mb																		
July	.73	88	11.4	121	15.8	.77	102	13.0	157	18.9	.57	135	15.5	.77	115	14.2	175	20.6
Sep.	.81	88	10.7	154	18.4	.82	108	12.8	192	21.6	.80	113	13.3	.82	126	14.6	221	23.8
Nov.	.91	97	12.0	239	27.0	.90	121	14.1	288	30.3	(not available)			.88	148	16.7	299	30.6
850 mb																		
July	.62	88	12.9	87	11.3	.61	112	15.9	112	13.5				.64	119	16.4	126	14.9
Sep.	.74	80	12.0	106	12.8	.72	105	14.2	132	14.9				.75	108	14.5	148	16.0
Nov.	.87	84	12.0	159	16.6	.80	127	15.7	193	19.9				.80	135	15.8	191	18.7
1000 mb																		
July	.64	98	13.9	125	16.4	.63	111	13.9	135	17.0				.63	138	17.7	162	20.3
Sep.	.77	82	11.2	118	15.5	.72	114	13.8	151	18.0				.76	117	15.1	164	18.9
Nov.	.82	111	13.4	186	19.9	.81	143	16.2	211	22.0				.74	172	19.3	217	22.3

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.

VI. MACHINE PERFORMANCE AND UTILIZATION

A. IBM 7094/II

1. Profile

a. Released equipment

1 - IBM 1301 Disk Storage Unit	9-72
1 - IBM 7631 Disk File Control Unit	9-72
2 - IBM 729-4 Magnetic Tape Unit	9-72

2. Use - 1,306 hours.

B. IBM 360/30

1. Profile

a. Released equipment

1 - DIGIFAX COM System	8-72

b. Purchased equipment

1 - Hamilton Standard, DFI	8-72

2. Use - 1,663 hours.

C. IBM 360/40

1. #1 Profile - no changes

2. Use - 4,386 hours.

D. IBM 360/40

1. #2 Profile

a. Purchased Equipment*

1 - Memorex 661 Disk Storage Control Unit	8-72
1 - Memorex 660 Disk Storage Drive	8-72

2. Use - 4,333 hours.

*These units were shown as purchased instead of leased in the First Half 1972, Numerical Weather Prediction Activities, page 40, VII. C. 1. a.

VII. PERSONNEL CHANGES

A. Office of the Director

1. Ann E. Purdy, Support Services Assistant, retired on June 30.

2. Katherine M. Wallace, Personnel Division, NOAA, transferred to Office of Director, NMC, Support Services Assistant, August 20.

B. Development Division (DD)

1. Louise McDonald joined NMC August 6 as Secretary, UAB.

2. Edward M. Gross, Research Meteorologist, transferred to Weather Analysis and Prediction Division, August 5.

3. Hugh M. O'Neil, Research Meteorologist, joined the staff of DD, September 17.

4. James D. Laver, Research Meteorologist, joined the staff of UAB, October 29.

5. William D. Bonner, Research Meteorologist, joined the staff of DD as Chief of Data Assimilation Branch, October 15.

C. Automation Division (AD)

1. Peggy T. Wingert, Mathematician, joined the staff of AD, Services and Applications Branch, November 12.

D. Forecast Division

1. Harold M. Jordan, Supervisory Meteorologist, Chief of Automated Analysis Branch, died December 8.

VIII. DISTRIBUTION OF PRODUCTS

As of December 18, 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)	96
Aviation Meteorological Facsimile Service (AMFAX)	71
Navy Facsimile Network:	
70S537	28
GF18204	69
Air Force Facsimile Network:	
GF20309	50
GF10814	60
RAFAX	16
International Facsimile Network (Offenbach, Germany)	47
Russian Facsimile Network	21
Forecast Office Facsimile Network (FOFAX):	
Circuit #10206	60
Circuit #10207	57
Circuit #10208	57
Caribbean Radio	17
Tropical Analysis Network (TROPAN)	38
Suitland-Honolulu Circuit	58

IX. PUBLICATIONS BY NMC PERSONNEL

1. EXAMETNET Executive Committee, "Experimental Inter-American Meteorological Rocket Network, the First Five Years, 1966-70," NASA SP-293, National Aeronautics and Space Administration, Washington, D.C., Feb. 1972, 53 pp.

2. Finger, Frederick G., and Miller, Alvin J., "Results of a Rocket-Nimbus Sounder Comparison Experiment," NASA Contractor Report 62081, prepared under Purchase Order No. P-48606 (G) by NOAA, NMC, Hillcrest Heights, Maryland, June 1972.

3. Fritz,[+] Sigmund, and McInturff, Raymond M., "Stratospheric Temperature Variations in Autumn - Northern and Southern Hemispheres Compared," Monthly Weather Review, Vol. 100, No. 1, Jan. 1972, pp. 1-7.

4. Gelman, Melvyn E., Miller, Alvin J., and Woolf,[+] Harold M., "Regression Techniques for Determining Temperature Profiles in the Upper Stratosphere From Satellite-measured Radiances," Monthly Weather Review, Vol. 100, No. 7, July 1972, pp. 542-547.

5. Gerrity, Joseph P., McPherson, Ronald D., and Polger, Paul D., "On the Efficient Reduction of Truncation Error in Numerical Weather Prediction Models," Monthly Weather Review, Vol. 100, No. 8, Aug. 1972, pp. 637-643.

6. Gerrity, Joseph P., "A Note on the Computational Stability of the Two-Step Lax-Wendroff Form of the Advection Equation," Monthly Weather Review, Vol. 100, No. 1, Jan. 1972, pp. 72-73.

7. Gerrity, Joseph P., "Global Data Requirements in Support of NMC Operations," Proceedings of Second Symposium on Meteorological Instrumentation and Observations, San Diego, Mar. 1972.

8. Johnson, Keith W., "Accuracy of Objective Analysis at Stratospheric Levels," Monthly Weather Review, Vol. 100, No. 3, Mar. 1972, pp. 218-221.

9. McInturff, Raymond M., and Fritz,[+] Sigmund, "The Depiction of Stratospheric Warmings With Satellite Radiance Data." Preprinted volume of International Conference on Aerospace and Aeronautical Meteorology, May 22-26, 1972, Washington, D.C. Published by the American Meteorological Society, Boston, Mass., pp. 115-120.

[+]NESS

Publications continued:

10. McInturff, Raymond, and Miller, Alvin J., "A Note on Variation in the Quasi-Biennial Oscillation," *Monthly Weather Review*, Vol. 100, No. 11, Nov. 1972, pp. 785-787.

11. Miller, A. J., and Campana, K. A., "A Study of the Energetics of an Upper Stratospheric Warming (1969-1970)," *Quarterly Journal of the Royal Meteorological Society*, Vol. 98, Oct. 1972, pp. 730-744.

12. Quiroz, Roderick S., "On the Relative Need for Satellite Remote Soundings and Rocket Soundings of the Upper Atmosphere," *Bulletin of the American Meteorological Society*, Vol. 53, No. 5, Feb. 1972, pp. 122-133.

13. Quiroz, Roderick S., Kellogg[*], W. W., and Bromley[x], Edmund, Jr., "Conference Summary, International Conference on Aerospace and Aeronautical Meteorology," *Bulletin of the American Meteorological Society*, Vol. 53, No. 9, Sept. 1972, pp. 872-878.

14. Quiroz, Rodney S., and Gelman, Melvyn E., "Stratospheric Thickness Determined Directly From Satellite Radiance Measurements," Preprint Volume of the International Conference on Aerospace and Aeronautical Meteorology, May 22-26, 1972, Washington, D.C. Published by the American Meteorological Society, Boston, Mass., pp. 115-120.

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[*] NCAR

[x] FAA

Publications continued:

Technical Memorandum

#51 Desmarais, Armand J., "Updating Data for Use in Objective Analyses."

Office Notes

#68 Shuman, F. G., "More on Detection and Correction of Errors in Height and Temperature Analyses."

#69 Stackpole, J. D., "On the Longitudinal Smoothing of the Tendency Fields in the Eight-Layer Hemispheric PE Model (HEMPEP/8).

#70 Brown, John A., Jr., "An Oscillation in the NMC Primitive Equation Model Prior to August 1971."

#71 Gerrity, J. P., Jr., "A Note on the Thermodynamics of the NMC PE Model."

#72 Shuman, F. G., "The Research and Development Program at the NMC."

#73 Wagner, A. J., "Verification of Winter Seasonal Temperature Forecasts for Southern New England Using the Rules Developed by Franz Baur."

#74 Gerrity, J. P., Jr., McPherson, R. D., Sela, J., Scolnik, S., "Free Gravity Oscillations of the Shuman-Hovermale Model."

#75 Gross, E., Jones, R., McPherson, R. D., "A Description of the NMC Planetary Boundary Layer Model."

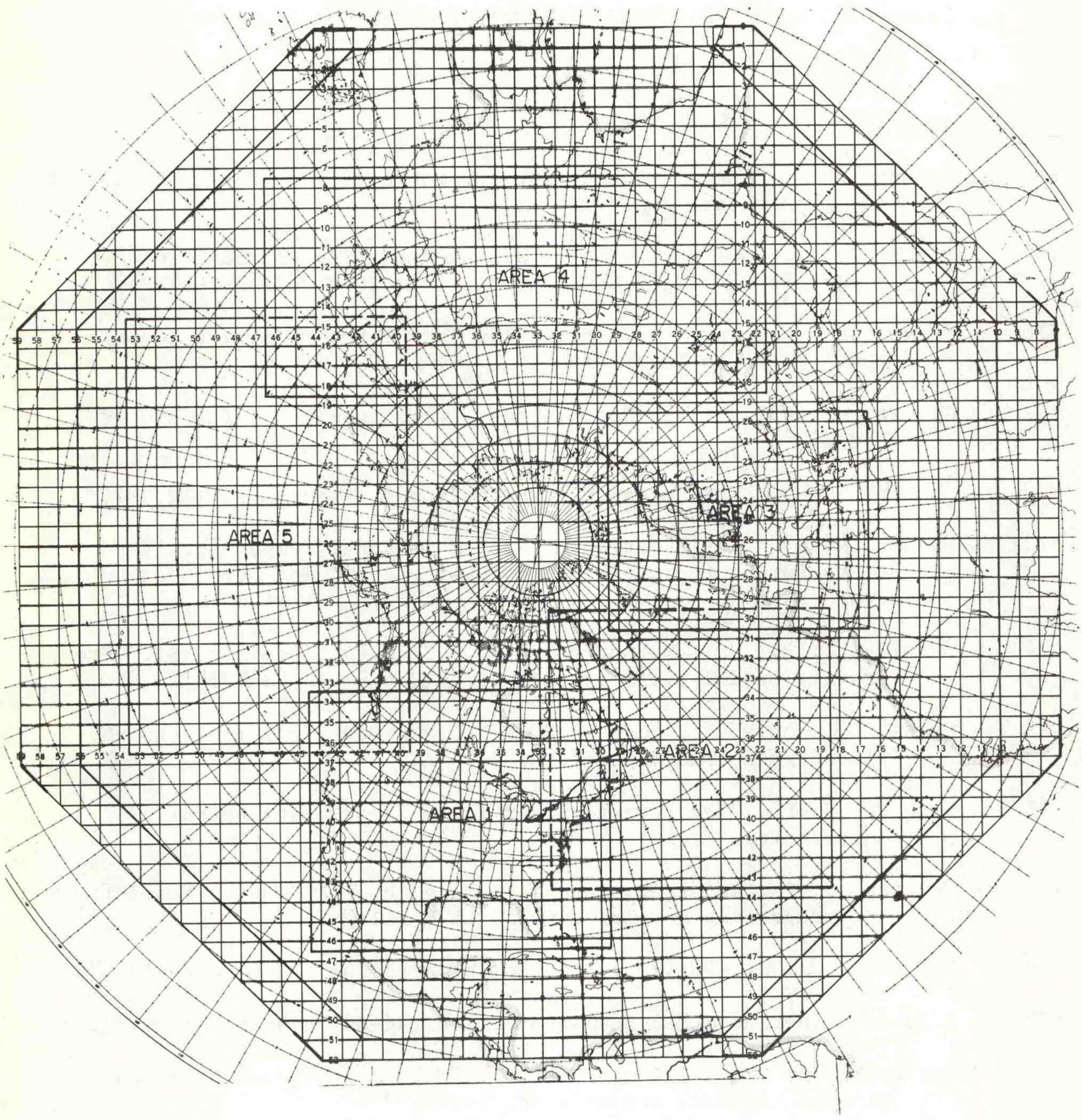
#76 Gerrity, J. P., "The Potential Vorticity Theorem in General σ-Coordinates."

#77 Gerrity, J. P., Gross, E., and McPherson, R. D., "On the Feasibility of Integrating a Combined LFM-PBL Model."

#78 Desmarais, A. J., "Utility Program To Gridpoint NMC Data Fields."

#79 Hiland, Catherine, "NMC Permanent Files (36-Day Historical Data)."

#80 McPherson, R. D., and Bonner, W. D., "Toward an Operational Four-Dimensional Data Assimilation System."



Verification Areas