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UNITED STATES DEPARTMENT OF COMMERCE
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NATIONAL WEATHER SERVICE

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I. REVISIONS IN OPERATIONAL PROGRAM

New NMC "First Guess" and Monitoring Procedures

The operational objective analysis procedure at NMC consists of adjusting "first-guess" fields by a weighted average of observational data available in an influence area surrounding each grid point. Most of these first-guess fields are based on 12-hour numerically produced forecasts. These guess fields are manually monitored by a monitoring analyst who makes subjective assessments of the validity of the 12-hour forecasts and introduces manual control data (bogus) to correct obvious deficiencies. This bogusing had been done at 1000, 500, and 300 mb. Analyses were then performed at 1000 and 500 mb, from which first guesses at other levels were formed.

Since 1200Z June 15, there has been only one key upper level 300 mb. This takes advantage of the more abundant aircraft reports available and also allows for a more efficient and accurate bogusing system. (In the old system, *both* 500- and 300-mb levels were monitored, and the chance for introducing a vertical inconsistency from improper bogusing was greater.) After analyzing at 1000 and 300 mb, first guesses at other levels are obtained that are vertically consistent with these levels. (See Item IV.A.).

II. DEVELOPMENT DIVISION

A. Eight-Layer Primitive Equation (PE) Model

Among other problems, the initial conditions for the 8-layer PE model seem to require some adjustment to prevent a rapid growth of gravity-wave-type instabilities. In an effort to discover just what kind of adjustments are needed, the computer program was modified to make the 8-layer a barotropic model. All references to the vertical structure were deleted, leaving in effect a single-layer barotropic model. This allowed the double advantage of checking for programming errors in the horizontal sections of the code independently of the vertical sections, and allowing for experimentation relating to barotropic causes of the instabilities.

The initial data were Hough-Flattery's analysis of 500 mb winds and heights (see Item II.C.); without any further manipulation, the forecast deteriorated to short waves by 36 hours. However, when the data were initialized by the Nitta-Hovermale method marching in place for the equivalent of 12 hours with an Euler-Backward time-step, the forecast (using centered time-stepping as before) showed no traces of short-wave difficulties. The Nitta-Hovermale initialization method consumes considerable computer time. With this in mind, we also tried using an Euler-Backward time-step for the first six hours of the forecast and finally a weighted time smoother (developed by A. Robert) on the centered time-step throughout the entire forecast (with 0.25, 0.5, 0.25 weights). Both of these methods eliminated the difficulties in the barotropic case. Since the Robert time-smoother is much the least time-consuming, it was applied to the full baroclinic case.

Although the viable length of the forecast was extended considerably, it was still meteorologically inconsistent by 36 hours. The problem is evidently related to the vertical structure. The vertical advection terms were reformulated in such a way as to remove certain ambiguities that grew out of the finite difference scheme (in effect, a smoother was applied to the $\dot{\sigma}$ vertical velocity). Also, a theory developed by Shuman, relating to implied two-grid waves in spherical coordinates, was applied to the parameters of the model (effectively, an additional longitudinal smoothing of the tendencies). When these two effects were included (along with the time smoother), the quality of the forecast improved somewhat, but the 36-hour forecast was still undesirable.

It seems that the time smoother can and does take care of essentially barotropic problems, the external gravity wave. The search must continue, however, for a means (or combination of means) to keep the internal gravity waves under control. [Stackpole]

B. Limited-Area Fine-Mesh (LFM) Forecasting Model

As of this time, 29 test cases have been run using the LFM model; of these, 26 have been evaluated by the NMC Basic Weather Branch. Eighteen cases, scattered more or less at random, were run covering the period from October 26, 1970, through February 4, 1971. The objective S_1 Scores for evaluating surface-pressure forecasts and Threat Scores for measurable and quantitative precipitation were prepared for these cases and for the corresponding operational Primitive Equation Prognostic (PEP) forecast. The S_1 and Threat Scores for occurrence of measurable precipitation show that, at least in these cases, the LFM forecasts were improvements over the PEP forecasts out to 36 hours. Rather significant improvements have been observed for the LFM in forecasting precipitation quantified at the one-half- and one-inch levels for the 0-12 hour and 12-24 hour periods, with some deterioration of its ability to forecast for the 24-36 hour period. A more detailed description of the testing is presented in NMC Office Note #50, "Local Forecasting Model: Present Status and Preliminary Verification," January 1971.

Testing was suspended temporarily in January while the LFM code was being rewritten to incorporate the NMC analysis techniques and cast into an operational configuration, using the new data formats and permanent files on the CDC 6600. The principal changes in the model involve the use of 12-hour forecasts as guess fields for the analysis, in lieu of the coarse-mesh analyses as was done on the previous set, and a 3-dimensional analysis scheme based on the operational analysis. For the eight cases verified so far, the results using the newer model are somewhat disappointing. By and large, the LFM is on a par with the operational PEP model. Individual maps display some improvements in speeds of smaller systems. These cases were not randomly selected. They were selected because these were cases in which the operational PEP model had not done very well on one feature or another.

In these newer cases, some difficulty with the new analysis scheme was noted. In sparse-data areas, the guess system coupled with exotic data resulted in questionable details being incorporated into the analyses. The problem has been diagnosed as an error in the analysis program which has since been corrected. [Howcroft, Desmarais]

C. Spectral Analysis and Prediction

A hemispheric three-dimensional analysis program was used to construct initial conditions for testing the new 8-layer PE forecast model. While the height and wind fields were accepted without difficulty, the temperature fields were not satisfactory. Difficulties were encountered in determining a surface temperature, and the problem of specification of a tropopause has not been completely solved. These problems were not unexpected, however. The temperature fields at some of the upper levels, especially 150 mb, appeared to be erroneous. A complete explanation of the source of this difficulty has not been found, but contributing factors may be: (a) a discontinuity at 100 mb in the zonal empirical orthogonal functions which could affect the temperature functions adversely; (b) unexpectedly large amplitudes in the higher vertical modes, where the temperature functions tend to have large variations and exhibit irregular behavior; and (c) a possible seasonal effect (the vertical functions were constructed from April data, and the analysis was made using February data).

In order to obtain a set of analyses with satisfactory temperature fields and to build a set of hemispheric analyses suitable for investigation of the problems encountered using the empirical vertical functions, a series of experiments was performed in which Hough analyses were performed at pressure surfaces and a "build-up" technique employed. However, in sparse-data areas, unrealistic temperature analyses again resulted.

Emphasis has therefore been directed toward the 3-dimensional spectral approach. An error was uncovered in the computation of the original vertical functions, and they have been recomputed. Various ways of extracting temperature information are being tried.

A major contribution to this problem is undoubtedly the absence of a realistic first-guess field. If the analysis were being cycled with the forecast model (i.e., a forecast first-guess field being used), there might well be no problem. However, it is desirable to be able to achieve a meteorologically consistent analysis regardless of the guess so that an operable analysis can be provided in any circumstances. This goal appears to be a feasible one. Recent results indicate a considerable improvement in the analyzed thermal field. [Flattery, Johnson]

D. Finite Difference Formulations

1. NMC Technical Memorandum #50, *Recent Research in Numerical Methods at the National Meteorological Center*, has been printed.

2. A linear stability analysis of a scheme for filtering the local time tendency has been documented as NMC Office Note #51.

3. The possibility of developing a staggered-grid, explicit-integration scheme is being considered. Difficulties with the calculation of orographic and diabatic effects in a multi-level model formulated with a staggered grid are anticipated. We have consequently decided to first explore the possibility of increasing the accuracy of the presently employed finite-difference schemes. In principle, one ought to be able to use the redundant lattice-structure of the semi-momentum scheme to estimate derivatives with an accuracy comparable to that obtainable with

one-half the present spatial mesh. Numerical experimentation has been carried out with a free-surface, PE barotropic atmosphere in a cyclic channel.

The first steps involved the use of the semi-momentum form of the equations with a modification of the average operator applied to the tendencies. Two alternative schemes were used for the operator by which "cell tendencies" are interpolated onto the grid points. The schemes involve higher order interpolation. Suppression of high-wave number components of the tendency field and more faithful preservation of the long wave components are achieved. These methods produce improvements in the translation of the meteorological modes.

The experiments were repeated using a fine mesh ($\frac{1}{2}\Delta x$). The improvement in tendency interpolation attained about one-half the correction in phase speed obtained with the fine mesh. This result suggested the desirability of utilizing higher order accurate estimates for the derivatives, in addition to improved interpolation of the tendencies. This work is in progress. It was also noted that the solution calculated on the fine mesh was qualitatively different (by 48 hours) from those obtained with the regular-mesh computations. The explanation for this observation must lie in the nonlinear aspects of the meteorological mode evolution and the fact that the initial data contained considerable energy in a wave of $6\Delta x$ length. Further study of these aspects of fine-mesh calculation will be made.

4. A "recursive" filter has been designed for selectively damping components of a field having wave length near four grid intervals. This filter may prove useful as a component of the post-processing package of the LFM forecasts.

In one dimension, the filter may be written

$$\overline{y}_j = \frac{1}{(1+\varepsilon)^2} \left\{ y_j + y_{j-2} - \overline{y}_{j-2} \right\} \left(\frac{1+(1+\varepsilon)^2}{2} \right\}.$$

This operator is passed twice - first from right to left, and then from left to right. The mean of the resulting fields is then taken.

The sharpness of the response is a function of the choice of ε. For a field with 52 grid intervals, the response, which is symmetric about $4\Delta x$ for two choices of ε, is tabulated below:

Wave Length	$52\Delta x$	$26\Delta x$	$13\Delta x$	$10.4\Delta x$	$6.5\Delta x$	$5.2\Delta x$	$4.3\Delta x$	$4\Delta x$
Response ε=.1	.94	.97	.97	.94	.96	.95	.81	.28
Response ε=.01	.99	.99	.99	.99	.99	.99	.99	.87

Table 1.

[Gerrity, McPherson, Polger]

E. Implicit Integration Methods

1. A paper entitled *On an Efficient Scheme for the Numerical Integration of a Primitive Equation Barotropic Model* has been accepted for publication in the June 1971 issue of the Journal of Applied Meteorology.

2. Efforts to develop a two-layer model based on Phillips' σ-coordinate and employing a semi-implicit integration scheme along the lines suggested by A. Robert in Canada, but formulated on a staggered grid, have been disappointing. The principal difficulty seems to involve both initialization and prediction on the staggered grid. This effort has been temporarily shelved. The emphasis has been shifted to the development of a similar model, but based on a simpler derivation and employing standard semimomentum space differencing. Debugging with analytic initial data is nearly complete; a stable integration to 24 hours, using a one-hour time step, has been achieved. An integration using real data awaits the debugging of a suitable initialization procedure which is also nearly complete.

3. Documentation of the calculation of free-gravitational modes for one-, two-, and four-layer isothermal models based on Phillips' and Shuman's σ-coordinate has been completed in Office Note 47.

4. Analysis of linearized, two-layer, vertical-plane models, based on Phillips' σ-coordinate and employing various implicit integration procedures, has been pursued as far as it seems profitable. The original intent of this project was to devise a method by which the external gravity mode would be treated implicitly (and stably), while the internal mode would be treated explicitly. Complete success has not been achieved, but in one system the conditional stability criterion associated with the external mode is relaxed so as to allow a time step three times as long as an explicit method would allow. In another, separation of the gravitational modes was achieved, but the external mode is damped.

The analyses are being verified by integration of the models and documentation summarizing these experiments will be prepared.

5. The analysis of a four-layer, vertical-plane, linearized model, based on Shuman's σ-coordinate and employing a modified implicit integration, has been completed. The analyses show that a time step three times that allowed by an explicit method may be used, and only two boundary-value problems, rather than one per layer, must be solved each time step. This model is being coded, along with an explicit and a fully implicit version, for verification of the analysis and comparison of the solutions.

6. A project to examine the handling of the geostrophic-adjustment process in multilayer models by explicit and implicit integration methods is being designed. The project would use the models developed in Items 2 and 3. [Gerrity, McPherson, Polger, Gordon]

F. Air Pollution Potential (APP) Forecast Program

1. On February 8, 1971 NMC began transmitting air pollution stagnation guidance twice daily on FOFAX along with narratives (FKUS2) over Service "C" teletypewriter. For more details, see Technical Procedures Bulletin No. 58. Automated sounding plots and mixing-height calculations using a scan technique are being produced twice daily for use by NMC. A method is being tested for calculating morning mixing heights and corresponding relative concentrations based on heat addition methods of P. W. Summers (1965). A climatology of relative concentrations is being incorporated into the program. In this manner, dispersion conditions at a specified time and location can be represented by a single number that could be readily compared with relative concentrations for other periods, locations, or climatological statistics. The relative concentrations can then be used to determine the severity of individual air pollution episodes. We are testing the relative concentrations for fixed city sizes and those related to specified wind directions.

2. We are also testing more critical values (higher confidence areas) within areas of large-scale stagnation. We are utilizing screening techniques to delimit variations of our criteria during various synoptic situations. The probability of precipitation (POP) forecast used in the program is being verified objectively. We are continually testing and evaluating new parameters for future inclusion into the APP program.

3. Changes in POP forecasts for the APP program include: (1) check and reduction of Relative Humidity Stations with observed over-forecast bias (Gordon, 1971), (2) inclusion of southerly wind components of PE boundary-layer wind, and (3) lifted index trend for individual stations. A climatological array has been added for the periods 12-00Z

and 00-12Z in such a manner that each POP forecast is compared to frequency of occurrence for that station, time of forecast, and then adjusted for that frequency. Table 2 below shows climate and adjustment factor. For example, if POP is 80 during period 12-00Z FCST and climate is 12, final POP is 80x.75 = 60%. This change was implemented on June 1, 1971.

Climate	>25	25-21	20-19	18-16	15-11	10-9	8	7
Adjustment Factor	None	.95	.90	.80	.75	.70	.65	.60
Climate	6	5	4	3	2	1	0	
Adjustment Factor	.55	.50	.45	.40	.30	.20	.10	

Table 2.

An office note is being prepared on the use of POP forecasts in the APP program. [Gross]

G. Initialization Experimentation with the Operational PE Model

The initialization experiments that were reported in the last NWP Activities Report have been continued. A total of six cases have been successfully tested, and, as before, the synoptic-scale features were very similar to those of the corresponding operational forecasts.

In contrast to the operational balanced method, the new scheme ignores the question of the mass-wind balance and utilizes the analyzed wind fields directly. The rotational part of the objectively analyzed wind field and the divergent wind component from the previous 12-hour PE forecast (valid at the initial time) are used to obtain the initial wind field. No additional damping or dispersing mechanisms are used in the forecast model.

Presently, the operational objective-analysis scheme uses a geostrophic first guess for the wind field; however, a satisfactory technique of using a gradient-wind first guess has also been found and is now being utilized. Test forecasts using the above method of initialization with both types of wind analyses show similar results. A test case was run to 84 hours without any apparent development of model instability.

Statistical verification of seventy stations for five of the six cases have been made (see Table 3). The RMS temperature errors for the operational and the test forecasts are quite similar, but the improvement in the RMS wind vector errors of the test is quite evident from initial hour to 48 hours, especially at the higher levels.

We plan to implement this scheme early next quarter.
[Campana, Brown]

H. Mountain Flow

The study of flow over mountains was continued using time-dependent primitive equation two-dimensional multilayered models. The scale of the flow was assumed small enough so that Coriolis acceleration could be neglected. The adiabatic flow was calculated utilizing the equations written in sigma-coordinates. Emphasis has shifted to the hydrostatic model which is expected to indicate under what conditions rotor flow would occur in the atmosphere due to nonlinearities. Preparation of the model for extensive testing began in this period.
[Collins]

I. Use of PE Model Output (FOUS) to Forecast Precipitation

1. The versatility of the 6-layer PE model has made it practicable to output values of a variety of meteorological parameters at specific geographical locations. Forecasts are provided for 66 cities, divided into two sets to minimize transmission time. Transmission of this digital form of guidance over Service C began in October 1969. The original program has been modified several times since then. Three additional cities were added (IPT, MSO, DAY) in February 1971 to FOUS-2.

2. The Scientific Services Division, ERH, has developed a procedure for objectively forecasting precipitation using the above PE output. The technique is applicable to the three consecutive 12-hour forecast periods included in the public weather forecast (i.e., today, tonight, and tomorrow) for the area east of the Appalachian Mountains and north of North Carolina. A complete report describing the technique has been published by ERH as an Eastern Region Technical Memorandum. A computer program was written to duplicate the Eastern Region's technique. Using the coded output from the 6-layer PE, probability of precipitation (POP) forecasts for 16 cities are computed and coded into a special message transmission for ERH.
[Smith]

J. Six-Layer PE Model Development

1. The Locked-in-Low Problem

A rather annoying, almost systematic error, in the PE model in which a 500-mb trough, on the lee side of the Rockies, remains

VERIFICATION OF 5 PE FORECASTS FROM 1200Z DATA

MB	ANAL	00-HR	12-HR	24-HR	36-HR	48-HR
		2.29 19.05	2.88 19.64	3.40 24.30	3.71 27.20	4.55 33.79
200	1.28 + 8.83	+	+	+	+	+
		2.29 15.42	3.72 18.05	3.51 21.79	3.81 24.39	4.74 30.72
		2.41 19.21	2.76 24.42	3.34 28.70	3.41 30.92	4.04 39.34
250	1.11 + 10.24	+	+	+	+	+
		2.41 15.58	2.89 22.82	3.31 25.43	3.51 28.52	4.04 36.27
		2.07 20.97	2.29 24.42	2.73 29.19	3.07 32.56	3.29 40.49
300	1.16 + 10.97	+	+	+	+	+
		2.07 16.63	2.41 22.95	2.69 26.18	2.94 29.96	3.14 37.29
		1.44 13.55	2.07 16.05	2.51 18.76	2.79 22.30	3.25 25.76
500	.88 + 8.42	+	+	+	+	+
		1.44 11.25	2.05 15.13	2.38 17.59	2.71 20.64	3.17 24.09
		1.61 11.11	2.09 12.75	2.35 14.59	2.78 16.21	3.53 19.02
700	.83 + 6.04	+	+	+	+	+
		1.61 9.02	2.05 12.47	2.34 14.59	2.72 15.61	3.55 18.38
		2.33 13.12	2.42 12.48	3.03 14.15	3.33 16.04	3.67 19.60
850	1.16 + 6.27	+	+	+	+	+
		2.33 9.82	2.44 12.13	3.00 14.21	3.36 15.32	3.61 18.94
	ANAL	00-HR	12-HR	24-HR	36-HR	48-HR

8 AUG 70		
23 DEC 70	RMSVE = ROOT-MEAN-SQUARE VECTOR ERROR (KTS)	PLOTTING MODEL
7 FEB 71	RMSTE = ROOT-MEAN-SQUARE TEMPERATURE ERROR	
16 MAR 71		RMSTE RMSVE - OPNL
28 APR 71	70 STATIONS	+
		RMSTE RMSVE - TEST

Table 3.

erroneously fixed (*locked-in*) in the forecast, while the associated surface feature moves correctly to the east or northeast, was given particular attention. A number of experiments were run involving reformulations of the present gradient terms, the hydrostatic equation, or the precipitation section. Precipitation was included because it can be demonstrated (experimentally) that the presence of the latent heat is what causes the correct motion of the surface feature; if the latent heat is eliminated, the surface low remains *locked-in* with the upper air feature. The experiments have not yet been successful, but we are continuing to search for the answer.

2. Precipitation Forecasting

A long-standing deficiency of the PE model, the precipitation section, has been its inability to forecast or even suggest the possibility of convective-type rain over large areas of the country during the summer. The difficulty is partly a matter of scale and partly a matter of physics. As an effort to by-pass both difficulties, a forecast of convective rain by parameterization is being investigated. In essence, the vertical temperature structure of each point in the model is being tested for conditional instability (by the parcel method), and, if found, a quantity of rain proportional to the degree of instability is assumed to fall to the ground. No accounting for release of latent heat or evaporation of falling rain is made during this process; however, the pair of unstable layers are mixed in the vertical after the *rain* is calculated to simulate the sort of mixing that would take place in a convective situation (and also to prevent excessive amounts of precipitation from accumulating). The physical justification for all of this is that if an area, as large as that which one grid point represents as an average, were in a state of conditional instability, the chances seem good that there would be a shower of some sort somewhere within that area (a locally heated area or convergent area which could set off the instability could exist). This possibility is what we wish to add to the model. Two tests completed by the time of this writing seem quite promising. If the good results hold up, the effect will be incorporated into the operational model in due course.

3. Conversion to New Identifiers and Data Format

In conjunction with the conversion of the operations from the IBM 7094 to the CDC 6600 and the associated changes in the data format and identification system, portions of the PE programs that read analysis data fields were rewritten so as to accept the new formats and sources of the data (i.e., disk files rather than tapes, etc.). Given these data, then the PE model can run independently of the IBM 7094, if necessary.

[Stackpole]

K. Global Forecast Model

1. The 3-layer global PE model was run on initial data for 00Z February 7, 1971, provided by Hough function analyses (see Item II.C.). This forecast was provided to support the Apollo 14 splash-down effort. Southern Hemisphere data were reflected into the Northern Hemisphere and the model was run with no topographic, frictional, or heating effects.

Computational instability generated by the use of too long a time step prevented any forecast beyond 24 hours. Subsequent attempts with the proper time step successfully produced 60-hour forecasts. Considerable loss in magnitude was noted in wind maxima when initial data on pressure levels were converted to sigma surfaces and output once more on pressure levels. In extreme cases, these losses amounted to 40% of the maxima. The offending programs were corrected so that the wind maxima now suffer no more than a 15% loss in extreme instances.

The new input-output (I/O) program is better at preserving the initial gradients on all pressure levels. The root-mean-square vector errors (RMSVE) are calculated in Table 4 below for a hemisphere.

	1000	850	700	500	300	200	mb
Old I/O	1.4	.9	3.5	3.9	5.1	8.1	(m sec^{-1})
New I/O	.1	.3	.2	1.8	2.2	1.6	(m sec^{-1})

Table 4. [Hirano]

2. Numerical Experiments

Tests of the latitude-longitude grid calculations scheme were continued using a primitive equation barotropic forecast model. For these tests, data are being carried on a 5-degree grid (2522 distinct points). Using a 15-minute time step (with a mean atmospheric depth of 1500 meters and centered in time with a time smoother), a one-hour forecast was calculated in 1.9 seconds on a CDC 6600 computer. Some minor but important revisions were made in the finite difference formulations and the method of treating values at the poles and high latitudes. This resulted in stable forecast calculations past 19 days without the necessity of overt diffusion. It seems that the problem which causes high-frequency noise and final destruction of the calculation is a damping, small-amplitude ultra-long gravity wave(s) traveling north-south from pole to pole with a period of about 18.5 hours. Ordinarily, these forecast calculations are preceded by the equivalent of 36 hours of forward-backward in time initialization calculation using the Euler-backward time-tendency smoother. This appears to eliminate high-frequency noise in the initial data but has little or no effect on the ultra-long gravity wave(s). A study of the initial wind and height values before and after initialization calculation indicates that the Hough Function analyses (see Item II.C.) leave systematic disagreement between winds and heights. The winds are too-near geostrophic. One can speculate that this is the cause for the ultra-long gravity wave(s) in the global calculation and that this sort of effect is probably present, to some extent, in all PE forecast model calculations. Schemes for eliminating or controlling ultra-long gravity waves or the high-frequency waves and noise are under study. [Vanderman]

L. Upper Air Branch (UAB)

The Upper Air Branch is engaged in a broad program of basic and applied research. Its fundamental goals consist of defining the structure and circulation of the upper atmosphere and the coupling of this region with the troposphere. It is anticipated that the results of these investigations will be utilized in extended forecast models and possible forecast techniques with application to various aerospace vehicle operations. The principal activities within this effort are:

1. Analysis of Stratospheric Data

a. Determination of Temperatures and Heights from Radiances

Temperature and height profiles are being retrieved from SIRS-B radiance measurements by means of a combined iterative-direct model development by Smith and Fleming of NESS and Woolf of NMC. [Woolf]

b. Application of SIRS Radiance Data

Radiances measured in the 669 and 680 cm^{-1} channels of SIRS are mapped on both polar stereographic and Mercator projections on a daily operational basis to aid in the detection of stratospheric warmings. Longitude-time sections of these radiances at selected latitudes are also constructed to provide additional information on stratospheric thermal structure. [Woolf]

SIRS radiances have been used to depict stratospheric temperature changes in both Northern and Southern Hemispheres during autumn transition periods. A joint paper with Fritz of NESS is being published. [McInturff]

c. Change in Data-Merge for IQSY Analysis

Since September 17, 1970, two IQSY analyses per day have been performed. The 00Z analysis is based on data for the preceding 12Z as well as 00Z, while the 12Z analysis is based on data for the preceding 00Z as well as 12Z. (This contrasts with the earlier system of analyzing only one map per day and of merging data for a nominal 12Z map from both the following and preceding 00Z times with the 12Z data.) It was later discovered that the accompanying modification of the IQSY lister program, which prepares the data for the IQSY analysis program, required changes in the system of applying radiation corrections. These program changes are being carried out by DAD personnel and will be evaluated by UAB when completed. It is anticipated that the modified procedure will be put into operational use about July 1, 1971. [Johnson]

d. Evaluation of SIRS Data

A comprehensive effort is underway to determine the compatibility of SIRS-B retrievals with radiosonde data. Preliminary results on the evaluation of SIRS-derived height and temperature data were reported by M. Gelman at the April 1971 AGU meeting in Washington, D.C. These results indicate that, during many periods of the year, the SIRS retrievals for the stratosphere may be used with confidence. However, during periods of winter stratospheric warming and other times when large-scale changes take place in the high stratosphere (such as occurred during December 1970-February 1971), the retrievals may be much less reliable.
[Finger, Johnson, McInturff, Miller, Gelman]

e. Improving First Guess

An improved first guess is being developed for the SIRS retrieval process. Need for this was indicated by the poor stratospheric retrievals during the most recent stratospheric warming episode. Preliminary results are encouraging. [Gelman, Miller, Woolf]

f. Conversion of Stratospheric Synoptic Analysis Program to CDC 6600 Computer

The multilevel analysis program for mandatory levels above 100 mb has been written in FORTRAN Extended (level 3.0) for the CDC 6600 Computer. Checking of regression equations continues and utilization of disk data files remains to be programmed. [Johnson]

2. Research on Stratospheric Circulation

a. Stratospheric Warming

An extensive study of the stratospheric warming in the winter of 1969-1970 is continuing. For the period December 10, 1969, to January 21, 1970, vertical motions, derived from the geostrophic omega equations, are being computed up to 30 mb on a daily basis (at 12Z only). Atmospheric energy and energy conversions in various pressure layers are also being obtained during this period. At various stages of the stratospheric warming, the study will be extended up to 2 mb.
[Finger, Miller, Brown, Campana, Johnson]

b. Energetics

Preparation of summaries of various terms in the equations for energy and momentum budgets has continued for the warming period of December 1969-January 1970 under study. [Miller, Johnson]

c. Accuracy of High-Level Temperatures

Data obtained at Wallops Island using radiosondes, rocketsondes, and satellites are being analyzed. [Miller, Finger]

d. Planning for Meteorological Support of SST Operations

Forecasting requirements for the stratosphere are being investigated. [Finger, McInturff]

e. SIRS Radiance Data Interpretation

The development of a method for determining the amplitude and altitude of stratospheric warmings from observed radiances has been followed by work directed toward defining the spatial and time scales of warm air anomalies, with special attention to events in the winters 1969-70 and 1970-71. [Quiroz]

3. Quality Control

a. Quality Control Working Group (QCWG)

A QCWG has been established with NMC and OMO. The group will act as an inter- and intra-agency intermediary for investigating and remedying operational data problems.

Representatives from the Air Weather Service, Navy, Coast Guard, and FAA have been appointed to the QCWG by their respective agencies. This provides NMC with direct interagency channels for investigating and remedying data deficiencies which affect joint NWP activities.

b. Acquisition of Marine Upper Air Data

(1) Pacific

Due to the progress made during 1970 in improving the moving ship (MSRP) data base, our data monitoring responsibility has been transferred to the Marine Supervisor, PWP, San Francisco, per verbal agreement. NMC will continue to provide machine listings for ADP data. A plan to improve the acquisition of surface data from Pacific marine sources is being undertaken. This will be a joint NMC/OMO effort.

(2) Atlantic

Data quality control information (primarily machine listings and raw data, with deficiencies annotated) is being provided to the Marine Supervisor, AWP, Boston. This is being done to improve the quality of upper air data from U.S. OSVs (Ocean Station Vessels).

c. Notification of Operational Data Deficiencies

Since September 1, 1970, notification of deficiencies in rawinsonde data from the Western Hemisphere has been sent to Weather Service Offices having jurisdiction over the regions where data are generally deficient. Information from the field is being evaluated to determine the cause of the problem.

d. An automated program has been developed which computes monthly summaries of the frequency with which RAOB and pibal data are being processed within the 3+25 operational deadlines. Complementary programs are also being developed to provide similar information for the 1+30, 2+50, and 10+00 operational runs. Performance standards are being studied, and samples of the output have been distributed to field units for their review. Statistical analyses that are derived from these programs will be used to expand the quality control of operational data.
[Thomas]

III. EXTENDED FORECAST DIVISION

A. Thermodynamic Model for Long-Range Numerical Weather and Ocean Temperature Predictions

The model continues to be run twice a month on a real-time basis for possible use in preparation of the official forecast; and a discussion of its performance is included in the postmortem of the 30-day outlook.

The highlights of the research activities for the period of this report are given below:

1. Continued efforts were put into numerical experiments in which forward integrations are used, instead of an implicit method, both for the atmosphere and the ocean. The general procedure was discussed in Item III.A.1. of the report for the Second Half of 1970.

Numerical experiments for several cases using forward integration in the ocean for January through December 1970 have been completed. Time steps of 5 and 30 days were used in each case. Results indicate that more work must be done on the advective terms.

2. Numerical experiments were undertaken with the most complete model, for the Northern Hemisphere, for studying possible climatic and seasonal changes in temperature and in the heat sources and sinks in the atmosphere-ocean-continent system due to fluctuations of the following parameters: the solar constant, surface albedo, cloudiness, absorption of short-wave radiation by the atmosphere and clouds, atmospheric window, storage of heat in the ocean, austausch coefficient, boundary conditions, initial conditions, evaporation from the surface layer, heat given off to the atmosphere from the surface and the condensation of water vapor in the clouds. The numerical experiments for January and July are complete.

3. A systematic comparison was made of the observed ocean temperature from Monterey data with that from EFD-conventional data, and will be continued on a permanent basis. Almost one year of comparisons has been completed.

4. New parameterizations of the advection of heat by mean ocean currents have been developed for the model. These will be tested in the near future.

5. A manual on the computer program of the revised model is now being prepared.

[Adem, Bostelman]

B. Evaluation and Adaptation of Extended-Range Numerical Predictions

1. The last three of 24 half-monthly sets of regression equations for specifying daily precipitation probability from prognostic heights and height changes have been selected, coded, and put into operation. The results were summarized in a talk at the AMS-AGU Spring Meeting and will be documented as a journal paper.

2. The last four of 12 monthly sets of percentile limits (5% and 95%) for daily anomalies of maximum and minimum temperatures at 130 stations have been completed. Other percentile limits (1% and 99%) are being drawn from the data by Techniques Development Laboratory (TDL) for their use.

3. A CDC 6600 code for plotting and analyzing temperature and precipitation by Varian is being modified and checked out.

[Gilman, Durdall]

C. Vertically Integrated Primitive Equation Model

A vertically integrated PE model is being designed for application to the extended range. The integration, with respect to the vertical, introduces eddy and boundary terms. The necessary parameterization of the vertical eddies is investigated using normal and daily values of the meteorological variables. The use of normals allows the determination of one parameter, while a time series of daily data permits more degrees of freedom. The best parameterization must be determined experimentally.

Coding of the model continues. The stability problems of the part without the eddies are believed to be solved. An initialization procedure appropriate to the program variables has been devised and is expected to work in the generalized form.

Data accumulation for parameterization of the vertical eddies continues, and diabatic heating in crude form is being tested. [Sela]

D. Objective Prediction of Sea-Surface Temperature

Work continues on different phases of the project. [Namias]

E. Programming Support for Operations and Research

1. Extended Forecast System

a. All components of the system were revised to use initial data from 00Z analyses and forecasts, but 12Z verifying time was retained.

[Hiland, Gelhard]

b. Modifications were added to provide guidance for 5-day mean temperature and precipitation forecasts.

c. Automation of max-min temperature and daily pressure bias calculations was programmed to produce maps and tables of daily and time-averaged errors of objective temperature and pressure forecasts for the 3rd, 4th, and 5th day of the forecast period. [Jones]

d. Efforts to convert from DIGIFAX to Varian graphic output continues.

2. Long-Range Forecast Programs

a. Routine monthly forecast guidance is now produced by CDC 6600 programs from data retrieved from an IBM 7094 disk data bank. Graphics are produced via Varian. [Jones, Gelhard]

b. Seasonal guidance, formerly produced by a series of IBM 1401 programs, is now computed on the CDC 6600 from a binary data base instead of a decimal history. [Gelhard]

3. Additional Program Revisions Necessitated by Removal of NMC's IBM 1401

a. Calendar month climatological summary program, MWR66, formerly card-oriented and post-processed on the 1401, required complete input-output revision. Input data are now from 7094 disk data bank and output are via CDC systems and Varian. [Gelhard, Jones]

b. A completely new temperature verification system was required. [Hiland]

c. A family of programs is being rewritten to update and utilize the 24-year history of daily sea-level pressure, 700-mb height, and 700-mb temperature. These historical data, in decimal format and polar coordinates, have been widely used by EFD and the scientific community, but must remain inactive until a series of updating, retrieval, and computational programs can be written.

COBAL programs for maintaining tape files have been written (to eliminate card files); retrieval and utilization codes have been outlined. [Durdall, Gelhard]

4. Services

a. A tape collection of daily 700-mb heights, 700-mb temperatures, and sea-level pressures in polar coordinates is provided to the Bonneville Power Administration each week.

b. A weekly summary of growing-degree-days is provided to EDS for publication in the _Weekly Weather and Crop Bulletin._

c. A 24-year history of daily 700-mb heights and sea-level pressure was provided to Air Force Cambridge Research Laboratories.

IV. DATA AUTOMATION DIVISION

A. Statistical Techniques and Analysis Branch

1. Objective Analysis

a. The operational procedure for analyses at constant pressure levels consists of adjusting "first-guess" fields by a weighted average of observational data available in an influence area surrounding each grid point. Most of these first-guess values of height and temperature are based on 12-hour numerically produced forecasts. These guess fields are manually monitored by a monitoring analyst who makes subjective assessments of the validity of the 12-hour numerical forecasts and introduces manual control data (bogus) to correct obvious deficiencies. This activity was performed prior to every operational analysis and involved the sea-level pressure (1000-mb height) and two upper air levels (500 and 300 mb) in the sparse-data regions, primarily over the Pacific Ocean.

The procedural change implemented on June 15, 1971 was to make the 300-mb level the single key upper level to be monitored instead of 500 mb. The first guesses for the other levels are then made to agree with the 1000-mb and 300-mb levels. Use of 300 mb as the key level has these two beneficial effects:

(1) The more abundant jet aircraft reports are utilized in the key-level analysis and their information is then reflected in the levels below and above 300 mb by means of the first-guess methods for the other levels; and

(2) The total amount of time and effort required for manual monitoring is reduced because nearly all efforts are directed toward a single upper level. In the old system, both 500- and 300-mb levels were monitored, and the chance for introducing a vertical inconsistency from improper bogusing was greater.

The method for obtaining the new 300-mb height guess is simply to use the 12-hour 300-mb numerical forecast. Having completed the height analysis for this level, the 500-mb height (expressed in departure from the U.S. standard reference height) and temperature guesses, in meters and degrees C, respectively, are formed as follows:

$$D_5' = .383\ D_{10} + .617\ D_3 + S_5'$$

$$T_5' = .0279\ (D_3 - D_{10}) - 21.2$$

where

D'_5 is the 500-mb guess D-value,

D_{10} is the analyzed 1000-mb D-value,

D_3 is the analyzed 300-mb D-value,

S'_5 is a predicted stability factor for the 1000- to 300-mb layer, and

T'_5 is the 500-mb guess temperature.

The remaining first-guess equations for the other levels remain unchanged. As before, in areas where no data are available the new method returns the numerical forecast heights.

Since May 1, 1971, the new version of the analysis program has been run routinely to produce the 1200 GMT FINAL (10+00) analyses. The monitoring analysts treated the 300-mb level as the key level and introduced bogus data as deemed necessary. In this way, considerable experience was gained with the new procedures. The resulting analyses were compared with the OPNL (3+25) analyses and found to be of good quality. The new analyses over data-rich areas were essentially duplicates of the OPNL ones. The analyses at 300- and 500-mb were judged to be satisfactory over the Pacific Ocean where absolute evaluation is extremely difficult for either the new or the old methods.

Over the U.S., where the 1000- and 300-mb analyses are based on a good observational network, the mean RMS height error in the new 500-mb first guess was 18.2 meters versus 28.1 meters for the 500-mb height forecast. The patterns in the new 500-mb first guesses clearly indicated they were vertically consistent with 1000- and 300-mb, in addition to agreeing well with the observations. [McDonell, Costello]

b. A significant amount of time and effort has been devoted to preparing all the analysis programs for the 6600 computer. These programs use the new NMC data formats and permanent file systems. With minor differences, they will operate on the operational 1977-point octagonal grid or the 3021-point LFM grid. The analysis job is separated into four main codes: (1) a sea-level pressure and surface air temperature analysis; (2) a height, temperature, and wind analysis for nine mandatory levels (850- to 100-mb); (3) a moisture (relative humidity) analysis for the three lowest sigma-layers for the PE model; and (4) a tropopause pressure and temperature analysis for the PE model.

Program (1) is essentially the same as the 7094 version except some improved methods for detecting erroneous reports have been incorporated and the procedures for using ship wind reports are being investigated. A technical memorandum is being prepared to describe the procedures used in Program (2). Program (3) differs from the 7094 version primarily in that it uses the 12-hour forecast tropopause pressure and the reported surface pressure to define the pressures of the three lowest sigma-layers in the PE model, and then proceeds to analyze for each layer. Program (4) differs in that the reported tropopause is introduced as "data" to be analyzed. Where tropopause reports are not available, the first guess prevails, and the resulting analysis is essentially the same as the 7094 version. [Newell, Zbar, Desmarais, McDonell, Costello]

2. Updating Asynoptic Reports

Tests have been conducted to evaluate methods for updating asynoptic reports to synoptic time for possible use in operational analysis programs. An Advective Method, currently being used for the FINAL (10+00) analysis to make short-period (up to 6 hours) updates, was used to update 12-hour old radiosonde reports in the data-rich area of the United States. A 500-mb space mean flow, obtained from the PE initial and 12-hour forecast stream function fields, was used to advect the old radiosonde report, in toto, to a new location where the heights and temperatures at the mandatory nine levels from 850 to 100 mb were hydrostatically checked and then verified against the appropriate operational analyses. Eleven synoptic cases were used for this test. The results showed that updated height reports had smaller RMS errors than 12-hour persistence and that updated temperature reports had about the same RMS errors as 12-hour persistence at most levels.

The system of obtaining the first-guess height fields was also subjected to the same verification procedure (by verifying at the updated positions); and this showed the guess fields to have smaller RMS errors than the updated height reports, except at the 100-mb level where 12-hour persistence was best. The guess temperatures showed the RMS errors to be about the same as for the updated temperature reports. For comparison, a different advective flow based on a highly smoothed 500-mb steering field, described by Dr. G. Hayden, NESS, was also used for the same data sample.

A Tendency Method test has been made to update the same 12-hour old radiosonde-height data using forecast-height changes. Updates were made by adding the forecast-height changes to the old reports at the 850-, 500-, and 200-mb levels, and were then verified against the operational analyses. Forecast-height changes from the PE and 3-Level models were tested. The forecast changes were computed by using the forecast heights minus the analyzed heights. Results of the Tendency Method test (see Table 5) show that: (1) 12-hour updated heights are significantly better than both 12-hour persistence of the old reported heights and of the old analyzed heights; (2) updated heights are a little better with the use of 3-level model than with the PE model; (3) the 12-hour forecasts verified slightly better than the 12-hour updates; and (4) the Tendency Method updates verify better than the Advective Method.

Average Height RMS Errors (Meters) for 11 Cases

		850	500	200 mb
Advective Method Update	(NMC)	30.6a	31.1a	47.3a
	(Hayden)	24.7a	29.9a	48.6a
Tendency Method Update	(PE)	18.2b	27.2b	44.0b
	(3L)	17.7b	25.5b	39.8b
12-Hour Forecast	(PE)	17.1b	26.5b	40.6b
	(3L)	16.7b	24.3b	35.5b
12-Hour Persistence	(Anal. Hgt.)	28.4b	46.3b	56.5b
	(Old Obsn.)	29.4b	47.3b	58.4b
First Guess for Verifying Anal.		9.7*	23.0a	36.3a
Verifying Anal. vs Obsvd. Hgt.		7.0a	9.2a	14.7a

a determined at relocated position; b determined at radiosonde station; * includes influence of operational 1000-mb height analysis.

Table 5.

Results for updating 12-hour old temperature reports using the 12-hour PE forecast temperature changes are presently being evaluated. [Desmarais]

3. Support Programs

a. Programming assistance to the Development Division continued. Modifications have been made to LFM Initialization package to operate with new NMC data formats; new surface, upper air, tropopause, and moisture analyses; and permanent file features on the CDC 6600 for operational implementation. [Desmarais]

b. The FAXGRD program (see IV.A.6.a. of previous report) has been modified to accelerate the relaxation process for the first forecast period. This was accomplished by saving an appropriate stream function field from the previous cycle to be available for use as a first guess. A savings of two minutes daily of CDC 6600 CPU time resulted from this method and was implemented in early March 1971. This same program was also converted to the new NMC data formats. [Irwin]

4. Machine-Processed Observations

a. A comparison of capability of the NMC aircraft report decoder with that of the Fleet Weather Central in Honolulu was made during January 1971. The results of this check indicated that they are of about the same quality. [Irwin]

B. Programming Branch

1. Program Conversion

All programs operational on the CDC 6600 have been converted to output data in NMC's new field format (see Item IV.B.1. NWP Activities, Second Half 1970). At the same time, all forecast fields from the Six-Layer PE were placed in random access files. This made possible the processing of forecast information while the model continues to compute later period forecasts. Some forecast products are now available from the CDC 6600 thirty to sixty minutes earlier than before. NMC is still dependent upon the IBM 7094 for the processing of observations and for objective analyses. However, analysis programs and output processing programs are ready to run on the CDC 6600, giving a limited number of Varian charts. The processing of upper air observations will be done on the IBM 360 computers, and the necessary programming should be completed early in the next reporting period.

2. Computer Graphics System

When the new AMFAX Schedule was inaugurated on March 30, 1971, a group of graphics programs were instituted on the CDC 6600. Forty-six NMC facsimile charts for AMFAX are now produced on the CDC 6600 and transmitted directly through the Digital Facsimile Interface (DFI) each day. Similar changes were also made in the Honolulu, Offenbach, and Caribbean FAX Circuits.

3. Support to the Bureau of Reclamation

Radiosonde data for selected stations and PE forecast data (12- and 24-hr) at 154 grid points covering the western United States are being sent twice daily to Denver via a 2400 baud line. These data are being processed on a time-shared computer at Denver by the Division of Atmospheric Water Resources Management of the Bureau of Reclamation.

4. Programming support for the Development Division continues.

C. Information Processing Branch

1. Major changes were made to the CCAP software (IBM 360 #1) to accomodate the conversion to larger disk drives. On May 11, a 3-disk interim CCAP package became operational with the installation of the larger drives. On May 26, a 2-disk CCAP package was implemented with the following features:

a. Full utilization of the larger disk capacity (4 times that of the smaller). This allows an increase in disk wrap-around time of about 6 hours on the input disk and 12 hours on the output disk.

b. Elimination of the monitor disk and distribution of its contents on the two remaining disks (mostly on the output disk).

c. Full "on-the-fly" updating capability for batch codes, the directory, and the CCAP monitor (similar on-line updating is slated for the CRT control programs).

d. Elimination of disk packs on Channel 2 by placing the swinging disks on Channel 1 (this prevents excessive disk activity which overloads the CPU).

e. Making the monitor resident on both disks (for flip-flop updating and backup).

2. Eight important directory changes were implemented, including those required to bring our bulletin names up to WMO requirements, such as dropping originator additives (e.g., KWBCN became KWBC) and adding suffix additives (e.g., SMMX became SMMX1).

3. On May 4, after a 2-month testing period, the half-duplex 2400 bps bi-sync line between NMC and the Bureau of Reclamation (at Denver) became fully operational. Currently, NMC is furnishing Denver with upper air encoded data (USXXs', ULXXs', and UKUS) as well as FUXX bulletins (described below).

4. A number of new bulletins generated by NMC were added to our switching tables:

Feb. 1 - FUPN 1-14 - Upper air wind and temperature data

Feb. 4 - FOUS3 - Precipitation forecast

Feb. 23 - FUPA1-2 - Upper air wind and temperature data

Apr. 19 - FUXX10-8S - Upper air heights, winds, temperature, and dewpoints up to 300 mb

May 14 - STUS1, STCN1, STAK1 - Snow depths

June 8 - SMAK1-2 - Alaskan synoptics.

In addition, the FUMT 52, 54, and 56 bulletins were expanded on Feb. 19 to include J-points 29, 30, and 31. (At the request of the Scandanavian countries.)

5. ATA Network

The FHIO (Indian Ocean) bulletin was added to those being sent to the ATA (Feb. 16). Also a few bulletins were enlarged so that data from the entire Northern Hemisphere (as bounded by the NMC grid) is now being sent. Honoring frequent and numerous requests for retrievals of data became operational March 30.

6. During a survey taken during January 26 through January 28 (to satisfy a WMO request), NMC gathered, sorted and processed all data received. A portion of this survey was sent to WMO.

7. On March 8, a new CRT control package was introduced. This package handles multiple CRT's and CRT programs. One of the most significant accomplishments was a program designed to correct upper air data and reinsert them into the system.

8. Swinging disk program (RGTR) was revised to process and store FA reports.

9. The header analysis program (HDAN) was made more efficient and modified to enable the code to split long bulletins into smaller, more digestible parts.

10. FAX Changes

a. On March 30, the new FAX schedule went into effect, culminating over two months of feverish activity. This schedule added the AMFAX, Offenbach,and Caribbean circuits to the Honolulu, FOFAX, National,and Miami circuits. It also increased the total number of maps transmitted from 30 to 124.

b. Several codes were newly written or changed to accomplish the above.

(1) A new labeling and control system for input tapes, enabling any user to create FAX maps for transmission on a standard facsimile circuit or to display the maps on the Varian recorder.

(2) Two FAX map-packing programs were written, one for the CDC 6600 and one for the IBM 7094 computer, to allow input maps to be stored on disk with pointers and controls to automatically transmit them.

(3) FAX utility programs to format the disks, write the schedules, and display input tapes in dump form.

(4) Major revision of the FAX transmission program to provide the following:

(a) Automatic-clock start of maps from a schedule on designated lines with manual-starting capability from any line.

(b) Composite map capabilities allowing subsets merged with one or more insets.

(c) Doubling the scale of a subset and/or inset during transmission (halving disk storage needs).

(5) Rewrite of Varian display programs using triple-buffer input, double scale,and subsetting output capabilities.

(6) Creation of a new FAX schedule whose printout displays all pertinent facts about any transmission to the operator (destination circuit number, length of maps, etc.)

c. Designed logic modifications to the DFI to correct the problem of FAX lines dropping out and to enable FAX maps to be restarted at any point on a map without losing sync or phase with the recorders monitoring that map.

11. General Programming Efforts

a. Formation of various bulletins for transmission on the communication computer (FUPN 1-14, FUPA 1-2, etc.)

b. Upper air processor to decode upper air weather reports is currently semioperational. It runs operationally, but the products derived from it (encoded upper air reports, dumps, etc.) are being evaluated and are not available for operational use.

c. Aircraft report decoder was revised to output variable-length data reports by translating coded weather/hazard groups into plain language remarks for printout and transmission. Also program written to print out all aircraft reports which are currently not processes.

d. Writing a program to provide surface, upper air, and aircraft data to Monterey in the event of difficulty with their primary data source.

e. Developing a disk data bank for climatic temperature data.

D. Operations Branch

1. A tape library routine, which runs on the 360 systems, was acquired and checked out. This will make it possible to keep an up-to-data inventory of all NMC magnetic tapes.

2. Copies of all operational programs have been stored in a vault, located at a site other than FOB #4, in the event of loss of software systems.

3. Systems activities on the 360 computers include:

a. DOS Release 22/23 maintenance for both 360 systems #2 and #3. (Catalog operational jobs, change supervisors, etc.)

b. DOS Spool (POWER II Ver. 3) for Release 22/23 using the small disk drives.

c. DOS Release 24 using the larger disk drives with the larger storage capacity. All NMC, NOS, and Engineering jobs are cataloged in the Core Image library. This version of DOS uses disk drive 190 for work areas and 192.

d. DOS Spool (POWER II Ver. 3) for Release 24 using the larger disk drives. This version of Spool uses 192 for QFILE and DATAFILE. Tape-writer option has been added so that 7094/II print can be done directly from tape in the future.

e. A complete DOS on System #3 so that all jobs can be cataloged without having to punch operational programs from System #2 and then cataloging to System #3.

4. Operational background job control program (NMCJSKP) now controls the loading of needed operational jobs. Jobs are called by using the 1052 keyboard typewriter and typing the job name. All needed jobs will be chained until completion of job chain. Each job returns to background control job and a check is made for mode set, writing tape marks, tape rewinds, and tape unloads. A check is then made for valid time and job chain. If chain is complete, control job will cycle and every 10 minutes bring in surface decoder, ship decoder, hourly weather, and upper air decoder. An automatic update of time is now in the checkout stage and will eliminate the need for operator intervention at hour 24.

E. Electronic Equipment Branch

1. Until recently, Varian charts could not be generated via the Digital Facsimile Interdata (DFI) at the same time that facsimile charts were being transmitted through one of the DFI's. The circuits in the DFI plus the selector channel and 301 interface board of the Interdata computer were modified, together with a major program change by Mr. Hopkins. It is now possible to output Varian maps on DFI #2, while at the same time output facsimile maps on three circuits using DFI #1.

2. When maps were chained together for transmission from the IBM 360 via DFI and a map was to be cancelled, there was no way for the computer operator to do so. Now by using a switch installed by EEB, the operator can start the map and then cancel it so the next map can be transmitted.

3. A new interface board (103) for the Interdata computer was purchased and installed. Also a few new switches were designed and installed in the IBM 360 area. When the program modification is completed, these new devices will enable DAD personnel to monitor raw data on the Varian recorder while it is being transmitted or received.

F. Other

1. Uninterruptible Power System Status Report

The Uninterruptible Power System (UPS) which supplies power conditioning for the IBM 360 Complex had an engineering change performed. This change is expected to correct certain start-up deficiencies and provide the utmost in Mean-Time-To-Failure. The UPS/Generator System performed extraordinarily well during recent scheduled power outages when preventative maintenance required the normal power to be shut off for many hours. For four days, the diesel electric generator provided prime power to the computer complex via the UPS for approximately 36 hours. This gives a confident feeling regarding future power outages or brown-outs.

2. AM FAX Looks Encouraging

The Aviation Meteorological Facsimile work is being accepted very well. The software construction of facsimile charts by computer techniques gains in flexibility every day. Initially, the only shortcomings to the AMFAX schedule were due to certain elusive hardware problems with the 360/30 CPU and the shake down performance procedures with the UPS. The question remaining is, how much farther can we push the little old 360/30 computer before it balks?

3. Digital Graphics Terminal (DGT)

The Interdata/Varian System has performed very well throughout its development stages. Hardware procurement is under way to place the Interdata minicomputer directly on the 360 channel and to increase the output speed by as much as eight-fold. The new speed could then output charts in as little as nine seconds each. It is interesting to note that any given segment on any chart may be expanded to almost any scale desired. From thence, the segments can be joined together to form a mosaic of any geographical area with preferred scale factor.

V. FORECAST VERIFICATIONS - Monthly Means for 1971

A. NMC Grid Area (1977 Grid Points)

	24 HOURS					36 HOURS								48 HOURS				
	PE MODEL			PERS		PE MODEL			PERS		BAROTROPIC			PE MODEL			PERS	
	R	H	W	H	W	R	H	W	H	W	R	H	W	R	H	W	H	W
200 mb																		
Jan.	.75	202	17.5	288	24.2	.75	256	20.0	365	28.1				.76	293	22.4	419	30.8
Mar.	.76	187	16.1	270	23.9	.79	221	18.2	341	28.1				.77	261	21.0	376	29.8
May	.77	146	14.7	222	21.1	.77	188	17.2	285	25.5				.77	213	19.3	315	27.5
300 mb																		
Jan.	.81	181	16.6	302	26.5	.80	235	19.4	382	30.8				.79	283	22.4	438	33.8
Mar.	.82	170	16.0	298	27.9	.84	208	18.4	373	33.0				.81	251	21.7	408	34.8
May	.82	136	14.1	237	23.7	.82	174	16.7	302	28.6				.81	201	19.1	334	30.6
500 mb																		
Jan.	.83	125	11.5	217	19.3	.80	173	13.8	279	22.6	.63	223	16.8	.79	208	15.9	320	24.8
Mar.	.84	117	11.2	213	20.1	.83	151	13.1	267	23.7	.72	188	15.6	.81	180	15.3	293	25.1
May	.82	95	9.7	162	16.2	.82	121	11.5	208	19.4	.70	149	13.3	.80	142	13.1	231	20.9
850 mb																		
Jan.	.77	108	9.7	150	12.9	.75	142	11.2	190	14.9				.74	160	12.2	214	15.8
Mar.	.79	96	9.1	144	12.8	.78	122	10.5	179	15.0				.78	136	11.7	197	15.6
May	.78	77	7.9	114	10.7	.76	96	9.1	143	12.6				.77	110	9.9	157	13.2
1000 mb																		
Jan.	.80	115	11.4	173	16.3	.80	152	13.3	216	18.6				.76	172	14.5	237	19.3
Mar.	.80	102	10.6	163	15.7	.80	129	12.2	202	18.0				.78	149	13.9	219	18.8
May	.79	83	9.1	129	13.7	.78	108	10.8	162	15.4				.77	121	11.7	174	15.8

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

	24 HOURS					36 HOURS								48 HOURS				
	PE MODEL			PERS		PE MODEL			PERS		BAROTROPIC			PE MODEL			PERS	
	R	H	W	H	W	R	H	W	H	W	R	H	W	R	H	W	H	W
200 mb																		
Jan.	.85	149	14.4	307	23.4	.84	212	18.0	416	28.9				.83	268	21.3	504	33.7
Mar.	.86	149	14.6	312	28.1	.86	187	17.5	390	33.5				.81	248	21.5	419	35.3
May	.87	127	13.3	261	26.2	.86	173	16.8	341	32.3				.83	215	20.0	384	35.6
300 mb																		
Jan.	.89	147	14.8	350	29.1	.87	211	19.0	462	34.7				.85	275	23.3	552	39.9
Mar.	.91	150	15.9	377	36.2	.90	198	19.7	467	42.8				.86	260	24.1	498	44.7
May	.90	134	15.1	305	32.4	.88	180	18.9	389	39.3				.86	223	22.6	427	42.1
500 mb																		
Jan.	.89	111	10.5	247	21.1	.86	158	13.8	327	25.2	.74	217	17.6	.84	198	16.5	387	28.3
Mar.	.90	107	11.2	253	24.5	.89	145	13.7	315	29.1	.79	191	16.7	.85	185	16.4	338	30.3
May	.89	93	9.9	201	20.8	.88	125	12.6	258	25.6	.82	148	14.4	.85	155	15.0	286	27.6
850 mb																		
Jan.	.85	95	8.6	157	13.4	.83	118	10.2	198	15.6				.81	138	11.7	226	16.7
Mar.	.90	76	7.9	169	15.4	.89	103	10.0	212	18.4				.86	123	11.8	227	19.0
May	.84	70	7.4	122	12.0	.85	88	8.8	158	14.9				.83	105	10.0	174	15.7
1000 mb																		
Jan.	.87	105	10.8	188	16.9	.85	132	12.6	235	19.6				.83	156	14.9	259	20.8
Mar.	.90	92	10.3	200	18.7	.90	115	12.3	251	22.1				.87	140	14.6	269	22.8
May	.84	80	9.3	139	14.2	.85	99	10.5	176	17.0				.83	120	12.3	192	17.8

C. Europe - Area 3 (143 Grid Points)

	24 HOURS					36 HOURS								48 HOURS				
	PE MODEL			PERS		PE MODEL			PERS		BAROTROPIC			PE MODEL			PERS	
	R	H	W	H	W	R	H	W	H	W	R	H	W	R	H	W	H	W
200 mb																		
Jan.	.79	194	16.8	325	28.8	.76	257	20.2	396	32.1				.74	312	24.5	445	35.0
Mar.	.85	155	14.4	286	24.4	.85	197	17.3	375	29.7				.85	238	19.9	438	33.6
May	.78	131	13.0	200	18.8	.77	178	16.8	264	23.9				.76	211	18.2	304	26.6
300 mb																		
Jan.	.84	194	18.0	375	34.7	.79	264	22.5	446	37.9				.76	330	27.5	498	40.9
Mar.	.89	167	16.6	374	34.1	.89	212	20.0	479	40.9				.86	278	24.7	557	45.9
May	.83	143	14.8	259	25.3	.83	194	18.9	346	32.7				.82	231	21.2	397	36.5
500 mb																		
Jan.	.83	143	12.3	261	23.3	.78	196	15.8	322	26.4	.70	224	18.3	.76	244	19.3	362	28.4
Mar.	.89	119	11.7	266	24.1	.88	156	14.5	343	29.0	.76	215	18.3	.85	206	17.8	400	32.3
May	.85	98	9.9	188	18.1	.85	134	13.0	252	23.3	.75	168	15.4	.83	162	14.5	292	26.3
850 mb																		
Jan.	.84	111	9.2	198	16.3	.81	149	11.8	246	18.7				.78	180	14.1	273	19.8
Mar.	.81	97	8.6	172	14.8	.83	126	10.7	224	18.1				.79	160	12.8	252	19.5
May	.82	71	6.7	121	10.7	.80	97	8.7	159	13.6				.78	114	9.7	184	15.1
1000 mb																		
Jan.	.86	108	10.0	212	17.8	.84	146	12.5	263	20.4				.79	185	15.6	290	21.9
Mar.	.85	99	9.3	185	16.6	.84	129	11.5	233	19.4				.80	165	14.0	264	21.3
May	.82	72	7.1	124	11.4	.79	101	9.2	164	14.2				.78	118	10.4	187	15.7

D. Asia - Area 4 (275 Grid Points)

	24 HOURS					36 HOURS								48 HOURS				
	PE MODEL			PERS		PE MODEL			PERS		BAROTROPIC			PE MODEL			PERS	
	R	H	W	H	W	R	H	W	H	W	R	H	W	R	H	W	H	W
200 mb																		
Jan.	.69	199	18.1	274	23.7	.72	240	20.4	328	27.0				.72	269	22.8	370	28.5
Mar.	.77	179	16.5	294	24.6	.75	238	19.4	366	28.7				.73	277	21.9	396	30.0
May	.82	142	14.4	247	23.0	.81	188	17.2	321	28.3				.80	221	19.7	359	31.0
300 mb																		
Jan.	.76	174	16.6	294	27.0	.75	231	19.5	352	30.3				.75	256	21.8	389	31.5
Mar.	.82	166	16.1	313	27.9	.78	233	19.2	385	32.7				.75	280	22.4	410	33.7
May	.86	133	14.2	263	25.9	.85	174	16.7	336	31.3				.84	205	19.6	377	33.8
500 mb																		
Jan.	.81	112	10.5	207	19.7	.76	160	12.9	247	21.9	.51	232	15.9	.76	181	14.6	272	22.8
Mar.	.85	108	10.6	214	20.1	.80	154	12.5	257	22.9	.63	204	15.6	.76	186	15.3	271	23.6
May	.84	92	9.5	169	16.8	.85	117	11.0	215	20.2	.69	155	12.8	.85	135	12.6	243	21.8
850 mb																		
Jan.	.65	128	11.3	132	12.2	.57	168	13.6	160	14.1				.55	173	13.3	166	13.7
Mar.	.72	106	10.4	136	12.1	.70	140	12.2	164	13.8				.69	153	13.3	173	13.9
May	.77	89	9.3	124	11.7	.76	110	10.8	151	13.4				.75	126	12.1	166	14.0
1000 mb																		
Jan.	.72	128	12.3	172	16.8	.65	175	15.6	206	19.6				.62	185	15.3	204	18.0
Mar.	.79	106	11.0	165	15.5	.79	133	13.2	202	17.7				.77	157	14.8	215	18.0
May	.75	91	9.1	144	14.4	.76	124	11.7	181	16.7				.77	135	13.2	192	17.1

R	Correlation coefficient of forecast versus 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 6-layer primitive equation baroclinic forecast model.
PERS	Persistence forecast.
BAROTROPIC	Operational barotropic forecast model.

VI. MACHINE PERFORMANCE AND UTILIZATION

A. IBM 7094/II

1. 7094/II Profile

   a. Released equipment:

      1 - IBM 729-4 'Magnetic Tape Unit' 02-71

2. Utilization - 2,724 hrs.

B. IBM 1401

1. 1401 Profile

   a. Released equipment:

      2 - IBM 729-4 'Magnetic Tape Unit' 03-71
      1 - IBM 1012-1 'Paper Tape Punch' 03-71
      1 - IBM 1401-C4 'Central Processing Unit' 03-71
      1 - IBM 1402-1 'Card Read/Punch' 03-71
      1 - IBM 1403-2 'Printer' 03-71
      1 - IBM 1406-1 'Storage Unit' 03-71
      1 - IBM 1903 'Paper Tape Reader' 03-71

2. Utilization - 568 hrs.

C. IBM System 360/30

1. 360/30 Profile

   a. Leased equipment:

      1 - IBM 2701-1 'Data Adapter Unit' 03-71

   b. Released equipment:

      1 - IBM 2911 'Switching Unit' 06-71

2. Utilization - 3,864 hrs.

D. IBM System 360/40

1. 360/40 #1 Profile

a. Leased equipment:

3 - Memorex 660-1	'Disk Storage Drives'	05-71
1 - Memorex 661-1	'Disk Storage Control Unit'	05-71
1 - IBM 2914-1	'Switching Unit'	06-71

b. Released equipment:

4 - MAI 2301-1	'Disk Storage Drives'	05-71
1 - IBM 2841-1	'Disk Storage Control Unit'	05-71
1 - IBM 2911	'Switching Unit'	06-71

2. Utilization - 4,276 hrs.

E. IBM System 360/40

1. 360/40 #2 Profile

a. Leased equipment:

3 - Memorex 660-1	'Disk Storage Drives'	05-71
1 - Memorex 661-1	'Disk Storage Control Unit'	05-71
1 - IBM 1416-1	'Train Cartridge'	06-71

b. Released equipment:

1 - IBM 2841-1	'Disk Storage Control Unit'	05-71
1 - IBM 1416-1	'Train Cartridge'	06-71

b. Utilization - 2,590 hrs.

F. CDC 6600, Computer Division, NOAA

1. CDC 6600 Profile - No changes

2. Utilization for NMC work - CPU 835 hrs.
PPU 1,478 hrs.

VII. PERSONNEL CHANGES

A. Development Division (DD)

1. Ralph V. Jones, Research Meteorologist, joined DD on February 8, 1971.

2. Stephen H. Scolnik, LTJG, NOAA Corps, was assigned to DD on May 28, 1971.

3. Harold M. Woolf, Research Meteorologist, Upper Air Branch, transferred to NESS, June 27, 1971.

B. Analysis & Forecast Division (A&FD)

1. Boyd P. White, Meteorologist, Surface Analysis Branch, transferred to Albuquerque, New Mexico, January 11, 1971.

2. Mildred Matthews, Chief, Verification, resigned on May 31, 1971. Mrs. Matthews joined the Weather Bureau in 1943.

3. William J. Drewes, Deputy Branch Chief, Automated Analysis Branch, transferred to Albany, New York, June 13, 1971.

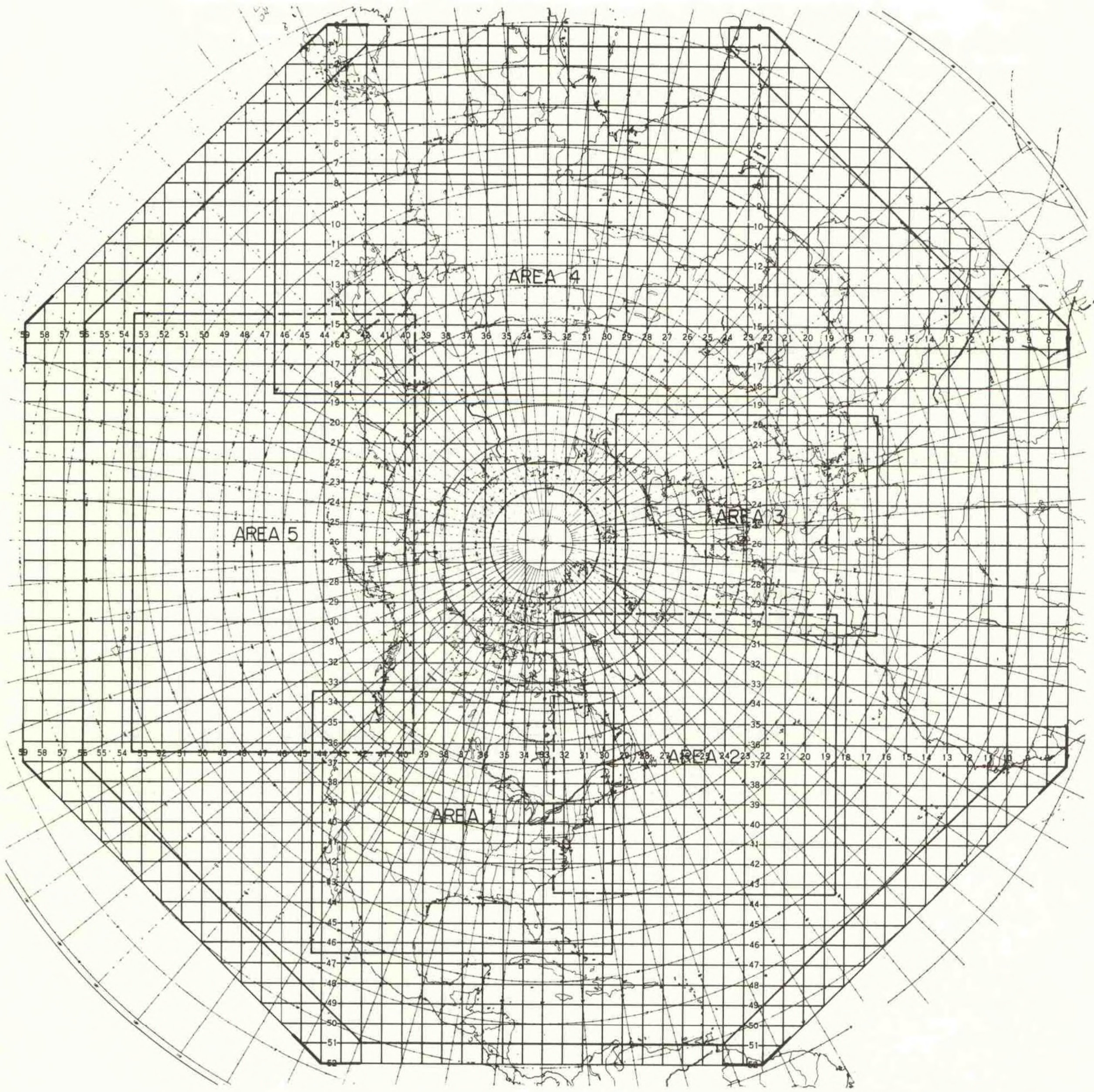
C. Extended Forecast Division (EFD)

1. Julian Adem, Research Meteorologist, Research Branch, resigned on April 17, 1971.

VIII. DISTRIBUTION OF PRODUCTS

As of June 30, 1971, the National Meteorological Center was originating approximately 472 separate teletype bulletins per day for transmission over Weather Service, Navy, Air Force, and Air Transport Association (ATA) teletype service. In addition, NMC makes the following daily facsimile transmissions:

National Facsimile Network (NAFAX)	99
Aviation Meteorological Facsimile Service (AMFAX)	65
Navy Facsimile Network	15
Air Force Facsimile Network	77
International Facsimile Network (Offenbach)	56
Russian Facsimile Network	36
Forecast Office Facsimile Network (FOFAX):	
Circuit #10206	56
Circuit #10207	51
Circuit #10208	52
Caribbean Radio	19
Tropical Analysis Network (TROPAN)	16
Suitland-Honolulu	55
Australian Broadcast	2



Verification Areas