U.S. DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
NATIONAL WEATHER SERVICE
NATIONAL METEOROLOGICAL CENTER

OFFICE NOTE 212

A Review of Developments for Monitoring and Controlling the Timeliness, Accuracy, and Completeness of Data for Meteorological Analysis

James Kerlin*
Lt. Colonel, USAF

Arthur Thomas
Climate Analysis Center

MARCH 1980

*Air Force Liaison to the National Meteorological Center, NWS/NOAA

This is an unreviewed manuscript, primarily intended for informal exchange of information among NMC staff members.

Abstract

Acquisition of timely, high quality data from reasonably dense evenly distributed observing points is essential to production of accurate sequential analyses. Establishment and continuous operation of such networks are a demanding task in light of national interests, economics, technology, and geopolitical factors.

Apart from the important aspects of international cooperation and comprehensive network design, increased automation at major world weather analysis centers has introduced a unique set of problems associated with total procurement, utilization, and onward dissemination of data. Due to computer sensitivity and a rigid requirement for inter-system compatibility, practically every meteorological analysis produced is degraded to some extent by the absence of essential data. At times the losses of these data have direct implications on the accurate depiction of the state of the atmsophere.

Detection, investigation, and resolution of data deficiencies is essential to optimum system operation but is, at best, a complex and involved undertaking. Cause/effect relationships of data deficiencies must be determined and then followed by decision processes appropriate in dealing with the characteristics of the deficiency. Objectivity is essential in determining the reasons for data deficiencies in order to avoid initiating inappropriate action which may be resented.

A review is presented of the latest procedures for evaluating data in terms of timeliness, accuracy, and completeness. Recent developments of procedures and techniques for systematically appraising the distribution and quality of global data is discussed. New involvements of the WMO in comparing the availability and quality of data at each major meteorological

center throughout the world are taken into account. Procedures developed and implemented by the National Meteorological Center and Air Force Global Weather Central for minimizing data discrepancies and losses are presented.

INTRODUCTION

Quality control in meteorology has traditionally emphasized the taking of accurate observations, proper encoding of the observations and reliability in transmitting the observations. The U.S. and most other meteorological services throughout the world expend a lot of effort on the checking and validation of observational records. This form of quality control has, despite its limitations, accomplished a great deal in ensuring that archived data are made about as correct as possible. This fills an important need by creating consistently accurate information for future climatological studies and other research needs. The process of performing comprehensive post-facto data validation also carries with it the ability to feed back to the data sources information concerning inaccurate observations and incorrect procedures.

Despite their value, such methods of quality control have serious shortcomings in bringing about significant continuing improvements in data for the purpose of operational analysis and subsequent forecasting (prognostication). Perhaps the biggest drawback is the extensive delay involved in informing data sources of observational deficiencies- generally on the order of several months. These delays do little to impress observers about the potential impact on operations of "accidental" errors which are by far the most prevalent. Moreover, record checking fails by and large to take into account most errors that occur during the transmission of data. Also, due to budgetary restraints in recent years, these quality control programs have become increasingly more limited. Whereas some data centers were formerly heavily staffed and quality-controlled every observation, in recent years the trend has been toward spot checking and using statistical techniques to evaluate performance. More complete quality control of full data sets is then performed by data users.

In the mid-60's the entire concept of data quality control began to change. A system was proposed which would result in permanently improving data for operational use and also for archiving data for subsequent applications. This program was named the World Weather Watch. Of course, the World Weather Watch is more than simply the quality control of data. "Its primary purpose is to ensure that all World Meteorological Organization Members obtain the meteorological information they require for operational and research purposes. The conversion of this theoretical concept into practical proposals required a thorough re-appraisal of the world weather system and preparation of new plans incorporating all modern scientific and technological developments." (WMO, 1968).

Monitoring and quality control are an integral part of this concept. From the early stages of the World Weather Watch came a series of Planning Reports one of which was No. 26 - Quality Control Procedures for Meteorological Data. This comprehensive document formed the basis for much of what was to evolve in World Meteorological Organization quality control activities. WWW Planning Report No. 26, like its companion planning reports, became predecessors of later written guides and manuals on the Global Observing, Telecommunications, and Data Processing Systems. The U.S., as a member country, has played an important role in the development, extension, and implementation of these concepts.

This discussion centers on the purpose and application of these developments.

REQUIREMENTS

While meteorological interests are broadening geographically, they are at the same time becoming more precise scale-wise. This type of expansion causes the requirements for data which are needed to describe the state of the atmosphere to increase exponentially. Thus, deficiencies increase proportionally.

The most urgent requirement for high quality data exists within the National, Regional, and World Meteorological Centers, as defined by the World Meteorological Organization. Within the United States, Organizations such as the National Meteorological Center, the Fleet Numerical Oceanography Center, the Air Force Global Weather Central, and other comparable centers have equally important needs for the procurement of accurate data. These organizations can ill-afford to allow erroneous data to pass into their data bases where they are apt to mislead an objective analysis and deteriorate a forecast. More importantly the centers must be judicious about depriving their analyses of too much "suspect" data. This in itself "waters down" an analysis and destroys resolution. Also, the cost of taking and communicating the data necessitates optimum use of the data.

A study prepared by the Bureau of Census (1977) lists primary activities supported by the National Weather Service's products in the organizations survey. These activities include Agriculture, Airlines, Airport Operations, Air Services, Automobile Clubs, General Aviation, Commerce and Finance, Consultants, Federal Government, Local Governments, State Governments, Manufacturing, Marine, Mineral Processing, Museums, Press Services, Private Meteorologists, Railroads, Research and Development, Retailing, Schools, Research Institutes, Service Companies, Television and Radio, Trucking Companies, and Utilities. Many of these data recipients have to either forfeit data they are unable to control or endeavor to control data without the necessary tools or skills.

The World Weather Watch's concept for quality control employs the total systems concept. It has provisions for monitoring and quality control at the observing point, within the telecommunications phase, and at the meteorological centers. It includes provisions for real-time and non-real-time activities. It includes both the monitoring and the quality control functions. Logical objectives of the monitoring and quality control effort are to improve the performance of the World Weather Watch on a national, regional, and global level.

Cooperative non-duplicative quality control programs are carried out by both the National Meteorological Center and the Air Force Global Weather Central (AFGWC, 1979). Because both centers exchange considerable amounts of data, each benefits from the activities of the other. These activities are among the most advanced in the world and are directed toward:

A. Salvaging data which would otherwise be lost.

B. Developing statistical information for management analysis.

C. Informing data sources in real-time of data deficiencies (e.g. missing data) and discrepancies (e.g. incorrect values).

Obtaining high quality data from the worldwide meteorological observing network is necessary for the production of accurate analyses of the atmosphere worldwide.

Research into improving numerical weather prediction is being conducted at national centers. These activities center on improving not only the physics of the models but also the horizontal and vertical scales of motion being dealt with. The keys to improvement lie not only with better NWP forecast models but with a better (i.e. more accurate) depiction of the initial state of the atmosphere. As more sophisticated techniques develop to use the data, the data in turn must be more accurate or an incorrect interpretation of the state of the atmosphere may result.

In addition to dealing with the traditional twice-a-day 00Z and 12Z observing cycles there are now, and have been for some time, 6-hourly data analysis and forecast cycles at the AFGWC and the NMC. As the trend to deal with smaller scale features continues, more emphasis is being put on synoptic and asynoptic data both from conventional and remotely placed sensors.

As an example of the volume of data we are talking about, the worldwide rocketsonde network provides 25 observations each week. The radiosonde network reports every 12 hours for 650 stations, and every 6 hours for 150 stations. The surface observing network has at least 8000 stations reporting every 3 hours. In addition there are during a 24 hour period a considerable number of aircraft reports, ASDAR reports, constant level balloon reports, and satellite soundings.

All of these types of observing systems have their own characteristics and methods of observing data and encoding reports. How these data are now dealt with and what to look for in the future will greatly impact on the progress that will be made in weather forecasting in the future.

The Air Force and the Navy utilize radio broadcast weather intercept sites to collect data broadcast by other nations that is neither available from other sources nor as timely. This intercept system collects 60 to 70% of the Eastern Hemisphere data used by the automated weather network. Granted that some of these data may be available through the GTS, it is still necessary to intercept them by radio since any GTS data usually go through a number of processing or switching centers before reaching the NMC or the AFGWC.

In addition to the intercept system other unique methods of obtaining data include use of civil contractors such as Aeronautical Radio Inc. (AIRINC) who supply AIREP data and Braniff Airlines who provide about half of the data from South America.

PROCEDURES

The quality control of data starts with the instrument at the observing point and ends when the information is delivered to a user. The stages at which errors can and do occur include instrument manufacture, instrument installation, instrument deteoriation, visual observing, reading of instrument, reading of observation, instrument corrections, processing of an instrument's signal, coding of the observation, and transmission of the observation (WMO, 1968).

Since these types of causes of error are normally not apparent to the user of the data, these errors have to be kept in mind when processing the data. Some help is provided by processing centers such as the NMC and the AFGWC by their ability to summarize the errors of individual stations and feed these results back to the station (Figures 3, 4, 5, 6, and 7). The transmission of data through communications channels remains as a large source of errors.

The checking of data as to its acceptability at a processing center usually is derived from experience. This checking deals with first identifying the data, then decoding it, and then checking its meteorological goodness.

According to the WMO "the purpose of quality control of observational data is error detection, possible error correction, and therefore error prevention in order to ensure the highest possible standard of accuracy for the optimum use of these data by all possible users" (WMO 1977). The WMO Minimum Standards for Quality Control of Incoming Data described in the WMO Manual of the GDPS (1979) include real and non-real time procedures.

Frequent exchange of information between WMO centers is used to improve the quality of data. This exchange of information is accomplished by the use of monitoring reports. The reports are important because the primary responsibility for quality control, with the aim of error detection and correction of all observational data, should rest with the national meteorological services from which the observations originated (WMO, 1977).

Some general methods for quality control recommended by the WMO and used in some form by providing centers include internal consistency checks, qualitative logical inferences, time and space consistency, physical limitations, statistical checks, and empirical checks.

Internal consistency might include looking at cloud types compared to cloud height or high relative humidity compared to the weather reported. A logical inference could compare a visibility with an obstruction to vision or wind speed. Time and space consistency can check past and present aircraft location reports, or pressures with pressure tendency. Physical limits are checks against a standard such as climatological extremes. Statistical and empirical checks deal with such relationships.

PROGRAMS

Quality control is carried out in basically two ways. The first involves interception and identification of discrepancies and either correction or rejection of data prior to their use within the centers. This is primarily real-time. The second form is in the issuance of information to data sources concerning discrepancies that have been encountered. This procedure is carried out in real-time, and in non-real-time on a weekly, monthly, and semi-annual basis. Figure 1 is a generalized diagram of the process.

The procedures used to perform quality control of data vary with the type of data. In general, the data flow and quality control influences are basically the same. Figure 2 is a generalized scheme of the typical data flow in a major processing center. A number of communication lines connect to a high speed processor. As the meteorological bulletins flow into the computer the bulletin headings are compared to those in a master directory. If a match-up is found, a check is made between the circuit the bulletin was received on and the one it was supposed to be received on. If they are the same and the bulletin is one scheduled to be relayed elsewhere, it is retransmitted onto the circuits designated in the directory. If the circuit on which the bulletin was received was not the one designated, the bulletin is not relayed. However, its contents are stored for analysis at the center. If the bulletin heading agrees with none other in the directory, the bulletin is deviated for electronic display and manual inspection.

If the inspector can determine that the bulletin heading is in error and can resolve the discrepancy based on the bulletin contents or clues in the heading itself, the editor corrects the heading. The bulletin is then re-entered into the computer and re-cycled through

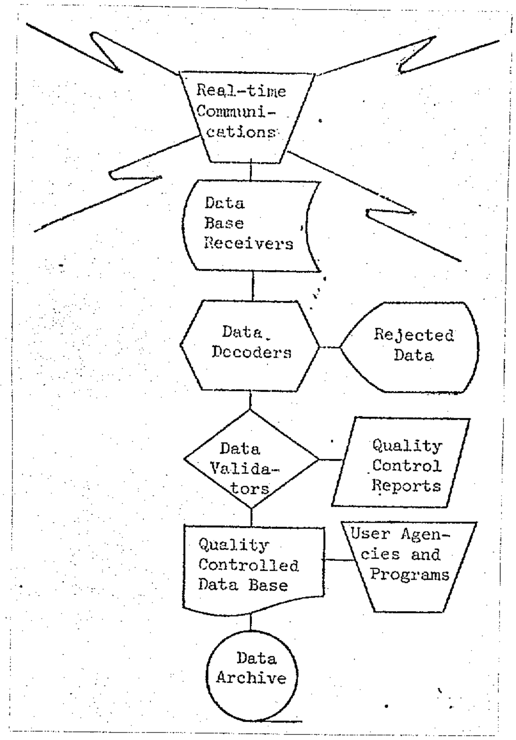

Figure 1. Processing Center Data Flow

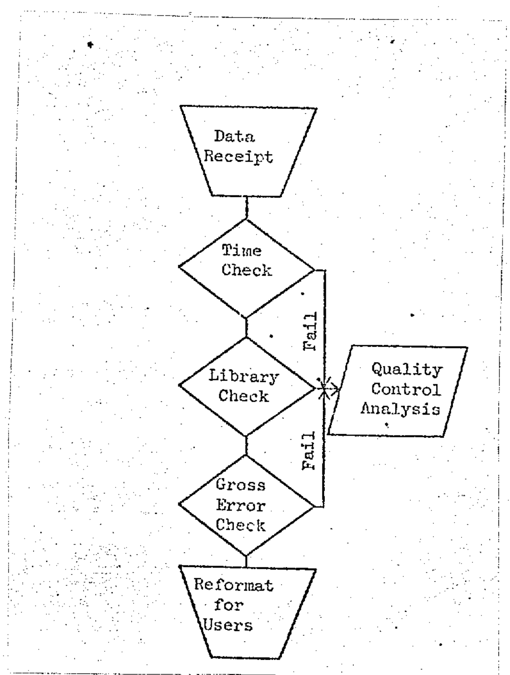

Figure 2. Data Control Real-Time

the system as though it was entering from an external circuit. The success rate of this quality control procedure is quite good in salvaging bulletins with discrepant identifications. The remaining ones, generally with completely indistinguishable identifications and contents, are discarded.

A record is kept of unknown bulletins. If they are received repeatedly and frequently they are identified and added to the master directory. This important aspect of quality control accounts for preventing the loss of thousands of pieces of data daily. However, it is not completely fool-proof. There is nothing to prevent a communications source from assigning a legitimate yet incompatible bulletin heading to a message. For example, a collection of upper air data could be transmitted with a heading reserved for terminal forecasts. Although this doesn't appear to happen very often, it does happen. When it occurs, the bulletin flows into and through the system automatically and the deficiency will remain undetected. As a result, some clients will not receive their data, others will get something they probably don't need, and the data will be lost from the analysis. The solution to this problem lies in automatically comparing bulletin headings with their contents to ensure agreement; something presently being done by the AFGWC.

The bulletin heading identifies the contents, originating country or region, originating communications point, and the date and time of either the transmission or when the contents of the bulletins were assimilated. As the various bulletins flow into the system, they are directed to specified files based on their heading.

For the sake of brevity and to simplify the discussion we will trace two major types of data, TEMP (upper air) and SYNOP (synoptic) through the system and describe the process of internal and external quality control.

It is important to note that TEMP data include a time of observation in each individual report but SYNOP data have the observation time only in the heading. Also, data collections often come in from far distant countries late in synoptic periods and sometimes during an ensuing period. This can compound problems more with SYNOP data which have synoptic times separated by only six hours than with TEMP data which are usually analyzed on a 12-hour cycle. Late receipts of SYNOP data are more apt to spill into the next collection period than are late receipts of TEMP data. This precludes most automated tests of SYNOP data for synopticity. They must be taken at face value initially. TEMP data on the other hand have considerable redundancy between the bulletin headings and individual reports.

General Characteristics of TEMP
and SYNOP Data

	SYNOP	TEMP
Number of Parts to a Report	1	4
Similarity with Intermediate Reports	yes	yes

The first four characters of each TEMP report can be matched against the first two characters of the bulletin heading for consistency. The time included in each report can be compared to the bulletin heading for comparability. Each level in each TEMP report has a fixed and identified location which must be accounted for. If an extra data group is included or one is omitted, the sequence of levels is interrupted and this can be automatically detected and dealt with.

When discussing quality control of meteorological data it is important to note that the style and format of several types of telecommunicated reports have remained essentially unchanged since their introduction during the 1940's and 50's. The code forms were designed for efficiency in operations other than computerized ones. Brevity of communications, speed in manual interpretation and plotting, and simplicity for extracting and archiving of data were some of the paramount considerations in the early development. Even when evaluations of coding practices began to take place during the 60's and 70's, automated processing could not always be the principal consideration. The world is still made up of dual operations, automated and manual, even in so-called developed or technologically advanced countries. Greater emphasis is now being placed on designing code forms more suitable for automated processing and analysis.

A typical example of the conflict involved in designing data formats which can easily be processed automatically with a low incidence of misinterpretation by a computer program and yet be easily read and understood by a person are the hourly aviation data. The user community, aviation interests in this case, want frequent and expeditious availability of accurate fine-scale analyses and forecasts. Yet they also want the individual reports for quick personal updates. Thus the data must be readable by a person and processable by a computer with a low failure rate in both regards. Existing hourly data, although reasonably simple to read and translate, are not easily encoded, are highly susceptible to error either in preparation or transmission, and cannot be easily programmed for computer processing. The reports are not in a fixed format, they are a blend of alphanumeric characters, and elements are not uniquely identified.

Despite these shortcomings, considerable progress has been achieved through extensive and complex programming to automatically process hourly reports. Unfortunately, the error rate in hourly data remains relatively high thereby increasing the risk factor in misinterpreting parameters.

SYNOP data, although essentially in a fixed format, have few distinctive identifiers for specific groups. Indeed, the data groups most essential for operations; those which are compulsory for foreign exchange, have none. This means that if a data group is inadvertently or purposely added to or omitted from the report, all ensuing data are apt to be misinterpreted. SYNOP data cannot stand alone and readily be identified as to source, time or type.

TEMP and pilot data, although not perfectly formatted for computer operations, are the least difficult to handle with automatic processors. Each report is a self-contained entity, independently identifiable as to type, time, and origin.

Though not completely infallible, upper air data lend themselves most easily to automated processing. They are in a fixed format. They are almost completely numeric except for their initial identifier group. Data sets within the reports have double-digit identifiers throughout. If a processor "stumbles" on a discrepancy, it can key on a subsequent identifier in order to prevent loss of a full data set.

Incidently, when a discrepancy does occur the computer can be programmed to register and store it. Moreover, upper air data can be tested for hydrostatic and vertical consistency with a high degree of accuracy. Surface data can be exposed to rudimentary and limited internal consistency and time consistency checks but these techniques impose heavy storage and processing demands on the on-line operational systems.

The National Weather Service and the Air Weather Service are proceeding on ambitious and progressive data monitoring and quality control programs. Three major aspects of data gathering and utilization are being monitored and quality controlled: observing, telecommunications, and processing.

The Air Force Global Weather Central and National Meteorological Center both perform in-house man-machine quality control. They disseminate and exchange real time notifications of data deficiences. Jointly or separately they disseminate weekly, monthly, and semi-annually produced appraisals of data receipts, losses, and quality on a local, regional, national, and international basis. They also perform special studies to investigate and diagnose chronic or persistent problem areas and initiate action to get such problems corrected.

Program developments are shared between the centers in order to provide mutual benefits and minimize duplicated activities. Parallel analysis of data acquisition successes and failures which are essential for isolating major system problems are exchanged between the centers. The quality control activities of these centers result in many data subscribers obtaining data which they would otherwise not receive.

The AFGWC communications hub at Carswell AFB, Texas automatically screens incoming data. Garbled or improperly formatted reports are directed to a manual monitoring position and are repaired and re-entered into the data base. The data base is periodically scanned for missing reports. The scan frequency is a function of data type. Hourlies are scanned at least twice each hour; three- and six-hourly synoptics less freqeuntly, and six- or twelve-hourly upper-air data least frequently.

NMC scans its six-hourly synoptic data base four times a day, three hours after observation time. NMC also interrogates its upper air data base four times during each 12-hour cycle.

Each center transmits real time advisory messages informing data sources if their report has not been properly received. The purpose of these messages is to advise data sources that necessary data are unavailable at the center and a retransmission from the originator is desirable. They are not intended to discredit a station for poor performance because the data loss is often beyond the originator's control. Unfortunately, when chronic or persistent problems prevail, this unavoidably and understandably becomes the net result. Figures 3 thru 7 are examples of the advisory bulletins issued by the centers.

The major difference between the quality control method used by the NWS and the AWS as compared to those of other centers is the emphasis on action in real-time to minimize discrepancies.

The NMC and the AFGWC Detachment 7 at Carswell AFB, Texas, both monitor incoming traffic for discrepancies. Recognition codes are programmed into the communications computer to identify bulletin types. If recognition is not accomplished or, at Carswell, if an inconsistency exists between the bulletin heading and its contents, the bulletin is directed to a human monitor/quality control/edit function for correction and is re-entered into the system.

Bulletins or data which are so badly mangled that they cannot be confidently corrected are discarded. Bulletins or data which are "clean" but cannot be identified are flagged and stored. Repetitive receipts of the same unknown message or contents triggers an effort to determine legitimacy and to identify the source. When these things have been verified, the item becomes part of the recognition code.

Applications

Figure 3 shows an NMC advisory of unreceived SYNOP reports. It is transmitted at about 2 1/2 to 3 hours after each main synoptic observation time. These advisories are addressed to the country of data origin for subsequent procurement and retransmission of the report by the data source or the individual national meteorological center. NMC disseminates these message to all countries throughout the Western Hemisphere.

Figure 3

```
ZCZC WBC942
AAMX60 KWBC 270844

THE INDICATED SURFACE REPORTS FROM THE FOLLOWING
STATIONS HAVE NOT BEEN SUCCESSFULLY RECEIVED AND
PROCESSED IN THE WMC WASHINGTON COMPUTER.  PLEASE
RE TRANSMIT THEM AS SOON AS POSSIBLE.

270600
76151 76323 76471 76525 76625 76632 76644 76647 76675 76685 76692
76695 76737 76743 76775 76833

WASHINGTON MONITOR
```

Figure 4 is a composite example of a series of advisories transmitted by the NMC Washington to upper air units throughout North America. The NMC advisory identifies the nature of the data discrepancy by:

a. Data source.

b. Date/time deficiency was noted.

c. Time of observation.

d. Circuit.

e. Non-receipt by PART A, B, C or D.

f. I.D. discrepancy by PART.

g. Incomplete PART A and identification of the first missing isobaric surface.

h. Text error by PART, level, and parameter.

These messages are transmitted at least four times every twelve hours.

Figure 4

ZCZC WBC466
AAXX48 KWBC 210921
UPPER AIR RECEIPT ADVISORY 00Z
KXXX

STA ID	NR	ID	IC	TEXT
70086	CD	A	15	99W 00H 00D
72528	B D			
74486		A		99P 00H 85H
76256			20	
76612	ABCD			
78016				B11 B12 B13 C22 C23
78367		B		50W 40H 30H 07T 07W 05H

Figure 5 is an example of an AFGWC real-time message notifying synoptic reporting stations of unreceived or unidentified SYNOP reports. These are updated and retransmitted several times during each synoptic period.

Figure 5

```
ZCZC WBC773
AXXX15 KAWN 211840
STATNS NOT RCVD KAWN
71081 71094 71911 71919 71925 71939 99021
STATNS SURVYD 48 REPORT MISG 7
INT ZDK
```

Figure 6 is an example of an AFGWC real-time message notifying upper air stations of unreceived or unidentified PART A TEMP reports. Similar advisories are transmitted for PARTs B, C, and D of the TEMP reports and for all PARTs of PILOT (winds aloft) reports. As with SYNOP advisories, these are updated and retransmitted periodically during each 12-hour period. This advisory is for stations in North, South, and Central America, the Caribbean, and Antartica.

Figure 6

```
ZCZC WBC985
AXXX61 KAWN 220320
220000 TTAA RAOB DATA NOT RCVD KAWN
70026 71926 72385 76723 78016 78367 78501 78954 80222 84628
87047 87418 87715 89664 99008
STATNS SURVYD 156 REPORT MISG 15
```

Figure 7 is an example of an AFGWC teletype message providing summary statistics of the receipt of PART A TEMP data. This message is updated and transmitted several times each cycle. The column showing "Reports Expected" is based on the recent history of data availability from each block, not on the published WMO schedule of operations. In this regard it is useful in planning meteorological operations such as objective analysis schedules.

Figure 7

ZCZC WBC902
BKUJ KAWN 220150
220000Z TTAA RPTS RCVD KAWN

BLK NR	RPTS EXPCTD	RPTS RCVD	PCNT EXPCTD RCVD	BLK NR	RPTS EXPCTD	RPTS RCVD	PCNT EXPCTD RCVD
01	006	000	000	02	009	007	077
03	009	009	100	04	007	003	042
06	006	005	083	07	004	006	150
08	006	004	066	09	003	002	066
10	005	007	140	11	003	003	100
12	005	002	040	13	002	002	100
15	004	000	000	16	005	006	120
17	003	000	000	20	008	002	025
21	008	000	000	22	006	004	066
23	008	005	062	24	010	007	070
25	010	002	020	26	011	007	063
27	008	003	037	28	007	005	071
29	009	004	044	30	013	008	061
31	014	007	050	32	009	009	100
33	011	003	027	34	008	002	025
35	009	005	055	36	005	004	080
37	005	000	000	38	015	003	020
40	014	001	007	42	005	000	000
43	004	000	000	44	006	000	000
45	001	000	000	46	003	000	000
47	023	014	060	48	008	001	012
50	004	001	025	51	011	003	027
52	012	008	066	53	010	005	050
54	014	005	035	55	002	001	050
56	017	010	058	57	017	003	017
58	012	000	000	59	012	000	000
60	002	001	050	61	001	000	000
62	002	001	050	63	001	002	200
67	000	003	999	68	008	003	037
70	014	015	107	71	030	014	046
72	066	068	103	74	002	003	150
76	009	004	044	78	010	005	050
80	001	000	000	83	006	000	000
84	001	000	000	85	002	001	050
87	000	004	999	89	003	000	000
91	022	011	050	93	006	006	100
94	029	022	075	96	003	000	000
97	001	000	000	98	003	001	033
99	006	001	016				
TOTAL	654	353	053				

MANAGEMENT QUALITY CONTROL

The final step in centralized quality control of meteorological data destined for operational analysis deals with the follow-up action which takes place to minimize future discrepancies and losses. This phase of quality control closes the loop which began with on-station monitoring and control. It has many applications. To name a few:

a. It provides information on comparative performance both spatially and time-wise.

b. It aids in isolating system and procedural deficiencies.

c. It enables centralized analysis and forecasting centers to gear objective analysis schedules to optimum times of data availability.

d. It allows major centers to do statistical comparisons of data quality and availability and to isolate internal or exchange problems.

A number of programs have been developed by both AFGWC and NMC to produce detailed viable summary statistics on data receipt and quality. Most of these can easily be modified to provide specific information depending on the application. In this manner special problem areas can be isolated for more detailed evaluation. Often the statistical summaries provide the necessary clues concerning the general nature of a problem. This can be instrumental in significantly minimizing investigative and corrective processes.

Figure 8 shows a typical NMC summary of receipt of radiosonde data for a select group of National Weather Service stations. This type of summary can be produced for any combination of stations in the world and any TEMP or PILOT data parameter and standard level. It can identify data by PART and time of availability. Total daily receipts, by level and parameter for the stations chosen, are produced along with period averages. Station groupings can be made on the basis of region, nation, communications circuit or many other predetermined choices. The high degree of flexibility in this program readily lends it to versatile applications of monitoring and quality control.

Figure 8

DEFINITION OF PARAMETERS

Z - HEIGHT   T - TEMPERATURE   P - PRESSURE   W - WIND

00 - 1000MB
99 - SURFACE
88 - TROPOPAUSE
85 - 850MB
77 - MAXIMUM WIND
70 - 700MB
50 - 500MB
44 - VERTICAL WIND SHEAP
40 - 400MB
30 - 300MB
25 - 250MB
20 - 200MB
15 - 150MB
10 - 100MB
07 - 70MB
05 - 50MB
03 - 30MB
02 - 20MB
01 - 10MB
•7 - 7MB
•5 - 5MB
•3 - 3MB
•2 - 2MB
•1 - 1MB

AAR - PART A BASED ON TEST THAT 1000 MB HEIGHT PRESENT
BBH - BASED ON TEST THAT THERE ARE ONE OR MORE WINDS PRESENT WITH HEIGHTS LESS THAN OR EQUAL TO 60,000 FEET (EXCLUDING SURFACE WIND)
BBR - PART B BASED ON TEST THAT ONE OR MORE SIGNIFICANT LEVELS PRESENT WITH PRESSURE GREATER THAN CR EQUAL TO 100 MB (EXCLUDING SURFACE LEVEL)
DDH - BASED ON TEST THAT THERE ARE ONE OR MORE WINDS PRESENT WITH HEIGHTS GREATER THAN 60,000 FEET
CCR - PART C BASED ON TEST THAT 70 MB HEIGHT PRESENT
BBP - BASED ON TEST THERE ARE ONE OR MORE WINDS AT PRESSURE LEVELS GREATER THAN OR EQUAL TO 100 MB (EXCLUDING SURFACE WIND)
DDR - PART D BASED ON TEST THAT ONE OR MORE SIGNIFICANT LEVELS PRESENT WITH PRESSURE LESS THAN 100 MB
DDP - BASED ON TEST THAT THERE ARE ONE UR MORE WINDS AT PRESSURE LEVELS LESS THAN 100 MB
MIU - DATA CORRECTED OR INSERTED BY MANUAL ASSISTANCE VIA SANDERS CRT TUBE
SOT - NUMBER OF TIMES STATION REPORTED SOMETHING
PAC - STATION REPORTED TWO OUT OF THREE HEIGHTS(700, 400, AND 200MB)

STATIONS USED IN THIS RUN ARE:

72208	72304	72317	72402	72403
72425	72429	72518	72520	72528
72606	72712	74486	74494	

OPRN DATA SUMMARY FOR PERIOD PAGE 1

1 JAN 1980 TO 7 JAN 1980

BASED ON RECEIPT BY H+ 375- 18 OR + 10 MINUTES
TOTAL 00Z RUNS 7

PAC = 2 OF 3 HGTS FROM 700,400,200 MB

WEEKLY SUMMARY OF U/A DATA FOR EASTERN REGION

STATION	PAC	SOT	AAR	BBR	CCR	DDR	50T	10T	05T	01T
72208	7	7	7	7	4	4	7	6	2	0
72304	6	7	7	7	5	5	7	6	4	0
72317	7	7	7	6	4	4	7	6	4	2
72402	7	7	7	7	4	4	7	6	4	0
72403	7	7	7	7	6	6	7	6	6	0
72425	7	7	7	7	5	5	7	7	5	0
72429	7	7	6	7	5	6	7	7	4	0
72518	6	7	7	7	5	5	7	5	5	1
72520	7	7	7	7	7	7	7	7	7	0
72528	6	7	6	7	6	6	6	6	5	0
72606	7	7	7	7	6	6	7	7	6	0
72712	7	7	7	7	6	6	7	6	5	0
74486	7	7	7	7	6	7	7	7	6	0
74494	7	7	7	7	7	7	7	7	6	0

OPRN DATA SUMMARY FOR PERIOD PAGE 1

1 JAN 1980 TO 7 JAN 1980

BASED ON RECEIPT BY H+ 375- 18 OR + 10 MINUTES
TOTAL 12Z RUNS 7

SOT = STATION REPORTED SOMETHING

WEEKLY SUMMARY OF U/A DATA FOR EASTERN REGION

STATION	PAC	SOT	AAR	BBR	CCR	DDR	50T	10T	05T	01T
72208	7	7	7	7	6	6	7	7	6	2
72304	7	7	7	7	4	4	7	6	4	4
72317	7	7	7	7	6	6	7	6	6	4
72402	6	7	7	7	6	6	7	7	6	4
72403	7	7	7	7	7	7	7	7	7	0
72425	7	7	[illegible]	7	5	7	7	7	5	0
72429	7	7	7	6	5	5	7	7	5	2
72518	6	7	6	7	7	7	7	7	6	3
72520	6	6	6	6	5	5	6	5	5	0
72528	7	7	7	7	6	6	7	6	6	1
72606	7	7	7	7	7	7	7	7	6	4
72712	7	7	7	7	6	6	7	7	6	0
74486	6	7	7	7	5	5	7	5	5	0
74494	7	7	7	7	4	5	7	5	4	1

OPRN DATA SUMMARY FOR PERIOD PAGE 2

1 JAN 1980 TO 7 JAN 1980

BASED ON RECEIPT BY H+ 375- 18 OR + 10 MINUTES
TOTAL 00Z RUNS 7

DAYS 00Z RUN MSG

TOTAL NUMBER REPORTED BY DAY

DAY	PAC	SOT	AAR	BBR	CCR	DDR	50T	10T	05T	01T
1	14	14	14	14	11	11	14	12	11	1
2	14	14	14	13	12	12	14	13	10	0
3	13	14	13	14	5	5	13	12	5	1
4	13	14	13	14	11	12	14	13	9	0
5	14	14	14	14	12	12	14	12	12	0
6	14	14	14	14	14	14	14	14	12	0
7	13	14	14	14	11	12	14	13	10	1
AVERAGE	14	14	14	14	11	11	14	13	10	0

OPRN DATA SUMMARY FOR PERIOD PAGE 2

1 JAN 1980 TO 7 JAN 1980

BASED ON RECEIPT BY H+ 375- 18 OR + 10 MINUTES
TOTAL 12Z RUNS 7

DAYS 12Z RUN MSG

DAY	PAC	SOT	AAR	BBR	CCR	DDR	50T	10T	05T	01T
1	14	14	14	14	13	13	14	14	13	4
2	13	14	14	13	12	12	14	14	12	2
3	13	14	13	14	12	12	14	12	12	4
4	14	14	14	14	11	12	14	14	10	3
5	12	13	13	13	9	10	13	11	9	3
6	14	14	14	14	13	13	14	13	13	5
7	14	14	14	14	9	10	14	11	8	4
AVERAGE	13	14	14	14	11	12	14	13	11	4

Figure 9 is an example of an AFGWC real-time message intended to notify U.S. and Canadian aviation hourly reporting stations in real-time of unreceived or unrecognized reports. These are also updated and transmitted more than once an hour.

Figure 9

```
ZCZC WBC785
AXXX30 KAWN 212030
STATNS NOT RCVD KAWN
BCE BLU CID ELY EVV EVW EYW FTY HHR MDT
MIV PUC RDG RTN SZN WAE WAX WBD WBJ WBS
WCA WDH WDS WEO WEU WEY WGN WGR WHJ WHN
WHT WJC WKE WLG WMN WRP WSQ WTC WTW WUR
WUU WUY WUW WUZ WVK WVM WVT WWY WZC WZW
YAJ YCB YCO YFR YKF YLT YMD YOC YPY YSR
YUA YUJ YUK YUQ YUR YUS YUX YVN YZU ZUE
STATNS SURVYD 685 REPORT MISG 70
INT ZDK
```

As with the statistical summary for TEMP and PILOT data, the equivalent program for global synoptic data has corresponding good versatility. See Figure 10. At the moment individual parameters cannot be surveyed but development to do this at NMC is underway. Individual stations and groupings of stations can be selected. Availability of data as a function of elapsed time after the observation time is included. Subtotals of the amount of data processed according to observation time is included. An indicator of the frequency receipt for off-time reports is given. Summary totals for the station grouping and period are appended. A separate list of "zero-receipt stations" is given. An inventory of dates and observation times surveyed is prefixed.

Figure 10

LAND STATION RECEIPT TIME SUMMARY

THE FOUR CHARACTERS TO THE LEFT OF EACH BLOCK AND STATION NUMBER ARE INDICATORS OF THE NUMBER OF RECEIPTS WITH OBSERVATION TIMES OTHER THAN ONE OF THE NOMINAL SYNOPTIC TIMES. THE ONLY OFF-TIME RECEIPTS SUMMARIZED ARE THOSE WITH OBS TIMES ONE OR TWO HOURS EARLIER THAN A NOMINAL SYNOPTIC TIME. RECEIPTS WITH OBS TIMES OF 22Z OR 23Z ARE GROUPED UNDER 00Z, FOR EXAMPLE.

THE FIRST CHARACTER GIVES THE COUNT FOR 00Z, THE SECOND FOR 06Z, THE THIRD FOR 12Z AND THE FOURTH FOR 18Z.

A SLASH (/) INDICATES ZERO RECEIPTS.
AN ASTERISK INDICATES ONE OR MORE RECEIPTS, NONE OFF-TIME.
AN A, B, OR C INDICATES ONE, TWO, OR THREE OR MORE OFF-TIME RECEIPTS, RESPECTIVELY.

THE SUMMARY IS CATEGORIZED ACCORDING TO THE TIME INTERVAL BETWEEN THE RECEIPT TIME AND THE NOMINAL SYNOPTIC TIME. A REPORT WITH AN OFF-TIME OBS TIME IS PLACED IN THE 0-1 HOUR CATEGORY IF ITS RECEIPT TIME IS EARLIER THAN THE NOMINAL SYNOPTIC TIME.

	STATION	0-1 HOUR				1-2 HOURS				2-3 HOURS				3-6 HOURS				6HOURS OR MORE				TOTAL					
		00Z	06Z	12Z	18Z	00Z	06Z	12Z	18Z	00Z	06Z	12Z	18Z	00Z	06Z	12Z	18Z	00Z	06Z	12Z	18Z	00Z	06Z	12Z	18Z		
****	72405	29	31	30	26	1	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	30	31	30	28	=	119
****	72406	28	31	27	29	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	29	31	27	29	=	116
A***	72407	27	28	30	25	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	27	29	30	26	=	112
****	72408	28	31	31	28	1	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	29	31	31	30	=	121
****	72412	29	30	31	28	1	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	30	30	31	31	=	122
****	72414	29	30	31	30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	29	30	31	30	=	120
****	72425	29	30	31	31	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	30	30	31	31	=	122
****	72503	29	30	29	31	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	30	30	29	31	=	120
****	72504	28	29	29	29	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	28	29	29	29	=	115
****	72507	29	29	31	29	1	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	30	29	31	31	=	121
****	72508	27	26	28	24	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	28	26	28	25	=	107
****	72509	29	31	31	30	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	30	31	31	30	=	122
****	72513	28	30	30	31	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	29	30	30	31	=	120
****	72515	29	30	31	30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	29	30	31	30	=	120
****	72517	28	30	30	27	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	29	30	30	27	=	116
****	72518	27	31	30	29	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	28	31	31	29	=	119
****	72519	28	29	29	29	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	28	29	29	29	=	115
****	72520	29	31	31	31	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	30	31	31	31	=	123
*/**	72523	24	0	30	27	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	25	0	30	27	=	82
****	72528	28	31	31	26	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	28	31	31	27	=	117
*A**	72529	27	30	30	28	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	28	31	30	28	=	117
****	72605	26	28	30	29	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	27	29	30	29	=	115
****	72606	28	29	31	31	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	29	29	31	31	=	120
*/**	72608	27	0	29	28	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	28	0	29	28	=	85
****	72612	27	30	30	25	1	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	28	30	30	27	=	115
****	72613	29	29	31	31	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	30	29	31	31	=	121
****	72617	28	30	30	29	1	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	29	30	30	31	=	120
****	72618	28	28	30	30	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	29	28	30	30	=	117
*/**	72712	27	0	30	30	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	28	0	30	30	=	88
//	74483	27	0	28	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	28	0	29	0	=	57
****	74486	28	31	28	30	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	30	31	28	30	=	119
****	74494	29	30	30	27	1	0	0	1	0	0	0	1	0	0	1	0	0	0	0	0	30	30	31	29	=	120
****	78016	22	29	25	27	0	0	0	0	1	0	0	0	0	0	0	0	4	2	3	3	27	31	28	30	=	116

The AFGWC produces a variety of similar shared information pertaining to the availability of data at Carswell AFB. Space permits discussion of only a couple of typical AFGWC monitoring and quality control products. Normally, AFGWC statistics are made available on a restricted one-time basis only to specific requestors in other Federal agencies with reasonable justification. Extensive use of the products is made by the AFGWC for special studies and applications. The net result is smoother uninterrupted flow of data among the centers.

Figure 11 is a copy of one page of an AFGWC reference library. It provides vital information about all known weather stations including their location, observing program, and availability of data. It also shows certain types of equipment used and variations from normal operations. It is a valuable supplement to the NMC production because it provides information on availability of additional types of data like hourlies and AIREPS.

Figure 11

```
MASTER STATION LIBRARY - 1108 FORMAT - VERSION 038 JULIAN DATE 017 1980        DATE 020380     PAGE 390
702710 GKN  +  GULKANA AIRPORT        W    L     AK US 6209N 14527W 0481 11 4                    N362502 800207WMO  0
702710KAWN-S-3.....3.....3.....3.....P-----R-----W-YZXYZYXZXXYYYYYVXYYXYYY-D------------A----L-U+0Y-------JAN-1
702715 STO  ++ TYONE LAKE                        AK US 6237N 14643W 0720 10 4                    N362627 720831ETAC 0
702715KAWN-S-------------------------P-----R-----H-------------------------D------------A----L-------------JAN-1
702716 5GN  +  TAHNETA PASS/GUNSIG   W           AK US 6154N 14719W 0899 10 4                    N362502 780420USWB 0
702716KAWN-S-------------------------P-----R-----W PAORSNNK...6....32XNPOSR D-----------A----L-------------JAN-1
702717 5SO  +  SNOWSHOE LAKE         W           AK US 6202N 14646W 0735 10 4                    N362531 7103  USWB 0
702717KAWN-S-------------------------P-----R-----W KSO+R+X.....+...8+RT1GM+J D----------A----L-------------JAN-1
702718 Z18  ++ LAKE LOUISE                       AK US 6218N 14635W 0747 10 4                    N362505 740614SUPP 0
702718KAWN-S-------------------------P-----R-----H-------------------------D------------A----L-------------JAN-1
702719 Z01  ++ TONSINA CAMP                      AK US 6133N 14513W 0518 10 4                    N362502 790503KAWN 0
702719KAWN-S-------------------------P-----R-----W-------------------------D------------A----L-------------JAN-1
702720 PAED +  ELMENDORF AFB         W   A   C  *AK US 6115N 14948W 0064 101408                 1 N361702 791004WMO  0
702720KAWN-S-------------------------P-----R-----W YXZYYYXZXXYYYZZYYYYZZZYZ D-----------A-XXZZ-L-4888-------JAN-1
702723 EDF  ++ ELMENDORF AFB                     AK US 6115N 14940W 0059 101408                  N361702 770505WMO  0
702723KAWN-S-------------------------P-----R-----W-------------------------D------------A----L-------------JAN-1
702725 LHD  ++ ANCHORAGE/LAKE HOOD               AK US 6111N 14957W 0022 10 4                    N361702 750418USWB 0
702725KAWN-S-------------------------P-----R-----W-------------------------D------------A----L-------------JAN-1
702730 ANC  +  ANCHORAGE INTL     M  W RP L      AK US 6110N 15001W 0038 11 408 6110N 15001W 0045 1711   N361710 750307WMO  0
702730KAWN-S-Z.....Z.....Z.....W.....P-W.X.-R-Y.Z.-W YYXYZZZYXXWYZZZZZZZYYYZW D---------A----L-WURY----------JAN-1
702733 PANC ++ ANCHORAGE INTL            A       AK US 6110N 15001W 0038 11 408                  N361702 750214WMO  0
702733KAWN-S-------------------------P-----R-----H-------------------------D------------A-XVTT-L-----------JAN-1
702735 MRI  +  ANCHORAGE/MERRILL F   W           AK US 6113N 14950W 0041 10 4                    N361700 710331USWB 0
702735KAWN-S-------------------------P-----R-----W-XZZYYZZZXYXZZYZZXZXYZXXY-D-----------A----L-------------JAN-1
702736 PAFR +  FT RICHARDSON/BRYAN   W   A   C   AK US 6116N 14939W 0115 1014                  1 N361702 771110SUPP 0
702736KAWN-S-------------------------P-----R-----W-TVTVUUWW2.....53UXWWXYXXW-D----------A-01PU-L-----------JAN-1
702740 PAQ  +  PALMER                W   L       AK US 6136N 14905W 0073 10 4                    N361718 740913WMO  0
702740KAWN-S-------------------------P-----R-----W-UVGFGGGF.9......FYZWXYZW-D-----------A----L-++-Z--------JAN-1
702750 VWS  +  VALDEZ             M  W           AK US 6108N 14621W 0009 11 4                    N362507 780622WMO  0
702750KAWN-S-Z.....V.....S.....T.....P-----R-----W-YYYYZWYWWXXYYZYWVZZXXWZX-D-----------A----L-------------JAN-1
702755 MXY  +  MCCARTHY              W           AK US 6126N 14255W 0455 10 4                    N362518 741213SUPP 0
702755KAWN-S-------------------------P-----R-----W-PQB..8.T.+0....FTTUOQOPL-D-----------A----L-------------JAN-1
702756 VDZ  +  VALDEZ 2              W           AK US 6108N 14615W 0034 10 4                    N362500 750411SUPP 0
702756KAWN-S-------------------------P-----R-----W-VSW4........B2...3YUWTX5-D-----------A----L-------------JAN-1
702757 5WT  ++ WHITTIER                          AK US 6046N 14814W 0047 10 4                    N362502 790920NOAA 0
702757KAWN-S-------------------------P-----R-----W-55555555559949964S5..9..-D-----------A----L-------------JAN-1
702770 SWD  +  SEWARD                W           AK US 6007N 14927W 0023 10 4                    N361718 740913WMO  0
702770KAWN-S-------------------------P-----R-----W-IURV.X+U1GOL+LELAHTHPNPN-D-----------A----L-------------JAN-1
702790 5HN  +  CAPE HINCHINBROOK     W           AK US 6019N 14639W 0056 1024                  C N362535 790726WMO  0
702790KAWN-S-------------------------P-----R-----W-++A++++++++++++++++++++A-D-----------A----L-------------JAN-1
702795 HBK  ++ HINCHINBROOK                      AK US 6024N 14605W 0110 10 4                    N362511 741213SUPP 0
702795KAWN-S-------------------------P-----R-----H-------------------------D------------A----L-------------JAN-1
702796 Z05  ++ MACLEOD HARBOR                    AK US 5953N 14745W 0012 10 4                    N362500 741108USWB 0
702796KAWN-S-------------------------P-----R-----H-------------------------D------------A----L-------------JAN-1
702910 ORT  +  NORTHWAY              W   L       AK US 6257N 14156W 0523 10 4                    N362601 741108WMO  0
702910KAWN-S-------------------------P-----R-----W-XXYWXXYXWXXZZZZZYZZYZXYY-D-----------A----L-USSY--------JAN-1
702915 55Z  +  SLANA/DUFFYS TAVERN   W           AK US 6244N 14355W 0738 10 4                    N362604 740823SUPP 0
702915KAWN-S-------------------------P-----R-----W-LLQMMPML.......3+LONONKL-D-----------A----L-------------JAN-1
702920 TSG  -* TANACROSS                 R        AK US 6322N 14320W 0472 11 4  6322N 14321W 0488 1711   N362602 791004NOAA 0
702920KAWN-S-------------------------P-----R-----H-------------------------D------------A----L-------------JAN-1
702924 Z12  ++ TOK (USCG)                        AK US 6319N 14243W 0509 15 4                    N36  02 790503KAWN 0
702924KAWN-S-------------------------P-----R-----W-.................7.77.8.-D-----------A----L-------------JAN-1
702960 CDV  +  CORDOVA/MILE 13       W   L       AK US 6030N 14530W 0012 10 4                    N362518 740913WMO  0
702960KAWN-S-------------------------P-----R-----W-YWXXYYYYWYWZZYYZYYXXYYZX-D-----------A----L-TRTV--------JAN-1
702965 JOH  ++ JOHNSTONE POINT                   AK US 6029N 14636W 0010 10 4                    N362502 790503SUPP 0
702965KAWN-S-------------------------P-----R-----W-------------------------D------------A----L-------------JAN-1
702980 CYT  +  YAKATAGA              W           AK US 6005N 14230W 0004 10 4                    N362518 740913WMO  0
702980KAWN-S-------------------------P-----R-----W-UGUUTXSUR7.8.6..+RUTYYXS-D-----------A----L-------------JAN-1
```

A program similar to the one producing summary statistics for TEMP and PILOT data received is the NMC "Error Check Program." This program provides companion information to the one producing TEMP and PILOT data receipt statistics.

However, the Error Check Program specifies greater detail about the quality of upper air data processed by the NMC. Figure 12 is an example of the information provided by this program. It categorizes information according to:

a. Data source.

b. Heights, temperatures, or winds reported.

c. Number of times the parameter was available during the period for levels from 1000 to 100 mb, or 70 to 10 mb inclusively.

d. Frequency with which the parameter was automatically processed and used in analysis without interference.

e. Frequency with which the parameter failed vertical consistency checks and what the disposition was.

f. How often the data were forcibly held in or discarded from the analysis.

g. How frequently a manual monitor/edit function intervened to manipulate the data for improvement of the analysis.

h. Other discrepancies such as extraneous characters within the raw data.

In addition to specific information about individual cases, the program further summarizes the statistics into totals and percentages by class for the period and station grouping evaluated.

Figure 12 illustrates the performance of a broad grouping of stations in the Western European sector. Standard isobaric height between 1000 and 100 mb is the parameter.

Figure 12

CODE FIGURE	MEANING
A	PASSED VERTICAL CONSISTENCY CHECK WITH TIGHT LIMITS
B	FAILED VERTICAL CONSISTENCY CHECK AND HAS NOT BEEN RECOMPUTED
C	FAILED VERITICAL CONSISTENCY CHECK AND RECOMPUTED
F	HAS BEEN CHECKED BUT DID NOT PASS VERTICAL CONSISTENCY CHECK WITH LOOSE LIMITS
P	PURGE UNDER ALL CIRCUMSTANCES
H	HOLD UNDER ALL CIRCUMSTANCES
MAN	MANUAL INTERVENTIONS OF ALL TYPES
OTHER	OTHER CODE FIGURES(SUCH AS BLANK-NOT SPECIFIED)

FINA DATA SUMMARY FOR PERIOD PAGE 13

1 FEB 1960 TO 29 FEB 1960

BASED ON RECEIPT BY H+1000-70 OR + 0 MINUTES
TOTAL 00Z RUNS 29

TOT HGTS-TOT TMPS-TOT WNDS ACCESS 1000-100MB HGT. MARKS ONLY
TOTAL POSSIBLE 290

STATION	THE TMPS	A	B	C	F	MAN	P	H	OTHER
71924	246	236	0	4	1	4	0	0	1
71925	265	264	0	0	0	0	0	0	1
71926	0	0	0	0	0	0	0	0	0
71934	255	254	0	0	0	0	0	0	1
71945	242	234	0	2	0	5	0	0	1
71957	262	250	0	1	0	0	0	0	3
71964	250	239	1	0	0	9	0	0	1
72201	276	272	0	4	0	0	0	0	0
72203	280	279	0	0	0	0	0	0	1
72209	260	285	0	1	0	0	0	0	2
72211	289	288	0	0	0	0	0	0	0
72215	288	288	0	0	0	0	0	0	0
72220	287	279	0	7	0	1	0	0	0
72225	0	0	0	0	0	0	0	0	0
72228	0	0	0	0		0	0	0	0
72229	277	277	0	0	0	0	0	0	0
72232	229	226	0	1	0	0	0	0	2
72235	270	270	0	0	0	0	0	0	0
72239	0	0	0	0		0	0	0	0
72240	265	265	0	0	0	0	0	0	0
72247	262	262	0	0	0	0	0	0	0
72250	260	260	0	0	0	0	0	0	0
72255	290	290	0	0	0	0	0	0	0
72257	0	0	0	0	0	0	0	0	0
72260	232	215	0	7		0	10	0	0
72261	258	258	0	0	0	0	0	0	0
72265	234	234	0	0	0	0	0	0	0
72269	0	0	0	0	0	0	0	0	0
72270	255	245	0	0	0	9	0	0	0
72274	258	251	0	0		7	0	0	0
72290	255	195	0	20	0	20	0	0	0
72291	20	20	0	0	0	0	0	0	0
72304	276	275	0	0	0	0	0	0	0
72311	258	249	0	0	0	9	0	0	0
72317	245	246	0	0	0	0	0	0	0
72327	207	206	0	1	0	0	0	0	0
72340	278	277	0	1	0	0	0	0	0
72349	254	243	0	0	0	1	10	0	0
72353	260	260	0	0	0	0	0	0	0
72355	0	0	0	0	0	0	0	0	0
72363	261	260	0	0		0	0	0	1
72365	226	219	0	0	0	7	0	0	0
72374	241	238	0	1	0	0	0	0	2
72381	0	0	0	0	0	0	0	0	0
72387	255	255	0	0	0	0	0	0	0
72391	70	70	0	0	0	0	0	0	0
72393	266	251	0	5		0	10	0	0
72402	256	239	0	1	0	10	0	0	0
72403	284	284	0	0	0	0	0	0	0
72425	258	257	0	1		0	0	0	0
72429	258	241	0	1	0	15	0	0	1
72434	275	275	0	2	0	0	0	0	0
72451	256	256	0	0	0	0	0	0	0
72455	0	0	0	0		0	0	0	0
72456	251	242	0	0	0	9	0	0	0
72458	28	19	0	1	0	0	0	0	4
72469	232	232	0	0	0	0	0	0	0
72476	244	243	0	1	0	0	0	0	0
72486	232	224	0	4	0	0	0	0	0
72493	285	275	0	10	0	0	0	0	0
72519	244	241	0	3	0	0	0	0	0
72520	249	239	0	0		0	10	0	0

FINA DATA SUMMARY FOR PERIOD PAGE 13

1 FEB 1960 TO 29 FEB 1960

BASED ON RECEIPT BY H+1000-70 OR + 0 MINUTES
TOTAL 12Z RUNS 29

TOT HGTS-TOT TMPS-TOT WNDS ACCESS 1000-100MB HGT. MARKS ONLY
TOTAL POSSIBLE 290

STATION	THE TMPS	A	B	C	F	MAN	P	H	OTHER
71924	246	234	0	2	0	12	0	0	1
71925	258	244	0	0	0	9	0	0	4
71926	208	194	0	1	0	11	0	0	2
71934	240	225	0	0	0	13	0	0	2
71945	233	225	0	0	0	7	0	0	1
71957	247	238	0	1	1	5	0	0	2
71964	240	223	0	0	0	13	0	0	4
72201	270	258	0	0	0	10	0	0	2
72203	275	275	0	0	0	0	0	0	0
72208	279	279	0	0	0	0	0	0	0
72210	273	253	0	0	0	20	0	0	0
72215	275	249	0	15	0	10	0	0	1
72220	273	250	0	7	0	14	0	0	2
72225	72	0	0	0	0	0	72	0	0
72228	47	24	0	0	0	0	0	0	23
72229	267	255	0	0	0	10	0	0	1
72232	219	209	0	0	0	0	10	0	0
72235	259	248	0	1	0	10	0	0	0
72239	17	0	0	0	0	0	17	0	0
72240	280	250	0	0	0	10	10	0	0
72247	274	262	0	0	0	10	0	0	2
72250	279	255	0	0	0	10	0	0	4
72255	280	260	0	0	0	10	10	0	0
72257	67	0	0	0	0	0	67	0	0
72260	223	214	0	0	0	9	0	0	0
72261	252	242	0	0	0	9	0	0	1
72265	228	227	0	0	0	0	0	0	1
72269	18	16	0	0	1	0	0	0	1
72270	246	236	0	8	0	0	0	0	0
72274	252	251	0	0	0	0	0	0	1
72290	207	164	0	1	0	40	0	0	2
72291	0	0	0	0	0	0	0	0	0
72304	269	254	0	0	1	14	0	0	0
72311	247	223	0	1	0	22	0	0	1
72317	251	236	0	0	0	13	0	0	0
72327	207	196	0	0	0	11	0	0	0
72340	271	261	0	0	0	10	0	0	0
72349	249	240	0	0	0	9	0	0	0
72353	237	226	0	0	0	9	0	0	2
72355	66	0	0	0	0	0	65	0	0
72363	252	233	0	0	1	18	0	0	0
72365	213	208	0	5	0	0	0	0	0
72374	242	235	0	2	0	0	0	0	5
72381	164	0	0	0	0	0	164	0	0
72387	237	231	0	6	0	0	0	0	0
72391	104	104	0	0	0	0	0	0	0
72393	251	247	0	13	0	0	0	0	1
72402	280	255	0	0	0	24	0	0	1
72403	258	247	0	1	0	10	0	0	0
72425	245	221	0	1	0	22	0	0	1
72429	250	218	0	3	0	26	0	0	0
72433	256	256	0	0	0	0	0	0	0
72451	251	241	0	0	0	9	0	0	0
72455	9	0	0	0	0	0	9	0	0
72456	251	243	0	0	0	8	0	0	0
72468	16	10	0	0	0	0	0	0	6
72469	212	208	0	4	0	0	0	0	0
72476	240	233	0	7	0	0	0	0	0
72486	216	204	0	4	0	8	0	0	0
72493	273	269	0	1	0	3	0	0	0
72519	263	244	0	9	0	10	0	0	0
72520	252	243	0	0	0	9	0	0	0

CONCLUSION

In the past decade revolutionary changes in the philosophy and applications of quality control of meteorological data have taken place. This evolution has came about both from necessity and foresight. Quality control has been necessitated by increasingly automated operations at most meteorological centers where ingestion of erroneous data can result in serious degradation of analyses, forecasts and other products because of a lack of human safeguards. Early in the transition from manual to computerized communications, data processing, and objective analysis of data, it became obvious that a high degree of monitoring and control of these data was both necessary and desirable.

Foresight in improving quality control was applied by people with the vision to perceive both the tangible and intangible benefits to be gained by introducing objective and statistical methods to get at the root of data problems and to correct them there.

The World Meteorological Organization developed the World Weather Watch Plan and made data monitoring and quality control an integral part of it. They assigned responsibilities within the Global Observing System, the Global Telecommunication System, and the Global Data Processing System and provided recommended procedures and guidelines for effective programs. Federal meteorological agencies, civil and military alike, adopted and implemented these World Weather Watch precepts and concepts both domestically and internationally.

The Air Force Global Weather Central and the National Meteorological Center are bilaterally developing complementary quality control procedures. These are a delicately balanced blend of automated, and manual procedures aimed at controlling the availability and accuracy of present and future data for both current operations and subsequent use. These Centers' procedures address data difficulties associated with observing practices, measurements, data reduction, coding communications, and processing. They use real-time, non-real-time and management concepts to bring about a full measure of comprehensive inspection and control.

OUTLOOK

The outlook for the 1980's suggest that there will be broader applications of meteorological principles to more fundamental prcactical considerations such as weather influences on ecology, world food production, defense, energy use, and basic human comfort and safety.

A greater dependency on technology will be essential to further the capabilities of the discipline. Fiscal restraints are likely to remain high as the climate of government activity becomes increasingly austere. This signals a need for applications of automated systems in playing an ever-increasing role in carrying out work heretofore performed by people. Data monitoring and quality control are prime candidates in such applications.

REFERENCES

AFGWC, 1979: Data Base Quality Control Handbook; AFGWC Pamphlet 105-2.

Bureau of the Census, 1977: Weather Data Needs Survey 1977; Conducted for the National Oceanic and Atmospheric Administration, National Weather Service, 88 pp.

WMO, 1966: The Global Data-Processing System and Meteorological Service to Aviation, 40 pp.

WMO, 1968: Quality Control Procedures for Meteorological Data; World Weather Watch Planning Report No. 26, 38 pp.

WMO, 1974: Manual on the Global Telecommunications System; Publication No. 386, Vol. I, 119 pp.

WMO, 1977: Guide on the Global Observing System; Publication No. 488, 100 pp.

WMO, 1979: Manual on the Global Data-Processing System, Vol. I, Supplement No. 2; Publication No. 485, 9 pp.