NCEP/NCAR Re-analysis Observation Reformatting for ERA-40

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1.   Introduction

i)   Develop a BUFR file format in which to deliver processed Re-analyses I&II observations, as well as new translations of NCAR archived data that had been added or improved since the US re-analyses.

a) Completed Dec 2000.

ii)   Process Reanalysis II observations from 1979-1994 into BUFR files for ERA-40. The files contain the QC results and guess and analyzed values from Re-analysisII. Most of the data represented is from the NMC/NCEP daily dumps, but there is a significant amount of data from the JMA, the ECMWF, as well as additional datasets for the period from NCAR archives.

a) 200+ Gb of Re-analysisII files ftp'd to NCEP from Livermore.

b) Merged precipitation and clouds from ON29 into Re-analysisII SYNOPs.

c) Completed Feb 2000.

iii)   Process a combination of Reanalysis I datasets and NCAR source data into BUFR files for ERA-40 for the period 1957-1978.

a) Obtained latest copies of NCAR datasets for the period.

b) Re-translated all of the TEMP, PILOT, and SYNOP observations.

c) Re-translated all AIREPs 1957-1972.

d) Re-translated SATOBs 1967-1972.

e) Processed Re-analysisI AIREPs and SATOBs 1973-1978.

f) Initial delivery completed in Feb 2001.

g) Serious errors discovered in several datasets July 2001.

h) Reprocessing completed Aug 2001.

Observation Contents in the BUFR File Format

Standard Report Header:

ID and location:	SID	XOB	YOB	ELV	
Data source codes:	TYP	T29	ITP	PRG	SRC
Date/time:	YEAR	MNTH	DAYS	HOUR	MINU

TEMP/PILOT data:

POB	PQM	PFC	PAN	PMO	
QOB	QQM	QFC	QAN	TDO	
TOB	TQM	TFC	TAN		
ZOB	ZQM	ZFC	ZAN		
UOB	WQM	UFC	UAN	DDO	FFO
VOB		VFC	VAN		
QC and Radiation Corrections:		PCC	QCC	TCC	ZCC
		TRC	ZRC		

SYNOP data:

POB	PQM	PFC	PAN	PMO
QOB	QQM	QFC	QAN	TDO
TOB	TQM	TFC	TAN	
UOB	WQM	UFC	UAN	DDO	FFO
VOB		VFC	VAN	

Surface weather, clouds, and precipitation:

3HPC	CHPT	HOVI	PRWE	PSW1	PSW2
VSSO	TOCC	CLAM	HOCB	CLTPx3	
TP06	TP12	TP24	TOSD		

AIREP, ACARS, SATOB data:

POB	PQM				
TOB	TQM	TFC	TAN		
UOB	WQM	UFC	UAN	DDO	FFO
VOB		VFC	VAN		

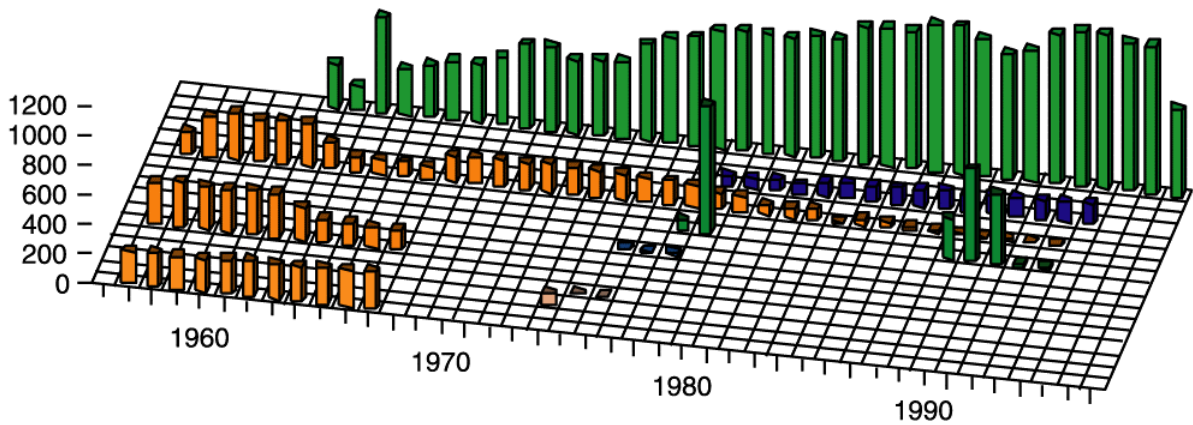## 2. Forty Year Inventories of Reanalysis-1 Data

Figure 1 Raob/pibal inventory. From back to front, in megabytes; NMC, JMA, SPEC, FGGE/ECM, USAF, TD54, TWERLE, GATE, USCR.
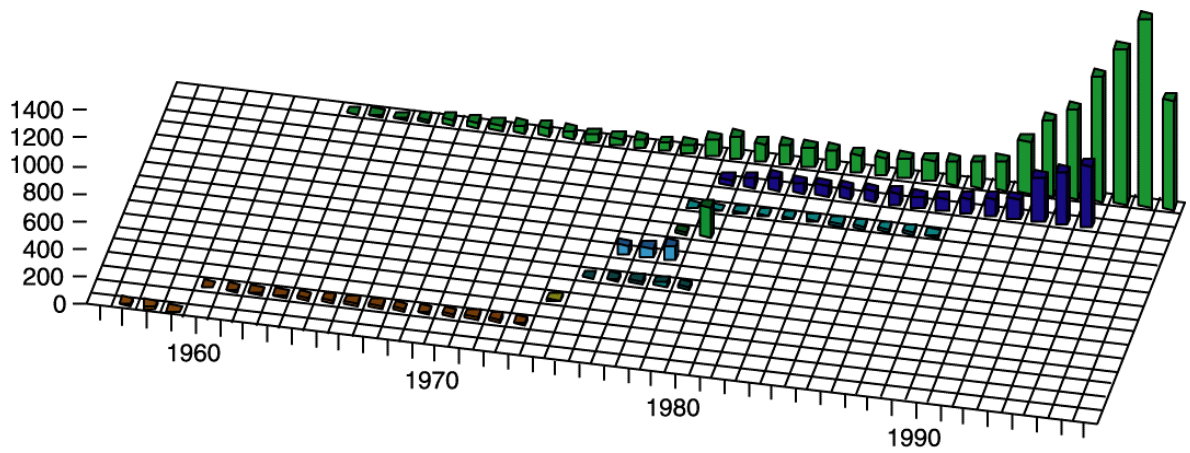

Figure 2 Aircraft inventory. From back to front, in megabytes; NMC, JMA, NZAC, FGGE, USAF, GASP, GATE, SDAC, TD57.
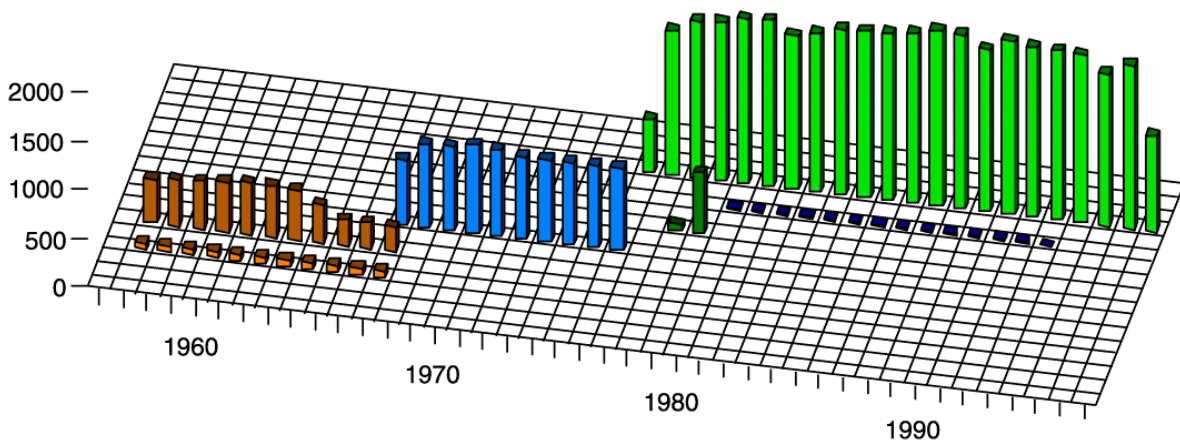

Figure 3 Land surface inventory. From back to front, in megabytes; NMC, ICEB, FGGE, USAF, TD13 and TD14.

3. Missing Significant Level Wind Observations, 1989-1991

During preparation of Reanalysis I data for 1989, Bob Kistler noticed a significant drop in the number of raob/pibal levels starting in August 1989. The deficit remained in the data until October 1991. More investigation showed the data lack was entirely due to missing significant level winds in the NMC archive for this period from all WMO blocks except 50-59 and 70-79.

Per Kållberg happened to attend a reanalysis meeting at which this was discussed, and he offered to supply ECMWF data for that period in order to fill the void. What we found when combining data from the ECMWF set with the NMC set was somewhat surprising.

Diagnostics of the data combination process illustrated that the amount of mandatory levels and significant temperature levels present in the data agreed fairly well between the two sets. However, although the ECMWF files supplied the data missing from the NMC files, significant level winds in blocks 50-9 and 70-79, which the NMC set had, were apparently missing in the ECMWF raob/pibal set.
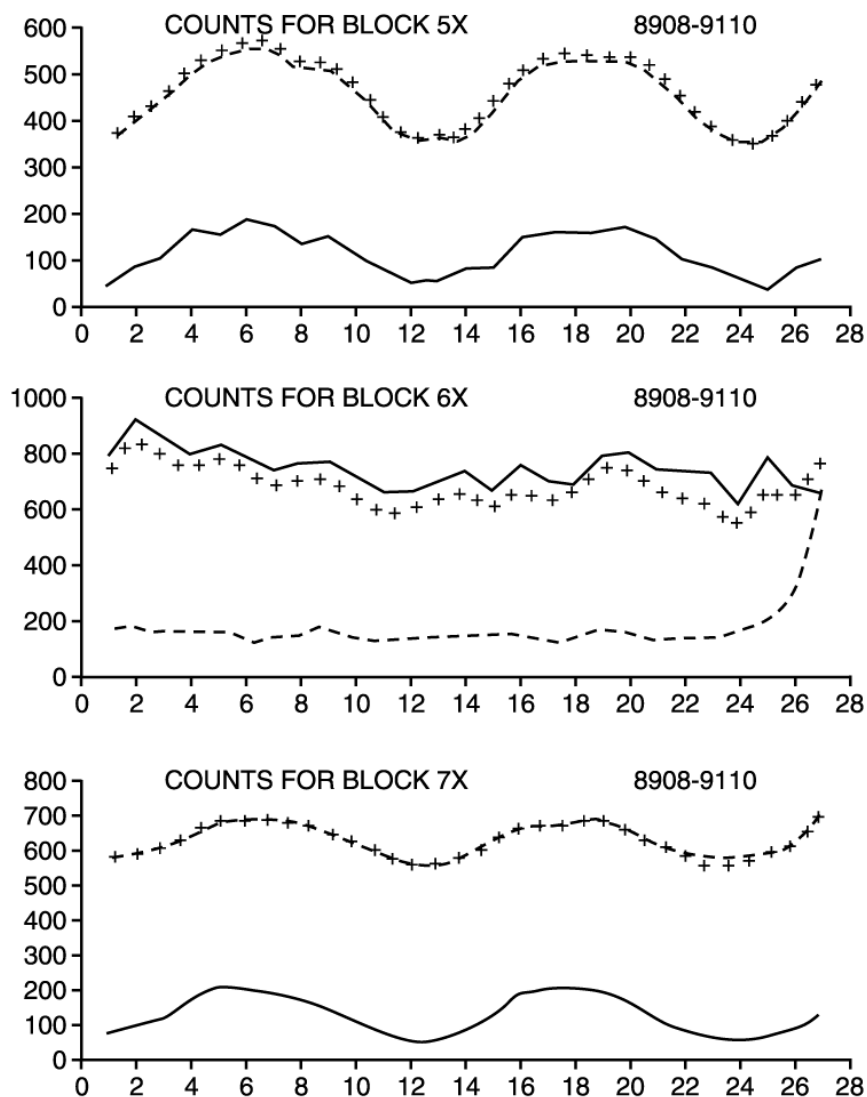
Figure 4 Combination of Significant Level Winds from ECMWF and NMC Data

A combination of ECMWF data and NMC data made for this period is illustrated. The solid line shows the ECMWF data counts of significant level winds, the dashed line the same for NMC data, and ++++ represents the combination. The combination process always picked the report with the most total levels. The block groups shown, 50-9, 60-69, and 70-79, are representative of the situation. The rest of the word resembles blocks 6x.
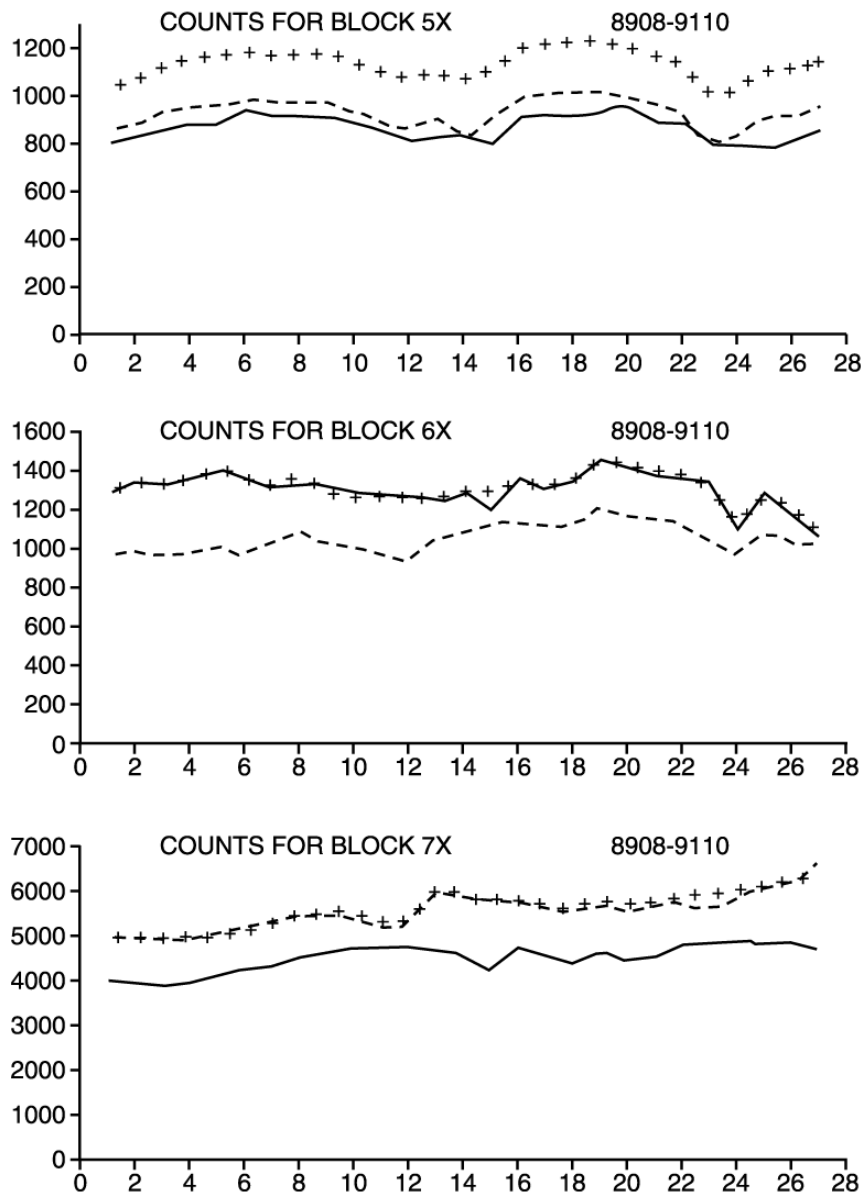

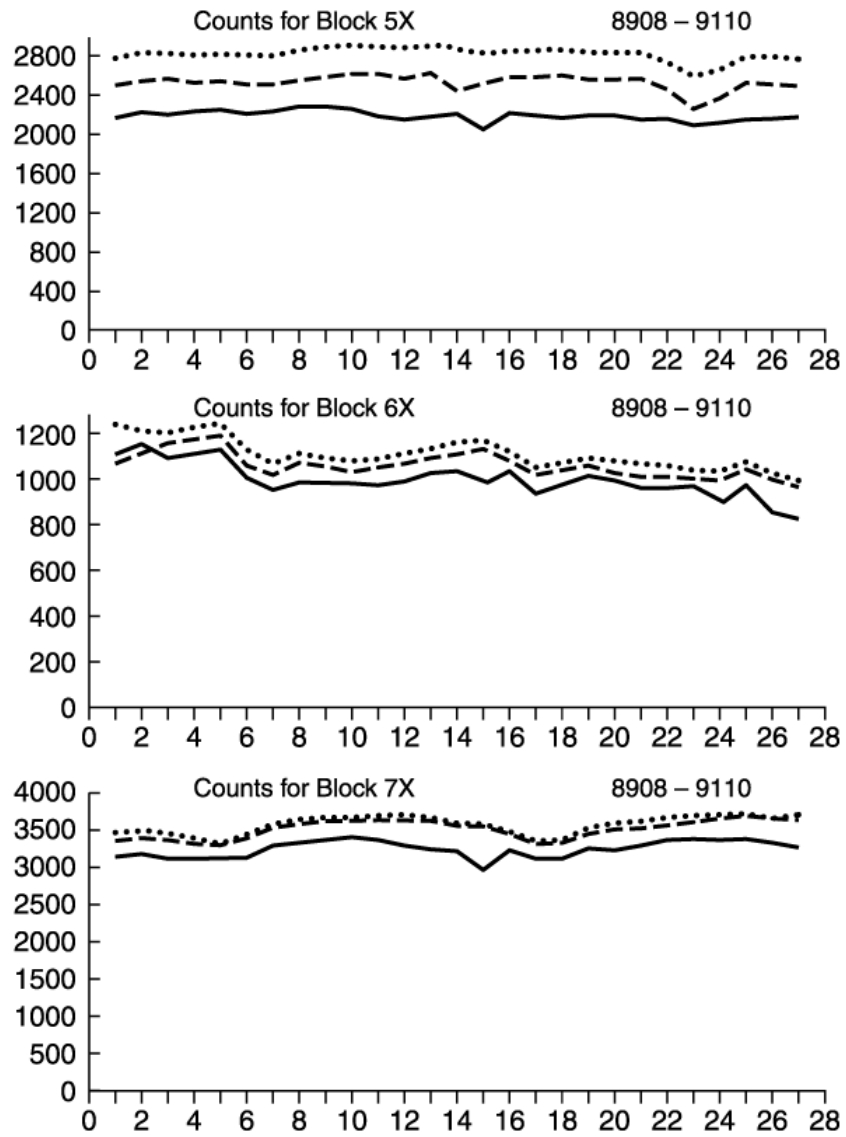*Figure 5 Combination of Significant Level Temperatures from ECMWF and NMC Data*

Figure 6 Combination of Mandatory Levels from ECMWF and NMC Data

TEMP/PILOT	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78
China	●	●	●	●	●	●																
Raobs	●	●	●	●	●	●	●	●	●	●	●											
Countries	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
US Control	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
France	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Misc	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Russia				●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
TD52				●	●	●	●	●	●	●	●	●	●	●	●	●						
TD53	●	●	●	●	●	●	●	●	●	●	●	●	●									
TD54	●	●	●	●	●	●	●	●	●	●	●											
ON20						●	●	●	●	●	●	●	●	●	●	●						
US Navy									●	●	●	●		●	●	●						
GATE/TWERLE																	●	●	●			
USAF																	●	●	●	●	●	●
ON29																	●	●	●	●	●	●

SYNOP	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78
TD13	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●					
TD14	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
USSR	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
USAF												●	●	●	●	●	●	●				
ON124																				●	●	●

AIREP	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78
Australian																	●	●	●	●	●	●
US Navy															●	●	●	●	●	●	●	●
ON20						●	●	●	●	●	●	●	●	●	●	●						
Sadler				●	●	●	●	●	●	●	●	●	●	●	●	●						
Rean-1	●	●	●	●	●												●	●	●	●	●	●

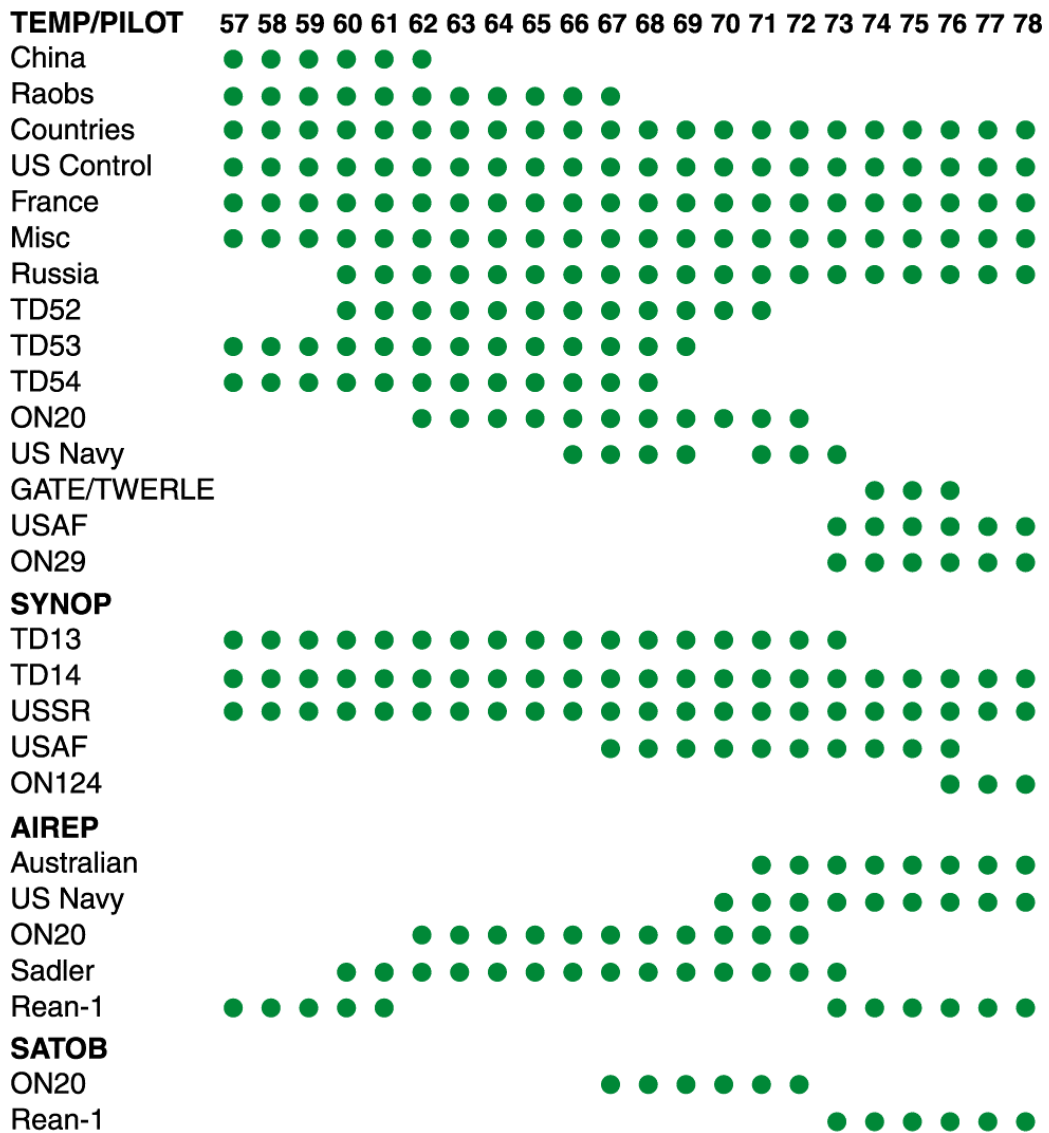| SATOB	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78
ON20												●	●	●	●	●	●					
Rean-1																	●	●	●	●	●	●

Figure 7 NCAR Source Datasets Processed for the Period 1957-1978

4.   Summary of Observation Reprocessing for ERA-40, July 2001

General improvements in the translation software

i)   All codes thoroughly checked again for mistakes, big or small

ii)   Files for all sets now in compressed months of data, tarred into yearly groups

iii)   Translation scripts now set up to process all data in discrete yearly chunks

iv)   Increased and improved diagnostic programs and procedures

v)   Optimized translation codes run 2-3 times faster

vi)   Inventory by month, dataset, variable, and quality mark made for all translations

Corrections / improvements to the surface observations

i)   TD13 temperatures corrected

ii)   USAF wind speed truncation corrected

iii)   New, more time extensive, files provided for TD13, TD14, and USSR data.

iv)   Scarcity of US surface observations starting 1968 to be addressed with USWBAN/TD14 set

v)   Removed station pressure computation when report contains only sea level pressure

vi)   Re-translated USSR, TD13, TD14, and USAF surface observations from the sources

vii)   Improved translation and specification of moisture data

viii)   Nasty bug in ob time corrected

Corrections / improvements to the raob/pibal data

i)   Ob times corrected

ii)   Re-translating all the raob/pibal data (TSR, ON20, ON29)

iii)   Better assignment of source dataset codes for the raob and miscellaneous sets

iv)   Improved translation and specification of moisture data

v)   Copied most of the possible quality marks in the time series raob data into BUFR

vi)   Several new datasets including a Navy set for 1968-1972, and Hong Kong in the 70's

vii)   Full height Russian ice island data nearly ready, will replace 3 km rusice dataset

viii)   New *countries* dataset has better attribution of national sources

ix)   One old and one new problem were found and corrected in ON20 dataset

5.   Quality marks in the BUFR data

The BUFR format, into which the source data is translated, contains data quality code table elements for pressure, moisture, temperature, height, and winds, at each level in the data.

PQM|	007193	TABLE B ENTRY	-	PRESSURE (QUALITY) MARKER
QQM|	013193	TABLE B ENTRY	-	SPECIFIC HUMIDITY (QUALITY) MARKER
TQM|	012195	TABLE B ENTRY	-	TEMPERATURE (QUALITY) MARKER
ZQM|	010196	TABLE B ENTRY	-	HEIGHT (QUALITY) MARKER
WQM|	011192	TABLE B ENTRY	-	WIND (QUALITY) MARKER

These code table elements share the same set of code table values. The code values, which are relevant to the newly translated datasets, are as follows:

    0 - MANUAL KEEP
    1 - CHECKED AND FOUND GOOD
    3 - CHECKED AND FOUND SUSPICIOUS
    14 - MANUALLY REJECTED BY SDM (HUMAN DATA MONITOR)
    15 - REJECTED BY PREPROCESSOR PROGRAM
    21 - DEWPOINT COMPUTED FROM RELATIVE HUMIDITY
    22 - DEWPOINT COMPUTED FROM MIXING RATIO
    23 - DEWPOINT FROM DATA
    24 - DEWPOINT COMPUTED FROM SPECIFIC HUMIDITY
    25 - COMPUTED NEGATIVE DEWPOINT DEPRESSION
    26 - UNABLE TO COMPUTE DEWPOINT FROM RH, MR, OR Q
    27 - REPLACEMENT, ASSUMED OR ESTIMATED VALUE

6.   Quality marks in the source data

Several of the time series raob/pibal datasets contain a relatively large number of internal quality markers for level-by-level observations of p, q, t, z, and w. Many of the files include flags for well more than half the data. Not all the sources are as well annotated, but at least some quality markers show up in many of the TSR datasets. Seven (7) of the possible flag values were converted into the BUFR format. Quality marks exist in the ON20 (1962-72) data, but as of yet have not been decoded. The ON29 data contains quality flags, of which the data monitor "keeps" and "purges" have been retained. Other ON29 flags reflect results of various automatic checks, and require further investigation to understand.

TSR Quality flags and meanings			BUFR equivalent QM codes
0	Element is correct	>>>>	1
1	Element is doubtful	>>>>	3
2	Element is wrong	>>>>	15
3	Replacement value	>>>>	27
4	Assumed or estimated value	>>>>	27
H	Human monitor keep flag	>>>>	0
P	Human monitor purge flag	>>>>	14

Quality marks documented in the surface datasets seem mostly redundant, i.e. missing value, couldn't decode, value present, etc. These didn't seem particularly useful, and were not converted into BUFR.

7. Improved moisture translation and quality marks

Two issues came up when reprocessing the moisture data. The first has to do with general rules for translating moisture observations. The original translation would not copy a moisture ob if there was no accompanying temperature or pressure, either for surface observations, or most of the upper air sets. This has been changed to treat all observations independently as much as possible. The second and related issue concerned the various units of moisture in the collective data. In many of the source datasets, surface and upper air, the observed or recorded units of moisture would vary, but the BUFR format includes only dew point and/or specific humidity. Some of the surface datasets contain one or both of two different units of measurement. Improvements in the moisture translations are mainly focused on representing as much of the original moisture information as possible into the BUFR data. BUFR quality mark code table values were introduced for the moisture observations, to specify the original units of moisture in each report, and for the temperature to indicate when a conversion of the moisture variable from the data to dew point could not be made, or produced a negative depression.

BUFR moisture conversion and temperature flags

Moisture from relative humidity	>>>>	21
Moisture from mixing ratio	>>>>	22
Moisture from dew point	>>>>	23
Moisture from specific humidity	>>>>	24
Negative dew point depression	>>>>	25
Could not compute dew point	>>>>	26

8. Sample inventories displaying distribution of BUFR quality marks in the data

Date	Tag1	Tag2	Var	Total	qm0	qm1	qm3	qm14	qm15	qm27
61011	rusu	Russia	PRES	163559	0	0	0	0	0	0
61011	rusu	Russia	DEWP	87606	0	0	0	0	231	0
61011	rusu	Russia	TEMP	117171	0	102156	341	0	428	158
61011	rusu	Russia	GPHT	163429	0	123585	1078	0	1481	1167
61011	rusu	Russia	WIND	119211	0	82116	588	0	811	229
61011	rusu	Russia	TOTL	163559	6953	(total levels|total report locations)				

Date	Tag1	Tag2	Var	Total	qm0	qm1	qm3	qm14	qm15	qm27
5905	raob	mit00z	PRES	301999	0	0	0	0	0	0
5905	raob	mit00z	DEWP	110566	0	0	0	0	0	0
5905	raob	mit00z	TEMP	253311	0	161220	0	0	0	92091
5905	raob	mit00z	GPHT	253263	0	201230	0	0	0	52016
5905	raob	mit00z	WIND	131060	0	129537	0	0	0	1523
5905	raob	mit00z	TOTL	302016	14234	*				

Date	Tag1	Tag2	Var	Total	qm0	qm1	qm3	qm14	qm15	qm27
5905	raob	mit12z	PRES	126549	0	0	0	0	0	0
5905	raob	mit12z	DEWP	56891	0	0	0	0	0	0
5905	raob	mit12z	TEMP	90915	0	84903	0	0	0	6012
5905	raob	mit12z	GPHT	122713	0	122698	0	0	0	15
5905	raob	mit12z	WIND	77368	0	77368	0	0	0	0
5905	raob	mit12z	TOTL	126549	4070	*				

Table 1 Inventories for some of the datasets, illustrating TSR quality flags

Date	Tag 1	Tag 2	Var	Total	qm21	qm22	qm23	qm24	qm25	qm26
5807	td13	td13	PRES	97302	0	0	0	0	0	0
5807	td13	td13	DEWP	393289	5010	0388279	0	0	0	
5807	td13	td13	TEMP	409017	0	0	0	0	156	0
5807	td13	td13	WIND	419199	0	0	0	0	0	0
5807	td13	td13	PMSL	349881	0	0	0	0	0	0
5807	td13	td13	TOTL	426853	426853	*				

Table 2 Inventory for TD13 surface obs, July, 1958, illustrating moisture and temperature quality flags

9.   Data Hours in the NMC/NCEP/NCAR B3 Data, 1962-1972

We are spending some time trying to understand the data archive scheme used to collect the b3 data from the early sixties into the early seventies. This is an important dataset containing the bulk of raob/pibal and aircraft reports for that period. The problem in understanding the data precisely involves the convention used to record complete date/time information for each report. Two collections of data were made each day, nominally for 0000z and 1200z. There is a date from each archive header, but internally each observation contains only an hour element to locate it in time.

In a scheme such as this, we could define three types of observations represented in the archives, which might be called early data, timely data, and late data. Early data would be those observations from (relative) yesterday, i.e. data with hours from 21z through 24z occurring in the in the 0000z set. Timely data would consist of observations where the hour in the data refers to the date of the archive it occurs in. Then, late, or late arriving, data, which could occur at any hour, and could be from yesterday, or last week, or who knows? So the problem becomes identifying, confidently, which is what.

Short of verifying the actual date/time of each observation, a virtual impossibility at this point, we need to develop rules for translating (or not) each observation in the archives, based on which particular hour it reports, and in which particular archive file it resides. An examination of the archive contents, broken down by archive hour (0000z or 12000z), ob hour, and year, provides some help along these lines.
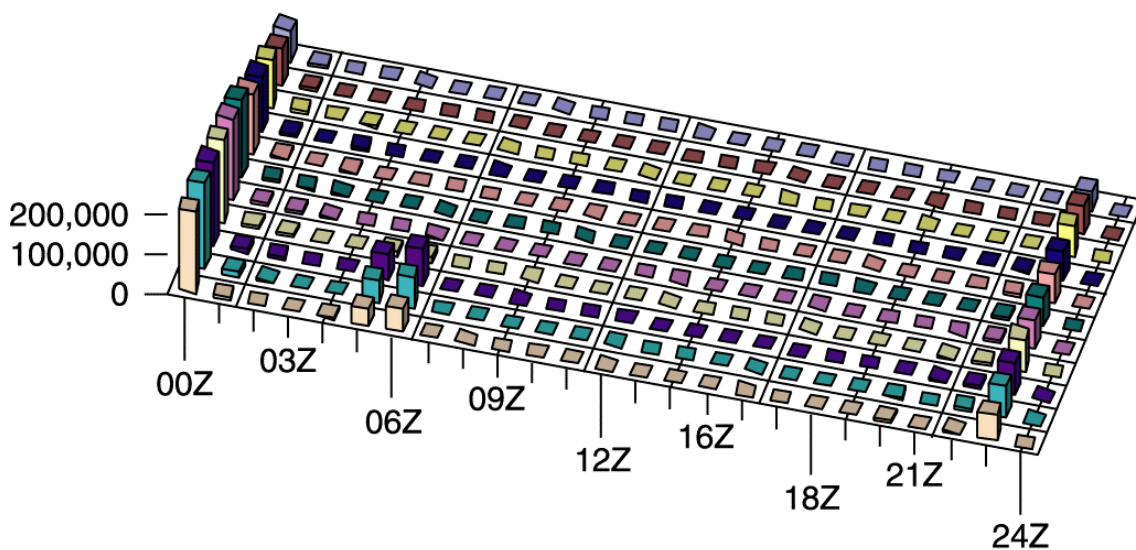

Figure 8 Distribution of hours in 0000z b3 raob data, 1962-1972

From the figure above, one can see the great majority of the data in the 0000z archive occurs during the hours of 0z (timely data) and 23z (early data). During the final four years of the archiving, a significant amount of (presumably timely) data occurs during 5z and 6z. Unfortunately, because there are orders of magnitude differences in the number of reports falling in the large groups and those falling in the small ones, this view of the data is skewed by the sheer weight of the large numbers. Viewing the same inventory, but scaling the vertical axis by the base 10 log of the amounts, reveals more details.
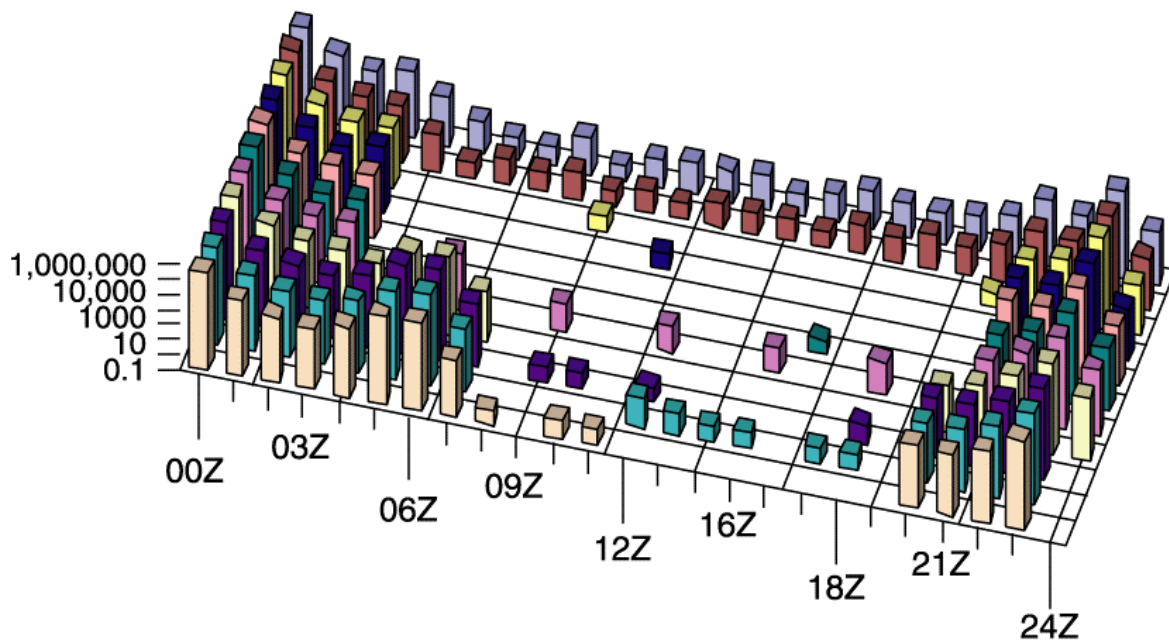
Figure 9 Distribution of hours in 0000z b3 raob data, 1962-1972, vertical axis scaled by the base log 10

In this perspective, we now seem to be able see cut-off and cut-on times during the various years of the archive, and the hours with zero reports are clearly shown. This picture suggests three mini-epochs over the years of the archiving. The back two rows, showing 1962-63, have observations at every hour of the day! The off hours for these years (say, 4z-20z), must be considered unclassifiable in terms of early, timely, or late, because any observation falling in one of the off-hours could conceivably fit any of timeliness categories. In fact, the actual amounts of data showing up in the off-time hours is almost always very small, and not using it results in very little overall data loss. In general, if we know the cut-on and cut-off times of the archive, we should be able to ignore the off-time hours, and assume that observations falling in the on-time hours can be confidently classified as early or timely.

The cut-off at 3z, and cut-on at 21z, seems to have been more strictly enforced during the next five years (1964-68) in the archive. From this, one might think the administrators of the database system recognized the ambiguity of data being accepted into the off-time section of the archives. The year 1968 is unique in one regard; although the cut-off and cut-on times seem to be the same as prior years, groups of off-time data show up at 6z, 9z, 12z, 15z, and 18z. Interesting, but these groups are off-time and also unusable. From 1969 and on, a sea change takes place. The cut-off time is evidently moved to 7z, and the cut-on time to 20z. This probably reflects the advent of the four synoptic time per day observing strategy. We should see the same scenario in the 1200z archives.

Here we do see much the same hourly patterns found in the 0000z archives, only complemented. In the first 7 years, (1962-68), the cut-on/cut-off times for 1200z appear to be 9z and 15z. Then starting in 1969 the cuts are moved to 8z and 19z, again reflecting the development of 6z and 18z synoptic observing times. These patterns in the raob/pibal data seem convincing and suggest rules for confidently assigning valid date/times to any of the data occurring in the on-time sections of each year of each archive. The other data of interest from the b3 archives are the aircraft reports, so we look at them in the same way.
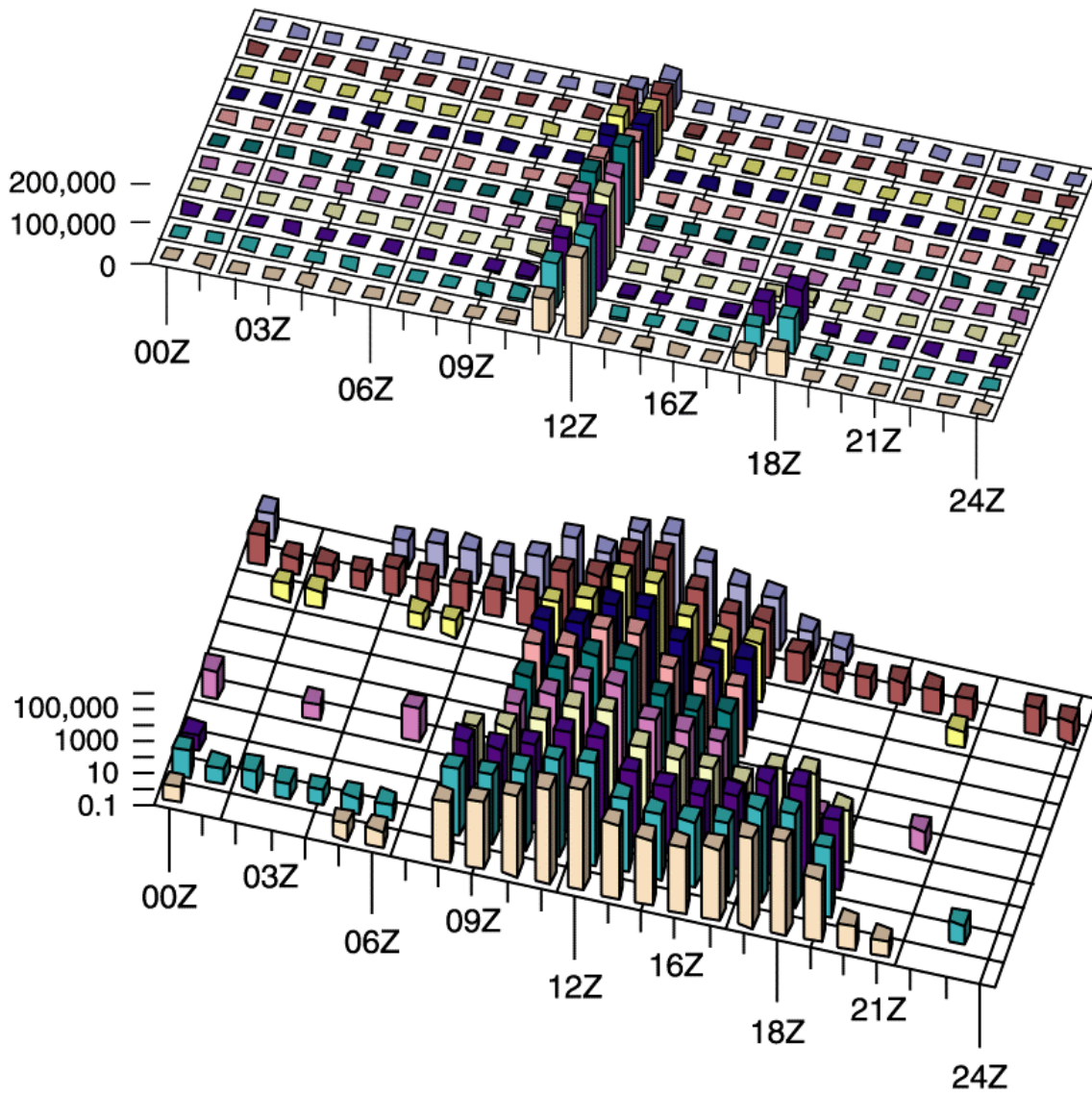
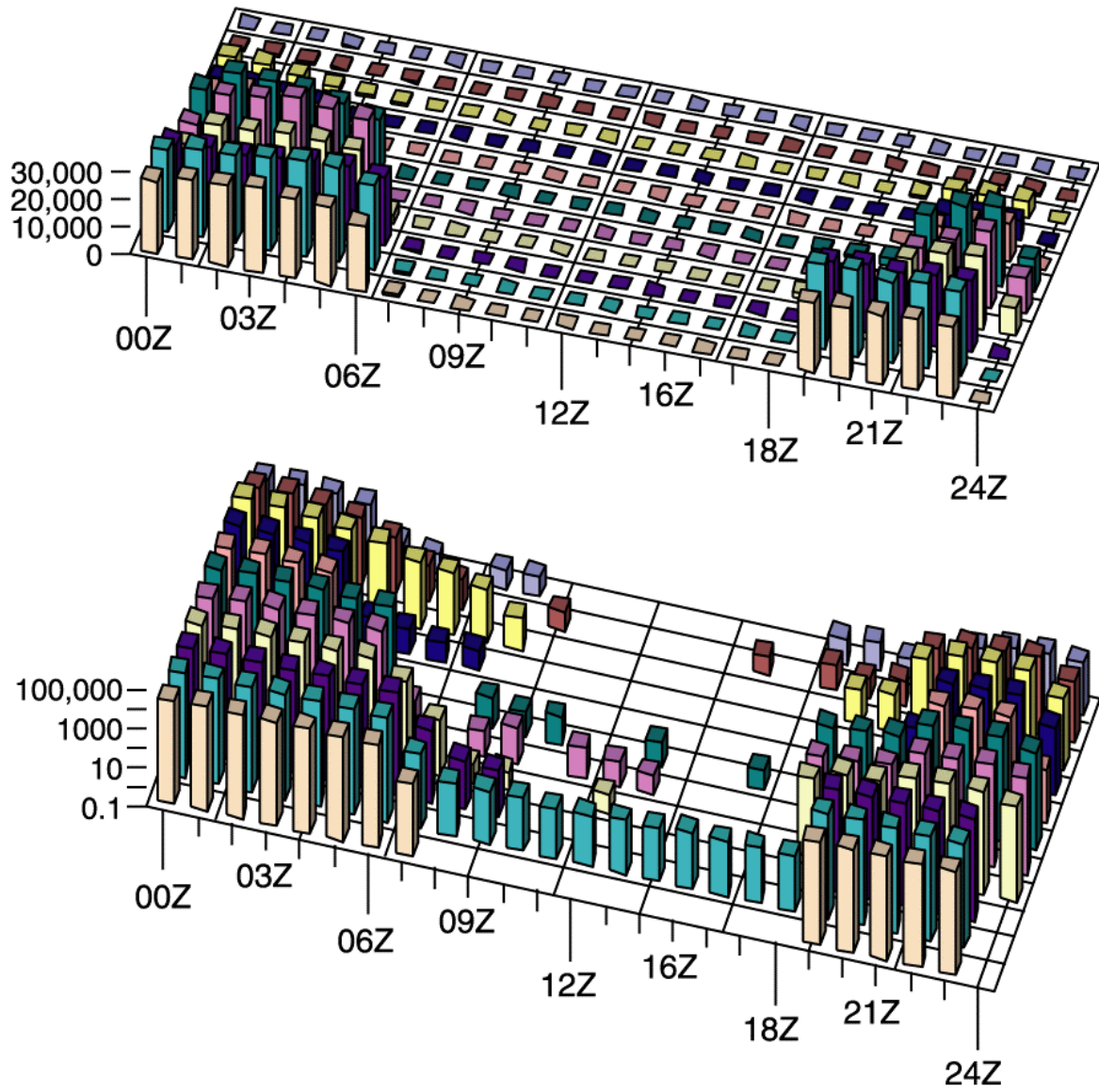*Figure 10 Distribution of hours in 1200z b3 raob data, 1962-1972*

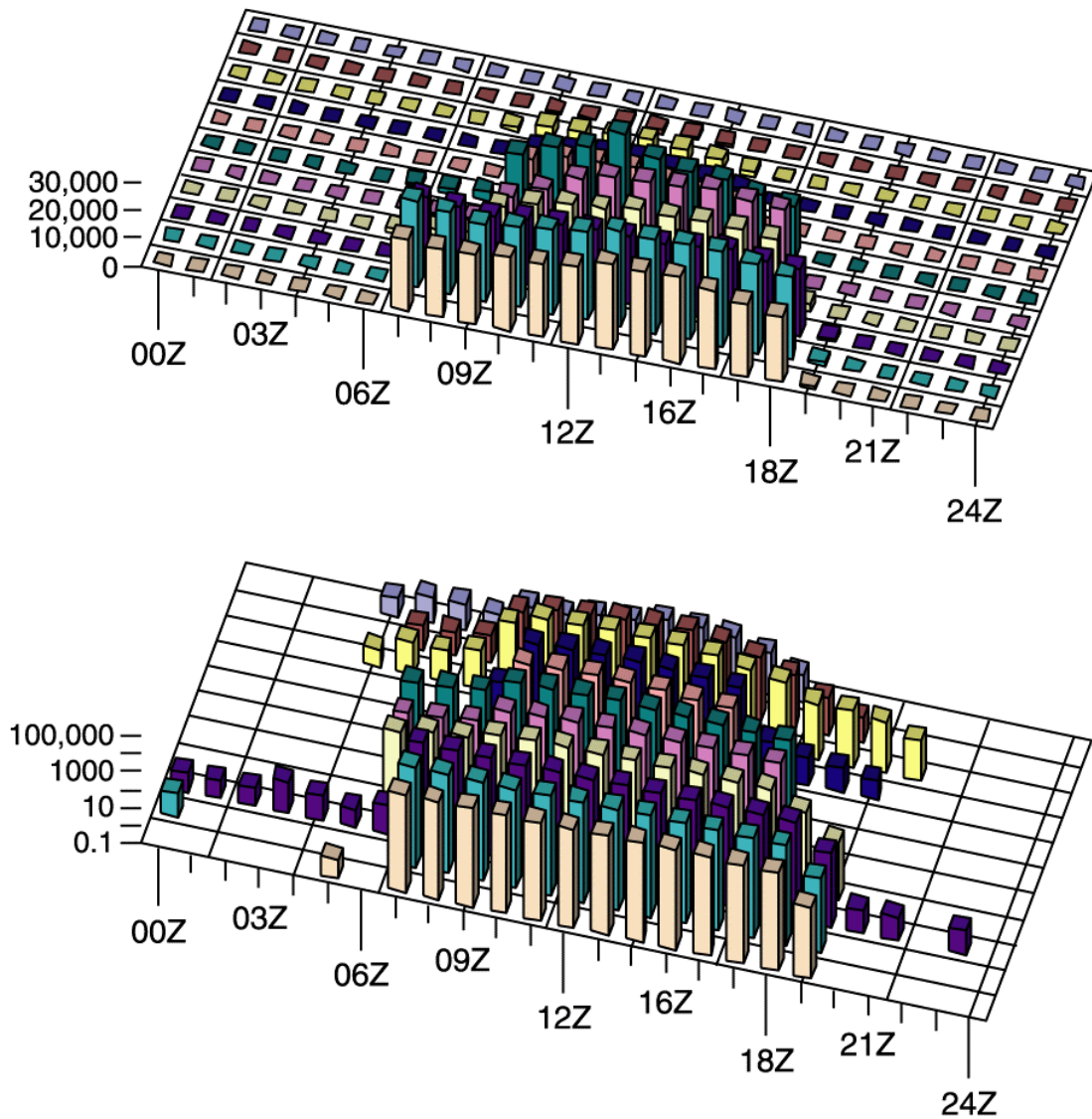*Figure 11 Distribution of hours in 0000z b3 aircraft data, 1962-1972*

Figure 12 Distribution of hours in 1200z b3 aircraft data, 1962-1972

Again, the two views of the aircraft data for 0000z show the bulk amounts and relative distribution of the data hours in this archive. These are substantially similar to the 0000z distributions in the raob data, and imply similar on-time rules for translating the data. One noticeable difference from the raob archive is the possibility that the pre-1969 0000z aircraft cut-off time is 5z rather than 3z, although the cut-on time looks the same, at 21z. The years 1969 and later seem also to have a slight difference from raobs, as those cut-on time looks like 19z instead of 20z. Lastly, a look into the 1200z aircraft.

The 1200z aircraft data archives seems also to conform to the cut-off/cut-on conventions seen in the raob archive, with some small differences. Pre-1969, the open time looks like 9-17z, rather than 9-15z, whereas 1969 and later open time seems to be 7-19z, instead of 8-19z. To summarize the foregoing analysis, the following table illustrates the main points in the form of defining useful, on-time, periods in each archive for each year.

10. Open time (cut-on to cut-off) in each daily tank for b3 raob/pibal and aircraft

raobs	pre-1969	1969 and later
0000z	21z-03z (7 hrs)	20z-07z (12 hrs)
1200z	09z-15z (7 hrs)	08z-19z (12 hrs)
aircraft	**pre-1969**	**1969 and later**
0000z	21z-05z (9 hrs)	19z-06z (12 hrs)
1200z	09z-17z (9 hrs)	07z-18z (12 hrs)

11. Examples of Some Different ON20 Aircraft Reports

The Dropsonde

The earliest aircraft report in the ON20 archive happens to be a complete Dropsonde profile. The only one in the entire archive that I could find. It does appear that throughout the entire ON20 period of aircraft observing, there seems to be a protocol of ascent or descent observations reported in a single aircraft entry.

```
----------------------------------------------------------------------
MESSAGE: ADPUPA       1      1     62032006
STATION: UNKNOWN     -33.30     61.90
TIME:    1962.    3.    20.    5.    0.
ELV:     ********
PCC:          0.00
TYPE:          11.       40. ********
SOURCE:  101. 101.
DATA:
 LVL CAT        POB           DWP          TOB         ZOB          DIR          SPD
   1   1   1000.0(*)        1.2(*)       5.8(*)     268.0(*)    140.0(*)      4.2(*)
   2   1    850.0(*) *******(*)         -4.0(*)    1578.0(*)    160.0(*)      4.7(*)
   3   1    700.0(*)      -32.2(*)      -5.2(*)    3105.0(*)    160.0(*)      2.6(*)
   4   1    500.0(*) *******(*)        -23.0(*)    5669.0(*)    170.0(*)      9.4(*)
   5   1    400.0(*)      -50.2(*)     -36.8(*)    7257.0(*)    180.0(*)      1.6(*)
   6   1    300.0(*) *******(*)        -52.2(*)    9189.0(*)    180.0(*)     10.4(*)
   7   1    200.0(*) *******(*)        -68.5(*)   11689.0(*)    200.0(*)     20.8(*)
   8   1    150.0(*) *******(*)        -64.5(*)   13429.0(*)    200.0(*)     15.6(*)
   9   1    100.0(*) *******(*)        -64.8(*)   12109.0(*) *******(*) *******(*)
----------------------------------------------------------------------
```

Mandatory and Flight Level Aircraft Reports

From 1962-1967, many of the reports contain mandatory level data. A number of those also have dew point measurements. We decided to leave the dew points out for now, but make a separate set of these reports for research. Some come with two or three mandatory levels.

```
----------------------------------------------------------------------
MESSAGE: ADPUPA       2      1     62120112
STATION: UNKNOWN     -81.50     20.10
TIME:    1962.   12.    1.    13.    0.
ELV:     ********
PCC:          0.00
TYPE:          11.       40. ********
SOURCE:  101. 101.
DATA:
 LVL CAT        POB           DWP          TOB         ZOB          DIR          SPD
   1   1    700.0(*)       -3.0(*)       5.0(*)    3115.0(*)    230.0(*)      6.3(*)
----------------------------------------------------------------------
```

Starting around 1967 most of the aircraft reports started including at least one mandatory level and one flight level. Most often the winds are the same for both. It seems reasonable to produce reanalysis data from the flight level when present.

```
--------------------------------------------------------------------------
MESSAGE: ADPUPA       4      1    67010100
STATION: 00082      -165.00    20.00
TIME:    1967.    1.    1.    0.    0.
ELV:     ********
PCC:         0.00
TYPE:        11.       43. ********
SOURCE:  101. 101.
DATA:
 LVL CAT        POB         DWP        TOB         ZOB         DIR        SPD
   1   1    700.0(*) *******(*) *******(*) *******(*)    120.0(*)     7.8(*)
   2   4 *******(*) *******(*) *******(*)   2438.0(*)    120.0(*)     7.8(*)
--------------------------------------------------------------------------
```

Matched and Unmatched Mandatory/Flight Levels

The next two examples, from 1968, show two mandatory and two flight levels. Many of these are like the first, with the flight levels measuring the same wind as the mandatory levels, but there are also many like the second case, where they are different. Regardless, each flight level was used as a separate report for reanalysis.

```
--------------------------------------------------------------------------
MESSAGE: ADPUPA    1020      1    68010218
STATION: 00192      -170.00    20.80
TIME:    1968.    1.    2.    17.    0.
ELV:     ********
PCC:         0.00
TYPE:        11.       43. ********
SOURCE:  101. 101.
DATA:
 LVL CAT        POB         DWP        TOB         ZOB         DIR        SPD
   1   1    300.0(*) *******(*) *******(*) *******(*)    200.0(*)    20.8(*)
   2   1    250.0(*) *******(*) *******(*) *******(*)    340.0(*)    39.6(*)
   3   4 *******(*) *******(*) *******(*)   9448.0(*)    200.0(*)    20.8(*)
   4   4 *******(*) *******(*) *******(*)  11582.0(*)    340.0(*)    39.6(*)
--------------------------------------------------------------------------
--------------------------------------------------------------------------
MESSAGE: ADPUPA    1132      1    68010212
STATION: 00332       132.00    29.50
TIME:    1968.    1.    2.    12.    0.
ELV:     ********
PCC:         0.00
TYPE:        11.       43. ********
SOURCE:  101. 101.
DATA:
 LVL CAT        POB         DWP        TOB         ZOB         DIR        SPD
   1   1    300.0(*) *******(*) *******(*) *******(*)    260.0(*)    71.9(*)
   2   1    250.0(*) *******(*) *******(*) *******(*)    260.0(*)    79.7(*)
   3   4 *******(*) *******(*) *******(*)   9448.0(*)    260.0(*)    85.9(*)
   4   4 *******(*) *******(*) *******(*)  10668.0(*)    260.0(*)    78.1(*)
--------------------------------------------------------------------------
```

More (Better?) Multiple Level Aircraft Data

The final two examples are more common in the later years (1968-1972), containing multiple flight and mandatory levels. These are samples of the largest of these I could find. And, like above, the flight levels are sometimes matched to mandatory levels, and sometimes not.

```
--------------------------------------------------------------------------
MESSAGE: ADPUPA    1020      1    68010218
STATION: 00192     -170.00    20.80
TIME:    1968.    1.    2.    17.    0.
ELV:     ********
PCC:        0.00
TYPE:       11.        43. ********
SOURCE: 101. 101.
DATA:
 LVL CAT        POB         DWP         TOB         ZOB         DIR         SPD
   1   1    300.0(*) *******(*) *******(*) *******(*)   200.0(*)    20.8(*)
   2   1    250.0(*) *******(*) *******(*) *******(*)   340.0(*)    39.6(*)
   3   4 *******(*) *******(*) *******(*)   9448.0(*)   200.0(*)    20.8(*)
   4   4 *******(*) *******(*) *******(*)  11582.0(*)   340.0(*)    39.6(*)
--------------------------------------------------------------------------
--------------------------------------------------------------------------
MESSAGE: ADPUPA    1132      1    68010212
STATION: 00332     132.00    29.50
TIME:    1968.    1.    2.    12.    0.
ELV:     ********
PCC:        0.00
TYPE:       11.        43. ********
SOURCE: 101. 101.
DATA:
 LVL CAT        POB         DWP         TOB         ZOB         DIR         SPD
   1   1    300.0(*) *******(*) *******(*) *******(*)   260.0(*)    71.9(*)
   2   1    250.0(*) *******(*) *******(*) *******(*)   260.0(*)    79.7(*)
   3   4 *******(*) *******(*) *******(*)   9448.0(*)   260.0(*)    85.9(*)
   4   4 *******(*) *******(*) *******(*)  10668.0(*)   260.0(*)    78.1(*)
--------------------------------------------------------------------------
```