Lecture #3 STATUS OF MONITORING OF SATELLITE AND AIRCRAFT DATA, NMC WASHINGTON

In response to Recommendation 8 of CBS-IX, the U.S. National Meteorological Center accepted the responsibility of acting as a lead center for monitoring the quality of observations from satellites and from aircraft. In addition, the NMC is prepared to monitor the quality of other observing systems, and to pass these monitoring statistics to the appropriate lead center.

At NMC, we have assembled the necessary software programs to carry out these obligations. Attached herewith is the results of the monitoring program for the month of January 1989. Also presented are some monitoring tools that have been developed to enable the operations personnel to have rapid access to statistical information on the observations data base. These tools are available at a work station, but are shown here as computer hard-copy.

Radiosonde and Pilot Observatons.

Tables 1 & 2 show the results of monitoring the radiosonde/pilot subsystem. The format follows that set out by the lead center, ECMWF. There are, however, some important differences to consider when comparing or considering the lists from the two centers.

1: The observations of geopotential height that are differenced to the assimilating forecast have been adjusted for the solar radiation effects that NMC has, in the past, determined to be appropriate for each observing station. Thus, the differences do not, in general, apply to the data transmitted on the GTS; nor will they be strictly comparable to the statistics generated by the ECMWF, which does not make such corrections.

2: The observations of geopotential height have also been corrected, when appropriate, for obvious errors of hydrostatic consistency. This algorithm was explained in Lecture #2, together with a brief summary of the monitoring statistics this checking produces.

3: No statistics are given on the frequency with which the listed stations are rejected by the analysis scheme. This information is not readily available in summary form at the present time.

Aircraft Wind Observations.

Figure 1 shows the display of the mean vector differnce for the month of Jan 1989 between the aircraft observations and the assimilating forecast. The vectors are the average of all differences occurring during the month in each 10 by 10 degree longitude-latitude interval. A minimum of 10 differences has been adopted as a threshold for displaying the vectors. A number of comments are also appropriate here:

1. The statistics for the aircraft observations (as well as for the SATOB vectors to be shown next) are averaged in 10x10 degree intervals, rather than in 5x5 degree intervals as is the practice of the ECMWF. (No information is available to us on any threshold number for the ECMWF vector differences.)
2. The presence of vectors over the continental U.S. in the NMC map, and the lack thereof in the comparable ECMWF map, is explained by the fact that the aircraft observations involved are PIREP observations which are not transmitted on the GTS. This deficiency has only recently been rectified. It will be necessary, however, for each operating center to convert from PIREP to a more useable form by considering the proper latitude-longitude coordinates for each position reported by the PIREP. These PIREP reports are of a much lower quality than regular aircraft reports (for a number of reasons). This is clearly shown by the magnitudes of the difference vectors over the continental U.S. versus those over the oceans.

Satellite Cloud Motion Vectors.

Figures 2,3,& 4 show the average bias in the differences between the SATOB vectors (high levels only, here) and the assimilating forecast. The format is the same as with the aircraft winds. However, NMC has chosen to depict the results for each of the SATOB producers separately, instead of together as with the ECMWF. In addition, the NMC accumulates statistics on colocated SATOB vectors. An example of approximately one month of such colocation comparsions is given in Table 3. These results indicate some rather interesting differences in height assignment practices between the satellite operators, as well as an estimate of the uncertainty that can be ascribed to these vectors.

Satellite Temperature Soundings.

Figure 5 & 6 show the monthly average bias between the SATEM 1000-850hPa thickness reports and the assimilating forecast. In these figures, only NOAA-10 SATEM data for the clear-path,(A), and the microwave-channel retrievals,(C), are shown. NMC has chosen this particular graphical depiction because of the obvious, and apparently time-consistent, geographic variations in the bias. Colocation difference profile statistics for a selected net of radiosonde stations are also available, but are not given here.

Discussion

In Table 1, the statistics of geopotential height differences were presented, and attention was drawn to the fact that the NMC attempts to account for some amount of radiosonde instrument incompatability by making short-wave (solar) radiation corrections. This procedure has been carried out at the NMC for many years. We attempt to keep a dictionary of each radiosonde reporting location with the type of sonde used and appropriate correction tables. These correction tables were constructed by consideration of day-night differences in geopotential heights and are set out in McInturff et al (1979). In recent times, maintenance of this procedure has become difficult because of changing radiosonde technology and instrument use practices. Figure 7 indicates the magnitude of the problem. This figure shows the difference in the 100hPa analysis corrections (the analysis minus the assimilating forecast) at 1200UTC from that at 0000UTC for the month of January 1989. The main feature of this map display is the large number of centers located over particular radiosonde sites (or site complexes) with differences of order 40m and greater. In almost every case, the difference center can be ascribed to consistent differences in the reported, and assimilated, 100hPa heights at 00UTC and 12UTC. Such a result indicates that the NMC procedure is not making the appropriate correction. We are presently engaged in revamping our radiosonde correction procedures to use the results of sonde colocation programs, and to extend the procedures to include long-wave, or night-time, corrections as needed.

TABLE 3
Colocation statistics - SATOB vs SATOB High level only
December 1988

GOES-EAST minus ESA(EuMetSat)

Latitude	u diff mps	v diff mps	vector s.d. mps	Alt diff km	Number
40-30N	0.7	4.0	10.1	0.8	10
30-20N	-0.2	-0.1	6.5	0.6	43
20-10N	-0.9	0.3	3.6	0.4	49
10-00N	0.5	-0.5	3.7	0.6	41
00-10S	0.5	-0.6	5.0	0.2	31
10-20S	-0.3	0.1	4.2	0.2	79
20-30S	-0.1	0.1	5.7	-0.1	22
30-40S	0.0	-3.6	9.5	0.3	22

GOES-WEST minus JMA(GMS)

Latitude	u diff mps	v diff mps	vector s.d. mps	Alt diff km	Number
40-30N	-0.9	3.0	7.4	1.2	8
30-20N	-0.1	3.2	6.3	0.7	27
20-10N	1.3	1.8	4.8	-0.8	22
10-00N	1.4	0.9	6.2	-0.4	19
00-10S	2.4	2.8	4.2	-0.8	7
10-20S	1.2	0.5	7.5	-0.3	16
20-30S	-4.6	2.5	8.9	0.7	10
30-40S	-3.4	-2.8	12.6	1.2	19

REFERENCES

Collins, W. & L. Gandin. 1989. The Hydrostatic Checking of Radiosonde Heights and Temperatures, Parts I & II. Office Notes 344 & 351. NOAA, National Weather Service, National Meteorological Center, Washington D.C. (Available from the authors)

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Gandin,L. 1988. Complex Quality Control of Meteorological Observations. Monthly Weather Review, 116,1137-1156.

McInturff,R.M.,F.G. Finger,K.M.Johnson & J. D. Laver. 1979. NOAA Technical Memo,NWS NMC 63, 47pp.

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Observations Data Base Inventory
Example of CRT scope display

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DATE ------------------------> 89-03-02                  -------> LAST 30 DAYS <-------

DATA    DATA    DATA       DATA   30-DAY                  000000000111111111122222222223
FILE    TYPE    TIME       COUNT  MEAN      DEV.   SD     123456789012345678901234567890

SFCSM   511     0000Z   $  4594   4790.3  -196.3   80.3   $_______________$*________*___   SURFACE LAND STATION
        511     0600Z      4940   4983.9   -43.9  127.7   ___________$_*_*______________     BY BLOCK AND STATION
        511     1200Z      5245   4982.0   263.0  479.3   ________________*____#________
        511     1800Z      5018   4900.1   117.9  125.8   __________*_____________$__$_*

        512     0000Z       400    393.1     6.9    9.6   ____*____$*$___*________*_____   SURFACE LAND STATION
        512     0600Z       320    320.7    -0.7    5.0   ____$_____$_____*___________*_     BY CALL LETTERS
        512     1200Z       353    338.0    15.0   63.3   _____________________#________
        512     1800Z   $   353    393.1   -40.1   19.3   $___$___________________#_____

SFCSI   511     0300Z      3500   3710.1  -210.1  247.8   _____________________#________   SURFACE LAND STATION
        511     0900Z      3981   4093.1  -112.1  152.8   ___________*_______$_*_*______     BY BLOCK AND STATION
        511     1500Z   *  3579   3853.2  -274.2  170.5   *__________________________#__
        511     2100Z   *  3763   3895.0  -132.0   98.5   *____________*_____*_______$$_

        512     0300Z       365    364.7     1.3    6.7   ___$$____________________*__*_   SURFACE LAND STATION
        512     0900Z       302    302.9    -0.9    3.8   _$_____*___*_______*___*______     BY CALL LETTERS
        512     1500Z       400    390.4     9.6   13.8   ____**_______________$____$___
        512     2100Z       393    390.3     2.7   10.8   ____________**_________*$___*_

SFCSHP  521     0000Z        11      6.0     5.0    2.1   ______________________________   SURFACE OCEAN STATION
        521     0600Z        12      5.9     6.1    2.1   ______________________________     OCEAN WEATHER STATION
        521     1200Z         8      5.9     2.1    1.9   ______________________________
        521     1800Z        12      6.2     5.8    2.4   ______________________________

        522     0000Z       965    866.7    98.3   35.7   __$___________________________   SURFACE OCEAN STATION
        522     0600Z       818    810.7     7.3   28.1   _____#________________________     MOVING SHIP WITH NAME
        522     1200Z       793    797.5    -4.5   35.1   ______________________________
        522     1800Z       775    788.2   -13.2   17.1   ______________________________

        523     0000Z        41     36.7     4.3    3.7   ______________________________   SURFACE OCEAN STATION
        523     0600Z        33     32.0     1.0    3.9   ___*__________________________     MOVING SHIP WITHOUT N
        523     1200Z        33     33.1    -0.1    5.1   ______________________________
        523     1800Z   $    27     35.1    -8.1    2.8   $_$___________________________

        531     0000Z        82     80.5     1.5    1.0   ______________________________   SURFACE OCEAN STATION
        531     0600Z        82     80.5     1.5    0.9   ______________________________     STATIONARY (CMAN AND
        531     1200Z        82     80.5     1.5    1.0   ______________________________
        531     1800Z        82     80.4     1.6    0.8   ______________________________

        561     0000Z       123    120.8     2.2    3.6   ___*__________________________   SURFACE OCEAN STATION
        561     0600Z       138    131.8     6.2    5.6   ______*_______________________     STATIONARY BUOYS
        561     1200Z   *   127    132.2    -5.2    3.4   *_____________________________
        561     1800Z       130    129.7     0.3    5.7   ______________________________

        562     0000Z       252    164.5    87.5   20.8   __$___________________________   SURFACE OCEAN STATION
        562     0600Z       214    152.6    61.4   30.2   _*____________________________     DRIFTING BUOYS
        562     1200Z       221    175.3    45.7   31.0   ______________________________
        562     1800Z   *   179    203.9   -24.9   25.9   *___*_________________________
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ADPUPA  011   0000Z      948    925.4    22.6   15.5   ____*______**_______________*$__*   UPPER-AIR LAND STATION
        011   0600Z      371    378.7    -7.7   12.1   ____________*__*______***___$____     BY BLOCK AND STATION
        011   1200Z      977    939.4    37.6   34.4   _____________*_______*_*____*#___
        011   1800Z      405    389.5    15.5   16.1   ________________*___*________#___

        021   0000Z        3      2.7     0.3    0.5   _____********________*___________   UPPER-AIR OCEAN STATIO
        021   0600Z  *     2      2.6    -0.6    0.5   *____****$***________*___________     OCEAN WEATHER STATIC
        021   1200Z        3      2.7     0.3    0.5   _____****#****___________________
        021   1800Z        3      2.6     0.4    0.7   ______$__$$______________________

        022   0000Z       12     10.3     1.7    1.9   _________*________*___*________$_   UPPER-AIR OCEAN STATIO
        022   0600Z        0      0.5    -0.5    0.6   _________________________________     MOVING SHIP WITH NAM
        022   1200Z       11     10.3     0.2    1.8   _**___________*________*________*
        022   1800Z        0      0.5    -0.5    0.5   _________________________________

        023   0000Z        1      1.3    -0.3    0.6   ____$________________________$__$   UPPER-AIR OCEAN STATIO
        023   0600Z        0      0.1    -0.1    0.3   _________________________________     MOVING SHIP WITHOUT
        023   1200Z        1      1.1    -0.1    0.3   _________________________________
        023   1800Z        0      0.0     0.0    0.0   _________________________________

        031   0000Z       10     10.3    -0.3    8.5   ____*_*___*___*__________**___*__   UPPER-AIR RECONNAISSAN
        031   0600Z        0      1.2    -1.2    2.5   _________________________________
        031   1200Z        0      5.2    -5.2    6.1   _________________________________
        031   1800Z        2      7.0    -5.0    6.7   _____***__*_____**________*___*_

AIRCFT  041A  0000Z      938    993.8   -55.8   57.9   __________________$__*_______*_**   UPPER-AIR AIREPS
        041A  0600Z      980    971.1     8.9   66.4   _______**_________*_______*______
        041A  1200Z      898    921.8   -23.8   57.2   __$$___________________*_________
        041A  1800Z  *   983   1089.5  -106.6   87.6   *___*______*_______________$_____

        041P  0000Z      101     94.3     6.7   24.6   _____*_____**______**_______*____   UPPER-AIR PIREPS
        041P  0600Z       25     32.0    -7.0   12.0   __*__**____**_______*_______*____
        041P  1200Z       69     37.1    31.9   14.0   ______*______**_____**______*____
        041P  1800Z      164    123.2    40.8   28.1   ______*____*_*______*$_______*___

SATWND  063A  0000Z      624    593.4    30.6  134.9   __________*__________*_____**_*__   UPPER-AIR CLOUD WIND E
        063A  0600Z      285    338.9   -52.9  134.0   ______________________$_______***     GOES EAST
        063A  1200Z      388    392.2    -4.2  101.5   ______________*____*____#________
        063A  1800Z      553    492.9    60.1   84.3   __________*___________$______*___

        063B  0000Z        0      0.0     0.0    0.0   _________________________________   UPPER-AIR CLOUD WIND E
        063B  0600Z        0      0.0     0.0    0.0   _________________________________     GOES WEST
        063B  1200Z        0      0.0     0.0    0.0   _________________________________
        063B  1800Z        0      0.0     0.0    0.0   _________________________________

        063V  0000Z        0      0.0     0.0    0.0   _________________________________   UPPER-AIR CLOUD WIND E
        063V  0600Z       71     95.6   -24.6   75.2   ______________*________________**     INDIA
        063V  1200Z        0      0.0     0.0    0.0   _________________________________
        063V  1800Z        0      0.0     0.0    0.0   _________________________________

        063Y  0000Z  #     0    646.8  -646.8  130.1   #________________________________   UPPER-AIR CLOUD WIND E
        063Y  0600Z  $   615    715.1  -100.1   49.8   $________**___________**_________     JAPAN
        063Y  1200Z      451    531.5   -30.5  172.9   _#______________________*_____**_
        063Y  1800Z      637    549.6    87.4  131.6   __*_____*__**___**_______**______

        063Z  0000Z      489    450.9    38.1  148.4   _________*_____________*_______##   UPPER-AIR CLOUD WIND E
        063Z  0600Z      517    522.2    -5.2  162.6   _________________*_____________##     EUROPE
        063Z  1200Z      587    566.2    20.8  125.3   ____*___________________________#
        063Z  1800Z      401    492.2   -91.2  152.9   _____*________#_________________#

SFCBOG  051D  0000Z      320    348.3   -28.3   93.4   __________***__*_________________   SURFACE BOGUS
        051D  0600Z  M     0      0.0     0.0    0.0   MMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMM     SLP FOR NORTHERN HEM
        051D  1200Z      242    254.4   -12.4  120.8   ______________________$$$$_______
        051D  1800Z  M     0      0.0     0.0    0.0   MMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMM

        051S  0000Z      518    446.1    71.9   61.1   __________________________*******   SURFACE BOGUS
        051S  0600Z  M     0      0.0     0.0    0.0   MMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMM     MOISTURE
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TABLE 1
LIST OF SUSPECT STATIONS: TEMPS - GEOPOTENTIAL HEIGHT

Jan 1989

Monitoring Center: U.S. NMC

Standard of Comparison : Six-Hour Forecast
Standard Level (1000-100 hPa)
Selection Criteria : at least 10 Obs and 100m RMS difference

WMO Ident	Obs Time	Level	Obs Recd	RMS Dif	Bias
4202	12	100	14	101	-59
15420	12	100	27	148	88
21358	12	100	28	121	103
22113	00	100	28	130	101
22113	12	100	28	161	132
22820	00	150	27	118	85
22820	12	100	28	166	137
22845	12	100	19	150	122
23078	00	100	24	145	110
23078	12	100	23	165	127
23205	00	100	27	105	-11
24641	12	100	23	106	99
26063	12	250	24	109	74
26422	00	100	25	149	-138
26422	12	100	28	131	-116
26781	12	100	17	108	50
29263	00	100	26	105	95
29263	12	100	25	108	92
31168	00	100	19	103	93
31770	00	100	26	102	95
33393	00	100	31	103	31
33393	12	100	31	115	33
33658	12	100	28	114	68
34300	00	100	20	140	124
34300	12	100	26	161	151
38507	00	100	26	154	143
38507	12	100	30	143	132
38879	12	200	11	104	-38
40437	00	100	18	180	68
44259	12	100	27	141	113
44288	00	100	25	111	22
44354	00	150	25	113	71
44354	12	100	23	108	82
44373	00	100	28	206	174
44373	12	100	27	161	155
48327	00	100	24	152	-13
48820	00	100	13	107	100
51886	12	150	22	108	-24
54337	00	100	17	122	-61
56964	00	100	28	139	119

TABLE 1

IST OF SUSPECT STATIONS: TEMPS - GEOPOTENTIAL HEIGHT
(meters)

Jan 1989

Monitoring Center: U.S. NMC

Standard of Comparison : Six-Hour Forecast
Standard Level (1000-100 hPa)
Selection Criteria : at least 10 Obs and 100m RMS difference

MO Ident	Obs Time	Level	Obs Recd	RMS Dif	Bias
56964	12	100	29	135	128
57957	12	100	27	103	94
59431	00	100	24	106	92
59431	12	100	29	105	93
59758	12	100	28	105	98
60760	12	100	25	121	29
61996	12	100	15	102	-95
62721	12	100	10	153	142
82193	12	100	23	115	98
82400	12	100	16	133	97
83378	00	100	27	114	90
83378	12	100	30	109	93
89001	12	100	16	167	38
94312	00	100	28	103	19
96237	00	100	13	140	-108
UHQS	12	150	15	104	80

N.B. All geopotential observations from Block 42&43 stations
are not used and do not appear in this Table.

TABLE 2
LIST OF SUSPECT STATIONS: TEMPS/PILOTS - WINDS

JAN 1989

Monitoring Center: U.S. NMC

Standard of Comparison : Six-Hour Forecast

Standard Level (1000-100 hPa)
Selection Criteria : at least 10 Obs and 15 mps rms vector

WMO Ident	Obs Time	Level	Obs Recd	RMS Dif	uBias	vBias
7510	00	200	23	22.4	0.9	3.2
15120	00	100	24	16.9	-6.4	-3.2
15420	00	100	21	17.1	-4.1	-0.8
15480	00	100	29	16.0	-6.3	-5.3
16622	12	250	21	15.7	0.1	2.5
24259	00	100	28	17.3	-4.9	-15.4
24959	12	100	26	17.2	-4.2	-15.2
30635	00	100	27	15.3	-3.2	7.8
30635	12	250	29	15.0	0.6	6.8
38392	00	200	26	18.7	-1.7	0.3
41530	00	150	16	26.7	-0.6	-6.9
41661	00	300	14	41.1	-38.1	-2.0
41675	00	300	13	28.2	-20.9	-6.6
41780	00	200	12	20.9	-9.1	3.5
41780	12	200	23	16.3	-6.9	2.9
42027	00	250	19	27.8	-17.9	-2.2
42027	12	200	17	26.5	-13.9	-7.2
42182	00	250	22	18.1	11.2	-1.5
42182	12	200	22	15.6	8.1	4.1
42339	12	150	13	18.4	1.1	9.1
42410	00	250	17	16.1	2.5	-2.4
42492	12	300	13	15.6	2.4	-10.9
42779	12	250	12	16.8	-5.6	1.4
43014	00	250	15	17.4	10.6	-0.3
43014	12	150	11	16.7	10.8	-0.5
44259	00	200	20	17.3	-2.4	-0.3
47138	00	150	31	27.1	-22.9	9.1
47138	12	150	30	24.3	-20.0	8.9
47158	12	250	30	15.7	9.6	2.7
47185	12	250	29	15.2	2.4	3.3
48820	00	300	10	18.5	7.1	-1.7
54497	00	150	26	19.3	13.1	2.9
55299	00	300	24	15.5	-0.6	5.2
55299	12	200	11	23.5	3.3	-9.2
55591	00	300	26	15.8	7.0	-4.8
55591	12	250	23	19.8	12.7	-7.7
56029	00	250	28	15.5	2.7	-4.6
56137	00	250	19	15.7	5.1	-9.4
56146	12	400	28	15.8	0.6	-2.3
56571	00	250	28	15.1	7.7	-6.7
56651	00	300	14	17.8	10.2	-8.2
56651	12	300	18	16.7	0.9	-4.8

TABLE 2
LIST OF SUSPECT STATIONS: TEMPS/PILOTS - WINDS

JAN 1989

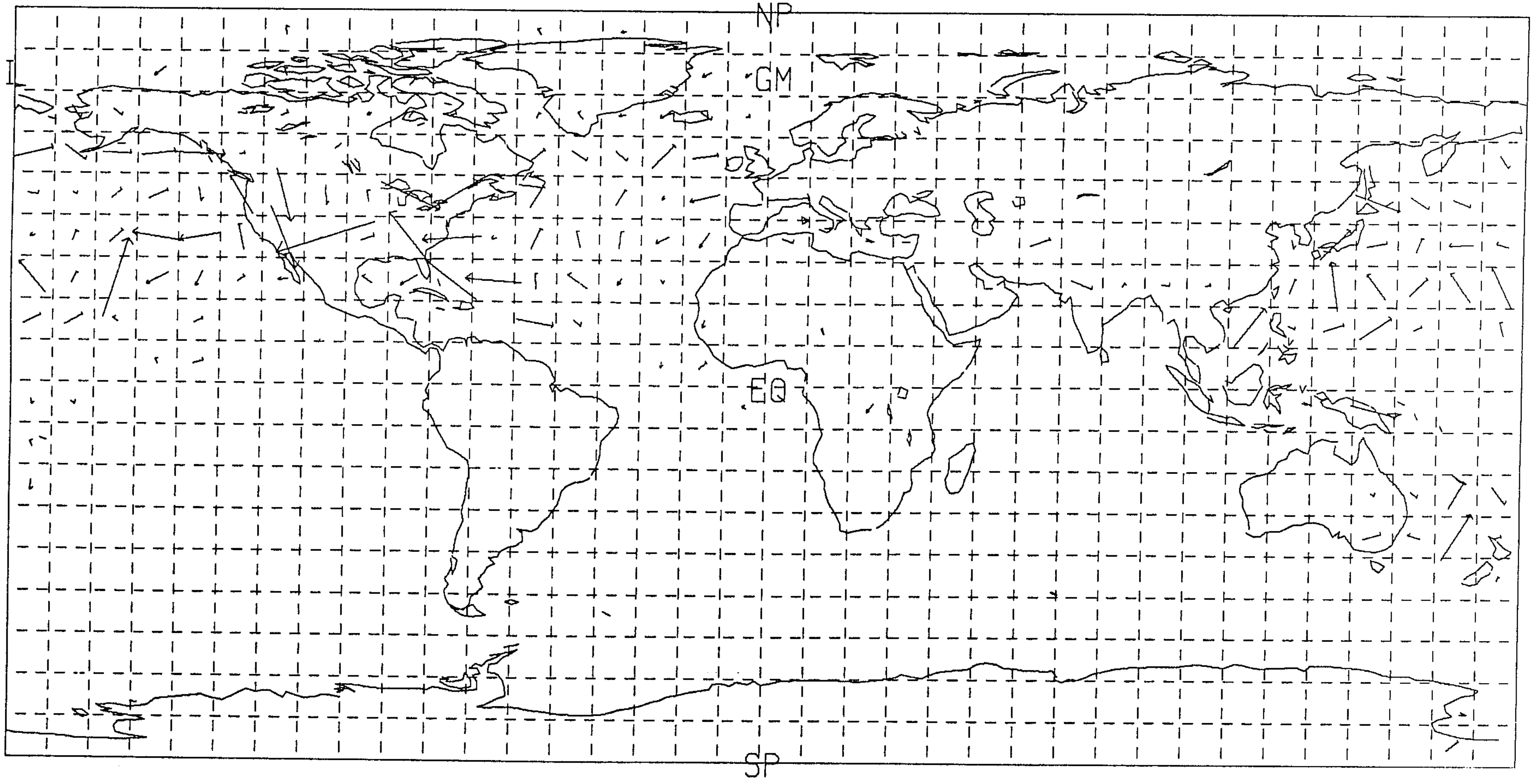
Monitoring Center: U.S. NMC

Standard of Comparison : Six-Hour Forecast

Standard Level (1000-100 hPa)
Selection Criteria : at least 10 Obs and 15 mps rms vector

WMO Ident	Obs Time	Level	Obs Recd	RMS Dif	uBias	vBias
57245	12	300	22	15.5	-3.9	-7.4
58666	00	300	29	25.1	12.1	13.9
58666	12	300	29	25.4	13.4	15.2
60571	00	200	24	15.2	8.3	-3
60630	00	150	16	24.9	11.2	-1.5
60630	12	200	19	15.5	5.4	-2.7
61223	12	300	12	16.8	-7.4	1.6
62721	12	200	13	20.3	3.6	0.4
68816	00	150	29	19.3	5.7	-9.6
68816	12	200	30	17.0	5.4	-6.8
68994	00	250	18	20.9	-6.2	-4.7
76151	12	250	19	15	0.1	4.0
76644	12	100	27	17.1	-4.3	-2.2
87155	12	150	29	16.1	6.4	2.6
87344	12	200	16	15.1	-3.2	-1.4
87576	12	250	29	15.8	3.5	0.6
87623	12	200	23	15.9	-4.8	-0.9
89001	00	300	16	17.6	-6.9	4.1
89001	12	300	18	23.1	-6.3	8.8
89009	00	300	25	15.7	4.0	0.7
89009	12	300	25	16.1	1.6	1.9
96237	00	100	16	16.3	2.1	-1.9
DBBH	12	300	13	16.0	-6.4	2.3

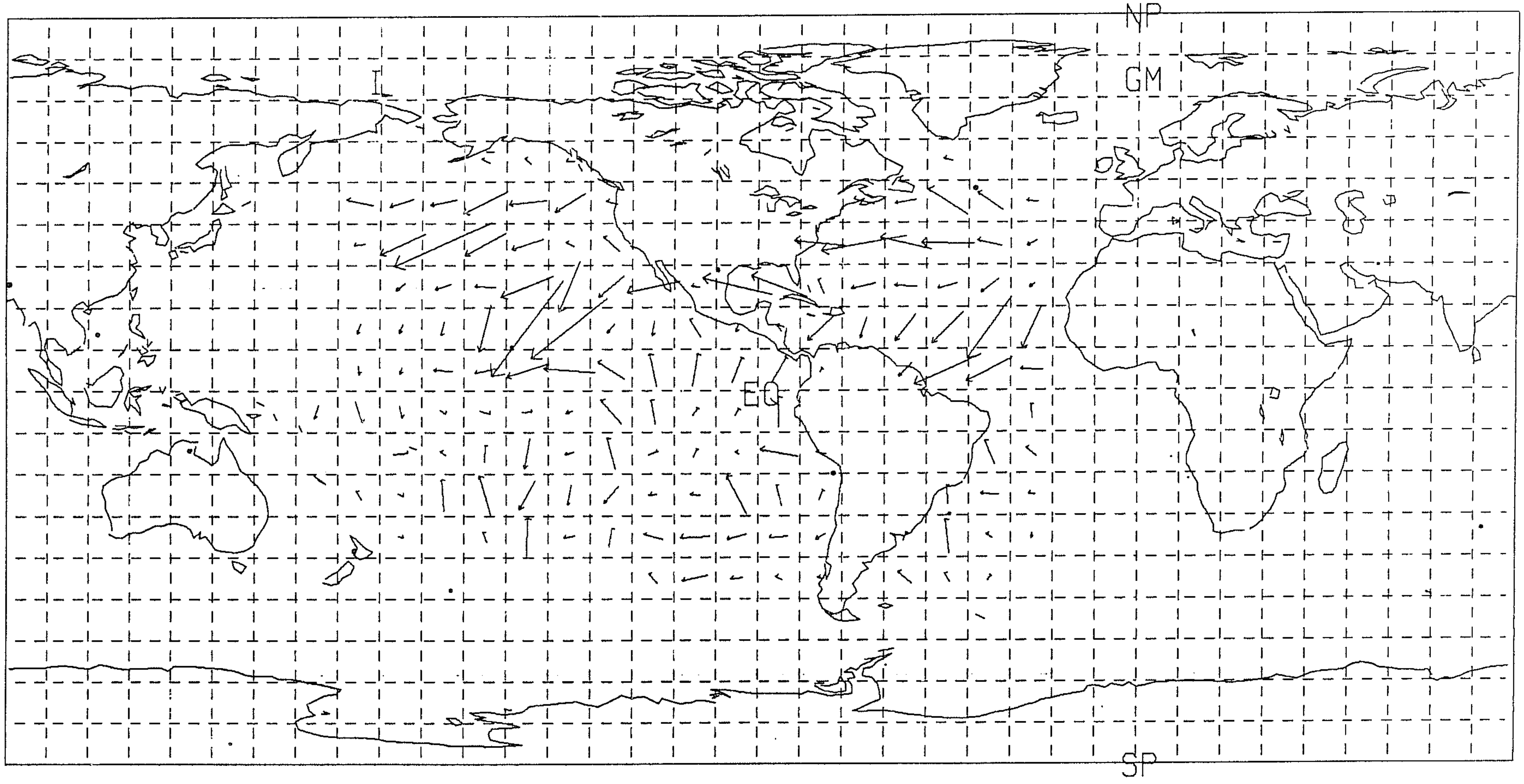
3



AIRCRAFT , OBS–6HR FCST

28 DAYS IN AVE., DATE 89/01/31

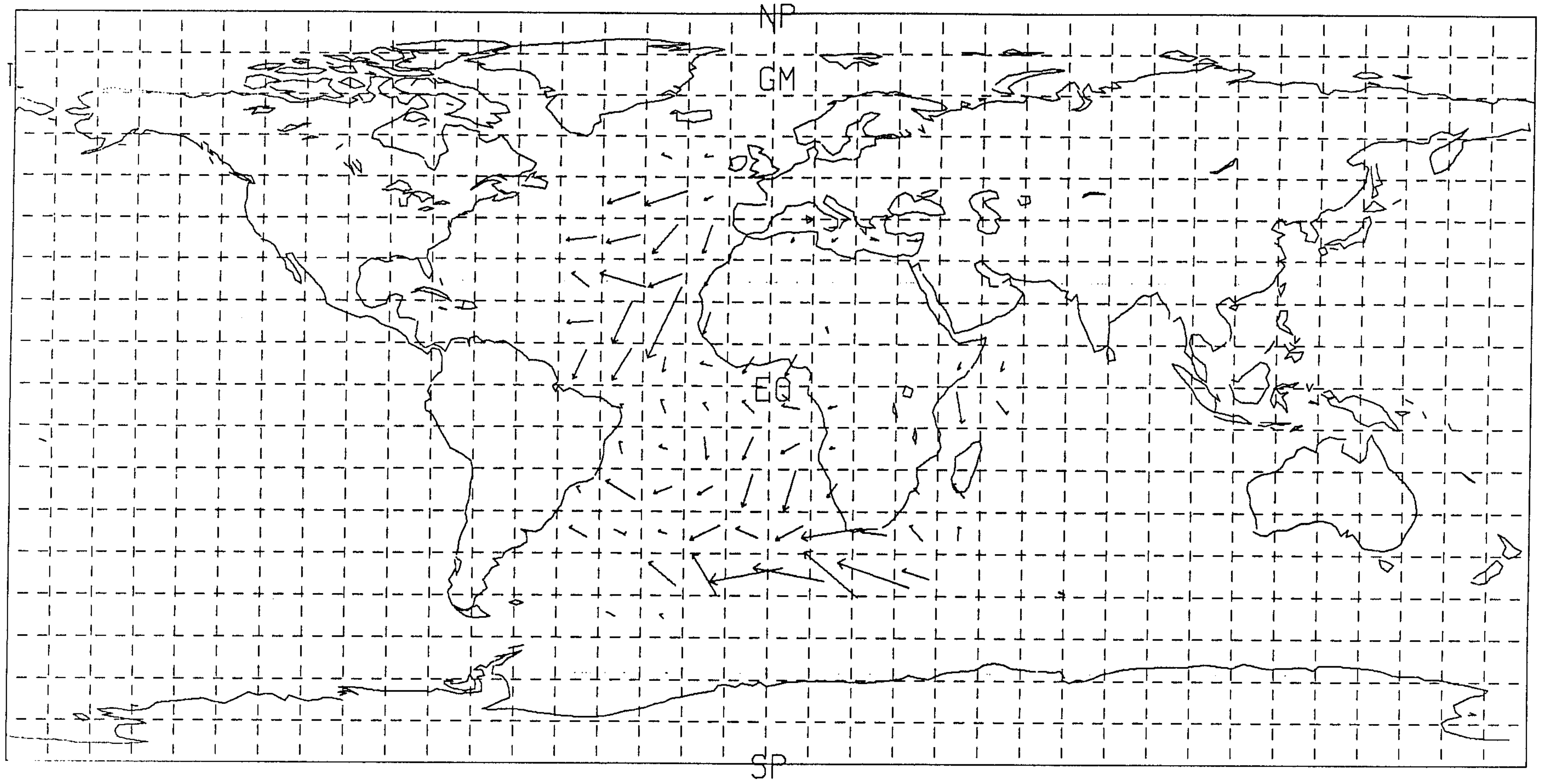
4 MPS 8 MPS



NESDIS SATOB , OBS−6HR FCS

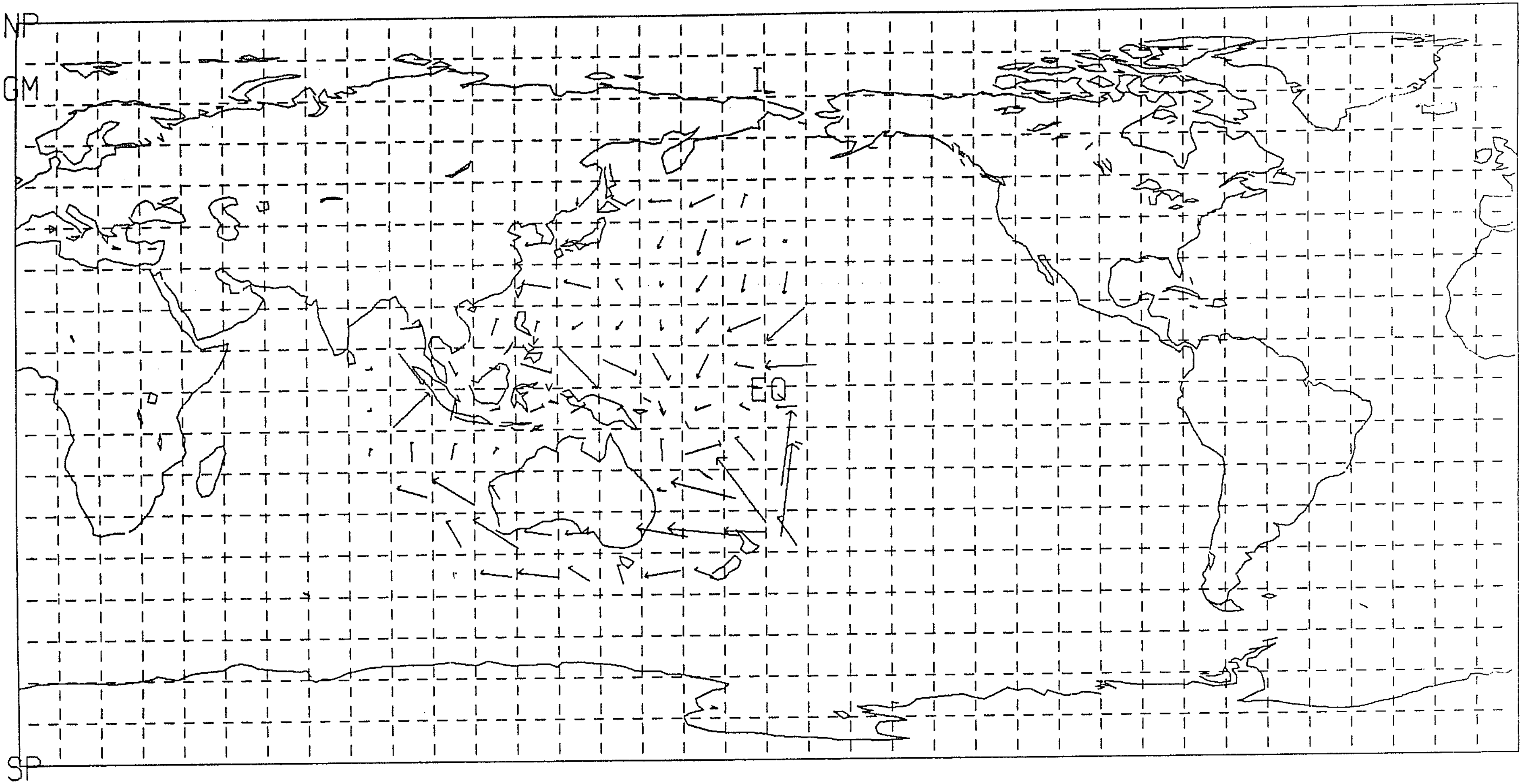
— 4 MPS — 8 MPS

28 DAYS IN AVE., DATE 89/01/31



ESA SATOB , OBS-6HR FCST

28 DAYS IN AVE., DATE 89/01/31



JMA SATOB , OBS–6HR FCST

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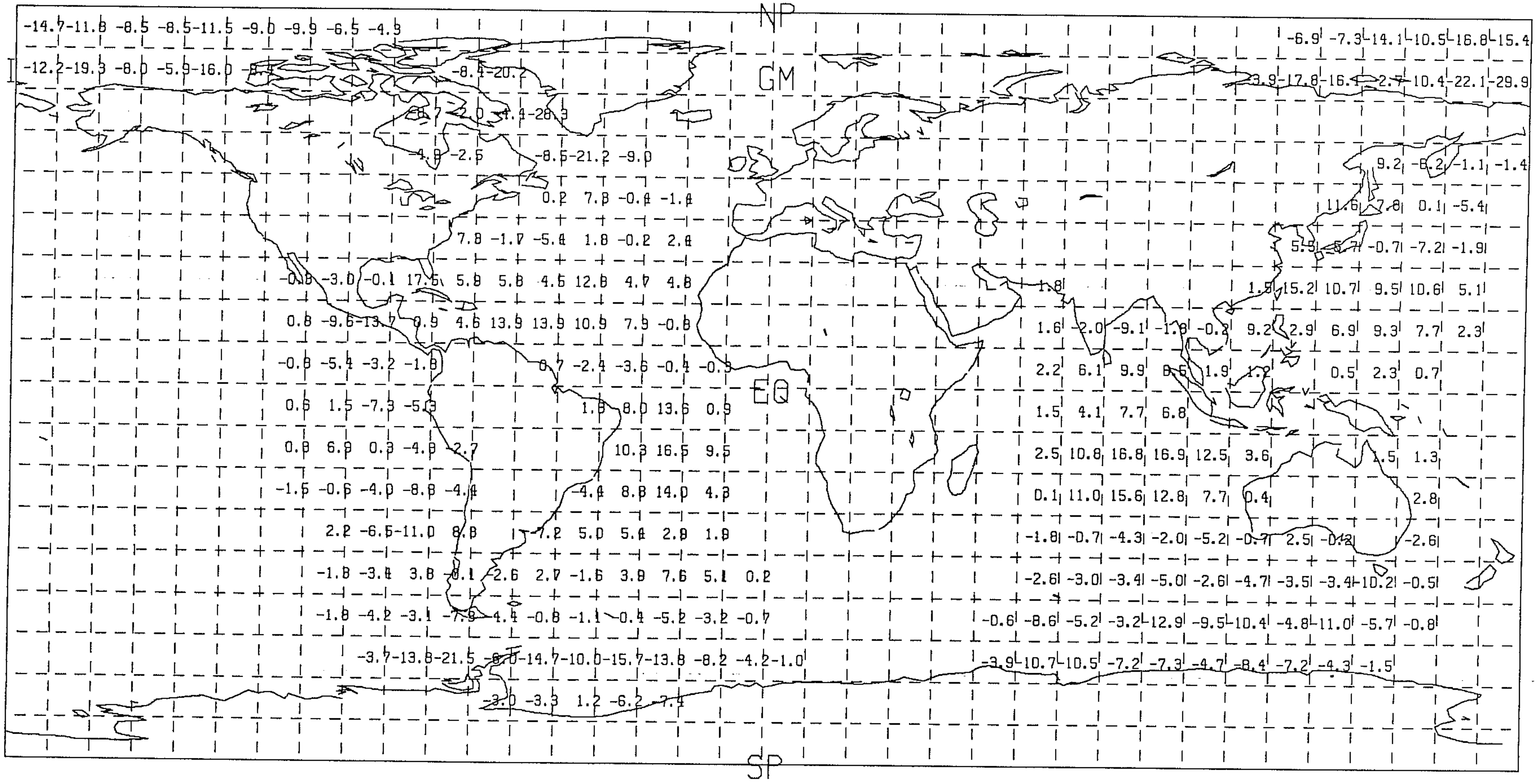
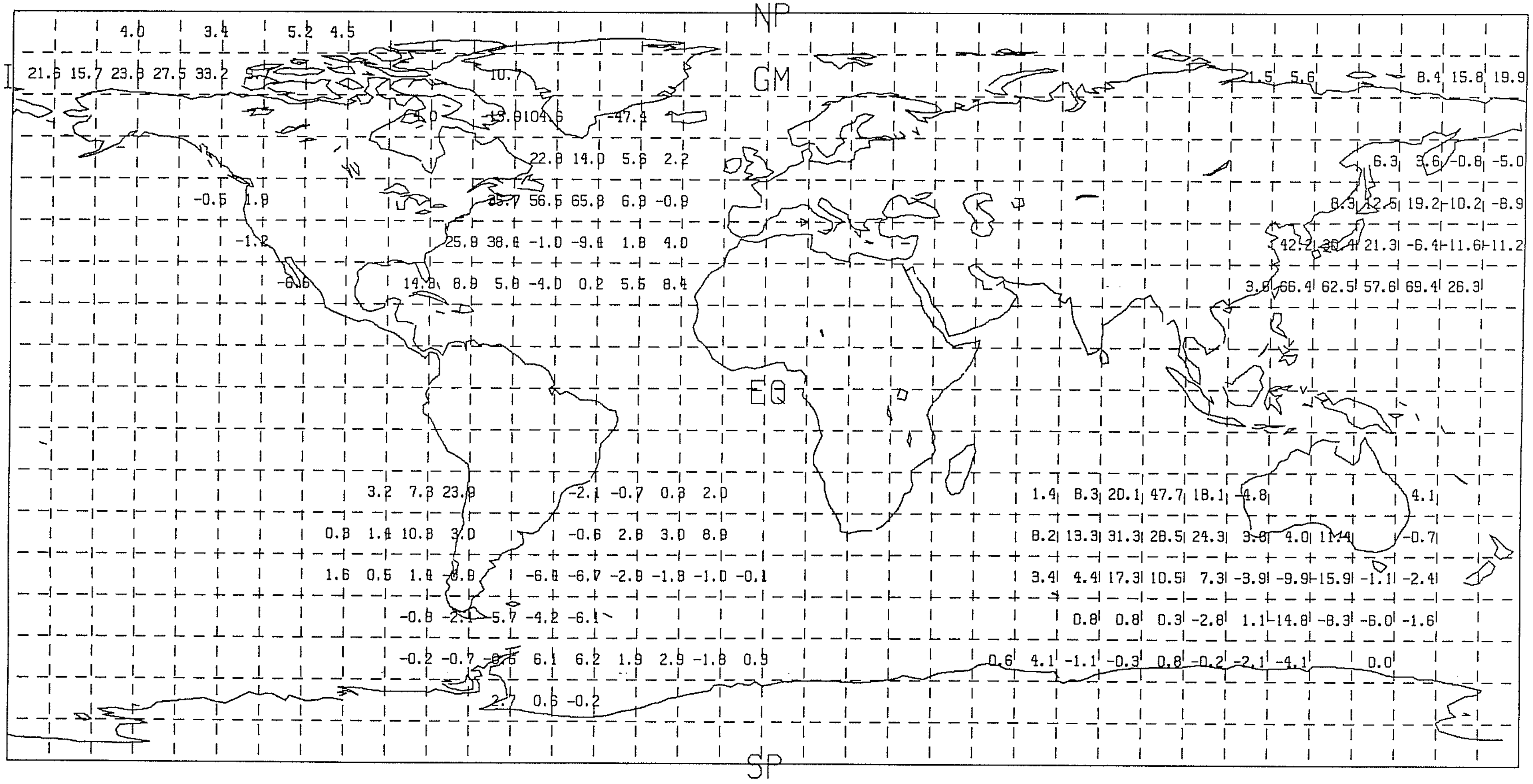


NOAA-10 (A)/H2O 850MB BIAS

28 DAYS IN AVE., DATE 89/02/28



NOAA-10 (C)/H20 850MB BIAS

28 DAYS IN AVE., DATE 89/02/28

Z 100MB 1989 1 JAN. FT= 0 12-00Z INCRM 31 DAY