CENTRAL FORECASTING MONITORING NOTE NO. 6

QUALITY OF HIGH-LEVEL SATOBS FROM DIFFERENT SATELLITES

FEBRUARY 1990 - APRIL 91

S. R. Waters

Central Forecasting Division

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Central Forecasting Division
Meteorological Office
London Road
Bracknell
Berkshire
RG12 2SZ

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Figures and Tables

1. Introduction

Ten by ten degree box statistics for various types of observations are produced on a monthly basis by C.F. division, from the OPD. The statistics for high-level (100 hPa to 400 hPa) SATOBS in recent months has led to concern over the quality of observations from the GOES satellite, see figures 1-3. The purpose of this study was to determine any changes in the quality of SATOBS over the past year, with particular interest in assessing whether any GOES observations should be rejected from the operational model. Also observations from GMS above 500 hPa, north of 20° N and south of 20° S are currently rejected, and one would like to know whether this is justified.

2. Data and Statistics Used

2.1 For the purposes of this study the OPD archive for individual SATOBS was used. Three lots of statistics were produced. The first set of statistics were for April 1990, and 1991, and concerned only GOES and GMS. The second set covered February 1990, and 1991, and covered GOES, GMS, METEOSAT, and INSAT. Lastly statistics covering the whole period from the beginning of May 1990 to the end of April 1991 were produced. Too few INSAT observations were received during the period concerned to produce meaningful statistics and are not considered further.

2.2 For the vertical band 100 hPa to 400 hPa, statistics were produced for each satellite. These were stratified by latitude bands (60°N to 30°N, 30°N to EQT, EQT to 30°S, 30°S to 60°S), and further broken down both by the observed speed, and by the mean of observed and background speed. Each of these were again broken down into two groups, one for all observations, and one with outliers excluded ('Outliers' refers to observations having a RMS vector difference from background greater than 25 m/s). The actual statistics produced for each of these were; observation minus background, and observation minus analysis speed difference, and RMS vector wind difference from background and from analysis.

3. Comments

3.1 A significant factor when comparing the RMS vector difference and mean biases, is that in general these increase with increasing speed. So an apparent improvement in the figures may merely reflect that fewer high speed observations are present. Table 1 shows the percentages of observations greater than 50 m/s for each satellite in each month.

Table 1

Table shows percentage of observations with a wind speed >50m/s and total number of observations for month.

	2/90	2/91	4/90	4/91
GOES	2.4 15872	4.0 11708	3.9 14915	4.9 18616
GMS	0.5 26251	0.3 13296	0.7 28138	1.7 20364
METEOSAT	2.9 28237	4.6 22359	- -	- -

3.2 During the study it became apparent that the GMS SATOBS are no longer assigned heights as detailed in 'Cloud track wind measurement by the Japanese' by Tetsuro Fukui, see table 2. For example in April 1991 a small number of observation were found to have been assigned to a height of 400 hPa.

3.3 The behaviour of the bias is interesting to note. In general, when the bias was broken down by the mean of observed and background wind speed, a positive bias is seen at both very low and very high speeds, but a negative bias at moderate speeds, table 3 is a typical example. Both SATOBs and the model background field are known to have a negative speed bias at high wind speeds when compared to AIREPS and Sondes. So the positive bias for SATOBS at high wind speeds implies that the negative bias of the model is greater than that of the observations.

4. Results

Tables 4 and 5 form a summary of the statistics obtained for February and April. Tables 6 to 11 are the statistics produced for the whole year May 1990 to April 1991 (Inclusive), in the latitude bands 30S to 60S and 30N to 60N. Examining these tables reveals the following.

4.1 No significant trends in biases for any of the satellites.

4.2 Despite a large proportion of high wind speeds observed, the GMS RMS values for February and April 1991 are in general better (smaller) than the corresponding values in 1990. However the percentage of high wind speed observations for GMS is much less than for either GOES or METEOSAT, although the mean jet strength in the North Pacific is higher than elsewhere.

4.3 METEOSAT also had an overall increase in the proportion of high observed wind speeds, except for the region 30N-60N where a significant reduction took place, but all the figures for RMS in February 1991 are slightly better than the corresponding figures in February 1990.

4.4 The RMS values for GOES are more mixed, in the Northern hemisphere the values for February 1991 were particularly bad, in the Southern hemisphere the values for April 1991 were also significantly worse than figures in the previous year. GOES has also had an increase in the number of observations of high wind speed.

4.5 The results for the complete year (tables 6-11) indicate that GOES is worse than GMS or METEOSAT in terms of RMS values for both 30N to 60N and 30S to 60S. (Note that O-A statistics cannot readily be compared for the different satellites since GMS observations are not used in these latitude bands whereas METEOSAT and GOES are used). The relative difference between GOES and the other satellites is greatest in the 30N to 60N band.

5. Conclusions

METEOSAT continues to give good observations in this vertical band (100 hPa to 400 hPa). These figures imply that GMS and METEOSAT have both improved in quality. GOES whilst not having deteriorated in terms of bias has shown more erratic behaviour and gives significantly larger RMS vector wind differences over the complete year.

There is little difference in the RMS values between METEOSAT and GMS in the Northern hemisphere, though as noted earlier, GMS produces significantly smaller proportion of observations with high wind speeds.

6. Implications

6.1 As a result of these findings, and other considerations such as data coverage, GOES observations north of 20°N and above 500 hPa are now rejected from the model (as of 16th July).

6.2 GMS observations polewards of 20N and 20S above 500 hPa continue to be rejected.

NUMBER OF SATOB OBSERVATIONS BETWEEN 101 AND 400 HPA
1/04/91 TO 30/04/91

0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	36	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11	0	0
0	89	158	157	153	87	0	0	0	0	0	80	91	52	137	193	116	87	71	89	124	230	0	0	0	0	0	0	16	38	43	57	68	73	97	51
101	107	160	163	138	127	38	13	0	0	160	219	198	226	287	183	109	112	138	224	230	400	288	0	0	0	0	0	114	182	161	112	207	242	320	295
107	72	54	78	299	448	511	407	373	289	167	125	101	205	187	302	342	203	167	254	391	257	274	0	0	0	0	53	75	75	90	117	161	143	103	69
498	192	275	304	371	401	395	272	178	270	320	274	376	656	638	284	116	262	339	290	248	79	60	29	0	0	37	345	250	73	88	90	160	205	271	393
264	52	122	173	164	164	156	135	185	118	173	195	159	431	181	204	281	369	376	382	334	198	74	0	0	0	62	586	394	395	321	441	334	398	345	331
362	104	108	145	143	123	85	116	102	100	132	149	96	546	312	216	150	273	476	677	377	233	120	0	0	0	101	511	375	464	375	431	396	382	396	392
346	123	148	183	173	89	53	65	107	100	105	180	235	326	241	93	39	0	31	64	34	52	329	91	0	0	0	245	215	166	178	185	259	212	255	287
347	113	198	274	311	264	162	149	49	70	107	93	162	444	231	230	253	156	42	60	27	36	169	39	0	0	0	46	49	109	144	138	162	191	327	320
69	53	66	108	157	160	131	157	175	126	113	69	73	137	385	374	268	359	276	30	187	205	88	0	0	0	0	33	190	127	197	138	103	80	127	191
0	0	0	23	37	58	55	57	61	62	18	33	30	0	115	219	280	289	303	361	299	212	0	0	0	0	0	0	40	219	284	248	163	127	150	28
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

GOES | METEOSAT | GMS

Fig 2

SATOBS : MEAN O-B SPEED DIFFERENCES (M/S) BETWEEN 101 AND 400 HPA
1/04/91 TO 30/04/91
ALL OBSERVATIONS
VALUES ARE PRINTED WHERE > 10 OBS ARE PRESENT

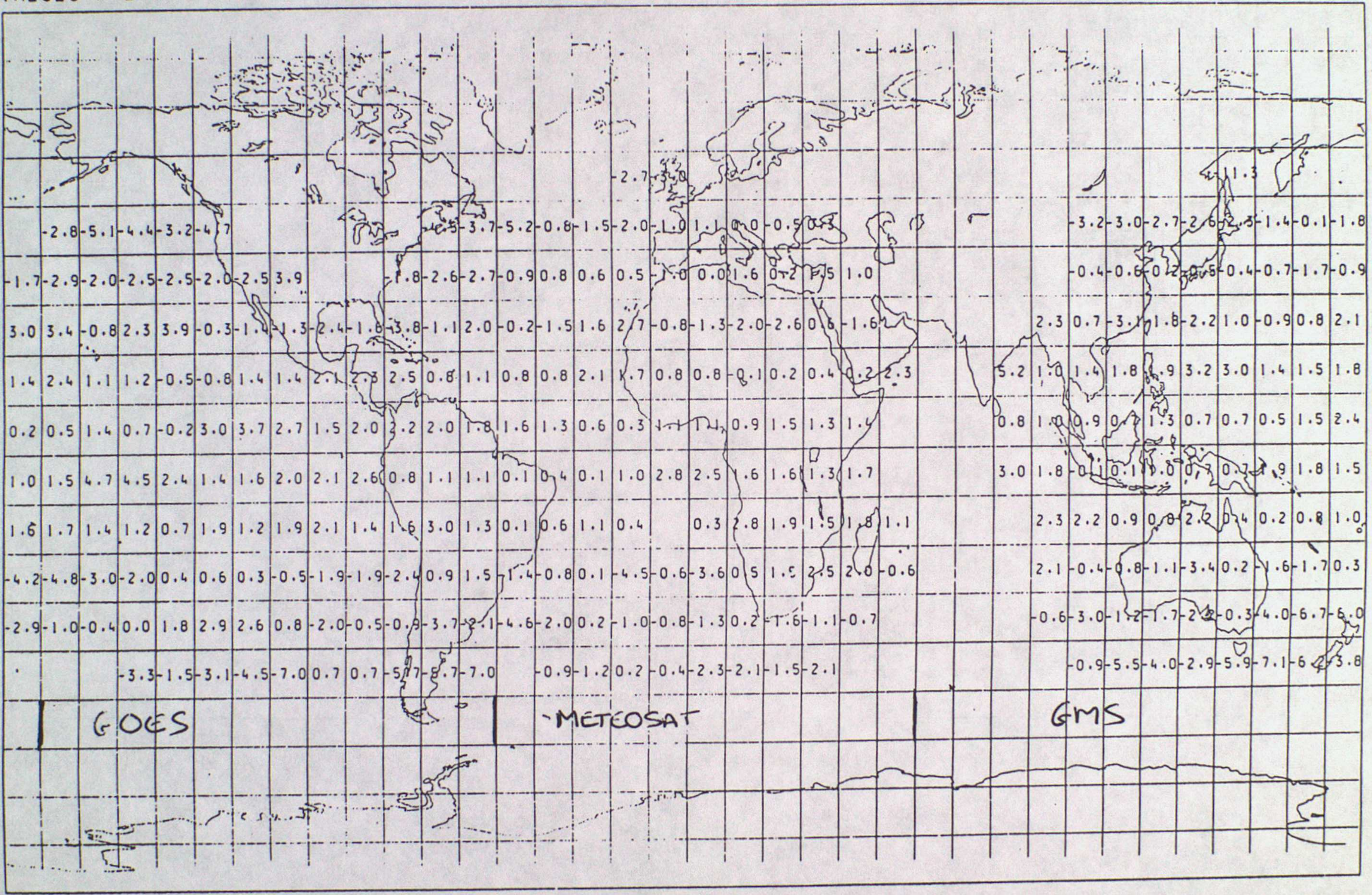

Fig 3

SATOBS : RMS O-B VECTOR DIFFERENCES (M/S) BETWEEN 101 AND 400 HPA
1/04/91 TO 30/04/91
ALL OBSERVATIONS
VALUES ARE PRINTED WHERE > 10 OBS ARE PRESENT

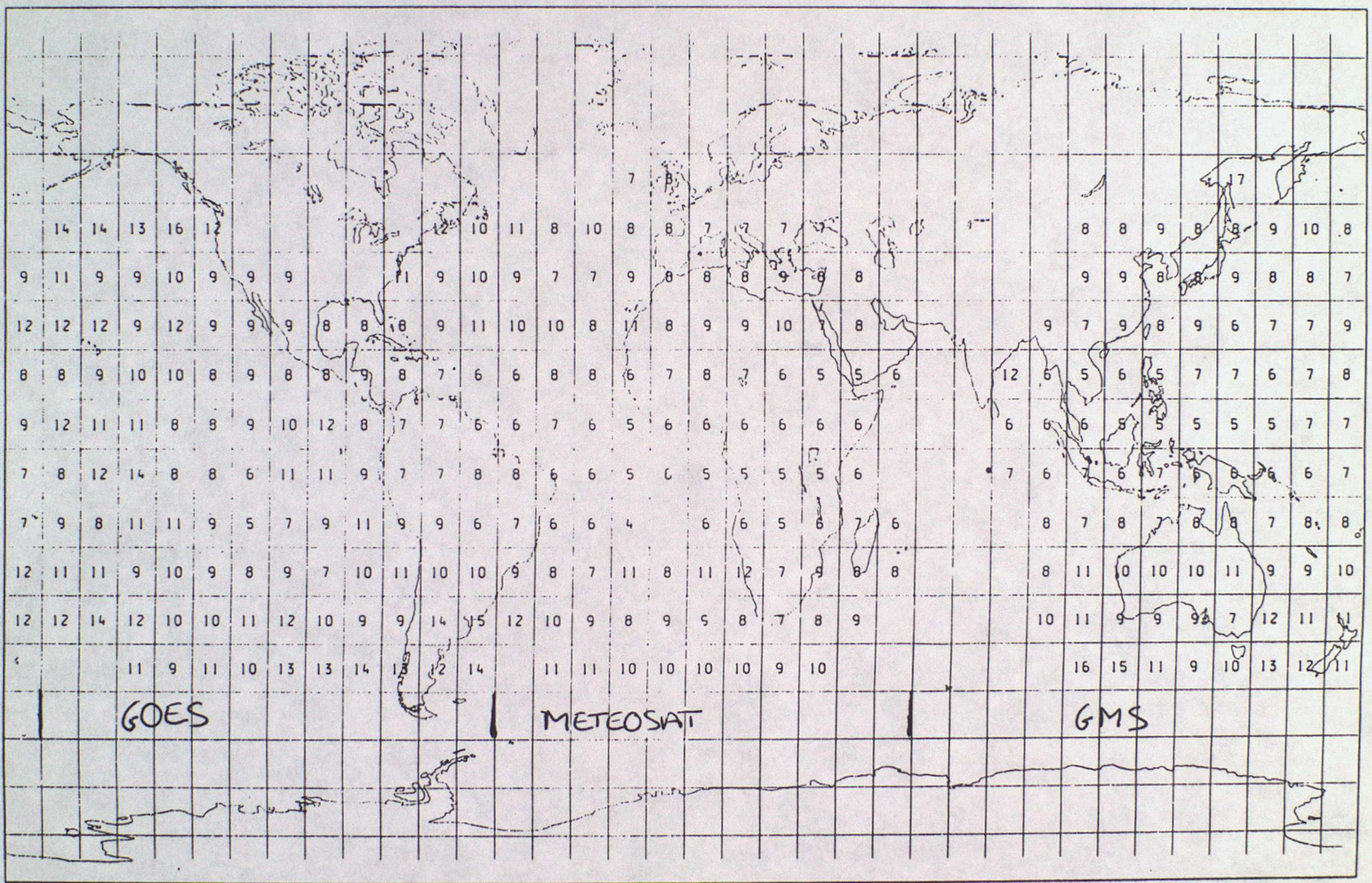

TABLE 2.

Wind representative height to be assigned to high-level cloud motion winds derived from CWES system

SEASON (Northern Hemisphere)	WINTER	SPRING	SUMMER	AUTUMN
NORTHERN HEMISPHERE (35°N / 25°N)	400 mb	300	250	300
NORTHERN HEMISPHERE	200	200	200	200
EQ				
SOUTHERN HEMISPHERE	200	200	200	200
SOUTHERN HEMISPHERE (25°S / 35°S)	250	300	400	300
SEASON (Southern Hemisphere)	SUMMER	AUTUMN	WINTER	SPRING
	DEC 14/15	MAR 14/15	JUNE 14/15	SEP 14/15

DEC 14

TABLE 3.

APRIL 1971

GOES: ALL OBSERVATIONS

LATITUDES 60N-30N

BAND 400-100 HPA

TOTAL NUMBER OF OBS USED 2438

MEAN. SPEED M PER S	MEAN SPEED DIF O-B	MEAN SPEED DIF O-A	RMSVW DIF O-B	RMSVW DIF O-A	NUMBER OF OBS
0-3	-999.0	-999.0	-999.0	-999.0	0
3-10	0.7	0.8	6.8	5.7	38
10-20	-1.0	-0.6	8.2	7.0	554
20-30	-3.7	-2.8	10.5	9.6	730
30-40	-4.7	-4.0	12.3	11.7	531
40-50	-3.5	-3.3	13.8	13.0	326
50-60	-2.9	-2.3	13.8	13.2	151
60-70	-0.1	-0.7	14.3	14.0	81
70-80	4.9	4.1	17.1	15.9	23
> 80	6.6	5.3	8.2	8.4	4
ALL	-2.9	-2.4	11.4	10.6	2438

TABLE 4

SUMMARY OF STATISTICS FOR FEBRUARY 1990/1991

LAT	SATID	NO. OF OBS.		91/90	NO. OF OBS. >50M/S				NO. OF OBS. |O-B|>25M/S				MEAN O-B M/S ALL OBS		MEAN O-B M/S GOOD OBS		RMS(O-B) M/S ALL OBS		RMS(O-B) M/S GOOD OBS	
		90	91	%	90	%	91	%	90	%	91	%	90	91	90	91	90	91	90	91
60N	GOES	1955	2157	110.3	202	10.3	248	11.5	97	5.0	16	7.5	-3.2	-3.6	-3.4	-3.5	12.9	14.3	11.1	11.3
TO	GMS	3733	818	21.9	81	2.2	15	1.8	45	1.2	5	0.6	1.8	0.0	1.8	0.1	9.4	9.8	8.9	9.4
30N	METEO	4077	2975	74.2	427	10.7	119	4.0	56	1.4	10	0.3	-2.0	-1.0	-2.0	-1.0	10.2	8.1	9.6	8.0
30N	GOES	6086	3587	58.9	112	1.8	118	3.3	115	1.9	140	3.9	-1.0	-0.3	-0.8	-0.6	10.5	11.8	9.6	9.8
TO	GMS	7254	4839	66.7	39	0.5	3	0.1	194	2.7	6	0.1	-0.9	2.2	-0.4	2.2	10.2	7.4	9.0	7.3
EQT	METEO	10344	8374	81.0	232	2.2	673	8.0	21	0.2	24	0.3	0.5	0.3	0.5	0.2	7.7	7.6	7.6	7.5
EQT	GOES	5691	4050	71.2	7	0.1	7	0.2	30	0.5	13	0.3	2.1	1.0	2.0	1.0	8.9	8.6	8.7	8.4
TO	GMS	11514	6010	52.2	1	0.0	3	0.0	32	0.3	4	0.1	-0.4	2.3	-0.3	2.3	8.2	7.7	8.1	7.6
30S	METEO	9822	6983	71.1	0	0.0	0	0.0	8	0.1	1	0.0	1.2	1.5	1.1	1.5	6.9	6.4	6.8	6.4
30S	GOES	2140	1914	89.4	54	2.5	92	4.8	24	1.1	42	2.2	0.1	-1.5	-0.1	-1.6	9.6	10.8	8.9	9.8
TO	GMS	3745	1629	43.5	16	0.4	20	1.2	85	2.3	26	1.6	-3.5	-3.1	-3.1	-2.8	11.2	10.5	10.4	9.8
60S	METEO	4064	4027	99.1	166	4.1	241	6.0	43	1.1	27	0.7	0.0	0.9	-0.1	0.8	8.9	8.8	8.4	8.4

TABLE 5

SUMMARY OF STATISTICS FOR APRIL 1990/1991

LAT	SATID	NO. OF OBS. 90	NO. OF OBS. 91	91/90 %	NO. OF OBS. >50M/S 90	%	91	%	NO. OF OBS. |O-B|>25M/S 90	%	91	%	MEAN O-B M/S ALL OBS 90	ALL OBS 91	GOOD OBS 90	GOOD OBS 91	RMS(O-B) M/S ALL OBS 90	ALL OBS 91	GOOD OBS 90	GOOD OBS 91
60N	GOES	2071	2418	116.7	142	6.9	233	9.6	63	3.0	63	2.6	-1.8	-2.9	-2.2	-3.0	11.7	11.4	10.3	10.2
TO	GMS	3466	2213	63.8	81	2.3	142	6.4	35	1.0	16	0.7	-3.5	-1.0	-3.3	-0.8	10.5	8.4	10.2	8.2
30N																				
30N	GOES	7916	8924	112.7	346	4.4	307	3.4	84	1.1	70	0.8	1.2	0.6	1.0	0.5	9.4	9.1	8.9	8.7
TO	GMS	10614	7288	68.7	22	0.2	7	0.1	18	0.2	10	0.1	0.6	1.0	0.7	0.9	7.8	6.8	7.7	6.7
EQT																				
EQT	GOES	3696	5293	143.2	77	2.1	92	1.7	27	0.7	66	1.2	1.4	0.6	1.3	0.5	9.3	9.6	9.0	9.1
TO	GMS	10631	8359	78.6	61	0.6	99	1.2	43	0.4	18	0.2	1.1	0.8	1.0	0.7	7.9	7.5	7.6	7.4
30S																				
30S	GOES	1232	1981	160.8	115	9.3	283	14.3	40	3.2	59	3.0	-0.3	-0.8	-1.1	-1.1	11.2	11.6	9.8	10.5
TO	GMS	3427	2504	73.1	34	1.0	34	1.4	98	2.9	73	2.9	-3.1	-3.9	-2.7	-3.6	11.2	11.1	9.9	9.9
60S																				

TABLE 6.

MAY 90 APR 91

GOES: ALL OBSERVATIONS

LATITUDES 60N-30N

BAND 400-100 HPA

TOTAL NUMBER OF OBS USED 27911

MEAN. SPEED M PER S	MEAN SPEED DIF O-B	MEAN SPEED DIF O-A	RMSVW DIF O-B	RMSVW DIF O-A	NUMBER OF OBS
0-3	0.5	0.0	3.5	3.1	21
3-10	1.0	0.8	6.8	5.3	1784
10-20	-0.5	-0.4	8.2	6.9	7543
20-30	-2.9	-2.4	10.5	9.4	7987
30-40	-3.9	-3.3	12.9	12.1	5487
40-50	-3.7	-3.5	15.2	14.7	3031
50-60	-1.8	-1.9	17.2	16.7	1341
60-70	0.2	-0.3	16.7	16.0	541
70-80	4.4	3.5	16.0	14.8	149
> 80	11.2	7.1	15.2	13.2	27
ALL	-2.1	-1.8	11.5	10.6	27911

TABLE 7.

MAY 90 APR 91

GOES: ALL OBSERVATIONS

LATITUDES 30S-60S

BAND 400-100 HPA

TOTAL NUMBER OF OBS USED 23590

MEAN. SPEED M PER S	MEAN SPEED DIF O-B	MEAN SPEED DIF O-A	RMSVW DIF O-B	RMSVW DIF O-A	NUMBER OF OBS
0-3	3.0	2.2	3.8	3.9	2
3-10	2.0	1.8	9.0	6.2	479
10-20	-1.2	-0.8	9.2	7.2	3999
20-30	-2.8	-2.2	11.0	9.4	7334
30-40	-3.4	-3.0	12.7	11.4	6195
40-50	-1.0	-1.6	14.8	13.3	3325
50-60	1.6	0.2	15.7	13.8	1522
60-70	3.6	1.9	15.8	13.7	534
70-80	6.7	4.5	14.6	12.5	164
> 80	12.3	9.6	18.2	14.8	36
ALL	-1.8	-1.7	12.3	10.7	23590

Table 8

MAY 90 APR 91

GMS: ALL OBSERVATIONS

LATITUDES 60N-30N

BAND 400-100 HPA

TOTAL NUMBER OF OBS USED 40086

MEAN. SPEED M PER S	MEAN SPEED DIF O-B	MEAN SPEED DIF O-A	RMSVW DIF O-B	RMSVW DIF O-A	NUMBER OF OBS
0-3	0.0	-0.8	3.5	4.2	137
3-10	-0.1	-0.2	7.3	7.3	4441
10-20	-1.0	-0.9	8.5	8.4	12983
20-30	-1.3	-1.3	9.3	9.3	13068
30-40	-0.7	-0.7	10.0	10.1	6775
40-50	-0.7	-0.8	10.7	11.0	2151
50-60	0.1	-0.1	11.4	11.7	466
60-70	4.6	4.0	13.1	13.5	52
70-80	1.3	1.1	17.8	19.0	13
> 80	-999.0	-999.0	-999.0	-999.0	0
ALL	-0.9	-0.9	9.1	9.1	40086

TABLE 9

AY 90 APR 91

MS: ALL OBSERVATIONS

LATITUDES 30S-60S

AND 400-100 HPA

TOTAL NUMBER OF OBS USED 37621

MEAN. SPEED M PER S	MEAN SPEED DIF O-B	MEAN SPEED DIF O-A	RMSVW DIF O-B	RMSVW DIF O-A	NUMBER OF OBS
0-3	-0.2	-0.8	3.8	4.0	27
3-10	0.1	0.0	7.9	7.7	1992
10-20	-1.2	-1.3	3.7	3.6	10509
20-30	-2.5	-2.6	10.0	9.9	14139
30-40	-3.9	-4.0	12.5	12.4	8451
40-50	-4.0	-4.0	13.9	13.8	2226
50-60	-1.6	-1.4	13.3	13.1	253
60-70	3.0	3.7	12.5	12.2	23
70-80	2.3	1.8	5.7	4.3	1
> 80	-999.0	-999.0	-999.0	-999.0	0
ALL	-2.4	-2.5	10.5	10.4	37621

Table 10.

IAY 90 APR 91

IETEOSAT: ALL OBSERVATIONS

.ATITUDES 60N-30N

BAND 400-100 HPA

'OTAL NUMBER OF OBS USED 42718

MEAN. SPEED M PER S	MEAN SPEED DIF O-B	MEAN SPEED DIF O-A	RMSVW DIF O-B	RMSVW DIF O-A	NUMBER OF OBS
0-3	-999.0	-999.0	-999.0	-999.0	0
3-10	1.3	0.9	5.3	3.8	1539
10-20	0.2	0.0	6.3	4.8	12507
20-30	-0.7	-0.6	7.5	6.0	16270
30-40	-1.4	-1.0	9.3	7.7	8138
40-50	-1.6	-1.3	10.3	8.7	2979
50-60	-0.3	-0.7	12.0	10.4	948
60-70	0.5	-0.2	12.1	10.7	265
70-80	-1.7	-1.1	12.4	10.7	66
> 80	5.0	4.5	6.7	5.9	6
ALL	-0.6	-0.5	7.9	6.4	42718

TABLE 11.

MAY 90 APR 91

METEOSAT: ALL OBSERVATIONS

LATITUDES 30S-60S

BAND 400-100 HPA

TOTAL NUMBER OF OBS USED 58666

MEAN. SPEED M PER S	MEAN SPEED DIF O-B	MEAN SPEED DIF O-A	RMSVW DIF O-B	RMSVW DIF O-A	NUMBER OF OBS
0-3	-999.0	-999.0	-999.0	-999.0	0
3-10	1.2	0.8	6.0	4.2	203
10-20	0.3	0.0	7.3	5.4	4973
20-30	-0.5	-0.6	7.9	6.2	16054
30-40	-1.2	-1.2	9.3	7.6	17942
40-50	-1.4	-1.4	10.6	8.9	12093
50-60	-0.8	-1.0	12.0	10.2	5217
60-70	0.3	-0.1	12.6	10.8	1733
70-80	0.6	0.2	13.9	11.9	402
> 80	-2.9	-2.7	14.0	12.8	49
ALL	-0.8	-0.9	9.5	7.8	58666