CO-LOCATION AREA FOR COMPARISON OF SATELLITE WINDS AND RADIOSONDES

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1. Introduction

In order to evaluate the accuracy of satellite winds, it is widely used to compare satellite winds with radiosondes. The 5th CGMS (Committee of Geostationary Meteorological Satellite) decided to adopt an elliptical co-location area for comparison of satellite winds and radiosondes.

MSC/JMA had been reported the results of evaluating satellite winds in the elliptical co-location area. The 25th CGMS decided to adopt the circular co-location area as Menzel (1996) proposed for evaluating satellite winds. MSC/JMA started to report the results of evaluating satellite winds in the elliptical co-location area since July 1998.

In this report we investigate the difference of the results of evaluating satellite winds between in the elliptical co-location area and in the circular co-location area in the GMS coverage.

2. Results

To investigate the difference of the results of evaluating satellite winds between in the elliptical co-location area and in the circular co-location area, they are compared with collocated radiosonde winds in the elliptical co-location area as shown in Appendix and in the circular co-location area where the radius is 150 km. Monthly mean statistics are calculated from July 1997 to June 1998 to compare results in the circular co-location area and in the elliptical area.

2.1 Low-level Cloud Motion Winds

Figure 1 shows a monthly comparison of low level visible CMWs (VIS- LCMW) and radiosonde winds from July to June 1998 in all regions (50N - 50S). Mean Vector Difference (MVD) in the elliptical area is about 0.4 m/s larger than that in the circular co-location area, while the Root Mean Square Error (RMSE) of vector difference in the elliptical area is 0 to 0.7 m/s larger than that in the circular co-location area. In average speed difference (BIAS), there is no significant difference between the two areas.

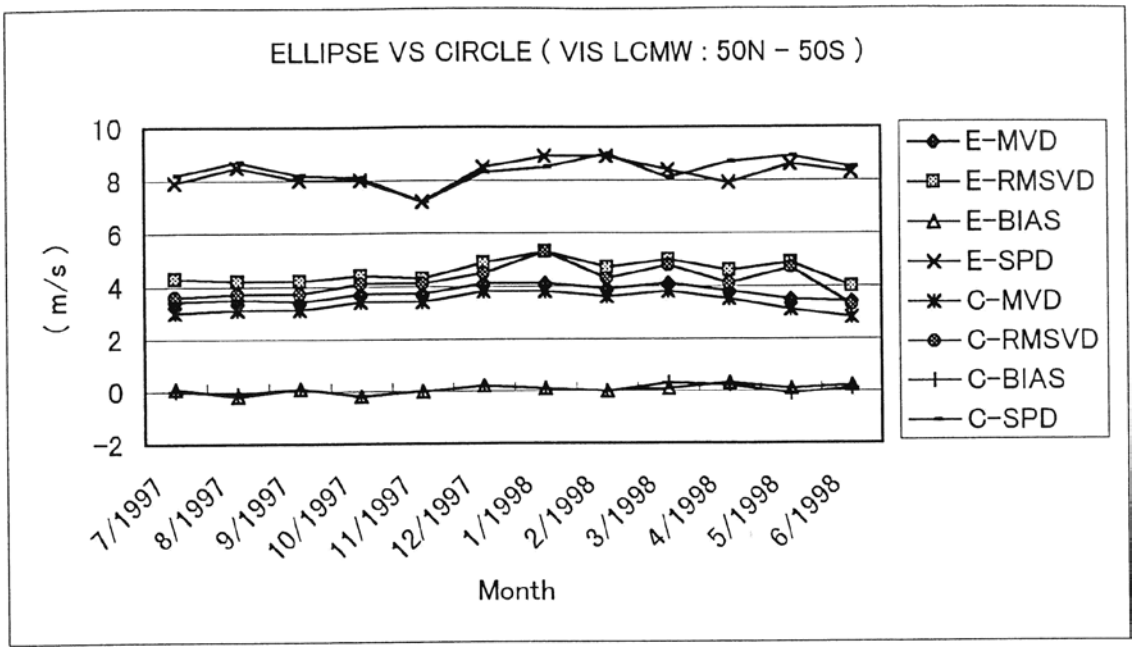

Fig.1 A monthly comparison between VIS-LCMWs and radiosonde winds in the elliptical co-location area and in the circular co-location area from July 1997 to June 1998 in all regions (50N - 50S). E- and C- mean a comparison result in the elliptical co-location area and in the circular co-location area, respectively. MVD : mean vector difference, RMSVD : root mean square error of vector difference, BIAS : average speed difference, SPD : rawinsonde speed. (unit: mls)

Table 1 shows the monthly average value of the difference of the statistic between in the elliptical co-location area and in the circular co-location area for VIS-LCMWs from July 1997 to June 1998 in the four latitude zones; all regions (50N - 50S), northern extra-tropical regions (50N - 20N), tropical regions (20N - 20S) and southern extra-tropical regions (20S - 50S). Number of collocations in the elliptical area is approximately twice as many as that in the circular area in all the zones. As expected, in all the zones, MVD and RMSE in the elliptical area is respectively about 10 % larger than that to the mean value in the circular area. On the other hand, there is no significant difference in BIAS and SPD in all the zones.

Table 1. The average value of the difference of the statistic between in the elliptical area and in the circular area for VIS-LCMWs from July 1997 to June 1998 in the four latitude zones; all regions (50N - 50S), northern extra-tropical regions (50N - 20N), tropical regions (20N - 20S) and southern extra-tropical regions (20S - 50S). MVD : mean vector difference, RMSVD : root-mean-square vector difference, BIAS : average speed difference, SPD : rawinsonde speed, NUM : number of collocations, CME : the mean value in the circular area, DME : the mean value of the difference of the statistic between in the elliptical area and in the circular area (the value in the elliptical area - that in the circular area), SD : standard deviation of the difference of the statistic between in the elliptical area and in the circular area.

VIS LCMW															
	MVD (m/s)			RMSVD (m/s)			BIAS (m/s)			SPD (m/s)			NUM		
	CME	DME	SD	CME	DME	SD	CME	DME	SD	CME	DME	SD	CME	DME	SD
50N – 50S	3.37	0.35	0.09	4.18	0.38	0.20	0.05	0.02	0.10	8.37	-0.11	0.30	336.4	307.7	46.5
50N - 20N	3.68	0.35	0.15	4.83	0.30	0.46	-2.00	0.03	0.25	8.09	0.03	0.49	108.3	115.8	39.5
20N – 20S	3.04	0.36	0.21	3.58	0.50	0.29	0.56	-0.03	0.45	7.83	-0.33	0.43	76.0	73.3	20.3
20S – 50S	3.41	0.28	0.17	4.03	0.35	0.23	0.01	0.05	0.13	8.51	-0.17	0.34	152.2	118.6	39.9

Figure 2 is the same as Figure 1 except for infrared low level CMWs (IR-LCMW). MVD in the elliptical area is 0.1 to 0.6 m/s larger than that in the circular area, while RMSE in the elliptical area is 0.1 to 0.7 m/s larger (except for March 1998) than that in the circular area. In BIAS and SPD, there is no significant difference between the two areas.

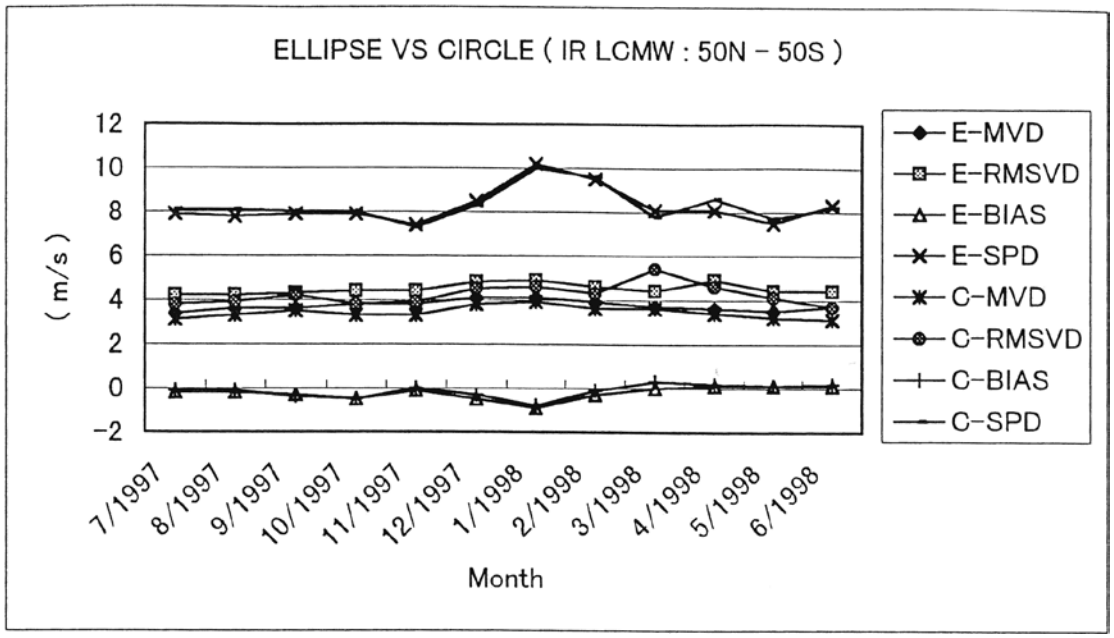

Fig. 2 The same as Fig. 1 except for IR-LCMW.

Table 2 is the same as Table 1 except for IR-LCMW. Number of collocations in the elliptical area is approximately twice as many as that in the circular area in all the zones. The largest positive difference of MVD between in the elliptical area and in the circular area is in the southern ex-tropical regions (0.33 m/s), respectively followed by in northern ex-tropical regions (0.31 m/s), and tropical regions (0.14 m/s). On the other hand, the largest positive difference of RMSVD between in the elliptical area and in the circular area is in southern ex-tropical regions (0.38 m/s), respectively followed by in tropical regions (0.21 m/s), and in northern ex-tropical regions (0.05 m/s). There is no significant difference in BIAS and SPD in all the zones.

Table 2. The same as Table 1 except for IR-LCMWs.

IR LCMW															
	MVD (m/s)			RMSVD (m/s)			BIAS (m/s)			SPD (m/s)			NUM		
	CME	DME	SD	CME	DME	SD	CME	DME	SD	CME	DME	SD	CME	DME	SD
50N – 50S	3.42	0.31	0.15	4.23	0.26	0.41	-0.13	-0.10	0.10	8.31	-0.05	-0.23	345.9	308.1	60.8
50N - 20N	3.80	0.31	0.22	4.96	0.05	1.15	-0.33	-0.21	0.45	7.92	0.10	0.40	120.6	137.7	62.6
20N – 20S	3.33	0.14	0.18	3.92	0.21	0.28	0.28	0.12	0.19	7.62	-0.18	0.38	105.2	69.5	43.3
20S – 50S	3.38	0.33	0.14	3.95	0.38	0.20	-0.12	-0.03	0.25	8.59	-0.27	0.39	120.2	100.9	52.2

2.2 IR High-level Cloud Motion Winds

Figure 3 shows a monthly comparison result of infrared high level CMW (HCMW) and radiosonde winds from July 1997 to June 1998 in all regions (50N - 50S). MVD and RMSE in the elliptical area is respectively a little larger than that in the circular area. SPD in the elliptical area is

0.5 to 1.4 m/s slower than that in the circular area. BIAS has no significant difference between the two areas.

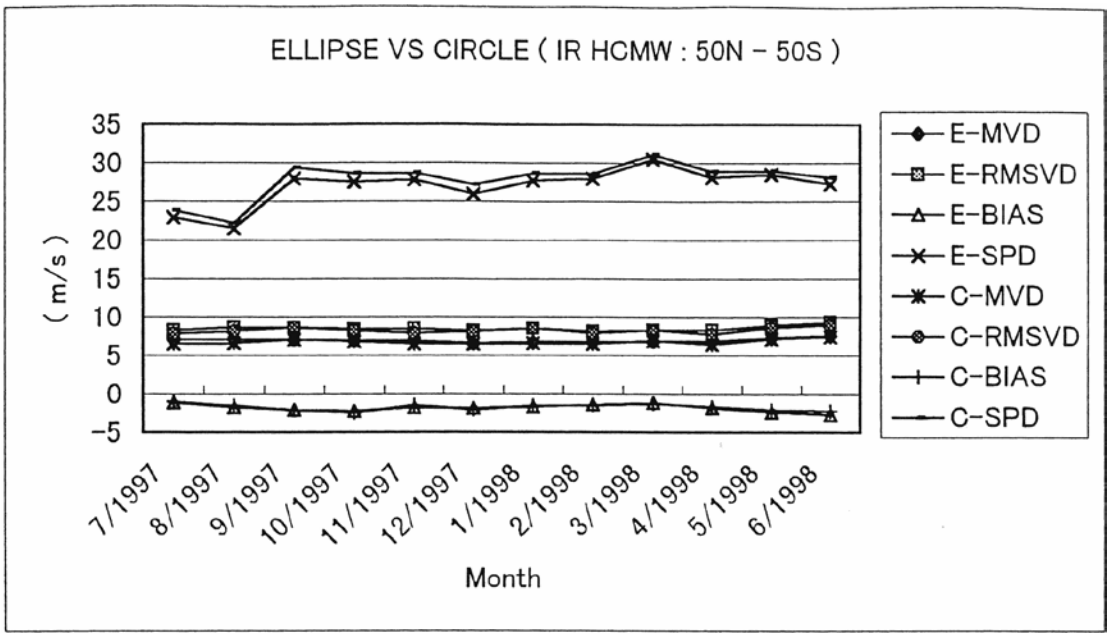

Fig. 3 The same as Fig. 1 except for HCMW.

Table 3 is the same as Table 1 except for HCMW. Number of collocations in the elliptical area is approximately 1.5 times as many as that in the circular area in all the zones. The largest positive difference of MVD between in the elliptical area and in the circular area is in the southern ex-tropical regions (1.22 m/s), respectively followed by in northern ex-tropical regions (0.25 m/s), and tropical regions (0.23 m/s). On the other hand, the largest positive difference of RMSVD between in the elliptical area and in the circular area is in southern ex-tropical regions (0.48 m/s), respectively followed by in northern ex-tropical regions (0.29 m/s), and in tropical regions (0.27 m/s). BIAS in the elliptical area is a little larger than that in the circular area. A little negative difference of SPD between in the elliptical area and in the circular area is in southern and northern ex-tropical regions, while a little positive difference of SPD is in tropical regions.

Table 3. The same as Table 1 except for infrared high level CMW.

IR HCMW															
	MVD (m/s)			RMSVD (m/s)			BIAS (m/s)			SPD (m/s)			NUM		
	CME	DME	SD	CME	DME	SD	CME	DME	SD	CME	DME	SD	CME	DME	SD
50N – 50S	6.73	0.22	0.19	8.23	0.28	0.24	-1.79	-0.08	0.21	27.86	-0.71	0.51	916.8	430.3	69.1
50N - 20N	7.10	0.25	0.23	8.58	0.29	0.24	-2.29	-0.11	0.27	34.52	-0..60	0.49	499.3	217.8	83.5
20N – 20S	5.95	0.23	0.30	7.45	0.27	0.60	-0.56	-0.19	0.24	15.09	0.16	0.39	196.6	124.4	31.1
20S – 50S	6.98	1.22	2.96	8.53	0.48	0.33	-2.23	-0.12	0.33	28.37	-0.70	1.29	220.9	88.1	41.4

2.4 Middle-level Water Vapor Motion Winds

Figure 4 shows a monthly comparison result of middle level WVMW (MWVMW) from July 1997 to June 1998 in all regions (50N - 50S). MVD and RMSE in the elliptical area is respectively a little larger than that in the circular area. SPD in the elliptical area is a little slower than that in the

circular area. A little negative BIAS is seen in all the zones.

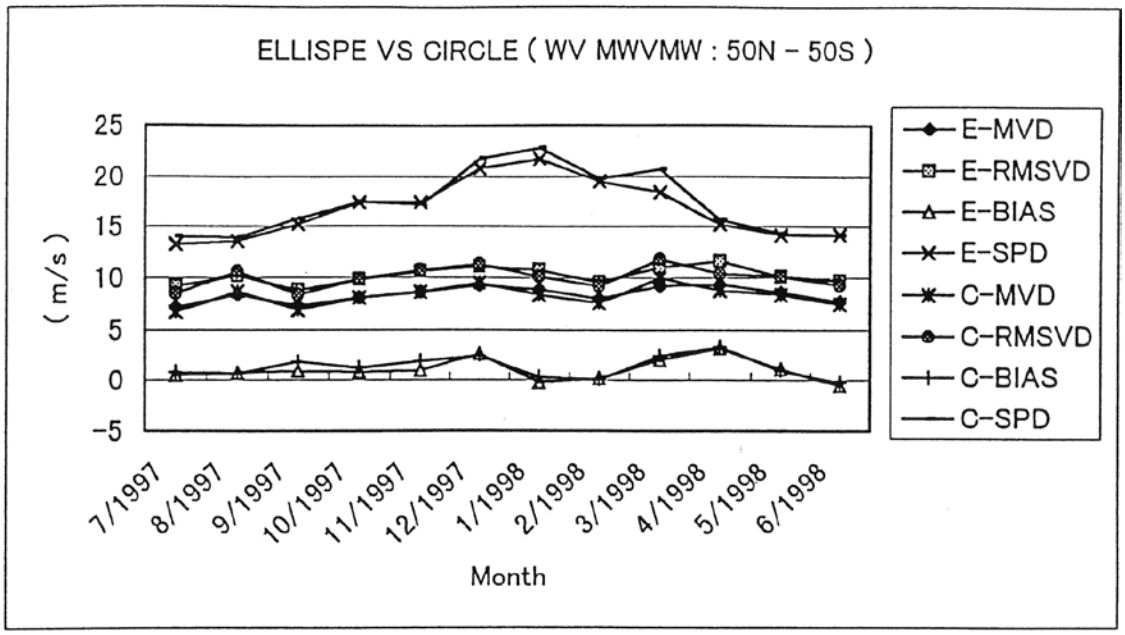

Fig. 4 The same as Fig. 1 except for MWVMW.

Table 4 is the same as Table 1 except for MWVMWs. Number of collocations in the elliptical area is approximately 1.5 times as many as that in the circular area in all the zones. A little positive difference of MVD and RMSVD between in the elliptical area and in the circular area is in all the zones, while a little negative difference of BIAS and SPD is in all the zones.

Table 4. The same as Table 1 except for MWVMWs.

WV MWVMW															
	MVD (m/s)			RMSVD (m/s)			BIAS (m/s)			SPD (m/s)			NUM		
	CME	DME	SD	CME	DME	SD	CME	DME	SD	CME	DME	SD	CME	DME	SD
50N – 50S	8.27	0.13	0.39	10.02	0.19	0.53	1.30	-0.28	0.36	17.30	-0.58	0.65	146.8	62.3	10.1
50N - 20N	8.28	0.17	. 0.35	9.91	0.28	0.49	1.32	-0.25	0.62	18.32	-0.49	0.93	85.9	32.0	7.8
20N – 20S	8.62	0.00	0.78	9.91	0.01	1.12	2.78	-0.31	1.24	8.63	-0.18	0.86	16.6	7.7	3.8
20S – 50S	8.01	O.05	0.68	9.76	0.19	1.06	1.35	-0.45	0.67	16.57	-0.26	0.69	44.3	22.6	6.4

2.5 High-level Water Vapor Motion Winds

Figure 5 shows a monthly comparison result of high level WVMW (HWVMW) from July 1997 to June 1998 in all regions (50N - 50S). MVD and RMSE in the elliptical area is respectively a little larger than that in the circular area. SPD in the elliptical area is 0.1 to 1.7 m/s (except for August 1997 and March 1998) slower than that in the circular area. BIAS has no significant difference between the two areas.

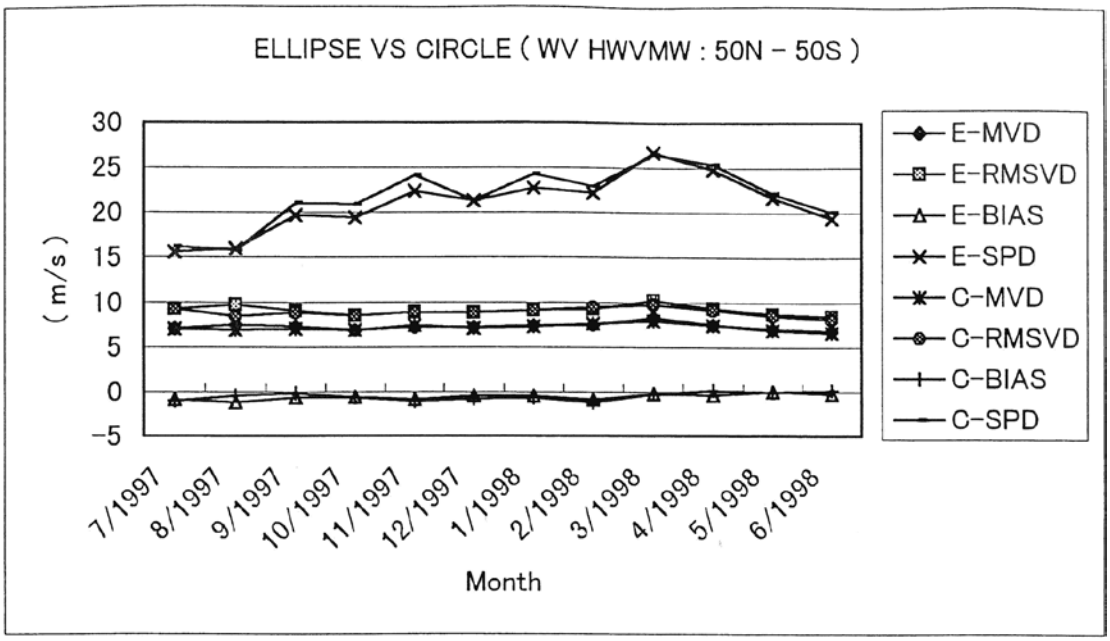

Fig. 4 The same as Fig. 1 except for HWVMWs.

Table 5 is the same as Table 1 except for HWVMWs. Number of collocations in the elliptical area is approximately 1.5 times as many as that in the circular area in all the zones. The largest positive difference of MVD between in the elliptical area and in the circular area is in the southern ex-tropical regions (0.65 m/s), respectively followed by in northern ex-tropical regions (0.19 m/s), and tropical regions (0.16 m/s). On the other hand, the largest positive difference of RMSVD between in the elliptical area and in the circular area is in southern ex-tropical regions (0.88 m/s), respectively followed by in tropical regions (0.30 m/s), and in northern ex-tropical regions (0.17 m/s). BIAS in the elliptical area is a little larger than that in the circular area. The feature of MVD and RMSVD in HWVMW is similar to that in HCMW. A little negative difference of SPD between in the elliptical area and in the circular area is in southern and northern ex-tropical regions, while a little positive difference of SPD is in tropical regions.

Table 5. The same as Table 1 except for HWVMWs.

WV HWVMW															
	MVD (m/s)			RMSVD (m/s)			BIAS (m/s)			SPD (m/s)			NUM		
	CME	DME	SD	CME	DME	SD	CME	DME	SD	CME	DME	SD	CME	DME	SD
50N – 50S	7.17	0.14	0.21	8.87	0.21	0.37	-0.53	-0.07	0.34	21.73	-0.74	0.63	706.1	311.3	94.3
50N - 20N	7.61	0.19	o.20	9.44	0.17	0.25	-1.27	-0.25	0.32	29.14	-0.38	0.77	409.3	155.4	95.7
20N – 20S	6.53	0.16	020	8.09	0.30	0.69	0.22	0.04	0.39	10.61	0.07	0.38	179.0	102.9	31.8
20S – 50S	7.47	0.65	1.28	9.14	0.88	1.74	-0.82	-0.39	1.49	25.80	-0.57	2.24	117.8	52.9	22.8

3. Conclusion

Forgoing analysis leads to the following conclusion. Verification statistics between in the elliptical area and in the circular area show that a positive difference of MVD and RMSEVD between the two areas is seen in satellite winds. Especially the feature is outstanding in LCMWs. In BIAS, there is no significant difference. MSC/JMA has used the circular co-location area in place of the elliptical co-location for comparison of satellite winds and radiosondes since July 1998. Therefore, we need to take notice of the difference for evaluating the accuracy of satellite winds.

Appendix

International Comparison of Satellite Winds (Hamada, 1982)

The eighth Coordination Meeting on Geostationary Meteorological Satellites (CGMS-VIII, in Paris in March 1977) agreed on the need for international intercomparison of satellite winds in order to assess the homogeneity and accuracy of the satellite wind vectors produced by the Operating Agencies (OA's). Two following forms of comparison were proposed and accepted:

(1) Type 1 Reports- Direct intercomparison between satellite winds in the areas of overlap between adjacent satellites, and
(2) Type 2 Reports- Intercomparison with conventional data.

The inter-comparison between adjacent satellites (Type 1 Reports) is achieved by all OA's sending wind data on magnetic tape to the USA, where the co-locations are found and results computed. The comparisons with conventional data (Type 2 Reports) are the responsibility of each OA, but the results are mailed to the USA for inclusion in a coordinated report. The first comparison took place in July 1978, and thereafter two periods each year.

A.1. Co-location area for comparison

The co-location area for comparison has been changed a few times, but the latest one was proposed at CGMS X (in Geneva in March 1980) and was confirmed at CGMS XI (in Washington, D.C. in February 1982). The area is defined as an elliptical co-location area as in Table A.1.

The ellipse co-location area in this report is the same as that of Type 2 Reports Inter-comparison with conventional data. The regular is the followings.

a) Co-location area for comparison.
   The area is defined as the elliptical co-location area as shown the Table A.1.
b) Time
   Satellite wind and its comparison ground truth observation are used within three hours.
c) Height
   Winds interpolated from rawinsondes are used as ground truth.

Table A.1. The size of elliptical collocation area for International Comparison of Satellite Winds by CGMS

Wind level	Satellite wind speed	Major Axis**	Minor Axis
High level and Mid-level wind (less than 700 hPa)	Less than 10 m/s 10 to 25 m/s Larger than 25 m/s	225 km 250 km 300 km	175 km 140 km 100 km
Low-level wind (700 hPa to Surface)	Any speed	225 km	175 km

**The major axis must be oriented along the satellite wind direction.

References

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Hamada, T., 1982 : Representative heights of GMS satellite winds. Meteorological Satellite Center Technical Note No. **6**, 35-47