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RESULTS OF THE VERIFICATION OF SATELLITE DATA BASED ON A COMPARISON WITH RADIOSONDE DATA

G. Steinhorst

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16. Abstract

Results of the verification of satellite wind data are represented by comparing them with radiosonde data for the geostationary satellites METEOSAT, GOES and GMS. The quality of METEOSAT pictures has improved since July 1979, reaching the quality of GOES and GMT wind data.

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Abstract

The Meteorological Evaluation Center at Darmstadt, West Germany, obtains approximately 400 wind vectors based on the imagery data of the geostationary satellite Meteosat twice a day. The most significant factor regarding the procedure applied in the determination of the wind characteristics is related to the completely automatic correlation method used for cloud tracing. During testing periods, the obtained data regarding the wind characterstics are compared with the corresponding radiosonde data. Considering the verification results, attention is given to a comparison between radiosonde data and Meteosat results, meteorological error sources, and a comparison of wind characteristics obtained on the basis of data from the European satellite Meteosat, the U.S. satellite GOES, and the Japanese satellite GMS.

RESULTS OF THE VERIFICATION OF SATELLITE DATA BASED ON A COMPARISON WITH RADIOSONDE DATA

G. Steinhorst

Deutscher Wetterdienst, Zentralamt, Offenbach (Main)

West Germany

Summary

The results of the verification of satellite wind data are represented by comparing them with radiosonde data for the geo- stationary satellites METEOSAT, GOES and GMS. It can be shown that the quality of the METEOSAT wind vectors has markedly improved since July, 1979; it has thus reached the quality of GOES and GMD wind data. /1

1. Introduction

In the Meteorological Evaluation Center (MIEC) of the ESOC in Darmstadt, about 400 wind vectors are obtained twice a day from the imagery data of the geostationary satellite METEOSAT.

It is the characteristic of wind determination from METEOSAT data to be based on a completely automatic correlation method for tracing clouds. Only in the final stage of wind determination a quality control at the MIEC console is carried out manually.

The satellite winds are entered into the numerical analysis of the DWD (German Weather Service) where, together with air reports, they supplement the observatory net of the radiosondes over the Atlantic Ocean and the Sahara. The satellite winds recorded in the relief maps also facilitate the determination of wind-maxima (jets) which again results in an improved jet and isotach forecast for

* Numbers in the margin indicate pagination in the foreign text.

air traffic.

2. Testing Method

The satellite winds received by the CTS (global telecommunications system) in Offenbach were compared with respective radiosonde data during the testing periods. Applying electronic data processing methods, direction and velocity of neighboring satellite winds are tested in a 2° interval around the radiosonde stations for the given pressure surface. Additionally, the "height of best assignment" (hba) is determined by linear interpolation of the radiosonde data. The hba is the pressure surface for which the vector difference between radiosonde and satellite wind vector is lowest within a certain limit.

The pressure difference Δp between the hba and the initially given pressure level of the satellite wind can be regarded as measure for the error in the height assignment of the satellite wind vectors.

The testing method is inadequate in:
- there are errors in the radiosonde data
- inadequate time and space assignment (2° interval) of the winds
- linear interpolation.

3. Results of Verification

3.1. Comparison radiosonde-METEOSAT

In co-operation with ESOC, the German Weather Service has participated in several wind test campaigns; the test from November 21 to December 5, 1978, provided the most information. The following table shows the statistical results of the wind comparisons subdivided in low (>700 mbar), medium high (700-400 mbar) and high winds (<400 mbar) for the absolute value of directions $|\Delta \ell|$ and vector difference $|\Delta v|$ as well as velocity $\Delta \mu$ and pressure difference Δp. The results of the new wind comparison from July 25 to October 17, 1979, in form of the arithmetic mean (arm) and the root mean square are given in parentheses (Table 1).

Table 1. Statistical results (radiosonde-METEOSAT) from November 21 to December 5, 1978; in ( ) from July 25 to October 17, 1979

		$\|\Delta\ell\|$ (^{0})	Δu m/s	$\|\Delta\vec{v}\|$ m/s	Δp mbar
1000-700 mbar	ARM	54.8 (26.5)	1.6 (0.1)	4.7 (5.0)	7.5 (-6.7)
	RMS	74.0 (39.8)	5.5 (5.1)	6.3 (6.4)	39.4 (60.0)
700 - 400 mbar	ARM	35.4 (25.7)	4.6 (0.1)	9.5 ([illegible])	[illegible] ([illegible])
	RMS	51.4 (40.2)	11.9 (6.1)	13.6 ([illegible])	150.0 (67.5)
< 400 mbar	ARM	33.7 (27.4)	7.9 (3.6)	16.9 (10.2)	116.2 (12.4)
	RMS	49.3 (42.6)	15.6 (9.5)	20.2 (13.7)	202.4 (177.4)

The results have basically improved since July 1979. This is especially true for the mean direction differences which now have almost identical values for all levels. The secondary maximum at 140^{o} in the frequency distribution for $|\Delta\ell|$ during the testing period between November 21 and December 5, 1978 does not appear any more. The mean velocity difference has markedly positive values only for the high winds since July 1979. This means that the wind velocity calculated from the satellite data is too small compared to the radiosonde values.

The vector difference $|\Delta v|$ has clearly improved for the medium and high levels in both mean values and deviation. The increase of $|\Delta v|$ with height can be explained by the general increase of wind velocity with height.

As can be seen from the mean pressure differences Δp, the /1
satellite winds were assigned to too low pressure values during the first testing period in 1978. Due to the newer results since 1979 the height assignment of MIEC software has been improved considerably.

3.2. Meteorological Error Sources

One of the reasons for the large vector differences during

November and December 1978 was the change of the overall weather situation during the testing period. As the trough over the Western Mediterranean became more prominent, the quality of the tested wind vectors decreased. This was due to the high wind velocities in the maximum of the jet and the strong gradient of wind velocity toward the trough. Very prominent horizontal or vertical gradients of wind velocity cause large vector differences especially when the altitude of the satellite wind is not measured correctly. By an inaccurate height assignment several satellite winds within the trough area were wrongly said to be above the tropopause.

Likewise large deviations between radiosonde and satellite winds are caused by orographically influenced clouds, especially windward and leeward of the Pyrenees and the Atlas Mountains.

3.3. Comparison of Satellite winds of METEOSAT, GOES, GMS

In order to be able to control the satellite winds which enter the numerical analysis, not only the windvectors of the European satellite METEOSAT but also those of the American satellite GOES-W and of the Japanese satellite GMS are tested by the German Weather Service. The above-described methods are used. The following table 2 shows the arithmetic mean and the root mean square of the wind vector differences $|\Delta v|$ radiosonde-satellite for the time between July 25 and October 17, 1979 for three different altitude ranges.

Table 2. Arithmetic mean and root mean square for $|\Delta v|$ of radiosonde wind-satellite wind.

		MET 1	GOES	GMS
Zahl der Fälle		598	350	573
1000 - 700 mbar	ARM	5.0	3.9	5.4
	RMS	6.4	4.6	7.5
700 - 400 mbar	ARM	6.9	6.6	8.2
	RMS	8.8	7.4	10.7
< 400 mbar	ARM	10.2	10.8	11.5
	RMS	13.2	13.2	13.3

Basically, the quality of all three geostationary satellites only differs little. The GOES winds in the lower and medium levels are slightly better.

4. References

METEOSAT Operations Advisory Group (editor) METEOSAT Cloud Winds Quality, ESA, MDMD, Darmstadt (1979)