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STATISTICAL PROPERTIES OF THE SSM/I DATA DURING THE GPCP-AIP/2. PRELIMINARY RESULTS

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G.L. Liberti

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Meteorological Office
London Road
Bracknell
Berkshire
RG12 2SZ
United Kingdom

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STATISTICAL PROPERTIES OF THE SSM/I DATA DURING THE GPCP-AIP/2. PRELIMINARY RESULTS

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G.L.LIBERTI [1]

Meteorological Office, London Rd., Bracknell, Berks, RG12 2SX, UK

ABSTRACT

For the GPCP-AIP/2 (Global Precipitation Climatology Project - Algorithm Intercomparison Project) data set, a statistical analysis of the SSM/I data has been carried out in order to:

- test the quality of the data;
- study the statistical properties of the data;
- help select interesting cases from the point of view of estimating precipitation.

A short description of the data set is given.

For each image and each channel several statistical quantities have been calculated.

The results of the analyses are shown and discussed. They have been also compared with similar analysis results from other instruments in the same data set and from SSM/I for the GPCP-AIP/1.

I. INTRODUCTION

The SSM/I data set of the GPCP-AIP/2 (Global Precipitation Climatology Project - Algorithm Intercomparison Project [1]) Campaign has been analysed in order to:

- test the quality of the data;
- study the statistical properties of the data;
- help select interesting cases from the point of view of estimating precipitation;
- compare with similar analysis for data sets from other instruments during the GPCP-AIP/2 Campaign and from the SSM/I for the GPCP-AIP/1.

A short description of the GPCP-AIP/2 SSM/I data set is reported in Section II. The statistical analyses applied and the correspondent results are reported and discussed in Section III. Some concluding remarks are made in Section IV.

II. THE DATA SET

During the GPCP-AIP/2 [1] Campaign (1/02-9/04/1991), as part of a WMO project aimed to improve global precipitation measurement, data from several surface or satellite based instruments have been intensively collected over the area shown in Fig.1 (dashed box).

The SSM/I [2] data analysed are collected from the DMSP Block 5D-2 Spacecraft F-8. The 85 GHz channel data, in both polarizations, were not available because of a problem with the instrument. The raw data have been processed and navigated according to [3]. In the following, the term *channel* we will mean any combination of frequency and polarization.

[1] EUMETSAT Research Fellow

Statistics of the calibration parameters, as well as the orbital ones, have been computed and analysed in order to assess the quality of the data.

Because of the presence of corrupted data in the data set, a first simple quality test has been applied to the data to eliminate scans with unreliable calibration parameters. Although a residual population of measurements corrupted corrupted by other causes may pass this test, the effect of this population on the results of the analysis is expected to be negligible. Table 1 shows the number of *swaths* (portion of orbit included in the area of interest), scans and pixels passing this quality test.

Tab.1: Number of orbits, swaths and pixels for the GPCP-AIP/2 compared with the correspondent values for GPCP-AIP/1.

	SWATHS	SCANS	PIXELS
GPCP-AIP/2	196	12583	805312
GPCP-AIP/1	209	14573	932700

The geographical distribution of the GPCP-AIP/2 SSM/I data set is shown in Fig.1. According to the surface index given with the data, the data set consists of 46.7 % land, 38.6 % water, 14.7 % coast and less than 0.1 % ice or possible ice.

Figure 2 shows (a) the number of swaths recorded per day, (b) the number of pixels for each swath, and (c) the percentage of pixels classified land (according with the SSM/I surface type index) for each swath.

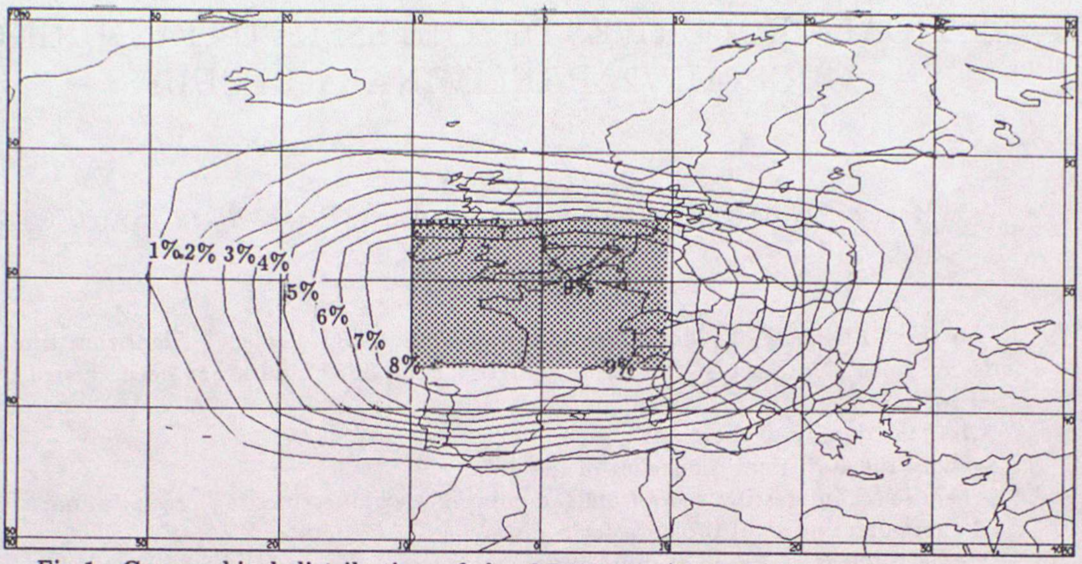

Fig.1: Geographical distribution of the GPCP-AIP/2 SSM/I Data Set. Contour lines represent percentage frequency of the data (in ‰) in 2.5°x2.5° boxes. The dashed box represents the GPCP-AIP/2 Area.

III. BRIGHTNESS TEMPERATURES STATISTICS

For each channel and each orbit, the following quantities have been computed:

- mean;
- minimum and maximum value;
- 2nd (Standard Deviation), 3rd (Skewness) and 4th (Kurtosis) moments;
- frequency distribution for 5 K wide classes.

An example of a time series of products from such an analysis is shown in Figs.3a-b for channel 19 GHz horizontal. Fig.3a shows a time series of the percentage frequency plotted in the time - brightness temperature plane as contoured maps. It can be seen that there are two peaks around 120 K and 250 K due to water and land surface backgrounds respectively. The warmer end of the distribution shows a seasonal trend during the period of the campaign. The greater variability of the distribution for the coldest values is due to a higher sensitivity to atmospheric variables when observed over water bodies. Fig.3b shows a time series of mean, standard deviation, minimum and maximum value for each swath.

The effects of both different population in each swath as well as different distribution of surface type are noticeable in the time series.

The same quantities have been computed for the whole data set and are shown in Tab.2 and Fig.4 compared with the correspondent values for the GPCP-AIP/1.

Tab.2: Single channel statistical properties for the whole data set and the correspondent values for GPCP-AIP/1 (*lower row*).

	19H	19V	22V	37H	37V
Mean	183.2	223.0	231.7	199.1	233.5
	175.4	*218.3*	*243.6*	*192.2*	*230.6*
S.D.	63.9	35.9	28.6	51.0	24.9
	49.6	*28.3*	*19.9*	*43.3*	*23.0*
Skewness	0.11	0.12	0.01	0.04	0.10
	0.85	*0.81*	*-0.47*	*0.75*	*0.75*
Kurtosis	-1.81	-1.78	-1.68	-1.76	-1.81
	-0.58	*-0.50*	*-0.17*	*-0.84*	*-0.73*
Min	96.2	75.0	64.3	123.4	176.5
	89.5	*89.5*	*89.5*	*89.5*	*89.5*
Max	276.2	285.0	279.5	274.8	285.0
	289.5	*289.5*	*289.5*	*289.5*	*289.5*

IV. CONCLUSIONS

The analysed data set contains a wide variety of meteorological cases occurring over a large number of different types of surface. Despite the generally good coverage in time (≃3 swaths/day), data for some interesting events were not available.

As a consequence of the complete absence of 85 GHz channel, a lower amount of information, especially over land, is expected from the SSM/I data.

Because of the different area and season covered by the the GPCP-AIP/2 compared with the GPCP-AIP/1, the following differences can be found from the brightness temperature analysis:

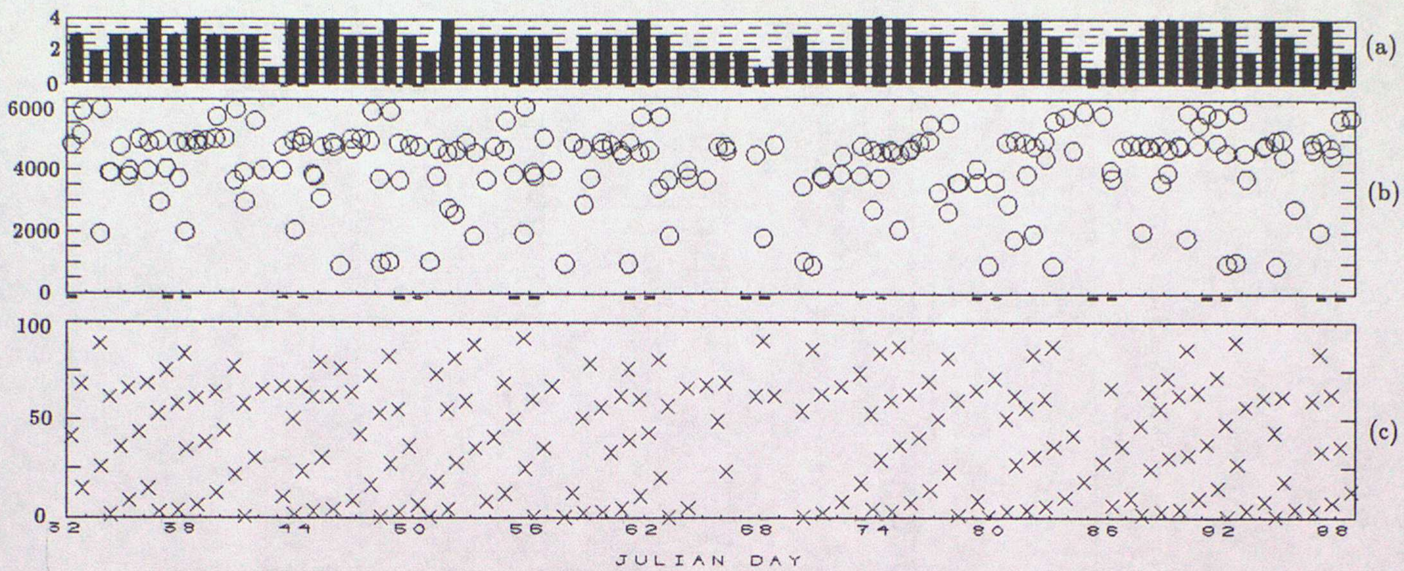

Fig.2: GPCP-AIP/2 SSM/I Data Set Summary: (a) number of swaths per day; (b) Number of pixels per swath; (c) percentage of pixels classified land (according with the SSM/I surface type index) for each swath.

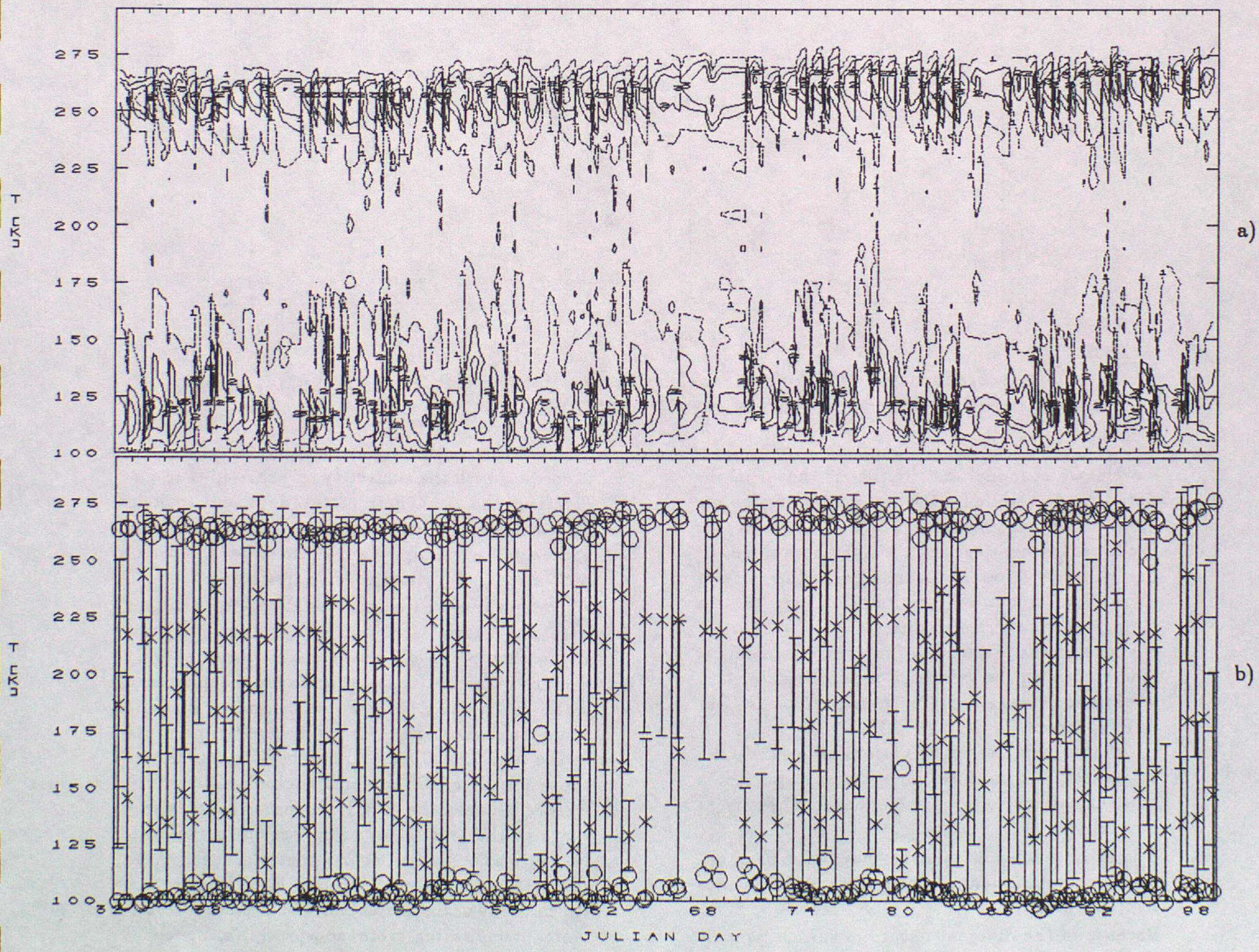

Fig.3: An example of single channel (19H) statistical parameters: swath by swath analysis: (a) time series of frequency distribution (Levels: [1]: 1%, [2]: 5%, [3]: 10%); (b) time series of mean value (x), standard deviation (represented as an error bar over the mean), minimum and maximum value (o) for each swath.

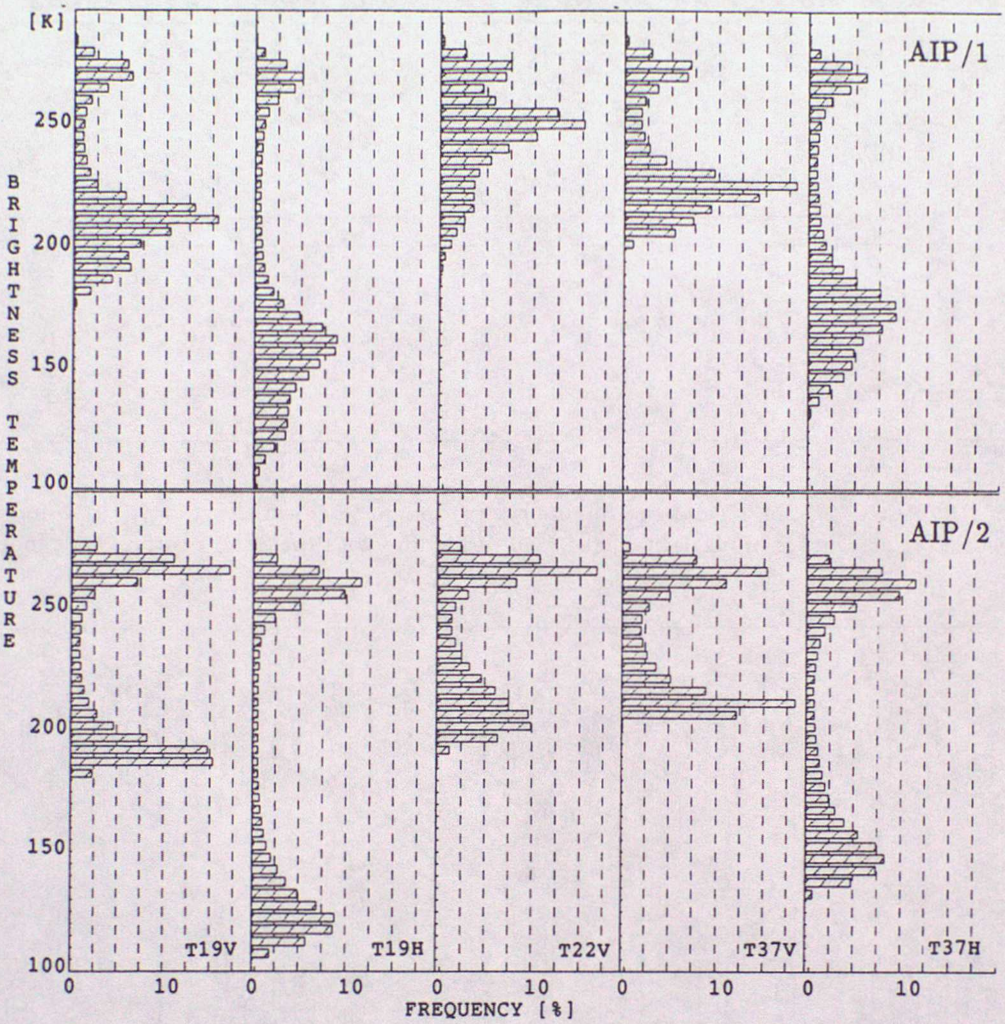

Fig.4: Frequency histograms channel by channel for the GPCP-AIP/2 SSM/I data set (lower panel) and for the correspondent GPCP-AIP/1.

- a clearly bi-modal distribution is shown in the data (Fig.4.a) while for the previous campaign the distribution was tri-modal (Fig.4.b), especially for the lower frequencies. Such a differences might be due either to a lower amount of coastline data or to a minor amount of precipitation over the sea surface in the current data set;

- as a result of ,mostly, the greater amount of land surface in the campaign area: the data show a warmer average value with respect to GPCP-AIP/1, except for the 22V GHz;

- the very different distributions of the 22V GHz brightness temperatures suggest, as expected, a more dry atmospheric environment for the current campaign.

The same statistical analyses have also been applied to combinations of single channels brightness temperature.

Because of the different nature of surface properties in the microwave spectrum, separate analyses, according with the surface type, are needed to understand the behaviour of the data and to help discriminate potential signals. Also, to minimize space-time sampling effects in the data, the use of daily averaged quantities is suggested.

A comparison with similar analyses for different data sets within GPCP-AIP/2 [4] is in progress. As an example, Fig.5 shows a time series of daily averaged cumulative frequencies for the difference T37V-T37H<40 K, over water, compared with the same statistical figure for brightness temperature in the AVHRR 10μm channel for T4<240 K over the whole area. Over water the polarization difference between the 37 GHz measurements is sensitive to the amount of precipitation in the optical path whereas the IR parameter is sensitive to the presence of cloud. Therefore, differences between the two time series could be used to discriminate precipitating from non-precipitating cloud systems, once removed the effects of different data

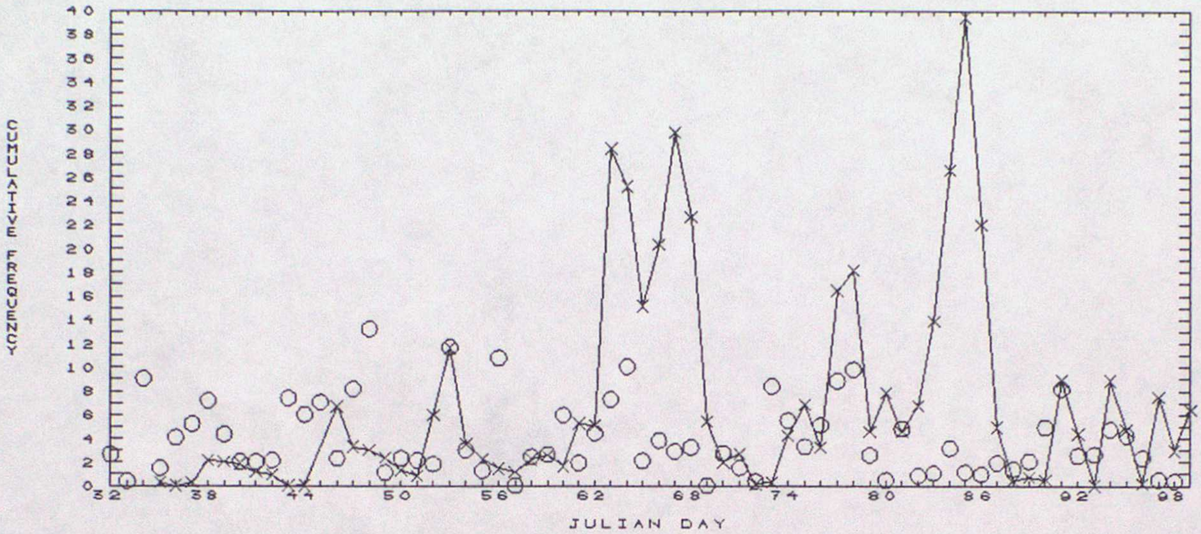

Fig.5: Time series of daily averaged cumulative frequencies for the difference T37V-T37H<40 K (o) over water compared with the same statistical figure for the AVHRR channel 4 measurements T4<240 K (x) over the whole GPCP-AIP/2 area.

sampling.
The results of the analyses described will be used, together with results from studies of other types of data, including surface precipitation measurements, to select the cases for which precipitation estimates will be required for the GPCP-AIP/2.

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