NOAA Technical Memorandum ERL OWRM-11

FACE-2 DATA REDUCTIONS AND ANALYSES (PRIOR TO DISCLOSURE OF THE TREATMENT DECISIONS): PART V. SATELLITE-ESTIMATED RAINFALL FROM A GEOSTATIONARY PLATFORM IN FACE-2

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Office of Weather Research and Modification
Boulder, Colorado
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ABSTRACT

Precipitation on the 51 FACE-2 B days was estimated for the FACE target area and an extended, surrounding area through use of the digital, GOES infrared imagery. The satellite rain estimation technique is described. Daily rain volumes and daily isohyetal maps are given. The approach to determine the extra-area effects of seeding with these rainfall data is outlined.

FACE-2 Data Reductions and Analyses (Prior to disclosure of the treatment decisions): Part V. Satellite-Estimated Rainfall from a Geostationary Platform in FACE-2

José G. Meitín, Jr.[1], William L. Woodley and Cecilia G. Griffith

1.0 Introduction

The possibility that cloud seeding might affect precipitation and other meteorological parameters (e. g., cloud cover, wind direction and speed) outside of the intended target has been recognized since the earliest days of cloud seeding (Langmuir, 1951). Such extended area effects might result from the simple transport of the seeding agent into clouds outside of the target or they might be caused by "dynamic contamination" (Simpson and Dennis, 1974) whereby the effect of dynamic invigoration of clouds in the target might propagate outward into the mesoscale or even the synoptic scales (e. g., actual movement of the invigorated cloud, gravity waves, anvil cover, etc).

Documentation of extended area effects of seeding has proven to be especially difficult in weather modification experiments, primarily because the anticipated effect is small when compared to the natural rainfall background. Nevertheless, arguments for extended area effects have been presented for such projects as Climax (Grant et al., 1971), Santa Barbara (Elliott et al., 1971),

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and Whitetop (Neyman et al., 1969). (See Appendix A.) Even so, there is no one project where it has been demonstrated beyond reasonable doubt that treatment effects extended outside the target area.

This fact gives us pause for thought for our efforts to detect extra-area effects of seeding in FACE-2, the second phase of the Florida Area Cumulus Experiment. Despite these misgivings, we intend to push forward with our plans to look for extended area effects of seeding in FACE-2. This Technical Memorandum describes these plans, including a description of the methodologies, a presentation of the data and the projected methods of analysis. All of this is provided prior to disclosure of the treatment decisions of FACE-2. Furthermore, it must be recognized at the outset that this will in no way confirm any result of FACE-1.

2.0 The FACE Program

The Florida Area Cumulus Experiment (FACE) is a long-term research program to determine the potential of dynamic seeding for increasing convective rainfall over a fixed target area. The initial, or exploratory phase of FACE (FACE-1), conducted during portions of the summers of 1970, 1971, 1973, 1975 and 1976 provided considerable evidence for increased, seeding-induced, rainfall at the ground (Woodley et al., 1982). The second phase of FACE (FACE-2) was conducted during the summers of 1978, 1979 and 1980 in an attempt at confirming the ground level precipitation results of FACE-1.

The design and evaluation of FACE-2 were specified in a NOAA Technical Memorandum (Woodley et al., 1978) prior to commencement of the experimentation. The double-blind nature of the experiment was strengthened, and fixed periods of experimentation, treatment and observation were specified. Treatment decisions were determined through a blocked randomization scheme based on mean vector wind speed and wind direction. The daily and cloud suitability criteria and seeding procedures of FACE-2 were similar to those employed during the latter portion of FACE-1. The gage-adjusted radar method of precipitation estimation, which was employed in FACE-1, will be the primary means of assessing treatment effects in FACE-2. Additional recording rain gages were placed throughout the target area to permit an independent assessment of target rainfall. These will be used in the extended area effects studies to be described.

On a typical day of experimentation in FACE-2 three seeder aircraft flew into the target area at altitudes ranging between 18,000 ft and 20,000 ft pressure altitude and began seeding at an average time of 1844 GMT (1444 EDT). Seeding was accomplished by dropping one or more 70 g silver iodide pyrotechnics into the tops of vigorously-growing, supercooled convective cloud towers. According to the FACE dynamic seeding hypothesis, this action leads to the sudden release of fusion heat in the individually seeded towers, leading to a sequence of events that result ultimately in larger, better organized clouds that produce more

precipitation (Woodley et al., 1982). In the mean, 334 silver iodide or placebo flares were released on each day of experimentation in FACE-2.

Because of the high seeding rates plus the indications from FACE-1 that the seeding may have increased the target precipitation by as much as 40%, it is not unreasonable to expect some effect of seeding on precipitation outside of the target area. At this writing, however, we are in no position to predict what sign any effect might have. When (and if) the invigorated clouds leave the target, one might reasonably expect an increase in rainfall. Flueck et al. (1981) suggest as much in their commentary on Nickerson's (1979) critique of FACE. On the other hand, one can also imagine a scenario whereby the invigorated seeded towers actually suppress the clouds outside the target leading to decreases in rainfall. The safest course at this point is to make no predictions and see what happens.

Unfortunately "seeing what happens" will not be all that easy with a sample of but 51 days. Unless the extended area effect is large, it may well get lost in the natural rainfall variability. The methods of analysis and inference to be used in an attempt to circumvent this problem are discussed in the ensuing sections.

3.0 Approach to the Study

Estimates of convective rainfall will be the sole means of inferring extended area effects in FACE-2. Rainfall will be estimated over the large area of Figure 1 (23-31N, 75-87W) using geosynchronous, infrared satellite imagery in conjunction with the

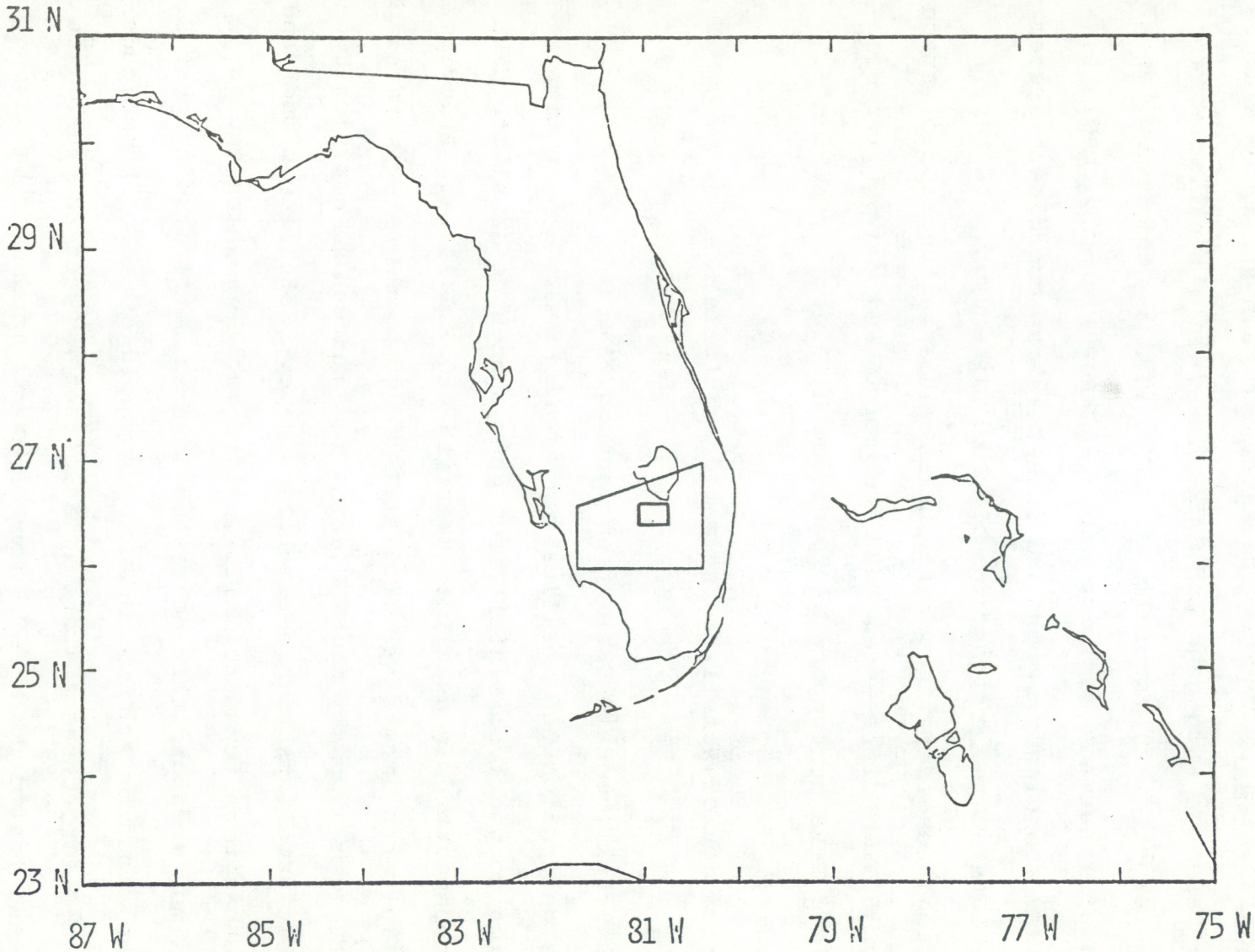

Figure 1. The area of estimation of GOES-inferred rainfalls for the determination of the extra-area effects of cloud seeding. The FACE target area (the trapezoid) and the FACE inner network area (the rectangle) are delineated on the Florida peninsula.

technique developed by Griffith and Woodley (see Griffith et al., 1978; Woodley et al., 1980). The satellite rain estimates will be adjusted based on rain gage and satellite rainfall estimates for the FACE target. All rainfall estimates will be composited as a function of treatment decision (not yet known) in an absolute, earth-fixed coordinate system and in a relative coordinate system that is rotated as a function of wind direction. After compositing, seeding effects will be sought as a function of space and time. All differences will be noted and tested for statistical P-value support as specified herein.

4.0 Derivation of Satellite-Estimated Rainfalls

4.1 The Satellite Rain Estimation Technique

The derivation and verification of a technique to estimate summertime convective rainfall from geosynchronous satellite data has been described in detail in Griffith et al. (1978). Briefly, thermal infrared images were calibrated by a combined system of gage and radar data in south Florida to produce an empirical, diagnostic satellite rain estimation scheme. Satellite clouds and radar echoes were found to follow a life cycle in which each grew to a maximum area and then decreased in area until it disappeared below the cloud or echo definition threshold of $-20^{o}C$ for clouds or 1 mm h^{-1} for echoes. There is an offset between the echo life history and the cloud life history which is important because it compensates for contamination from cold but inactive cirrus.

Radar echoes within 90 nmi of Miami were matched to clouds on the corresponding infrared image for a number of sequences of satellite pictures. The resulting empirical relationships between parameters measured from the satellite image and rainfall have the following properties:

- Raining clouds are those which are as cold or colder than $-20^{o}C$.
- Rainfall is directly proportional to cloud area on any given picture.
- Rainfall is inversely proportional to cloud top temperature.
- Rainfall is a function of cloud life cycle, that is, more rain is inferred in the early stage of a cloud's history than in the later stage.

The technique is fully automated (Woodley et al., 1980) so that estimates can be made routinely over large areas from digital satellite data. The four computer programs required to produce the estimates are 1) the image navigation program (NAV), 2) the cloud isolation and tracking program (TRACK), 3) the program which compiles cloud life histories and calculates volumetric rain production for each cloud (TRACER) and 4) the rain mapping program (RAINMAP). For a complete description of these programs, see Griffith et al. (1980).

The navigation program has three functions: to geographically locate the digital imagery, to smooth the data to a desired resolution and to rectify the image into a manageable two-dimensional array. The digital satellite imagery are

navigated, earth-located and rectified using a scheme described by Smith and Phillips (1972). The result is a Cartesian array of IR temperatures.

The navigation requires that updated parameters of satellite maneuvers be provided as well as a daily landmark measurement. This information is crucial in order to accurately position each temperature value over its corresponding gridpoint. This is a potential source of error when comparisons are made over relatively small areas. The exact position of individual gridpoints can only be determined to plus or minus one point accuracy.

On the days when some of this information was unavailable, the navigated image array could only be checked visually against available hard-copy photographs. On occasion, the lack of distinctive clouds on the photographs made for less than desirable confirmation of the accuracy of the navigation.

The computer program which tracks the clouds from image to image is essentially the program that tracks radar echoes. It is based on the routines described in Wiggert et al. (1976), Wiggert and Ostlund (1975) and Ostlund (1974) in which clouds are isolated by an eight-point search algorithm and tracked by fitting bivariate normal distributions. The isolation and tracking algorithms are general enough that given a field of data and an appropriate threshold, any type of data may be isolated and tracked with this program. The TRACK program also measures the

size of the cloud, determines the location of the cloud's digital count-weighted centroid and computes the fractional areal coverage within the cloud of specified temperature ranges.

A brief highlight of TRACER, the program which determines the cloud histories and calculates the rain values, is in order. Once the life cycle of each cloud is determined and the area of its maximum growth calculated, the rain volumes corresponding to each cloud for each of its stages is stratified according to the maximum area that the cloud reached during its lifetime. First, clouds which grow to less than 2000 km^2 in area are typically short-lived and most of the rain is produced in its very early stages. Secondly, clouds reaching a size between 2000 and 10000 km^2 produce a lower area-average rainfall, but over a larger area and over a longer time period. Lastly, clouds whose maximum area is greater than 10,000 km^2 are relatively long-lived and contribute rainfall over a number of satellite images. This differentiation is automated in the computer program. For all 3 cases the maximum rainfall precedes the time of the cloud's maximum size.

Since the technique, as described above, calculates rain volumes for individual clouds based on the life history information, it is necessary to distribute these rain volumes over an area covered by each cloud in order to produce isohyetal maps of rainfall at the ground. This is accomplished using the last of the computer programs, RAINMAP. The result is a grid array with the corresponding rain depth at each of the bins. Studies by Woodley _et al_. (1975) have shown that in Florida convection,

approximately 50% of the rain falls within 20% of the radar echo area. This relationship was applied to the satellite-estimated rain such that 50% of the volume computed for each cloud is mapped over the coldest 10% of the cloud as defined by the -20°C threshold. The remaining 50% of the rain volume is mapped over the next coldest 40% of the cloud; therefore, 100% of the volume is mapped in the coldest 50% of the bins that make up each cloud.

This rain mapping algorithm is a simplified model of very complex processes and no distinction is made as to its applicability to light and heavy rainshowers. As a consequence it is implicitly assumed that the temperature pattern at the top of the clouds is highly correlated with the precipitation pattern at the ground. This is true for most summertime convection in Florida but begins to deteriorate as wind shear increases with height or in the presence of cirrus decks. If too much or too little rain is mapped over the FACE target area, it is because the mapping is based solely on the distribution of cloud top temperatures. Clearly, this is another potential source of error in the satellite-estimated rainfalls when compared to rain gages over relatively small areas.

4.2 Data

The Griffith/Woodley satellite rain estimation technique was applied in FACE-2 from 23° to 31°N and 75° to 87°W, an area 8° of latitude by 12° of longitude. The area of estimation was chosen such that the Florida peninsula and particularly the FACE target area were centrally located in the grid array. The data processed

are the geosynchronous, thermal infrared imagery from GOES-East. The data are nominally recorded at a 30 min frequency and have a spatial resolution of 8 km, or approximately $1/15^{\circ}$. With this resolution over the area of Figure 1, the satellite array is composed of 120 lines by 180 pixels.

For the purposes of this study the FACE target area is described by a finite number of gridpoints or bins which closely approximate the geographical boundaries of the FACE trapezoidal area. The computerized target area has a northern boundary which is described by a step function such that some of the bins included in the target area lie partially outside of the area.

The satellite imagery used in FACE-2 was acquired through the Colorado State University Direct Readout Ground Station. The imagery is nominally available every 30 minutes from 1600 to 0400 GMT on FACE GO days. On occasion a picture or sequence of pictures was missed due to some malfunction or other reason uncontrolled by us. Every effort has been made to fill gaps in the sequence of images from other data archives; these included the National Space Science Data Center at NASA/Goddard and the Space Science and Engineering Center, University of Wisconsin-Madison.

In the event that images were still unavailable for processing, the Griffith/Woodley technique filled in the gaps by determining cloud histories as a function of the time for the images that were available. Therefore, rain volumes were calculated in spite of these gaps; but the quality of the estimate

is somewhat degraded if short-lived clouds were present. At this time, we cannot make any determination as to the effect of these data gaps on the estimates.

On some special days, the satellite imagery is available more frequently than every 30 minutes (e.g., 15 or 7.5 minutes between pictures) for a short period of time. When this happens, rainfall is estimated more frequently but for our purposes, the rain was accumulated over 30 minute intervals whenever possible.

Finally, for a period between 1 and 9 July 1980, the satellite signal was being calibrated by the Wallops Island ground station. A number of images was lost to all users and archives, and those available were of less than the usual quality. This is evident on two FACE GO days: 4 July 1980 and 7 July 1980; on these days estimates were made over a relatively short period of time with some large data gaps.

4.3 Adjustment of the Satellite-Derived Rainfalls

Potential sources of error in the satellite rain estimates have been discussed in the previous sections. In essence these error sources reduce to two types: 1) rainfall placement errors caused either by poor navigations or by the rain apportionment scheme and 2) rainfall volume errors arising from scatter in the component relationships of the Griffith/Woodley technique. Obviously, in looking for extra-area effects one desires to have the most accurate rainfall data set which is available over the extra-target region. In fact there would be no hope whatsoever of determining an extended area effect of seeding using satellite

imagery and the limited sample of FACE-2 were it not possible to adjust the satellite rain estimates to a rain gage standard. The method of adjusting the satellite rainfall estimates using rain gages is analogous to that used in FACE-2 to adjust the radar estimates of target precipitation. It proceeds in several steps.

First, area average rainfall for the FACE target (Fig. 1) in the time period 1630 to 0100 GMT is calculated on each day using both rain gages (G_T) and satellite imagery (S_T). The satellite rainfall in the bins that make up the FACE target are summed. This sum is divided by the total number of satellite bins. The 5-minute raingage data, accumulated over 30 minutes for comparisons with the satellite estimates, are similarly summed and then divided by the number of working rain gages within the FACE target area. Secondly, the ratio of G_T/S_T is calculated for each day. The third step involves multiplying the satellite rain estimates for the large array, S_E, (see Fig. 1) by the ratio G_T/S_T that was obtained for the FACE target within the array. This works reasonably well (see Thomas et al., 1982) when the rainfall in the adjusting area is greater than 1 mm. But when the rainfall is less than 1 mm in the adjusting area the method of adjustment becomes unreliable. In these instances the geometric mean of the G_T/S_T values on the days when adjustment was possible is used to adjust those days on which the rainfall is insufficient to calculate an adjustment.

This scheme was applied to all the days of experimentation in FACE-2. A tabulation of all the G_T/S_T values are provided in section 6.0. Whether the resultant satellite-estimated rainfalls

will be accurate enough to infer an extended area seeding effect (assuming there is one) remains to be seen.

5.0 The Rain Gage Standard

Both digital and analog recording rain gages were distributed over the target area in FACE-2. All raingages were P501 tipping bucket gages supplied by Weather Measure Corporation, Sacramento, California. The placement of raingages throughout the FACE target area became feasible with the development of a relatively inexpensive, long-term digital recorder. This digital recorder has been described by Thomas and Merceret (1979). The data from each raingage were reduced at 15 min intervals for each experimental day (digital recorders store data at 5 min intervals). Total rainfall amounts for each gage were calculated for various time periods. More detail on the raingage program of FACE-2 is provided by Thomas et al. (1982).

During FACE-2 the rain gages were placed in two arrays. An outer network contained raingages about 11 km apart over the FACE target area. An inner network of 48 gages with a 3.2 km spacing was used primarily to adjust the digitized radar estimate of rainfall in the FACE target area. The approximate raingage locations during FACE-2 are shown in Figure 2.

A method that assumes equal-area coverage for each available gage value was used to obtain the gage rainfalls which are the standard for comparison with the satellite-estimated rainfalls. The rainfall values from each gage in the outer and inner networks were used. The inner and outer raingage network values were

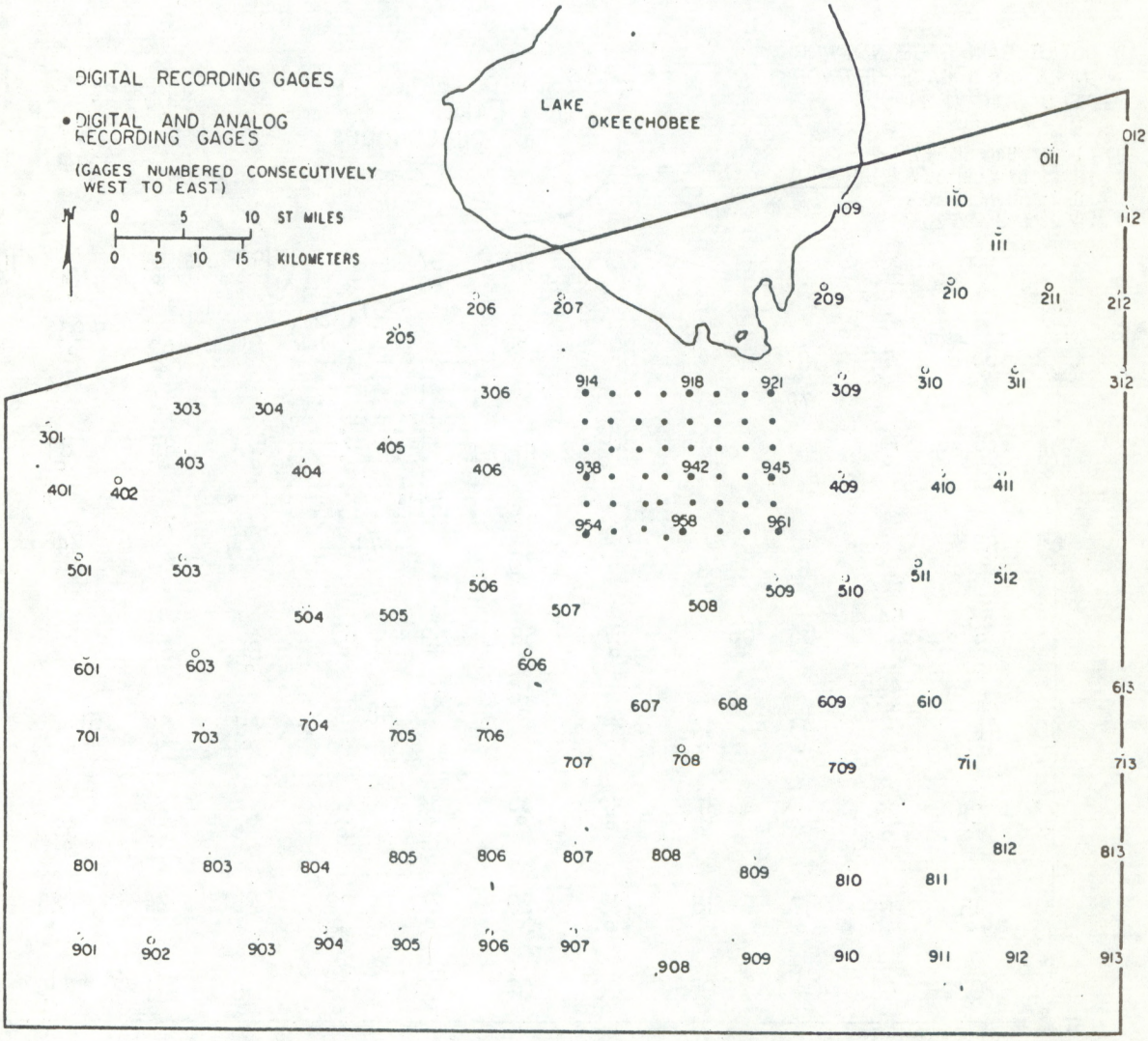

Figure 2a. The location of recording rain gages in the FACE target (trapezoidal) and inner network (rectangular) areas during FACE 1978.

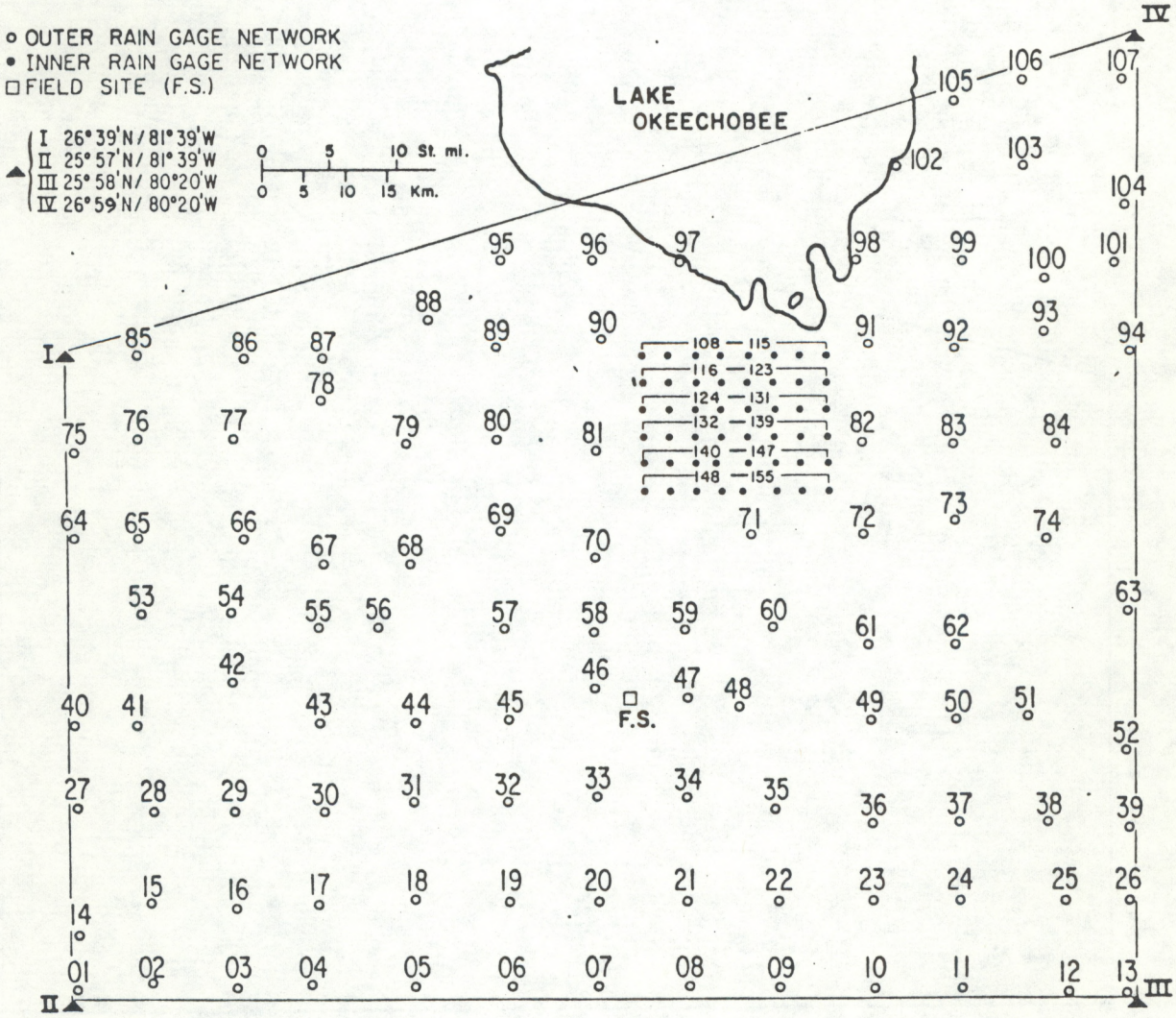

Figure 2b. As in Figure 2a, but for FACE 1979 and FACE 1980.

normalized for their differential gage densities and summed. This total was converted to area-averaged depths expressed in mm. This method is the most frequently used method for gage distributions which approach uniformity. Tests over the years on several uniform networks indicate that this method gives the same mean rainfall and area-depth relations as do planimetered isohyetal mapping techniques (see Thomas et al., 1982). However, it is not known whether consistent results can be expected from the network of gages used in FACE-2 because of design, gage malfunction, and/or vandalism which resulted in unavoidable gaps between gages. One case day is especially suspect (July 29, 1978) in which a large number of gages malfunctioned due to a badly constructed data cable on a recording control unit. As luck would have it, this particular day was also the wettest day in FACE-2.

6.0 The FACE-2 Satellite-Estimated Rainfalls

The satellite-estimated rainfalls for each B day ($\geq$ 60 flares expended) of experimentation in FACE-2 are tabulated in Appendix B. Half-hourly intervals for the FACE target and for the extended array are provided there. The daily values of G_T/S_T that will be used to adjust the satellite estimates of rainfall are listed at the bottom of each page. Daily rainfall maps accumulated over the period of rainfall estimation are provided in Appendix B as well. Remember that these maps are to be adjusted by the appropriate G_T/S_T values. Thus, the contour values will change, but the rainfall patterning will be preserved.

Summary rainfall data for the period of the satellite-gage comparison and for the entire period of satellite estimation for both the target and extended area are listed in Table 1. The daily G_T/S_T adjustments and a summary of the missing pictures are also included. The mean vector winds in the layers 850 mb to 500 mb and 700 mb to 300 mb (last columns in the table) will be used to assist with the mapping and examination of the rainfalls in a relative coordinate system. This is discussed in detail in section 7.0.

Data availability is the first concern. Note that there is a greater percentage of missing pictures in 1978 than in 1979 and 1980. Rainfalls on days on which five or more pictures are missing are especially suspect, particularly if they are consecutive.

The G_T/S_T values will be used as listed except for those days on which either the gage value or the satellite value is $\leq$ 1 mm. On these days (three in 1978, three in 1979 and three in 1980) a reliable adjustment is not possible and the yearly geometric mean value of G_T/S_T will be used instead. The geometric mean values of G_T/S_T to be used for 1978, 1979 and 1980 are 1.11, 0.62 and 0.72, respectively. These results suggest that the satellite rain estimation method tended to underestimate the rainfall in 1978 and overestimate it in 1979 and 1980.

Ratios of mean satellite-estimated area rainfall in the extended area (which also includes the target) to the satellite estimated target mean rainfall are provided in Table 1. Note that

Table 1.

BASIC DATA FOR EXTENDED AREA STUDIES IN FACE-2

DATE	TIME START	TIME END	MISSING PICTURES	SATELLITE ESTIMATED AREA AVERAGED DEPTH (MILLIMETERS) EXTENDED AREA	TARGET AREA	EA/T	TARGET AREA COMPARISONS AREA AVERAGED DEPTH (MILLIMETERS) TIME START	TIME END	SATELLITE	RAINGAGE	G/S	ADJ. FACTOR	MEAN VECTOR WIND 850-500 MBS DIR/SPD(kts)	MEAN VECTOR WIND 700-300 MBS DIR/SPD(kts)
1978														
6-29	1730	0400	1	0.24	2.25	.107	1730	0100	2.25	3.59	1.60	1.60	103/05	082/13
6-30	1600	0330	5	0.05	1.21	.041	1600	0100	1.21	1.71	1.41	1.41	141/04	065/05
7-01	1600	0400	0	0.12	5.84	.021	1600	0100	5.76	7.38	1.28	1.28	156/04	072/10
7-02	1630	0400	1	0.14	6.39	.022	1630	0100	5.40	4.33	0.80	0.80	144/03	064/02
7-03	1700	2330	3	0.03	1.32	.023	1700	2330	1.32	3.67	2.78	2.78	252/03	345/04
7-10	1930	0330	2	0.04	0.89	.045	1930	0100	0.89	2.24	2.52	1.11	127/06	071/05
7-25	1600	0130	5	0.11	0.91	.121	1600	0100	0.55	1.59	2.89	1.11	053/07	036/09
7-29	1730	0400	2	0.41	33.08	.012	1730	0100	25.35	19.31	0.76	0.76	288/08	299/08
8-04	1600	0400	2	0.23	0.55	.418	1600	0030	0.55	2.10	3.82	1.11	086/10	036/11
8-10	1630	0200	2	0.32	3.81	.084	1630	0100	3.81	4.33	1.14	1.14	137/07	052/03
8-11	1630	0400	4	0.31	6.19	.050	1630	0100	6.19	3.84	0.62	0.62	143/07	107/05
8-12	1600	0400	3	0.21	9.68	.022	1600	0100	9.46	12.72	1.35	1.35	188/07	171/06
8-13	1700	0400	1	0.18	3.48	.052	1700	0100	3.48	2.88	0.83	0.83	200/08	186/06
8-14	1700	0400	3	0.07	1.22	.057	1700	0100	1.22	1.67	1.37	1.37	127/02	143/04
8-16	1700	0300	1	0.15	7.93	.019	1700	0100	7.65	9.50	1.24	1.24	087/09	063/12
8-17	1630	0400	3	0.18	4.74	.038	1630	0100	4.55	3.52	0.77	0.77	114/08	066/11
8-29	1630	0200	3	0.07	6.89	.010	1630	0100	6.89	6.08	0.88	0.88	110/05	090/08
1979														
7-06	1730	0400	3	0.13	8.67	.015	1730	0100	7.73	8.26	1.07	1.07	115/08	119/08
7-08	1700	0400	1	0.20	6.90	.029	1700	0030	5.78	3.85	0.67	0.67	257/05	268/04
7-09	1900	0400	0	0.20	12.21	.016	1900	0100	11.12	5.40	0.49	0.49	294/06	294/04
7-28	1700	0300	1	0.24	0.21	1.14	1700	0100	0.21	1.28	6.10	0.62	101/06	065/07
7-30	1630	0330	0	0.19	1.86	.102	1630	0100	1.86	3.17	1.70	1.70	057/05	041/10
7-31	1630	0400	3	0.16	4.16	.038	1630	0100	4.16	1.88	0.45	0.45	170/02	221/01
8-03	1630	0400	0	0.20	18.43	.011	1630	0000	15.08	3.41	0.23	0.23	053/05	318/03
8-13	1630	0300	0	0.09	0.16	.562	1630	0100	0.16	0.24	1.50	0.62	247/07	311/03

Table 1, Continued

BASIC DATA FOR EXTENDED AREA STUDIES IN FACE-2

DATE	TIME START	TIME END	MISSING PICTURES	SATELLITE ESTIMATED AREA AVERAGED DEPTH (MILLIMETERS) EXTENDED AREA	TARGET AREA	EA/T	TARGET AREA COMPARISONS AREA AVERAGED DEPTH (MILLIMETERS) TIME START	TIME END	SATELLITE	RAINGAGE	G/S	ADJ. FACTOR	MEAN VECTOR WIND 850-500 MBS DIR/SPD(kts)	MEAN VECTOR WIND 700-300 MBS DIR/SPD(kts)
1979														
8-14	1600	0300	0	0.10	6.32	.009	1600	0100	6.32	3.91	0.62	0.62	098/06	081/09
8-16	1630	0400	4	0.07	0.05	1.400	1630	0100	0.05	0.45	9.00	0.62	081/07	065/05
8-18	1630	0400	1	0.13	14.10	.009	1630	0100	12.86	6.26	0.49	0.49	006/02	005/08
8-20	1630	0400	0	0.14	14.63	.010	1630	0100	12.28	9.87	0.80	0.80	075/06	043/07
8-28	1630	0400	1	0.20	5.83	.034	1630	0100	5.21	3.54	0.68	0.68	084/13	085/12
8-29	1700	0330	2	0.35	7.75	.045	1700	0100	6.80	11.01	1.62	1.62	110/05	107/05
1980														
6-23	1630	0400	1	0.15	7.10	.021	1630	0100	4.68	4.99	1.07	1.07	254/12	208/13
6-24	1630	0400	0	0.12	2.97	.040	1630	0100	2.26	1.17	0.52	0.52	260/12	273/13
6-25	1630	0400	1	0.13	13.79	.009	1630	0100	13.60	3.59	0.26	0.26	239/10	254/11
6-28	1730	0400	4	0.17	12.42	.014	1730	0100	12.02	5.15	0.43	0.43	212/08	197/10
7-04	1800	0200	4	0.03	0.00	.000	1800	0100	0.00	1.36	0.00	0.72	106/17	067/18
7-07	2000	0130	3	0.04	4.57	.009	2000	0100	4.57	2.33	0.51	0.51	335/08	336/05
7-08	1630	0000	0	0.05	9.91	.005	1630	0000	9.91	11.17	1.13	1.13	360/01	044/07
7-09	1630	0000	1	0.01	1.60	.006	1630	0000	1.60	4.54	2.83	2.83	090/07	091/14
7-10	1630	0400	0	0.04	2.02	.020	1630	0100	2.02	2.46	1.22	1.22	071/07	068/15
7-12	1630	0400	1	0.22	0.17	1.290	1630	0100	0.17	0.53	3.12	0.72	337/00	044/12
7-16	1630	0400	0	0.32	13.44	.024	1630	0100	10.82	6.69	0.62	0.62	311/06	017/16
7-25	1630	0400	0	0.45	23.55	.019	1630	0100	17.56	4.98	0.28	0.28	229/08	241/14
7-29	1700	0400	0	0.12	2.91	.041	1700	0100	1.86	1.31	0.71	0.71	248/07	309/07
7-31	1630	0200	0	0.15	2.63	.057	1630	0100	2.15	1.84	0.86	0.86	169/10	159/09
8-02	1630	0400	1	0.16	21.31	.008	1630	0100	19.55	11.22	0.57	0.57	344/05	285/02
8-03	1630	2300	3	0.06	9.70	.006	1630	2300	9.70	12.52	1.29	1.29	018/07	143/03
8-04	1630	0030	4	0.07	4.07	.017	1630	0100	4.07	0.91	0.22	0.72	062/07	119/04
8-18	1630	0400	2	0.22	12.56	.018	1630	0100	12.56	13.77	1.10	1.10	027/04	020/09
8-26	1630	0400	2	0.07	1.75	.040	1630	0100	1.41	1.11	0.79	0.79	234/10	223/15
8-29	1600	0400	1	0.18	19.47	.009	1600	0100	15.20	6.46	0.43	0.43	011/09	061/08

in all but a few cases the mean rainfall over the entire array is much less than the mean rainfall over the target, demonstrating rather conclusively that less rain falls over the water areas than over the land. The mean extended area rainfalls for 1978, 1979 and 1980 are 0.168 mm, 0.172 mm and 0.138 mm, respectively. This suggests that the B days of experimentation in the first two years of FACE-2 were wetter on the synoptic scale than the last year.

There clearly is interest in the overall performance of the satellite rain estimation technique relative to the rain gages over the target area. A preliminary look is provided in a scatter plot of rain gage and unadjusted satellite mean rainfalls for the FACE target (Fig. 3). Visual inspection suggests rather good overall performance except for four days on which the satellite substantially overestimated the gage-measured rainfall. The linear regression best fit line ($S_T = 1.15 + 1.05\ G_T$) is plotted. The correlation between S_T and G_T is 0.74. At present we have no explanation for the large overestimation by the satellite rain estimation technique on a few days, but it is probably due to high instability, vigorous updrafts and anomalously cold cloud tops on these days. Regardless of the reasons for the G_T vs. S_T differences, the reader should recall that the satellite will be adjusted to the gages (as described earlier) in the study of potential extended area effects of dynamic seeding.

7.0 Analysis of Seeding Effects

The main objective of the FACE satellite rain estimation project is a determination of whether seeding has affected the

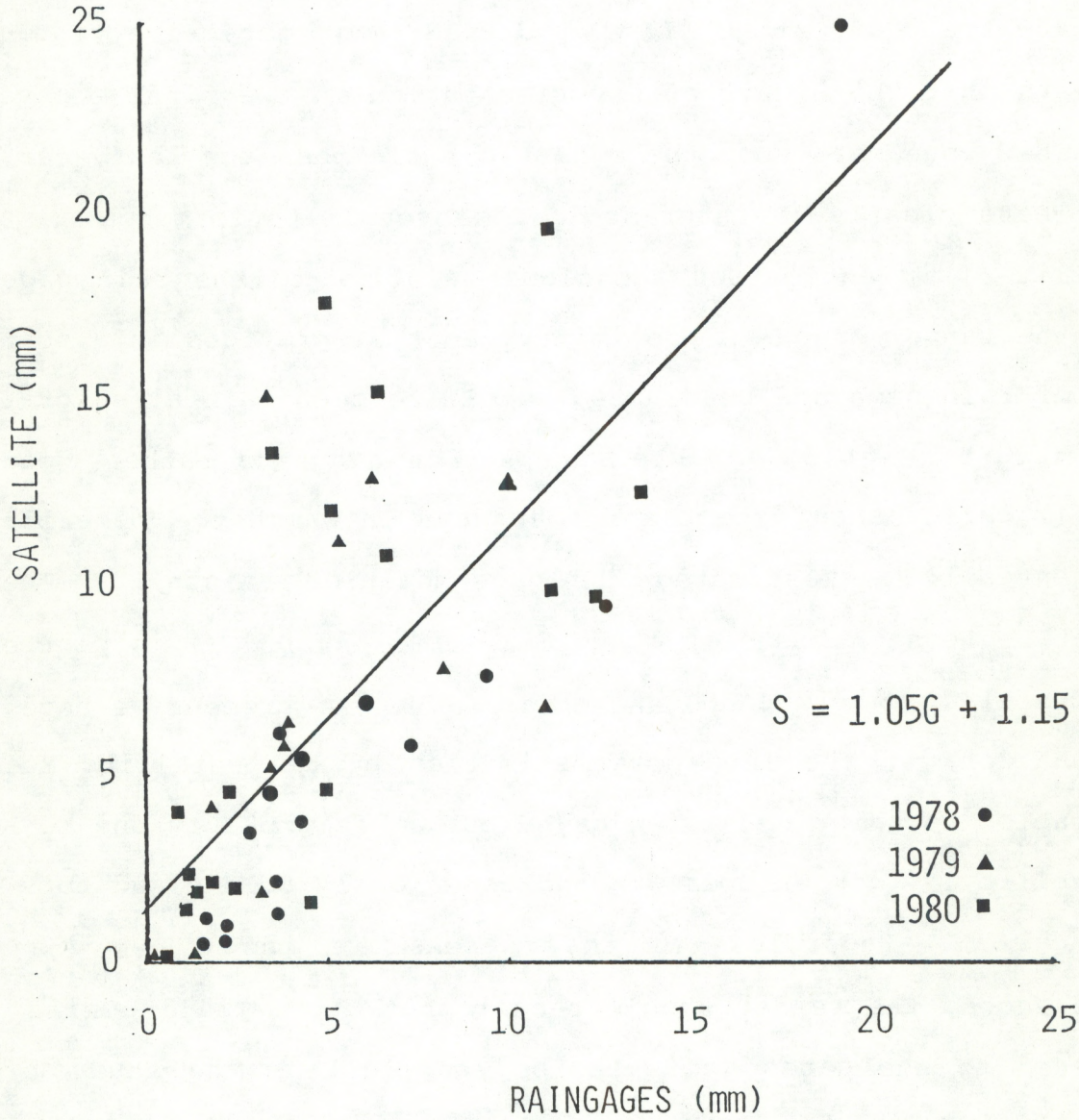

Figure 3. Scatter plot and linear regression of the daily (1630-0100 GMT) gage (G_T) and satellite (S_T) target rainfalls (mm) for the FACE-2 B days.

rainfall outside the intended target area. An investigation of this possibility will proceed in several steps once the treatment decisions are known.

The first step involves rainfall compositing. Rainfalls for each day of FACE-2 will be composited as a function of treatment decision. Compositing will be accomplished in both an absolute and relative coordinate system. In the absolute system composite seed (S) and no seed (NS) rainfall maps (1/15° resolution) will be generated for the area shown in Figure 1. In the relative system the rain map for each day will first be rotated to a common "downwind" directional reference before compositing. The directional references have been obtained for FACE-2 (Table 1) by calculating the 850 mb to 500 mb and the 700 mb to 300 mb mean vector winds from the 1200 GMT West Palm Beach sounding on each day of experimentation. The mean wind in the layer 850 mb to 500 mb is thought to best represent the motion of the rain-producing clouds while the mean vector wind in the layer 700 mb to 300 mb is probably most indicative of the transport of the seeding material.

The method of compositing in a relative coordinate system can best be understood by an example in conjunction with Figure 4. Assume that the mean vector wind direction for the layer 850 mb to 500 mb is from 235° on a particular day. This means that the wind is blowing from octant 8 into octant 4 (see Fig. 4, top). The downwind octant is therefore octant 4. Compositing the rainfall over the circular array (with the center of the FACE target at the origin) to a common reference is accomplished by rotating the map such that octant 4 overlies the downwind octant (DW) (Fig. 4,

bottom). When this is done the relative positions of the other octants are specified as well (i. e., octant 5 becomes the downwind right (DR) octant, octant 3 becomes the downwind left octant and so on). Similarly, if the wind on a particular day were from 145°, octant 2 would be rotated to coincide with octant DW and the other octants would be specified accordingly. To obtain the composited rainfall on these two days, the rainfall in octants 4 and 2 would be added during the compositing process even though they represent different geographical areas relative to the center of the FACE target. This process provides a common meteorological reference.

Besides compositing in the space domain as a function of the treatment decision, the compositing will also be done concurrently in the time domain. All rainfall calculations will be done in half-hour intervals relative to the time of initial treatment. Thus all rainfalls on seed days and on no seed days in the first half hour after treatment will be summed regardless of when these rainfalls occurred in real time. With judicious compositing in space and time it may be possible therefore to see an effect originating in the target area and propagating outward (probably in the downwind octants) as a function of time.

Mean rainfalls as a function of time for both methods of space compositing will be generated by dividing each bin or area sum by the number of days in the sample. Mean rainfall differences between each bin or area mean and the FACE target mean will also be calculated on each day. This is a crude method of compensating for large differences in day-to-day rainfall. Thus,

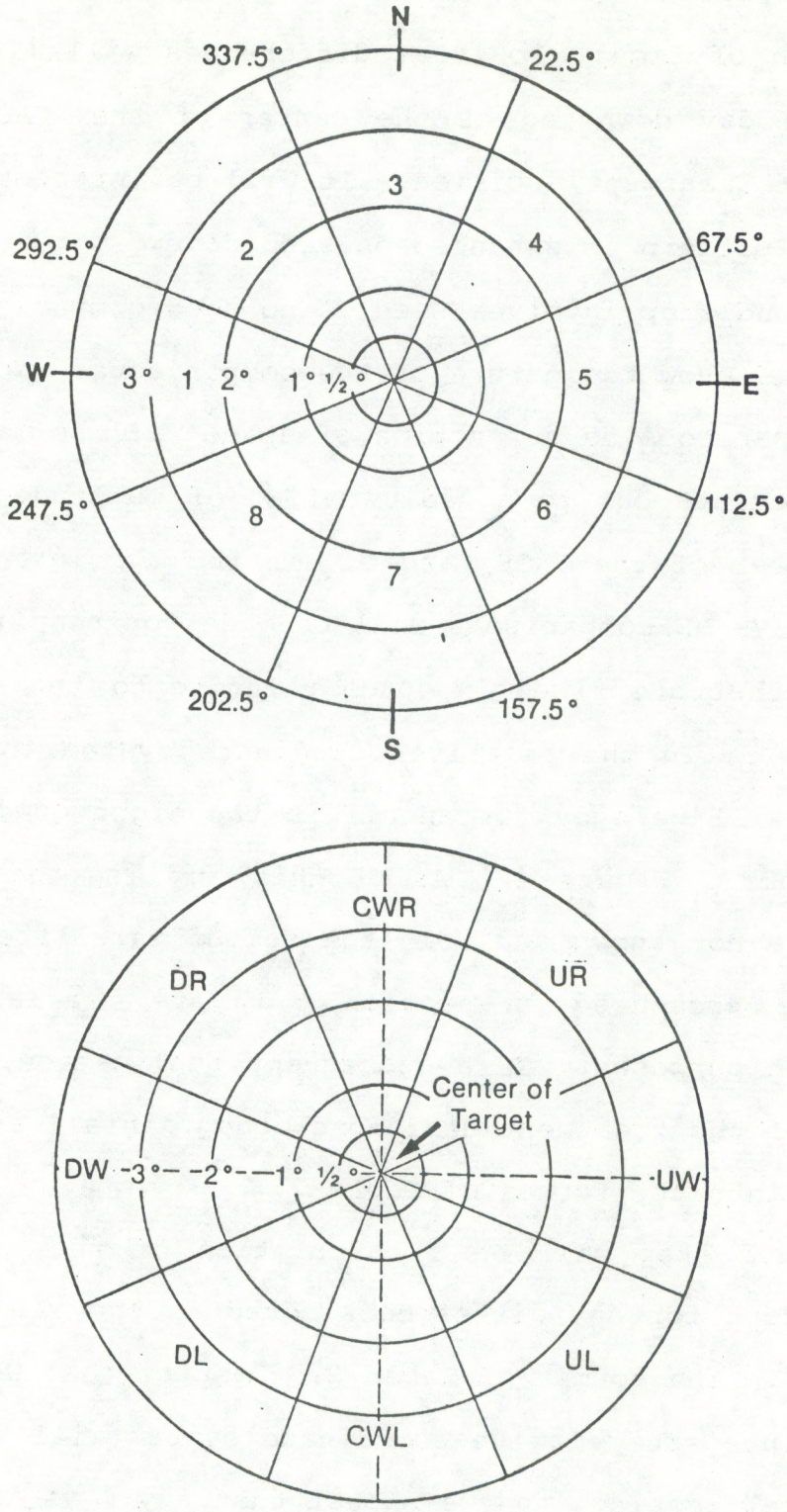

Figure 4. Schematic drawing of the absolute (top) and relative (bottom), wind-defined coordinate systems. Octants subdivided into five annuli are defined in each system. Compass points define the absolute system and the downwind octant (DW) defines the relative system.

a pattern of positive and negative differences will be generated as a function of time. Positive differences will likely occur later in the day downwind of the center of the FACE target regardless of treatment decision. It will be interesting to note whether this pattern is enhanced on seed days.

The second step involves seed vs no seed comparisons. Table 2 and Figure 4 show the nature of the comparisons. Note that the rainfall comparisons as a function of space will be made in annuli within the octants out to a radius of 3° of latitude (~180 nmi) from the center of the FACE target. In the absolute coordinate system the S vs NS comparisons will be made for annuli in octants 1 through 8 that are fixed in space relative to the FACE target (Fig. 4, top). In the relative coordinate system the S vs NS comparisons will be made for annuli in the eight quadrants shown in the bottom of Figure 4. As of this writing the treatment decisions are not known and only the summed satellite estimated rainfall, as presented in section 6.0, are available for documentation purposes. In a subsequent publication, following disclosure of the treatment decisions, the rainfall estimates will be inserted into the format of Table 2.

The third step will be a calculation of the statistical P-value support for any differences noted in the tabulation of S and NS data in the format of Table 2. Results that were generated in the absolute and relative coordinate system will be subjected to statistical testing, and we expect that any S vs NS differences will be most obvious in the relative system. Both the ratios R_S/R_{NS} and R_S/ R_{NS} (as defined in Table 2) within the annuli of

Table 2 - FACE-2 Extra-Area Mean Rainfalls on Seed and No Seed Days (Relative Coordinate System)*

Time wrt Seeding	Rainfalls	DW Annuli (in deg) 0 - ½	½ - 1	1 - 2	2 - 3	DR Annuli (in deg) 0 - ½	½ - 1	1 - 2	2 - 3	DL Annuli (in deg) 0 - ½	½ - 1	1 - 2	2 - 3	Balance of Table is similar for octants CWL, CWR, UR, UL and UW
-1 - ½	$\overline{R}$ (mm) S/NS													
	$\overline{\Delta R}$** (mm) S/NS													
-½ - 0	$\overline{R}$ (mm) S/NS													
	$\overline{\Delta R}$ (mm) S/NS													
0 - ½	$\overline{R}$ (mm) S/NS													
	$\overline{\Delta R}$ (mm) S/NS													

Balance of Table is similar out to time period 7½ to 8h.

* For absolute coordinate system the table will be identical except the octants 1 through 8 will replace the octants DW, DR, etc in the relative coordinate system.

** $\overline{\Delta R} = \sum_{j=1}^{n} (\overline{R}_{Ai,j} - \overline{R}_{Ti,j}) \div n$ where $\overline{R}_{Ti,j}$ = Mean target (T) rainfall in time period i on day j, and $R_{A,i,j}$ is the mean rainfall in annulus A in time period i on day j.

the various octants and for various time intervals will be tested for P value support using rerandomization tests. Simple Wilcoxon-Mann-Whitney tests will be performed as well.

Because the assessment of potential extra-area effects in FACE-2 using satellite imagery is clearly an exploratory effort, other analyses will also be attempted such as an examination of the interacting roles of wind speed, synoptic condition and the Florida peninsula in generating convective clouds and precipitation.

ACKNOWLEDGMENTS

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REFERENCES

Elliott, R.D., P. St. Amand and J.R. Thompson, 1971: Santa Barbara pyrotechnic cloud seeding test results 1967-1970. J. Appl. Meteor., 10, 785-795.

Flueck, J.A., W.L. Woodley, R.W. Burpee and D.O. Stram, 1981: Comments on E. Nickerson's "FACE rainfall results: Seeding effect or natural variability?". J. Appl. Meteor., 20, 98-107.

Grant, L.O., C.F. Chappell and P.W. Mielke, Jr., 1971: The Climax experiment for seeding cold orographic clouds. International Conference on Weather Modification, Canberra, Australia, September 6-11, 1971, 78-84.

Griffith, C.G., W.L. Woodley, P.G. Grube, D.W. Martin, J. Stout and D.N. Sikdar, 1978: Rain estimation from geosynchronous satellite imagery - visible and infrared studies. Mon. Wea. Rev., 106, 1152-1171.

_____, W.L. Woodley and J.A. Augustine, 1980: Final Report to the Water and Power Resources Service on the Estimation of Convective, Summertime Rainfall in the United States High Plains from Thermal Infrared, Geostationary Satellite Data, Volume II. Boulder, CO, 72 pp.

Langmuir, I., 1951: Project cirrus, final report. General Electric Research Laboratory, Schenectady, New York, July 1951.

Neyman, J., E. Scott, and J.A. Smith, 1969: Areal spread of the effect of cloud seeding at the Whitetop experiment. Science, 163, 1445-1449.

Nickerson, E.C., 1979: FACE rainfall results: Seeding effect or natural variability? J. Appl. Meteor., 18, 1097-1105.

Östlund:, S.S., 1974: Computer software for rainfall analysis and echo tracking of digital radar data. NOAA Tech. Memo. ERL WMPO-15, U.S. Dept. of Commerce, NOAA, Boulder, Colorado, 82 pp.

Simpson, J. and A.S. Dennis, 1974: "Cumulus clouds and their modification" in Weather Modification. W.N. Hess, Ed., New York, Wiley, 229-280.

Smith, E.A. and D.R. Phillips, 1972: Automated cloud tracking using precisely aligned digital ATS pictures. IEEE Trans. Comput., C-21, 715-729.

Thomas, J.L. and F.J. Merceret, 1979: A digital recording system for tipping bucket raingages; design and field testing. J. Appl. Meteor., 10, 1376-1379.

_____, A.G. Barnston, W.L. Woodley and J.A. Jordan, 1982: A comparison of radar and rain gage rainfall estimates in FACE-2. Submitted to J. Appl. Meteor.

Wiggert, V. and S.S. Östlund, 1975: Computerized rain assessments and tracking of south Florida weather radar echoes. Bull. Am. Meteor. Soc., 56, 17-26.

_____, S.S. Östlund, G.J. Lockett and J.V. Stewart, 1976: Computer software for the assessment of growth histories of weather radar echoes. NOAA Tech Memo. ERL WMPO-35, U.S. Dept. of Commerce, NOAA, Boulder, Colorado, 86 pp.

Woodley, W.L., A.R. Olsen, A. Herndon and V. Wiggert, 1975: Comparison of gage and radar methods of convective rain measurement. J. Appl. Meteor., 14, 909-928.

_____, R.I. Sax, J. Simpson, R. Biondini, J.A. Flueck and A. Gagin, 1978: The FACE confirmatory Program (FACE-2): Design and evaluation specifications. NOAA Tech. Memo. ERL NHEML-2, 51 pp.

_____, C.G. Griffith, J.S. Griffin and S.C. Stromatt, 1980: The inference of GATE convective rainfall from SMS-1 imagery. J. Appl. Meteor., 19, 388-408.

_____, J. Jordan, J. Simpson, R. Biondini, J. Flueck and A. Barnston, 1982: Rainfall results of the Florida Area Cumulus Experiment, 1970-1976. Accepted for publication in J. Appl. Meteor.

Appendix A

Assessment of Extended Area Effects in Cloud Seeding Programs

Table A-1 summarizes the information presented at the Workshop on Total-Area Effects of Weather Modification* regarding the statistical analyses of precipitation patterns in large areas surrounding long-term cloud seeding projects. The editor of the Workshop Transactions pointed out that there was no unanimity on the assessments presented in the table. Furthermore, he pointed out that virtually all extended area analyses were done after the fact. With these cautionary notes in mind, the editor put forth his opinion of the current state of knowledge of the Total-Area-Effect of planned weather modification (text taken verbatim from the transactions):

> The "better quality" evidence available from mostly a-posteriori analyses of past randomized seeding programs suggests that precipitation changes in extended areas tend to be of the same sign (increases or decreases) and roughly the same magnitude as the primary "target area" effects.
>
> These extended effects appear to be detectable at distances up to a few hundred kilometers from the seeding source. At distances beyond that the evidence is too weak to draw any conclusions.
>
> There is currently little evidence available to support the "Robbing Peter to pay Paul" hypothesis

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*Extracted from the Executive Summary of the Transactions of the Workshop on Total-Area Effects of Weather Modification, August 8-12, 1977, Fort Collins, Colorado by K.J. Brown, R.D. Elliott and M.W. Edelstein. North American Weather Consultants. July 1978.

that seeding to increase rain in one area will deprive some other area of its normal rainfall. However, the data base is inadequate to rule out the possibility that such a combination might occur.

The extended-area effect appears to be a continuum from the nucleating source to the final observed effect in most cases. However, in specific cases like the Climax, Colorado experiment, there may be a physical separation in the primary area precipitation changes and those in the extended area due to a unique situation in which different meteorological controls are operative in the two areas.

It is considered likely that more than one physical mechanism might produce changes in precipitation patterns in extended areas. Two possible mechanisms would be: 1) the transport of particulates (either ice crystals or silver iodide nuclei) from a seeded volume to some area well removed from the intended area of effect; or 2) a seeding produced dynamic effect in the intended target area which may affect other areas, either positively or negatively, by propagating stronger convective systems for some distance or producing a compensating suppression of convection in surrounding areas.

There are field observations and measurements of both ice crystals and ice nuclei being transported over 100 km from a seeding source.

There may be a "persistence effect" in some circumstances whereby seeding material may remain in an area for several days after being released.

Table A-1 Summary of observed seeding effects.

Project	Apparent Seeding Effect on Precip: Target	Apparent Seeding Effect on Precip: Extended	Maximum Distance Observed	Seeding Mode	Seeding Rate	Storm Type	Hypotheses
Grossversuch 1957-63	Increase Stat. Sig.	Increase Stat. Sig.	200 km	Ground Based	Low	Summer Conv.	Hypothesis: Dynamic response to seeding propogating convection into extended area.
Israel 1972-76	Increase	Increase Stat. Sig.	100 km	Aircraft Cloud Base	Moderate	Winter Conv.	Hypothesis: Transport of ice nuclei - Microphysical effect.
Santa Barbara 1967-74	Increase Stat. Sig.	Increase Stat. Sig.	150 km	Grd-based or arcrft. Convective bands	High	Winter Conv.	Hypotheses: Microphysical effect in one area. Dynamic intensification of bands in another area.
Climax 1961-70	Increase Stat. Sig.	Increase Stat. Sig.	130 km	Ground based	Low	Winter Stable	Hypothesis: Ice crystals from seeded clouds falling into lower upslope clouds.
Other projects with precipitation increases (values were not statistically significant) in both the target area and in an extended area included several Australian projects and a group of non-randomized operational programs in the western United States.							
Whitetop 1960-64	Decrease Stat. Sig.	Decrease Stat. Sig.	500 km	Aircraft Cloud Base	High	Summer Conv.	Hypothesis: Dynamic overseeding pumped all water out of top. Dynamic stabilization in surrounding area.
Arizona 1957-64	Decr. Stat. Sig. when combined	Decrease Stat. Sig.	300 km	Aircraft Cloud Base	High	Summer Conv.	Hypothesis: Same as Whitetop
Other projects with precipitation decreases (values were not statistically significant) in both the target and extended areas included the Colorado Summer Cumulus Program and some of the North Dakota studies.							
Other projects with statistically non-significant mixed results ranged from the New Mexico Jemez Project with increases followed by decreases; to a South Dakota program with decreases in primary areas followed by increases; to the Florida FACE program with significant increases in the primary area and apparently either increases, decreases or no effect in surrounding areas depending on the meteorological condition.							

KEY:

Seeding Rate:
- Low ≤ 100 gm/hr
- Moderate 100-1000 gm/hr
- High > 1000 gm/hr

Appendix B

FACE-2 Daily Satellite Rainfall Estimates

29 JUNE 1978

TIME GMT	TOTAL TARGET RAINFALL $m^3 \times 10^7$				EXTENDED AREA RAINFALL $m^3 \times 10^7$	
	SATELLITE RAIN	CUMULATIVE RAIN	RAINGAGE RAIN	CUMULATIVE RAIN	SATELLITE RAIN	CUMULATIVE RAIN
1600	----	----	0.00	0.00	----	----
1630	----	----	0.17	0.17	----	----
1700	----	----	0.01	0.18	----	----
1730	0.00	0.00	0.09	0.27	9.06	9.06
1800	0.00	0.00	0.00	0.27	8.70	17.76
1830	0.00	0.00	0.00	0.27	7.95	25.71
1900	0.00	0.00	0.00	0.27	7.92	33.63
1930	0.00	0.00	0.05	0.32	5.92	39.55
2000	0.00	0.00	0.11	0.43	8.68	48.23
2030	0.00	0.00	0.17	0.60	8.76	56.99
2100	0.42	0.42	0.58	1.18	10.27	67.26
2130	0.41	0.83	1.22	2.40	11.40	78.66
2200	0.13	0.96	0.82	3.22	17.41	76.07
2230	1.01	1.97	0.94	4.16	14.68	110.75
2300	----	----	0.42	4.58	----	----
2330	0.87	2.84	0.14	4.72	27.28	138.03
0000	0.01	2.85	0.02	4.74	27.22	165.25
0030	0.00	2.85	0.00	4.74	21.82	187.07
0100	0.00	2.85	0.00	4.74	20.58	207.65
0130	0.00	2.85			18.92	226.57
0200	0.00	2.85			17.23	243.80
0230	----	----			----	----
0300	0.00	2.85			30.61	274.41
0330	0.00	2.85			7.15	281.56
0400	0.00	2.85			6.96	288.52

TOTAL TARGET AREA AVERAGE RAINFALL FOR THE PERIOD 1730Z TO 0100Z

RAINGAGES (mm) $G_T = 3.59$

SATELLITE (mm) $S_T = 2.25$

$G_T/S_T = 1.60$

AREA AVERAGE RAINFALL FOR THE PERIOD 1730Z TO 0400Z

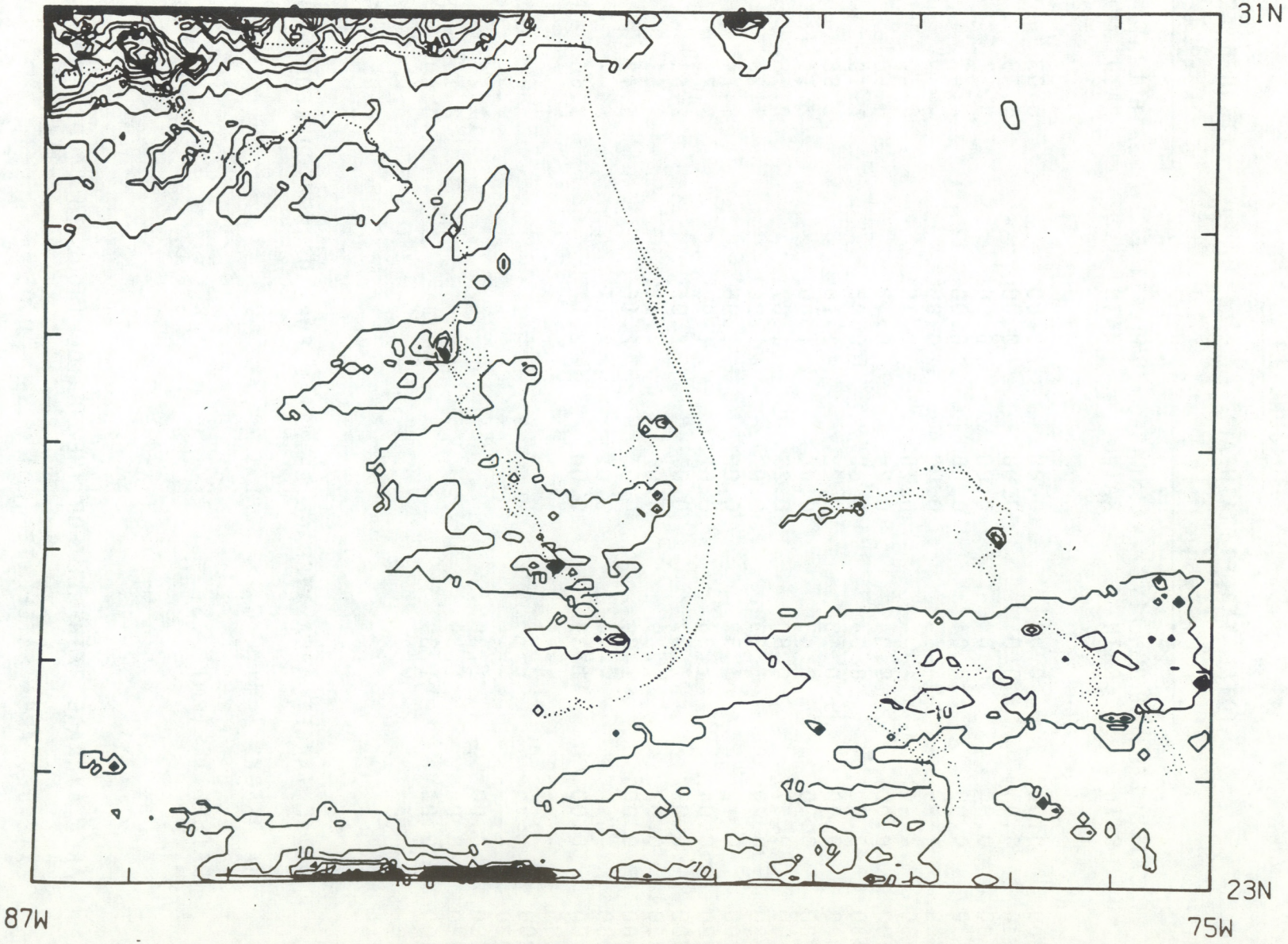
EXTENDED AREA SATELLITE (mm) $S_E = 0.24$

TARGET AREA SATELLITE (mm) $S_T = 2.25$

FACE SATELLITE RAINFALL

29 JUNE 78

UNADJUSTED



180/1732Z-181/0402Z

30 JUNE 1978

TIME GMT	TOTAL TARGET RAINFALL $m^3 \times 10^7$				EXTENDED AREA RAINFALL $m^3 \times 10^7$	
	SATELLITE RAIN	CUMULATIVE RAIN	RAINGAGE RAIN	CUMULATIVE RAIN	SATELLITE RAIN	CUMULATIVE RAIN
1600	0.00	0.00	0.00	0.00	0.03	0.03
1630	0.04	0.04	0.00	0.00	0.18	0.21
1700	0.00	0.04	0.00	0.00	0.27	0.48
1730	0.00	0.04	0.00	0.00	2.47	2.95
1800	----	----	0.00	0.00	----	----
1830	----	----	0.15	0.15	----	----
1900	0.00	0.04	0.28	0.43	6.50	9.45
1930	0.00	0.04	0.50	0.93	1.10	10.55
2000	0.09	0.13	0.23	1.16	1.88	12.43
2030	0.30	0.43	0.44	1.60	2.14	14.57
2100	0.37	0.80	0.27	1.87	2.18	16.75
2130	0.40	1.20	0.07	1.94	3.20	19.95
2200	0.12	1.32	0.02	1.96	2.24	22.19
2230	0.04	1.36	0.02	1.98	3.76	25.95
2300	0.01	1.37	0.07	2.05	2.67	28.62
2330	0.02	1.39	0.07	2.12	3.63	32.25
0000	0.00	1.39	0.04	2.16	5.49	37.74
0030	----	----	0.01	2.17	----	----
0100	0.00	1.39	0.00	2.17	5.66	43.40
0130	----	----			----	----
0200	----	----			----	----
0230	----	----			----	----
0300	0.00	1.39			11.21	54.61
0330	0.00	1.39			2.15	56.76
0400	0.00	1.39			0.89	57.65

TOTAL TARGET AREA AVERAGE RAINFALL FOR THE PERIOD 1600Z TO 0100Z

RAINGAGES (mm) $G_T = 1.71$

SATELLITE (mm) $S_T = 1.21$

$G_T/S_T = 1.41$

AREA AVERAGE RAINFALL FOR THE PERIOD 1600Z TO 0400Z

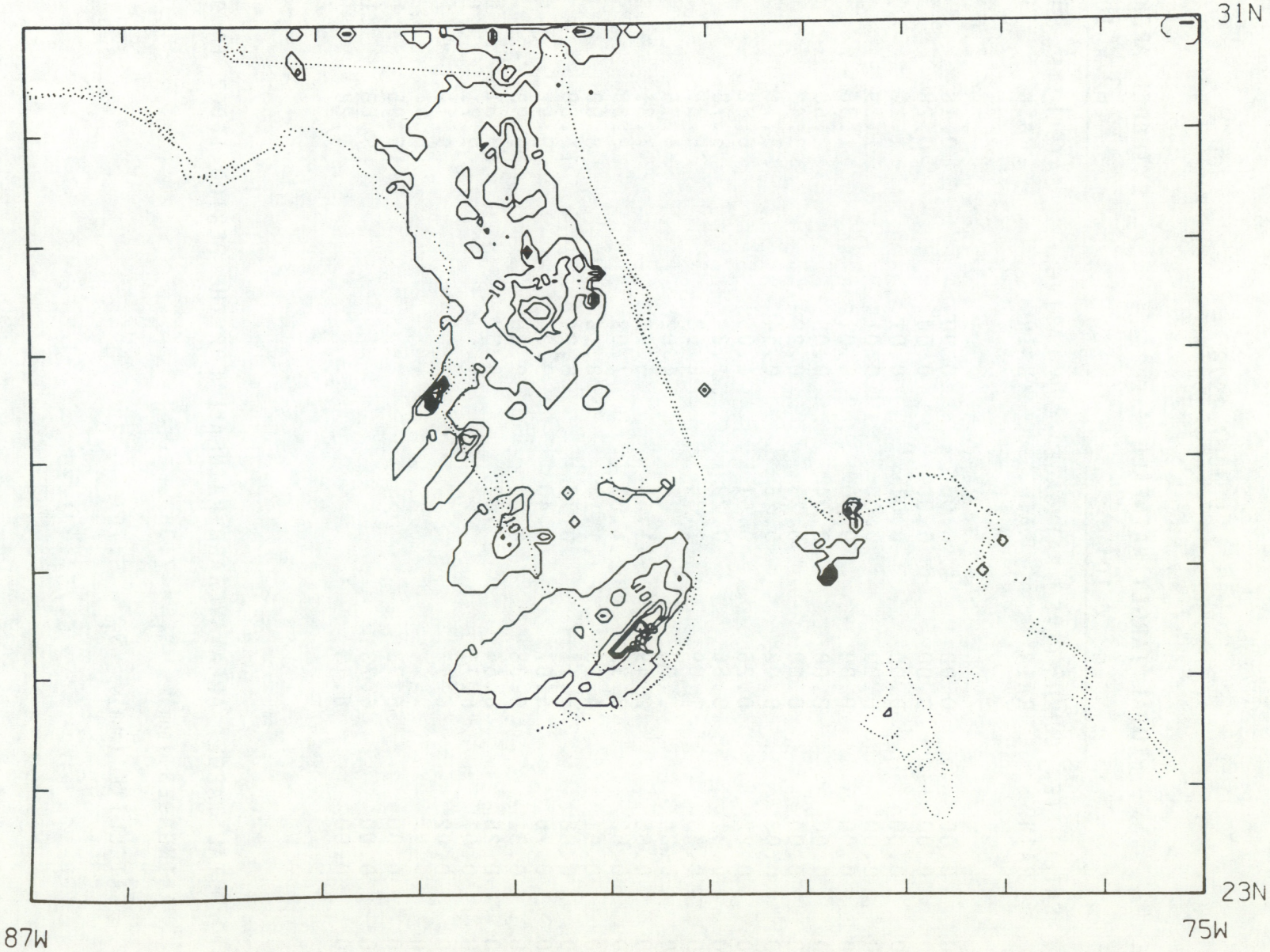
EXTENDED AREA SATELLITE (mm) $S_E = 0.05$

TARGET AREA SATELLITE (mm) $S_T = 1.21$

FACE SATELLITE RAINFALL

30 JUNE 78

UNADJUSTED



181/1602Z-182/0402Z

1 JULY 1978

TIME GMT	TOTAL TARGET RAINFALL $m^3 \times 10^7$				EXTENDED AREA RAINFALL $m^3 \times 10^7$	
	SATELLITE RAIN	CUMULATIVE RAIN	RAINGAGE RAIN	CUMULATIVE RAIN	SATELLITE RAIN	CUMULATIVE RAIN
1600	0.00	0.00	0.00	0.00	0.18	0.18
1630	0.00	0.00	0.00	0.00	0.28	0.46
1700	0.00	0.00	0.01	0.01	1.11	1.57
1730	0.00	0.00	0.00	0.01	1.29	2.86
1800	0.00	0.00	0.00	0.01	1.36	4.22
1830	0.00	0.00	0.04	0.05	2.58	6.80
1900	0.00	0.00	0.23	0.28	3.43	10.23
1930	0.03	0.03	0.26	0.54	3.15	13.38
2000	0.22	0.25	0.51	1.05	5.82	19.20
2030	0.31	0.56	0.29	1.34	5.78	24.98
2100	0.53	1.09	1.34	2.68	6.35	31.33
2130	0.84	1.93	1.34	4.02	4.76	36.09
2200	0.56	2.49	1.69	5.71	7.31	43.40
2230	0.83	3.32	1.31	7.02	8.35	51.75
2300	0.91	4.23	1.14	8.16	8.00	59.75
2330	0.88	5.11	0.78	8.94	11.30	71.05
0000	0.76	5.87	0.40	9.34	9.92	80.97
0030	0.51	6.38	0.01	9.35	9.98	90.95
0100	0.26	6.64	0.02	9.37	10.81	101.76
0130	0.07	6.71			9.71	111.47
0200	0.02	6.73			9.19	120.66
0230	----	----			----	----
0300	0.00	6.73			16.95	137.61
0330	0.00	6.73			5.88	143.49
0400	0.00	6.73			4.28	147.77

TOTAL TARGET AREA AVERAGE RAINFALL FOR THE PERIOD 1600Z TO 0100Z

RAINGAGES (mm) $G_T = 7.38$

SATELLITE (mm) $S_T = 5.76$

$G_T/S_T = 1.28$

AREA AVERAGE RAINFALL FOR THE PERIOD 1600Z TO 0400Z

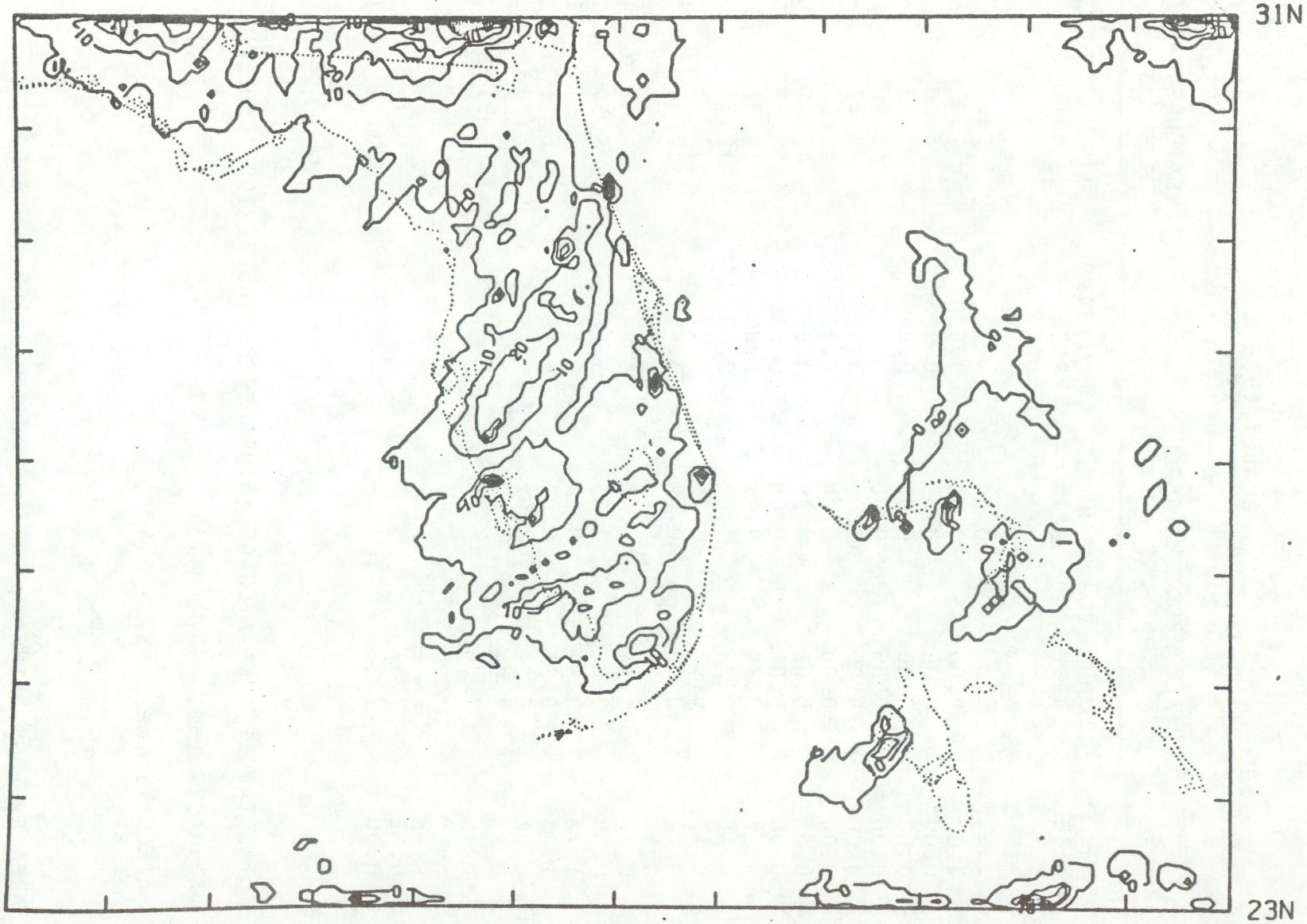
EXTENDED AREA SATELLITE (mm) $S_E = 0.12$

TARGET AREA SATELLITE (mm) $S_T = 5.84$

FACE SATELLITE RAINFALL

1 JULY 78

UNADJUSTED



182/1602Z-183/0402Z

2 JULY 1978

TIME GMT	TOTAL TARGET RAINFALL $m^3 \times 10^7$				EXTENDED AREA RAINFALL $m^3 \times 10^7$	
	SATELLITE RAIN	CUMULATIVE RAIN	RAINGAGE RAIN	CUMULATIVE RAIN	SATELLITE RAIN	CUMULATIVE RAIN
1600	----	----	0.00	----	----	----
1630	0.00	0.00	0.00	0.00	1.08	1.08
1700	0.00	0.00	0.00	0.00	4.66	5.74
1730	0.00	0.00	0.00	0.00	7.23	12.97
1800	0.00	0.00	0.00	0.00	8.40	21.37
1830	0.00	0.00	0.00	0.00	8.42	29.79
1900	0.00	0.00	0.36	0.36	10.60	40.39
1930	0.02	0.02	0.20	0.56	12.61	53.00
2000	0.00	0.02	0.08	0.64	9.95	62.95
2030	0.17	0.19	0.41	1.05	14.02	76.97
2100	0.16	0.35	1.03	2.08	10.77	87.74
2130	0.17	0.52	0.75	2.83	11.53	99.27
2200	0.21	0.73	0.62	3.45	10.61	109.88
2230	0.54	1.27	0.76	4.21	9.96	119.84
2300	0.70	1.97	0.36	4.57	8.01	127.85
2330	0.88	2.85	0.65	5.22	9.54	137.39
0000	1.12	3.97	0.24	5.46	9.61	147.00
0030	1.24	5.21	0.02	5.48	6.71	153.71
0100	1.01	6.22	0.02	5.50	4.79	158.50
0130	0.87	7.09			3.29	161.79
0200	0.26	7.35			1.14	162.93
0230	----	----			----	----
0300	----	----			----	----
0330	0.02	7.37			0.72	163.65
0400	0.00	7.37			0.16	163.81

TOTAL TARGET AREA AVERAGE RAINFALL FOR THE PERIOD 1630Z TO 0100Z

RAINGAGES (mm) $\bar{G}_T = 4.33$

SATELLITE (mm) $\bar{S}_T = 5.40$

$\bar{G}_T/\bar{S}_T = 0.80$

AREA AVERAGE RAINFALL FOR THE PERIOD 1630Z TO 0400Z

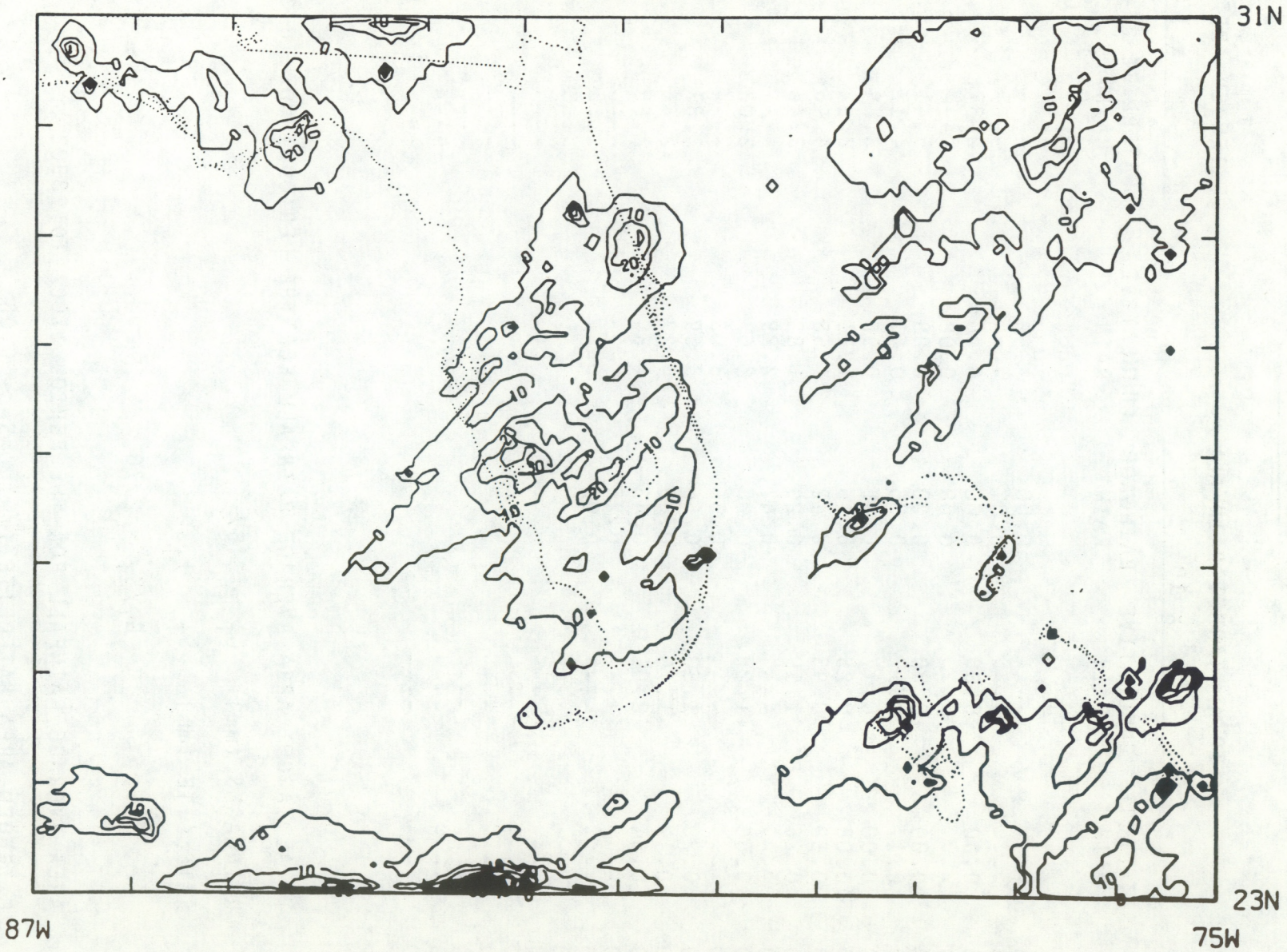
EXTENDED AREA SATELLITE (mm) $\bar{S}_E = 0.14$

TARGET AREA SATELLITE (mm) $\bar{S}_T = 6.39$

FACE SATELLITE RAINFALL

2 JULY 78

UNADJUSTED



183/1632Z-184/0402Z

3 JULY 1978

TIME GMT	TOTAL TARGET RAINFALL $m^3 \times 10^7$				EXTENDED AREA RAINFALL $m^3 \times 10^7$	
	SATELLITE RAIN	CUMULATIVE RAIN	RAINGAGE RAIN	CUMULATIVE RAIN	SATELLITE RAIN	CUMULATIVE RAIN
1600	----	----	0.00	----	----	----
1630	----	----	0.01	----	----	----
1700	0.00	0.00	0.00	0.00	0.87	0.87
1730	----	----	0.08	0.08	----	----
1800	0.00	0.00	0.00	0.08	5.41	6.28
1830	0.17	0.17	0.53	0.61	4.17	10.45
1900	0.00	0.17	0.35	0.96	3.84	14.29
1930	0.08	0.25	0.15	1.11	2.92	17.21
2000	0.68	0.93	0.42	1.53	4.46	21.67
2030	0.26	1.19	0.29	1.82	3.44	25.11
2100	----	----	0.47	2.29	----	----
2130	0.06	1.25	0.38	2.67	2.03	27.14
2200	----	----	0.36	3.03	----	----
2230	0.28	1.53	0.56	3.59	3.37	30.51
2300	0.17	1.70	0.63	4.22	2.44	32.95
2330	0.31	2.01	0.43	4.65	2.83	35.78
0000	----	----	0.25	----	----	----
0030	----	----	0.02	----	----	----
0100	----	----			----	----
0130	----	----			----	----
0200	----	----			----	----
0230	----	----			----	----
0300	----	----			----	----
0330	----	----			----	----
0400	----	----			----	----

TOTAL TARGET AREA AVERAGE RAINFALL FOR THE PERIOD 1700Z TO 2330Z

RAINGAGES (mm) $G_T = 3.67$

SATELLITE (mm) $S_T = 1.32$

$G_T/S_T = 2.78$

AREA AVERAGE RAINFALL FOR THE PERIOD 1700Z TO 2330Z

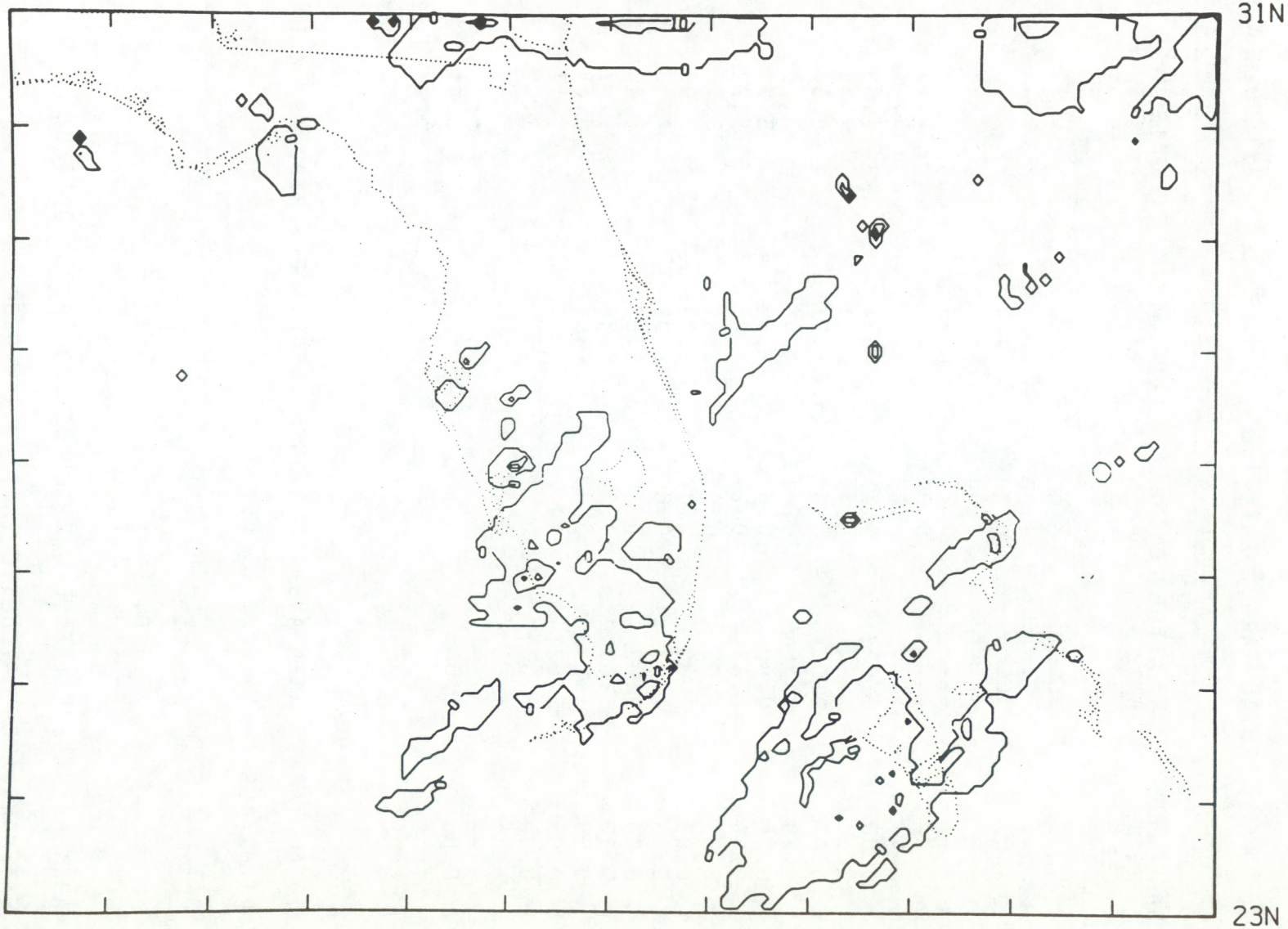
EXTENDED AREA SATELLITE (mm) $S_E = 0.03$

TARGET AREA SATELLITE (mm) $S_T = 1.32$

FACE SATELLITE RAINFALL

3 JULY 78

UNADJUSTED



184/1702Z-184/2332Z

10 JULY 1978

TIME GMT	TOTAL TARGET RAINFALL $m^3 \times 10^7$				EXTENDED AREA RAINFALL $m^3 \times 10^7$	
	SATELLITE RAIN	CUMULATIVE RAIN	RAINGAGE RAIN	CUMULATIVE RAIN	SATELLITE RAIN	CUMULATIVE RAIN
1600	----	----	0.00	----	----	----
1630	----	----	0.00	----	----	----
1700	----	----	0.00	----	----	----
1730	----	----	0.00	----	----	----
1800	----	----	0.20	----	----	----
1830	----	----	0.09	----	----	----
1900	----	----	0.03	----	----	----
1930	0.00	0.00	0.21	0.21	3.08	3.08
2000	----	----	0.48	0.69	----	----
2030	0.07	0.07	0.88	1.57	6.57	9.65
2100	0.49	0.56	0.31	1.88	3.79	13.44
2130	0.24	0.80	0.64	2.52	3.74	17.18
2200	0.08	0.88	0.29	2.81	5.73	22.91
2230	0.05	0.93	0.01	2.82	3.72	26.63
2300	0.07	1.00	0.00	2.82	3.95	30.58
2330	0.03	1.03	0.00	2.82	4.00	34.58
0000	0.00	1.03	0.00	2.82	2.20	36.78
0030	0.00	1.03	0.02	2.84	1.57	38.35
0100	0.00	1.03	0.00	2.84	2.69	41.04
0130	0.00	1.03			3.17	44.21
0200	0.00	1.03			1.99	46.20
0230	----	----			----	----
0300	----	----			----	----
0330	0.00	1.03			5.44	51.64
0400	----	----			----	----

TOTAL TARGET AREA AVERAGE RAINFALL FOR THE PERIOD 1930Z TO 0100Z

RAINGAGES (mm) $G_T = 2.24$

SATELLITE (mm) $S_T = 0.89$

$G_T/S_T = 2.52$

AREA AVERAGE RAINFALL FOR THE PERIOD 1930Z TO 0330Z

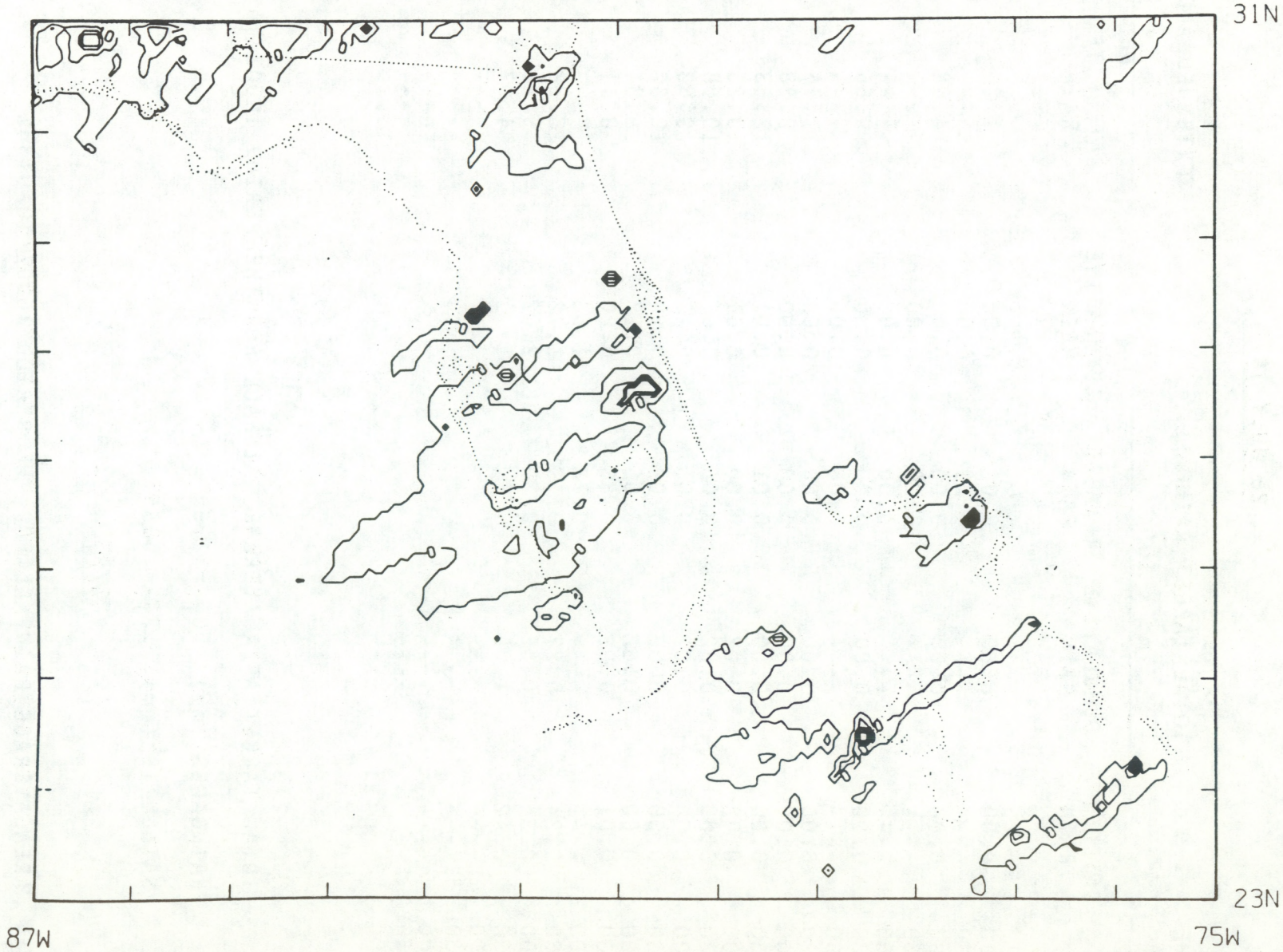
EXTENDED AREA SATELLITE (mm) $S_E = 0.04$

TARGET AREA SATELLITE (mm) $S_T = 0.89$

FACE SATELLITE RAINFALL

10 JULY 78

UNADJUSTED



191/1932Z-192/0332Z

25 JULY 1978

TIME GMT	TOTAL TARGET RAINFALL $m^3 \times 10^7$				EXTENDED AREA RAINFALL $m^3 \times 10^7$	
	SATELLITE RAIN	CUMULATIVE RAIN	RAINGAGE RAIN	CUMULATIVE RAIN	SATELLITE RAIN	CUMULATIVE RAIN
1600	0.00	0.00	0.00	0.00	1.20	1.20
1630	----	----	0.00	0.00	----	----
1700	0.00	0.00	0.00	0.00	4.08	5.28
1730	----	----	0.00	0.00	----	----
1800	----	----	0.00	0.00	----	----
1830	0.00	0.00	0.00	0.00	9.66	14.94
1900	----	----	0.00	0.00	----	----
1930	0.00	0.00	0.00	0.00	17.76	32.70
2000	0.00	0.00	0.00	0.00	8.28	40.98
2030	0.00	0.00	0.01	0.01	12.53	53.51
2100	0.02	0.02	0.00	0.01	10.23	63.74
2130	0.00	0.02	0.06	0.07	10.68	74.42
2200	0.00	0.02	0.06	0.13	9.63	84.05
2230	0.00	0.02	0.09	0.22	10.32	94.37
2300	0.00	0.02	0.05	0.27	9.31	103.68
2330	0.01	0.03	0.53	0.80	8.11	111.79
0000	----	----	0.73	1.53	----	----
0030	0.24	0.27	0.19	1.72	13.38	125.17
0100	0.36	0.63	0.30	2.02	5.78	130.95
0130	0.42	1.05			4.07	135.02
0200	----	----			----	----
0230	----	----			----	----
0300	----	----			----	----
0330	----	----			----	----
0400	----	----			----	----

TOTAL TARGET AREA AVERAGE RAINFALL FOR THE PERIOD 1600Z TO 0100Z

RAINGAGES (mm) $G_T = 1.59$

SATELLITE (mm) $S_T = 0.55$

$G_T/S_T = 2.89$

AREA AVERAGE RAINFALL FOR THE PERIOD 1600Z TO 0130Z

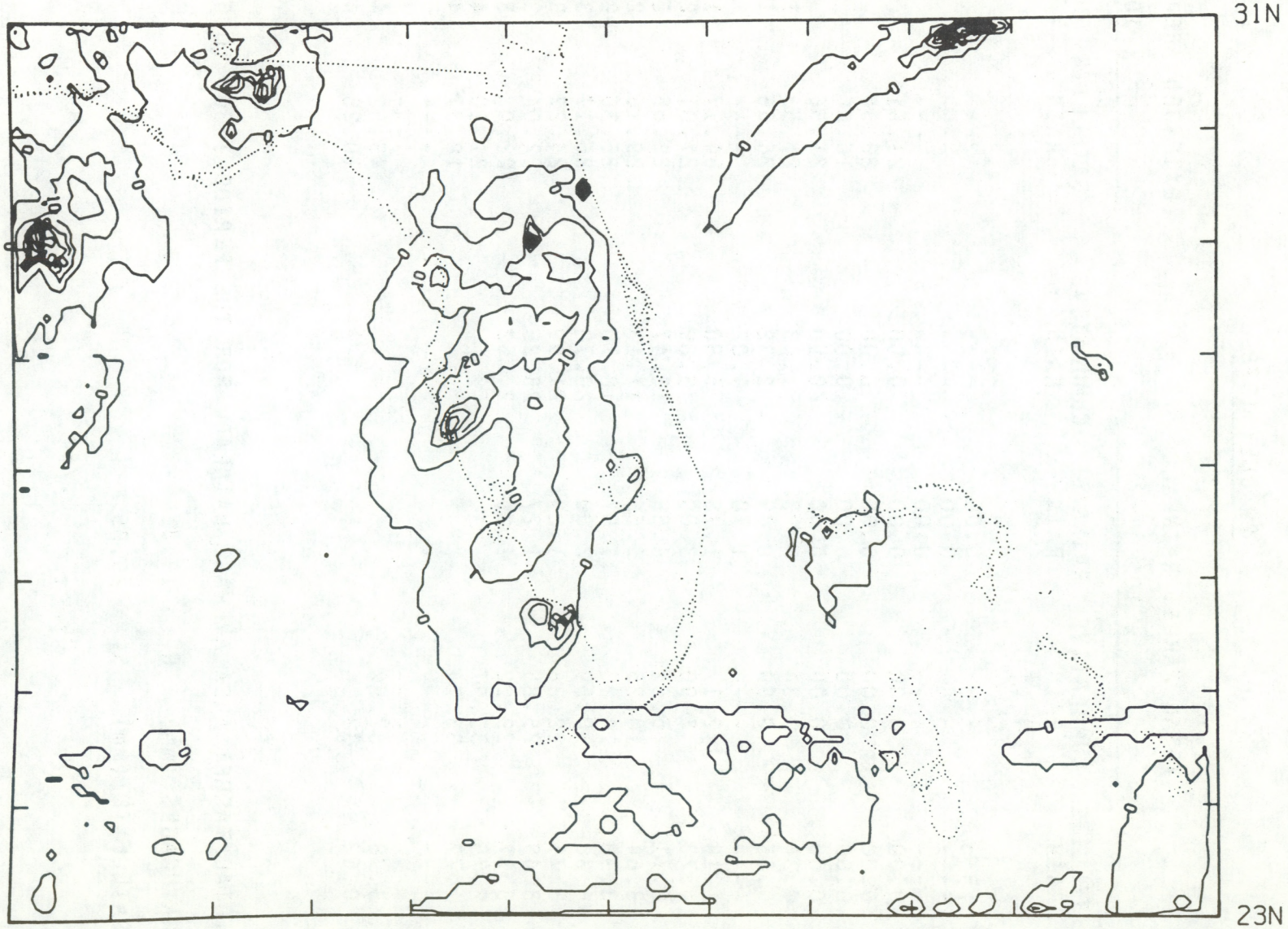
EXTENDED AREA SATELLITE (mm) $S_E = 0.11$

TARGET AREA SATELLITE (mm) $S_T = 0.91$

FACE SATELLITE RAINFALL

25 JULY 78

UNADJUSTED



206/1532Z-207/0124Z

29 JULY 1978

TIME GMT	TOTAL TARGET RAINFALL $m^3 \times 10^7$				EXTENDED AREA RAINFALL $m^3 \times 10^7$	
	SATELLITE RAIN	CUMULATIVE RAIN	RAINGAGE RAIN	CUMULATIVE RAIN	SATELLITE RAIN	CUMULATIVE RAIN
1600	----	----	0.00	----	----	----
1630	----	----	0.00	----	----	----
1700	----	----	0.00	----	----	----
1730	0.00	0.00	0.00	0.00	21.51	21.51
1800	0.00	0.00	0.00	0.00	23.34	44.85
1830	0.00	0.00	0.00	0.00	16.66	61.51
1900	0.00	0.00	0.50	0.50	21.56	83.07
1930	0.34	0.34	0.93	1.43	21.53	104.60
2000	0.65	0.99	0.89	2.32	26.66	131.26
2030	----	----	1.70	4.02	----	----
2100	1.18	2.17	1.78	5.80	54.17	185.43
2130	1.73	3.90	3.09	8.89	27.01	212.44
2200	2.71	6.61	4.58	13.47	28.65	241.09
2230	3.64	10.25	3.66	17.13	29.16	270.25
2300	3.98	14.23	1.57	18.70	25.36	295.61
2330	4.36	18.59	2.00	20.70	26.17	321.78
0000	3.77	22.36	1.29	21.99	24.27	346.05
0030	3.49	25.85	1.27	23.26	22.04	368.09
0100	3.37	29.22	1.26	24.52	22.03	390.12
0130	2.75	31.97			21.20	411.32
0200	1.77	33.74			18.37	429.69
0230	----	----			----	----
0300	----	----			----	----
0330	3.78	37.52			45.82	475.51
0400	0.62	38.14			10.28	485.79

TOTAL TARGET AREA AVERAGE RAINFALL FOR THE PERIOD 1730Z TO 0100Z

RAINGAGES (mm) $G_T = 19.31$

SATELLITE (mm) $S_T = 25.35$

$G_T/S_T = 0.76$

AREA AVERAGE RAINFALL FOR THE PERIOD 1730Z TO 0400Z

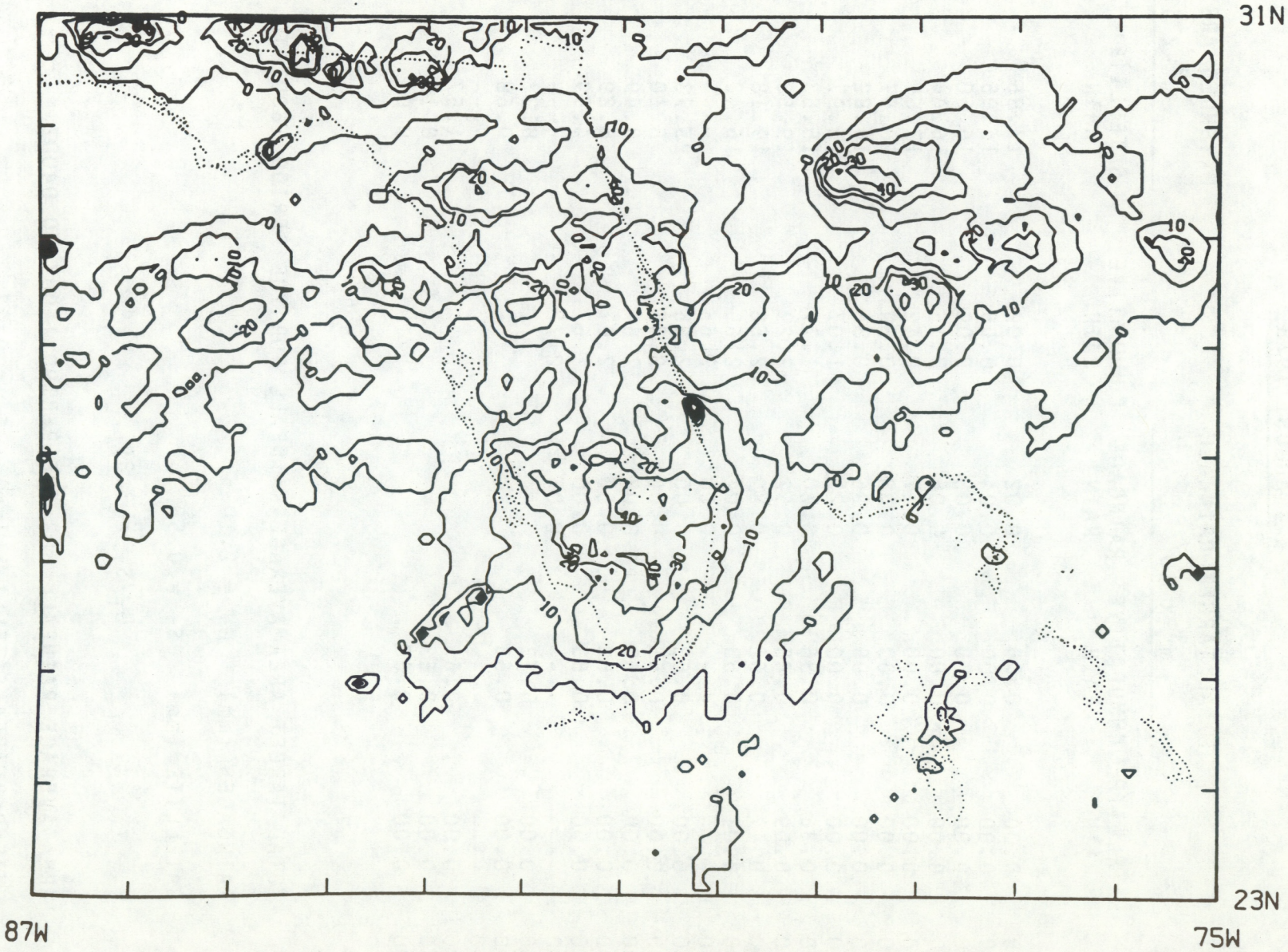
EXTENDED AREA SATELLITE (mm) $S_E = 0.41$

TARGET AREA SATELLITE (mm) $S_T = 33.08$

FACE SATELLITE RAINFALL

29 JULY 78

UNADJUSTED



210/1732Z-211/0402Z

4 AUGUST 1978

TIME GMT	TOTAL TARGET RAINFALL $m^3 \times 10^7$				EXTENDED AREA RAINFALL $m^3 \times 10^7$	
	SATELLITE RAIN	CUMULATIVE RAIN	RAINGAGE RAIN	CUMULATIVE RAIN	SATELLITE RAIN	CUMULATIVE RAIN
1600	0.00	0.00	0.02	0.02	17.85	17.85
1630	0.00	0.00	0.04	0.06	15.96	33.81
1700	0.00	0.00	0.03	0.09	16.60	50.41
1730	0.00	0.00	0.06	0.15	16.44	66.85
1800	0.00	0.00	0.27	0.42	17.69	84.54
1830	0.00	0.00	0.08	0.50	18.57	103.11
1900	0.00	0.00	0.36	0.86	14.82	117.93
1930	0.00	0.00	0.21	1.07	15.97	133.90
2000	0.36	0.36	0.70	1.77	15.53	149.43
2030	0.09	0.45	0.52	2.29	19.55	168.98
2100	0.17	0.62	0.29	2.58	19.18	188.16
2130	0.01	0.63	0.07	2.65	16.42	204.58
2200	----	----	0.00	2.65	----	----
2230	0.00	0.63	0.00	2.65	25.73	230.31
2300	0.00	0.63	0.00	2.65	8.10	238.41
2330	0.00	0.63	0.02	2.67	9.49	247.90
0000	0.00	0.63	0.00	2.67	6.29	254.19
0030	0.00	0.63	0.00	2.67	4.59	258.78
0100	----	----	0.05	2.72	----	----
0130	0.00	0.63			8.37	267.15
0200	0.00	0.63			0.68	267.83
0230	----	----			----	----
0300	0.00	0.63			1.57	269.40
0330	0.00	0.63			0.16	269.56
0400	0.00	0.63			0.04	269.60

TOTAL TARGET AREA AVERAGE RAINFALL FOR THE PERIOD 1600Z TO 0030Z

RAINGAGES (mm) $G_T = 2.10$

SATELLITE (mm) $S_T = 0.55$

$G_T/S_T = 3.89$

AREA AVERAGE RAINFALL FOR THE PERIOD 1600Z TO 0400Z

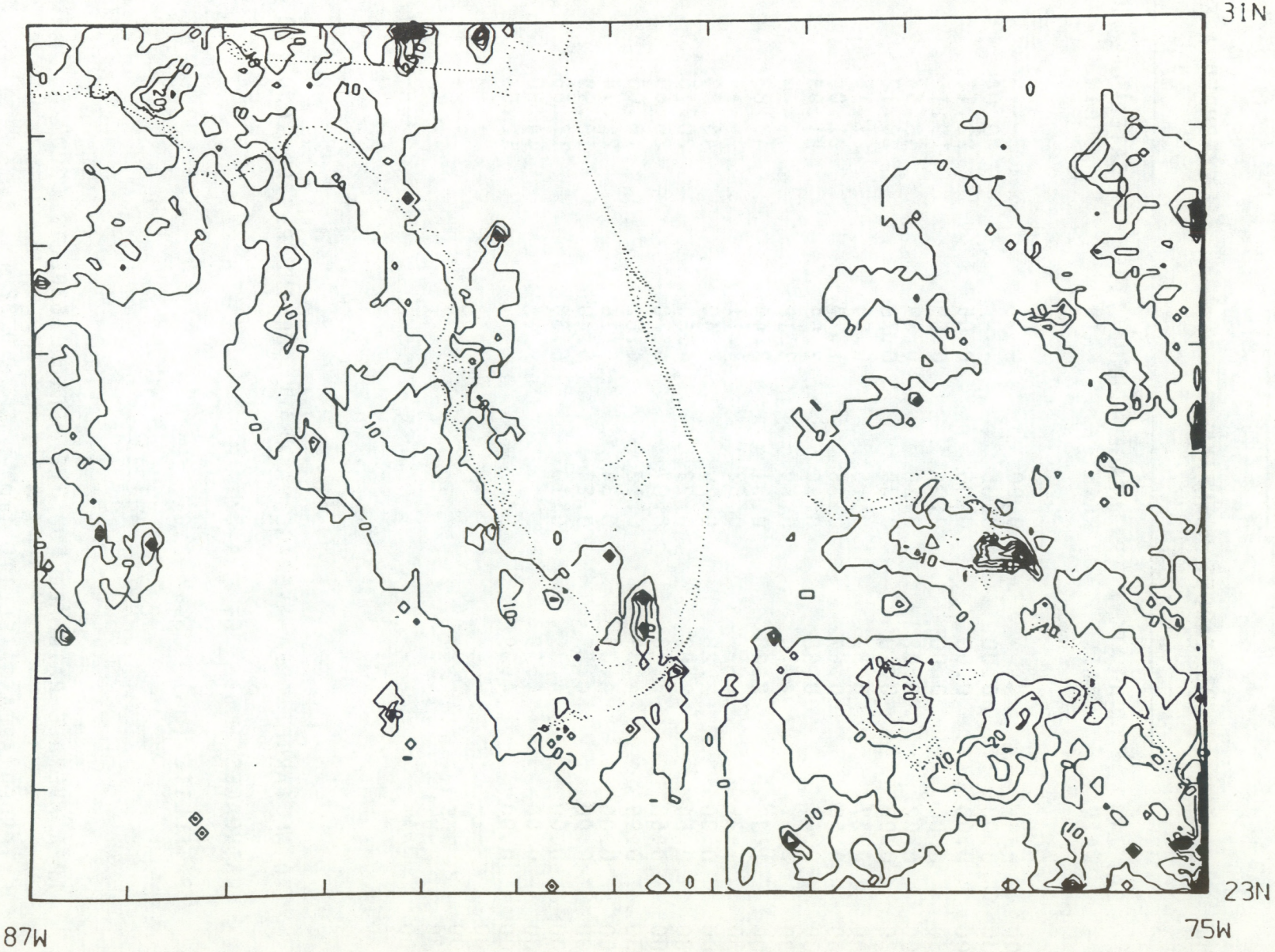
EXTENDED AREA SATELLITE (mm) $S_E = 0.23$

TARGET AREA SATELLITE (mm) $S_T = 0.55$

FACE SATELLITE RAINFALL

4 AUG 78

UNADJUSTED



216/1602Z-217/0402Z

10 AUGUST 1978

TIME GMT	TOTAL TARGET RAINFALL $m^3 \times 10^7$				EXTENDED AREA RAINFALL $m^3 \times 10^7$	
	SATELLITE RAIN	CUMULATIVE RAIN	RAINGAGE RAIN	CUMULATIVE RAIN	SATELLITE RAIN	CUMULATIVE RAIN
1600	----	----	0.00	----	----	----
1630	0.00	0.00	0.06	----	0.04	0.04
1700	0.00	0.00	0.05	0.05	22.13	22.17
1730	0.00	0.00	0.04	0.09	19.16	41.33
1800	0.02	0.02	0.30	0.39	18.54	59.87
1830	0.08	0.10	0.39	0.78	20.17	80.04
1900	0.27	0.37	0.15	0.93	21.15	101.19
1930	0.20	0.57	0.86	1.79	21.05	122.24
2000	0.41	0.98	0.80	2.59	21.93	144.17
2030	----	----	0.59	3.18	----	----
2100	1.30	2.28	0.31	3.49	43.83	188.00
2130	----	----	0.62	4.11	----	----
2200	0.00	2.28	0.29	4.40	45.83	233.83
2230	0.54	2.82	0.23	4.63	20.76	254.59
2300	0.58	3.40	0.07	4.70	20.69	275.28
2330	0.99	4.39	0.12	4.82	18.00	293.28
0000	0.00	4.39	0.34	5.16	22.74	316.02
0030	0.00	4.39	0.24	5.40	18.99	335.01
0100	0.00	4.39	0.10	5.50	17.65	352.66
0130	0.00	4.39			14.80	367.46
0200	0.00	4.39			12.55	380.01
0230	----	----			----	----
0300	----	----			----	----
0330	----	----			----	----
0400	----	----			----	----

TOTAL TARGET AREA AVERAGE RAINFALL FOR THE PERIOD 1630Z TO 0200Z

RAINGAGES (mm) $G_T = 4.33$

SATELLITE (mm) $S_T = 3.81$

$G_T/S_T = 1.13$

AREA AVERAGE RAINFALL FOR THE PERIOD 1630Z TO 0200Z

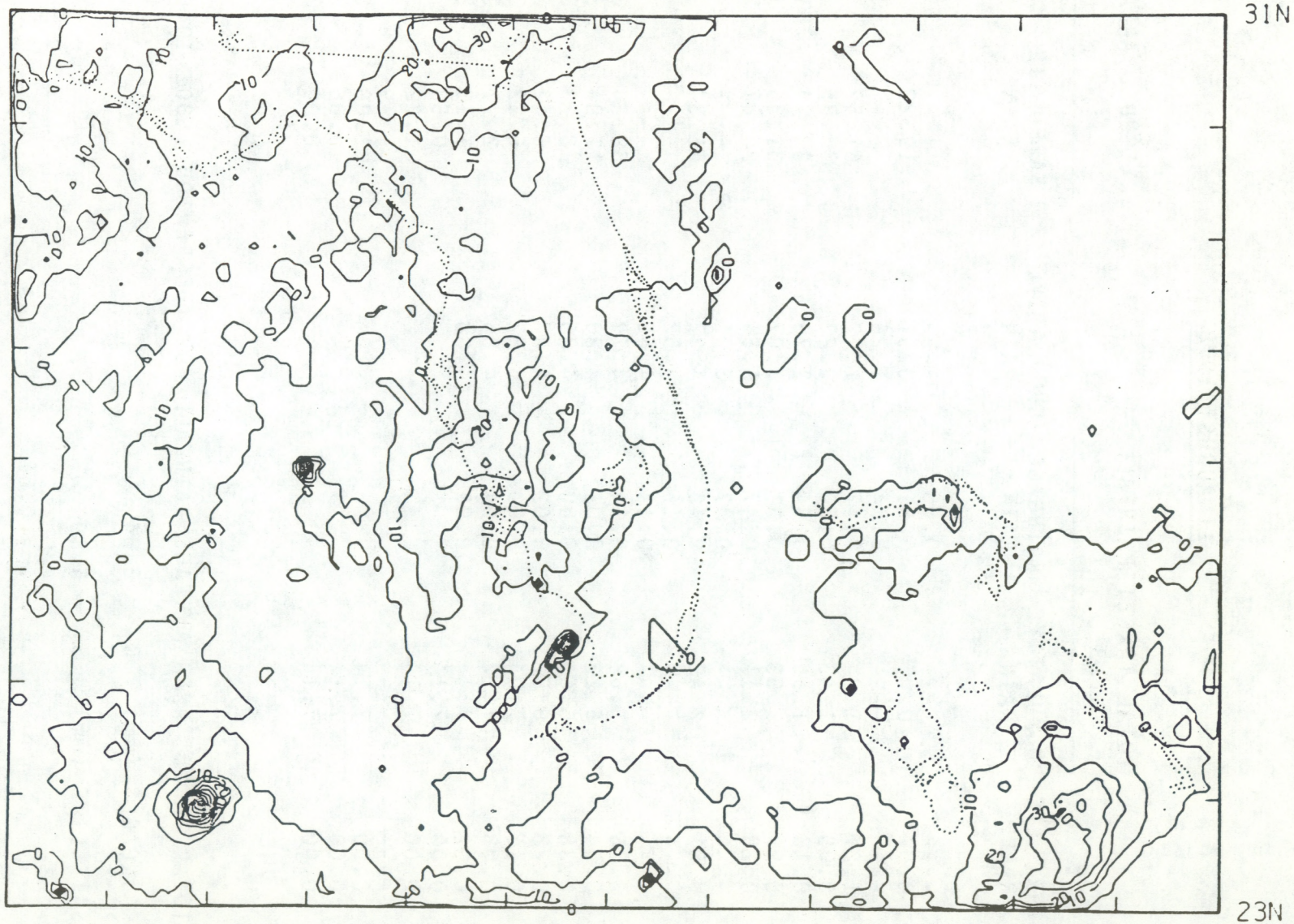
EXTENDED AREA SATELLITE (mm) $S_E = 0.32$

TARGET AREA SATELLITE (mm) $S_T = 3.81$

FACE SATELLITE RAINFALL

10 AUG 78

UNADJUSTED



222/1633Z-223/0204Z

11 AUGUST 1978

TIME GMT	TOTAL TARGET RAINFALL $m^3 \times 10^7$				EXTENDED AREA RAINFALL $m^3 \times 10^7$	
	SATELLITE RAIN	CUMULATIVE RAIN	RAINGAGE RAIN	CUMULATIVE RAIN	SATELLITE RAIN	CUMULATIVE RAIN
1600	----	----	0.65	----	----	----
1630	0.07	0.07	0.51	0.51	19.22	19.22
1700	----	----	0.74	1.25	----	----
1730	1.27	1.34	0.47	1.72	61.52	80.74
1800	0.09	1.43	0.50	2.22	33.85	114.59
1830	0.13	1.56	0.54	2.76	32.74	147.33
1900	0.27	1.83	0.31	3.07	31.36	178.69
1930	0.28	2.11	0.47	3.54	24.87	203.56
2000	----	----	0.37	3.91	----	----
2030	0.31	2.42	0.46	4.37	61.34	264.90
2100	----	----	0.15	4.52	----	----
2130	----	----	0.13	4.65	----	----
2200	3.26	5.68	0.14	4.79	68.54	333.44
2230	0.54	6.22	0.01	4.80	11.04	344.48
2300	0.38	6.60	0.00	4.80	8.73	353.21
2330	0.28	6.88	0.02	4.82	6.42	359.63
0000	0.16	7.04	0.00	4.82	5.22	364.85
0030	0.08	7.12	0.04	4.86	2.71	367.56
0100	0.02	7.14	0.02	4.88	1.13	368.69
0130	0.00	7.14			0.58	369.27
0200	0.00	7.14			1.22	370.49
0230	----	----			----	----
0300	0.00	7.14			1.00	371.49
0330	0.00	7.14			0.06	371.55
0400	0.00	7.14			0.00	371.55

TOTAL TARGET AREA AVERAGE RAINFALL FOR THE PERIOD 1630Z TO 0100Z

RAINGAGES (mm) $G_T = 3.84$

SATELLITE (mm) $S_T = 6.19$

$G_T/S_T = 0.62$

AREA AVERAGE RAINFALL FOR THE PERIOD 1630Z TO 0400Z

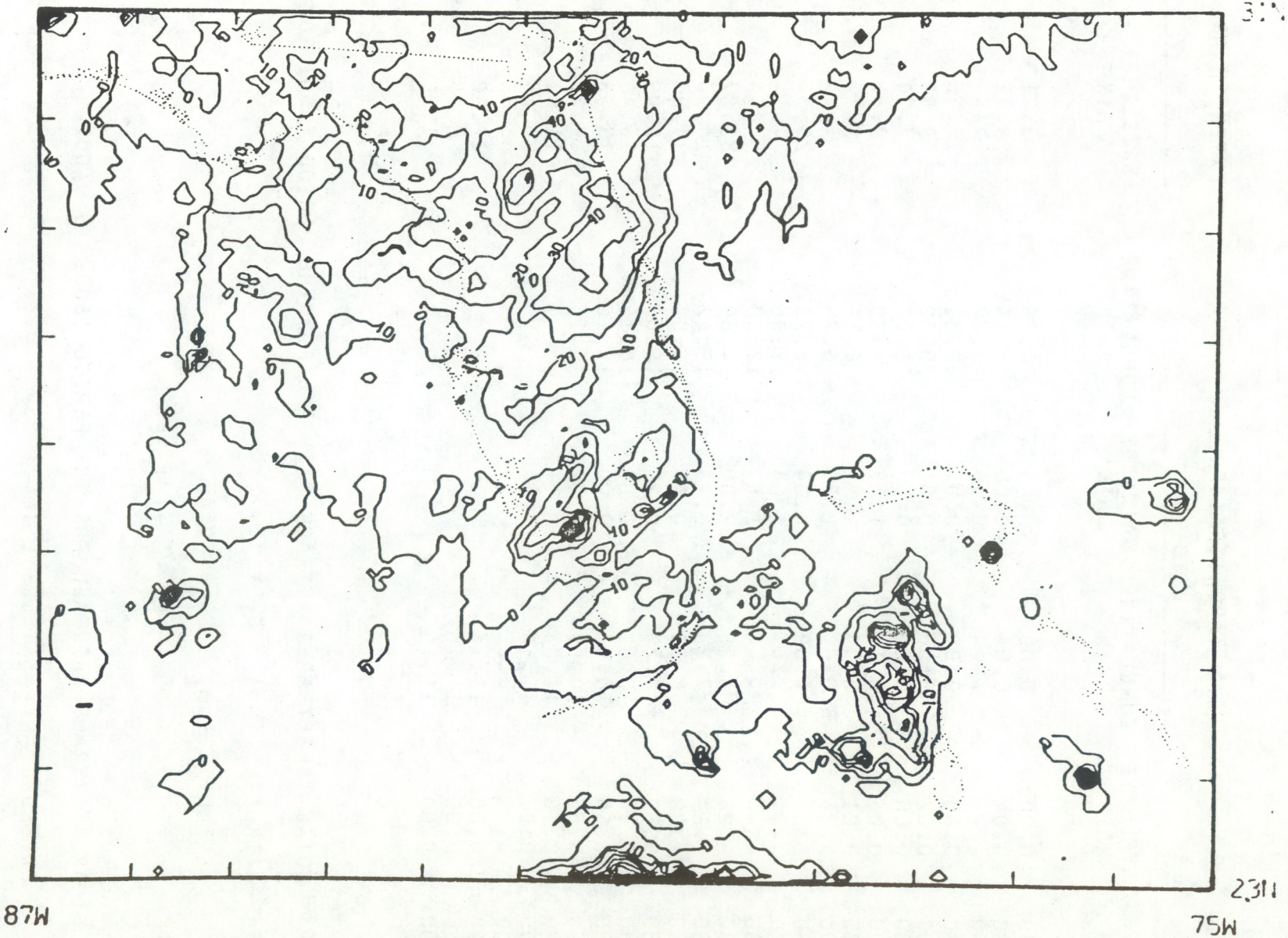
EXTENDED AREA SATELLITE (mm) $S_E = 0.31$

TARGET AREA SATELLITE (mm) $S_T = 6.19$

FACE SATELLITE RAINFALL

11 AUG 78

UNADJUSTED



223/1617Z-224/0402Z

12 AUGUST 1978

TIME GMT	TOTAL TARGET RAINFALL $m^3 \times 10^7$				EXTENDED AREA RAINFALL $m^3 \times 10^7$	
	SATELLITE RAIN	CUMULATIVE RAIN	RAINGAGE RAIN	CUMULATIVE RAIN	SATELLITE RAIN	CUMULATIVE RAIN
1600	0.00	0.00	0.06	0.06	3.71	3.71
1630	0.04	0.04	0.08	0.14	9.72	13.43
1700	----	----	0.16	0.30	----	----
1730	0.00	0.04	0.01	0.31	19.86	33.29
1800	0.02	0.06	0.01	0.32	9.99	43.28
1830	0.00	0.06	0.75	1.07	7.94	51.22
1900	0.06	0.12	1.13	2.20	9.52	60.74
1930	0.21	0.33	1.91	4.11	9.22	69.96
2000	0.36	0.69	2.27	6.38	----	----
2030	1.32	2.09	2.34	8.72	25.36	95.32
2100	----	----	2.34	11.06	----	----
2130	----	----	1.54	12.60	----	----
2200	4.24	6.25	2.09	14.69	33.87	129.19
2230	1.14	7.39	0.73	15.42	14.90	144.09
2300	1.00	8.39	0.42	15.84	14.91	159.00
2330	0.89	9.28	0.25	16.09	15.09	174.09
0000	0.74	10.02	0.07	16.16	15.43	189.52
0030	0.50	10.52	0.00	16.16	13.93	203.45
0100	0.38	10.90	0.00	16.16	12.24	215.69
0130	0.16	11.06			11.01	226.70
0200	0.07	11.13			8.05	234.75
0230	----	----			----	----
0300	0.03	11.16			12.38	247.13
0330	0.00	11.16			2.98	250.11
0400	0.00	11.16			1.36	251.47

TOTAL TARGET AREA AVERAGE RAINFALL FOR THE PERIOD 1600Z TO 0100Z

RAINGAGES (mm) $G_T = 12.72$

SATELLITE (mm) $S_T = 9.46$

$G_T/S_T = 1.35$

AREA AVERAGE RAINFALL FOR THE PERIOD 1600Z TO 0400Z

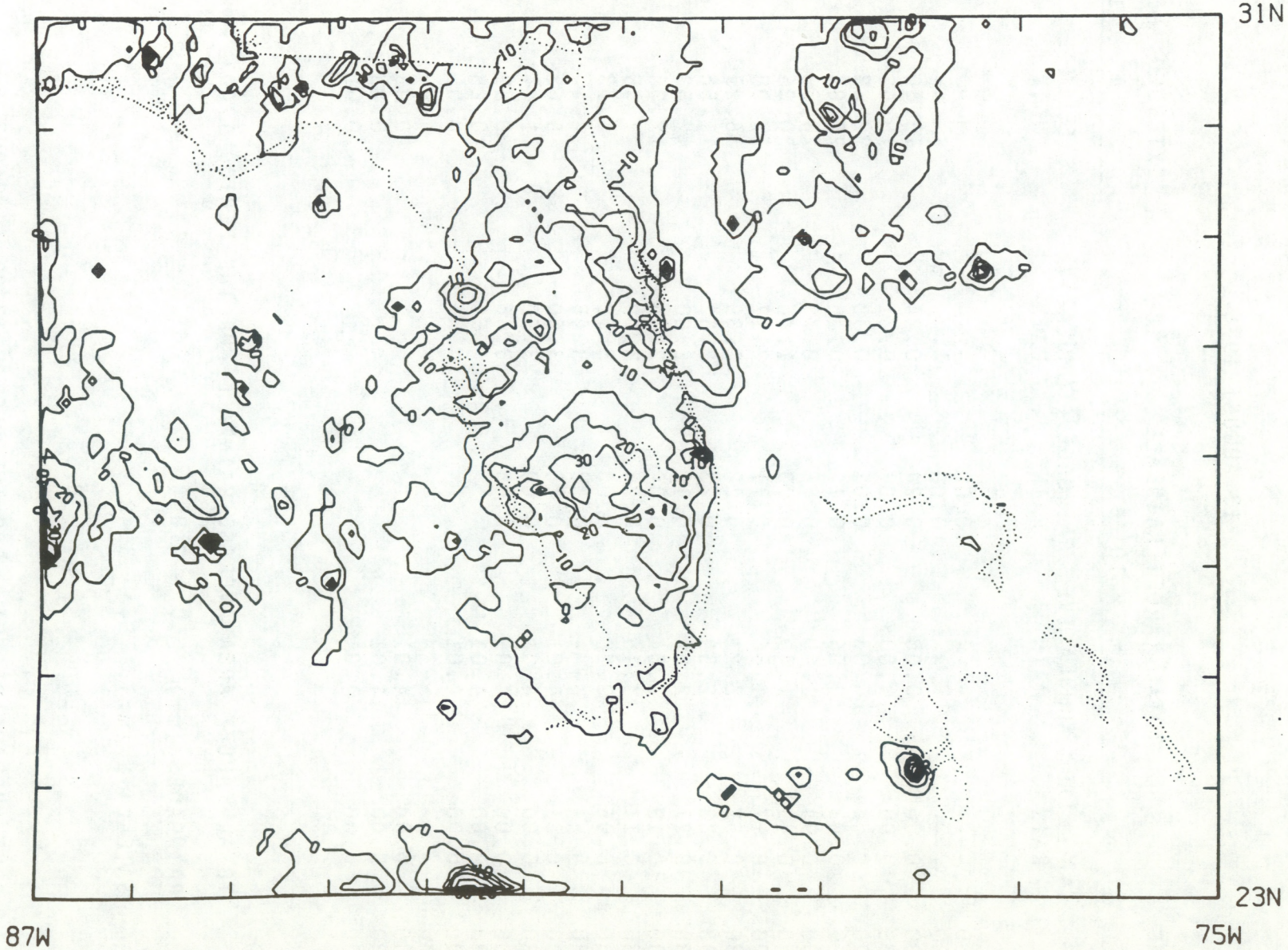
EXTENDED AREA SATELLITE (mm) $S_E = 0.21$

TARGET AREA SATELLITE (mm) $S_T = 9.68$

FACE SATELLITE RAINFALL

12 AUG 78

UNADJUSTED



224/1601Z-225/0402Z

13 AUGUST 1978

TIME GMT	TOTAL TARGET RAINFALL $m^3 \times 10^7$				EXTENDED AREA RAINFALL $m^3 \times 10^7$	
	SATELLITE RAIN	CUMULATIVE RAIN	RAINGAGE RAIN	CUMULATIVE RAIN	SATELLITE RAIN	CUMULATIVE RAIN
1600	----	----	0.00	----	----	----
1630	----	----	0.00	----	----	----
1700	0.00	0.00	0.24	0.24	15.50	15.50
1730	0.00	0.00	0.07	0.31	18.62	34.12
1800	0.03	0.03	0.02	0.33	22.32	56.44
1830	0.03	0.06	0.12	0.45	22.85	79.29
1900	0.94	1.00	0.28	0.73	24.38	103.67
1930	0.49	1.49	0.73	1.46	20.06	123.73
2000	0.17	1.66	0.71	2.17	17.08	140.81
2030	0.55	2.21	0.22	2.39	15.29	156.10
2100	0.38	2.59	0.23	2.62	11.56	167.66
2130	0.27	2.86	0.18	2.80	12.63	180.29
2200	0.18	3.04	0.04	2.84	12.36	192.65
2230	0.11	3.15	0.25	3.09	7.45	200.10
2300	0.05	3.20	0.03	3.12	6.13	206.23
2330	----	----	0.33	3.45	----	----
0000	0.81	4.01	0.15	3.60	6.62	212.85
0030	0.00	4.01	0.00	3.60	1.21	214.06
0100	0.00	4.01	0.06	3.66	0.89	214.95
0130	0.00	4.01			0.28	215.23
0200	0.00	4.01			0.05	215.28
0230	----	----			----	----
0300	0.00	4.01			0.05	215.33
0330	0.00	4.01			0.23	215.56
0400	0.00	4.01			0.01	215.57

TOTAL TARGET AREA AVERAGE RAINFALL FOR THE PERIOD 1700Z TO 0100Z

RAINGAGES (mm) $\bar{G}_T = 2.88$

SATELLITE (mm) $\bar{S}_T = 3.48$

$\bar{G}_T/\bar{S}_T = 0.83$

AREA AVERAGE RAINFALL FOR THE PERIOD 1700Z TO 0400Z

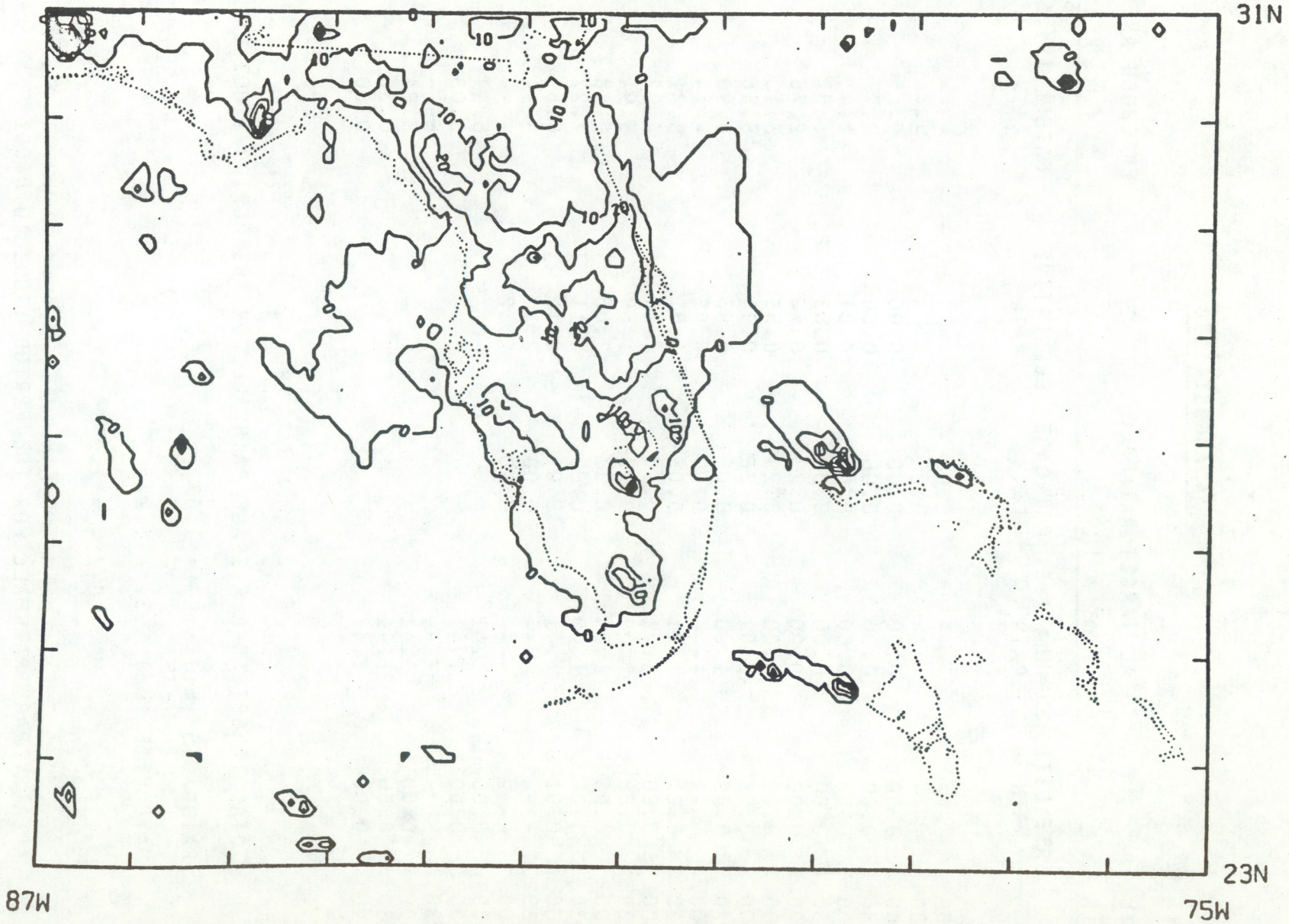
EXTENDED AREA SATELLITE (mm) $\bar{S}_E = 0.18$

TARGET AREA SATELLITE (mm) $\bar{S}_T = 3.48$

FACE SATELLITE RAINFALL

13 AUG 78

UNADJUSTED



225/1701Z-226/0402Z

14 AUGUST 1978

TIME GMT	TOTAL TARGET RAINFALL $m^3 \times 10^7$				EXTENDED AREA RAINFALL $m^3 \times 10^7$	
	SATELLITE RAIN	CUMULATIVE RAIN	RAINGAGE RAIN	CUMULATIVE RAIN	SATELLITE RAIN	CUMULATIVE RAIN
1600	----	----	0.00	----	----	----
1630	----	----	0.00	----	----	----
1700	0.00	0.00	0.00	0.00	0.65	0.65
1730	0.00	0.00	0.00	0.00	0.77	1.42
1800	0.00	0.00	0.01	0.01	1.91	3.33
1830	0.00	0.00	0.02	0.03	1.62	4.95
1900	0.00	0.00	0.23	0.26	2.76	7.71
1930	0.00	0.00	0.29	0.55	3.13	10.84
2000	0.51	0.51	0.36	0.91	5.56	16.40
2030	0.49	1.00	0.05	0.96	4.90	21.30
2100	----	----	0.00	0.96	----	----
2130	0.21	1.21	0.05	1.01	8.81	30.11
2200	0.00	1.21	0.10	1.11	4.92	35.03
2230	0.08	1.29	0.57	1.68	5.91	40.94
2300	0.05	1.34	0.37	2.05	6.48	47.42
2330	0.06	1.40	0.06	2.11	7.27	54.69
0000	0.01	1.41	0.01	2.12	6.51	61.20
0030	----	----	0.00	2.12	----	----
0100	----	----	0.00	2.12	----	----
0130	0.00	1.41			15.44	76.64
0200	0.00	1.41			3.08	79.72
0230	----	----			----	----
0300	0.00	1.41			2.84	82.56
0330	0.00	1.41			0.36	82.92
0400	0.00	1.41			0.00	82.92

TOTAL TARGET AREA AVERAGE RAINFALL FOR THE PERIOD 1700Z TO 0100Z

RAINGAGES (mm) $G_T = 1.67$

SATELLITE (mm) $S_T = 1.22$

$G_T/S_T = 1.37$

AREA AVERAGE RAINFALL FOR THE PERIOD 1700Z TO 0400Z

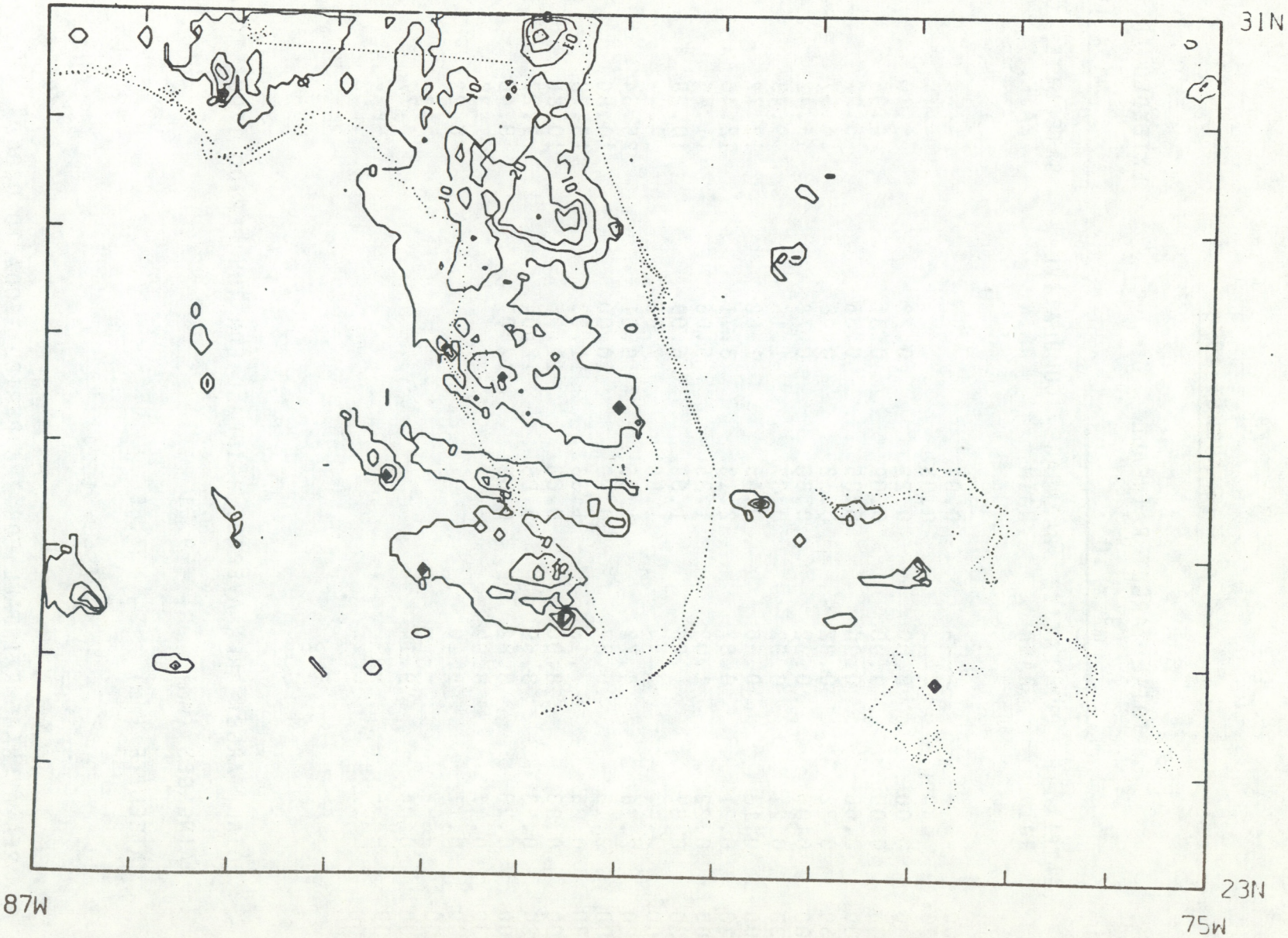
EXTENDED AREA SATELLITE (mm) $S_E = 0.07$

TARGET AREA SATELLITE (mm) $S_T = 1.22$

FACE SATELLITE RAINFALL

14 AUG 78

UNADJUSTED



226/1702Z-227/0402Z

16 AUGUST 1978

TIME GMT	TOTAL TARGET RAINFALL $m^3 \times 10^7$				EXTENDED AREA RAINFALL $m^3 \times 10^7$	
	SATELLITE RAIN	CUMULATIVE RAIN	RAINGAGE RAIN	CUMULATIVE RAIN	SATELLITE RAIN	CUMULATIVE RAIN
1600	----	----	0.01		----	----
1630	----	----	0.03		----	----
1700	0.00	0.00	0.22	0.22	6.70	6.70
1730	0.00	0.00	0.09	0.31	4.95	11.65
1800	0.00	0.00	0.05	0.36	5.97	17.62
1830	0.32	0.32	0.12	0.48	4.97	22.59
1900	0.00	0.32	0.30	0.78	5.42	28.01
1930	0.21	0.53	0.37	1.15	9.43	37.44
2000	0.13	0.66	0.43	1.58	12.72	50.16
2030	0.21	0.87	2.13	3.71	12.46	62.62
2100	0.22	1.09	1.35	5.06	11.75	74.37
2130	0.87	1.96	1.03	6.09	10.29	84.66
2200	----	----	1.56	7.65	----	----
2230	2.76	4.72	1.36	9.01	25.54	110.20
2300	2.15	6.87	0.99	10.00	10.80	121.00
2330	0.26	7.13	1.33	11.33	15.78	136.78
0000	0.93	8.06	0.63	11.96	10.86	147.64
0030	0.53	8.59	0.08	12.04	9.27	156.91
0100	0.23	8.82	0.03	12.07	8.40	165.31
0130	0.17	8.99			7.37	172.68
0200	0.11	9.10			6.23	178.91
0230	----	----			----	----
0300	0.04	9.14			4.77	183.68
0330	----	----			----	----
0400	----	----			----	----

TOTAL TARGET AREA AVERAGE RAINFALL FOR THE PERIOD 1700Z TO 0100Z

RAINGAGES (mm) $G_T = 9.51$

SATELLITE (mm) $S_T = 7.65$

$G_T/S_T = 1.24$

AREA AVERAGE RAINFALL FOR THE PERIOD 1700Z TO 0300Z

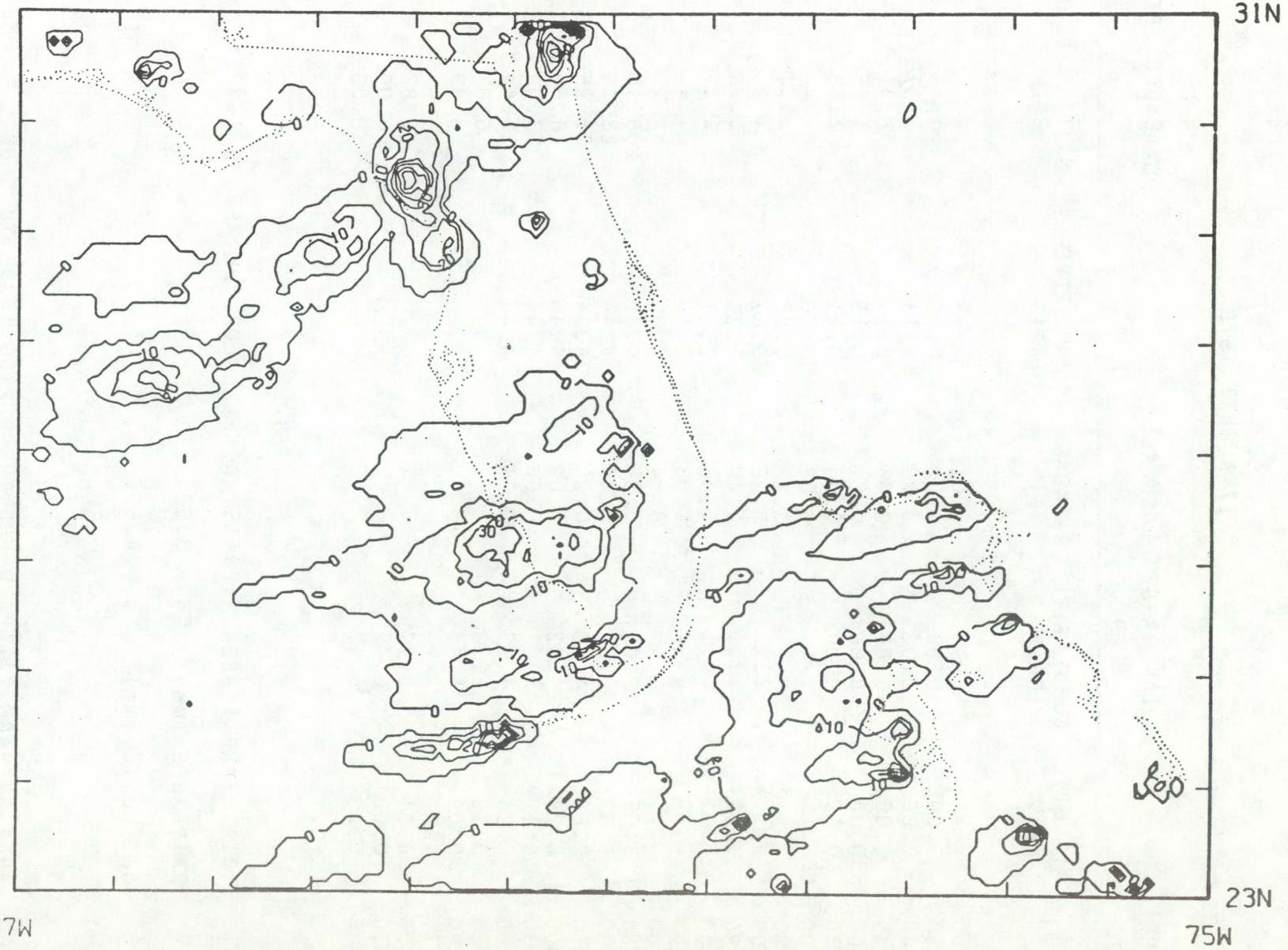
EXTENDED AREA SATELLITE (mm) $S_E = 0.15$

TARGET AREA SATELLITE (mm) $S_T = 7.93$

FACE SATELLITE RAINFALL

16 AUG 78

UNADJUSTED



228/1647Z-229/0302Z

17 AUGUST 1978

TIME GMT	TOTAL TARGET RAINFALL $m^3 \times 10^7$				EXTENDED AREA RAINFALL $m^3 \times 10^7$	
	SATELLITE RAIN	CUMULATIVE RAIN	RAINGAGE RAIN	CUMULATIVE RAIN	SATELLITE RAIN	CUMULATIVE RAIN
1600	----	----	0.01	----	----	----
1630	0.00	0.00	0.02	0.02	0.45	0.45
1700	0.00	0.00	0.09	0.11	0.87	1.32
1730	0.00	0.00	0.03	0.14	1.01	2.33
1800	0.00	0.00	0.01	0.15	1.55	3.88
1830	0.00	0.00	0.06	0.21	2.63	6.51
1900	----	----	0.09	0.30	----	----
1930	----*	----	0.22	0.52	----	----
2000	----*	----	0.35	0.87	----	----
2030	----*	----	0.48	1.35	----	----
2100	----*	----	1.06	2.41	----	----
2130	----	----	1.03	3.44	----	----
2200	----	----	0.54	3.98	----	----
2230	3.05	3.05	0.39	4.37	106.10	112.61
2300	0.83	3.88	0.07	4.44	23.46	136.07
2330	0.65	4.53	0.00	4.44	21.95	158.02
0000	0.29	4.82	0.02	4.46	16.69	174.71
0030	0.19	5.01	0.00	4.46	13.89	188.60
0100	0.24	5.25	0.01	4.47	11.44	200.04
0130	0.13	5.38			6.81	206.85
0200	0.08	5.46			4.89	211.74
0230	----	----			----	----
0300	0.01	5.47			2.82	214.56
0330	0.00	5.47			0.00	214.56
0400	0.00	5.47			0.00	214.56

TOTAL TARGET AREA AVERAGE RAINFALL FOR THE PERIOD 1630Z TO 0100Z

RAINGAGES (mm) $\bar{G}_T = 3.52$

SATELLITE (mm) $\bar{S}_T = 4.55$

$\bar{G}_T/\bar{S}_T = 0.77$

AREA AVERAGE RAINFALL FOR THE PERIOD 1630Z TO 0400Z

EXTENDED AREA SATELLITE (mm) $\bar{S}_E = 0.18$

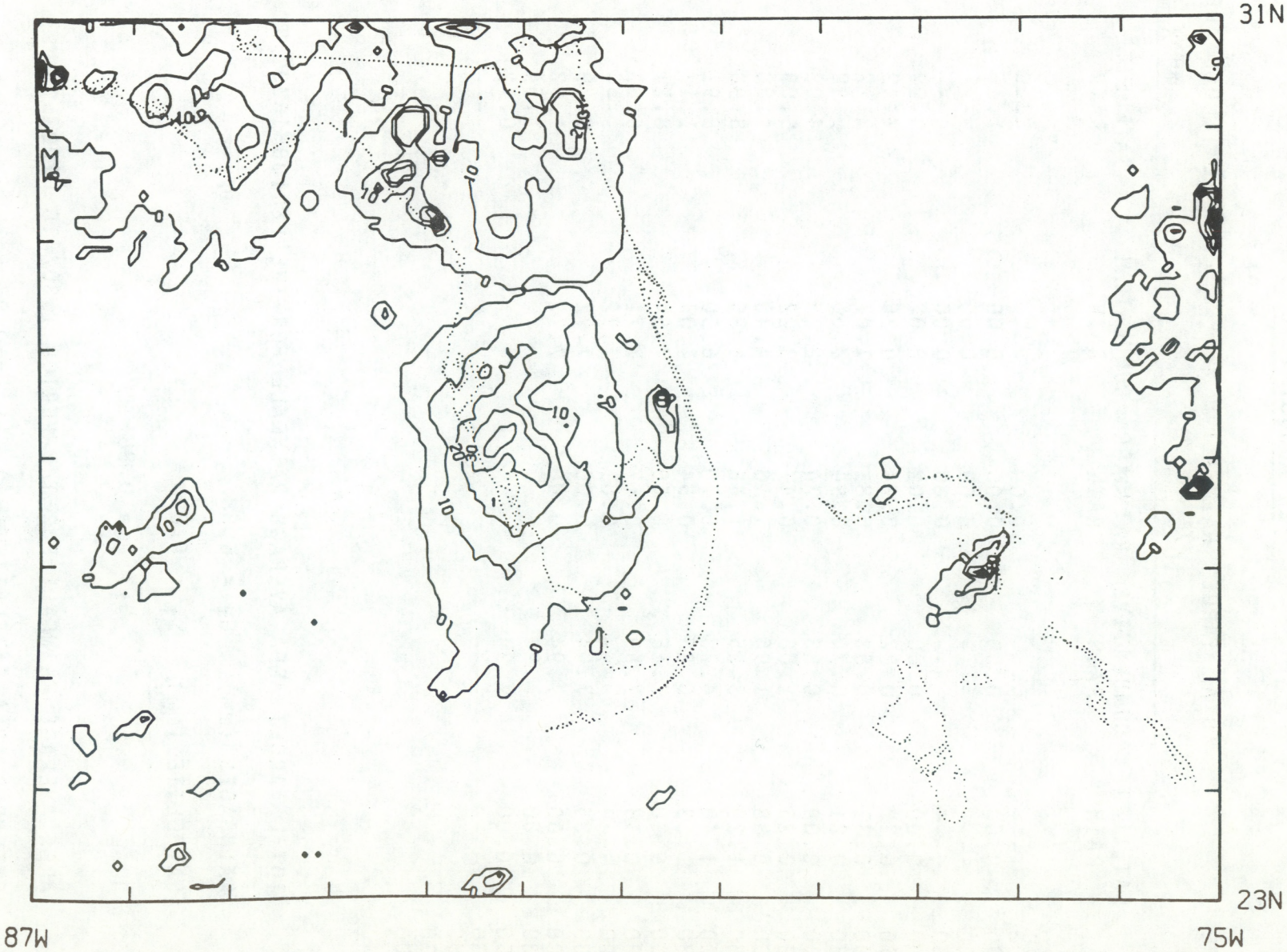
TARGET AREA SATELLITE (mm) $\bar{S}_T = 4.74$

* Satellite imagery available at 15 and 45 minutes after the hour.

FACE SATELLITE RAINFALL

17 AUG 78

UNADJUSTED



229/1617Z-230/0402Z

29 AUGUST 1978

TIME GMT	TOTAL TARGET RAINFALL $m^3 \times 10^7$				EXTENDED AREA RAINFALL $m^3 \times 10^7$	
	SATELLITE RAIN	CUMULATIVE RAIN	RAINGAGE RAIN	CUMULATIVE RAIN	SATELLITE RAIN	CUMULATIVE RAIN
1600	----	----	0.00	----	----	----
1630	0.00	0.00	0.00	0.00	1.16	1.16
1700	----	----	0.00	0.00	----	----
1730	----	----	0.00	0.00	----	----
1800	0.00	0.00	0.02	0.02	3.92	5.08
1830	0.22	0.22	0.24	0.26	2.42	7.50
1900	0.31	0.53	0.81	1.07	3.12	10.62
1930	0.21	0.74	0.94	2.01	5.90	16.52
2000	0.09	0.83	0.74	2.75	4.03	20.55
2030	0.25	1.08	0.47	3.22	5.03	25.58
2100	0.88	1.96	1.18	4.40	4.60	30.18
2130	1.29	3.25	1.46	5.86	8.80	38.98
2200	1.48	4.73	0.70	6.50	8.91	47.89
2230	1.53	6.26	0.54	7.04	11.17	59.06
2300	0.90	7.16	0.50	7.54	8.21	67.27
2330	0.43	7.59	0.17	7.71	6.83	74.10
0000	----	----	0.01	7.72	----	----
0030	0.35	7.94	0.00	7.72	9.29	83.39
0100	0.00	7.94	0.00	7.72	1.63	85.02
0130	0.00	7.94			1.54	86.56
0200	0.00	7.94			0.72	87.28
0230	----	----			----	----
0300						
0330						
0400						

TOTAL TARGET AREA AVERAGE RAINFALL FOR THE PERIOD 1630Z TO 0100Z

RAINGAGES (mm) $G_T = 6.08$

SATELLITE (mm) $S_T = 6.89$

$G_T/S_T = 0.88$

AREA AVERAGE RAINFALL FOR THE PERIOD 1630Z TO 0200Z

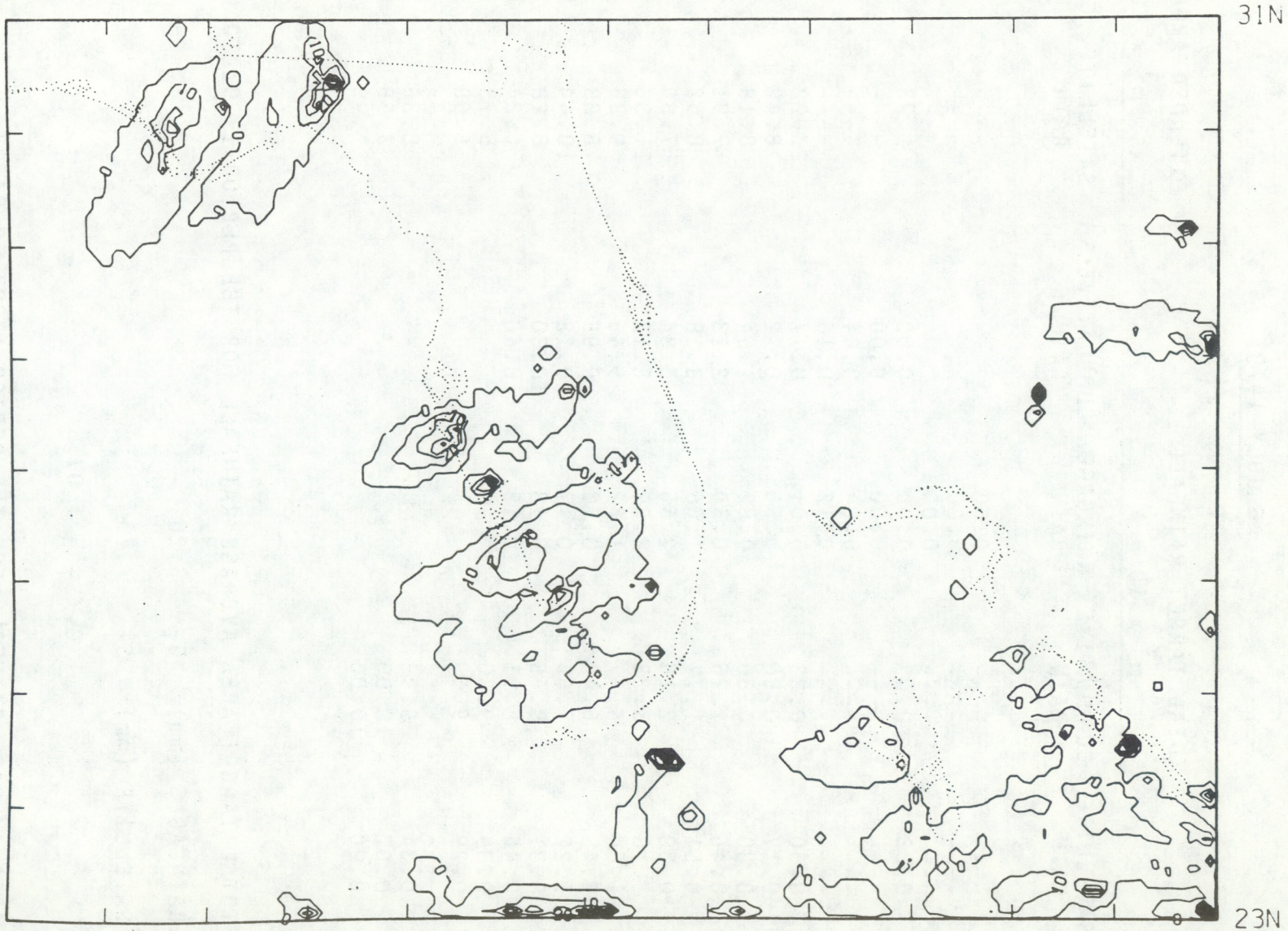
EXTENDED AREA SATELLITE (mm) $S_E = 0.07$

TARGET AREA SATELLITE (mm) $S_T = 6.89$

FACE SATELLITE RAINFALL

29 AUG 78

UNADJUSTED



241/1632Z-242/0202Z

6 JULY 1979

TIME GMT	TOTAL TARGET RAINFALL $m^3 \times 10^7$				EXTENDED AREA RAINFALL $m^3 \times 10^7$	
	SATELLITE RAIN	CUMULATIVE RAIN	RAINGAGE RAIN	CUMULATIVE RAIN	SATELLITE RAIN	CUMULATIVE RAIN
1600	----	----	0.00		----	----
1630	----	----	0.00		----	----
1700	----	----	0.00		----	----
1730	0.03	0.03	0.00	0.00	1.93	1.93
1800	----	----	0.00	0.00	----	----
1830	----	----	0.04	0.04	----	----
1900	----	----	0.12	0.16	----	----
1930	0.30	0.33	0.01	0.17	27.22	29.15
2000	0.17	0.50	0.55	0.72	8.42	37.57
2030	0.30	0.80	0.82	1.54	8.18	45.75
2100	0.46	1.26	0.59	2.13	7.91	53.66
2130	0.51	1.77	1.05	3.18	8.42	62.08
2200	0.38	2.15	2.66	5.84	7.86	69.94
2230	1.18	3.33	2.29	8.13	11.33	81.27
2300	1.64	4.97	1.32	9.45	9.36	90.63
2330	1.45	6.42	0.50	9.95	8.83	99.46
0000	1.22	7.64	0.17	10.12	10.44	109.90
0030	0.81	8.45	0.18	10.30	8.28	118.18
0100	0.46	8.91	0.18	10.48	6.24	124.42
0130	0.39	9.30			5.78	130.20
0200	0.29	9.59			5.68	135.88
0230	----	----			----	----
0300	0.34	9.93			8.36	144.24
0330	0.07	10.00			3.55	147.79
0400	0.00	10.00			1.96	149.75

TOTAL TARGET AREA AVERAGE RAINFALL FOR THE PERIOD 1730Z TO 0100Z

RAINGAGES (mm) $G_T = 8.26$

SATELLITE (mm) $S_T = 7.73$

$G_T/S_T = 1.07$

AREA AVERAGE RAINFALL FOR THE PERIOD 1730Z TO 0400Z

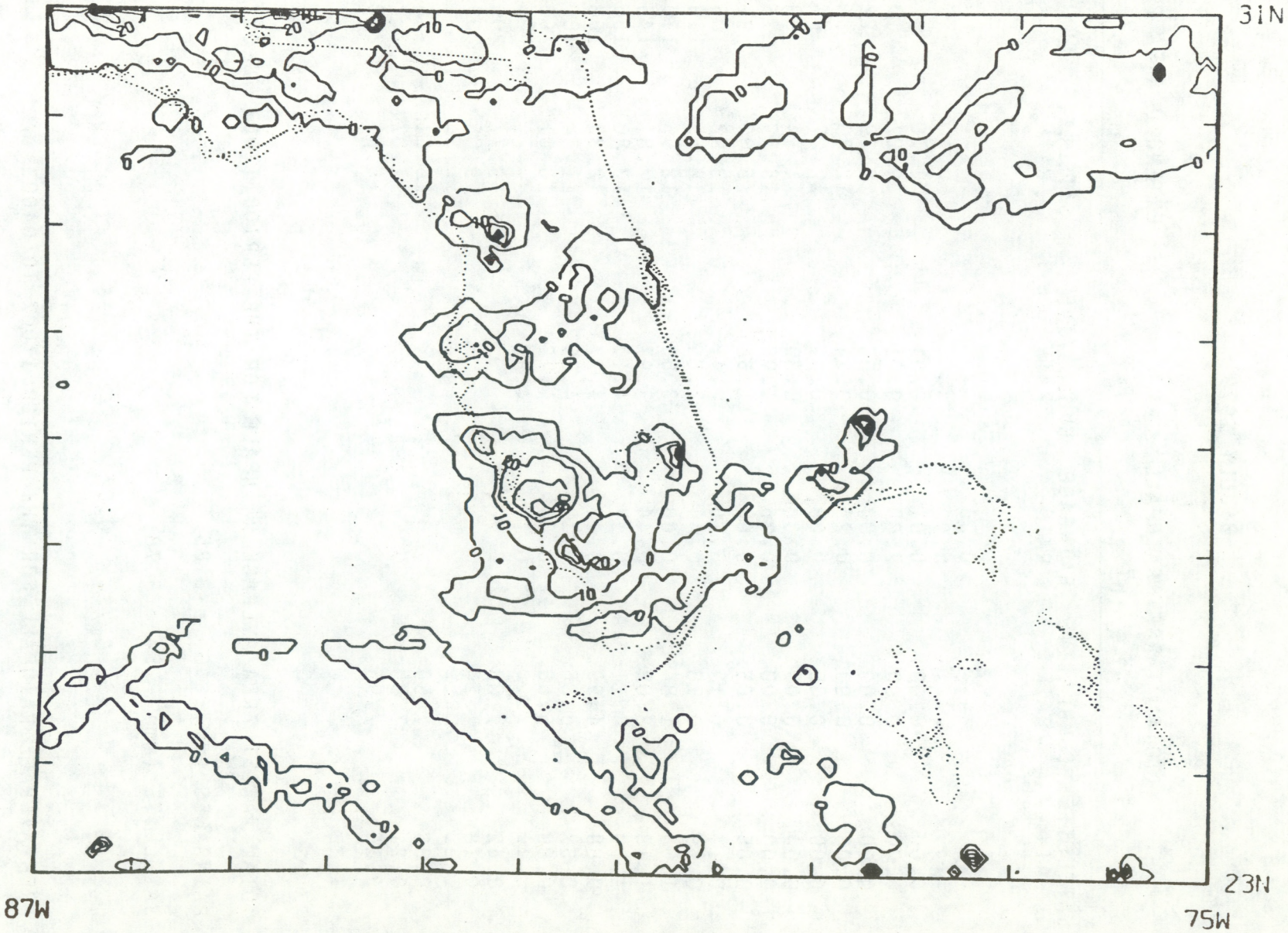
EXTENDED AREA SATELLITE (mm) $S_E = 0.13$

TARGET AREA SATELLITE (mm) $S_T = 8.67$

FACE SATELLITE RAINFALL

6 JULY 79

UNADJUSTED



187/1733Z-188/0404Z

8 JULY 1979

TIME GMT	TOTAL TARGET RAINFALL $m^3 \times 10^7$				EXTENDED AREA RAINFALL $m^3 \times 10^7$	
	SATELLITE RAIN	CUMULATIVE RAIN	RAINGAGE RAIN	CUMULATIVE RAIN	SATELLITE RAIN	CUMULATIVE RAIN
1600	----	----	0.00	----	----	----
1630	----	----	0.00	----	----	----
1700	0.00	0.00	0.01	0.01	1.16	1.16
1730	0.00	0.00	0.00	0.01	9.27	10.43
1800	0.00	0.00	0.04	0.05	12.39	22.82
1830	0.00	0.00	0.29	0.34	12.80	35.62
1900	0.00	0.00	0.08	0.42	12.27	47.89
1930	0.00	0.00	0.38	0.80	11.74	59.63
2000	0.00	0.00	0.26	1.06	15.79	75.42
2030	0.05	0.05	0.60	1.66	16.00	91.42
2100	0.14	0.19	0.75	2.41	13.93	105.35
2130	0.59	0.78	0.44	2.85	12.65	118.00
2200	1.06	1.84	0.68	3.53	12.95	130.95
2230	1.18	3.02	0.44	3.97	12.81	143.76
2300	1.09	4.11	0.17	4.14	12.80	156.56
2330	0.88	4.99	0.13	4.27	12.33	168.89
0000	0.87	5.86	0.12	4.39	11.34	180.23
0030	0.80	6.66	0.33	4.72	10.01	190.24
0100	----	----	0.17	4.89	----	----
0130	0.42	7.08			9.77	200.01
0200	0.18	7.26			9.05	209.06
0230	----	----			----	----
0300	0.33	7.59			16.61	225.67
0330	0.21	7.80			7.07	232.74
0400	0.15	7.95			5.61	238.35

TOTAL TARGET AREA AVERAGE RAINFALL FOR THE PERIOD 1700Z TO 0030

RAINGAGES (mm) $G_T = 3.85$

SATELLITE (mm) $S_T = 5.78$

$G_T/S_T = 0.67$

AREA AVERAGE RAINFALL FOR THE PERIOD 1700Z TO 0400Z

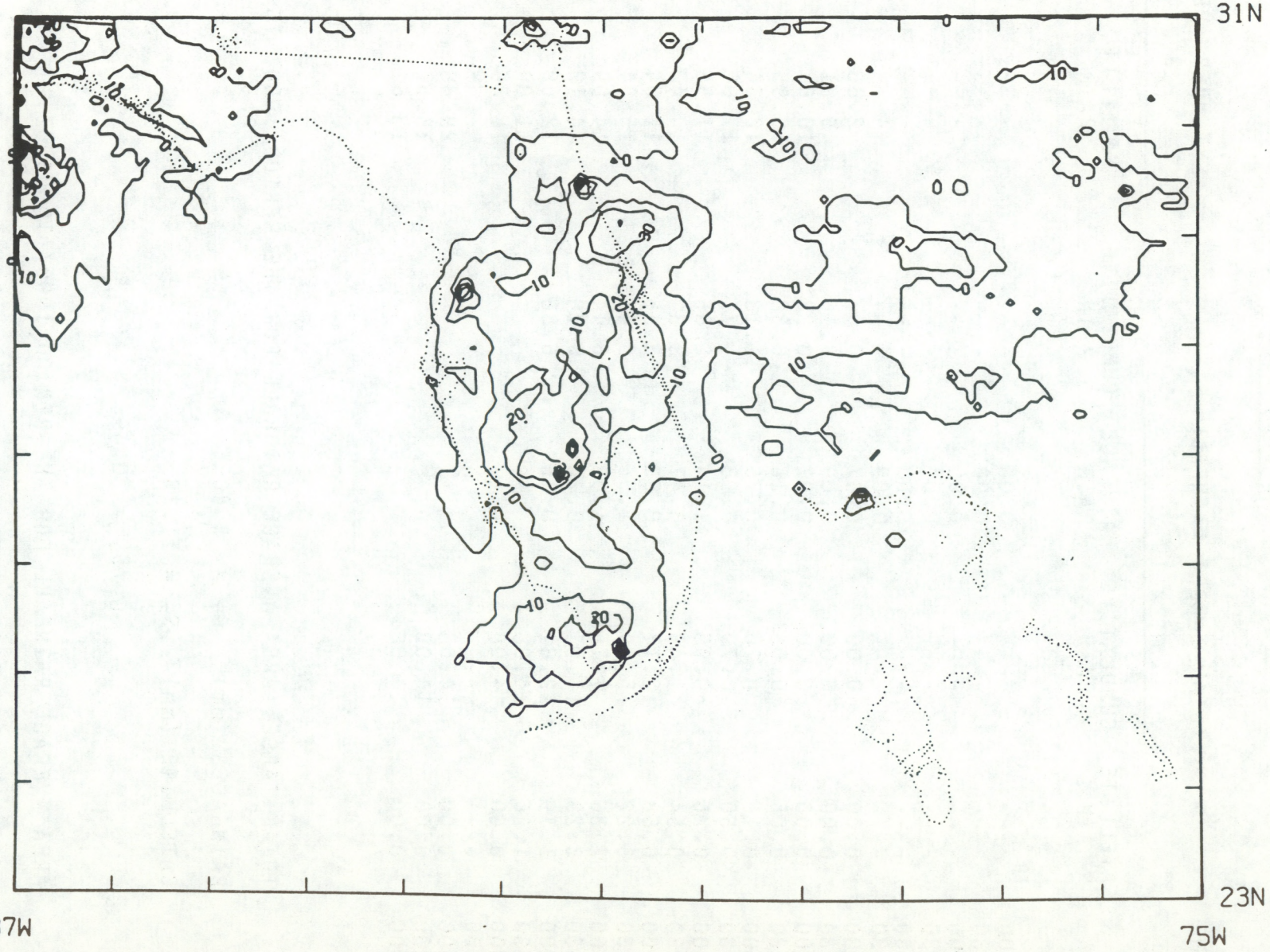
EXTENDED AREA SATELLITE (mm) $S_E = 0.20$

TARGET AREA SATELLITE (mm) $S_T = 6.90$

FACE SATELLITE RAINFALL

8 JULY 79

UNADJUSTED



189/1704Z-190/0404Z

9 JULY 1979

TIME GMT	TOTAL TARGET RAINFALL $m^3 \times 10^7$				EXTENDED AREA RAINFALL $m^3 \times 10^7$	
	SATELLITE RAIN	CUMULATIVE RAIN	RAINGAGE RAIN	CUMULATIVE RAIN	SATELLITE RAIN	CUMULATIVE RAIN
1600	----	----	0.00	----	----	----
1630	----	----	0.00	----	----	----
1700	----	----	0.00	----	----	----
1730	----	----	0.00	----	----	----
1800	----	----	0.00	----	----	----
1830	----	----	0.09	----	----	----
1900	0.00	0.00	0.07	0.07	2.88	2.88
1930	0.00	0.00	0.09	0.16	9.61	12.49
2000	0.00	0.00	0.07	0.23	10.07	22.56
2030	0.05	0.05	0.15	0.38	10.93	33.49
2100	0.15	0.20	0.75	1.13	12.34	45.83
2130	0.50	0.70	0.58	1.71	11.01	56.84
2200	0.25	0.95	1.14	2.85	11.55	68.39
2230	0.54	1.49	0.47	3.32	10.43	78.82
2300	0.68	2.17	0.53	3.85	11.64	90.46
2330	3.22	5.39	1.56	5.41	15.84	106.30
0000	2.36	7.75	1.03	6.44	14.09	120.39
0030	3.28	11.03	0.26	6.70	14.12	134.51
0100	1.79	12.82	0.16	6.86	12.69	147.20
0130	1.26	14.08			11.09	158.29
0200	0.00	14.08			15.36	173.65
0230	----	----			----	----
0300	0.00	14.08			29.48	203.13
0330	0.00	14.08			15.57	218.70
0400	0.00	14.08			13.61	232.31

TOTAL TARGET AREA AVERAGE RAINFALL FOR THE PERIOD 1900Z TO 0100Z

RAINGAGES (mm) G_T = 5.40

SATELLITE (mm) S_T = 11.12

G_T/S_T = 0.49

AREA AVERAGE RAINFALL FOR THE PERIOD 1900Z TO 0400Z

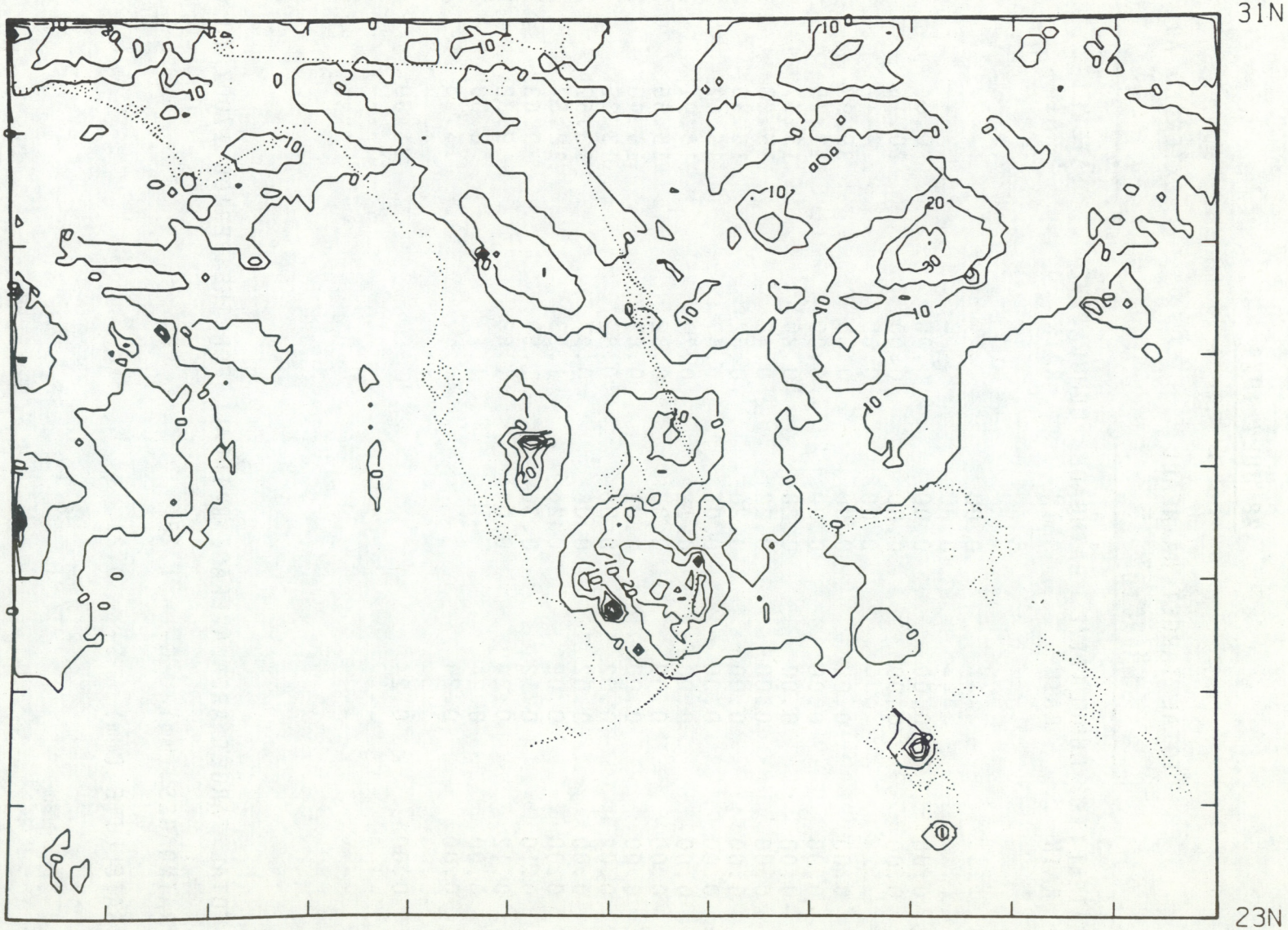
EXTENDED AREA SATELLITE (mm) S_E = 0.20

TARGET AREA SATELLITE (mm) S_T = 12.21

FACE SATELLITE RAINFALL

9 JULY 79

UNADJUSTED



190/1904Z-191/0402Z

28 JULY 1979

TIME GMT	TOTAL TARGET RAINFALL $m^3 \times 10^7$				EXTENDED AREA RAINFALL $m^3 \times 10^7$	
	SATELLITE RAIN	CUMULATIVE RAIN	RAINGAGE RAIN	CUMULATIVE RAIN	SATELLITE RAIN	CUMULATIVE RAIN
1600	----	----	0.00	----	----	----
1630	----	----	0.00	----	----	----
1700	0.00	0.00	0.00	0.00	0.04	0.04
1730	0.00	0.00	0.00	0.00	20.15	20.19
1800	----	----	0.00	0.00	----	----
1830	0.00	0.00	0.00	0.00	39.93	60.12
1900	0.00	0.00	0.00	0.00	13.75	73.87
1930	0.00	0.00	0.20	0.20	13.77	87.64
2000	0.00	0.00	0.22	0.42	15.20	102.84
2030	0.00	0.00	0.20	0.62	16.50	119.34
2100	0.00	0.00	0.05	0.67	16.67	136.01
2130	0.00	0.00	0.12	0.79	14.91	150.92
2200	0.00	0.00	0.03	0.82	15.55	166.47
2230	0.00	0.00	0.01	0.83	13.40	179.87
2300	0.02	0.02	0.06	0.89	13.35	193.22
2330	0.00	0.02	0.08	0.97	13.57	206.79
0000	0.00	0.02	0.26	1.23	12.57	219.36
0030	0.10	0.12	0.36	1.59	9.63	228.99
0100	0.12	0.24	0.04	1.63	9.38	238.37
0130	0.00	0.24			8.06	246.43
0200	0.00	0.24			13.56	259.99
0230	----	----			----	----
0300	0.00	0.24			21.89	281.88
0330	----	----			----	----
0400	----	----			----	----

TOTAL TARGET AREA AVERAGE RAINFALL FOR THE PERIOD 1700Z TO 0100Z

RAINGAGES (mm) $G_T = 1.28$

SATELLITE (mm) $S_T = 0.21$

$G_T/S_T = 6.10$

AREA AVERAGE RAINFALL FOR THE PERIOD 1700Z TO 0300Z

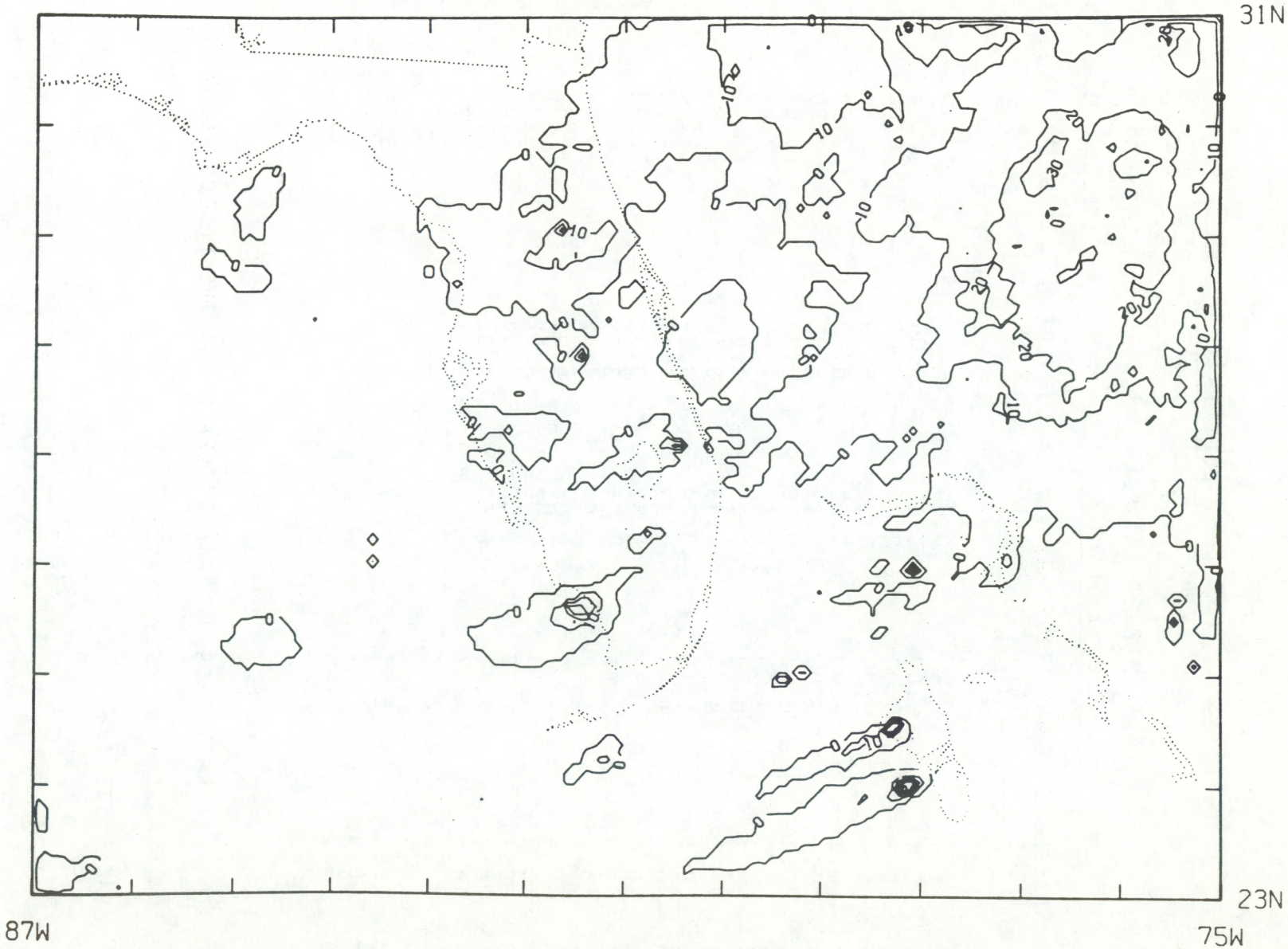
EXTENDED AREA SATELLITE (mm) $S_E = 0.24$

TARGET AREA SATELLITE (mm) $S_T = 0.21$

FACE SATELLITE RAINFALL

28 JULY 79

UNADJUSTED



209/1704Z-210/0304Z

30 JULY 1979

TIME GMT	TOTAL TARGET RAINFALL $m^3 \times 10^7$				EXTENDED AREA RAINFALL $m^3 \times 10^7$	
	SATELLITE RAIN	CUMULATIVE RAIN	RAINGAGE RAIN	CUMULATIVE RAIN	SATELLITE RAIN	CUMULATIVE RAIN
1600	----	----	0.00	----	----	----
1630	0.00	0.00	0.00	0.00	2.53	2.53
1700	0.00	0.00	0.00	0.00	9.32	11.85
1730	0.00	0.00	0.00	0.00	9.38	21.23
1800	0.00	0.00	0.02	0.02	10.69	31.92
1830	0.00	0.00	0.19	0.21	9.90	41.82
1900	0.00	0.00	0.78	0.99	16.38	58.20
1930	0.00	0.00	0.62	1.61	12.82	71.02
2000	0.28	0.28	0.26	1.87	17.61	88.63
2030	0.48	0.76	0.43	2.30	16.84	105.47
2100	0.42	1.18	0.84	3.14	15.26	120.73
2130	0.17	1.35	0.28	3.42	14.13	134.86
2200	0.02	1.37	0.42	3.84	13.93	148.79
2230	0.09	1.46	0.14	3.98	14.23	163.02
2300	0.12	1.58	0.04	4.02	13.56	176.58
2330	0.29	1.87	0.00	4.02	11.89	188.47
0000	0.07	1.94	0.00	4.02	10.31	198.78
0030	0.15	2.09	0.00	4.02	7.96	206.74
0100	0.05	2.14	0.00	4.02	5.33	212.07
0130	0.00	2.14			3.79	215.86
0200	0.00	2.14			3.70	219.56
0230	----	----			----	----
0300	0.00	2.14			3.75	223.31
0330	0.00	2.14			0.82	224.13
0400	----	----			----	----

TOTAL TARGET AREA AVERAGE RAINFALL FOR THE PERIOD 1630Z TO 0100Z

RAINGAGES (mm) $G_T = 3.17$

SATELLITE (mm) $S_T = 1.86$

$G_T/S_T = 1.70$

AREA AVERAGE RAINFALL FOR THE PERIOD 1630Z TO 0330Z

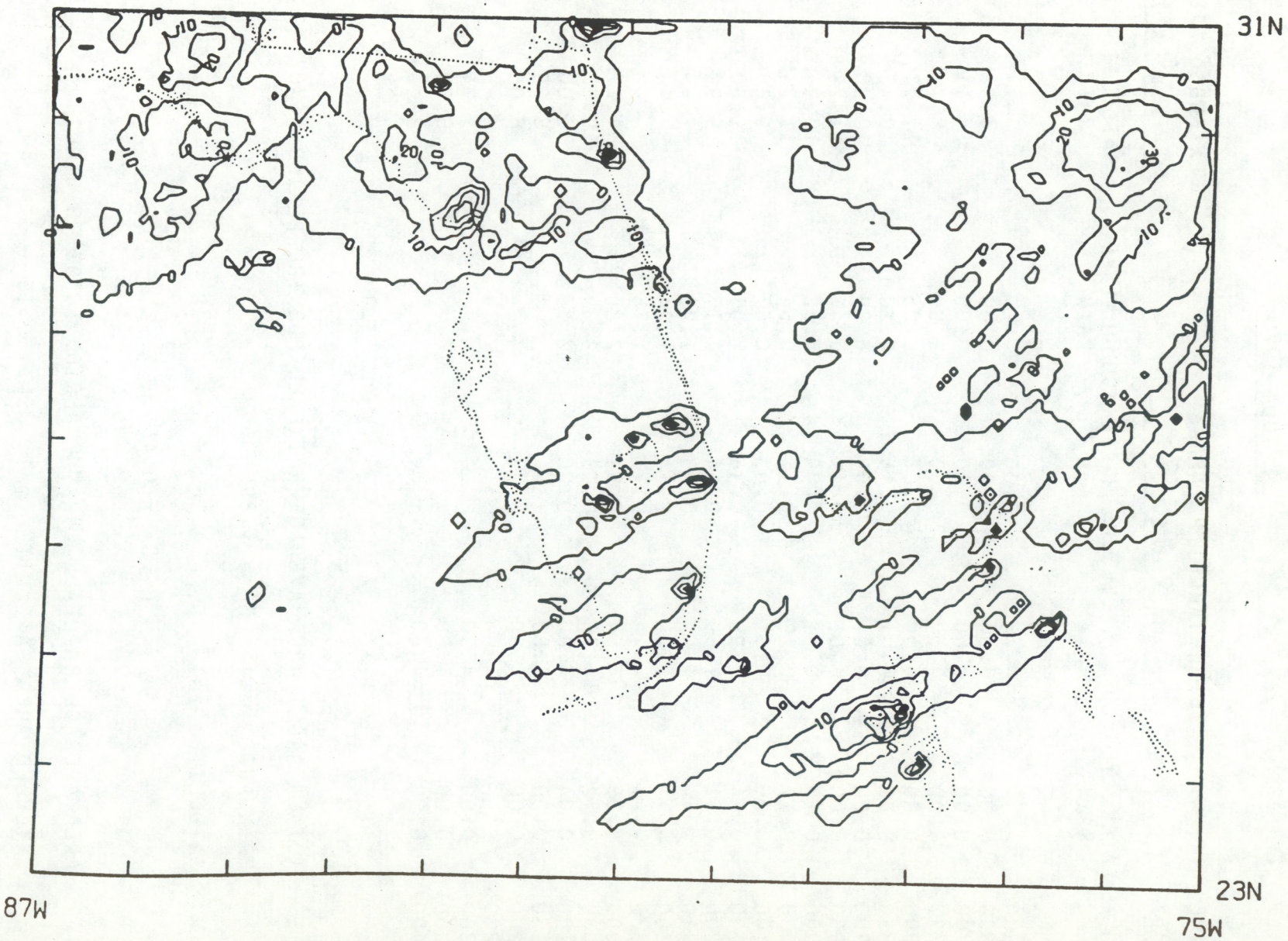
EXTENDED AREA SATELLITE (mm) $S_E = 0.19$

TARGET AREA SATELLITE (mm) $S_T = 1.86$

FACE SATELLITE RAINFALL

30 JULY 79

UNADJUSTED



211/1633Z-212/0334Z

31 JULY 1979

TIME GMT	TOTAL TARGET RAINFALL $m^3 \times 10^7$				EXTENDED AREA RAINFALL $m^3 \times 10^7$	
	SATELLITE RAIN	CUMULATIVE RAIN	RAINGAGE RAIN	CUMULATIVE RAIN	SATELLITE RAIN	CUMULATIVE RAIN
1600	----	----	0.00	----	----	----
1630	0.00	0.00	0.00	0.00	4.98	4.98
1700	0.00	0.00	0.00	0.00	8.11	13.09
1730	0.00	0.00	0.00	0.00	8.71	21.80
1800	0.00	0.00	0.05	0.05	11.51	33.31
1830	0.01	0.01	0.15	0.20	10.45	43.76
1900	0.00	0.01	0.09	0.29	10.23	53.99
1930	0.00	0.01	0.14	0.43	11.27	65.26
2000	0.10	0.11	0.09	0.52	10.25	75.51
2030	0.17	0.28	0.12	0.64	11.74	87.25
2100	0.26	0.54	0.03	0.67	9.86	97.11
2130	0.44	0.98	0.36	1.03	11.00	108.11
2200	0.61	1.59	0.14	1.17	9.92	118.03
2230	----	----	0.03	1.20	----	----
2300	----	----	0.14	1.34	----	----
2330	----	----	0.41	1.75	----	----
0000	3.05	4.64	0.51	2.26	34.27	152.30
0030	0.12	4.76	0.13	2.39	10.31	162.61
0100	0.04	4.80	0.00	2.39	6.00	168.61
0130	0.00	4.80			6.65	175.26
0200	0.00	4.80			6.06	181.32
0230	----	----			----	----
0300	0.00	4.80			1.14	182.46
0330	0.00	4.80			5.59	188.05
0400	0.00	4.80			4.81	192.86

TOTAL TARGET AREA AVERAGE RAINFALL FOR THE PERIOD 1630Z TO 0100Z

RAINGAGES (mm) $G_T = 1.88$

SATELLITE (mm) $S_T = 4.16$

$G_T/S_T = 0.45$

AREA AVERAGE RAINFALL FOR THE PERIOD 1630Z TO 0400Z

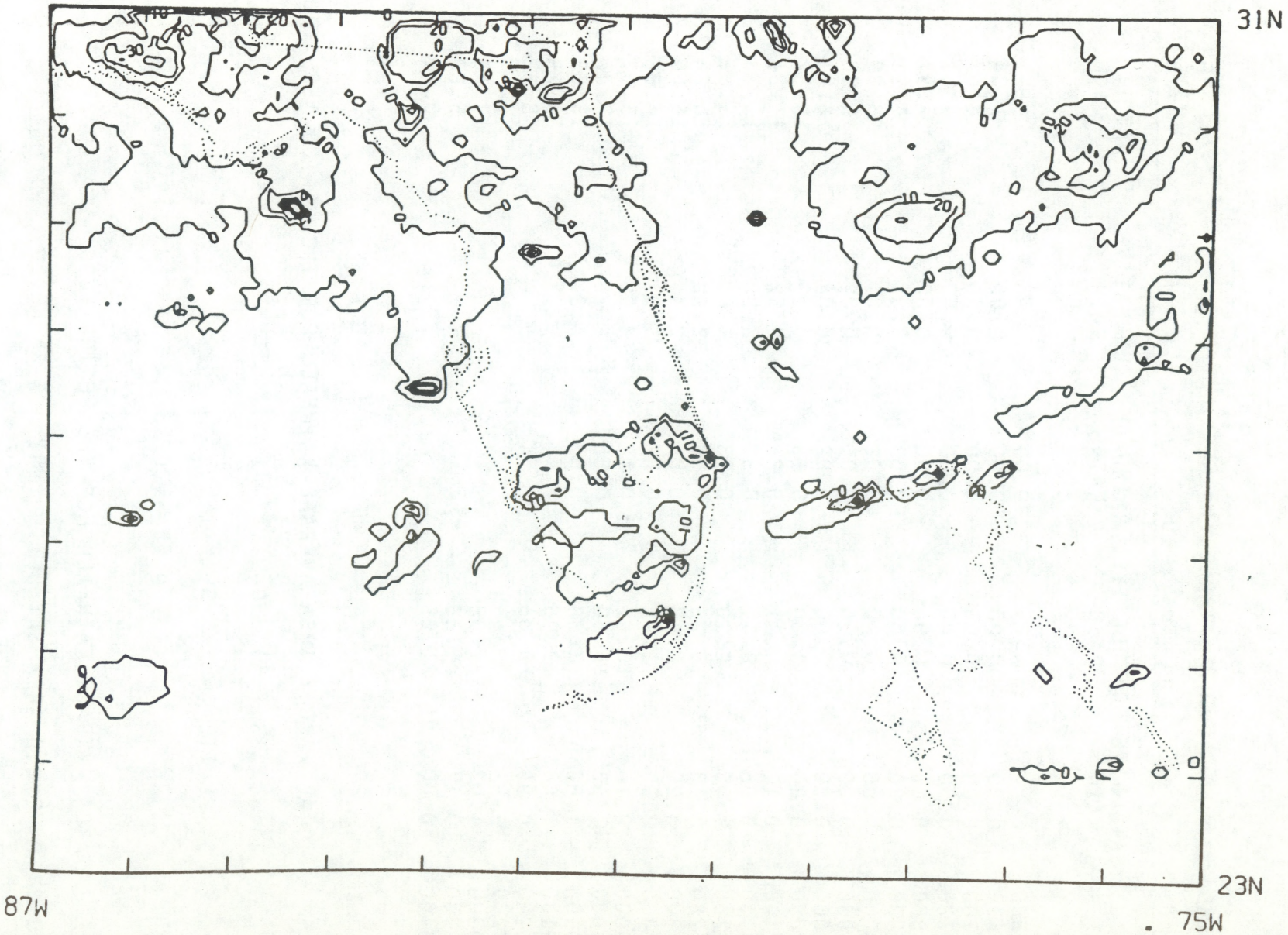
EXTENDED AREA SATELLITE (mm) $S_E = 0.16$

TARGET AREA SATELLITE (mm) $S_T = 4.16$

FACE SATELLITE RAINFALL

31 JULY 79

UNADJUSTED



212/1633Z-213/0404Z

3 AUGUST 1979

TIME GMT	TOTAL TARGET RAINFALL $m^3 \times 10^7$				EXTENDED AREA RAINFALL $m^3 \times 10^7$	
	SATELLITE RAIN	CUMULATIVE RAIN	RAINGAGE RAIN	CUMULATIVE RAIN	SATELLITE RAIN	CUMULATIVE RAIN
1600	----	----	0.00	----	----	----
1630	0.00	0.00	0.00	0.00	1.36	1.36
1700	0.00	0.00	0.00	0.00	3.67	5.03
1730	0.00	0.00	0.00	0.00	4.31	9.34
1800	0.00	0.00	0.00	0.00	4.37	13.71
1830	0.00	0.00	0.00	0.00	4.91	18.62
1900	0.00	0.00	0.01	0.01	8.29	26.91
1930	0.00	0.00	0.01	0.02	8.70	35.61
2000	0.00	0.00	0.02	0.04	12.81	48.42
2030	0.00	0.00	0.13	0.17	13.87	62.29
2100	0.11	0.11	0.35	0.52	11.31	73.60
2130	0.06	0.17	0.36	0.88	11.33	84.93
2200	1.93	2.10	0.73	1.61	15.83	100.76
2230	3.13	5.23	0.89	2.50	18.86	119.62
2300	3.20	8.43	0.85	3.35	16.66	136.28
2330	2.98	11.41	0.47	3.82	14.88	151.16
0000	2.16	13.57	0.18	4.00	15.07	166.23
0030	1.93	15.50	0.30	4.30	12.47	178.70
0100	1.88	17.38	0.03	4.33	13.03	191.73
0130	1.68	19.06			12.29	204.02
0200	0.99	20.05			8.35	212.37
0230	----	----			----	----
0300	1.03	21.08			13.45	225.82
0330	0.17	21.25			5.88	231.70
0400	0.00	21.25			3.61	235.31

TOTAL TARGET AREA AVERAGE RAINFALL FOR THE PERIOD 1630Z TO 0100Z

RAINGAGES (mm) G_T = 3.41

SATELLITE (mm) S_T = 15.08

G_T/S_T = 0.23

AREA AVERAGE RAINFALL FOR THE PERIOD 1630Z TO 0400Z

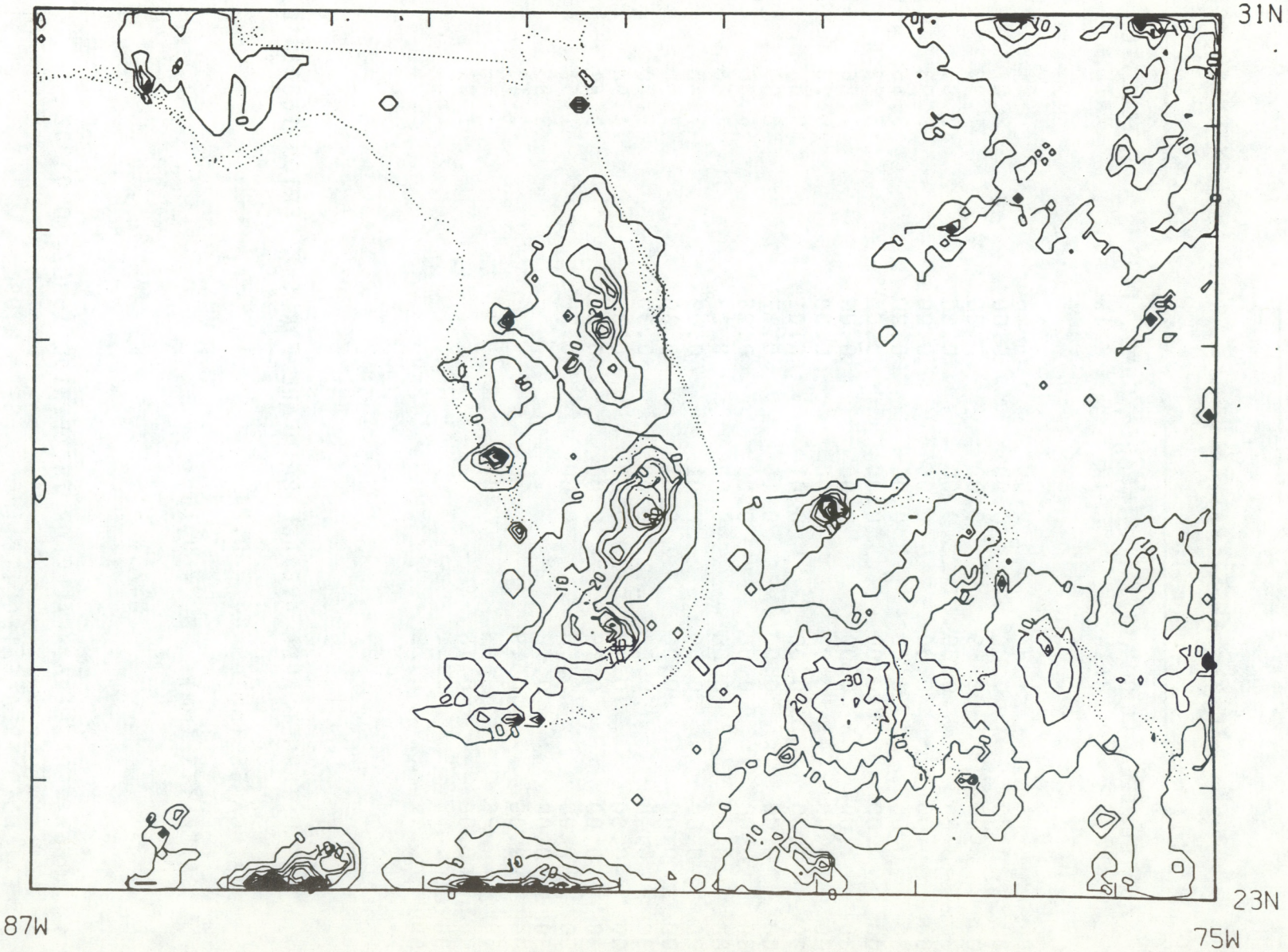
EXTENDED AREA SATELLITE (mm) S_E = 0.20

TARGET AREA SATELLITE (mm) S_T = 18.43

FACE SATELLITE RAINFALL

3 AUG 79

UNADJUSTED



215/1634Z-216/0404Z

13 AUGUST 1979

TIME GMT	TOTAL TARGET RAINFALL $m^3 \times 10^7$				EXTENDED AREA RAINFALL $m^3 \times 10^7$	
	SATELLITE RAIN	CUMULATIVE RAIN	RAINGAGE RAIN	CUMULATIVE RAIN	SATELLITE RAIN	CUMULATIVE RAIN
1600	----	----	0.00	----	----	----
1630	0.00	0.00	0.00	0.00	2.07	2.07
1700	0.00	0.00	0.00	0.00	1.90	3.97
1730	0.00	0.00	0.00	0.00	2.91	6.88
1800	0.00	0.00	0.00	0.00	5.93	12.81
1830	0.00	0.00	0.00	0.00	3.55	16.36
1900	0.00	0.00	0.00	0.00	5.22	21.58
1930	0.00	0.00	0.00	0.00	7.86	29.44
2000	0.00	0.00	0.00	0.00	9.23	38.67
2030	0.00	0.00	0.01	0.01	9.08	47.75
2100	0.00	0.00	0.16	0.17	8.89	56.64
2130	0.00	0.00	0.09	0.26	6.36	63.00
2200	0.00	0.00	0.02	0.28	7.80	70.80
2230	0.00	0.00	0.01	0.09	7.42	78.22
2300	0.00	0.00	0.01	0.30	7.40	85.62
2330	0.18	0.18	0.00	0.30	5.80	91.42
0000	0.00	0.18	0.00	0.30	4.94	96.36
0030	0.00	0.18	0.00	0.30	3.57	99.93
0100	0.00	0.18	0.00	0.30	1.51	101.44
0130	0.00	0.18			3.86	105.30
0200	0.00	0.18			2.43	107.73
0230	----	----			----	----
0300	0.00	0.18			1.01	108.74
0330	----	----			----	----
0400	----	----			----	----

TOTAL TARGET AREA AVERAGE RAINFALL FOR THE PERIOD 1630Z TO 0100Z

RAINGAGES (mm) $G_T = 0.24$

SATELLITE (mm) $S_T = 0.16$

$G_T/S_T = 1.50$

AREA AVERAGE RAINFALL FOR THE PERIOD 1630Z TO 0300Z

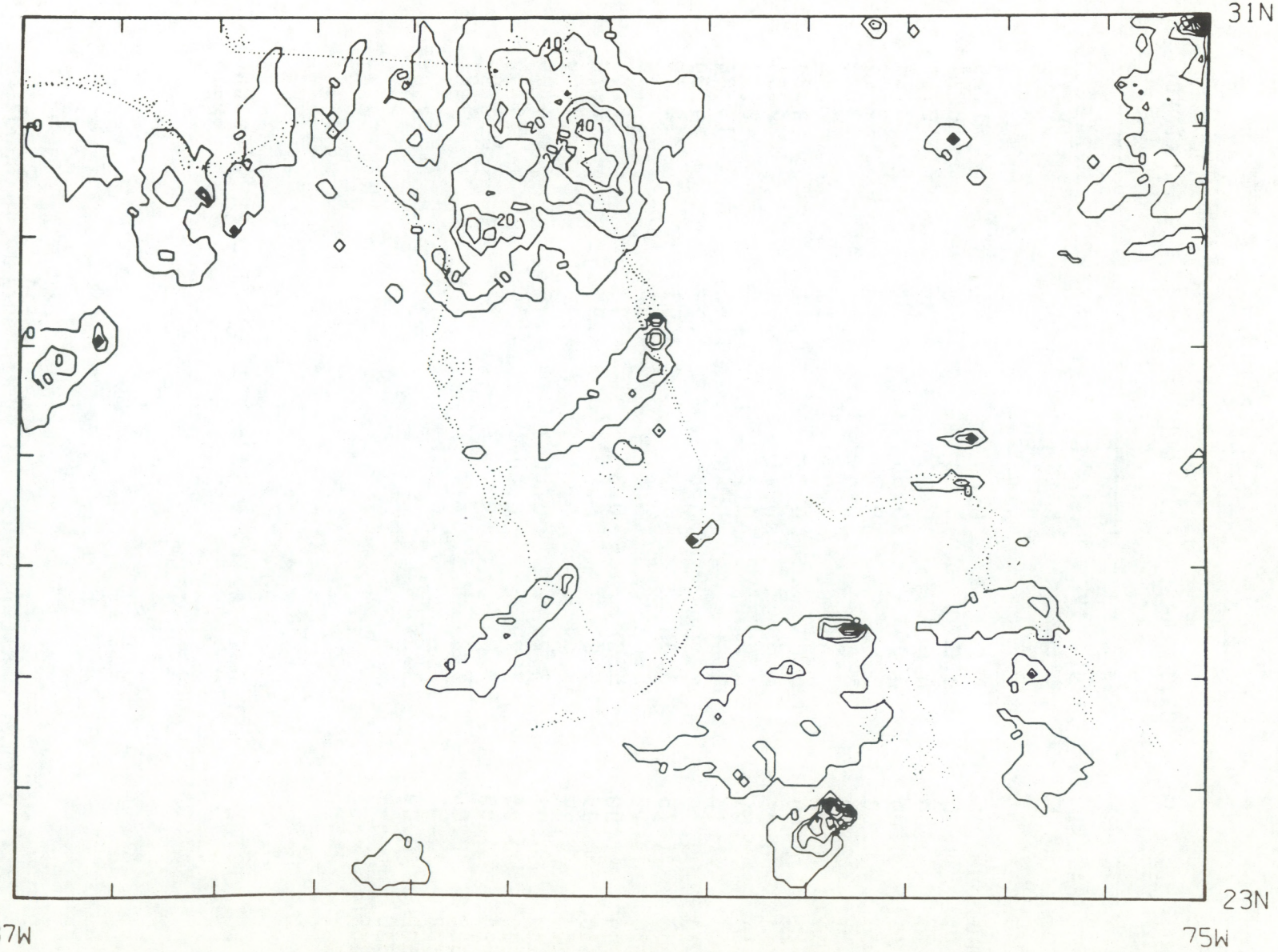
EXTENDED AREA SATELLITE (mm) $S_E = 0.09$

TARGET AREA SATELLITE (mm) $S_T = 0.16$

FACE SATELLITE RAINFALL

13 AUG 79

UNADJUSTED



225/1634Z-226/0304Z

14 AUGUST 1979

TIME GMT	TOTAL TARGET RAINFALL $m^3 \times 10^7$				EXTENDED AREA RAINFALL $m^3 \times 10^7$	
	SATELLITE RAIN	CUMULATIVE RAIN	RAINGAGE RAIN	CUMULATIVE RAIN	SATELLITE RAIN	CUMULATIVE RAIN
1600	0.00	0.00	0.00	----	1.25	1.25
1630	0.00	0.00	0.00	0.00	0.74	1.99
1700	0.00	0.00	0.00	0.00	0.54	2.53
1730	0.00	0.00	0.00	0.00	2.18	4.71
1800	0.00	0.00	0.00	0.00	3.93	8.64
1830	0.00	0.00	0.09	0.09	3.22	11.86
1900	0.00	0.00	0.07	0.16	2.65	14.51
1930	0.00	0.00	0.12	0.28	2.29	16.80
2000	0.01	0.01	0.41	0.69	2.56	19.36
2030	0.51	0.52	0.35	1.04	8.41	27.77
2100	1.14	1.66	0.58	1.62	10.86	38.63
2130	0.49	2.15	0.63	2.25	9.09	47.72
2200	1.75	3.90	1.68	3.93	12.46	60.18
2230	1.12	5.02	0.64	4.57	11.36	71.54
2300	1.00	6.02	0.35	4.92	8.55	80.09
2330	0.95	6.97	0.03	4.95	8.16	88.25
0000	0.31	7.28	0.01	4.96	7.23	95.48
0030	0.01	7.29	0.00	4.96	4.90	100.38
0100	0.00	7.29	0.00	4.96	4.35	104.73
0130	0.00	7.29			5.06	109.79
0200	0.00	7.29			5.27	115.06
0230	----	----			----	----
0300	0.00	7.29			7.01	122.07
0330	----				----	
0400	----				----	

TOTAL TARGET AREA AVERAGE RAINFALL FOR THE PERIOD 1600Z TO 0100Z

RAINGAGES (mm) G_T = 3.91

SATELLITE (mm) S_T = 6.32

G_T/S_T = 0.62

AREA AVERAGE RAINFALL FOR THE PERIOD 1600Z TO 0300Z

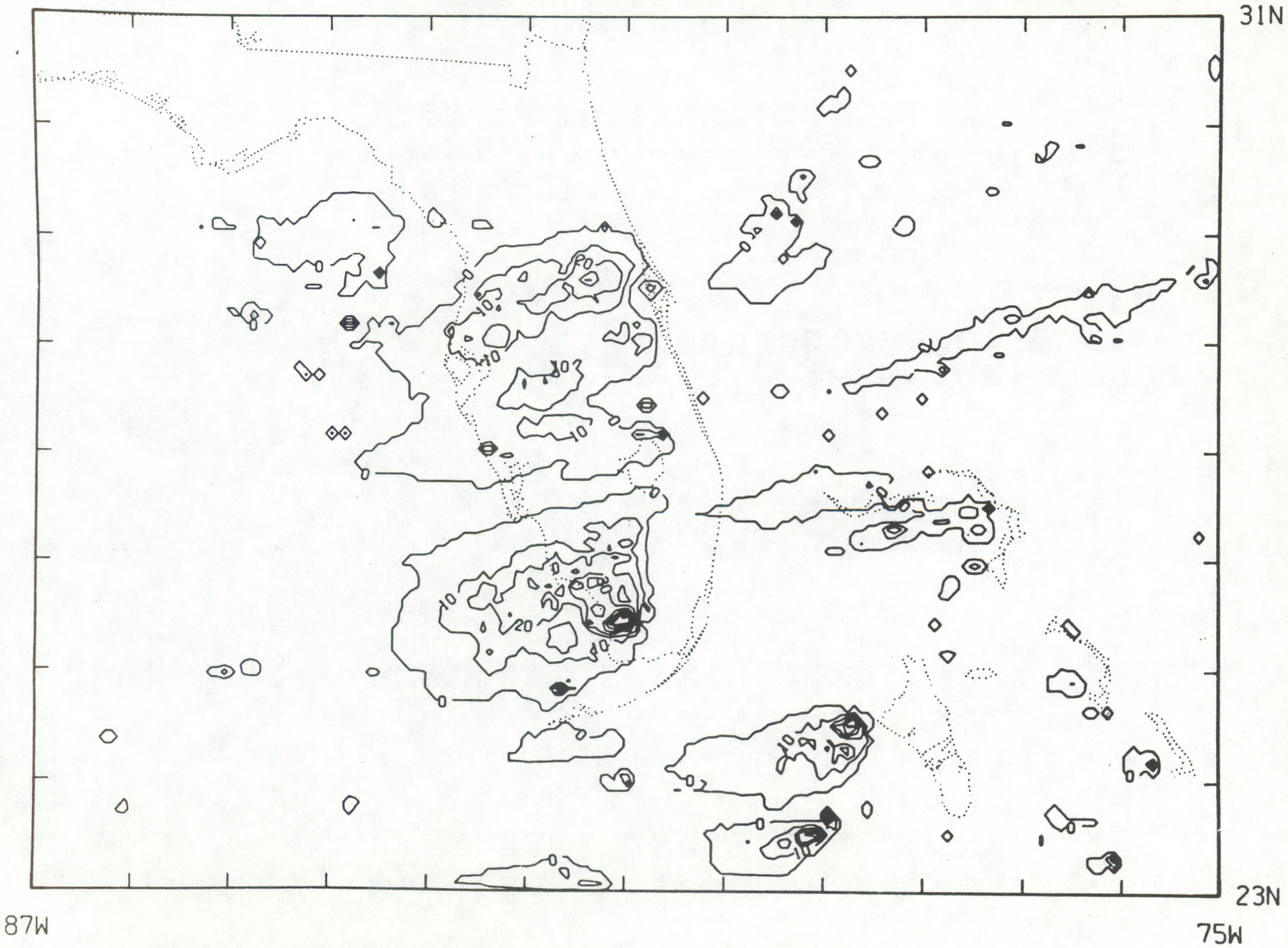
EXTENDED AREA SATELLITE (mm) S_E = 0.10

TARGET AREA SATELLITE (mm) S_T = 6.32

FACE SATELLITE RAINFALL

14 AUG 79

UNADJUSTED



226/1604Z-227/0304Z

16 AUGUST 1979

TIME GMT	TOTAL TARGET RAINFALL $m^3 \times 10^7$				EXTENDED AREA RAINFALL $m^3 \times 10^7$	
	SATELLITE RAIN	CUMULATIVE RAIN	RAINGAGE RAIN	CUMULATIVE RAIN	SATELLITE RAIN	CUMULATIVE RAIN
1600	----	----	0.00	----	----	----
1630	0.00	0.00	0.00	0.00	1.02	1.02
1700	0.00	0.00	0.00	0.00	2.02	3.04
1730	0.00	0.00	0.00	0.00	1.88	4.92
1800	----	----	0.00	0.00	----	----
1830	0.00	0.00	0.00	0.00	7.86	12.78
1900	0.00	0.00	0.01	0.01	5.32	18.10
1930	0.00	0.00	0.01	0.02	4.86	22.96
2000	0.00	0.00	0.01	0.03	7.92	30.88
2030	0.00	0.00	0.01	0.04	5.77	36.65
2100	----	----	0.00	0.04	----	----
2130	0.00	0.00	0.05	0.09	16.27	52.92
2200	0.00	0.00	0.02	0.11	6.38	59.30
2230	0.00	0.00	0.12	0.23	4.12	63.42
2300	0.00	0.00	0.25	0.48	2.30	65.72
2330	0.01	0.01	0.08	0.56	1.54	67.26
0000	0.01	0.02	0.01	0.57	2.80	70.06
0030	0.04	0.06	0.00	0.57	2.99	73.05
0100	0.00	0.06	0.00	0.57	2.99	76.04
0130	0.00	0.06			3.34	79.38
0200	0.00	0.06			3.17	82.55
0230	----	----			----	----
0300	0.00	0.06			3.89	86.44
0330	0.00	0.06			2.40	88.84
0400	0.00	0.06			2.29	91.13

TOTAL TARGET AREA AVERAGE RAINFALL FOR THE PERIOD 1630Z TO 0100Z

RAINGAGES (mm) $\bar{G}_T = 0.45$

SATELLITE (mm) $\bar{S}_T = 0.05$

$\bar{G}_T/\bar{S}_T = 9.0$

AREA AVERAGE RAINFALL FOR THE PERIOD 1630Z TO 0400Z

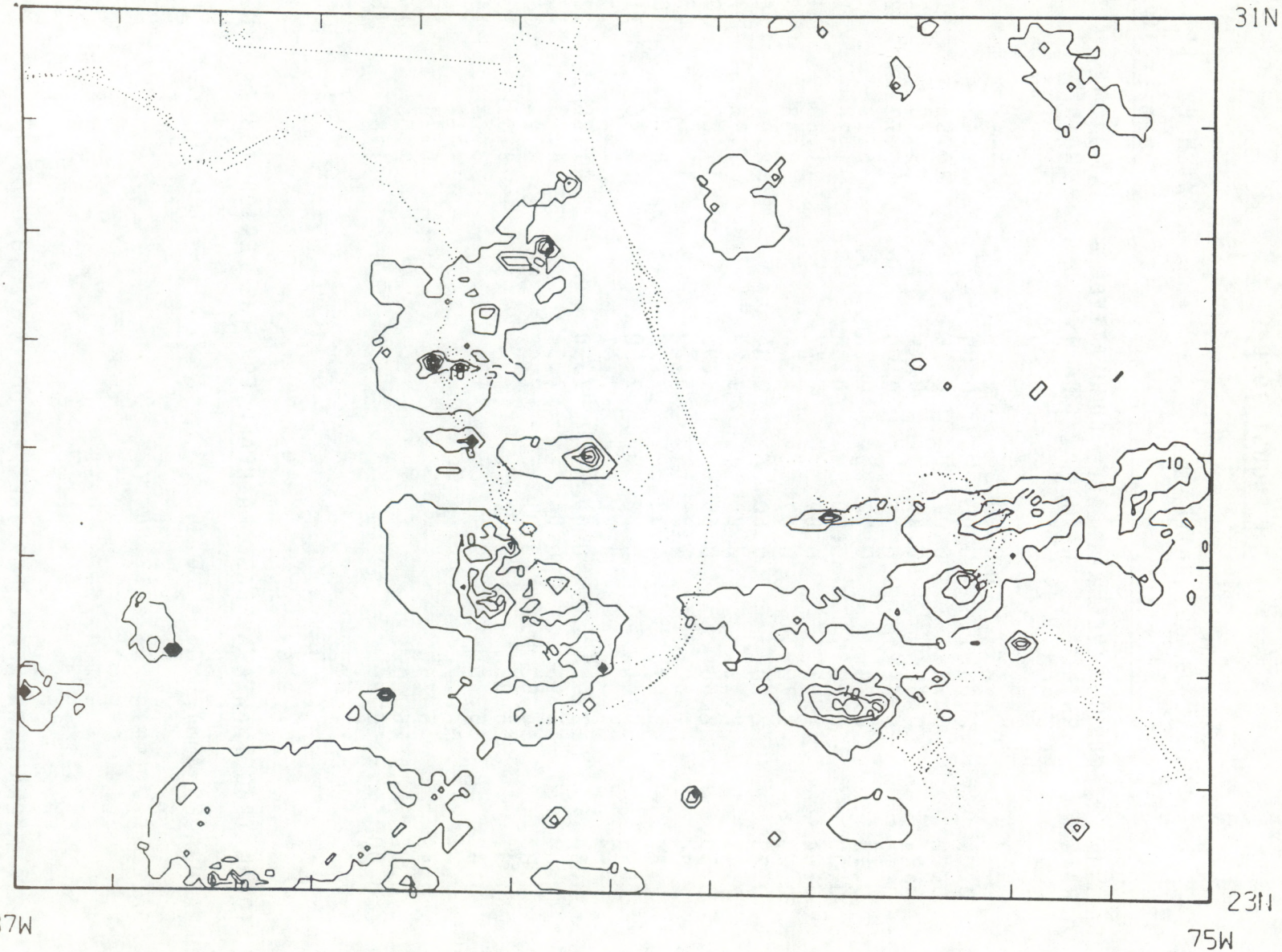
EXTENDED AREA SATELLITE (mm) $\bar{S}_E = 0.08$

TARGET AREA SATELLITE (mm) $\bar{S}_T = 0.05$

FACE SATELLITE RAINFALL

16 AUG 79

UNADJUSTED



228/1634Z-229/0404Z

18 AUGUST 1979

TIME GMT	TOTAL TARGET RAINFALL $m^3 \times 10^7$				EXTENDED AREA RAINFALL $m^3 \times 10^7$	
	SATELLITE RAIN	CUMULATIVE RAIN	RAINGAGE RAIN	CUMULATIVE RAIN	SATELLITE RAIN	CUMULATIVE RAIN
1600	----	----	0.00	----	----	----
1630	0.00	0.00	0.08	0.08	1.43	1.43
1700	0.22	0.22	0.07	0.15	10.56	11.99
1730	0.24	0.46	0.29	0.44	9.40	21.39
1800	0.15	0.61	0.16	0.60	6.73	28.12
1830	0.18	0.79	0.12	0.72	6.13	34.25
1900	0.00	0.79	0.16	0.88	1.76	36.01
1930	0.64	1.43	0.89	1.77	11.80	47.81
2000	0.29	1.72	0.67	2.44	8.43	56.24
2030	0.28	2.00	0.60	3.04	8.94	65.18
2100	0.11	2.11	0.24	3.28	7.96	73.14
2130	0.39	2.50	0.68	3.96	11.22	84.36
2200	1.80	4.30	1.83	5.79	11.62	95.98
2230	2.67	6.97	1.33	7.12	8.83	104.81
2300	2.44	9.41	0.38	7.50	9.46	114.27
2330	----	----	0.31	7.81	----	----
0000	3.54	12.95	0.09	7.90	11.88	126.15
0030	1.00	13.95	0.04	7.94	4.73	130.88
0100	0.87	14.82	0.01	7.95	5.28	136.16
0130	0.51	15.33			3.61	139.67
0200	0.42	15.75			3.73	143.40
0230	----	----			----	----
0300	0.49	16.24			6.74	150.15
0330	0.02	16.26			2.06	152.20
0400	0.00	16.26			1.88	154.08

TOTAL TARGET AREA AVERAGE RAINFALL FOR THE PERIOD 1630Z TO 0100Z

RAINGAGES (mm) G_T = 6.26

SATELLITE (mm) S_T = 12.86

G_T/S_T = 0.49

AREA AVERAGE RAINFALL FOR THE PERIOD 1630Z TO 0400Z

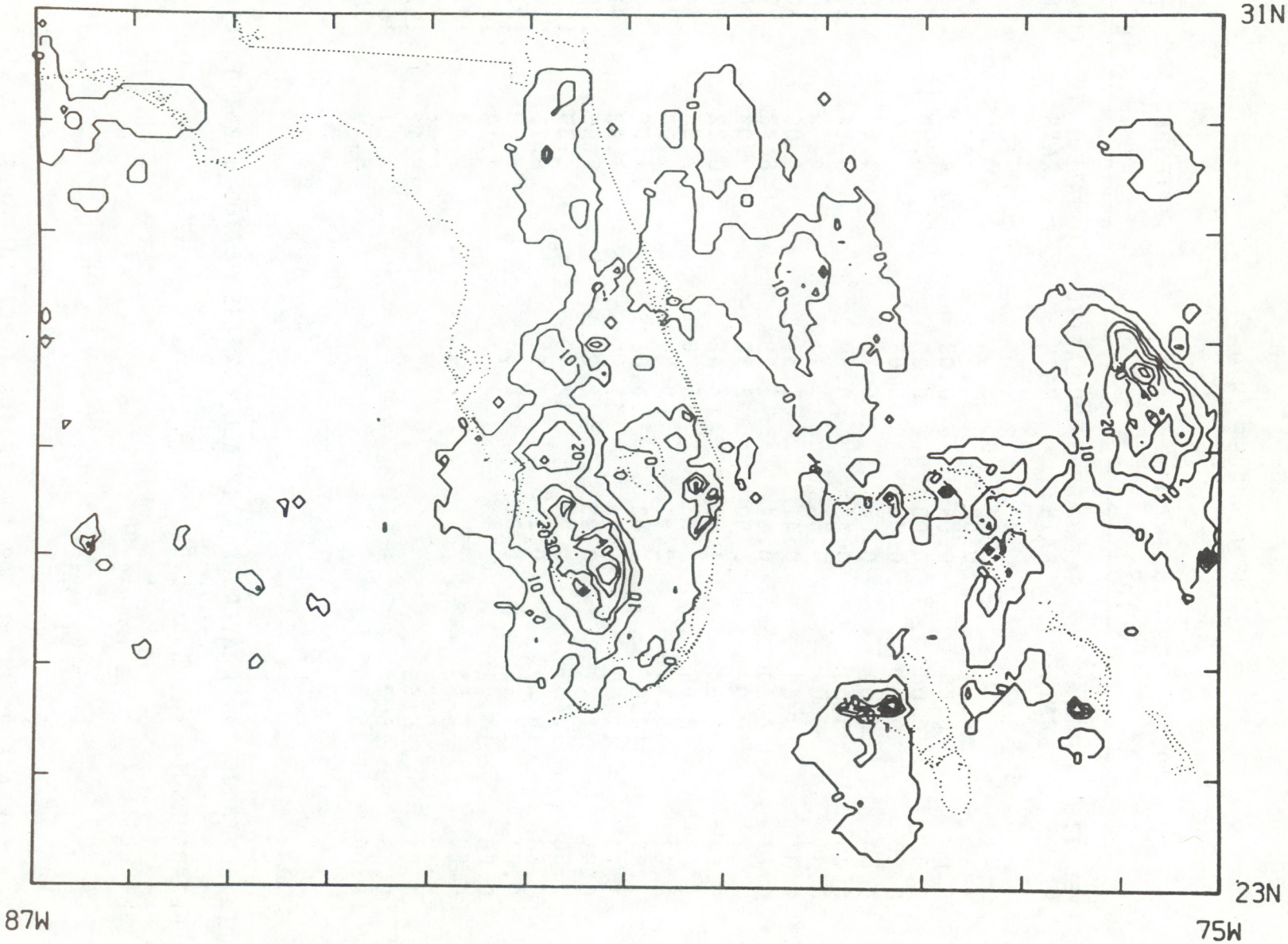
EXTENDED AREA SATELLITE (mm) S_E = 0.13

TARGET AREA SATELLITE (mm) S_T = 14.10

FACE SATELLITE RAINFALL

18 AUG 79

UNADJUSTED



230/1634Z-231/0404Z

20 AUGUST 1979

TIME GMT	TOTAL TARGET RAINFALL $m^3 \times 10^7$				EXTENDED AREA RAINFALL $m^3 \times 10^7$	
	SATELLITE RAIN	CUMULATIVE RAIN	RAINGAGE RAIN	CUMULATIVE RAIN	SATELLITE RAIN	CUMULATIVE RAIN
1600	----	----	0.00	----	----	----
1630	0.00	0.00	0.05	0.05	4.99	4.99
1700	0.00	0.00	0.00	0.05	4.88	9.87
1730	0.00	0.00	0.00	0.05	3.74	13.61
1800	0.00	0.00	0.07	0.12	4.67	18.28
1830	0.00	0.00	0.47	0.59	3.24	21.52
1900	0.31	0.31	0.54	1.13	5.19	26.71
1930	0.37	0.68	0.41	1.54	4.06	30.77
2000	0.12	0.80	0.34	1.88	6.43	37.20
2030	0.17	0.97	1.00	2.88	9.09	46.29
2100	0.57	1.54	1.57	4.45	10.32	56.61
2130	1.42	2.96	2.33	6.78	7.65	64.26
2200	2.23	5.19	2.51	9.29	6.98	21.24
2230	4.82	10.01	1.52	10.81	13.06	84.30
2300	1.49	11.50	1.04	11.85	7.92	92.22
2330	0.91	12.41	0.35	12.20	8.05	100.27
0000	1.00	13.41	0.20	12.40	8.39	108.66
0030	0.88	13.29	0.11	12.51	8.11	116.77
0100	0.87	14.16	0.02	12.53	8.60	125.37
0130	0.76	14.92			8.18	133.55
0200	0.66	15.58			8.33	141.88
0230	----	----			----	----
0300	1.07	16.65			15.12	157.00
0330	0.13	16.78			7.61	164.61
0400	0.08	16.86			6.38	170.99

TOTAL TARGET AREA AVERAGE RAINFALL FOR THE PERIOD 1630Z TO 0100Z

RAINGAGES (mm) $G_T = 9.87$

SATELLITE (mm) $S_T = 12.28$

$G_T/S_T = 0.80$

AREA AVERAGE RAINFALL FOR THE PERIOD 1630Z TO 0400Z

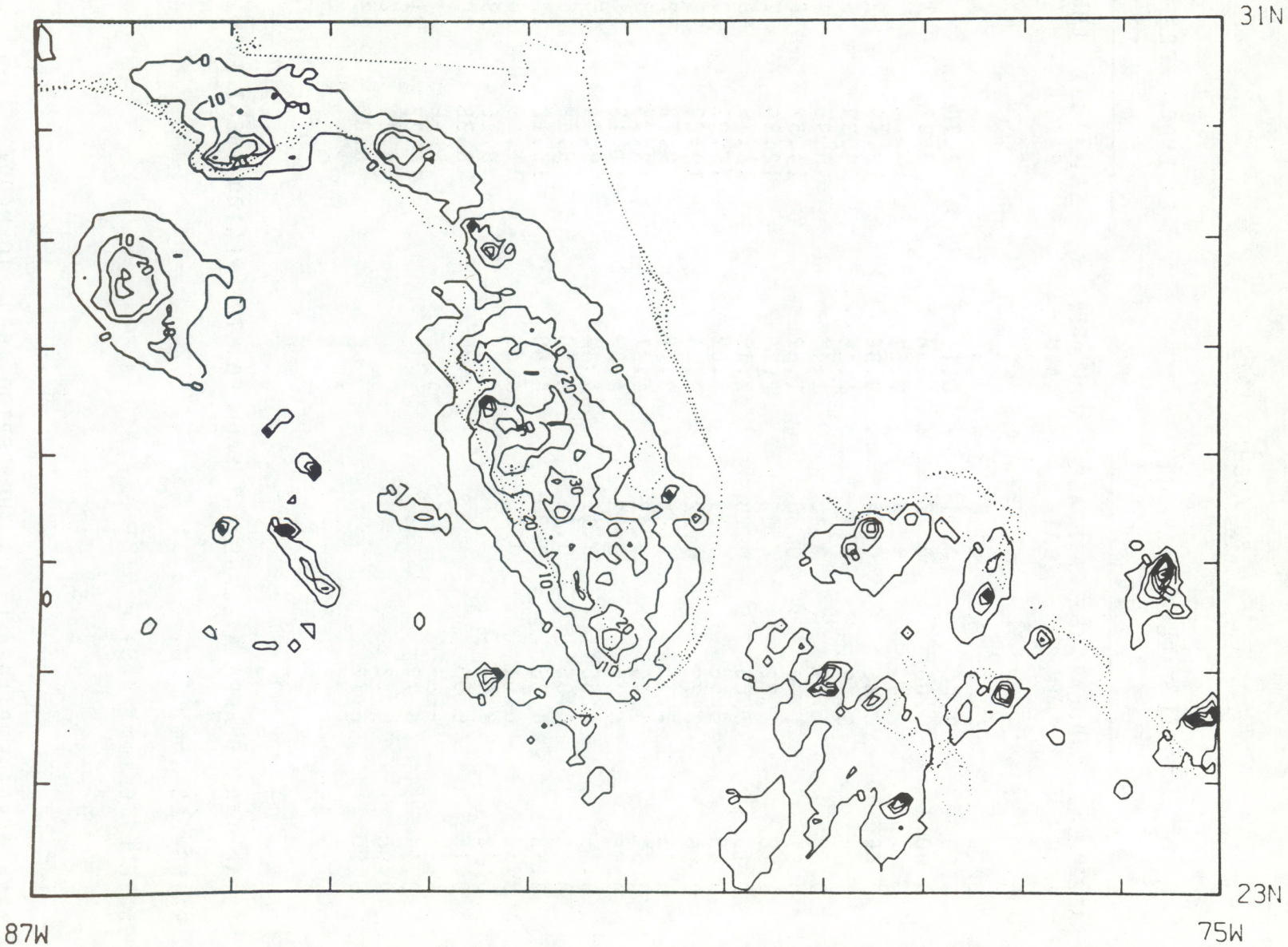
EXTENDED AREA SATELLITE (mm) $S_E = 0.14$

TARGET AREA SATELLITE (mm) $S_T = 14.63$

FACE SATELLITE RAINFALL

20 AUG 79

UNADJUSTED



232/1634Z-233/0404Z

28 AUGUST 1979

TIME GMT	TOTAL TARGET RAINFALL $m^3 \times 10^7$				EXTENDED AREA RAINFALL $m^3 \times 10^7$	
	SATELLITE RAIN	CUMULATIVE RAIN	RAINGAGE RAIN	CUMULATIVE RAIN	SATELLITE RAIN	CUMULATIVE RAIN
1600	----	----	0.00	----	----	----
1630	0.00	0.00	0.11	0.11	2.70	2.70
1700	0.00	0.00	0.27	0.38	8.02	10.72
1730	----	----	0.14	0.52	----	----
1800	0.45	0.45	0.34	0.86	18.49	29.21
1830	0.04	0.49	0.30	1.16	9.39	38.60
1900	0.58	1.07	0.28	1.44	10.95	49.55
1930	0.67	1.74	0.38	1.82	14.32	63.87
2000	0.18	1.92	0.33	2.15	12.59	76.46
2030	0.16	2.08	0.28	2.43	13.19	89.65
2100	0.48	2.56	0.59	3.02	15.27	104.92
2130	0.16	2.72	0.32	3.34	10.22	115.14
2200	0.43	3.15	0.45	3.79	9.72	124.86
2230	0.51	3.66	0.42	4.21	9.35	134.21
2300	0.55	4.21	0.12	4.33	11.13	145.34
2330	0.45	4.66	0.11	4.44	9.44	154.78
0000	0.19	4.85	0.06	4.50	9.49	164.27
0030	0.53	5.38	0.00	4.50	10.12	174.39
0100	0.63	6.01	0.00	4.50	11.69	186.08
0130	0.42	6.43			9.16	195.24
0200	0.15	6.58			8.38	203.62
0230	----	----			----	----
0300	0.14	6.72			16.22	219.84
0330	0.00	6.72			6.21	226.05
0400	0.00	6.72			6.07	232.12

TOTAL TARGET AREA AVERAGE RAINFALL FOR THE PERIOD 1630Z TO 0100Z

RAINGAGES (mm) $G_T = 3.54$

SATELLITE (mm) $S_T = 5.21$

$G_T/S_T = 0.68$

AREA AVERAGE RAINFALL FOR THE PERIOD 1630Z TO 0400Z

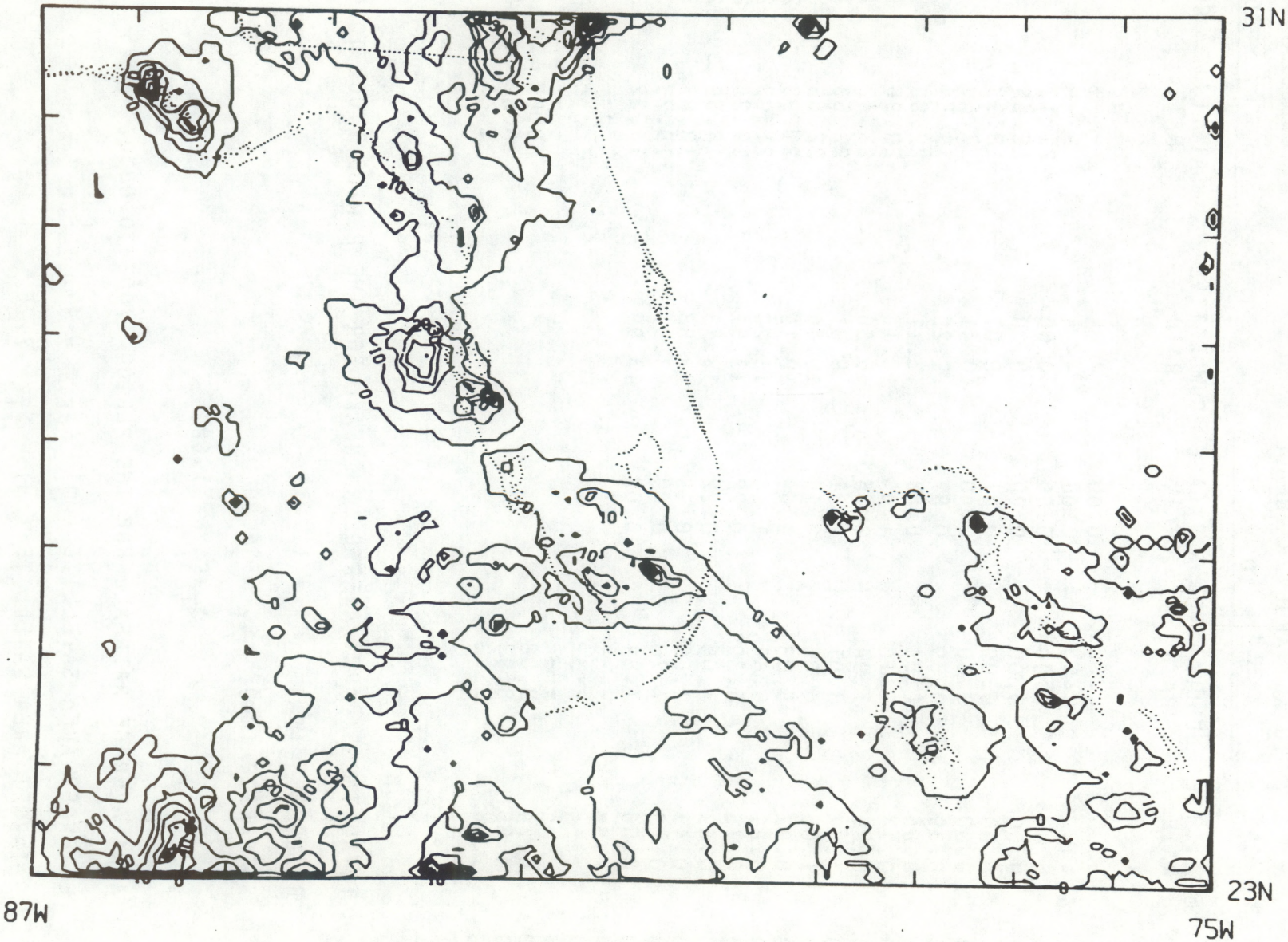
EXTENDED AREA SATELLITE (mm) $S_E = 0.20$

TARGET AREA SATELLITE (mm) $S_T = 5.83$

FACE SATELLITE RAINFALL

28 AUG 79

UNADJUSTED



240/1634Z-241/0404Z

29 AUGUST 1979

TIME GMT	TOTAL TARGET RAINFALL $m^3 \times 10^7$				EXTENDED AREA RAINFALL $m^3 \times 10^7$	
	SATELLITE RAIN	CUMULATIVE RAIN	RAINGAGE RAIN	CUMULATIVE RAIN	SATELLITE RAIN	CUMULATIVE RAIN
1600	----	----	0.00	----	----	----
1630	----	----	0.00	----	----	----
1700	0.00	0.00	0.00	0.00	21.13	21.13
1730	0.00	0.00	0.00	0.00	15.55	36.68
1800	0.00	0.00	0.01	0.01	18.93	55.61
1830	0.00	0.00	0.40	0.41	17.60	73.21
1900	0.39	0.39	0.87	1.28	19.54	92.75
1930	0.65	1.04	0.83	2.11	22.05	114.80
2000	0.14	1.18	1.04	3.15	20.96	135.76
2030	0.76	1.94	2.35	5.50	23.42	159.18
2100	1.07	3.01	2.81	8.31	23.53	182.71
2130	1.05	4.06	2.15	10.46	22.66	205.37
2200	0.97	5.03	1.69	12.15	21.99	227.36
2230	0.61	5.64	1.14	13.28	21.03	248.39
2300	0.75	6.39	0.22	13.51	19.26	267.65
2330	0.69	7.08	0.22	13.73	18.39	286.04
0000	0.47	7.55	0.15	13.88	18.83	304.87
0030	0.23	7.78	0.09	13.97	19.23	324.10
0100	0.06	7.84	0.02	13.99	16.22	340.32
0130	----	----			----	----
0200	----	----			----	----
0230	----	----			----	----
0300	0.24	8.08			60.97	401.29
0330	0.85	8.93			15.82	417.11
0400	----	----			----	----

TOTAL TARGET AREA AVERAGE RAINFALL FOR THE PERIOD 1700Z TO 0100Z

RAINGAGES (mm) $G_T = 11.01$

SATELLITE (mm) $S_T = 6.80$

$G_T/S_T = 1.62$

AREA AVERAGE RAINFALL FOR THE PERIOD 1700Z TO 0330Z

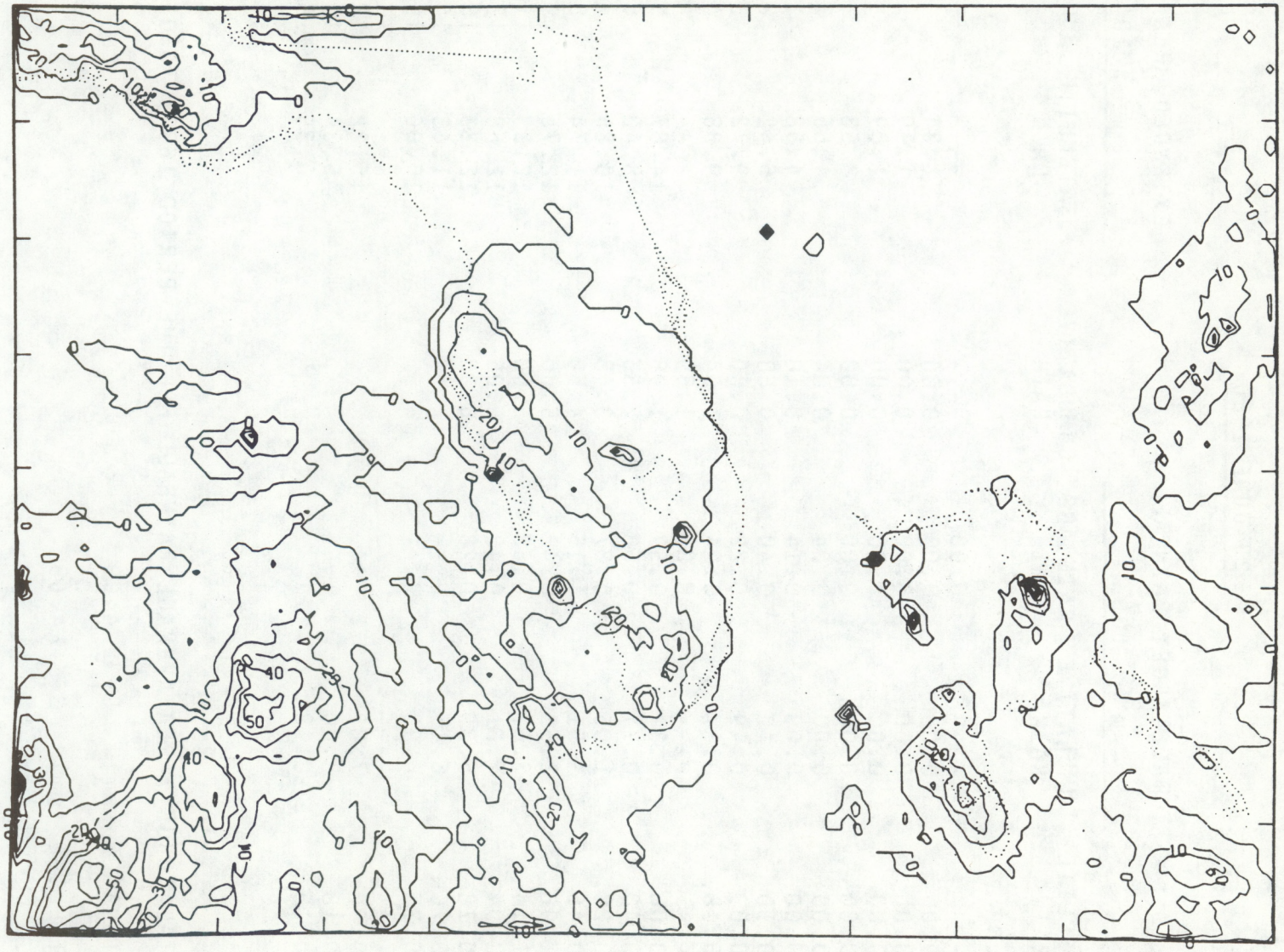
EXTENDED AREA SATELLITE (mm) $S_E = 0.35$

TARGET AREA SATELLITE (mm) $S_T = 7.75$

FACE SATELLITE RAINFALL

29 AUG 79

UNADJUSTED



241/1704Z-242/0334Z

23 JUNE 1980

TIME GMT	TOTAL TARGET RAINFALL $m^3 \times 10^7$				EXTENDED AREA RAINFALL $m^3 \times 10^7$	
	SATELLITE RAIN	CUMULATIVE RAIN	RAINGAGE RAIN	CUMULATIVE RAIN	SATELLITE RAIN	CUMULATIVE RAIN
1600	----	----	0.00	----	----	----
1630	0.00	0.00	0.00	0.00	1.34	0.34
1700	0.00	0.00	0.00	0.00	1.99	3.33
1730	0.00	0.00	0.00	0.00	1.09	4.42
1800	0.00	0.00	0.00	0.00	3.58	8.00
1830	0.00	0.00	0.04	0.04	4.65	12.65
1900	0.00	0.00	0.14	0.18	4.58	17.23
1930	0.10	0.10	0.40	0.58	5.42	22.65
2000	0.09	0.19	0.22	0.80	9.72	32.37
2030	0.18	0.37	0.24	1.04	9.38	41.75
2100	----	----	0.35	1.39	----	----
2130	0.00	0.37	0.59	1.98	14.87	56.62
2200	0.40	0.77	0.58	2.56	8.42	65.04
2230	0.28	1.05	0.87	3.43	10.26	75.30
2300	0.46	1.51	1.15	4.58	11.74	87.04
2330	1.02	2.53	0.42	5.00	12.75	99.79
0000	1.14	3.67	0.63	5.63	12.33	112.12
0030	0.94	4.61	0.42	6.05	12.68	124.80
0100	0.78	5.39	0.28	6.33	12.33	137.13
0130	0.76	6.15			11.43	148.56
0200	0.75	6.90			10.06	158.62
0230	----	----			----	----
0300	0.92	7.82			15.22	173.84
0330	0.18	8.00			5.34	179.18
0400	0.18	8.18			3.35	182.53

TOTAL TARGET AREA AVERAGE RAINFALL FOR THE PERIOD 1630Z TO 0100Z

RAINGAGES (mm) $\bar{G}_T = 4.99$

SATELLITE (mm) $\bar{S}_T = 4.68$

$\bar{G}_T/\bar{S}_T = 1.07$

AREA AVERAGE RAINFALL FOR THE PERIOD 1630Z TO 0400Z

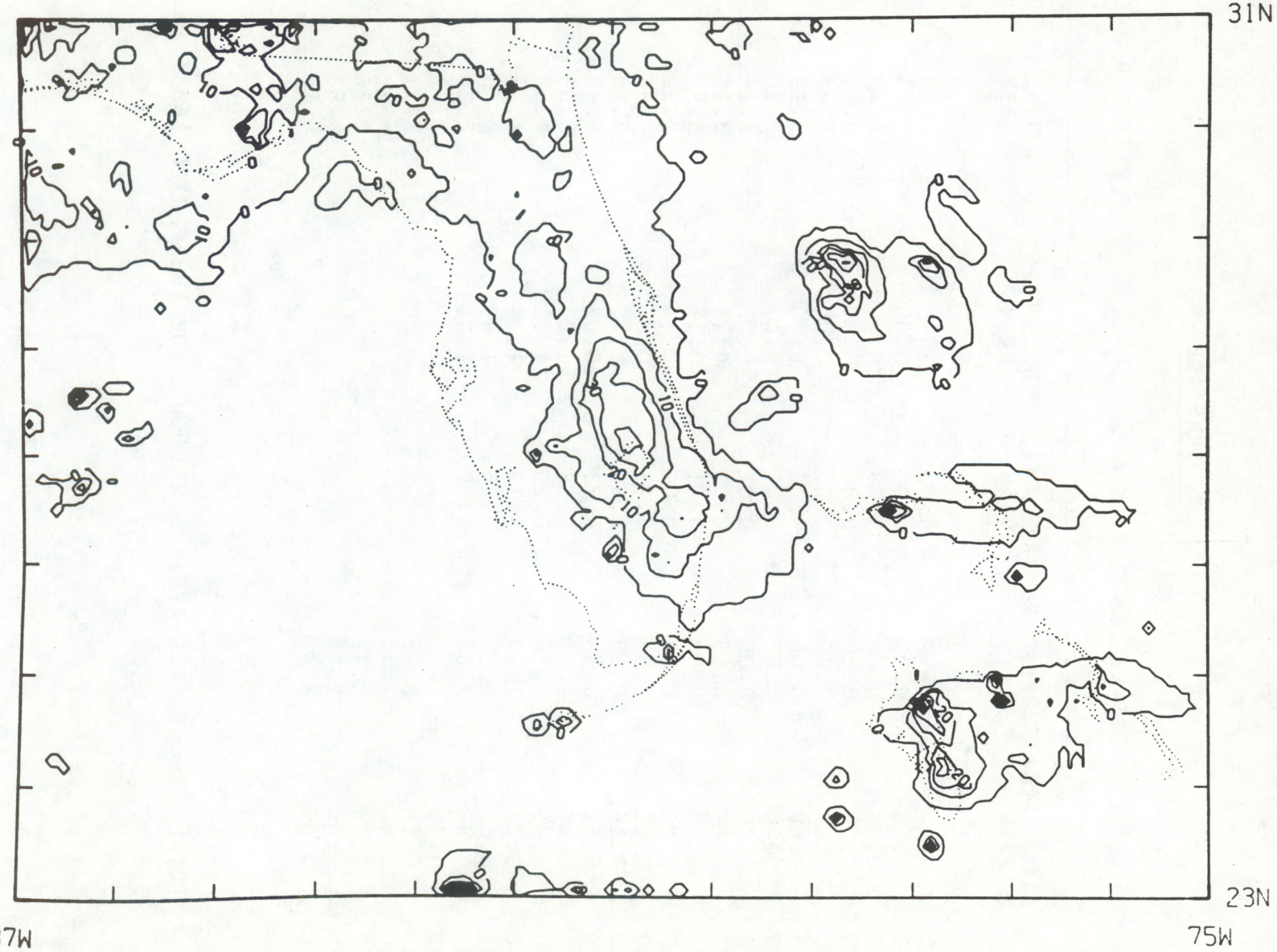
EXTENDED AREA SATELLITE (mm) $\bar{S}_E = 0.15$

TARGET AREA SATELLITE (mm) $\bar{S}_T = 7.10$

FACE SATELLITE RAINFALL

23 JUNE 80

UNADJUSTED



175/1634Z-176/0404Z

24 JUNE 1980

TIME GMT	TOTAL TARGET RAINFALL $m^3 \times 10^7$				EXTENDED AREA RAINFALL $m^3 \times 10^7$	
	SATELLITE RAIN	CUMULATIVE RAIN	RAINGAGE RAIN	CUMULATIVE RAIN	SATELLITE RAIN	CUMULATIVE RAIN
1600	----	----	0.00	----	----	----
1630	0.00	0.00	0.00	0.00	4.73	4.73
1700	0.00	0.00	0.00	0.00	7.95	12.68
1730	0.00	0.00	0.00	0.00	9.45	22.13
1800	0.00	0.00	0.00	0.00	9.85	31.98
1830	0.00	0.00	0.00	0.00	9.79	41.77
1900	0.00	0.00	0.01	0.01	7.66	49.43
1930	0.00	0.00	0.07	0.08	7.16	56.59
2000	0.00	0.00	0.03	0.11	8.18	64.77
2030	0.00	0.00	0.01	0.12	8.93	73.70
2100	0.00	0.00	0.02	0.14	7.32	81.02
2130	0.03	0.03	0.23	0.37	9.85	90.87
2200	0.15	0.18	0.33	0.70	10.40	101.27
2230	0.50	0.68	0.23	0.93	8.48	109.75
2300	0.43	1.11	0.08	1.01	5.03	114.78
2330	0.39	1.50	0.20	1.21	4.63	119.41
0000	0.44	1.94	0.13	1.34	4.07	123.48
0030	0.19	2.13	0.15	1.49	2.90	126.38
0100	0.47	2.60	0.00	1.49	2.90	129.28
0130	0.49	3.09			3.03	132.31
0200	0.19	3.28			2.11	134.42
0230	----	----			----	----
0300	0.14	3.42			2.24	136.66
0330	0.00	3.42			0.82	137.48
0400	0.00	3.42			0.15	137.63

TOTAL TARGET AREA AVERAGE RAINFALL FOR THE PERIOD 1630Z TO 0100Z

RAINGAGES (mm) $G_T = 1.17$

SATELLITE (mm) $S_T = 2.26$

$G_T/S_T = 0.52$

AREA AVERAGE RAINFALL FOR THE PERIOD 1630Z TO 0400Z

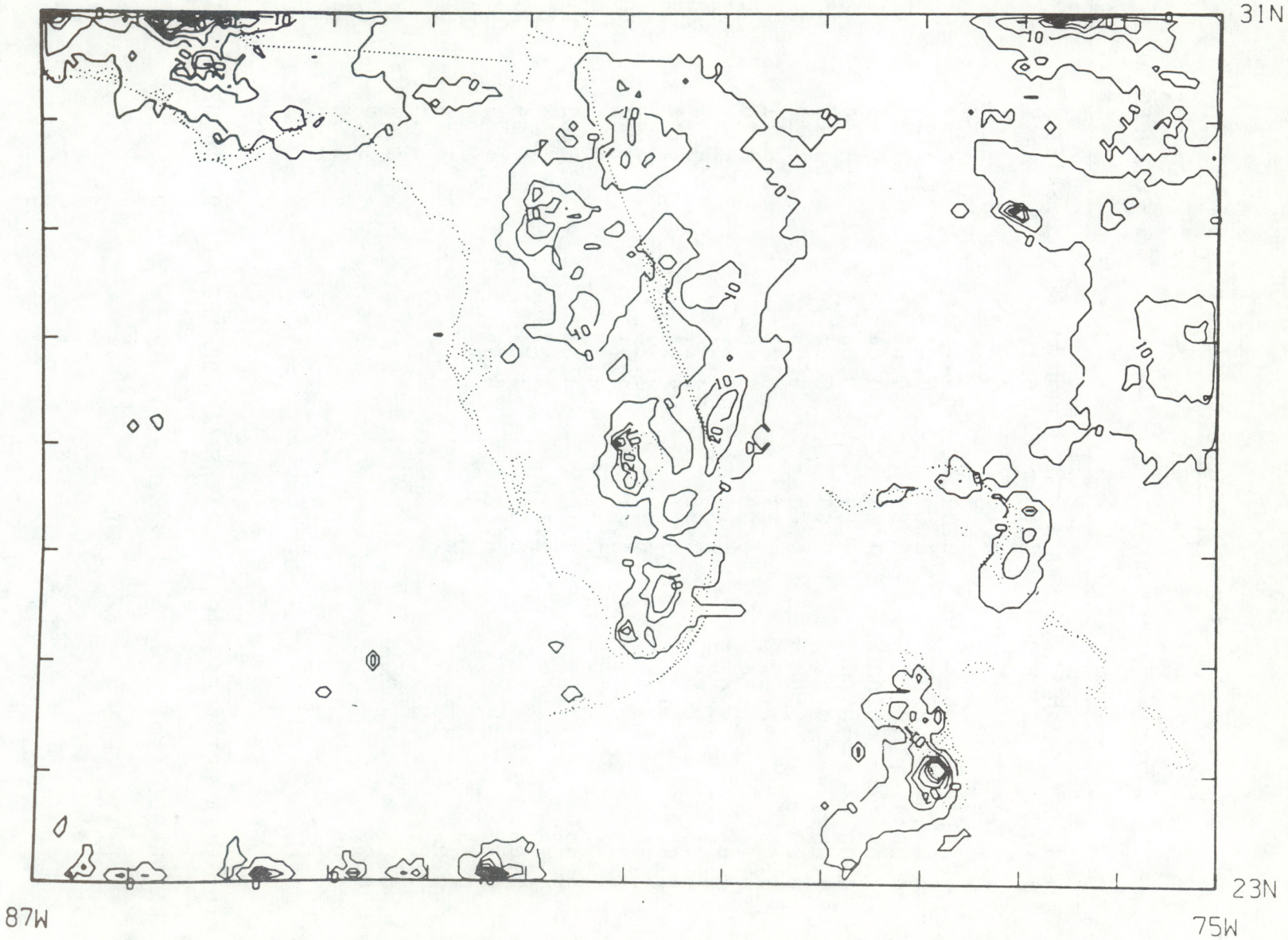
EXTENDED AREA SATELLITE (mm) $S_E = 0.12$

TARGET AREA SATELLITE (mm) $S_T = 2.97$

FACE SATELLITE RAINFALL

24 JUNE 80

UNADJUSTED



176/1634Z-177/0404Z

25 JUNE 1980

TIME GMT	TOTAL TARGET RAINFALL $m^3 \times 10^7$				EXTENDED AREA RAINFALL $m^3 \times 10^7$	
	SATELLITE RAIN	CUMULATIVE RAIN	RAINGAGE RAIN	CUMULATIVE RAIN	SATELLITE RAIN	CUMULATIVE RAIN
1600	----	----	0.00	----	----	----
1630	0.00	0.00	0.00	0.00	0.16	0.16
1700	0.00	0.00	0.00	0.00	9.31	9.47
1730	0.00	0.00	0.04	0.04	9.55	19.02
1800	0.00	0.00	0.00	0.04	10.44	29.46
1830	0.00	0.00	0.00	0.04	10.16	39.62
1900	0.00	0.00	0.00	0.04	8.12	47.74
1930	0.00	0.00	0.23	0.27	8.11	55.85
2000	0.14	0.14	0.39	0.66	8.20	64.05
2030	0.92	1.06	0.65	1.31	8.55	72.60
2100	1.49	2.55	0.96	2.27	10.36	82.96
2130	2.47	5.02	0.67	2.94	9.64	92.60
2200	2.56	7.58	0.30	3.24	8.80	101.40
2230	2.23	9.81	0.47	3.71	7.60	109.00
2300	----	----	0.52	4.23	----	----
2330	3.22	13.22	0.18	4.41	10.83	119.83
0000	1.65	14.68	0.11	4.52	7.54	127.37
0030	0.63	15.31	0.02	4.54	4.35	131.72
0100	0.37	15.68	0.02	4.56	4.37	136.09
0130	0.13	15.81			4.02	140.11
0200	0.04	15.85			3.14	143.25
0230	----	----			----	----
0300	0.05	15.90			4.54	147.79
0330	0.00				2.57	150.36
0400	0.00				1.95	152.31

TOTAL TARGET AREA AVERAGE RAINFALL FOR THE PERIOD 1630Z TO 0100Z

RAINGAGES (mm) G_T = 3.59

SATELLITE (mm) S_T = 13.60

G_T/S_T = 0.26

AREA AVERAGE RAINFALL FOR THE PERIOD 1630Z TO 0400Z

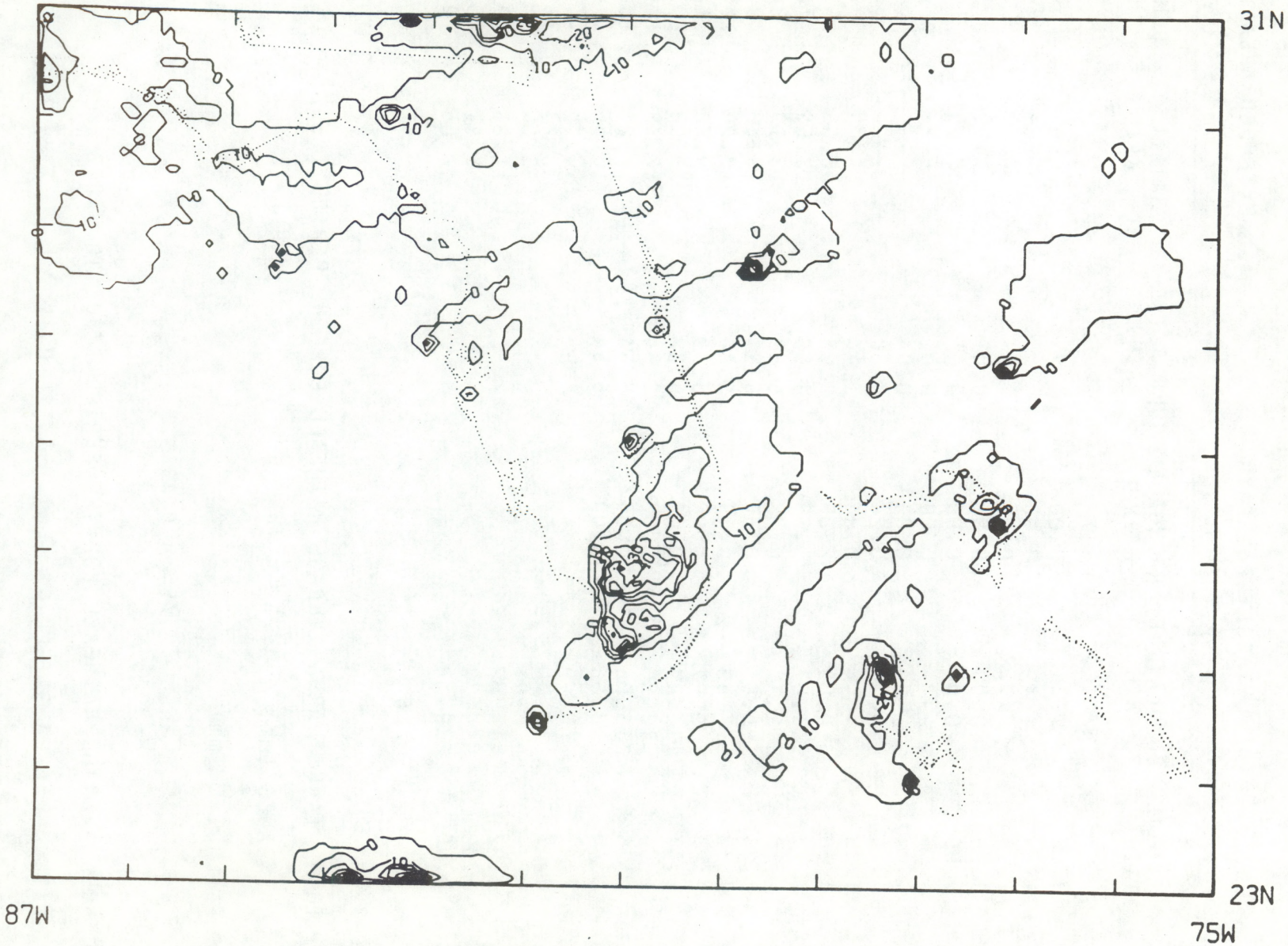
EXTENDED AREA SATELLITE (mm) S_E = 0.13

TARGET AREA SATELLITE (mm) S_T = 13.79

FACE SATELLITE RAINFALL

25 JUNE 80

UNADJUSTED



177/1634Z-178/0404Z

28 JUNE 1980

TIME GMT	TOTAL TARGET RAINFALL $m^3 \times 10^7$				EXTENDED AREA RAINFALL $m^3 \times 10^7$	
	SATELLITE RAIN	CUMULATIVE RAIN	RAINGAGE RAIN	CUMULATIVE RAIN	SATELLITE RAIN	CUMULATIVE RAIN
1600	----	----	0.00		----	----
1630	----	----	0.00		----	----
1700	----	----	0.02		----	----
1730	0.00	0.00	0.01	0.01	1.59	1.59
1800	0.00	0.00	0.00	0.01	9.09	10.68
1830	----	----	0.00	0.01	----	----
1900	----	----	0.03	0.04	----	----
1930	----	----	0.26	0.30	----	----
2000	----	----	0.84	1.14	----	----
2030	0.00	0.00	2.09	3.23	46.63	57.31
2100	1.07	1.07	1.37	4.60	13.56	70.87
2130	1.70	2.77	0.99	5.59	13.19	84.06
2200	2.24	5.01	0.62	6.21	13.58	97.64
2230	2.62	7.63	0.19	6.40	10.98	108.62
2300	2.34	9.97	0.09	6.49	9.78	118.40
2330	1.47	11.44	0.03	6.52	12.98	131.38
0000	1.06	12.50	0.02	6.54	12.78	144.16
0030	0.76	13.26	0.00	6.54	12.21	156.37
0100	0.60	13.86	0.00	6.54	10.56	166.93
0130	0.37	14.23			10.08	177.01
0200	0.07	14.30			8.24	185.25
0230	----	----			----	----
0300	0.02	14.32			11.83	197.08
0330	0.00	14.32			5.41	202.49
0400	0.00	14.32			2.85	205.34

TOTAL TARGET AREA AVERAGE RAINFALL FOR THE PERIOD 1730Z TO 0100Z

RAINGAGES (mm) $\bar{G}_T = 5.15$

SATELLITE (mm) $\bar{S}_T = 12.02$

$\bar{G}_T/\bar{S}_T = 0.43$

AREA AVERAGE RAINFALL FOR THE PERIOD 1730Z TO 0100Z

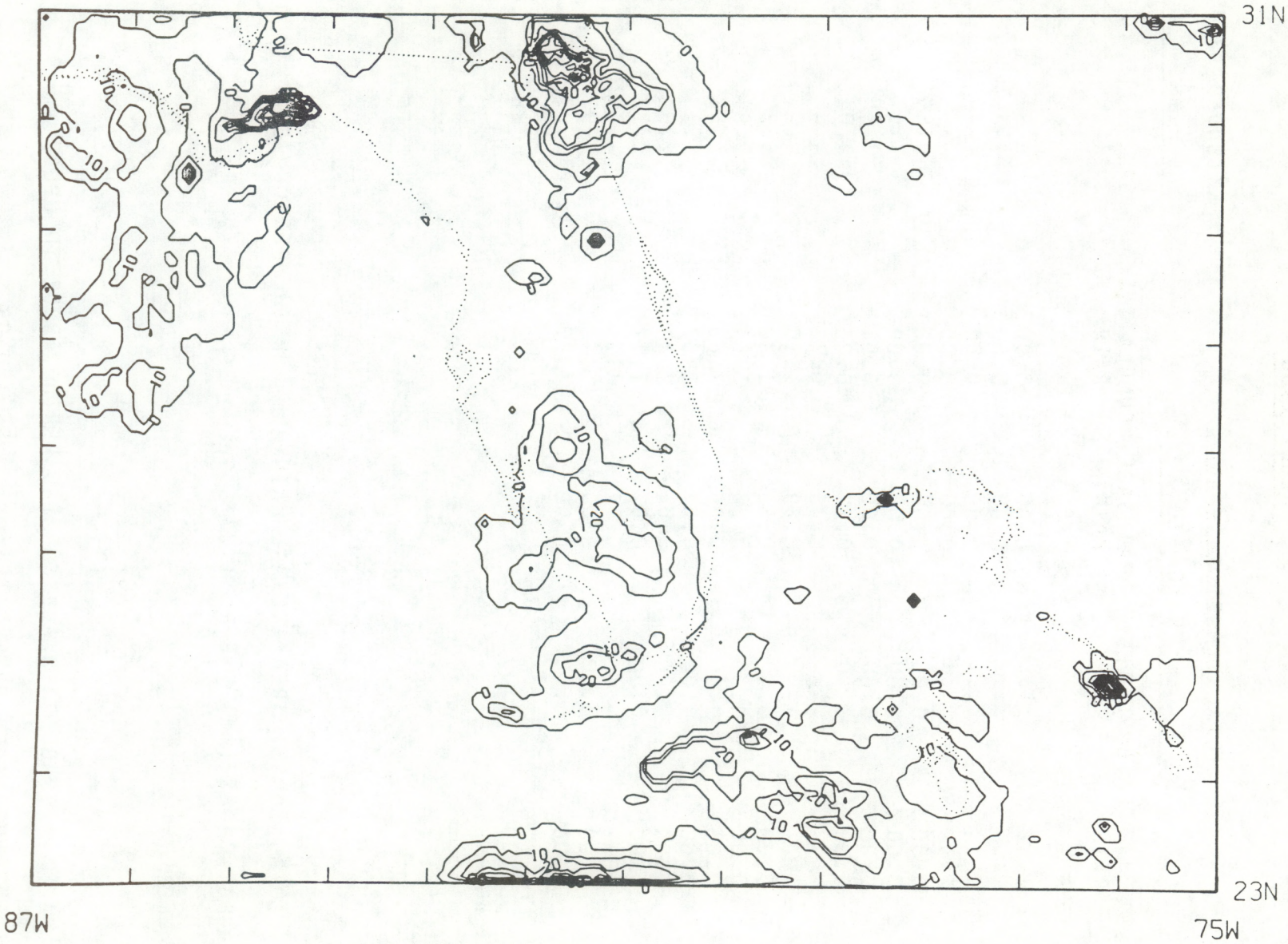
EXTENDED AREA SATELLITE (mm) $\bar{S}_E = 0.17$

TARGET AREA SATELLITE (mm) $\bar{S}_T = 12.42$

FACE SATELLITE RAINFALL

28 JUNE 80

UNADJUSTED



180/1734Z-181/0404Z

4 JULY 1980

TIME GMT	TOTAL TARGET RAINFALL $m^3 \times 10^7$				EXTENDED AREA RAINFALL $m^3 \times 10^7$	
	SATELLITE RAIN	CUMULATIVE RAIN	RAINGAGE RAIN	CUMULATIVE RAIN	SATELLITE RAIN	CUMULATIVE RAIN
1600	----	----	0.00	0.00	----	----
1630	----	----	0.00	0.00	----	----
1700	----	----	0.00	0.00	----	----
1730	----	----	0.00	0.00	----	----
1800	0.00	0.00	0.00	0.00	0.89	0.89
1830	0.00	0.00	0.00	0.00	3.67	4.56
1900	0.00	0.00	0.05	0.05	3.15	7.71
1930	0.00	0.00	0.21	0.26	3.04	10.75
2000	----	----	0.45	0.71	----	----
2030	----	----	0.39	1.10	----	----
2100	0.00	0.00	0.22	1.32	6.37	17.12
2130	0.00	0.00	0.22	1.54	1.94	19.06
2200	0.00	0.00	0.06	1.60	1.52	20.58
2230	0.00	0.00	0.07	1.67	2.19	22.77
2300	0.00	0.00	0.04	1.71	2.64	25.41
2330	0.00	0.00	0.01	1.72	1.72	27.19
0000	----	----	0.01	1.73	----	----
0030	0.00	0.00	0.00	1.73	2.91	30.10
0100	0.00	0.00	0.00	1.73	1.37	31.47
0130	----	----			----	----
0200	0.00	0.00			1.49	32.96
0230	----	----			----	----
0300	----	----			----	----
0330	----	----			----	----
0400	----	----			----	----

TOTAL TARGET AREA AVERAGE RAINFALL FOR THE PERIOD 1800Z TO 0100Z

RAINGAGES (mm) $G_T = 1.36$

SATELLITE (mm) $S_T = 0.00$

$G_T/S_T =$

AREA AVERAGE RAINFALL FOR THE PERIOD 1800Z TO 0200Z

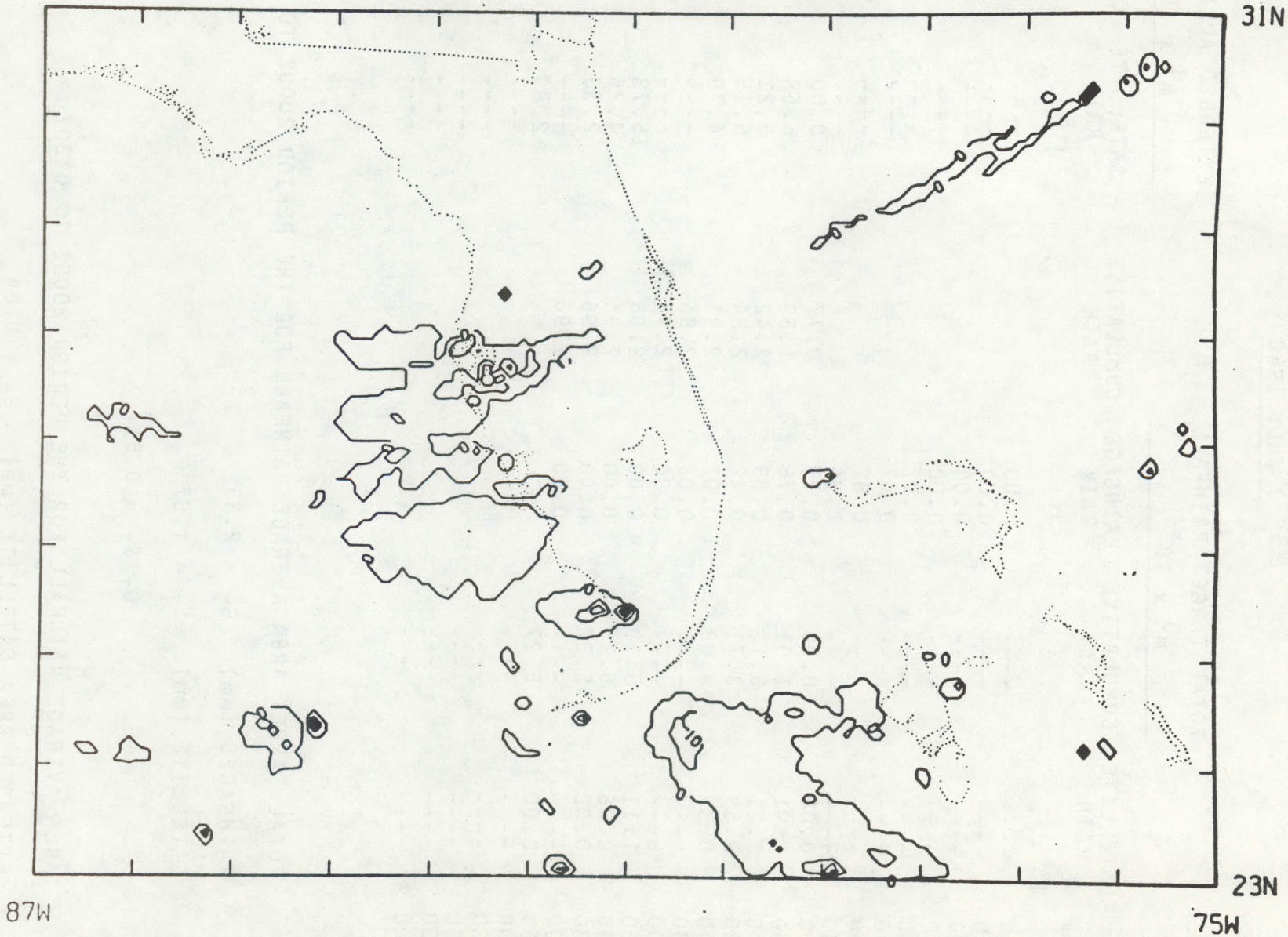
EXTENDED AREA SATELLITE (mm) $S_E = 0.03$

TARGET AREA SATELLITE (mm) $S_T = 0.00$

FACE SATELLITE RAINFALL

4 JULY 80

UNADJUSTED



186/1804Z-187/0204Z

7 JULY 1980

TIME GMT	TOTAL TARGET RAINFALL $m^3 \times 10^7$				EXTENDED AREA RAINFALL $m^3 \times 10^7$	
	SATELLITE RAIN	CUMULATIVE RAIN	RAINGAGE RAIN	CUMULATIVE RAIN	SATELLITE RAIN	CUMULATIVE RAIN
1600	----	----	0.00		----	----
1630	----	----	0.00		----	----
1700	----	----	0.00		----	----
1730	----	----	0.00		----	----
1800	----	----	0.07		----	----
1830	----	----	0.67		----	----
1900	----	----	0.82		----	----
1930	----	----	1.34		----	----
2000	0.00	0.00	0.77	0.77	0.00	0.00
2030	1.91	1.91	0.76	1.53	6.68	6.68
2100	1.21	3.12	0.89	2.42	5.21	11.89
2130	0.59	3.71	0.42	2.84	5.15	17.04
2200	0.37	4.08	0.07	2.91	4.79	21.83
2230	----	----	0.05	2.96	----	----
2300	----	----	0.00	2.96	----	----
2330	1.11	5.19	0.00	2.96	15.78	37.61
0000	0.06	5.25	0.00	2.96	4.26	41.87
0030	0.02	5.27	0.00	2.96	2.33	44.20
0100	----	----	0.00	2.96	----	----
0130	0.00	5.27			2.89	47.09
0200	----	----			----	----
0230	----	----			----	----
0300	----	----			----	----
0330	----	----			----	----
0400	----	----			----	----

TOTAL TARGET AREA AVERAGE RAINFALL FOR THE PERIOD 2000Z TO 0100Z

RAINGAGES (mm) $G_T = 2.33$

SATELLITE (mm) $S_T = 4.57$

$G_T/S_T = 0.51$

AREA AVERAGE RAINFALL FOR THE PERIOD 2000Z TO 0130Z

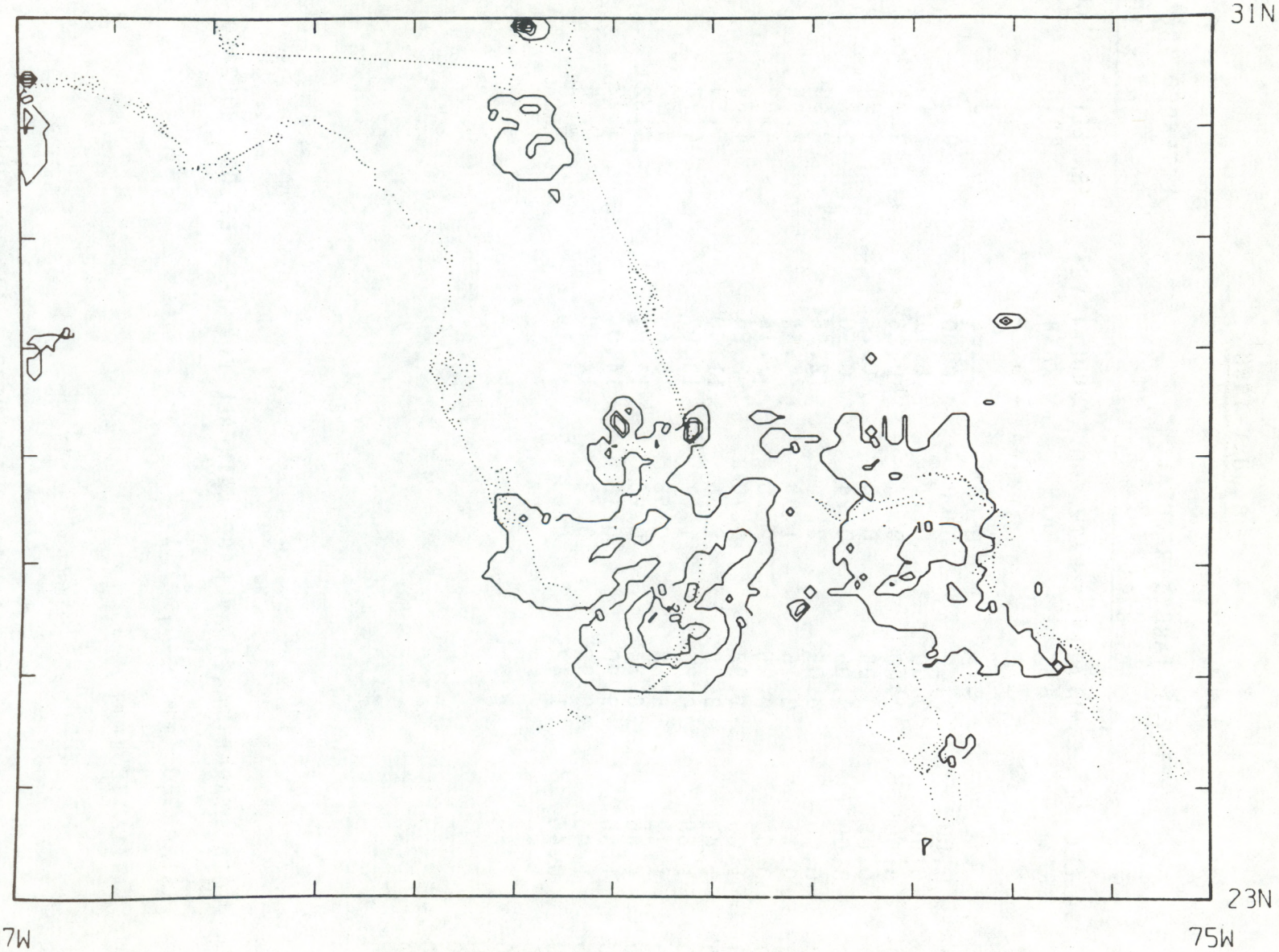
EXTENDED AREA SATELLITE (mm) $S_E = 0.04$

TARGET AREA SATELLITE (mm) $S_T = 4.57$

FACE SATELLITE RAINFALL

7 JULY 80

UNADJUSTED



189/1948Z-190/0133Z

8 JULY 1980

TIME GMT	TOTAL TARGET RAINFALL $m^3 \times 10^7$				EXTENDED AREA RAINFALL $m^3 \times 10^7$	
	SATELLITE RAIN	CUMULATIVE RAIN	RAINGAGE RAIN	CUMULATIVE RAIN	SATELLITE RAIN	CUMULATIVE RAIN
1600	----	----	0.00	----	----	----
1630	0.00	0.00	0.00	0.00	0.38	0.38
1700	0.00	0.00	0.11	0.11	1.18	1.56
1730	0.00	0.00	0.15	0.26	0.93	2.49
1800	0.05	0.05	0.00	0.26	4.36	6.85
1830	0.00	0.05	0.24	0.50	4.27	11.12
1900	0.00	0.05	2.04	2.54	2.96	14.08
1930	0.11	0.16	1.90	4.44	2.96	17.04
2000	0.69	0.85	2.70	7.14	4.02	21.06
2030	1.08	1.93	1.70	8.84	4.64	25.70
2100	1.45	3.38	2.56	11.40	5.89	31.59
2130	1.58	4.96	1.67	13.07	4.74	36.33
2200	1.72	6.68	0.58	13.65	4.92	41.25
2230	1.66	8.34	0.26	13.91	5.32	46.57
2300	1.56	9.90	0.13	14.04	5.42	51.99
2330	1.06	10.96	0.12	14.16	5.16	57.15
0000	0.46	11.42	0.03	14.19	4.78	61.93
0030	----	----			----	----
0100	----	----			----	----
0130	----	----			----	----
0200	----	----			----	----
0230	----	----			----	----
0300	----	----			----	----
0330	----	----			----	----
0400	----	----			----	----

TOTAL TARGET AREA AVERAGE RAINFALL FOR THE PERIOD 1630Z TO 0000Z

RAINGAGES (mm) $G_T = 11.17$

SATELLITE (mm) $S_T = 9.91$

$G_T/S_T = 1.13$

AREA AVERAGE RAINFALL FOR THE PERIOD 1630Z TO 0000Z

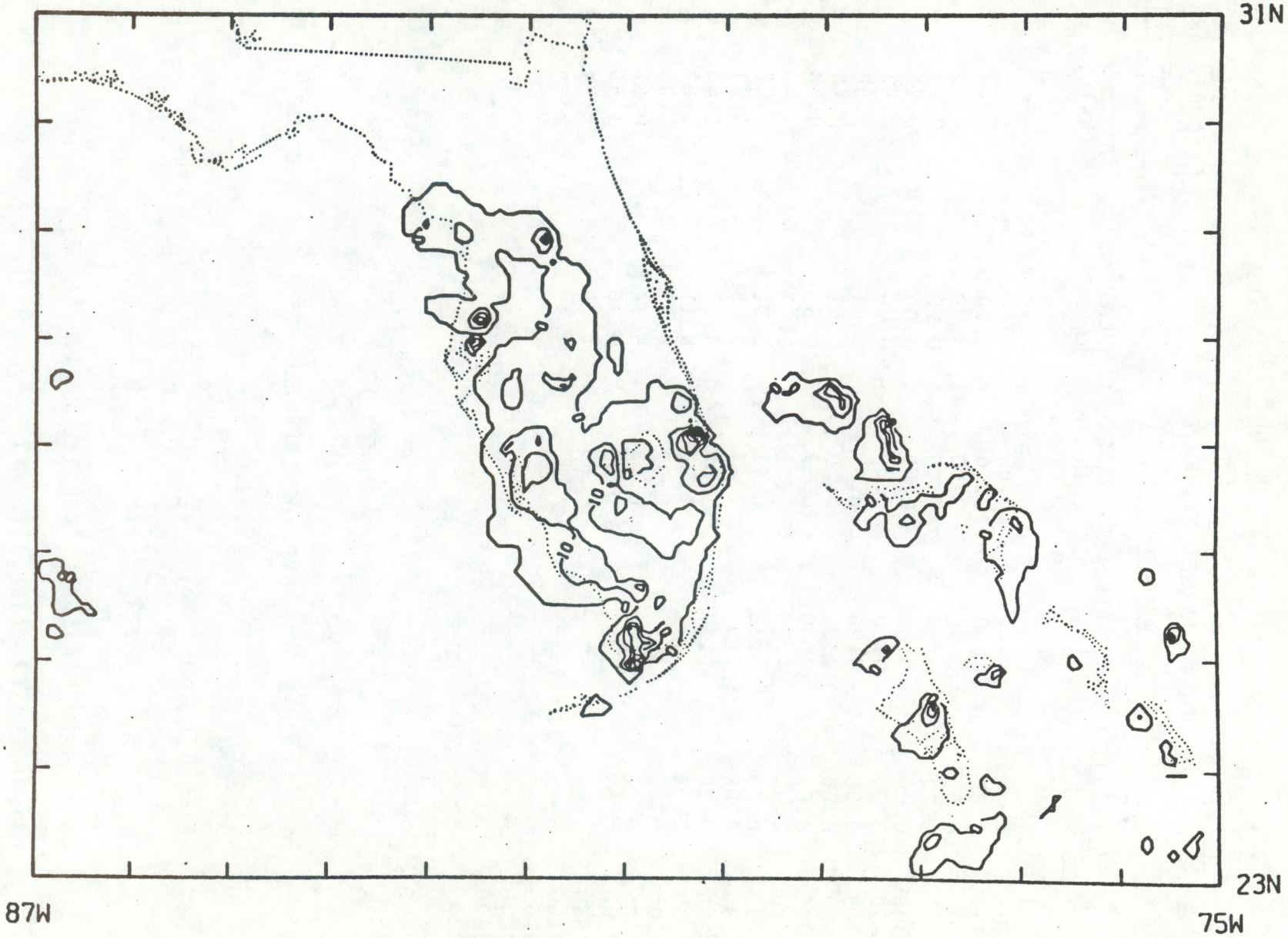
EXTENDED AREA SATELLITE (mm) $S_E = 0.05$

TARGET AREA SATELLITE (mm) $S_T = 9.91$

FACE SATELLITE RAINFALL

8 JULY 80

UNADJUSTED



190/1634Z-191/0 5Z

9 JULY 1980

TIME GMT	TOTAL TARGET RAINFALL $m^3 \times 10^7$				EXTENDED AREA RAINFALL $m^3 \times 10^7$	
	SATELLITE RAIN	CUMULATIVE RAIN	RAINGAGE RAIN	CUMULATIVE RAIN	SATELLITE RAIN	CUMULATIVE RAIN
1600	----	----	0.00	----	----	----
1630	0.00	0.00	0.00	0.00	0.53	0.53
1700	0.00	0.00	0.00	0.00	0.46	0.99
1730	0.00	0.00	0.00	0.00	0.25	1.24
1800	0.00	0.00	0.00	0.00	0.76	2.00
1830	0.00	0.00	0.00	0.00	0.63	2.63
1900	0.00	0.00	0.01	0.01	0.50	3.13
1930	0.00	0.00	0.00	0.01	0.48	4.11
2000	0.00	0.00	0.37	0.38	0.98	5.09
2030	----	----	1.01	1.39	----	----
2100	0.35	0.35	0.93	2.32	2.26	7.35
2130	0.02	0.37	0.73	3.05	0.34	7.69
2200	0.20	0.57	1.02	4.07	1.63	9.32
2230	0.54	1.11	1.04	5.11	1.61	10.93
2300	0.22	1.33	0.39	5.50	0.98	11.91
2330	0.28	1.61	0.24	5.74	0.62	12.53
0000	0.24	1.85	0.02	5.76	1.40	13.93
0030	----	----	0.00	5.76	----	----
0100	----	----			----	----
0130	----	----			----	----
0200	----	----			----	----
0230	----	----			----	----
0300	----	----			----	----
0330	----	----			----	----
0400	----	----			----	----

TOTAL TARGET AREA AVERAGE RAINFALL FOR THE PERIOD 1630Z TO 0000Z

RAINGAGES (mm) $G_T = 4.54$

SATELLITE (mm) $S_T = 1.60$

$G_T/S_T = 2.83$

AREA AVERAGE RAINFALL FOR THE PERIOD 1630Z TO 0000Z

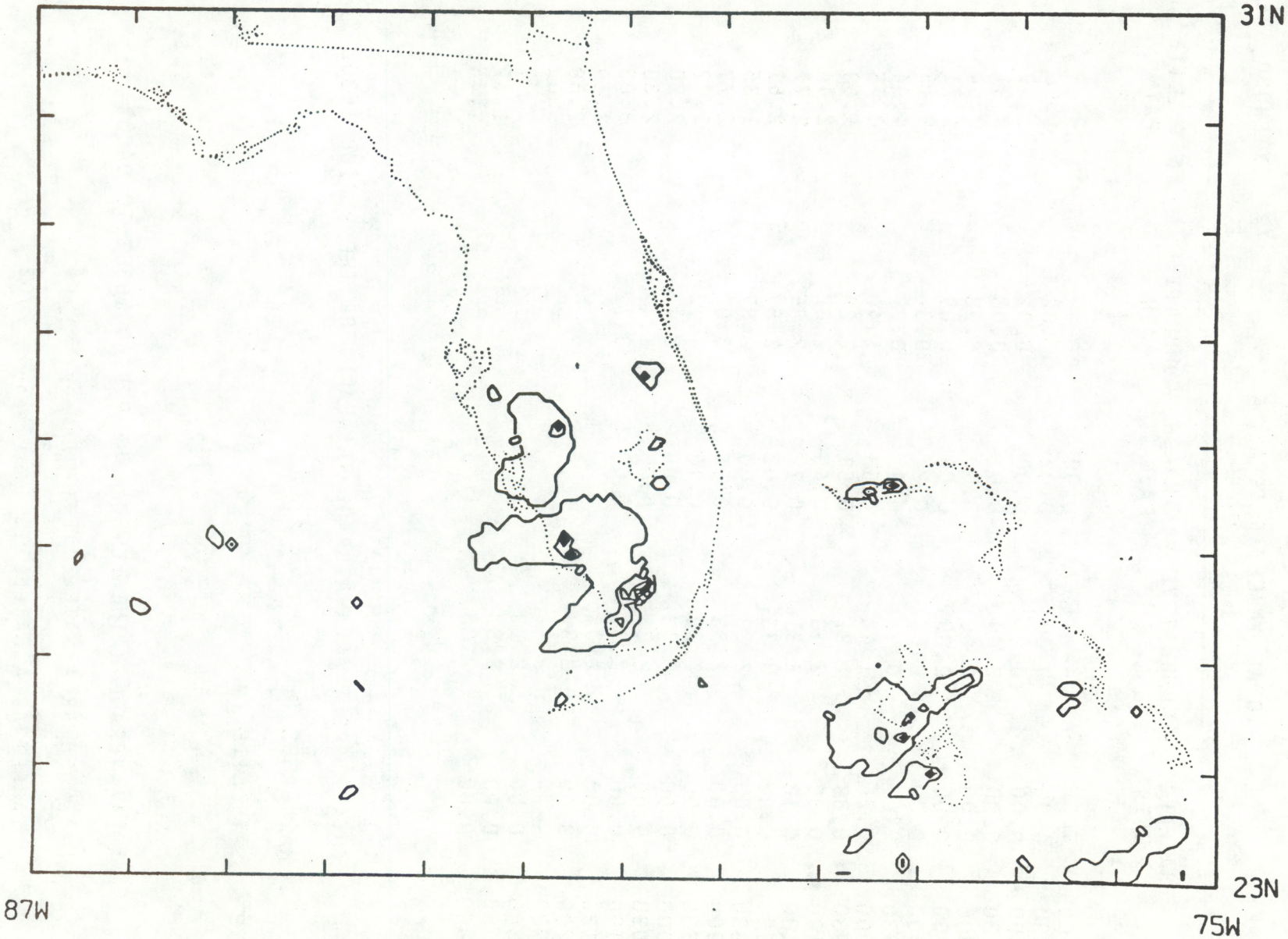
EXTENDED AREA SATELLITE (mm) $S_E = 0.01$

TARGET AREA SATELLITE (mm) $S_T = 1.60$

FACE SATELLITE RAINFALL

9 JULY 80

UNADJUSTED



191/1634Z-192/0 5Z

10 JULY 1980

TIME GMT	TOTAL TARGET RAINFALL $m^3 \times 10^7$				EXTENDED AREA RAINFALL $m^3 \times 10^7$	
	SATELLITE RAIN	CUMULATIVE RAIN	RAINGAGE RAIN	CUMULATIVE RAIN	SATELLITE RAIN	CUMULATIVE RAIN
1600	----	----	0.00	----	----	----
1630	0.00	0.00	0.02	0.02	1.06	1.06
1700	0.00	0.00	0.00	0.02	1.19	2.25
1730	0.00	0.00	0.01	0.03	0.91	3.16
1800	0.00	0.00	0.00	0.03	0.54	3.70
1830	0.00	0.00	0.06	0.09	1.71	5.41
1900	0.00	0.00	0.27	0.36	2.13	7.54
1930	0.67	0.67	0.41	0.77	4.04	11.58
2000	0.76	1.43	0.63	1.40	3.45	15.03
2030	0.38	1.81	0.88	2.28	1.63	16.66
2100	0.32	2.13	0.40	2.68	2.44	19.10
2130	0.18	2.31	0.17	2.85	2.77	21.87
2200	0.02	2.33	0.02	2.87	2.51	24.38
2230	0.00	2.33	0.00	2.87	1.35	25.73
2300	0.00	2.33	0.15	3.02	2.77	28.50
2330	0.00	2.33	0.10	3.12	1.72	30.22
0000	0.00	2.33	0.00	3.12	2.20	32.42
0030	0.00	2.33	0.00	3.12	2.30	34.72
0100	0.00	2.33	0.00	3.12	3.03	37.75
0130	0.00	2.33			3.19	40.94
0200	0.00	2.33			2.69	43.63
0230	----	----			----	----
0300	0.00	2.33			5.77	49.40
0330	0.00	2.33			1.32	50.72
0400	0.00	2.33			1.46	52.18

TOTAL TARGET AREA AVERAGE RAINFALL FOR THE PERIOD 1630Z TO 0100Z

RAINGAGES (mm) $G_T = 2.46$

SATELLITE (mm) $S_T = 2.02$

$G_T/S_T = 1.22$

AREA AVERAGE RAINFALL FOR THE PERIOD 1630Z TO 0400Z

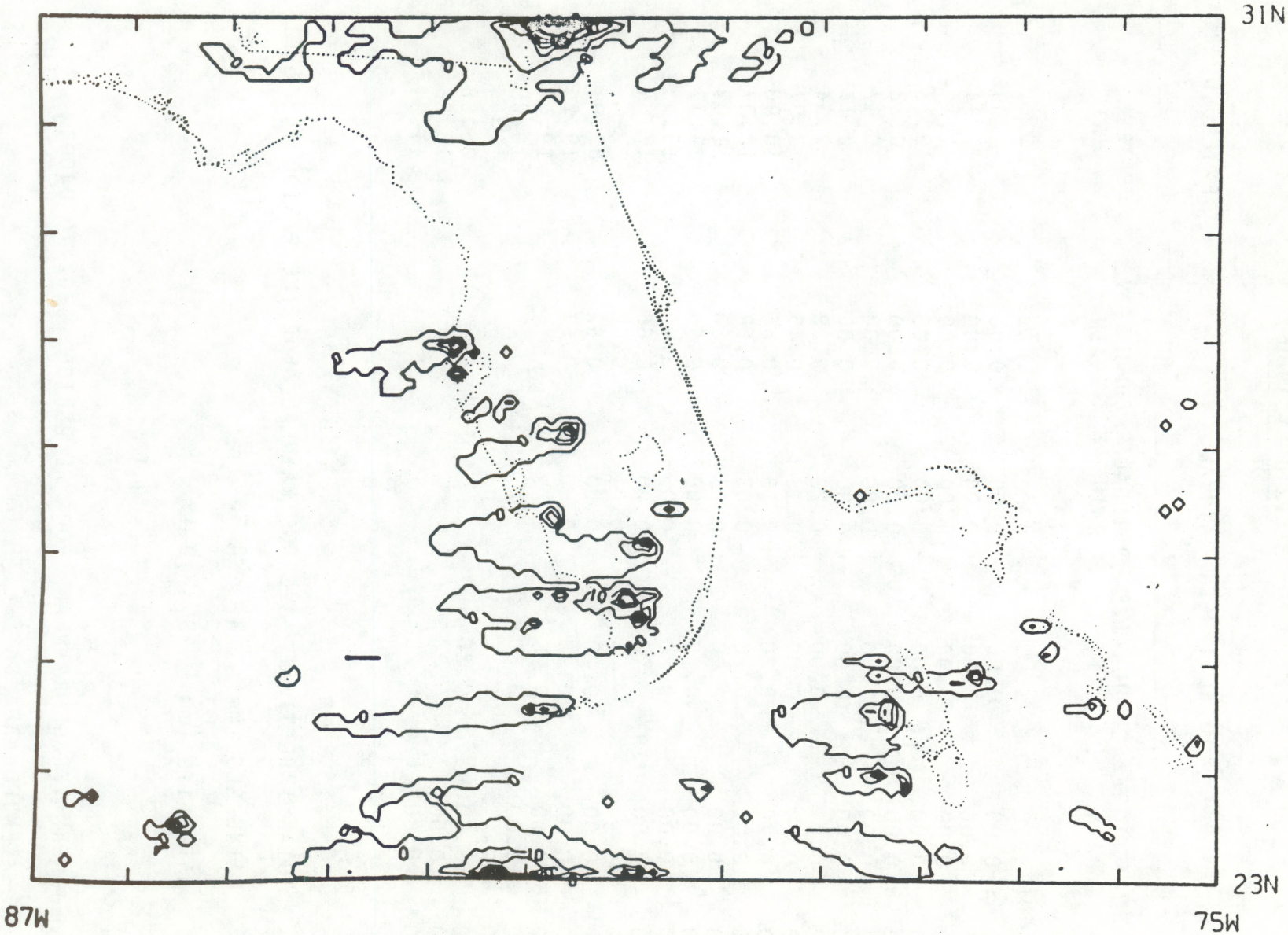
EXTENDED AREA SATELLITE (mm) $S_E = 0.04$

TARGET AREA SATELLITE (mm) $S_T = 2.02$

FACE SATELLITE RAINFALL

10 JULY 80

UNADJUSTED



192/1634Z-193/0404Z

12 JULY 1980

TIME GMT	TOTAL TARGET RAINFALL $m^3 \times 10^7$				EXTENDED AREA RAINFALL $m^3 \times 10^7$	
	SATELLITE RAIN	CUMULATIVE RAIN	RAINGAGE RAIN	CUMULATIVE RAIN	SATELLITE RAIN	CUMULATIVE RAIN
1600	----	----	0.00	----	----	----
1630	0.00	0.00	0.00	0.00	.09	.09
1700	0.00	0.00	0.00	0.00	1.44	1.53
1730	0.00	0.00	0.00	0.00	1.14	2.67
1800	0.00	0.00	0.00	0.00	0.33	3.00
1830	0.00	0.00	0.00	0.00	0.32	3.32
1900	0.00	0.00	0.00	0.00	0.47	3.79
1930	0.00	0.00	0.00	0.00	2.11	5.90
2000	0.00	0.00	0.28	0.28	2.04	7.94
2030	0.00	0.00	0.15	0.43	3.97	11.91
2100	0.20	0.20	0.13	0.56	10.90	22.81
2130	0.00	0.20	0.03	0.59	12.37	35.18
2200	0.00	0.20	0.01	0.60	11.03	46.21
2230	0.00	0.20	0.00	0.60	24.77	70.98
2300	0.00	0.20	0.06	0.66	15.53	86.51
2330	0.00	0.20	0.00	0.66	17.84	104.35
0000	----	----	0.01	0.67	----	----
0030	0.00	0.20	0.00	0.67	37.91	142.26
0100	0.00	0.20	0.00	0.67	19.25	161.51
0130	0.00	0.20			19.64	181.15
0200	0.00	0.20			19.28	200.43
0230	----	----			----	----
0300	0.00	0.20			36.58	237.01
0330	0.00	0.20			13.95	250.96
0400	0.00	0.20			11.81	262.77

TOTAL TARGET AREA AVERAGE RAINFALL FOR THE PERIOD 1630Z TO 0100Z

RAINGAGES (mm) $G_T = 0.53$

SATELLITE (mm) $S_T = 0.17$

$G_T/S_T = 3.12$

AREA AVERAGE RAINFALL FOR THE PERIOD 1630Z TO 0400Z

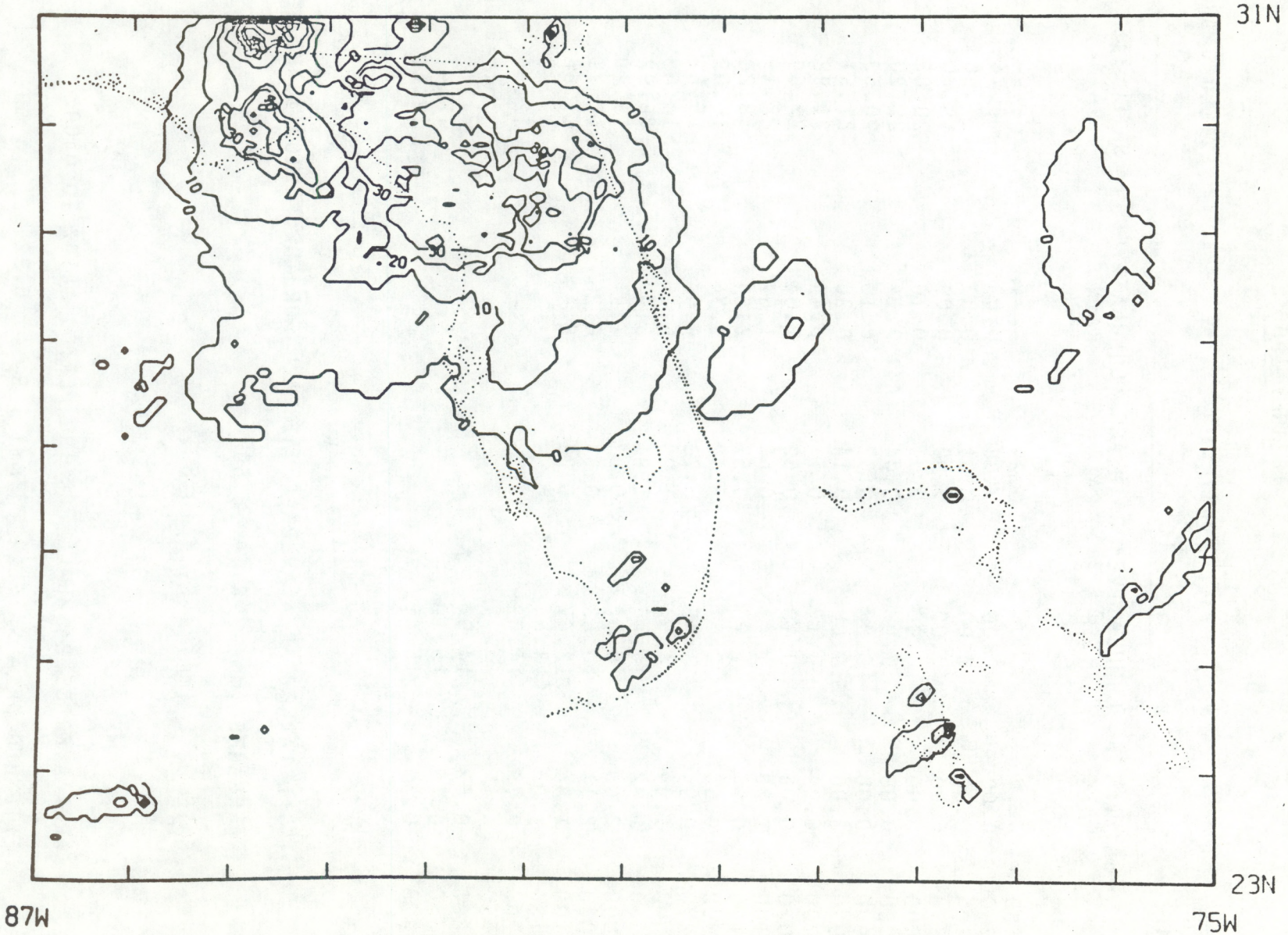
EXTENDED AREA SATELLITE (mm) $S_E = 0.22$

TARGET AREA SATELLITE (mm) $S_T = 0.17$

FACE SATELLITE RAINFALL

12 JULY 80

UNADJUSTED



194/1634Z-195/0404Z

16 JULY 1980

TIME GMT	TOTAL TARGET RAINFALL $m^3 \times 10^7$				EXTENDED AREA RAINFALL $m^3 \times 10^7$	
	SATELLITE RAIN	CUMULATIVE RAIN	RAINGAGE RAIN	CUMULATIVE RAIN	SATELLITE RAIN	CUMULATIVE RAIN
1600	----	----	0.29	----	----	----
1630	0.00	0.00	0.08	0.08	0.74	0.74
1700	0.00	0.00	0.01	0.09	17.50	18.24
1730	0.00	0.00	0.00	0.09	18.40	36.64
1800	0.00	0.00	0.01	0.10	20.03	56.67
1830	0.08	0.08	0.04	0.14	22.20	78.87
1900	0.00	0.08	0.02	0.16	20.53	99.40
1930	0.00	0.08	0.14	0.30	21.51	120.91
2000	0.04	0.12	0.14	0.44	21.98	142.89
2030	0.06	0.18	0.60	1.04	22.69	165.58
2100	1.23	1.41	0.63	1.67	22.19	187.77
2130	0.54	1.95	0.57	2.24	18.28	206.05
2200	0.66	2.61	1.12	3.36	16.99	223.04
2230	0.84	3.45	0.71	4.07	15.62	238.66
2300	1.09	4.54	1.09	5.16	14.68	253.34
2330	1.92	6.46	1.81	6.97	16.92	270.26
0000	2.06	8.52	0.97	7.94	13.79	284.05
0030	2.11	10.63	0.34	8.28	12.71	296.76
0100	1.84	12.47	0.21	8.49	11.66	308.42
0130	1.07	13.54			9.22	317.64
0200	0.78	14.32			12.56	330.20
0230	----	----			----	----
0300	0.62	14.94			21.74	351.94
0330	0.16	15.10			12.41	364.35
0400	0.39	15.49			12.62	376.97

TOTAL TARGET AREA AVERAGE RAINFALL FOR THE PERIOD 1630Z TO 0100Z

RAINGAGES (mm) G_T = 6.69

SATELLITE (mm) S_T = 10.82

G_T/S_T = 0.62

AREA AVERAGE RAINFALL FOR THE PERIOD 1630Z TO 0400Z

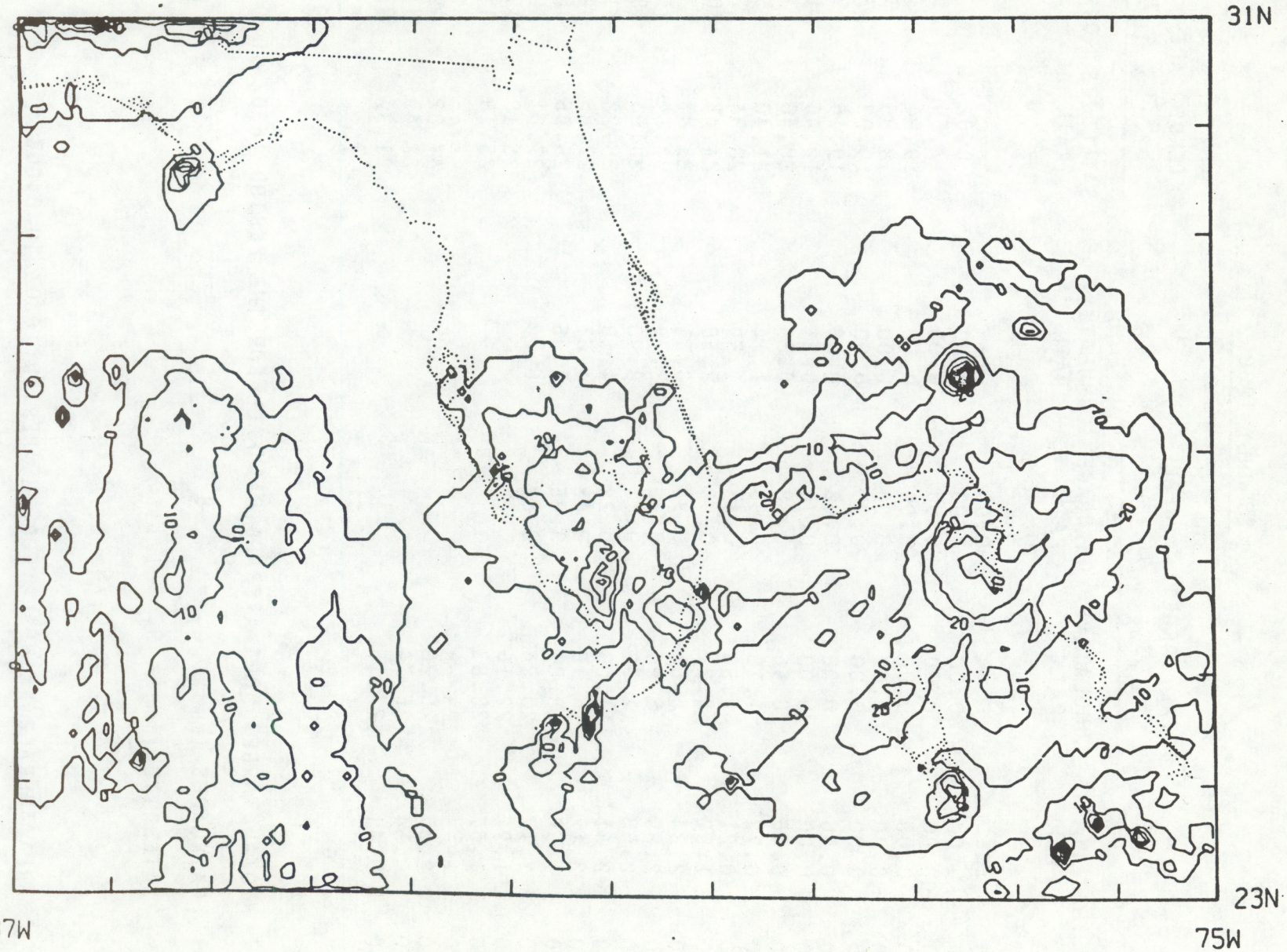
EXTENDED AREA SATELLITE (mm) S_E = 0.32

TARGET AREA SATELLITE (mm) S_T = 13.44

FACE SATELLITE RAINFALL

16 JULY 80

UNADJUSTED



198/1634Z-199/0404Z

25 JULY 1980

TIME GMT	TOTAL TARGET RAINFALL $m^3 \times 10^7$				EXTENDED AREA RAINFALL $m^3 \times 10^7$	
	SATELLITE RAIN	CUMULATIVE RAIN	RAINGAGE RAIN	CUMULATIVE RAIN	SATELLITE RAIN	CUMULATIVE RAIN
1600	----	----	0.00	----	----	----
1630	0.00	0.00	0.00	0.00	0.02	0.02
1700	0.00	0.00	0.00	0.00	17.59	17.61
1730	0.00	0.00	0.00	0.00	19.94	37.55
1800	0.00	0.00	0.00	0.00	18.85	56.40
1830	0.00	0.00	0.00	0.00	19.03	75.43
1900	0.00	0.00	0.03	0.03	19.16	94.59
1930	0.00	0.00	0.18	0.21	19.96	114.55
2000	0.46	0.46	0.38	0.59	20.40	134.95
2030	0.72	1.18	0.55	1.14	21.40	156.35
2100	0.21	1.39	0.45	1.59	23.34	179.69
2130	1.82	3.21	0.99	2.58	24.45	204.14
2200	2.84	6.05	0.93	3.51	25.83	229.97
2230	2.89	8.94	0.28	3.79	27.59	257.56
2300	2.58	11.52	0.11	3.90	28.04	285.60
2330	2.51	14.03	0.28	4.18	28.22	313.82
0000	2.12	16.15	0.43	4.61	27.85	341.67
0030	1.92	18.07	0.85	5.46	25.95	367.62
0100	2.17	20.24	0.87	6.33	27.91	395.53
0130	1.92	22.16			25.10	420.63
0200	1.67	23.83			25.18	445.81
0230	----	----			----	----
0300	2.37	26.20			47.82	493.63
0330	0.54	26.74			22.49	516.12
0400	0.41	27.15			21.37	537.49

TOTAL TARGET AREA AVERAGE RAINFALL FOR THE PERIOD 1630Z TO 0100Z

RAINGAGES (mm) G_T = 4.98

SATELLITE (mm) S_T = 17.56

G_T/S_T = 0.28

AREA AVERAGE RAINFALL FOR THE PERIOD 1630Z TO 0400Z

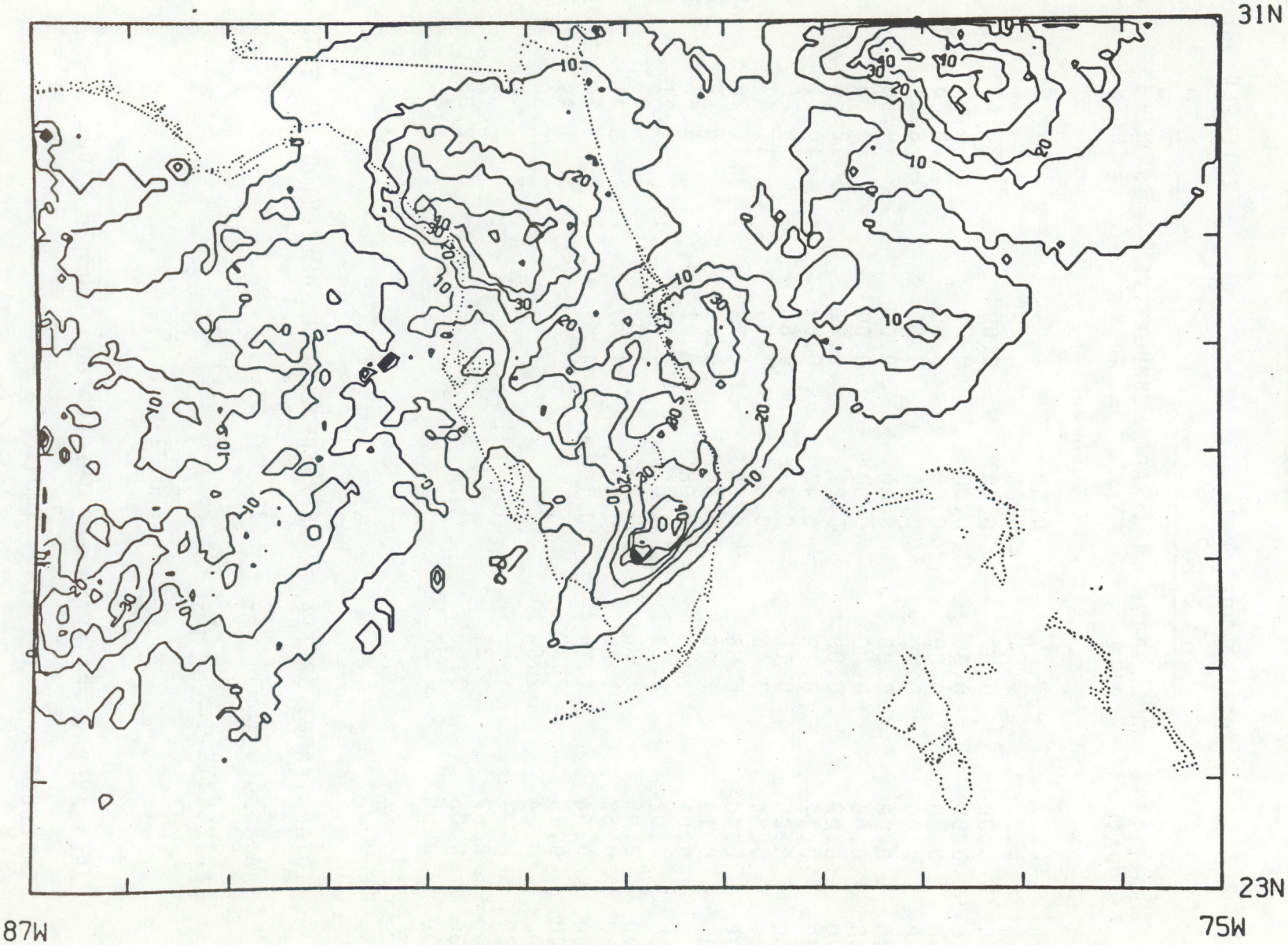
EXTENDED AREA SATELLITE (mm) S_E = 0.45

TARGET AREA SATELLITE (mm) S_T = 23.55

FACE SATELLITE RAINFALL

25 JULY 80

UNADJUSTED



207/1634Z-208/0404Z

29 JULY 1980

TIME GMT	TOTAL TARGET RAINFALL $m^3 \times 10^7$				EXTENDED AREA RAINFALL $m^3 \times 10^7$	
	SATELLITE RAIN	CUMULATIVE RAIN	RAINGAGE RAIN	CUMULATIVE RAIN	SATELLITE RAIN	CUMULATIVE RAIN
1600	----	----	0.00	----	----	----
1630	----	----	0.00	----	----	----
1700	0.00	0.00	0.00	0.00	2.42	2.42
1730	0.00	0.00	0.00	0.00	6.99	9.41
1800	0.00	0.00	0.00	0.00	8.86	18.27
1830	0.00	0.00	0.00	0.00	8.31	26.58
1900	0.00	0.00	0.00	0.00	10.96	37.54
1930	0.00	0.00	0.00	0.00	10.83	48.37
2000	0.00	0.00	0.21	0.21	12.31	60.68
2030	0.12	0.12	0.42	0.63	10.71	71.39
2100	0.00	0.12	0.03	0.66	9.85	81.24
2130	0.34	0.46	0.03	0.69	11.47	92.71
2200	0.40	0.86	0.04	0.73	11.29	104.00
2230	0.14	1.00	0.00	0.73	8.17	112.17
2300	0.01	1.01	0.08	0.81	5.87	118.04
2330	0.02	1.03	0.02	0.83	5.21	123.25
0000	0.05	1.08	0.54	1.37	4.92	128.17
0030	0.52	1.60	0.20	1.57	3.96	132.13
0100	0.54	2.14	0.10	1.67	3.34	135.47
0130	0.16	2.30			1.49	136.96
0200	0.34	2.64			2.56	139.52
0230	----	----			----	----
0300	0.67	3.31			5.22	144.74
0330	0.05	3.36			2.83	147.57
0400	0.00	3.36			0.60	148.17

TOTAL TARGET AREA AVERAGE RAINFALL FOR THE PERIOD 1700Z TO 0100Z

RAINGAGES (mm) $\bar{G}_T = 1.31$

SATELLITE (mm) $\bar{S}_T = 1.86$

$\bar{G}_T/\bar{S}_T = 0.71$

AREA AVERAGE RAINFALL FOR THE PERIOD 1700Z TO 0400Z

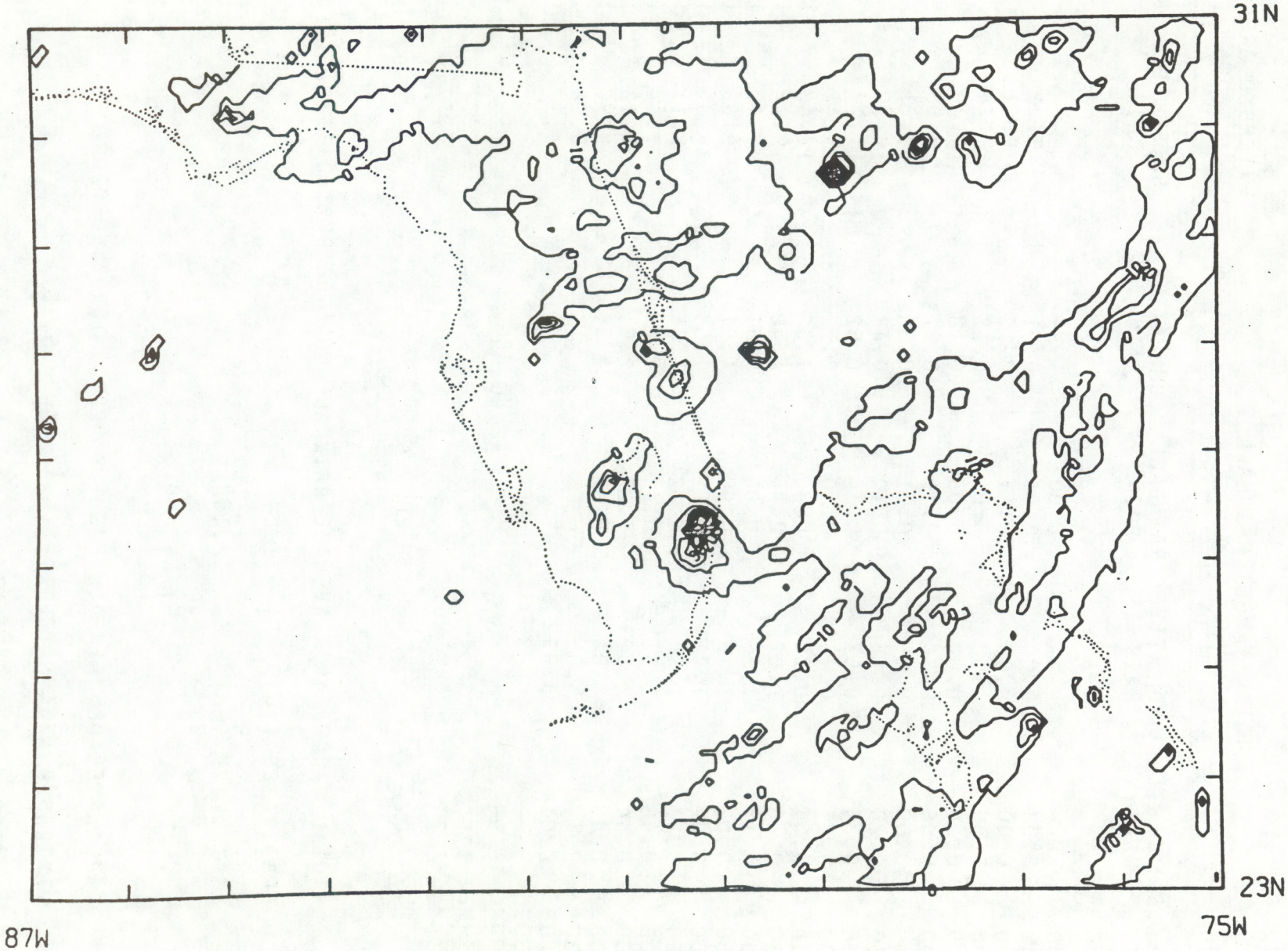
EXTENDED AREA SATELLITE (mm) $\bar{S}_E = 0.12$

TARGET AREA SATELLITE (mm) $\bar{S}_T = 2.91$

FACE SATELLITE RAINFALL

29 JULY 80

UNADJUSTED



211/1704Z-212/0404Z

31 JULY 1980

TIME GMT	TOTAL TARGET RAINFALL $m^3 \times 10^7$				EXTENDED AREA RAINFALL $m^3 \times 10^7$	
	SATELLITE RAIN	CUMULATIVE RAIN	RAINGAGE RAIN	CUMULATIVE RAIN	SATELLITE RAIN	CUMULATIVE RAIN
1600	----	----	0.00	----	----	----
1630	0.00	0.00	0.01	0.01	3.32	3.32
1700	0.00	0.00	0.11	0.12	8.21	11.53
1730	0.00	0.00	0.01	0.13	13.74	25.27
1800	0.00	0.00	0.05	0.18	14.40	39.67
1830	0.06	0.06	0.19	0.37	9.60	49.27
1900	0.00	0.06	0.01	0.38	10.21	59.48
1930	0.20	0.26	0.10	0.48	9.30	68.78
2000	0.31	0.57	0.14	0.62	11.77	80.55
2030	0.21	0.78	0.10	0.72	13.42	93.97
2100	0.01	0.79	0.30	1.02	12.43	106.40
2130	0.23	1.02	0.44	1.46	9.22	115.62
2200	0.15	1.17	0.05	1.51	9.47	125.09
2230	0.02	1.19	0.00	1.51	9.66	134.75
2300	0.02	1.21	0.02	1.53	8.85	143.60
2330	0.23	1.44	0.32	1.85	8.11	151.71
0000	0.48	1.92	0.44	2.29	7.64	159.35
0030	0.44	2.36	0.02	2.31	7.13	166.48
0100	0.48	2.84	0.03	2.34	6.93	173.41
0130	0.18	3.02			5.96	179.37
0200	0.01	3.03			4.17	183.54
0230	----	----			----	----
0300	----	----			----	----
0330	----	----			----	----
0400	----	----			----	----

TOTAL TARGET AREA AVERAGE RAINFALL FOR THE PERIOD 1630Z TO 0100Z

RAINGAGES (mm) $G_T = 1.84$

SATELLITE (mm) $S_T = 2.15$

$G_T/S_T = 0.86$

AREA AVERAGE RAINFALL FOR THE PERIOD 1630Z TO 0200Z

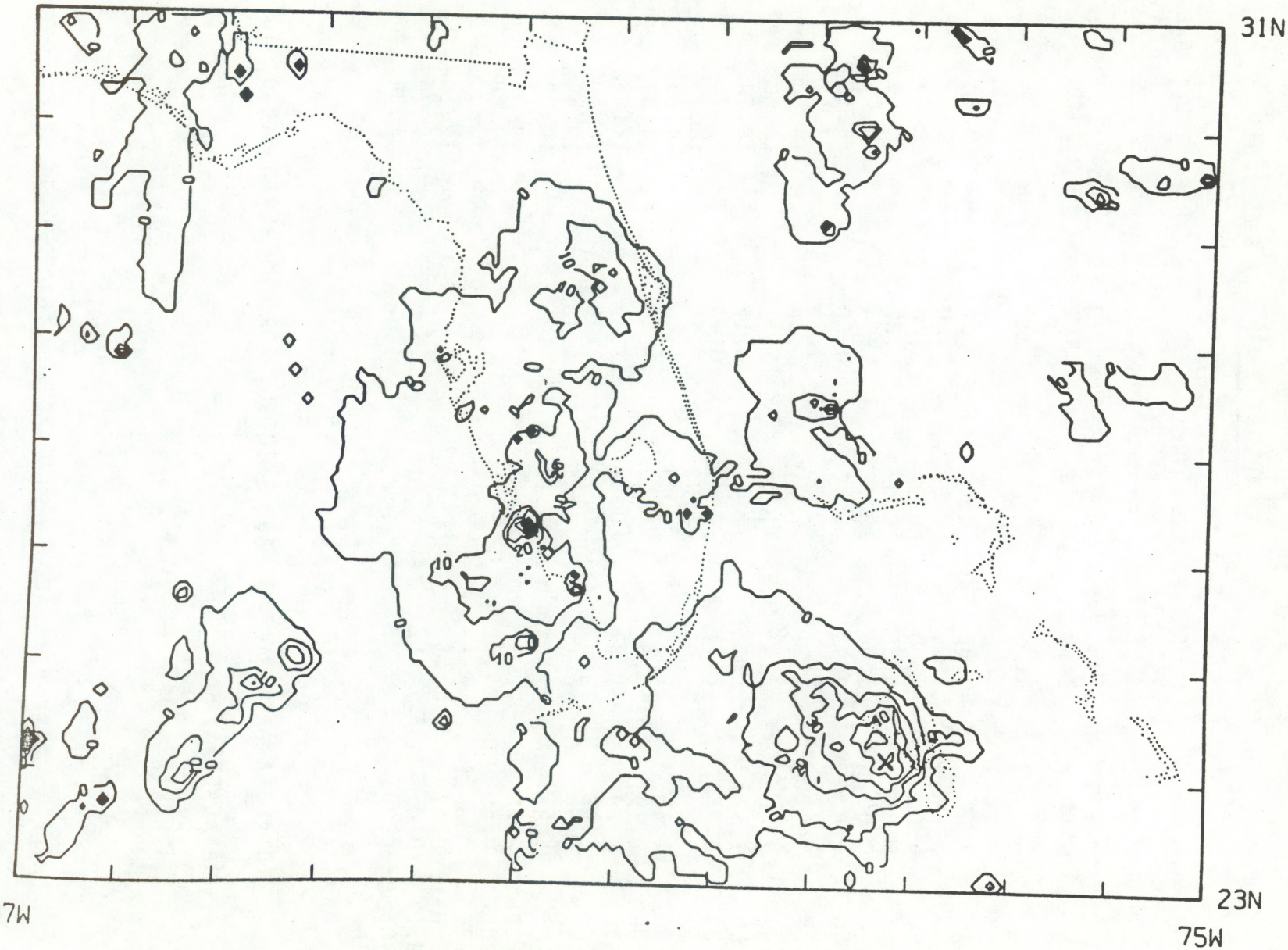
EXTENDED AREA SATELLITE (mm) $S_E = 0.15$

TARGET AREA SATELLITE (mm) $S_T = 2.63$

FACE SATELLITE RAINFALL

31 JULY 80

UNADJUSTED



213/1634Z-214/0204Z

2 AUGUST 1980

TIME GMT	TOTAL TARGET RAINFALL $m^3 \times 10^7$				EXTENDED AREA RAINFALL $m^3 \times 10^7$	
	SATELLITE RAIN	CUMULATIVE RAIN	RAINGAGE RAIN	CUMULATIVE RAIN	SATELLITE RAIN	CUMULATIVE RAIN
1600	----	----	0.00		----	----
1630	0.00	0.00	0.00	0.00	0.32	0.32
1700	----	----	0.00	0.00	----	----
1730	0.00	0.00	0.00	0.00	0.89	1.21
1800	0.06	0.06	0.02	0.02	1.39	2.60
1830	0.00	0.06	0.12	0.14	2.46	5.06
1900	0.87	0.93	0.46	0.60	6.16	11.22
1930	0.23	1.16	0.25	0.85	3.44	14.66
2000	0.59	1.75	0.61	1.46	6.50	21.16
2030	2.58	4.33	1.95	3.41	14.13	35.29
2100	1.58	5.91	2.78	6.19	9.54	44.83
2130	2.92	8.83	2.54	8.73	17.73	62.56
2200	2.24	11.07	1.62	10.35	14.79	77.35
2230	1.32	12.39	1.23	11.58	9.04	86.39
2300	2.70	15.09	0.89	12.47	18.31	104.70
2330	2.28	17.37	0.82	13.29	17.58	122.28
0000	1.98	19.35	0.50	13.79	15.50	137.78
0030	1.32	20.67	0.34	14.13	10.52	148.30
0100	1.34	22.01	0.12	14.25	10.09	158.39
0130	0.89	22.90			8.14	166.53
0200	0.69	23.59			7.28	173.81
0230	----	----			----	----
0300	0.97	24.56			12.10	185.91
0330	0.01	24.57			2.76	188.67
0400	0.00	24.57			1.34	190.01

TOTAL TARGET AREA AVERAGE RAINFALL FOR THE PERIOD 1630Z TO 0100Z

RAINGAGES (mm) $\bar{G}_T = 11.22$

SATELLITE (mm) $\bar{S}_T = 19.55$

$\bar{G}_T/\bar{S}_T = 0.57$

AREA AVERAGE RAINFALL FOR THE PERIOD 1630Z TO 0400Z

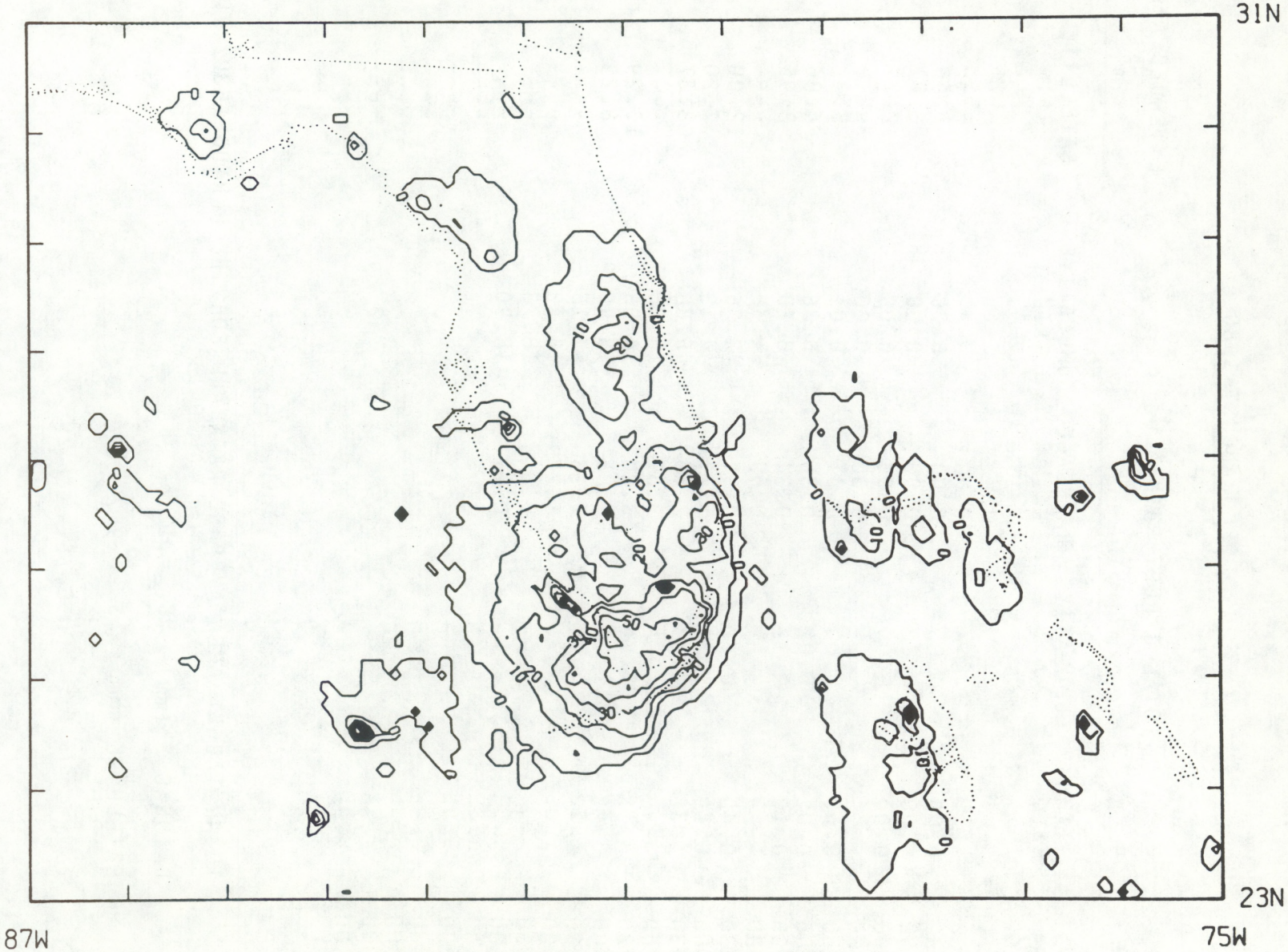
EXTENDED AREA SATELLITE (mm) $\bar{S}_E = 0.16$

TARGET AREA SATELLITE (mm) $\bar{S}_T = 21.31$

FACE SATELLITE RAINFALL

2 AUG 80

UNADJUSTED



215/1634Z-216/0404Z

3 AUGUST 1980

TIME GMT	TOTAL TARGET RAINFALL $m^3 \times 10^7$				EXTENDED AREA RAINFALL $m^3 \times 10^7$	
	SATELLITE RAIN	CUMULATIVE RAIN	RAINGAGE RAIN	CUMULATIVE RAIN	SATELLITE RAIN	CUMULATIVE RAIN
1600	----	----	0.00	----	----	----
1630	0.00	0.00	0.00	0.00	1.46	1.46
1700	0.00	0.00	0.00	0.00	3.51	4.97
1730	0.00	0.00	0.00	0.00	2.77	7.74
1800	----	----	0.00	0.00	----	----
1830	0.00	0.00	0.01	0.01	3.32	11.06
1900	0.02	0.02	0.35	0.36	4.86	15.92
1930	0.10	0.12	0.34	0.70	3.95	19.87
2000	----	----	0.69	1.39	----	----
2030	0.40	0.52	0.97	2.36	12.00	31.87
2100	0.79	1.31	1.77	4.13	7.20	39.07
2130	1.32	2.63	2.55	6.68	8.37	47.44
2200	----	----	3.57	10.25	----	----
2230	5.13	7.76	3.80	14.05	17.29	64.73
2300	3.42	11.18	1.85	15.90	8.29	73.02
2330	----	----	1.25	17.15	----	----
0000	----	----	1.27	18.42	----	----
0030	----	----	0.31	18.73	----	----
0100	----	----	0.17	18.90	----	----
0130	----	----			----	----
0200	----	----			----	----
0230	----	----			----	----
0300	----	----			----	----
0330	----	----			----	----
0400	----	----			----	----

TOTAL TARGET AREA AVERAGE RAINFALL FOR THE PERIOD 1630Z TO 2300Z

RAINGAGES (mm) $G_T = 12.52$

SATELLITE (mm) $S_T = 9.70$

$G_T/S_T = 1.29$

AREA AVERAGE RAINFALL FOR THE PERIOD 1630Z TO 2300Z

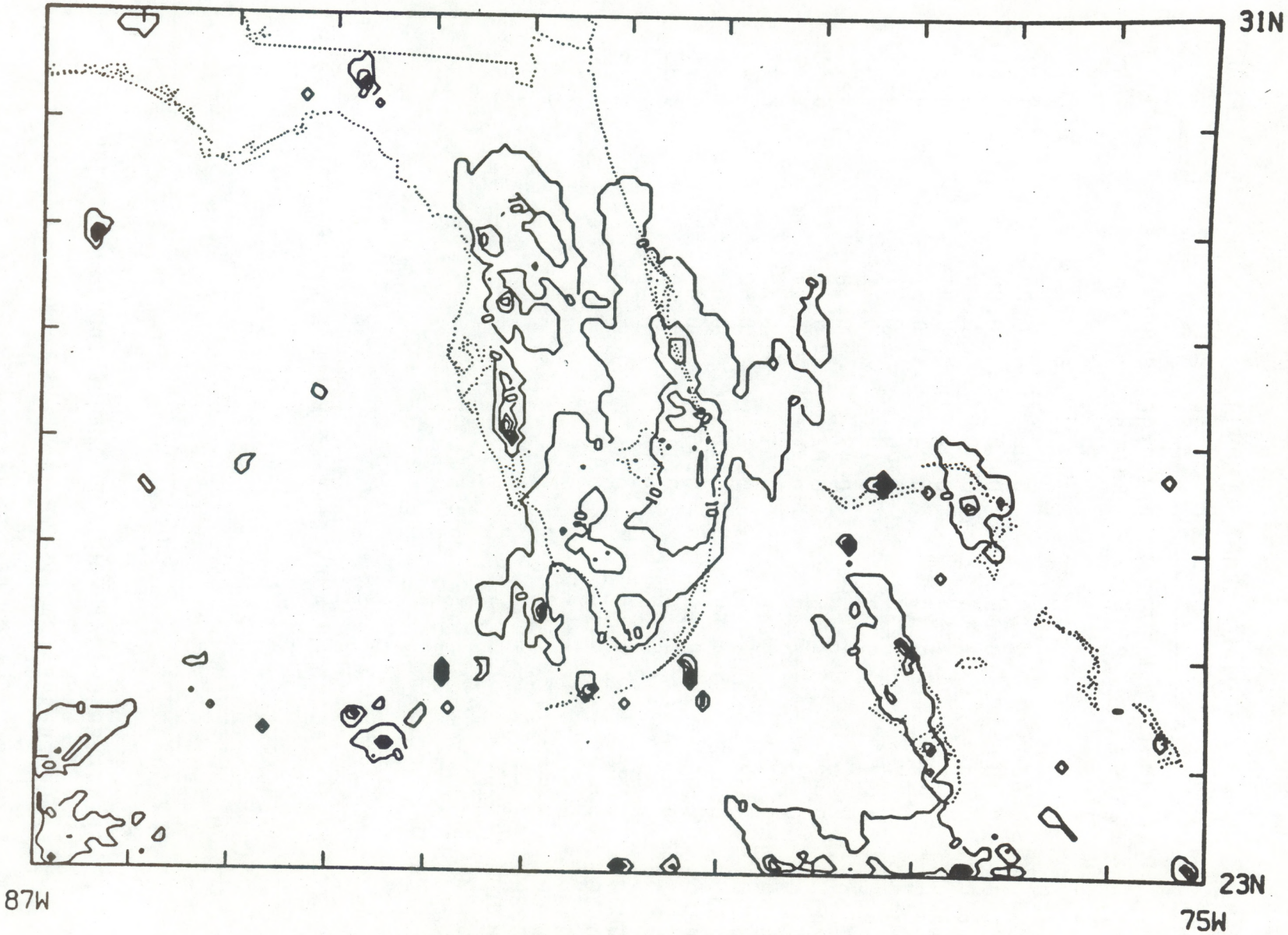
EXTENDED AREA SATELLITE (mm) $S_E = 0.06$

TARGET AREA SATELLITE (mm) $S_T = 9.70$

FACE SATELLITE RAINFALL

3 AUG 80

UNADJUSTED



216/1634Z-216/2304Z

4 AUGUST 1980

TIME GMT	TOTAL TARGET RAINFALL $m^3 \times 10^7$				EXTENDED AREA RAINFALL $m^3 \times 10^7$	
	SATELLITE RAIN	CUMULATIVE RAIN	RAINGAGE RAIN	CUMULATIVE RAIN	SATELLITE RAIN	CUMULATIVE RAIN
1600	----	----	0.00	----	----	----
1630	0.00	0.00	0.00	0.00	0.62	0.62
1700	0.10	0.10	0.00	0.00	2.55	3.17
1730	0.93	1.03	0.00	0.00	4.50	7.67
1800	----	----	0.01	0.01	----	----
1830	2.16	3.19	0.00	0.01	9.38	17.05
1900	0.17	3.36	0.00	0.01	5.63	22.68
1930	0.37	3.73	0.10	0.11	7.65	30.33
2000	----	----	0.07	0.18	----	----
2030	0.82	4.55	0.02	0.20	16.51	46.84
2100	0.13	4.68	0.27	0.47	6.91	53.75
2130	0.01	4.69	0.01	0.48	6.16	59.91
2200	----	----	0.05	0.53	----	----
2230	0.00	4.69	0.10	0.63	11.56	71.47
2300	0.00	4.69	0.06	0.69	4.18	75.65
2330	0.00	4.69	0.11	0.80	4.13	79.78
0000	----	----	0.18	0.98	----	----
0030	0.00	4.69	0.15	1.13	6.19	85.97
0100	----	----	0.02		----	----
0130	----	----			----	----
0200	----	----			----	----
0230	----	----			----	----
0300	----	----			----	----
0330	----	----			----	----
0400	----	----			----	----

TOTAL TARGET AREA AVERAGE RAINFALL FOR THE PERIOD 1630Z TO 0030Z

RAINGAGES (mm) $\bar{G}_T = 0.89$

SATELLITE (mm) $\bar{S}_T = 4.07$

$\bar{G}_T/\bar{S}_T = 0.22$

AREA AVERAGE RAINFALL FOR THE PERIOD 1630Z TO 0030Z

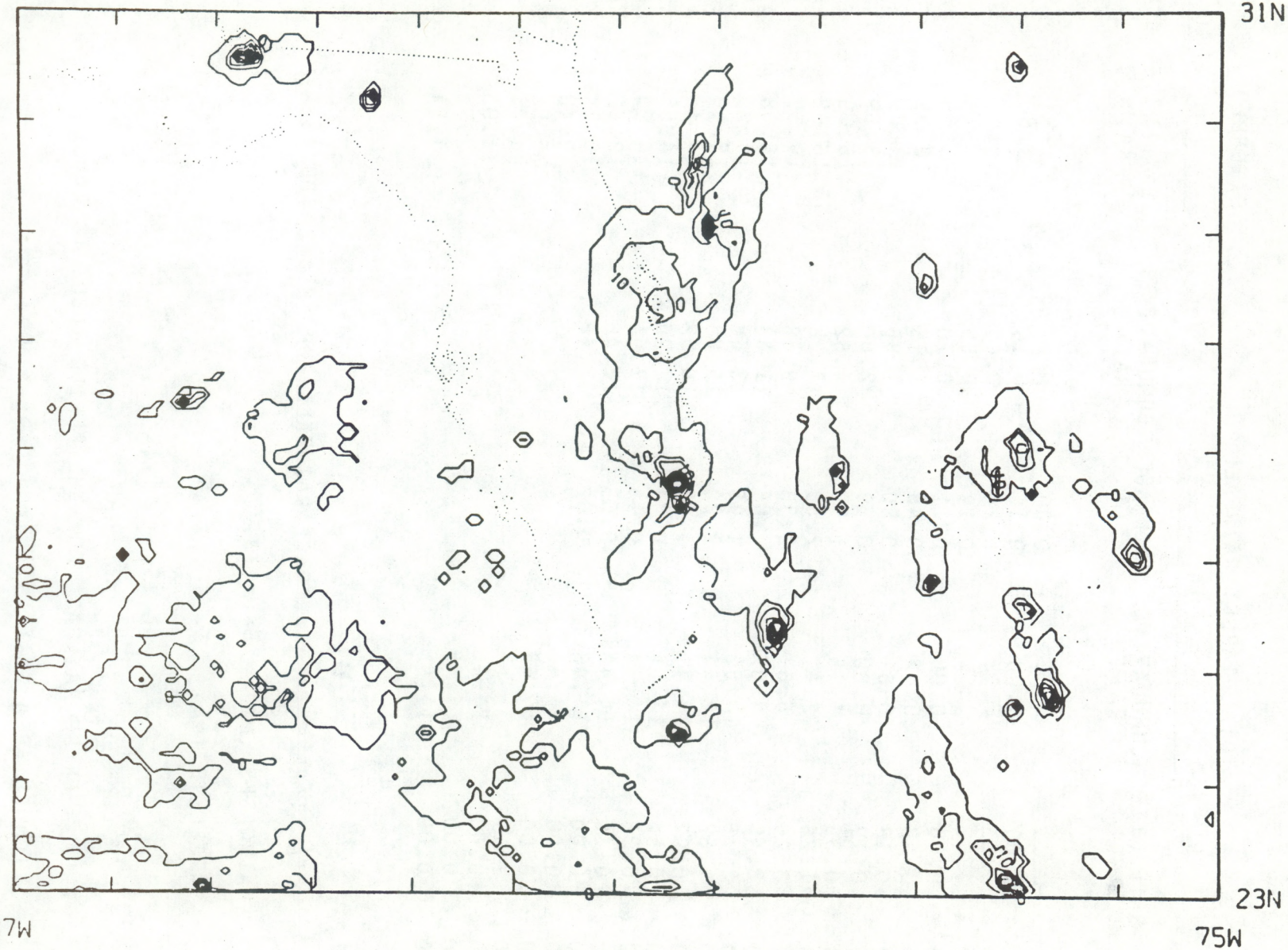
EXTENDED AREA SATELLITE (mm) $\bar{S}_E = 0.07$

TARGET AREA SATELLITE (mm) $\bar{S}_T = 4.07$

FACE SATELLITE RAINFALL

4 AUG 80

UNADJUSTED



217/1634Z-218/0 34Z

18 AUGUST 1980

TIME GMT	TOTAL TARGET RAINFALL $m^3 \times 10^7$				EXTENDED AREA RAINFALL $m^3 \times 10^7$	
	SATELLITE RAIN	CUMULATIVE RAIN	RAINGAGE RAIN	CUMULATIVE RAIN	SATELLITE RAIN	CUMULATIVE RAIN
1600	----	----	0.00	----	----	----
1630	0.00	0.00	0.16	0.16	3.50	3.50
1700	----	----	0.24	0.40	----	----
1730	----	----	0.19	0.59	----	----
1800	0.00	0.00	0.11	0.70	25.66	29.16
1830	0.43	0.43	0.45	1.15	10.31	39.47
1900	0.18	0.61	0.80	1.95	13.09	52.56
1930	0.19	0.80	0.69	2.64	13.59	66.15
2000	0.35	1.15	1.98	4.62	15.19	81.34
2030	1.26	2.41	2.63	7.25	16.82	98.16
2100	3.26	5.67	2.33	9.58	19.67	117.83
2130	2.40	8.07	2.05	11.63	15.68	133.51
2200	2.75	10.82	1.95	13.58	15.29	148.80
2230	1.62	12.44	2.22	15.88	15.19	163.99
2300	0.97	13.41	1.12	16.92	14.74	178.73
2330	0.54	13.95	0.34	17.26	14.55	193.28
0000	0.38	14.33	0.15	17.41	14.83	208.11
0030	0.15	14.48	0.05	17.46	12.52	220.63
0100	0.00	14.48	0.02	17.48	10.74	231.37
0130	0.00	14.48			8.48	239.85
0200	0.00	14.48			6.58	246.43
0230	----	----			----	----
0300	0.00	14.48			11.03	257.46
0330	0.00	14.48			2.73	260.19
0400	0.00	14.48			1.91	262.10

TOTAL TARGET AREA AVERAGE RAINFALL FOR THE PERIOD 1630Z TO 0100Z

RAINGAGES (mm) $\bar{G}_T = 13.77$

SATELLITE (mm) $\bar{S}_T = 12.56$

$\bar{G}_T/\bar{S}_T = 1.10$

AREA AVERAGE RAINFALL FOR THE PERIOD 1630Z TO 0400Z

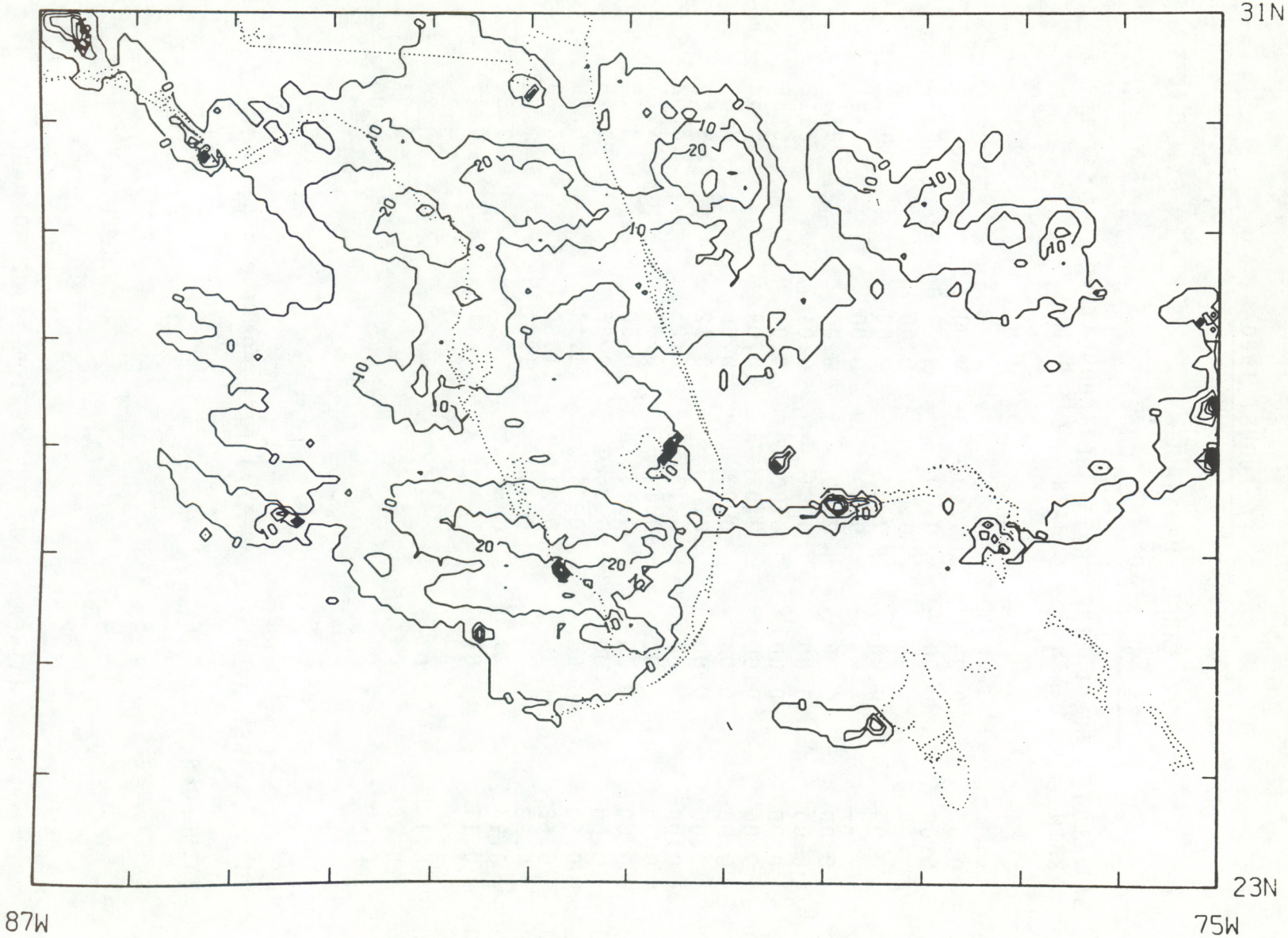
EXTENDED AREA SATELLITE (mm) $\bar{S}_E = 0.22$

TARGET AREA SATELLITE (mm) $\bar{S}_T = 12.56$

FACE SATELLITE RAINFALL

18 AUG 80

UNADJUSTED



231/1634Z-232/0404Z

26 AUGUST 1980

TIME GMT	TOTAL TARGET RAINFALL $m^3 \times 10^7$				EXTENDED AREA RAINFALL $m^3 \times 10^7$	
	SATELLITE RAIN	CUMULATIVE RAIN	RAINGAGE RAIN	CUMULATIVE RAIN	SATELLITE RAIN	CUMULATIVE RAIN
1600	----	----	0.00	----	----	----
1630	0.00	0.00	0.00	0.00	1.87	1.87
1700	0.00	0.00	0.00	0.00	4.41	6.28
1730	----	----	0.00	0.00	----	----
1800	0.00	0.00	0.00	0.00	10.52	16.80
1830	----	----	0.00	0.00	----	----
1900	0.00	0.00	0.00	0.00	8.97	25.77
1930	0.00	0.00	0.01	0.01	6.12	31.89
2000	0.00	0.00	0.00	0.01	5.59	37.48
2030	0.00	0.00	0.03	0.04	6.52	44.40
2100	0.00	0.00	0.01	0.05	3.89	47.89
2130	0.00	0.00	0.07	0.12	3.53	51.42
2200	0.00	0.00	0.13	0.25	4.52	55.94
2230	0.00	0.00	0.12	0.37	3.79	59.73
2300	0.00	0.00	0.13	0.50	3.65	63.38
2330	0.00	0.00	0.36	0.86	3.78	67.16
0000	0.68	0.68	0.25	1.11	4.55	71.71
0030	0.62	1.30	0.21	1.30	3.55	75.26
0100	0.33	1.63	0.11	1.41	1.66	76.92
0130	0.14	1.77			0.50	77.42
0200	0.11	1.88			0.45	77.87
0230	----	----			----	----
0300	0.14	2.02			0.28	78.15
0330	0.00	2.02			0.37	78.52
0400	0.00	2.02			0.00	78.52

TOTAL TARGET AREA AVERAGE RAINFALL FOR THE PERIOD 1630Z TO 0100Z

RAINGAGES (mm) $\bar{G}_T = 1.11$

SATELLITE (mm) $\bar{S}_T = 1.41$

$\bar{G}_T/\bar{S}_T = 0.79$

AREA AVERAGE RAINFALL FOR THE PERIOD 1630Z TO 0400Z

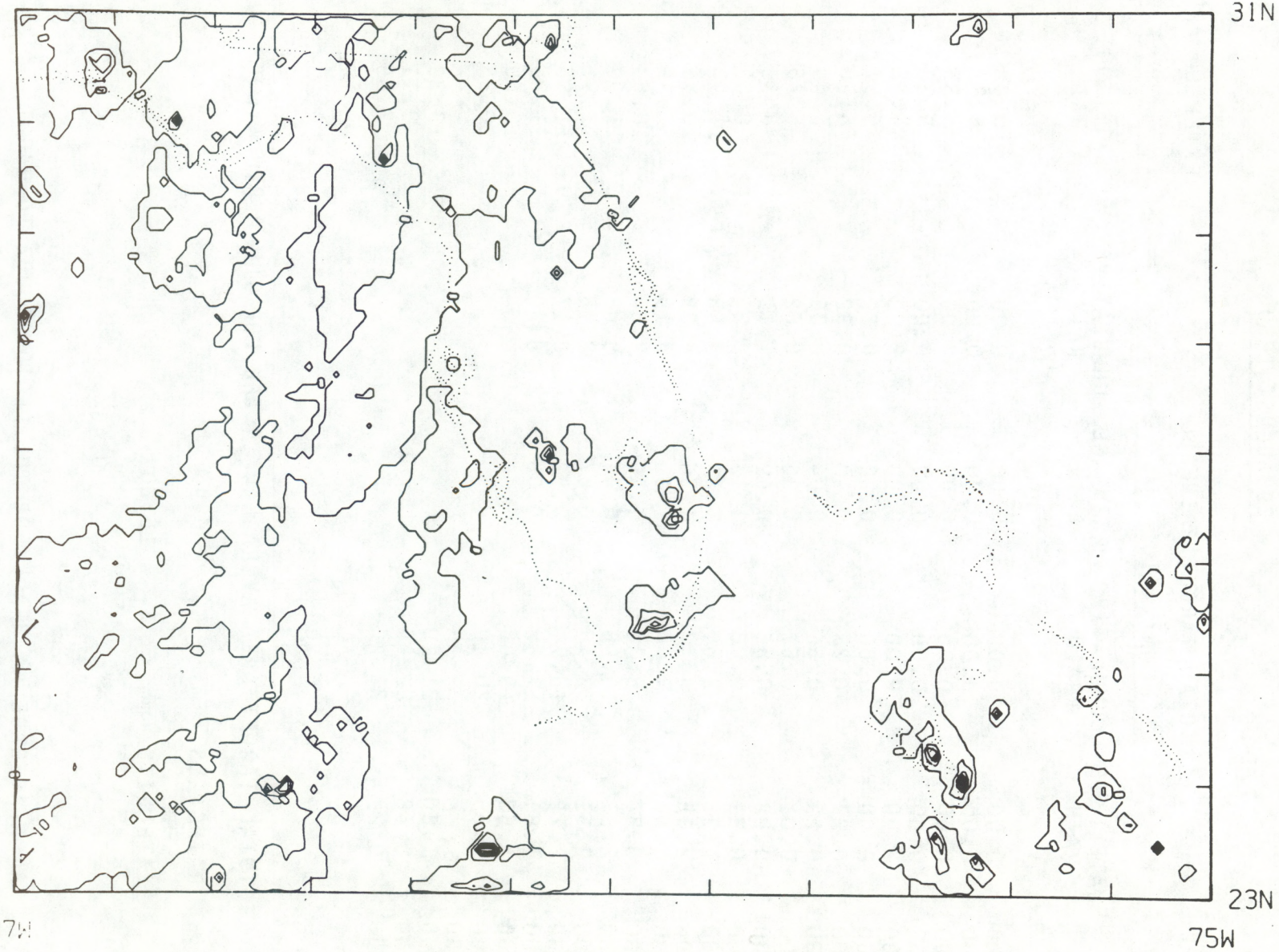
EXTENDED AREA SATELLITE (mm) $\bar{S}_E = 0.07$

TARGET AREA SATELLITE (mm) $\bar{S}_T = 1.75$

FACE SATELLITE RAINFALL

26 AUG 80

UNADJUSTED



239/1634Z-240/0404Z

29 AUGUST 1980

TIME GMT	TOTAL TARGET RAINFALL $m^3 \times 10^7$				EXTENDED AREA RAINFALL $m^3 \times 10^7$	
	SATELLITE RAIN	CUMULATIVE RAIN	RAINGAGE RAIN	CUMULATIVE RAIN	SATELLITE RAIN	CUMULATIVE RAIN
1600	0.00	0.00	0.00	0.00	10.47	10.47
1630	0.00	0.00	0.00	0.00	6.85	17.32
1700	0.00	0.00	0.00	0.00	5.33	22.65
1730	0.00	0.00	0.00	0.00	5.88	28.53
1800	0.00	0.00	0.00	0.00	4.62	33.15
1830	0.00	0.00	0.22	0.22	5.87	39.02
1900	0.27	0.27	0.10	0.32	6.50	45.52
1930	0.29	0.56	0.04	0.36	6.48	52.00
2000	0.01	0.57	0.26	0.62	5.26	57.26
2030	0.08	0.65	0.49	1.11	5.38	62.64
2100	0.31	0.96	1.13	2.24	6.69	69.33
2130	1.35	2.31	1.29	3.53	11.97	81.30
2200	2.16	4.47	1.36	4.89	10.85	92.15
2230	----	----	1.30	6.19	----	----
2300	3.84	8.31	1.45	7.64	18.53	110.68
2330	2.67	10.98	0.44	8.08	11.99	122.67
0000	2.51	13.49	0.07	8.15	12.92	135.59
0030	2.22	15.71	0.02	8.17	11.96	145.55
0100	1.81	17.52	0.03	8.20	11.86	159.41
0130	1.53	19.05			10.50	169.91
0200	1.05	20.10			10.25	180.16
0230	----	----			----	----
0300	1.60	21.70			19.33	199.49
0330	0.48	22.18			8.11	207.60
0400	0.27	22.45			7.85	215.45

TOTAL TARGET AREA AVERAGE RAINFALL FOR THE PERIOD 1600Z TO 0100Z

RAINGAGES (mm) G_T = 6.46

SATELLITE (mm) S_T = 15.20

G_T/S_T = 0.43

AREA AVERAGE RAINFALL FOR THE PERIOD 1600Z TO 0400Z

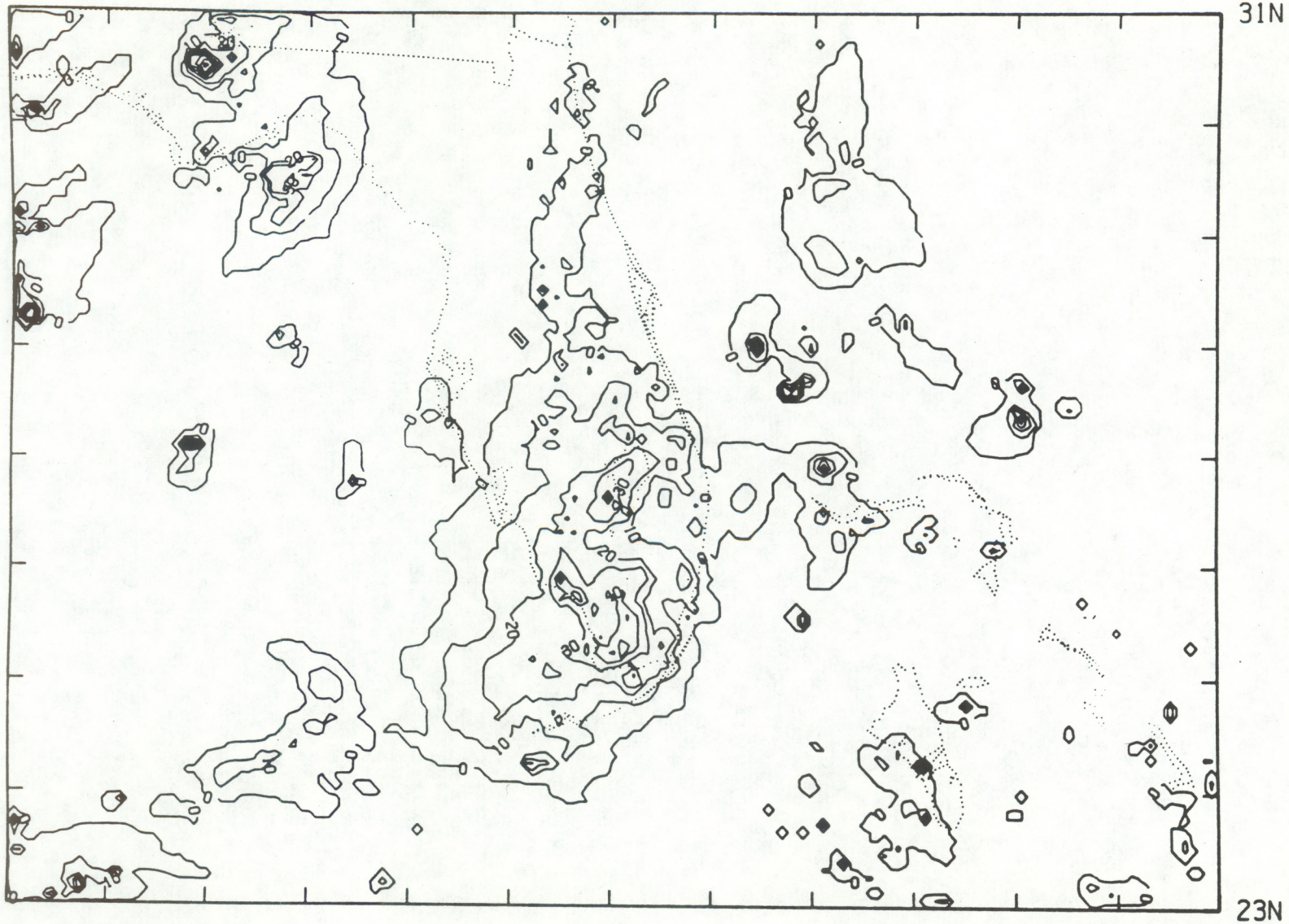
EXTENDED AREA SATELLITE (mm) S_E = 0.18

TARGET AREA SATELLITE (mm) S_T = 19.47

FACE SATELLITE RAINFALL

29 AUG 80

UNADJUSTED



242/1504Z-243/0434Z