ROYAL OBSERVATORY, HONG KONG

Technical Note No. 80

COOL SEASON WEATHER WITH CYCLONIC CIRCULATIONS IN THE SOUTH CHINA SEA

by

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Published June 1989

Prepared by

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551.509.3:551.515.2 (512.317)

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1. INTRODUCTION

Cuming (1968) studied 10 cyclonic circulations that traversed the South China Sea during November and December in the years 1957 to 1966 and found that the probability of rain in Hong Kong would increase considerably to 81% (comparing with the mean probability of 36%) when a cyclonic circulation was centred within the area bounded by 13°N and 16°N, 110°E and 115°E. This area (Figure 1) will be referred to as the "Cuming area" in the subsequent discussions. Poon (1981) extended the work by studying the effect of cool season (October - January) tropical cyclones over the South China Sea on the rainfall of Hong Kong during the period 1947 - 1980 and obtained similar results. The phenomenon has been referred to by forecasters as the "Cuming effect".

The statistical results of the work of Cuming and Poon have been applied by forecasters during the past years as a rule of thumb for forecasting deterioration in the weather. However, there were repeated occasions when weather was fine in Hong Kong even though tropical cyclones were centred within the Cuming area. The present study aims at elucidating the synoptic background of Cuming's statistical finding. In particular, the differences in synoptic patterns between the cases with and without rain in Hong Kong when cool season cyclonic circulations were centred within the Cuming area are also examined.

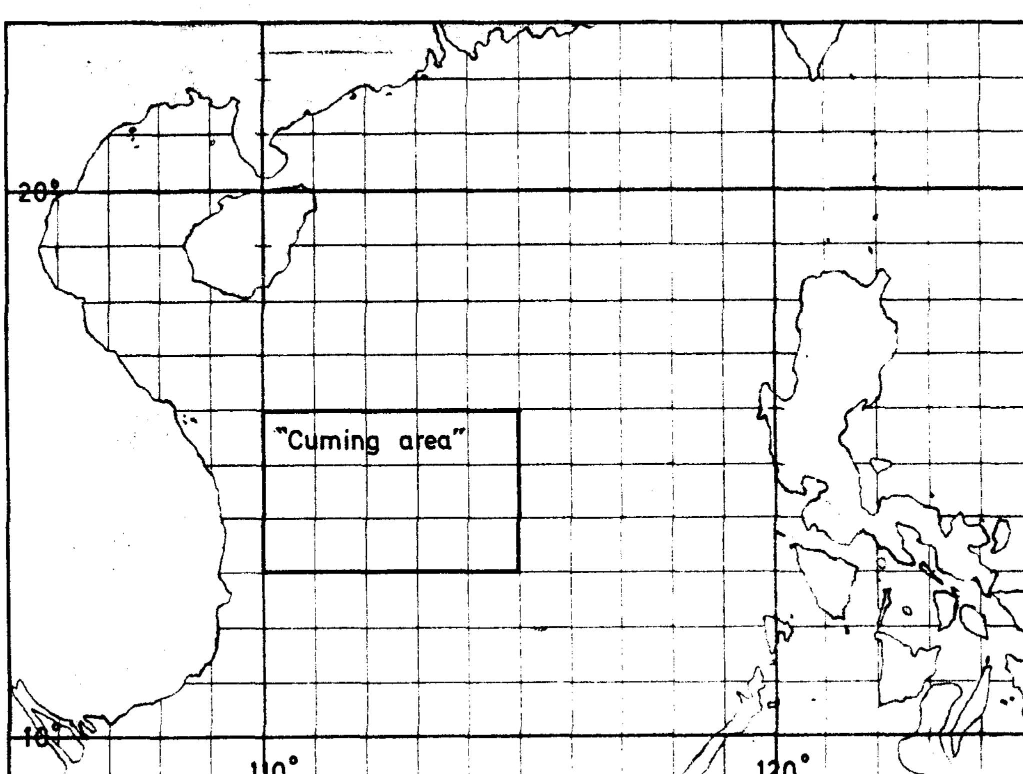


Figure 1. The probability of rain in Hong Kong is considerably higher when a cyclonic circulation is centred within the "Cuming area" in November and December (Cuming, 1968).

2. DATA AND ANALYSIS

Synoptic charts and satellite pictures of those days with a cyclonic circulation traversing the South China Sea in November and December during 1980-1987 were studied. During these periods, a total of 15 cyclonic circulations moved in a westward direction across the South China Sea north of 7°N (Table 1). Table 1 does not include Severe Tropical Storm Lee in December 1981 and Typhoon Nina in November 1987, since both of them recurved towards the South China coast. Out of these 15 circulations,

(i) 6 entered the Cuming area and there was rain in Hong Kong,

(ii) 2 entered the Cuming area but there was no rain in Hong Kong,

(iii) 4 remained south of the Cuming area as they traversed the South China Sea but rain occurred in Hong Kong, and

(iv) 3 stayed south of the Cuming area and there was no rain in Hong Kong.

To help forecasters appreciate the diversity of synoptic situations that could occur, six of these cases are described in some detail in the following sections. They include 3 cases of "Cuming effect" successfully verified (Case I - III), 2 cases of fine weather in Hong Kong when cyclonic circulations were centred within the Cuming area (Case V - VI), and also a case with rain in Hong Kong even though the cyclonic circulation was centred south of the Cuming area (Case IV). Synoptic systems responsible for conformation with or deviation from the conventional Cuming effect will be described.

TABLE 1. THE 15 CYCLONIC CIRCULATIONS TRAVERSING THE SOUTH CHINA SEA NORTH OF 7°N DURING NOVEMBER AND DECEMBER IN THE YEARS FROM 1980 TO 1987

Circulations	Remarks
1. Cary, Oct-Nov 1980	entered Cuming area, no rain in HK (Case V)
2. TD, Nov 1981	south of Cuming area, no rain in HK
3. Hazen, Nov 1981	entered Cuming area, rain in HK
4. Warren, Oct-Nov 1984	entered Cuming area, trace of rainfall in HK
5. Agnes, Nov 1984	entered Cuming area, no rain in HK (Case VI)
6. Gordon, Nov 1985	south of Cuming area, no rain in HK
7. Irving, Dec 1985	south of Cuming area, no rain in HK
8. Herbert, Nov 1986	entered Cuming area, rain in HK (Case II)
9. Ida, Nov 1986	entered Cuming area, rain in HK (Case III)
10. TD, Nov 1986	south of Cuming area, trace of rainfall in HK
11. Marge, Dec 1986	south of Cuming area, rain in HK
12. Maury, Nov 1987	entered Cuming area, rain in HK (Case I)
13. Ogden, Nov 1987	south of Cuming area, trace of in HK
14. Low, Dec 1987	south of Cuming area, rain in HK (Case IV)
15. Phyllis, Dec 1987	entered Cuming area, trace of rainfall in HK

3. CASE I : MAURY, 19 - 22 NOVEMBER 1987

3.1 Weather sequence

During this period, Tropical Storm Maury moved across the South China Sea. The track of Maury is shown in Figure 2.

On 15th, Maury was centred over the central Philippines. There was only a thin cloud line lying along the latitude of 22°N over the Bashi Channel (Figure 3).

On 16th, Maury had entered the South China sea. The cloud line over Bashi developed slightly (Figure 4). As Maury continued to move west and entered the Cuming area on 17th (Figure 5), this cloud line developed and moved northwestwards. Visually, it had linked up with the circulation of Maury. Although Maury was centred within the Cuming area on 17th, this cloud line remained to the south of the coast and there were sunny periods in Hong Kong.

On 18th, Maury was located just off the coast of southern Vietnam. In Hong Kong, the weather was fine in the morning after a weak northerly surge had arrived in the previous evening. The cloud line linked to Maury further developed, partly attributable to the northerly surge (Figure 6). This "cloud plume" moved north to cover Hong Kong on the afternoon of 18th when Maury was about to reach the longitude of 111°E, the western boundary of the Cuming area.

The "cloud plume" gave rise to light rain in Hong Kong early on 19th even though Maury had landed over southern Vietnam (Figure 7). Continuous light rain persisted until the evening of 21st and followed by light rain patches until the afternoon of 22nd. The "cloud plume" continued its northward movement and its southern edge cleared Hong Kong on 23rd (Figures 8 - 11).

The dew-point at Hong Kong fell after the arrival of the northerly surge, but rose sharply after the "cloud plume" had moved in. In fact, there were rises in dew-points along the whole coastal area of South China (Figure 12). The centre of dew-point rise had a northward moving tendency. The daily maximum, minimum and mean temperatures at the Royal Observatory also rose progressively from 19th onwards (Table 2).

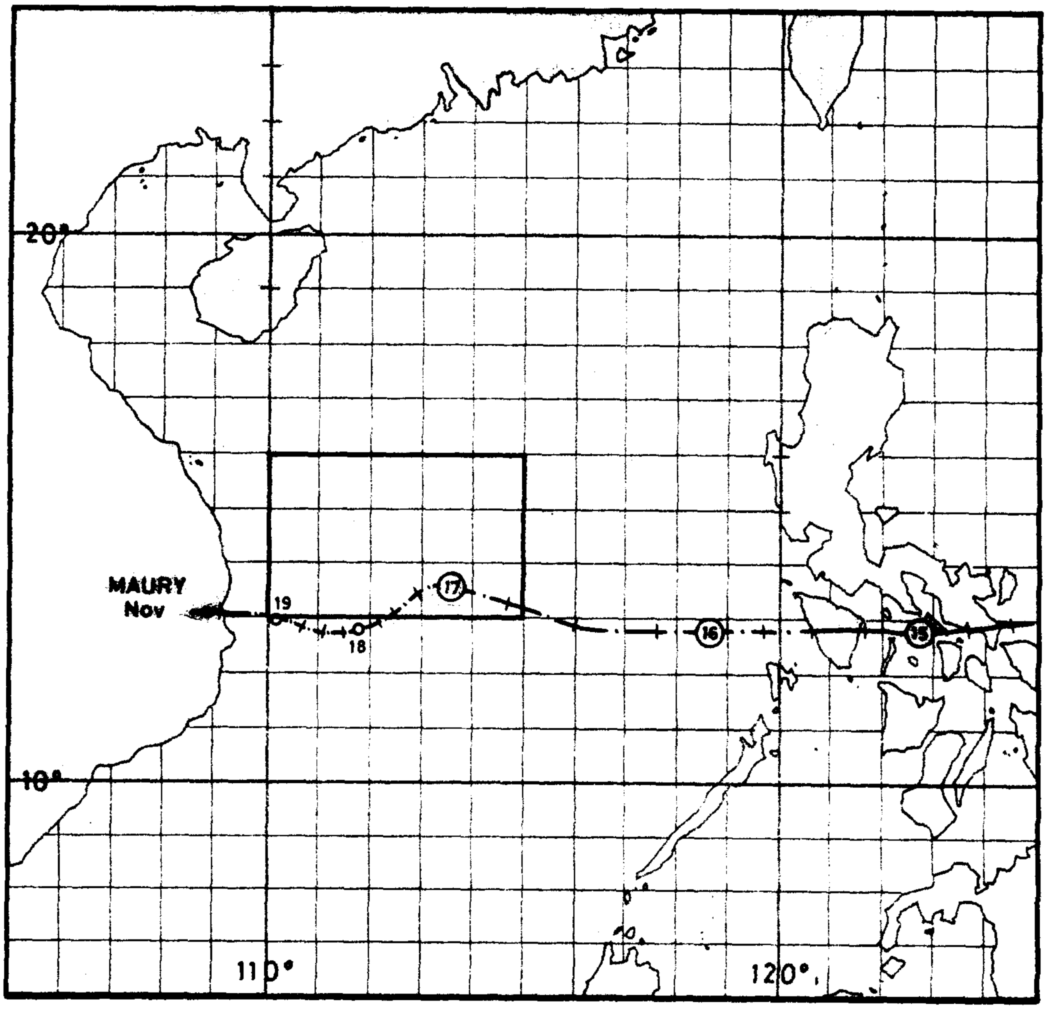


Figure 2. Track of Tropical Storm Maury.

TABLE 2. WEATHER ELEMENTS ON 16 - 24 NOVEMBER 1987

Date	Temperature (°C)			Dew-Point (°C)	Rainfall (mm)	Bright Sunshine (hours)
	Max.	Mean	Min.			
16	25.0	23.3	21.7	19.1	Tr	4.3
17	25.7	23.7	22.2	19.3	-	5.6
18	25.1	22.9	21.0	17.9	-	6.6
19	21.8	20.2	18.9	16.2	2.5	-
20	21.8	20.8	19.9	19.4	2.5	-
21	22.7	22.0	21.1	20.6	1.1	-
22	23.3	22.7	22.3	20.8	0.1	1.8
23	26.4	23.8	22.4	21.6	Tr	5.6
24	24.8	23.4	22.5	19.3	Tr	8.7

3.2 Upper-air pattern

On 17th, the flow at 850 hPa over the South China coastal region was weak southeasterly return flow from an anticyclone centred over the Ryukyu Islands (Figure 13a). Over 700 hPa, a ridge covered the northern part of the South China Sea (Figure 14a) and 700 hPa winds were westerly at Hong Kong. This contributed to inhibiting the cloud plume to the south of Hong Kong from moving in even though Maury was centred within the Cuming area.

On 18th, a dry continental airstream from an anticyclone over Central China replaced the return flow on the 850 level. The 850 hPa winds at Dongsha, however, remained southeasterly. A trough had formed over the South China coastal waters, which could help to explain the development of the cloud plume. At 700 hPa, Hong Kong was ahead of a trough (Figure 14b) and winds turned from west-northwest to southwest, allowing the cloud plume to edge in around noon.

On 19th, the 850 hPa anticyclone moved eastwards and reached the Ryukyus in the evening. Hong Kong then came under the return flow of this anticyclone. On 700 hPa, although the trough moved east and flattened, the return flow from an anticyclone over the Western Pacific dominated South China (Figure 14c). The return flow persisted until 21st. There were continuous light rain in Hong Kong between 19th and 21st. On 22nd, a weak anticyclone covered the local area, winds at 700 hPa became light and from the west (Figure 14f) and the rain gradually eased off.

3.3 Observations

(1) As found by previous workers (e.g. Lam, 1982), tropical cyclones over the central part of the South China Sea can enhance cloud systems over the South China coastal waters. It is believed that this is due to the interaction of the northeast monsoon with the tropical cyclone, which increases the baroclinicity of the air over the South China coastal waters. The enhanced cloud system would link to the cyclonic circulation. For convenience, this extensive cloud system stretching northeastwards from the centre of the circulation has been called "cloud plume" in the foregoing discussions. However, it should be distinguished from "cloud-plume outflow" of some workers (e.g. Tsui et al, 1977), which refers mainly to high clouds rather than the lower level clouds in this discussion. In the present case, the cloud plume developed most significantly after a surge of the winter monsoon had reached the coastal waters. After the cloud plume of Maury reached the coast, the dew-point, the maximum, minimum and mean temperatures at the Royal Observatory rose progressively.

(2) Even if a tropical cyclone enters the Cuming area, it may not necessarily mean rain or increase in cloudiness in Hong Kong. The upper level flow must be conducive to the northward shift of the cloud plume. In the present case, return flow from an anticyclone over the Ryukyus at 850 and 700 hPa served the purpose.

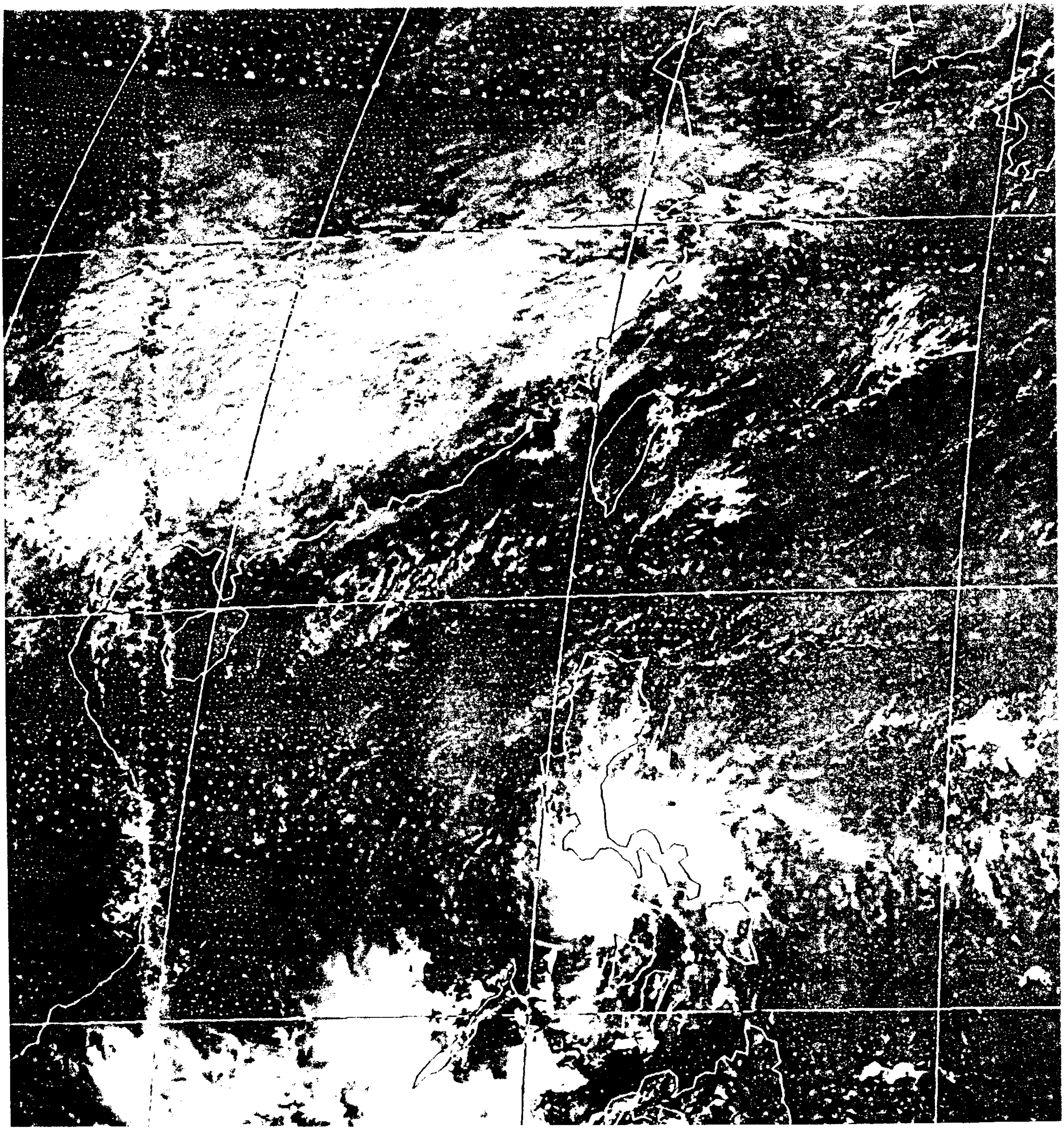


Figure 3. VS Satellite picture - 871115 03 UTC.

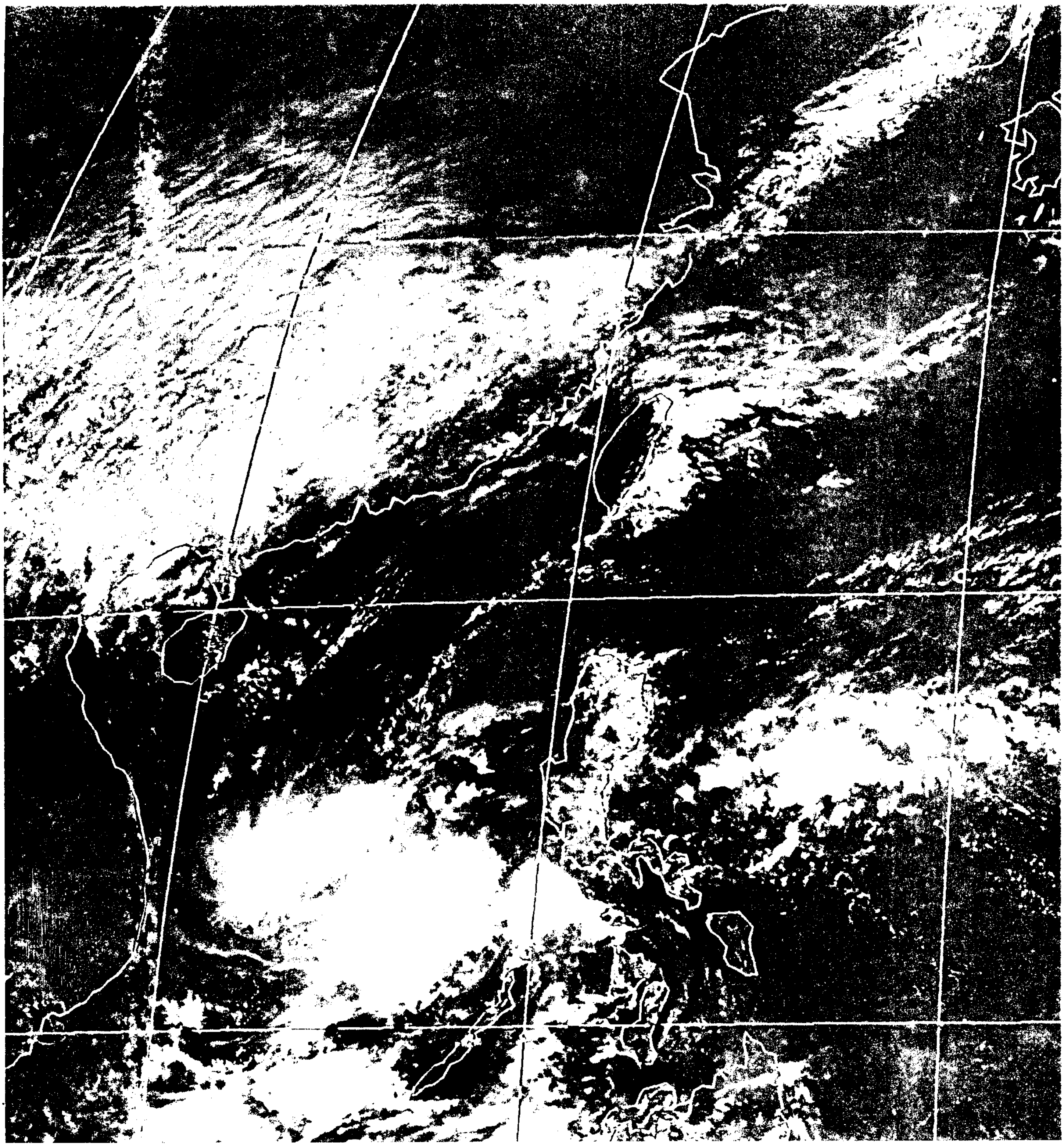


Figure 4. VS Satellite picture - 871116 03 UTC.

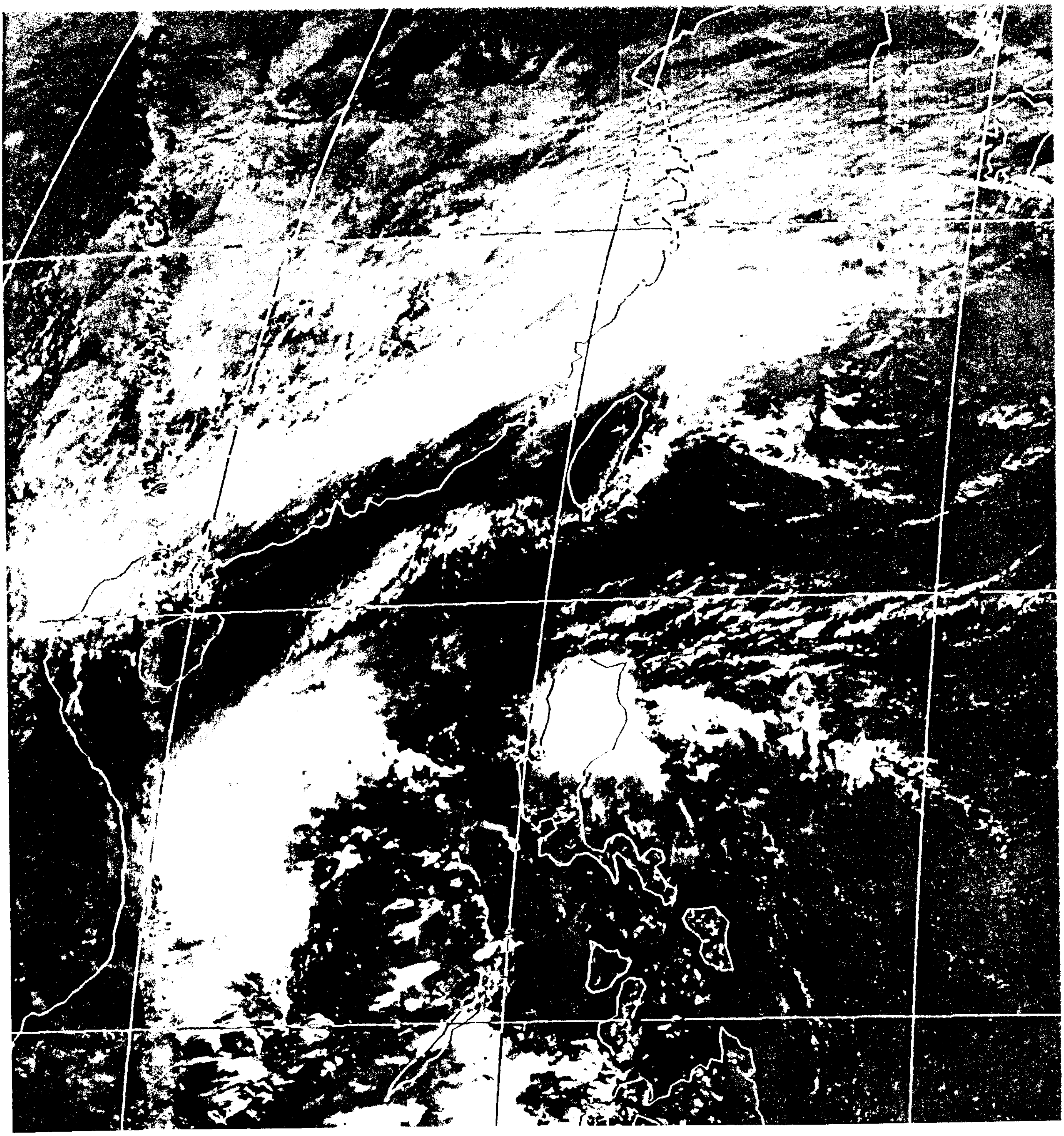


Figure 5. VS Satellite picture - 871117 03 UTC.

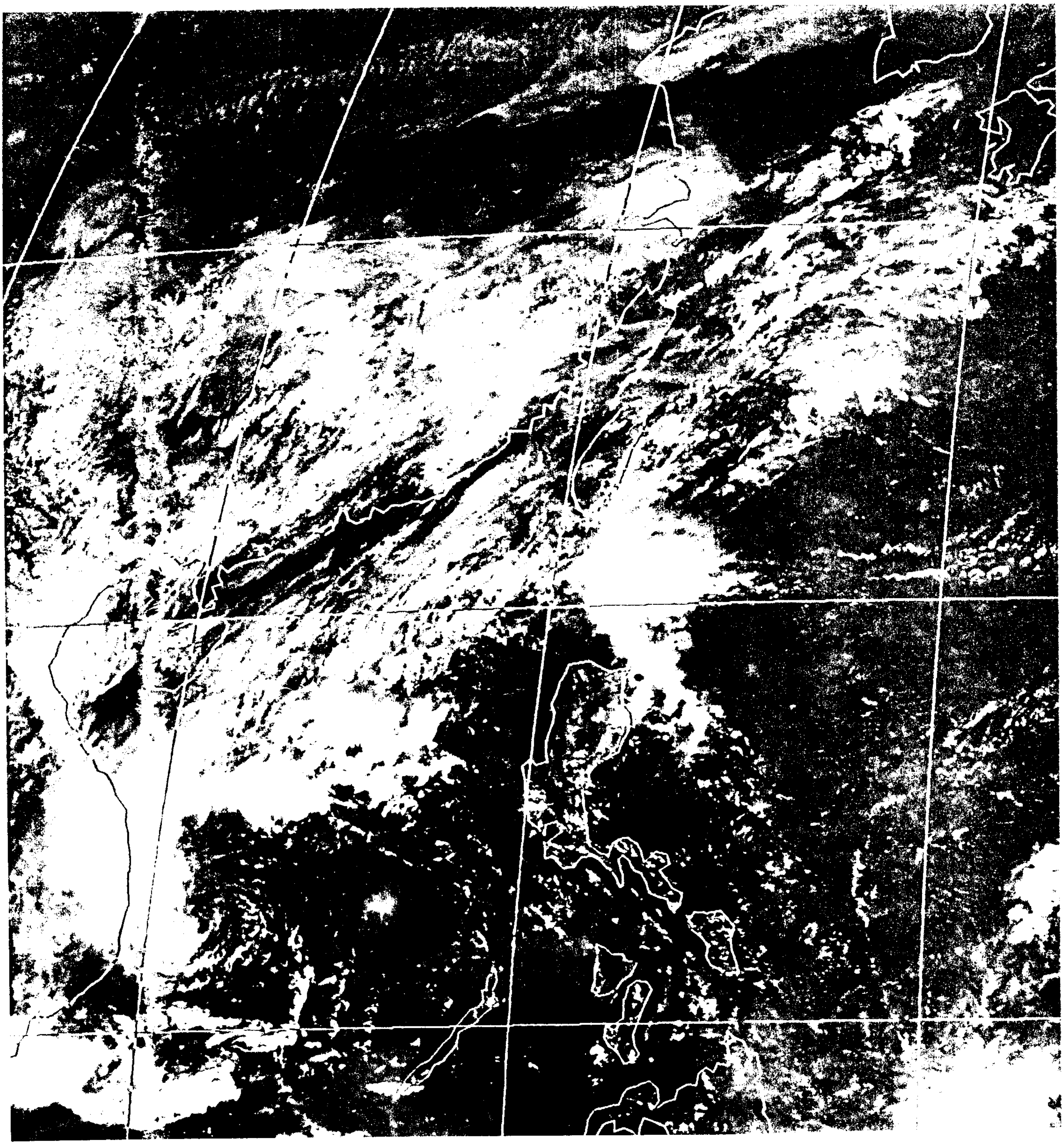


Figure 6. VS Satellite picture - 871118 03 UTC.

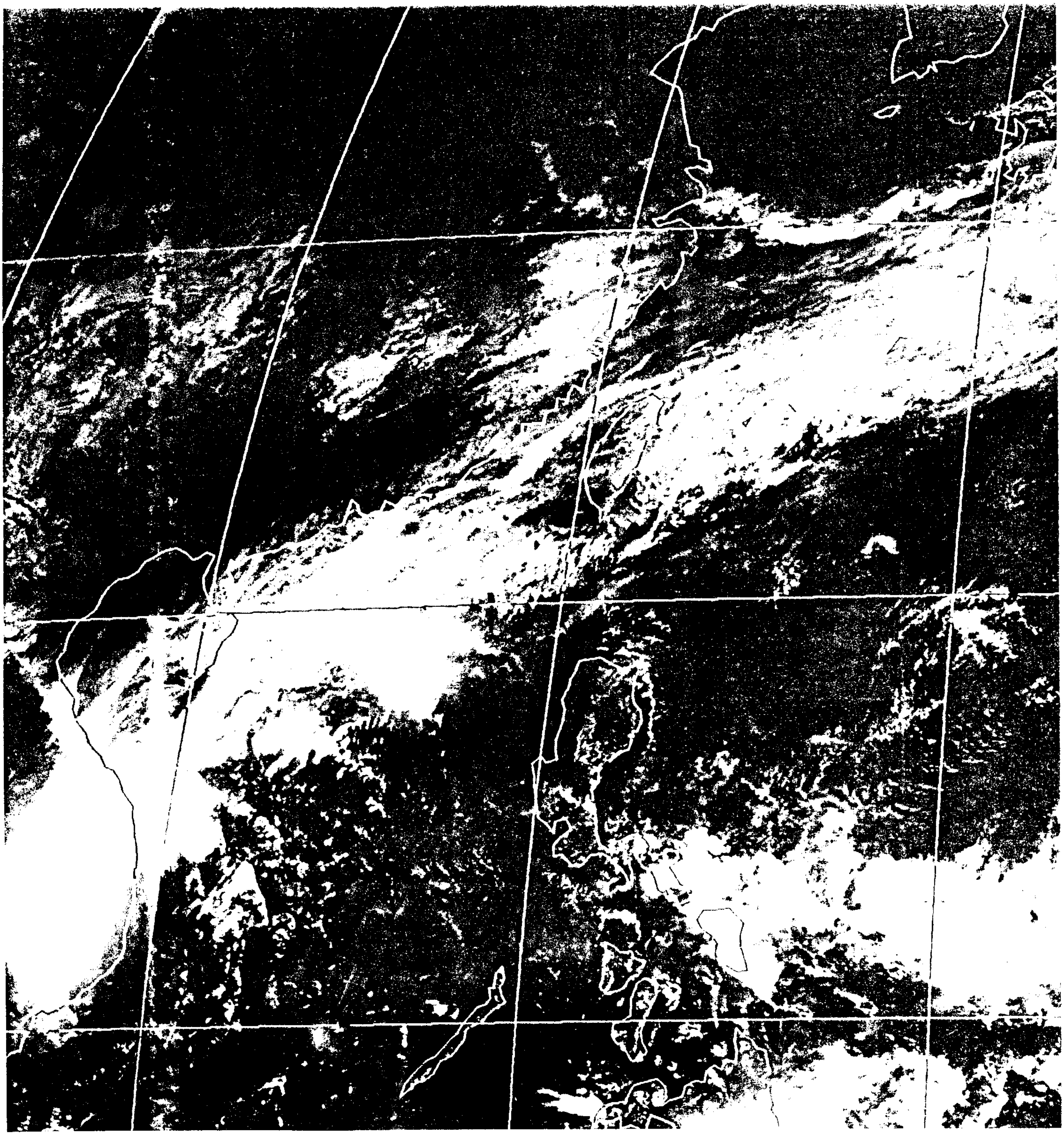


Figure 7. VS Satellite picture - 871119 03 UTC.

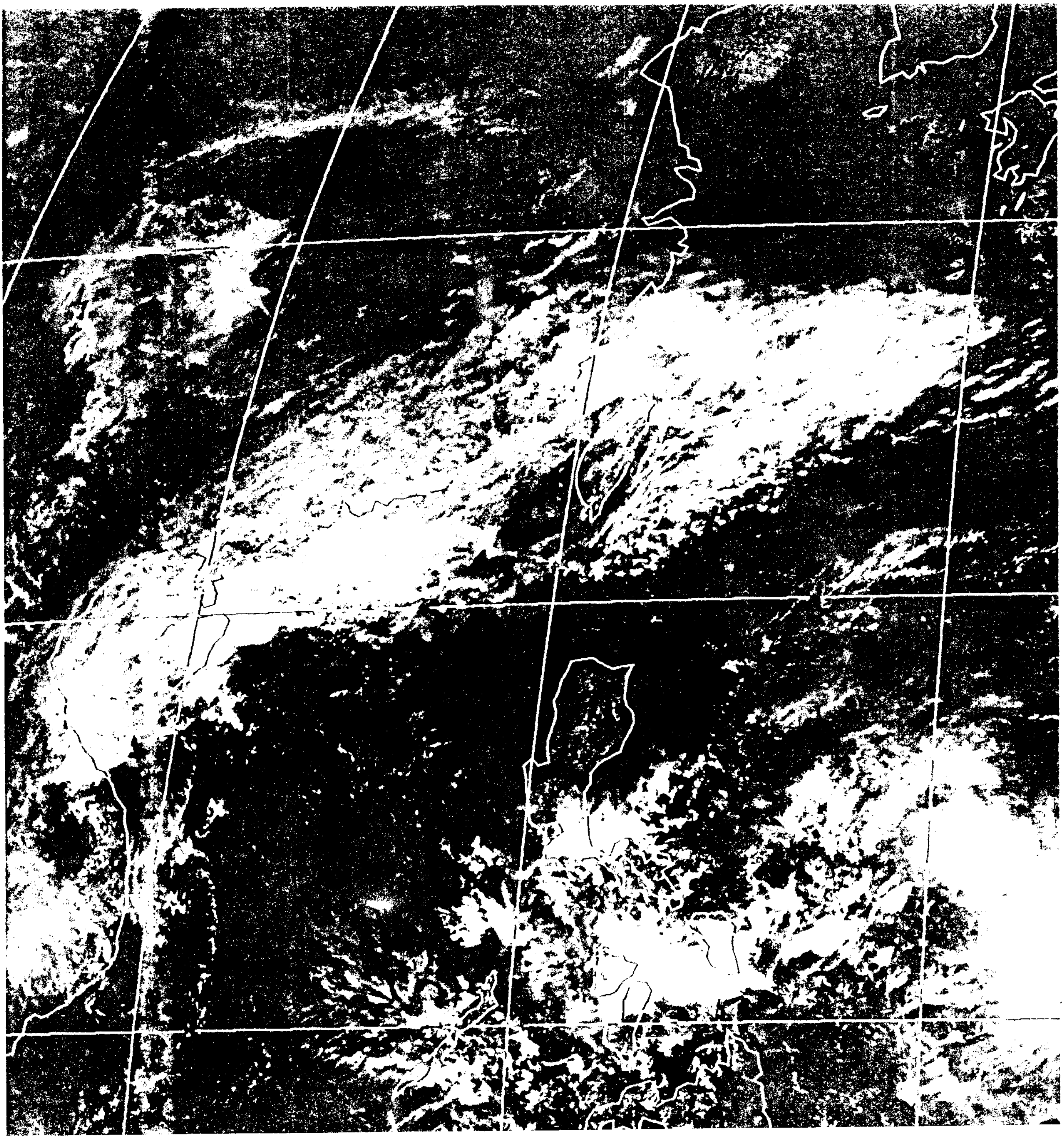


Figure 8. VS Satellite picture - 871120 03 UTC.

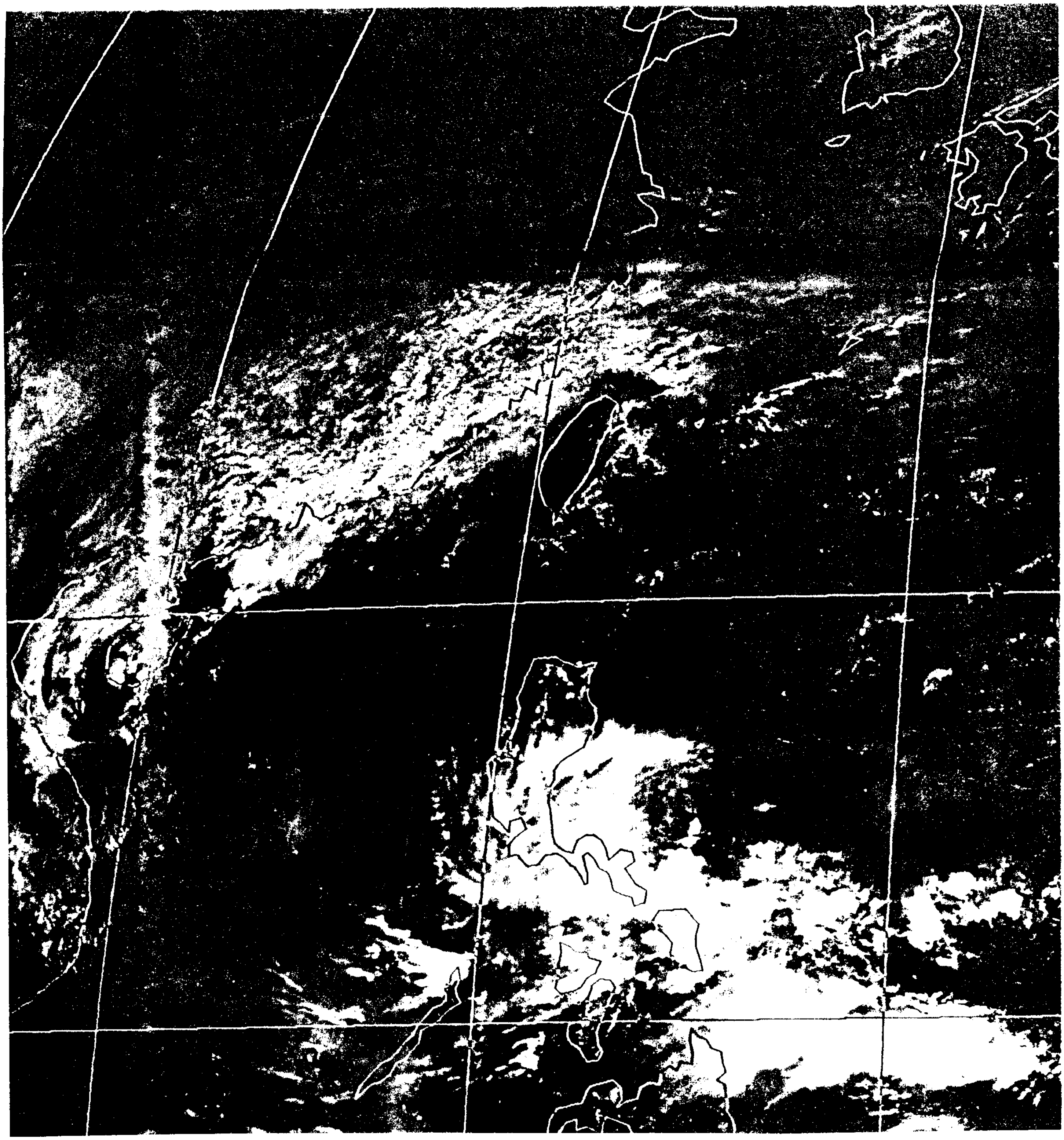


Figure 9. VS Satellite picture - 871121 03 UTC.

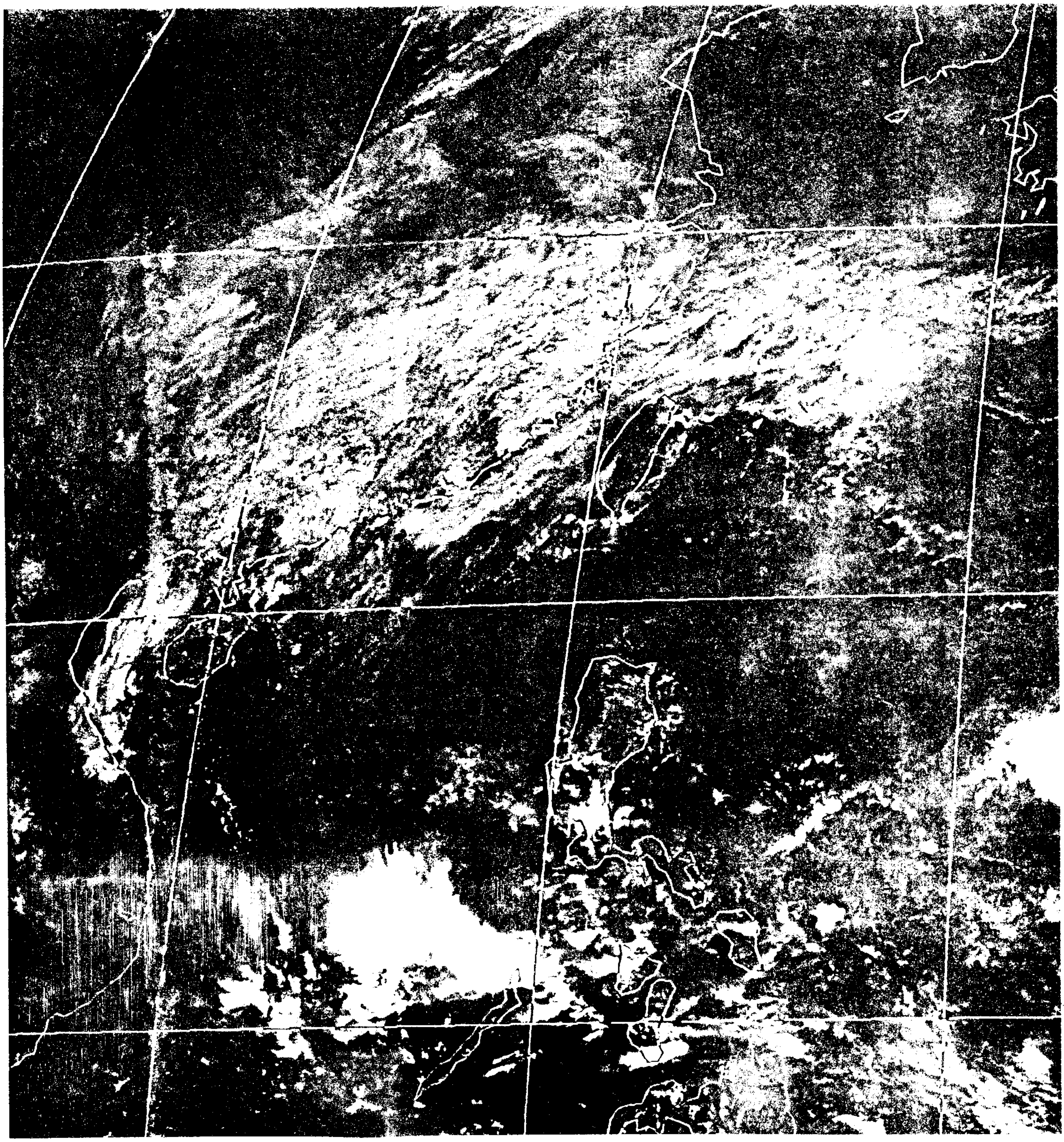


Figure 10. VS Satellite picture - 871122 03 UTC.

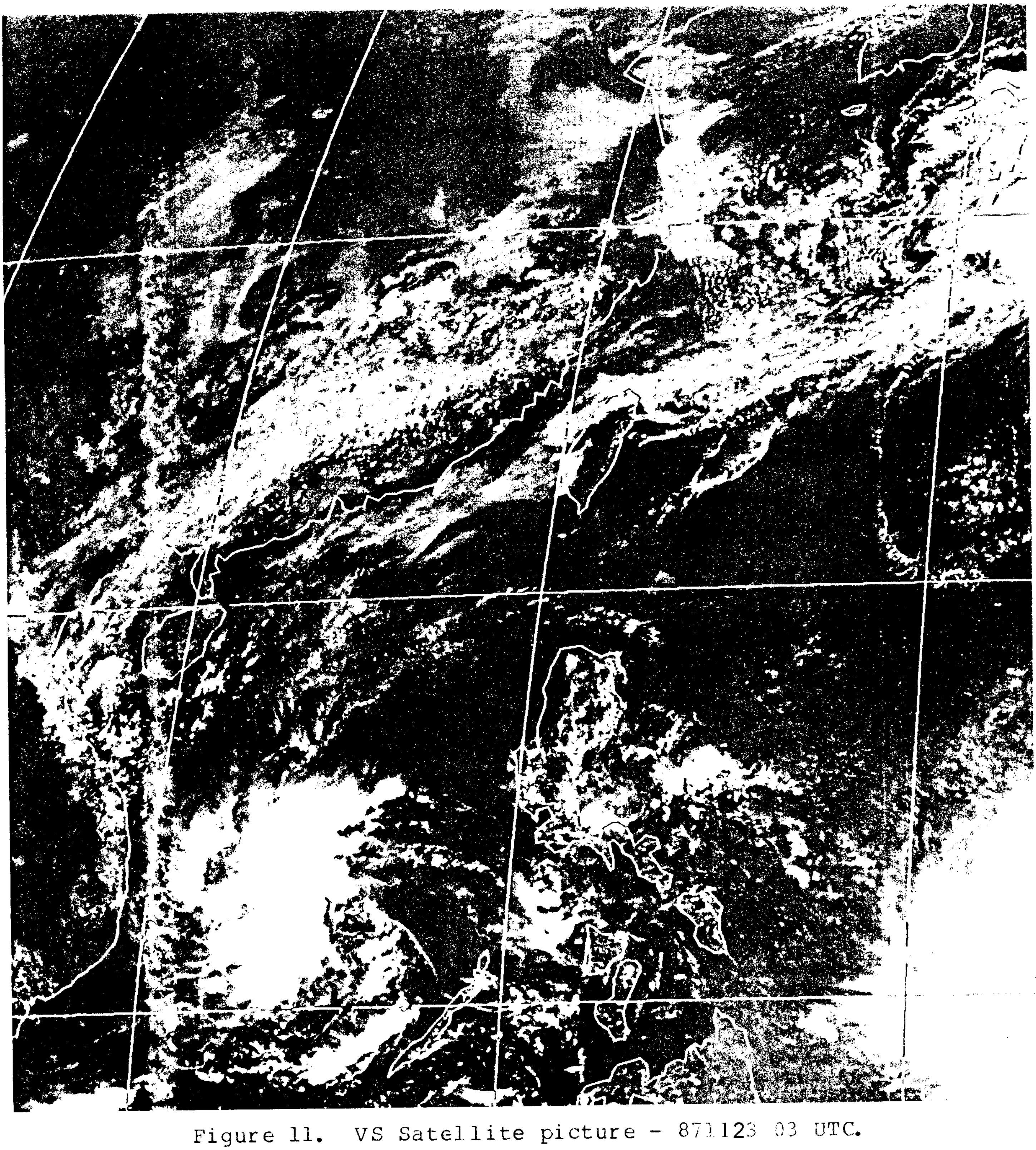


Figure 11. VS Satellite picture - 871123 03 UTC.

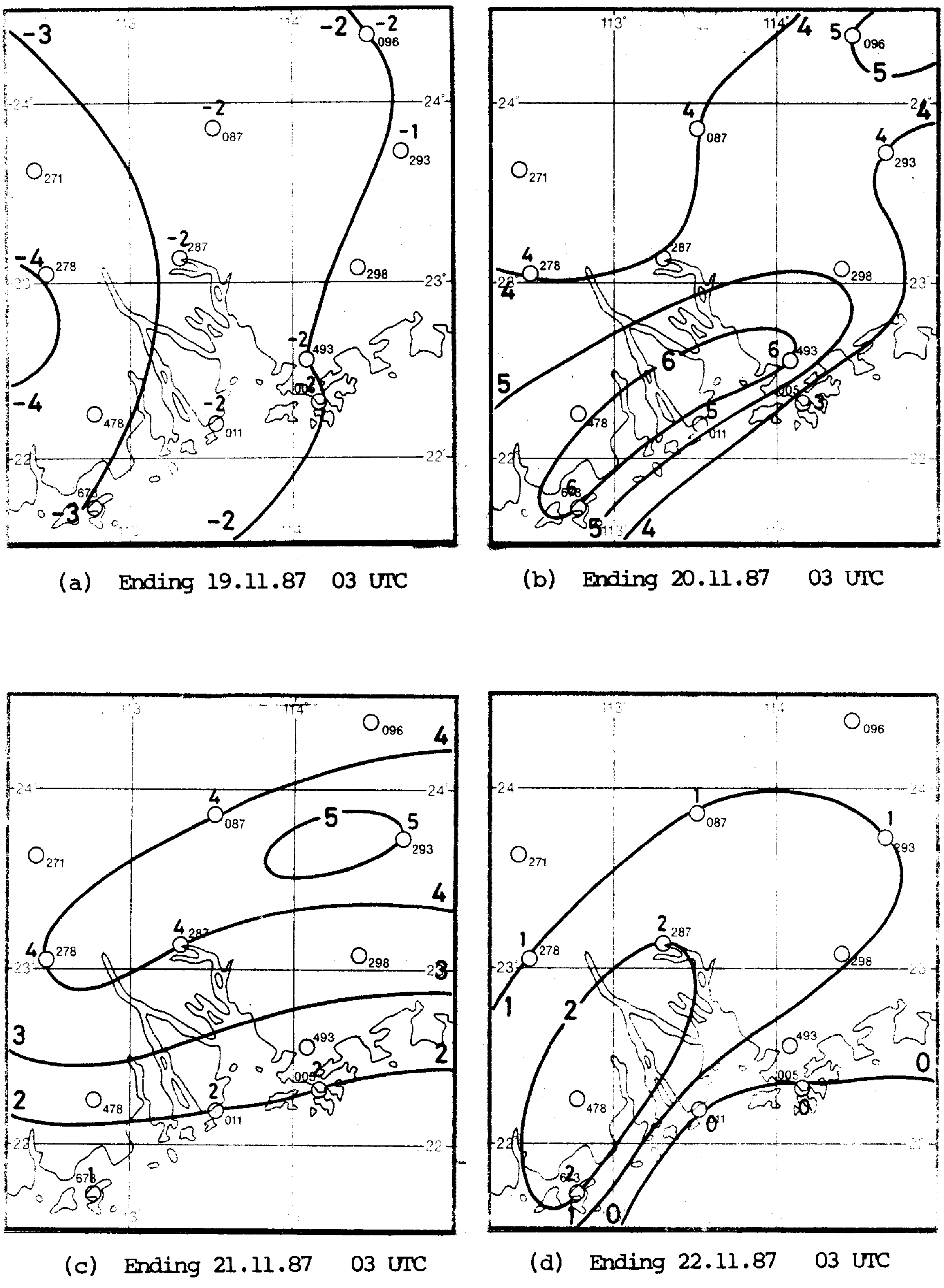
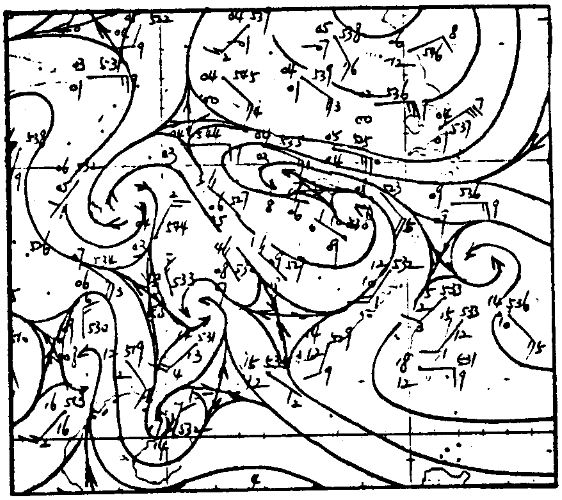


Figure 12. 24-hourly surface dew point change over South China.



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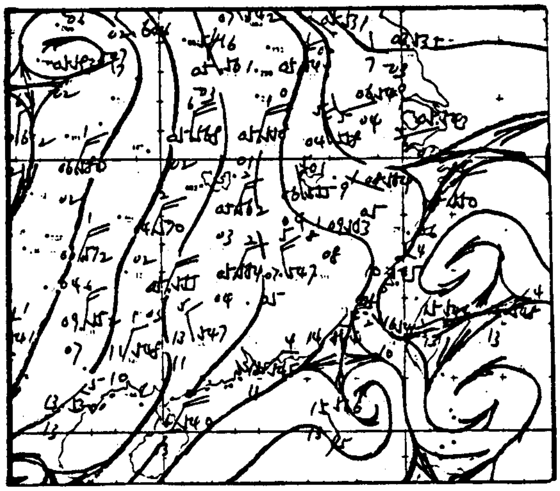
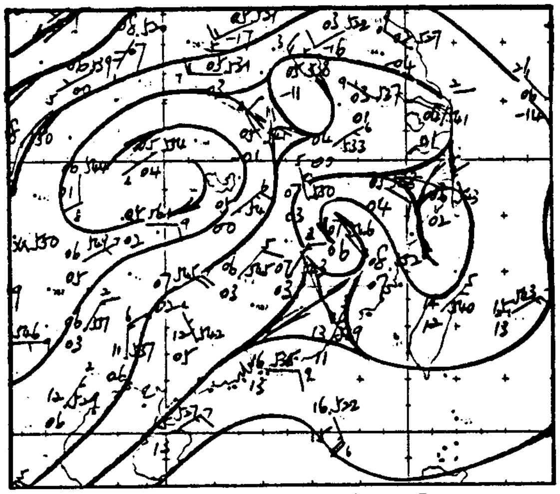
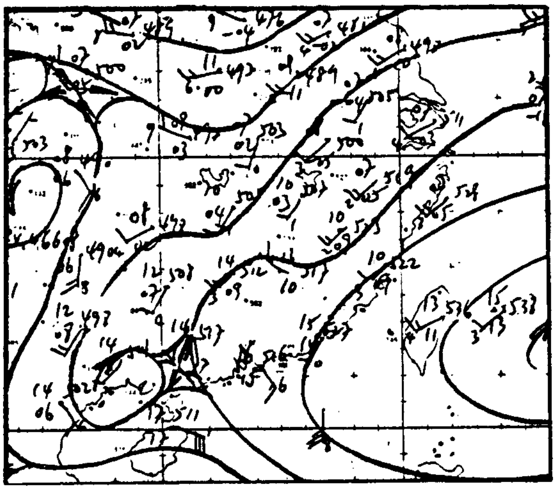


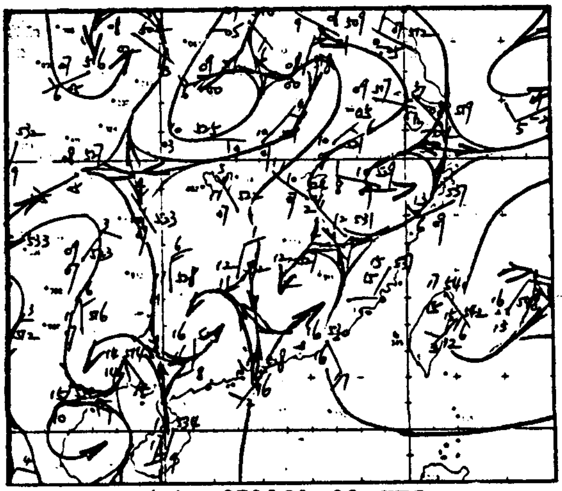
(b) 871118 00 UTC



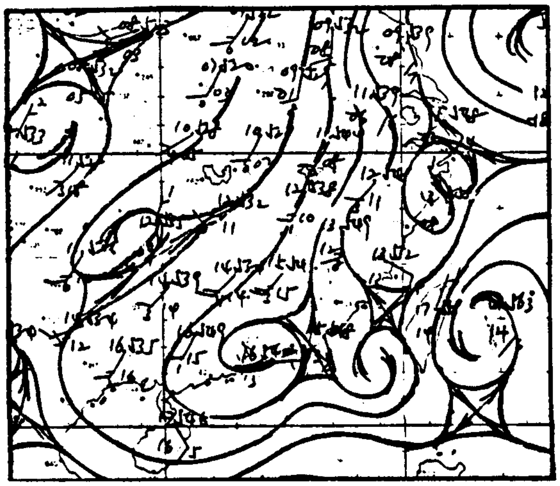
(c) 871119 00 UTC



(d) 871120 00 UTC

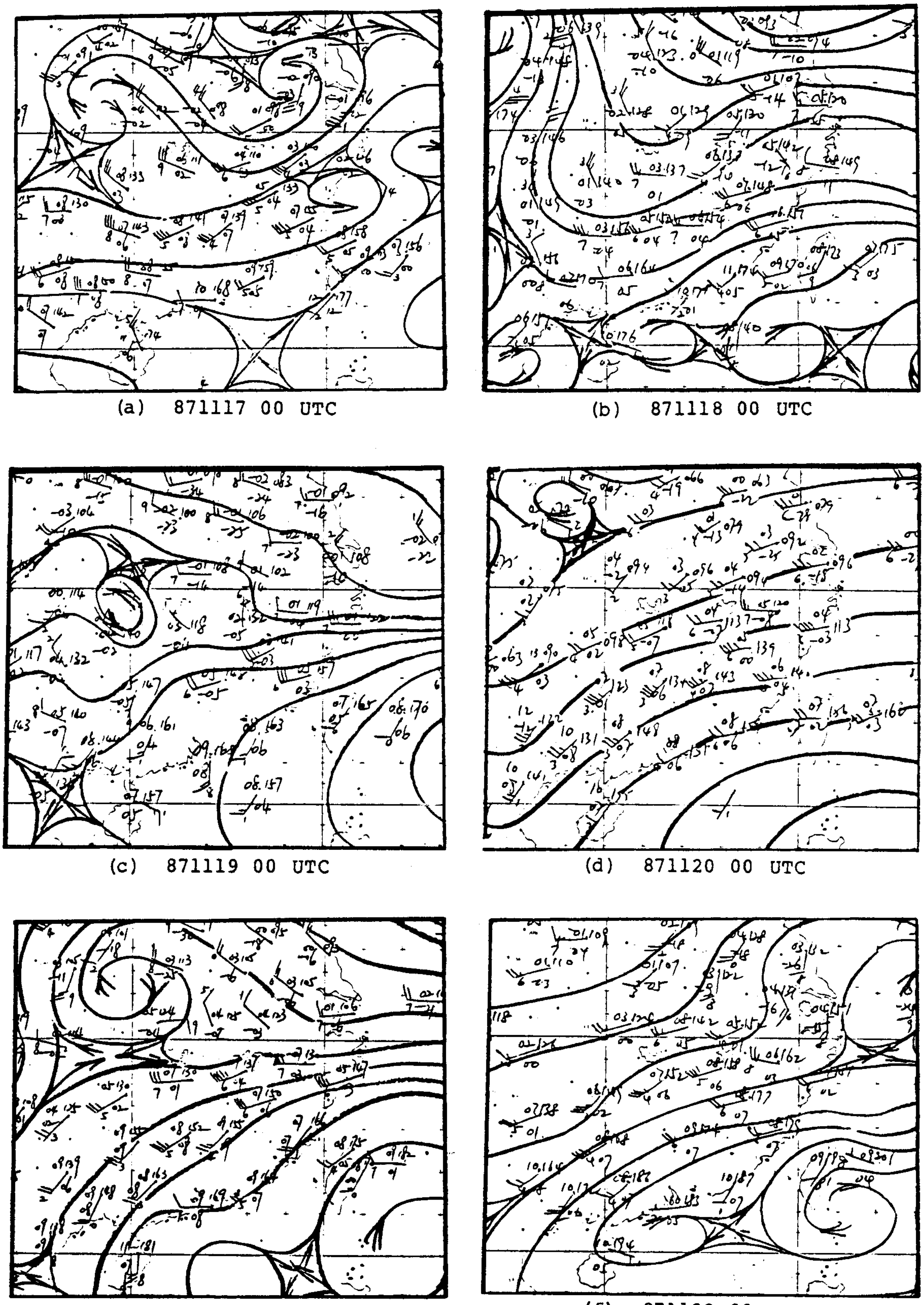


(e) 871121 00 UTC



(f) 871122 00 UTC

Figure 13. 850 hPa charts.



(a) 871117 00 UTC

(b) 871118 00 UTC

(c) 871119 00 UTC

(d) 871120 00 UTC

(e) 871121 00 UTC

(f) 871122 00 UTC

Figure 14. 700 hPa charts.

4. CASE II : HERBERT, 9 - 13 NOVEMBER 1986

4.1 Weather sequence and upper-air pattern

Tropical Storm Herbert moved across the South China Sea during this period (Figure 15).

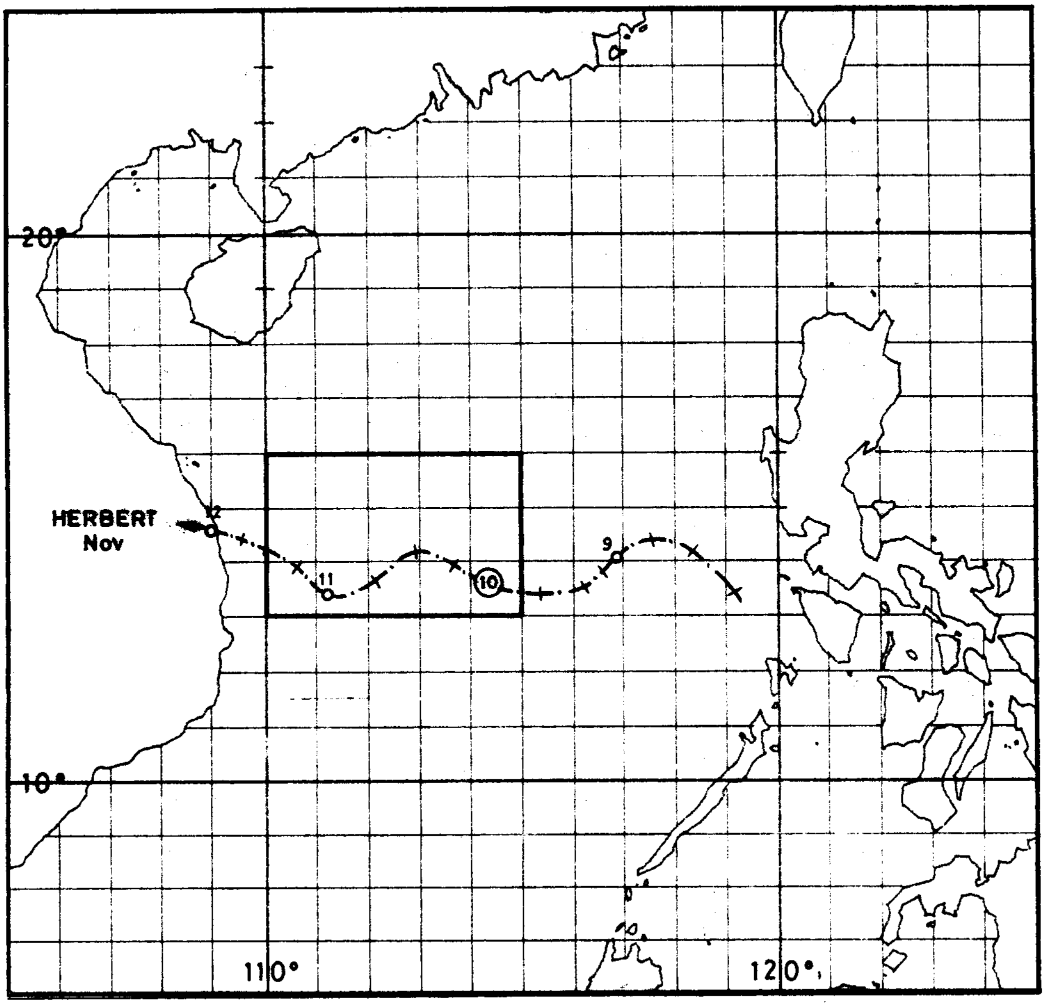


Figure 15. Track of Tropical Storm Herbert.

On 8th, a band of cloud associated with a 500 hPa trough lay along the coast of South China (Figure 16). Herbert was just off the western coast of the Philippines. After the 500 hPa trough had passed the longitude of Hong Kong on 9th (Figure 17), dry air from a continental anticyclone dominated South China at 850 and 700 hPa (Figure 21). The band of cloud associated with the 500 hPa trough was pushed by the continental air to the south of the coast and linked up with the circulation of Herbert (Figures 18,19) to form a cloud plume. As a result, fine weather prevailed over Hong Kong on 9th and 10th. The cloud plume moved northward back to the coast on 11th as Herbert moved westwards (Figure 20), bringing rain to Hong Kong. By this time, the continental airstream at 850 and 700 hPa had been replaced by south to southeasterly flow (Figure 21). Herbert dissipated over Vietnam on 12th while the cloud band continued to move northwards and eventually cleared Hong Kong on 13th (Figure 22).

TABLE 3. WEATHER ELEMENTS ON 9 - 13 NOVEMBER 1986

Date	Rainfall (mm)	Bright Sunshine (hours)
9	-	9.7
10	-	8.3
11	1.1	-
12	0.5	1.2
13	0.5	5.3

4.2 Observations

This case shows the interaction of a westerly trough moving across South China with a tropical cyclone over the South China Sea. Clouds associated with the trough linked up with the circulation of the tropical cyclone and moved back to the South China coast to produce rain.

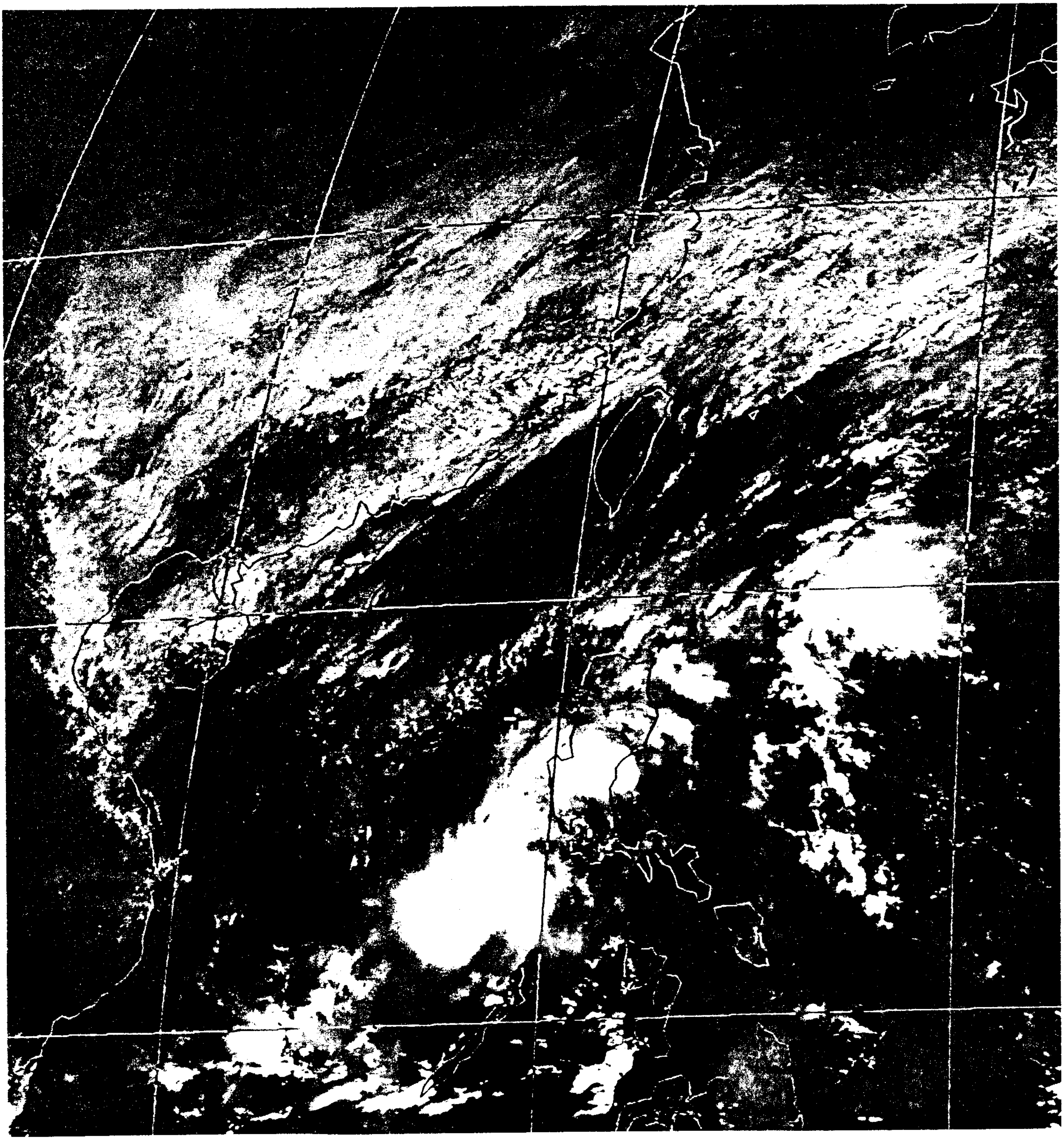


Figure 16. VS Satellite picture - 861108 03 UTC.

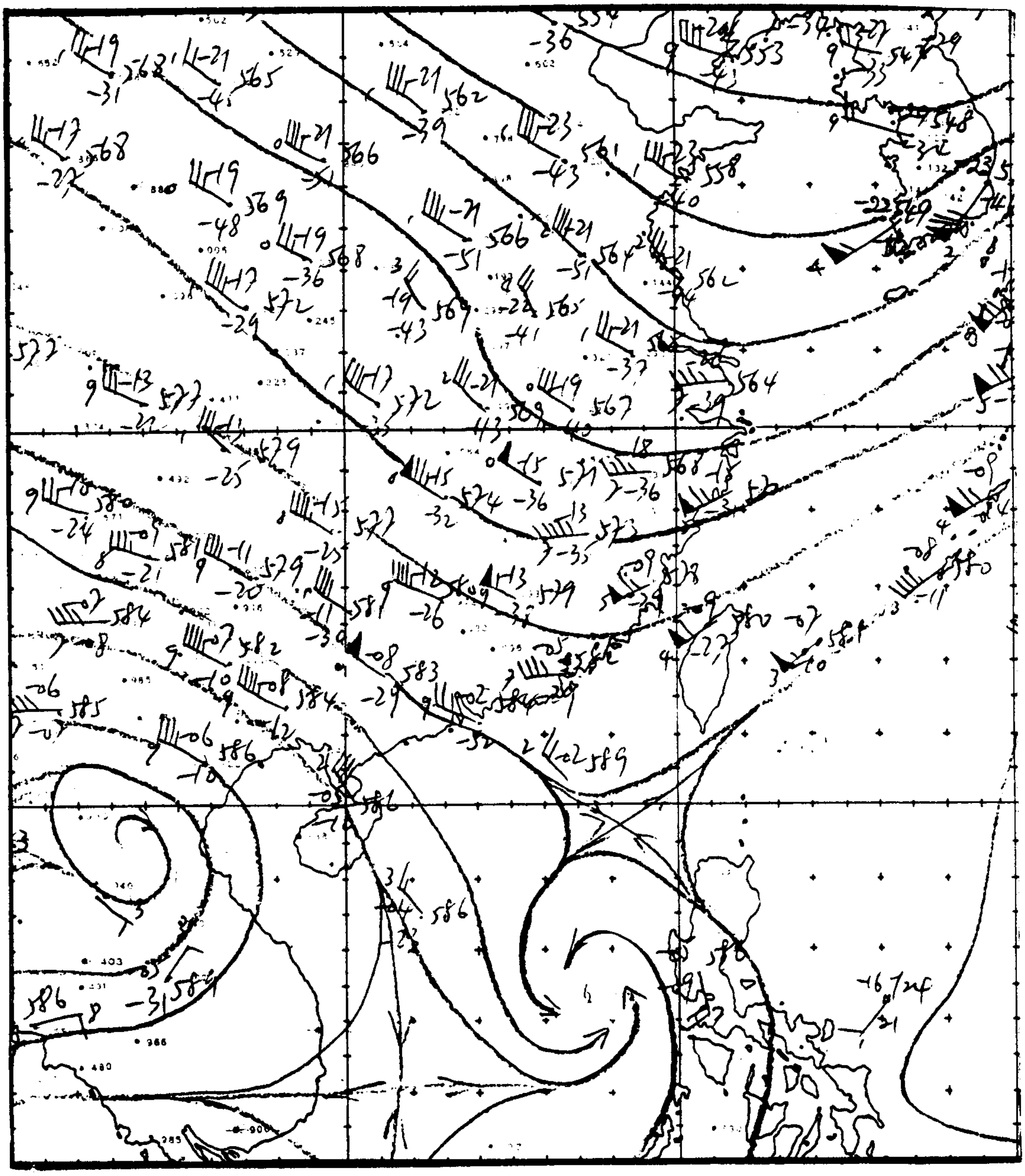


Figure 17. 500 hPa chart - 861109 00 UTC.

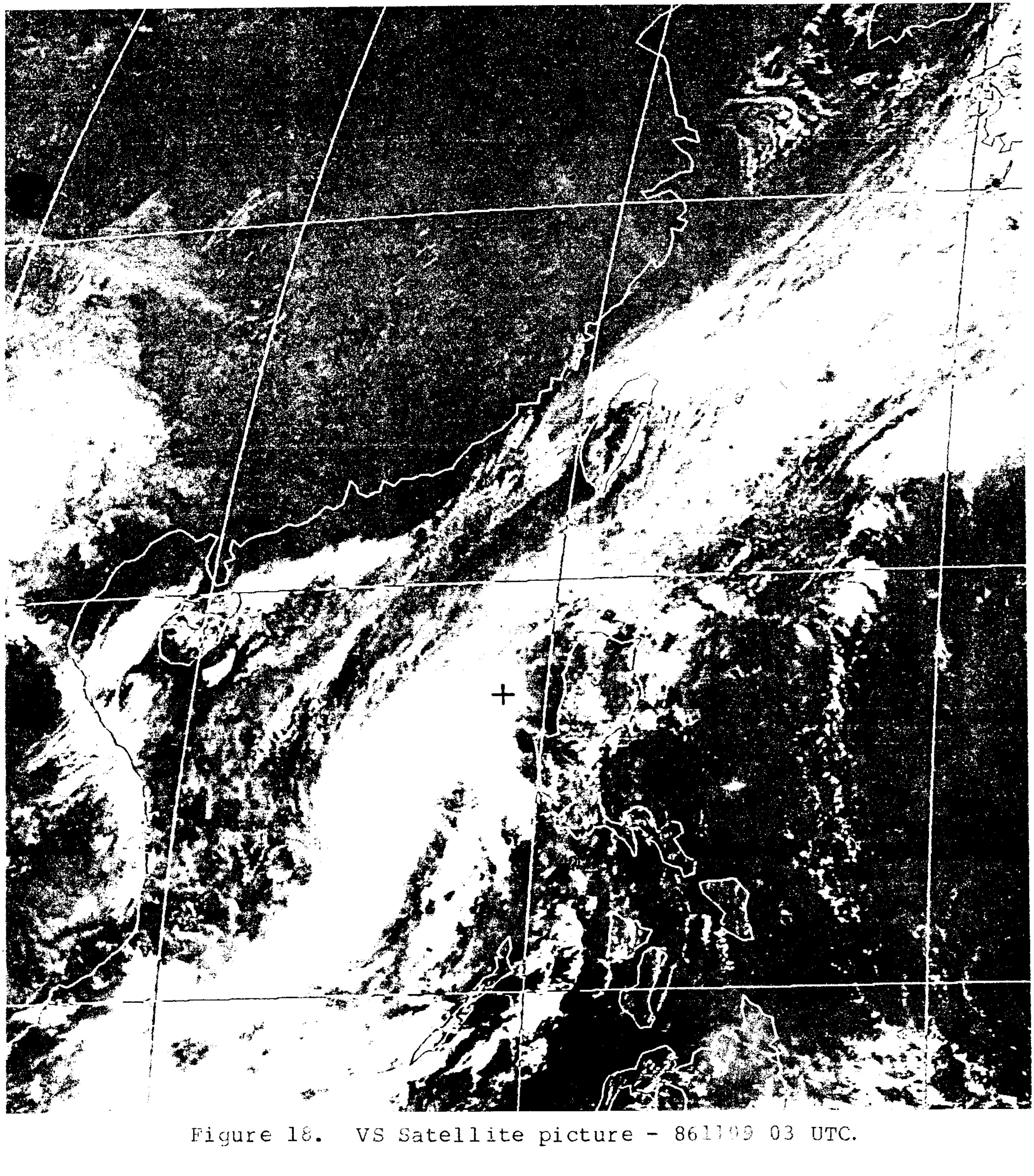


Figure 18. VS Satellite picture - 861109 03 UTC.

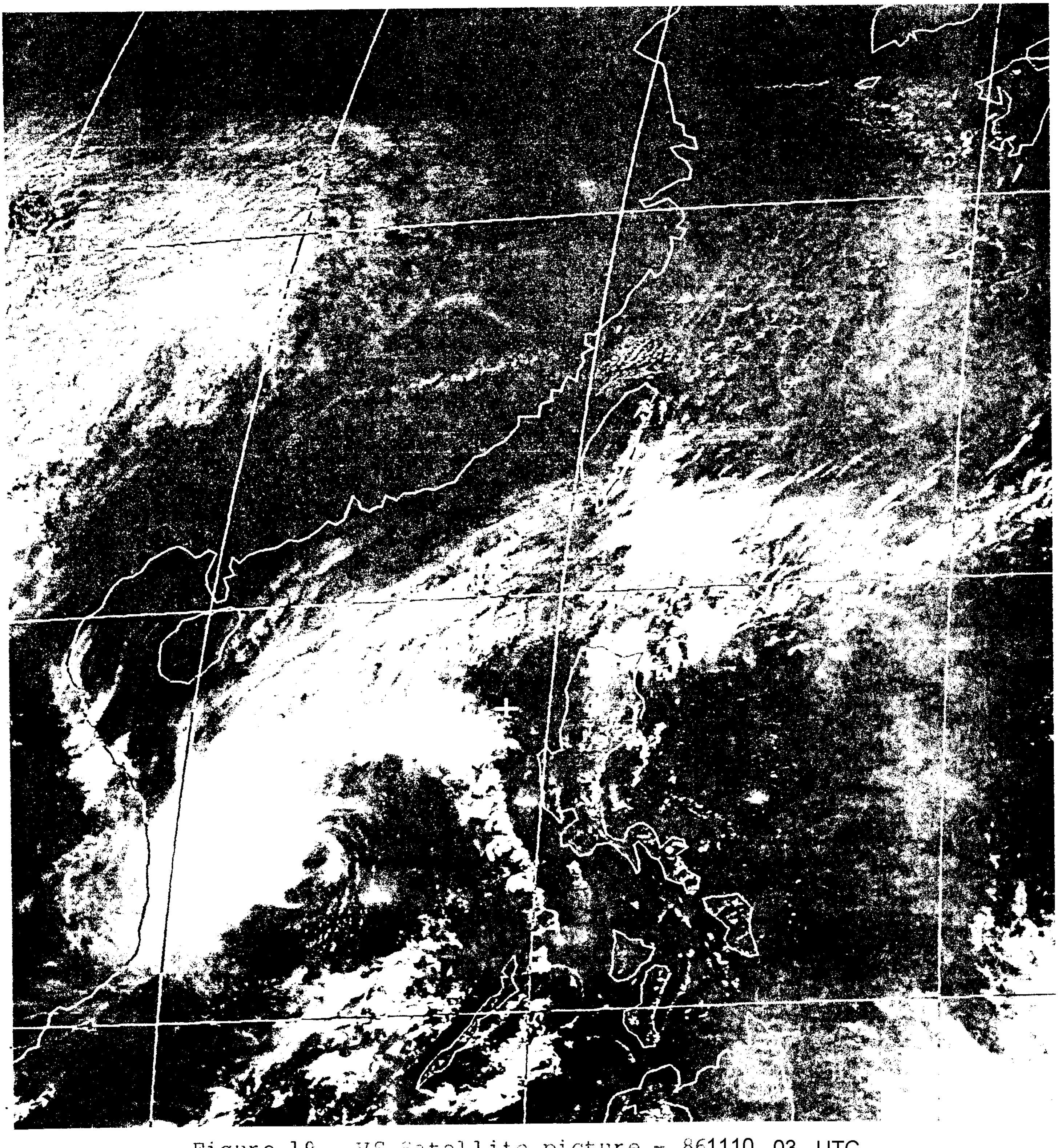


Figure 19. VS Satellite picture - 861110 03 UTC.

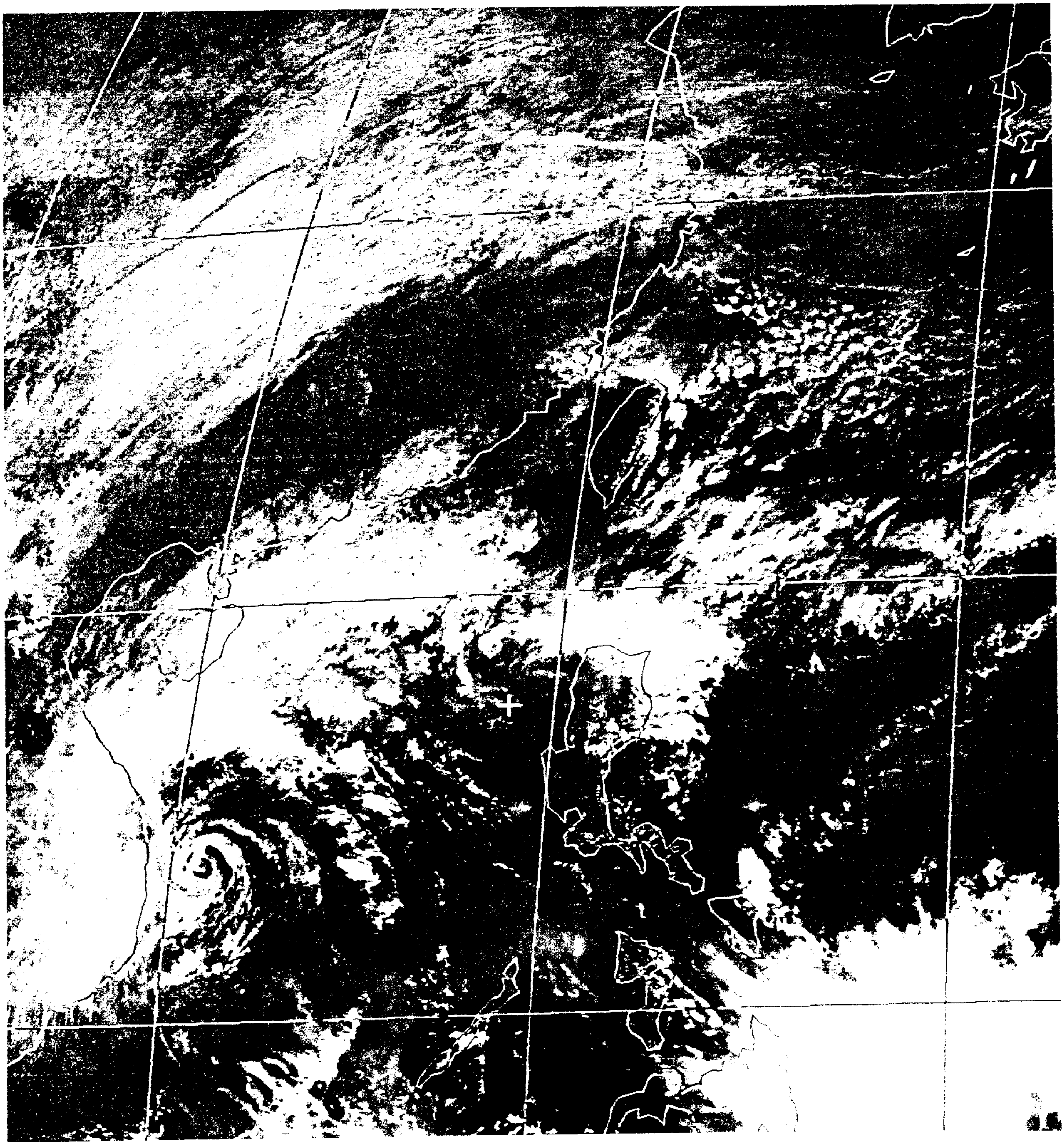
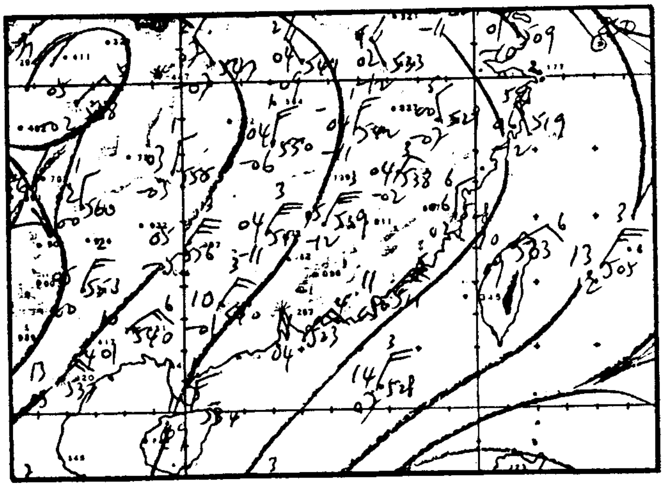
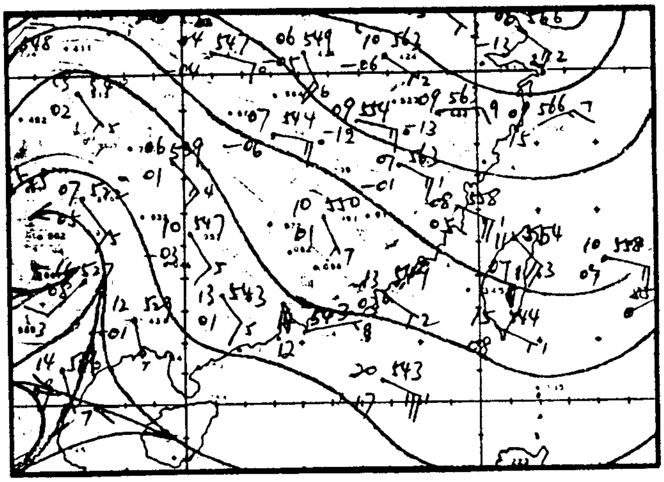


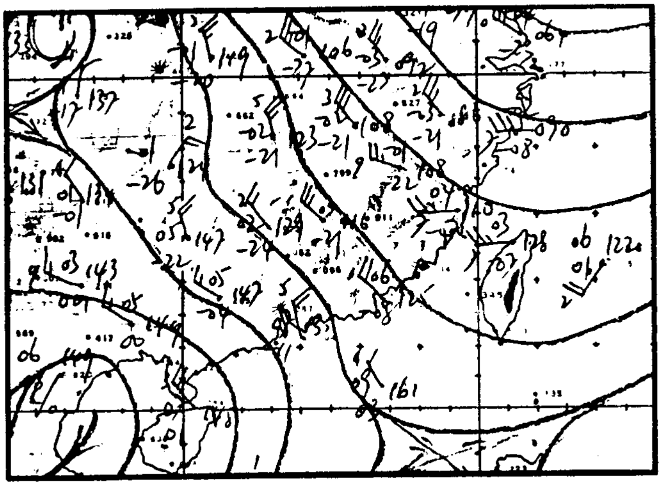
Figure 20. VS Satellite picture - 861111 03 UTC.



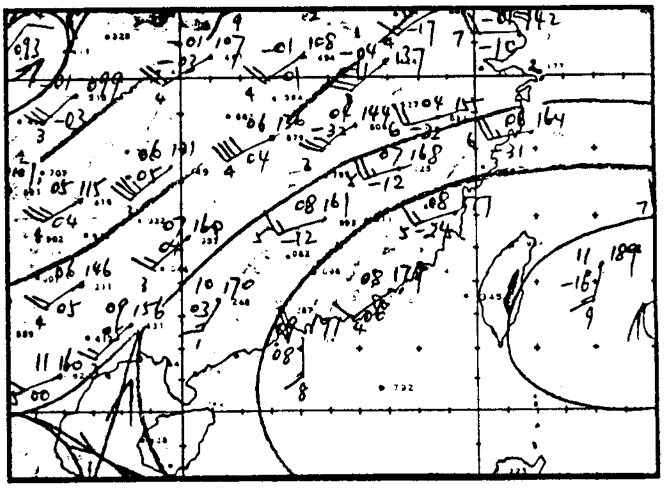
(a) 850 hPa 861109 00UTC



(b) 850 hPa 861111 00UTC



(c) 700 hPa 861109 00UTC



(d) 700 hPa 861111 00UTC

Figure 21. 850 and 700 hPa charts.

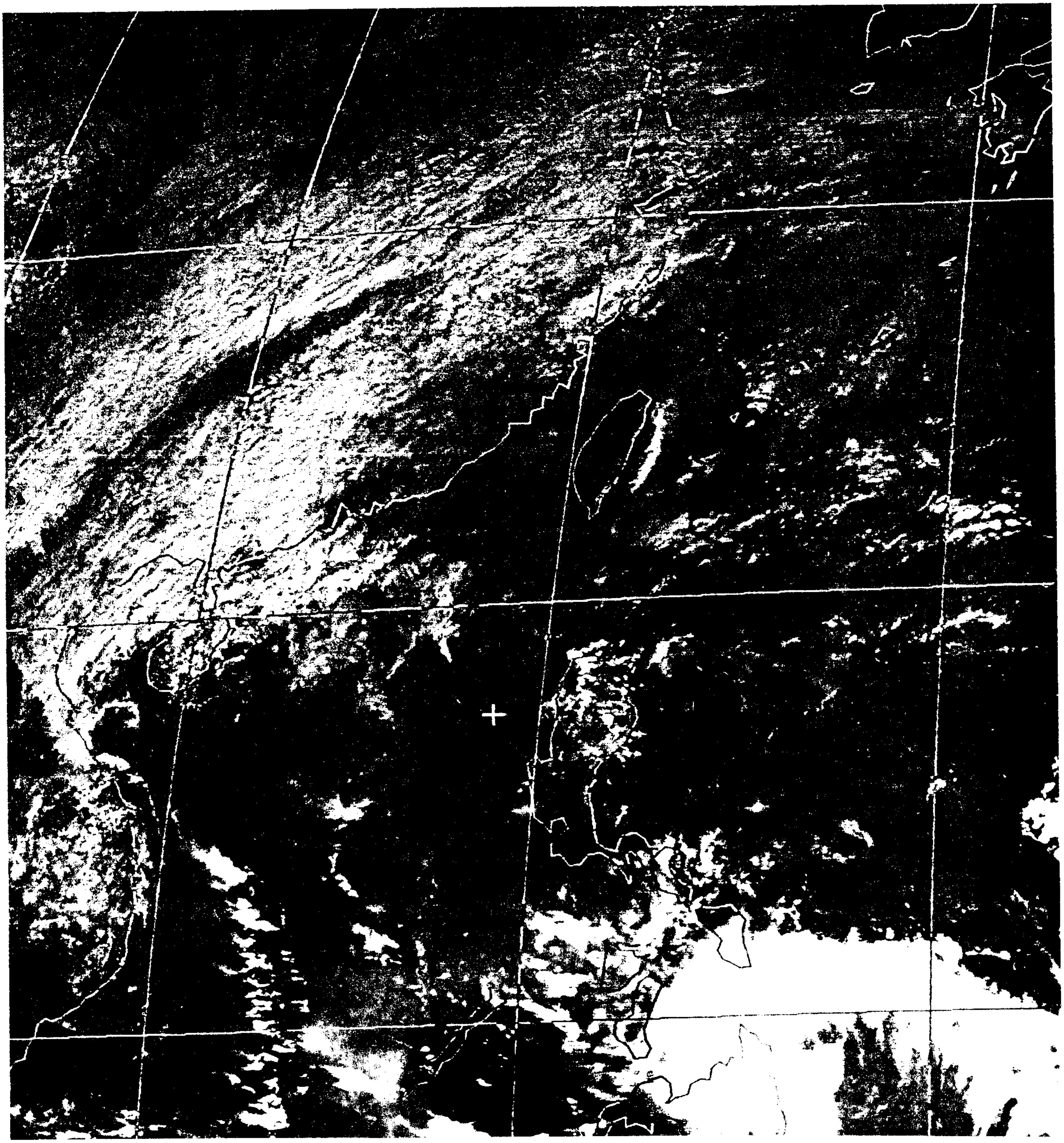


Figure 22. VS Satellite picture - 861112 03 UTC.

5. CASE III : IDA, 15 - 20 NOVEMBER 1986

5.1 Weather sequence

The track of Ida which meandered over the South China Sea during this period is shown in Figure 23. Tropical Storm Ida moved northwestwards across the central Philippines on 13th. It then intensified into a severe tropical storm over the South China Sea on the morning of 15th when it was about 230 kilometres east-northeast of Xisha.

From Ida, a band of cloud extended northeastwards (cloud plume of Ida) to cover the coast of southeast China on 15th (Figure 24). Weather of Hong Kong was overcast with periods of rain. Ida recurved to the northeast that evening and weakened to a tropical storm early the next day after the entrainment of cold air from the north into its circulation. Rain in Hong Kong continued until the late afternoon of 16th.

On 17th, Ida degenerated to an area of low pressure about 100 kilometres southeast of Dongsha. An area of fine weather over southwest China spread eastwards on the same day and gave rise to sunny periods in Hong Kong. The cloud band that brought rain to Hong Kong in the previous two days was held to the southeast of the South China coast (Figure 26). Rain returned to Hong Kong that night as the cloud band returned to the coast. This cloud band continued to give rise to rain over Hong Kong until the evening of 19th. It turned fine on 20th as this cloud band moved south of the coast again.

Meanwhile the remnant of Ida was steered by the low level northeast monsoon towards the southwest. Visible satellite picture and surface observations showed that a weak circulation survived until 19th.

TABLE 4. WEATHER ELEMENTS ON 15 - 20 NOVEMBER 1986

Date	Rainfall (mm)	Bright Sunshine (hours)
15	31.3	-
16	29.6	-
17	0.3	3.5
18	19.1	-
19	20.2	-
20	Tr	8.9

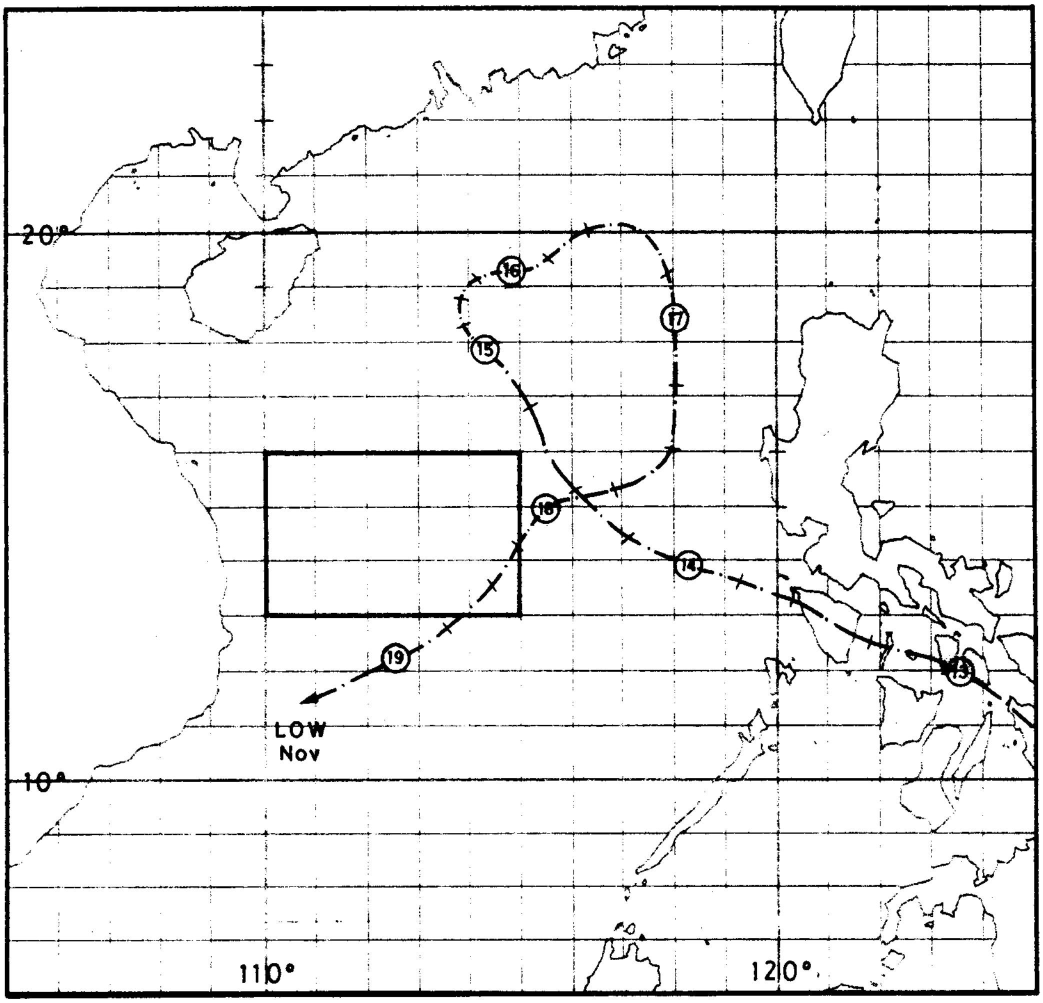


Figure 23. Track of Severe Tropical Storm Ida.

5.2 Upper-air pattern

On 15th, from an anticyclone over northwest China, continental northeasterlies dominated China at 850 hPa except for the South China coastal region which lay in the confluence zone between the northeasterlies and southeasterlies from the circulation of Ida (Figure 30a). Over 700 hPa, Hong Kong lay in the periphery of the circulation of Ida (Figure 31a). On that day, Hong Kong was affected by the cloud plume of Ida and had periods of rain. A ridge at 700 hPa over southwest China tied in well with the relatively fine weather there. This ridge was situated in the subsidence region behind a 500 hPa westerly trough.

On 16th, the 850 hPa anticyclone moved eastwards to northeast China while Hong Kong was just inside the circulation of Ida. The 700 hPa ridge also moved east. Consequently, winds over Hong Kong at 700 hPa turned from southeast to north-northwest later on 16th. Rain at Hong Kong eased off on the afternoon of 16th.

Under the influence of this 700 hPa ridge on 17th morning (Figure 31c), Hong Kong had sunny periods while the cloud plume of Ida was held to the southeast of Hong Kong. This ridge weakened during the day and local 700 hPa winds turned southeasterly again. The cloud plume returned that evening and it rained again around midnight and persisted until 19th.

Meanwhile, another anticyclone was getting established over west China at 850 hPa. From it, a continental north to northeasterly airstream dominated South China at 850 hPa again on 19th (Figure 30e). However, rain did not stop for at 700 hPa, Hong Kong was still under the influence of return flow from an anticyclone over Southern Taiwan (Figure 31e). After a 500 hPa westerly trough had passed the longitude of Hong Kong (Figure 32), another 700 hPa ridge developed over southwest China and the local winds at that level turned north of west on 20th (Figure 31f). The cloud plume then shifted to the south of the coast and it became fine in Hong Kong.

5.3 Observations

The 700 hPa ridge over Southwest China had direct effect on the movement of the cloud plume of Ida. If Hong Kong were under the influence of this ridge, Hong Kong would be spared weather associated with the cloud plume, for it would be kept south of the South China coast. The 850 hPa northeasterlies, however, had less effect on the movement of the cloud plume. Although the local 850 hPa winds were off-land on 19th (Figure 30e), rain did not stop until the 700 hPa ridge set in on 20th.

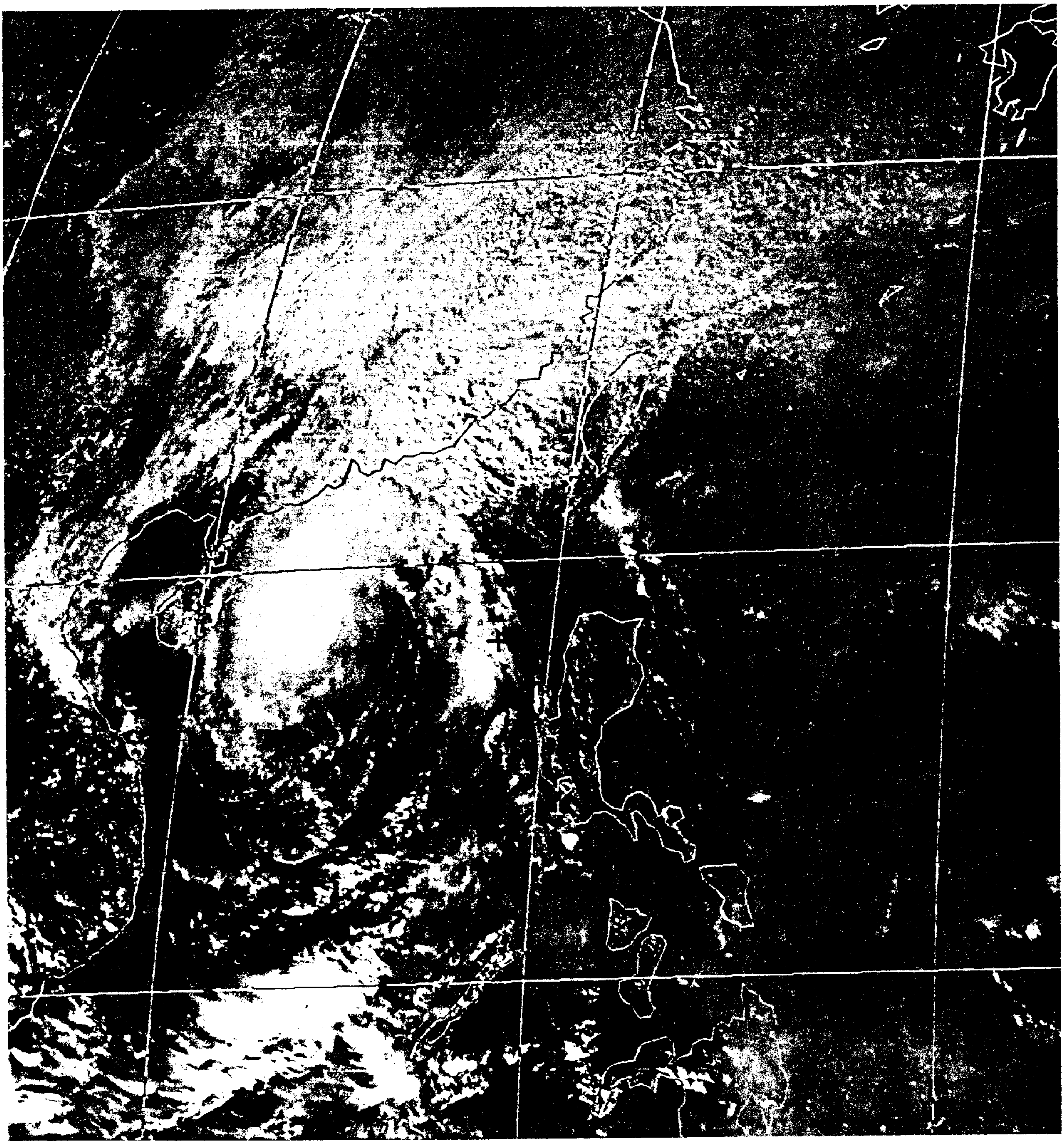


Figure 24. VS Satellite picture - 861115 06 UTC.

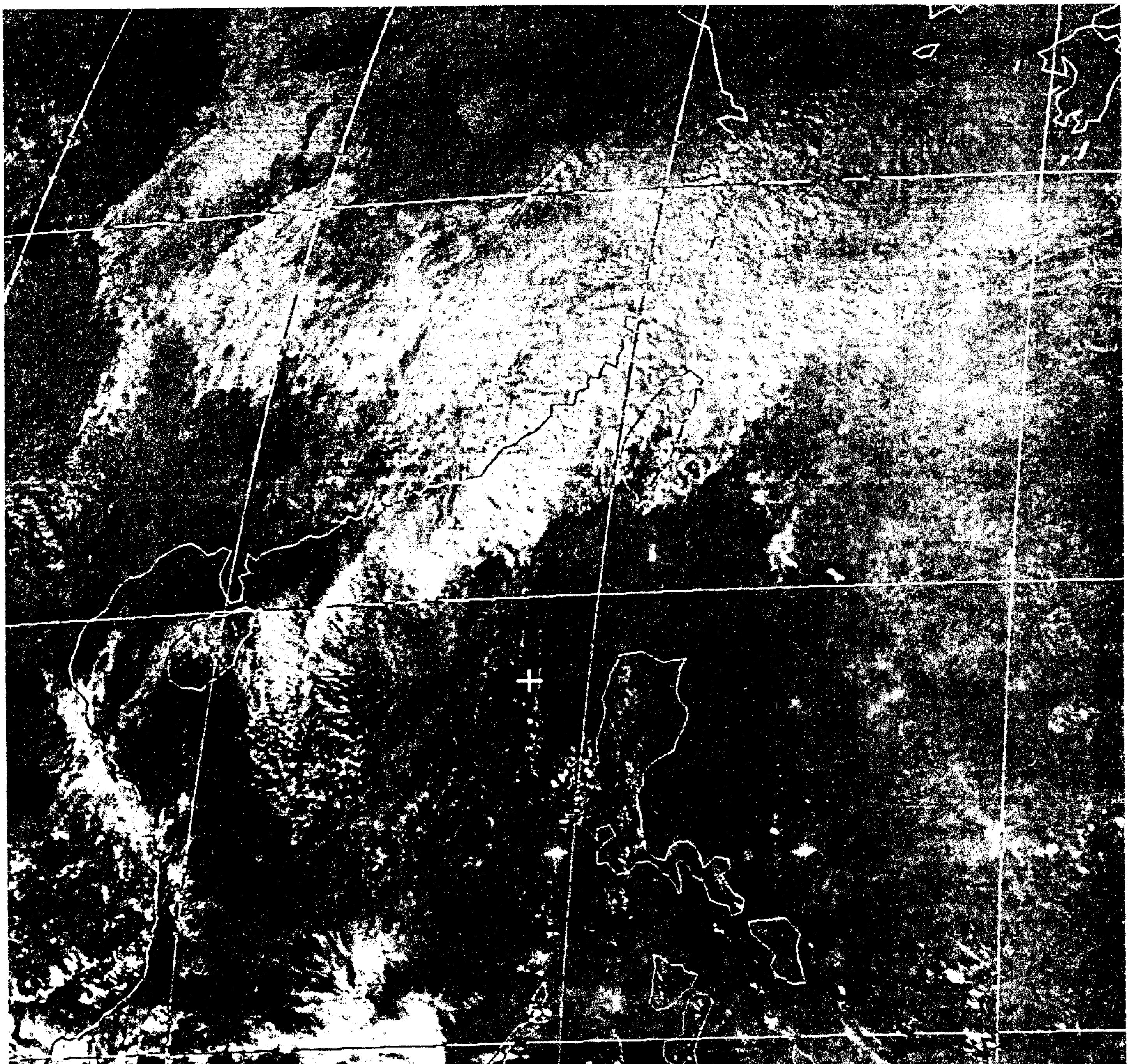


Figure 25. VS Satellite picture - 861116 06 UTC

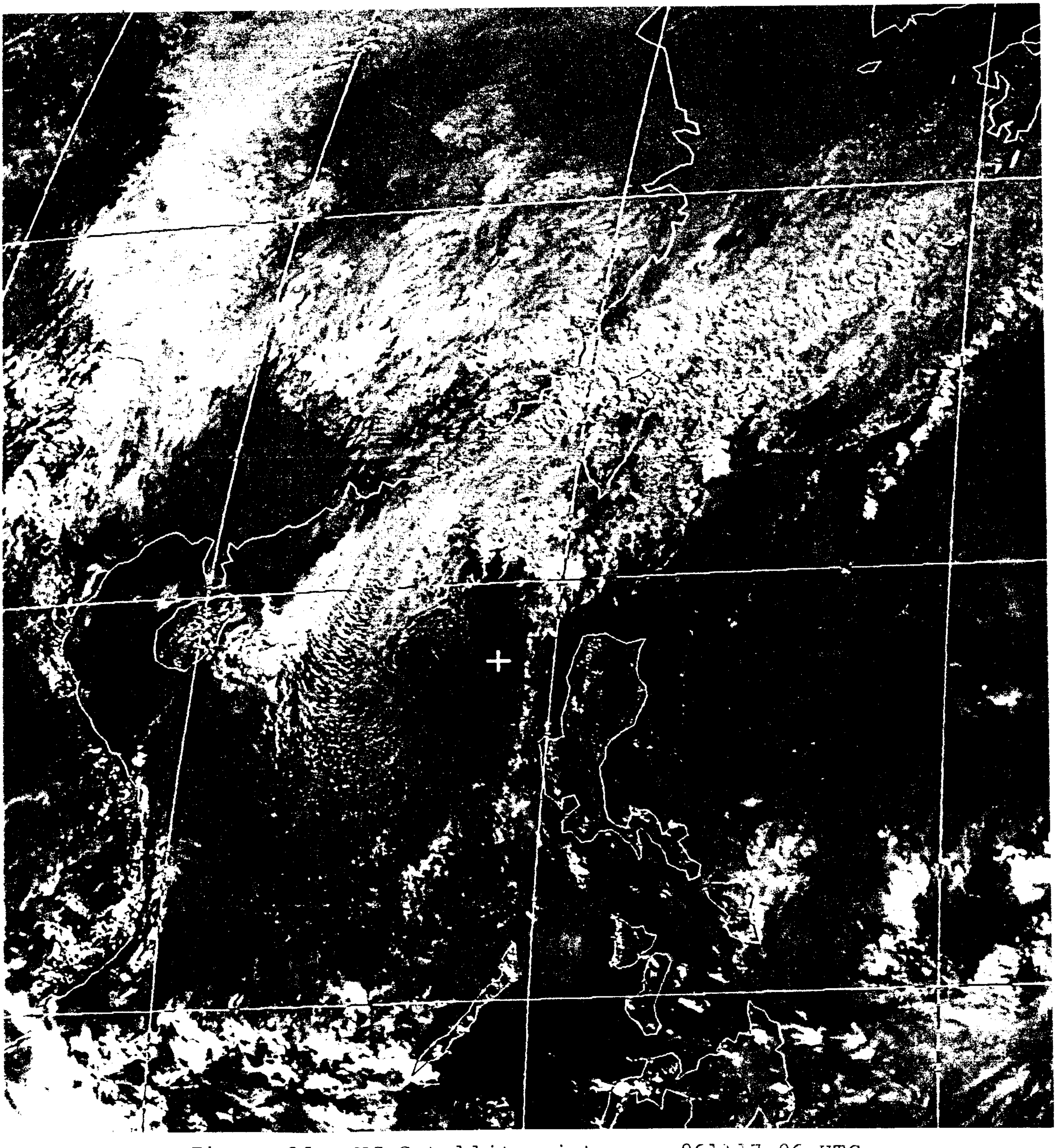


Figure 26. VS Satellite picture - 861117 06 UTC.

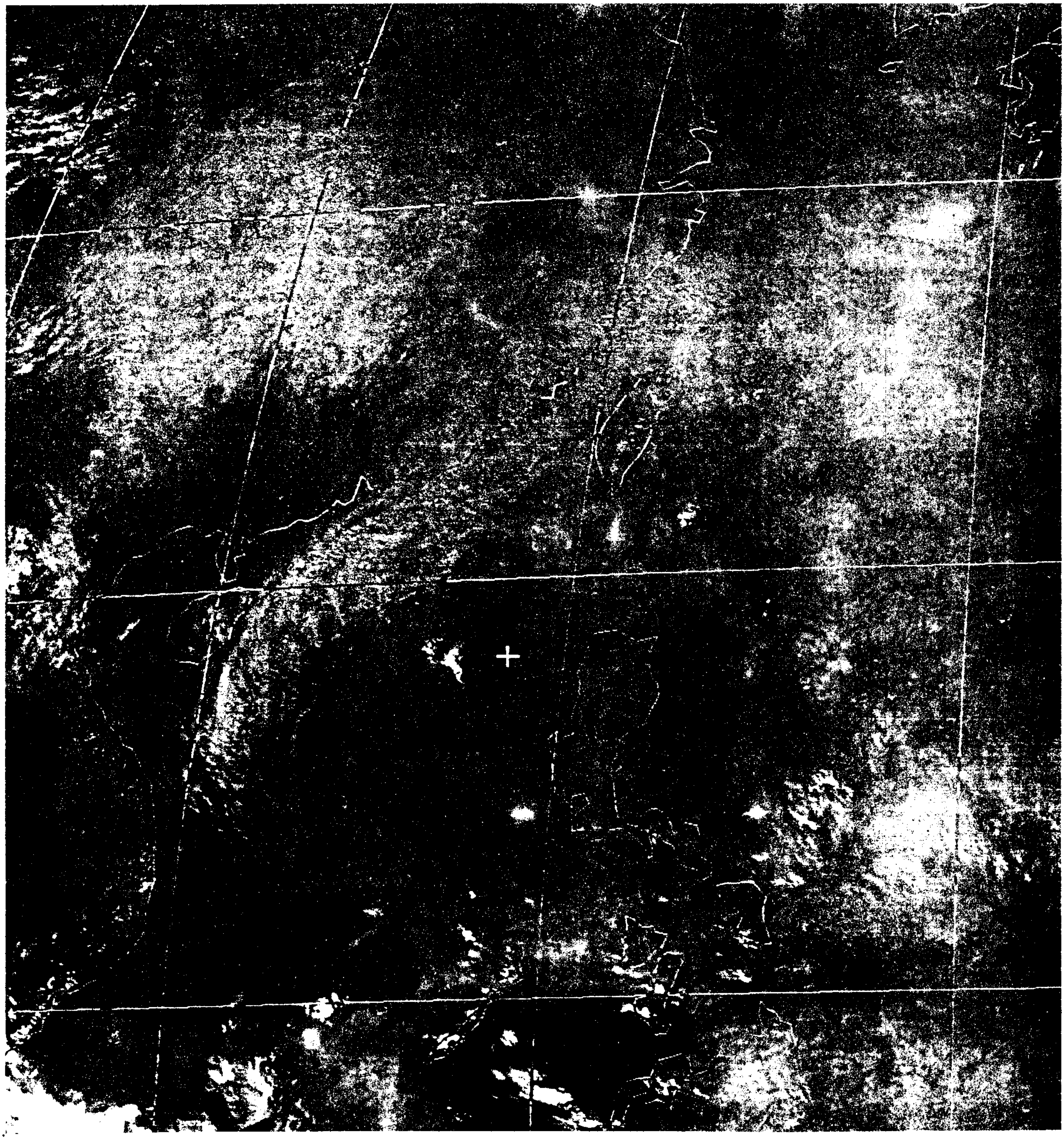


Figure 27. VS Satellite picture - 861118 06 UTC

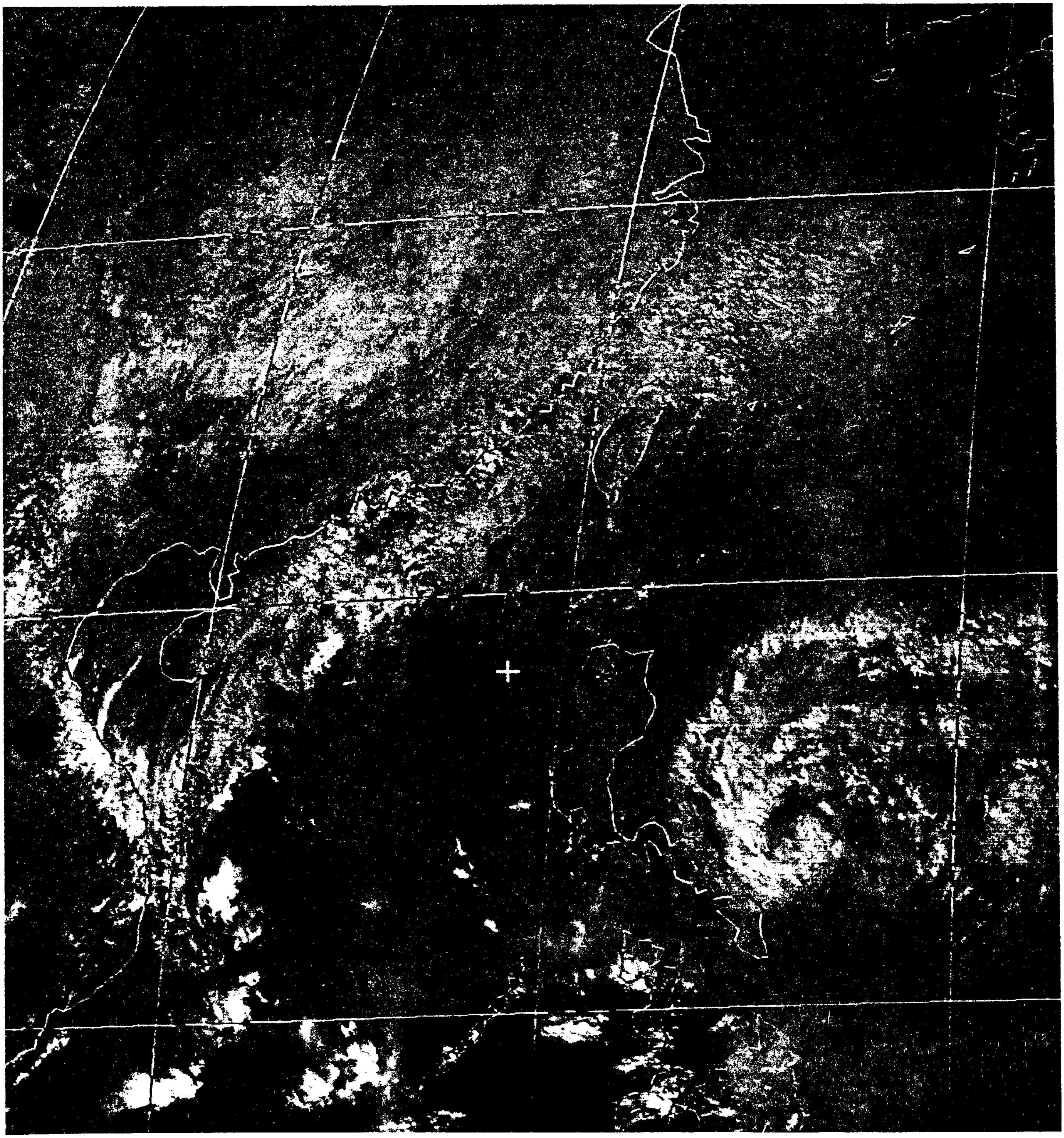


Figure 28. VS Satellite picture - 861119 06 UTC.

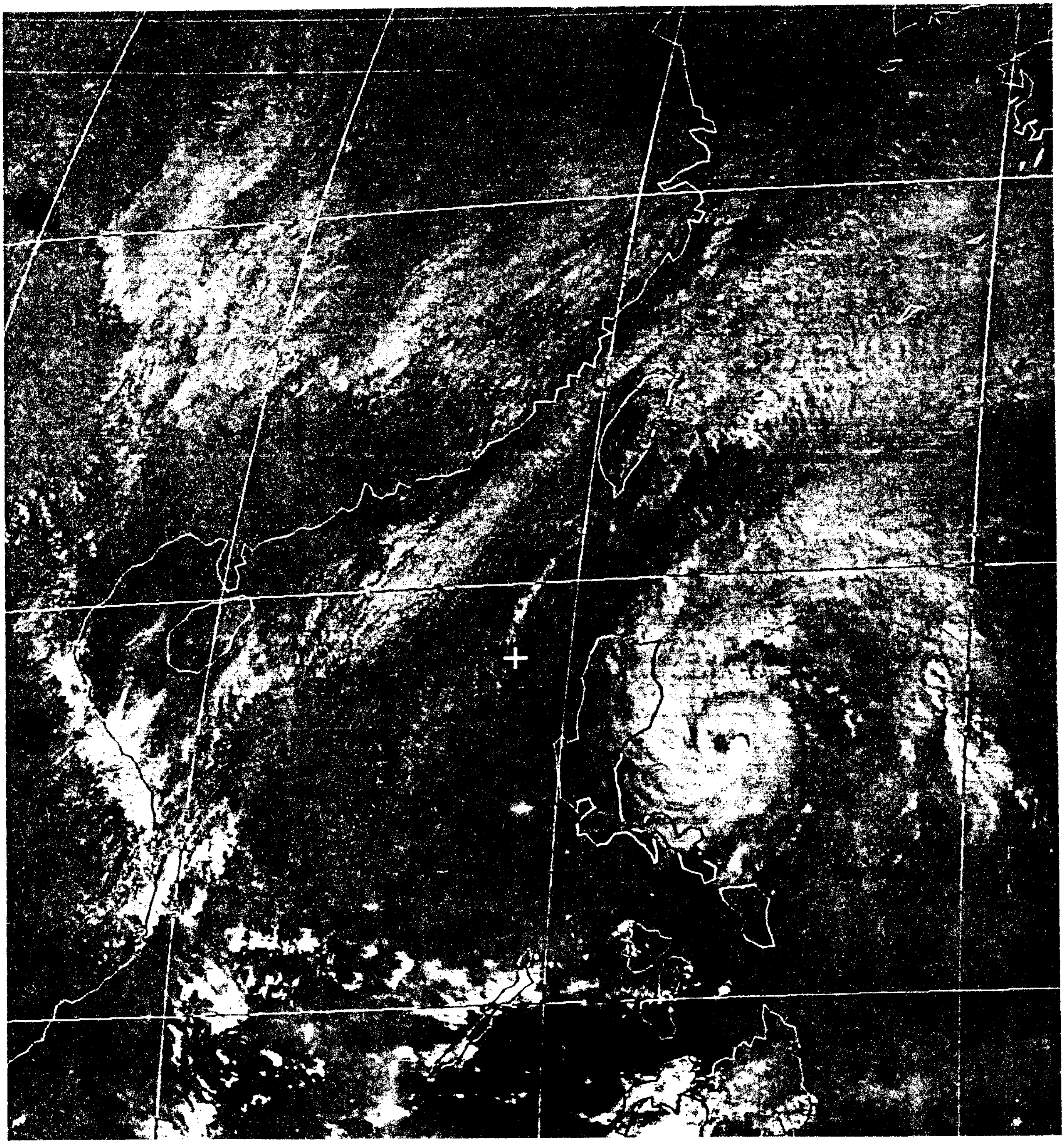


Figure 29. VS Satellite picture - 861120 06 UTC

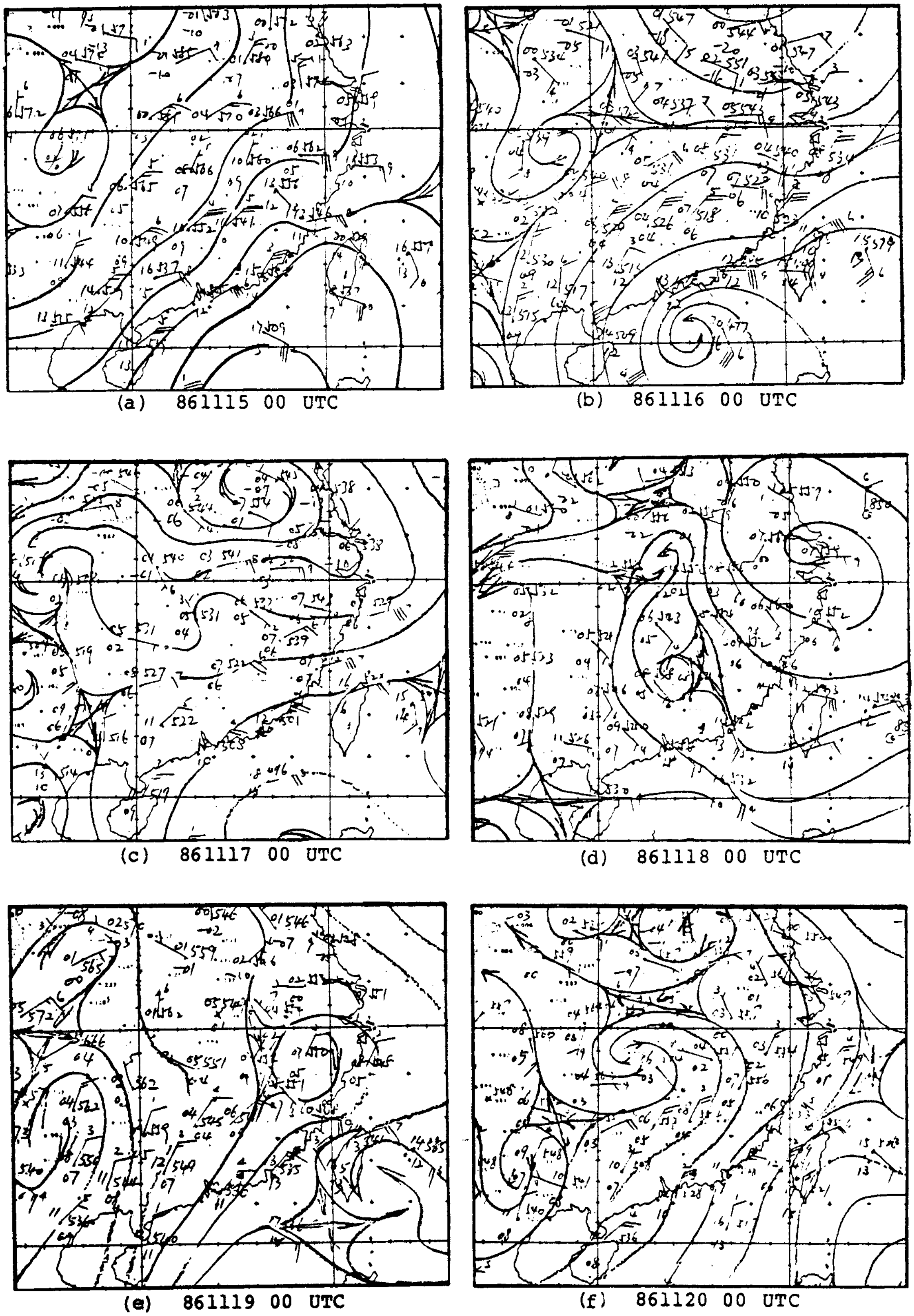
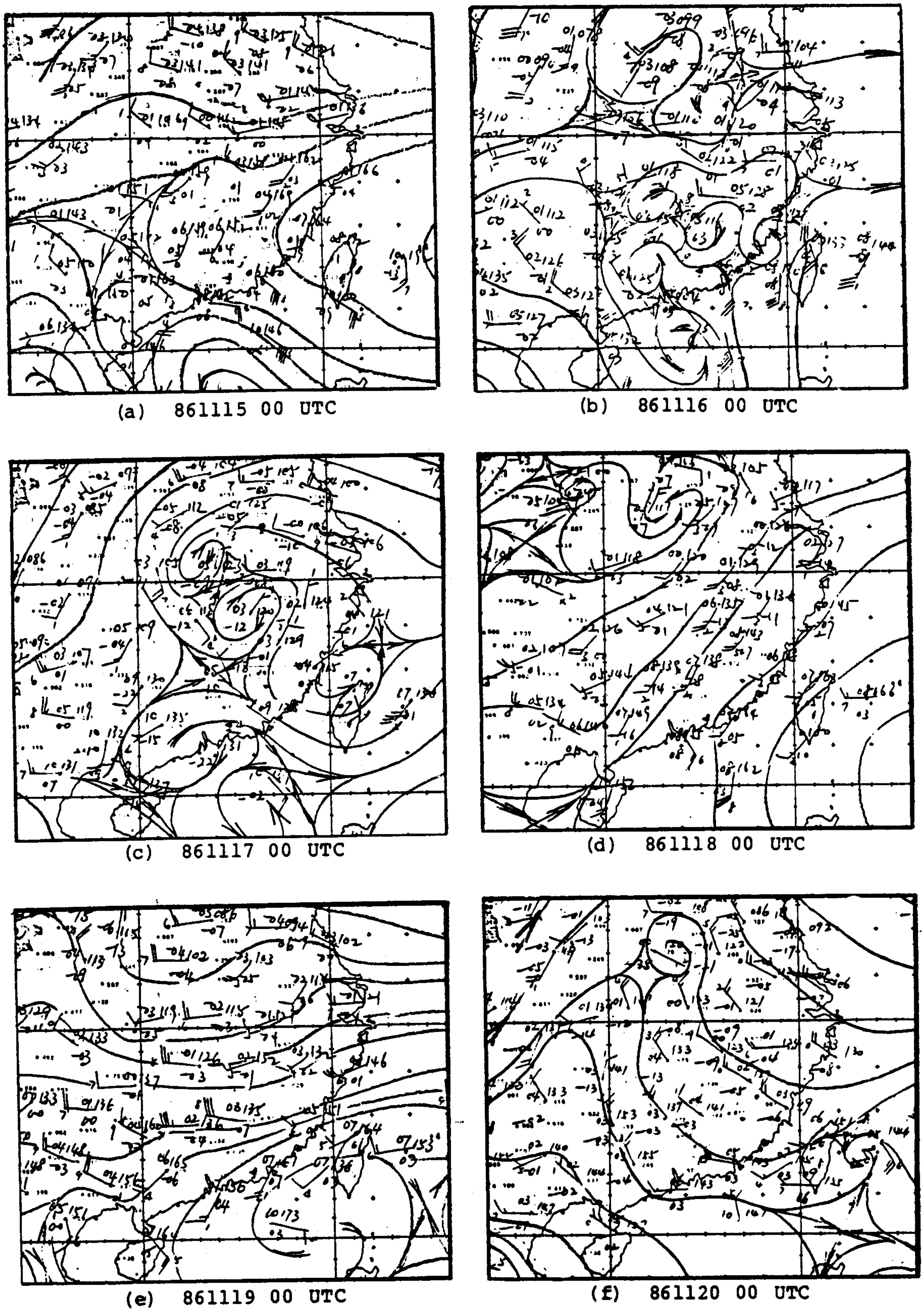


Figure 30. 850 hPa charts.



(a) 861115 00 UTC

(b) 861116 00 UTC

(c) 861117 00 UTC

(d) 861118 00 UTC

(e) 861119 00 UTC

(f) 861120 00 UTC

Figure 31. 700 hPa charts.

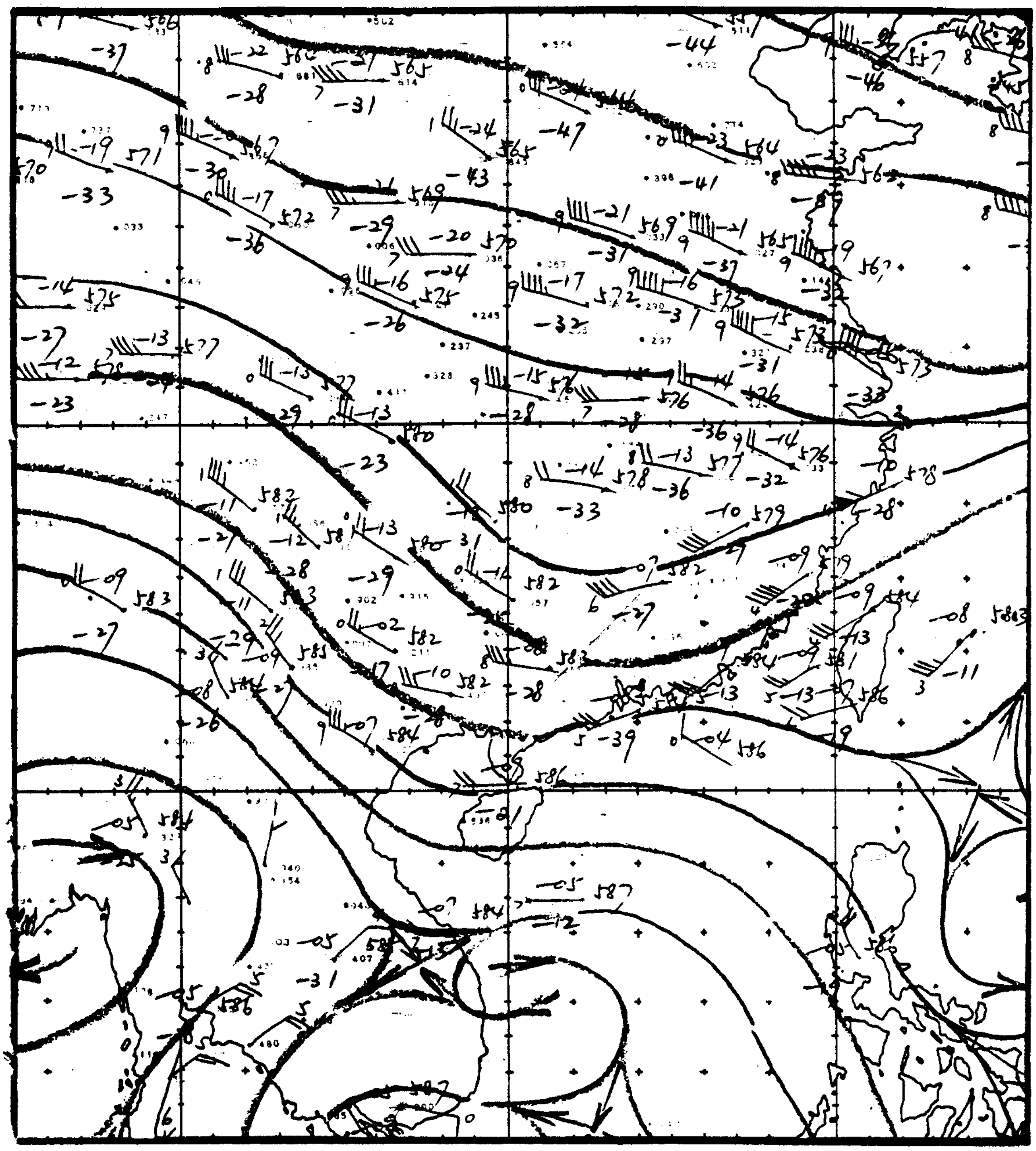
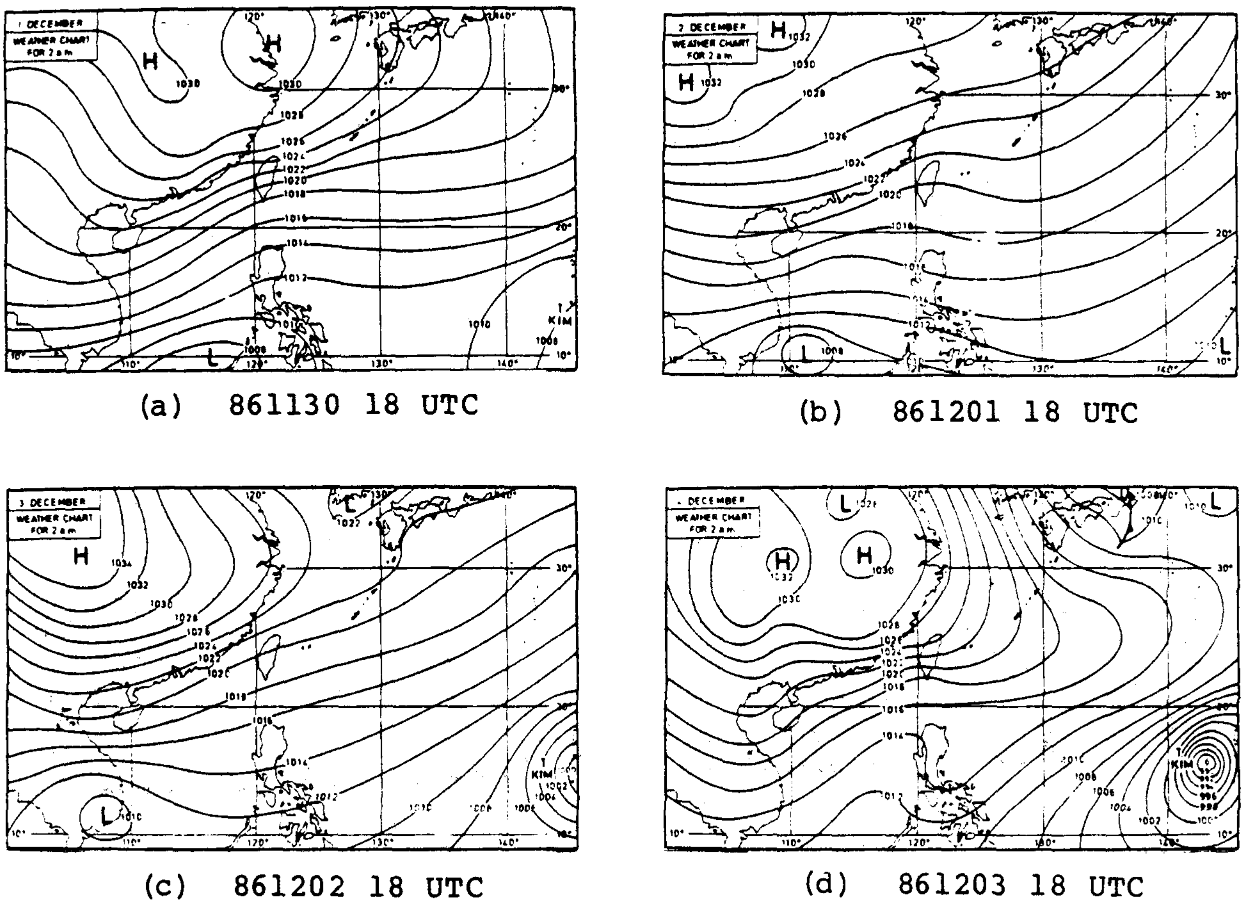


Figure 32. 500 hPa charts - 861120 00 UTC.

6. CASE IV : LOW, 1 - 4 DECEMBER 1986

6.1 Low over the South China Sea

During this period, satellite pictures and surface observations showed that a disturbance traversed the Southern Philippines, the South China Sea and then skirted the south coast of Indochina (Figure 33). Ship reports on 2nd indicated a closed circulation over the South China Sea off the coast of Southern Vietnam, which could be traced later to skirt the coast of southern Indochina. The centre of this low remained south of 11°N, i.e. south of the Cuming area throughout the period.



(a) 861130 18 UTC

(b) 861201 18 UTC

(c) 861202 18 UTC

(d) 861203 18 UTC

Figure 33. Surface charts.

6.2 Weather sequence

Background flow over South China remained in a northerly regime throughout this period. On 30 November, a band of cloud lay along the northern part of the South China Sea. Hong Kong was on the fringe of this cloud band (Figure 34). The cloud mass associated with the area of low pressure was located over the central part of the South China Sea.

On 1 December, the cloud band over the northern part of the South China Sea stayed south of the coast and it was mainly fine in Hong Kong (Figure 35). The cloud mass of the low moved westwards and linked up with the cloud band over the northern part of the South China Sea.

At 850 hPa, a ridge over the Ryukyus brought an east to southeasterly flow with long sea track to Hong Kong and southeast China on 1st. On 700 hPa, Hong Kong came under west to southwesterly flow from a ridge to the south (along 20°N) (Figures 36, 37). The return flow at these two levels persisted until the morning of 3rd.

On 2nd, the cloud mass of the low, which was sheared off from the centre, landed over southern Vietnam. The cloud band over the northern part of the South China Sea followed the southeasterly return flow at 850 and 700 hPa and made a marked northward movement and covered the coastal areas (Figure 38). Light rain commenced in Hong Kong early on 2nd.

Meanwhile, an anticyclone was establishing itself over west China. From it, a replenishment of the surface northerlies arrived at Hong Kong in the early morning of 3rd, causing heavier rain over the territory (Table 4). The northward movement of the cloud band that gave rise to rain over Hong Kong was checked on 3rd when it encountered the dry continental air from the north. Dry continental airstream at 850 hPa eventually reached Hong Kong on the evening of 3rd, about 12 hours later than the surface northerlies. The dry continental air was stacked up to 700 hPa (Figure 37d) in Hong Kong as dry air at 700 hPa reached the South China coast a few hours later. The whole cloud band moved to the south of the coast on 4th (Figures 39, 40), resulting in fine weather in Hong Kong.

TABLE 5. WEATHER ELEMENTS ON 1 - 4 DECEMBER 1986

Date	Rainfall (mm)	Bright Sunshine (hours)
1	—	6.5
2	2.1	-
3	35.2	-
4	—	7.9

6.3 Observations

The low never entered the Cuming area. From ship reports, it stayed south of 11°N i.e. south of the Cuming area throughout the time it rained in Hong Kong. However, the flow at 850 and 700 hPa levels were southeasterly or southwesterly, advecting the cloud band off the South China coast towards Hong Kong.

The cloud band cleared Hong Kong as it moved south when dry continental air reached the South China coast in-depth. However, when surface northerlies first reached Hong Kong, rain became heavier due to the increase in baroclinicity over the coastal areas and hence the uplifting mechanism of the warm and moist air associated with the cloud band. It was only when dry northerlies stacked up to 700 hPa that the weather became fine.

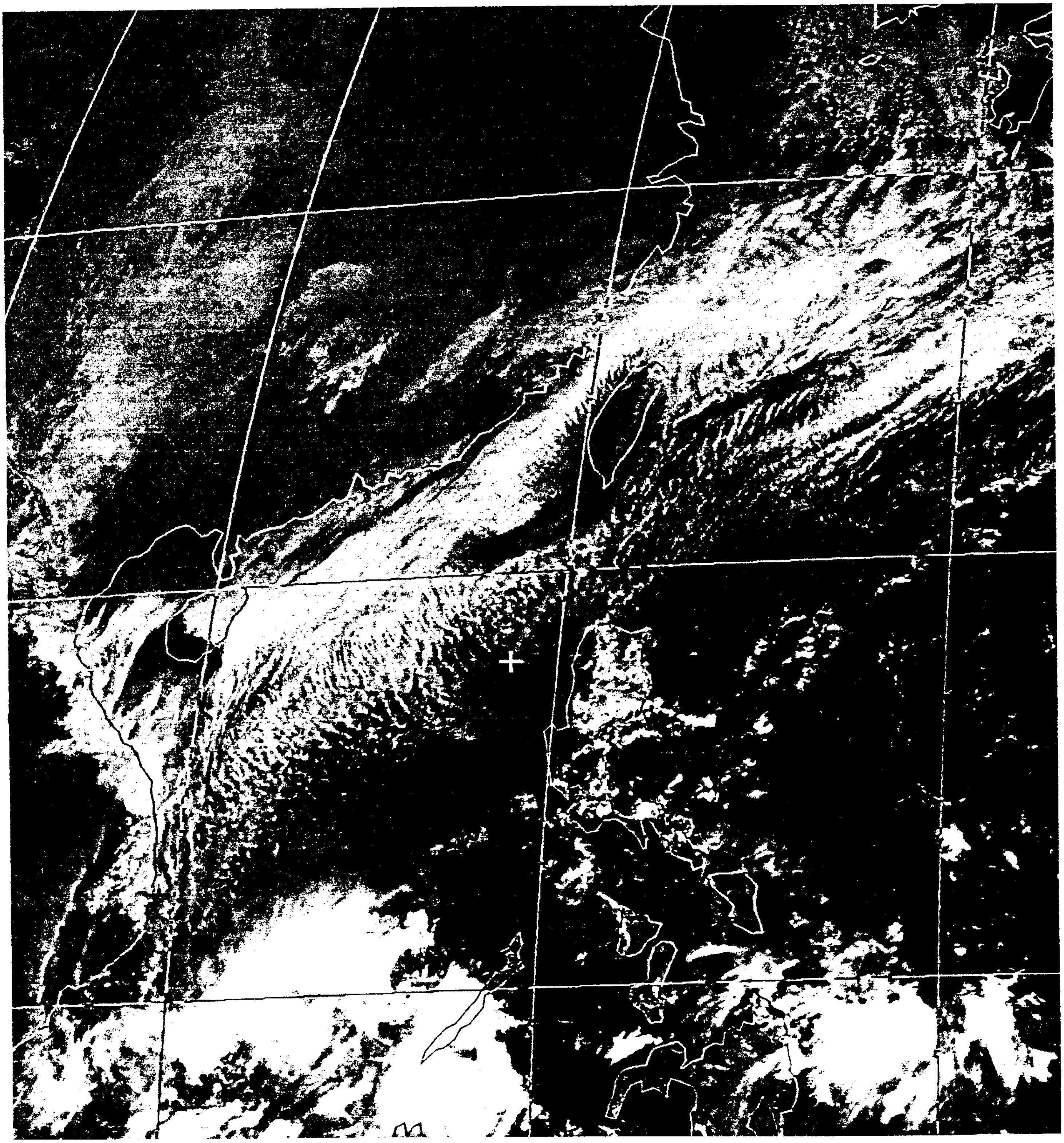


Figure 34. VS Satellite picture - 861130 03 UTC.

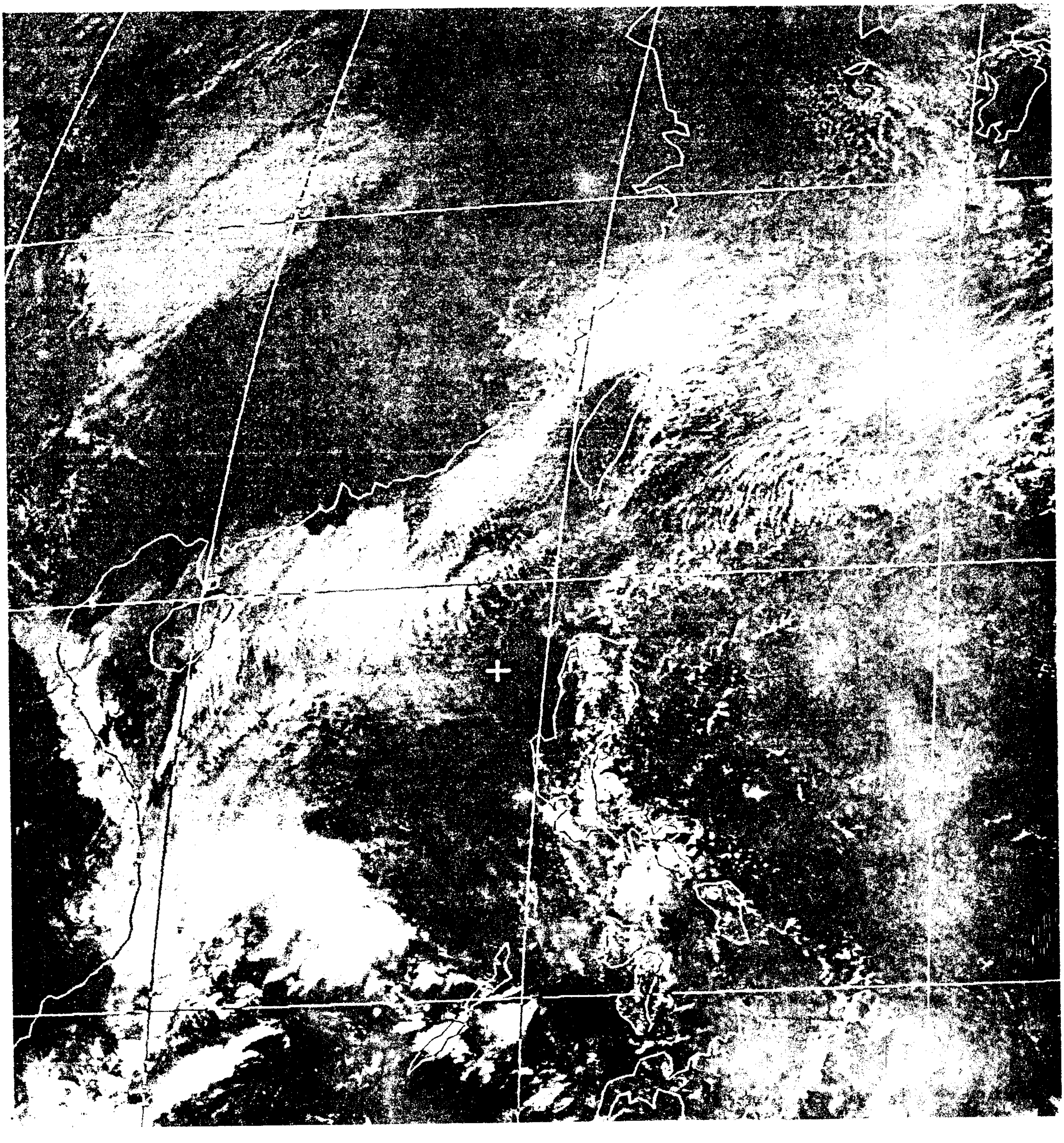
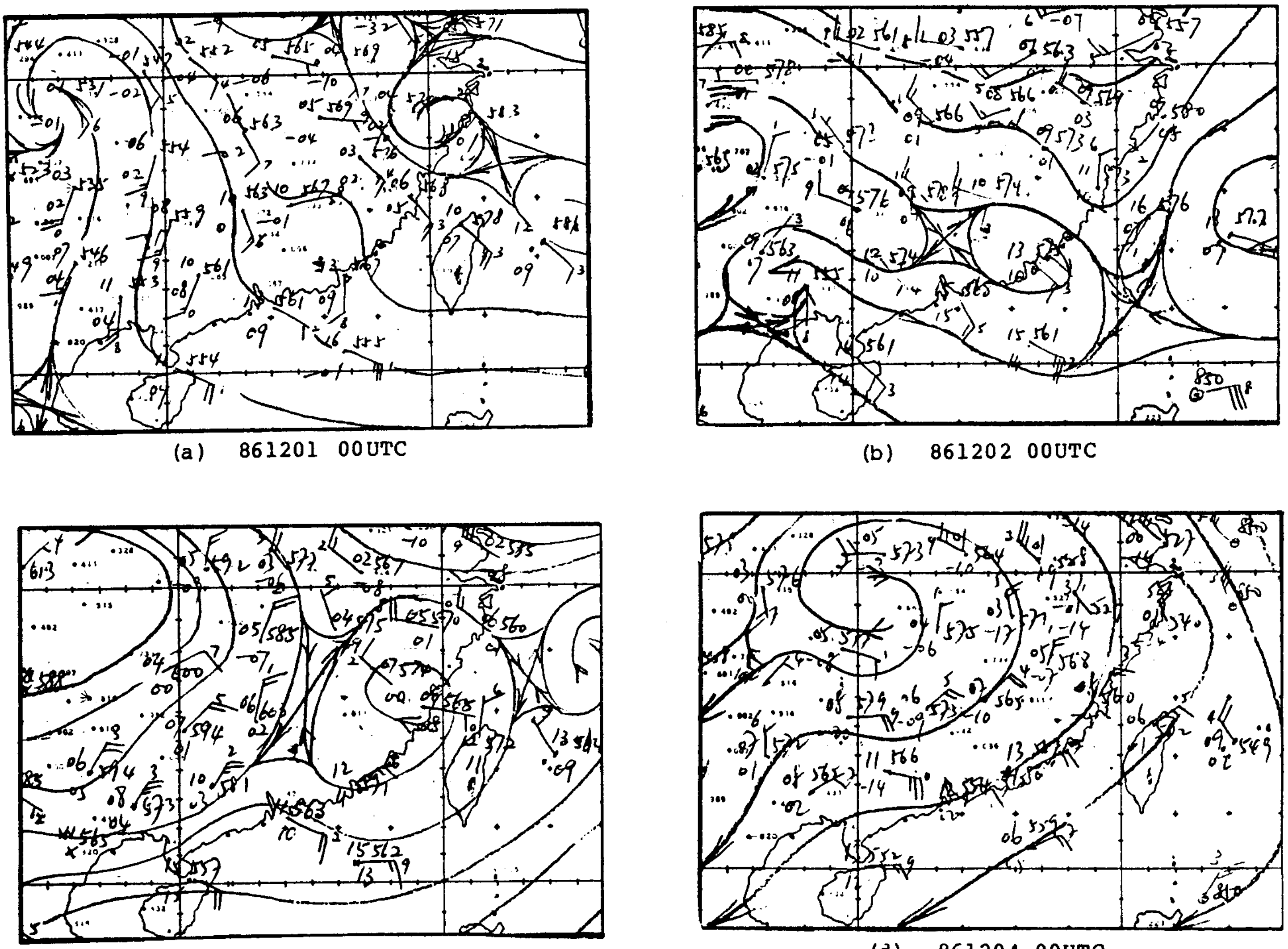


Figure 35. VS Satellite picture - 861201 03 UTC



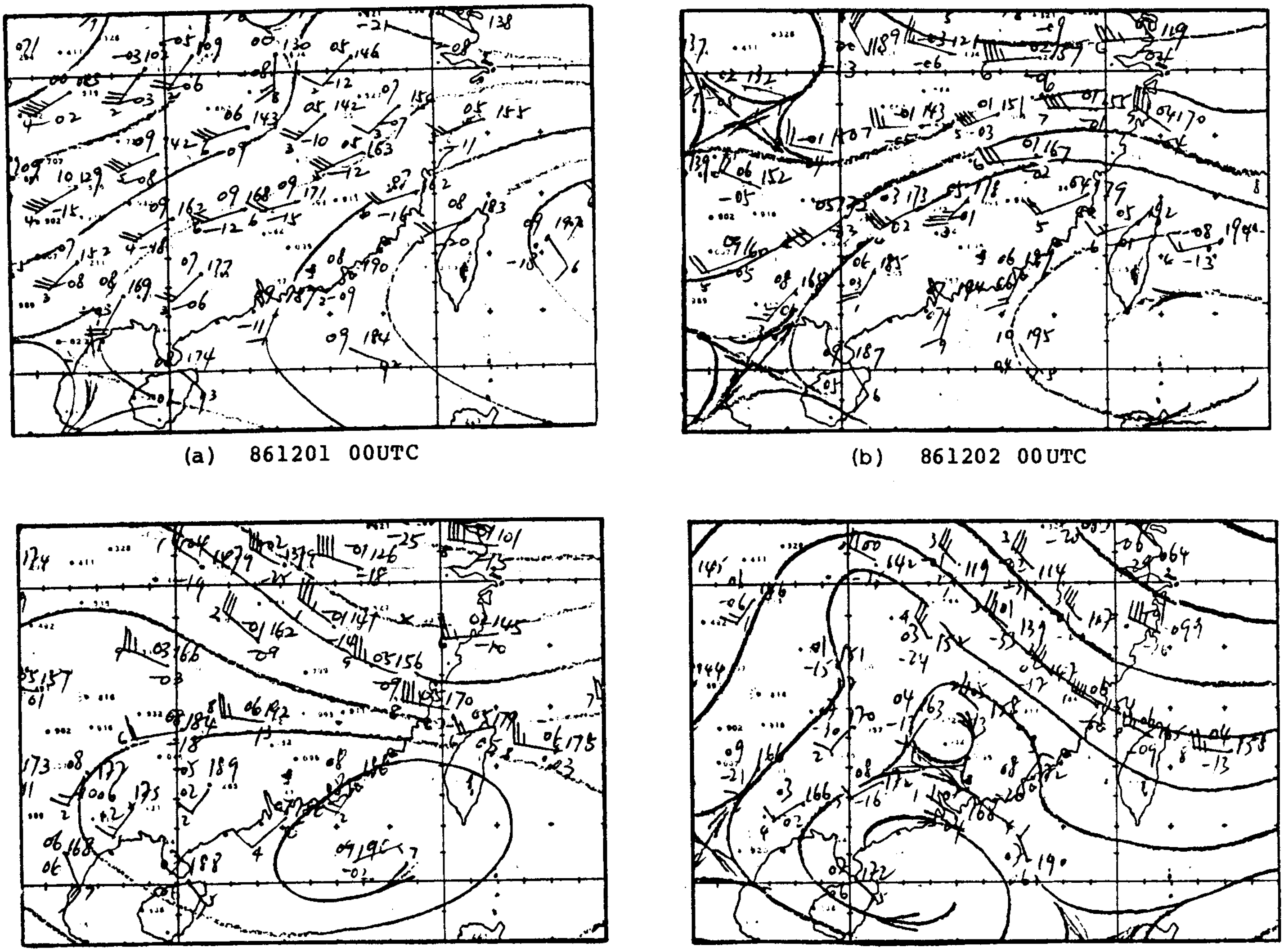
(a) 861201 00UTC

(b) 861202 00UTC

(c) 861203 00UTC

(d) 861204 00UTC

Figure 36. 850 hPa charts



(a) 861201 00UTC

(b) 861202 00UTC

(c) 861203 00UTC

(d) 861204 00UTC

Figure 37. 700 hPa charts

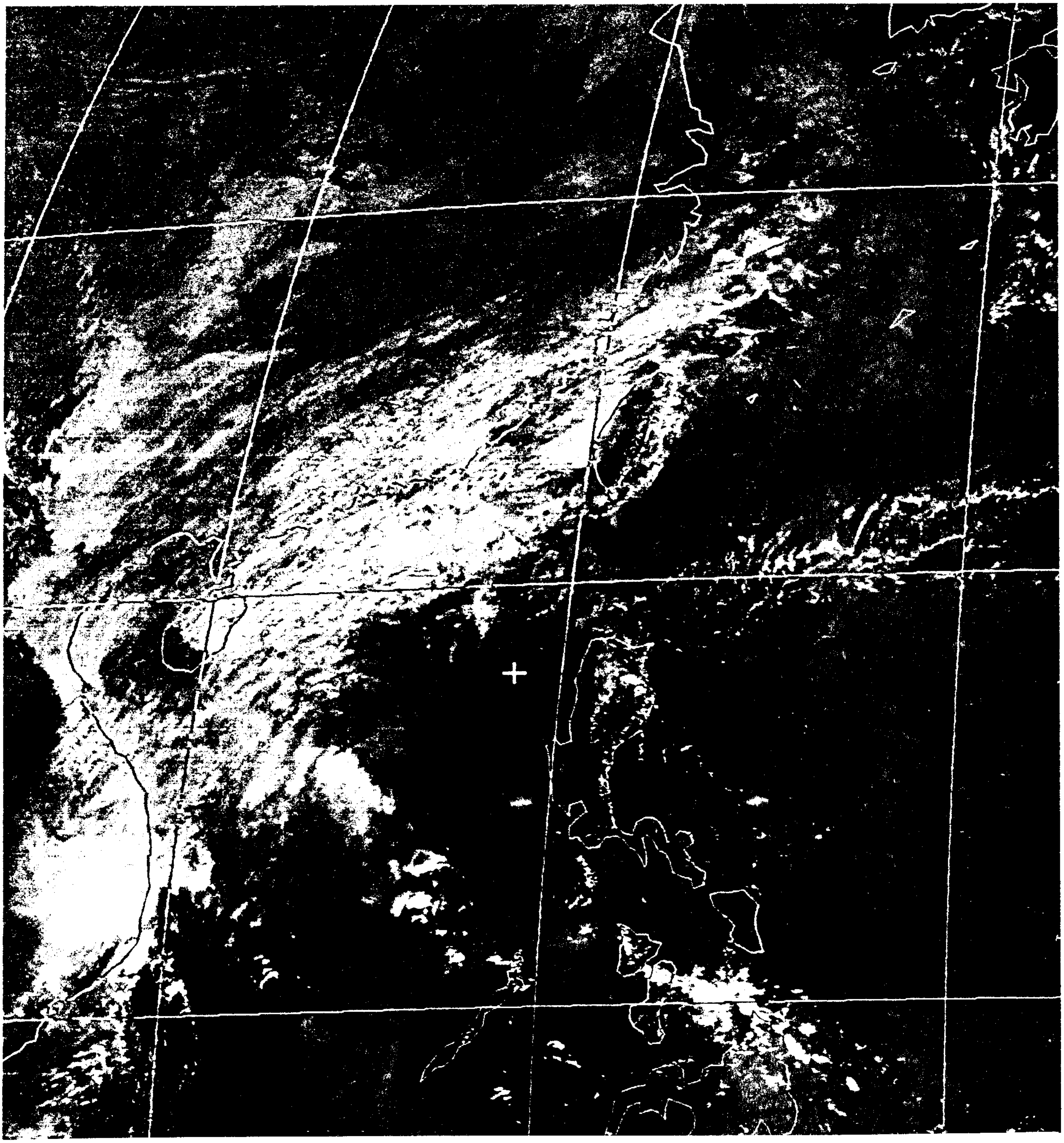


Figure 38. VS Satellite picture - 861202 03 UTC.

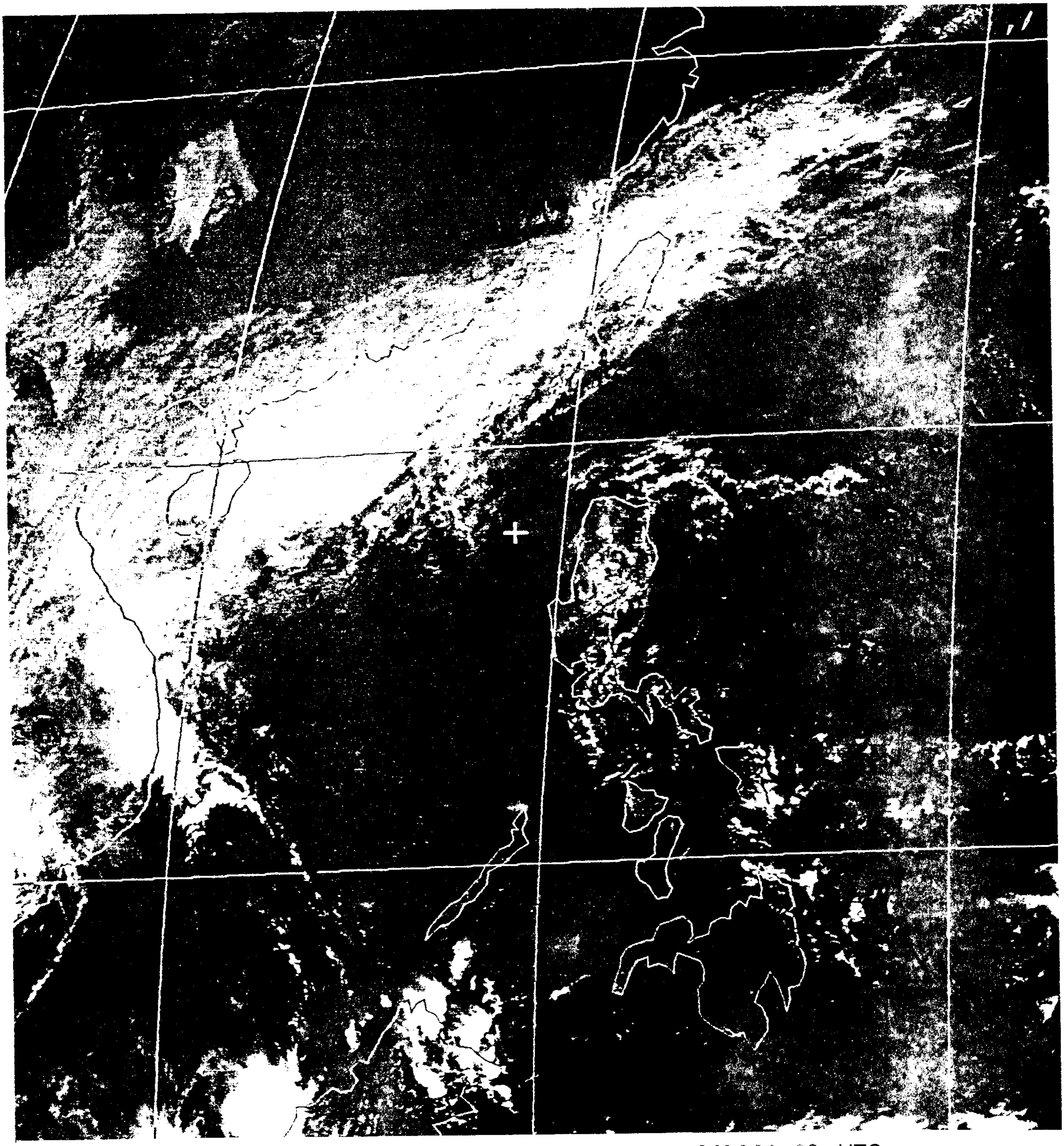


Figure 39. VS Satellite picture - 861203 03 UTC

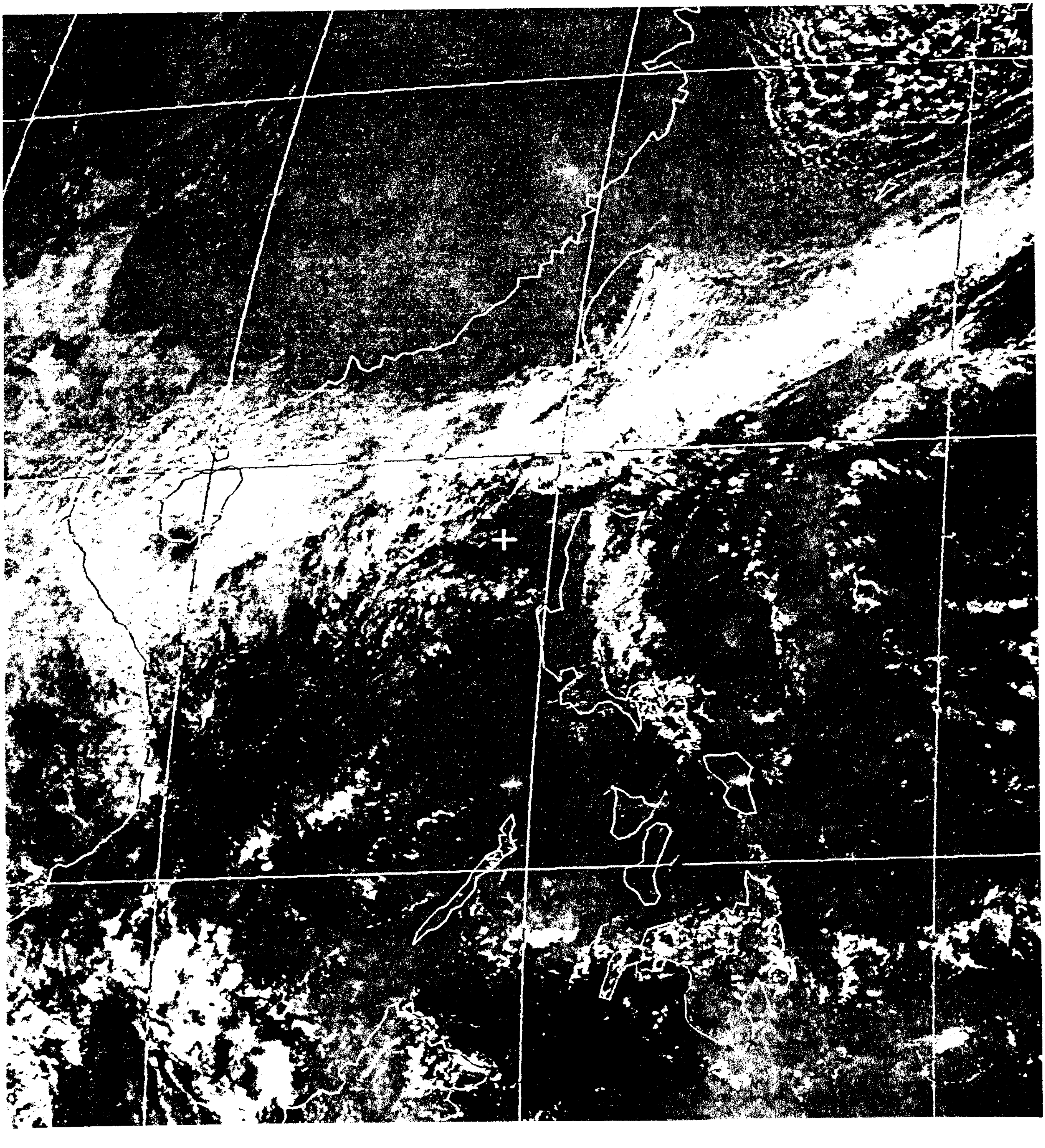


Figure 40. VS Satellite picture - 861204 03 UTC

7. CASE V : CARY, 31 OCTOBER - 2 NOVEMBER 1980

7.1 Weather sequence

Weather was fine during the entire period despite a tropical cyclone named Cary moving across the Cuming area between 03 UTC 31 October and 18 UTC 1 November (Figure 41). A weak northerly surge arrived at Hong Kong early on 30 October. Another replenishment of the northerlies reached the South China coast early on 1 November and Hong Kong stayed in the northerly regime in the following few days.

TABLE 6. WEATHER ELEMENTS ON 31 OCTOBER TO 2 NOVEMBER 1980

Date	Rainfall (mm)	Bright Sunshine (hours)
31/10	—	10.1
1/11	—	8.8
2/11	—	8.9

7.2 Upper-air pattern

The 850 hPa flow over South China remained northeasterly throughout this period. On the 700 hPa, an anticyclone persisted over southwest China, maintaining north to northeasterly winds at Hong Kong during these four days (Figures 42, 43). The cloud plume of Cary was kept to the south of Hong Kong on 31 October by the continental northeasterlies. As drier air associated with the northerly replenishment mentioned in 7.1 reached the South China coast on 1 November (Figure 44), the cloud plume moved further south and started breaking at the same time (Figures 46 - 48). This cloud plume never reached the South China coast.

7.3 Observations

Dry continental air prevailing over the South China coastal areas acted as a braking force to hold the cloud plume from moving north to affect the coastal areas. The drier air brought by the northerly replenishment eventually dissipated the cloud plume.

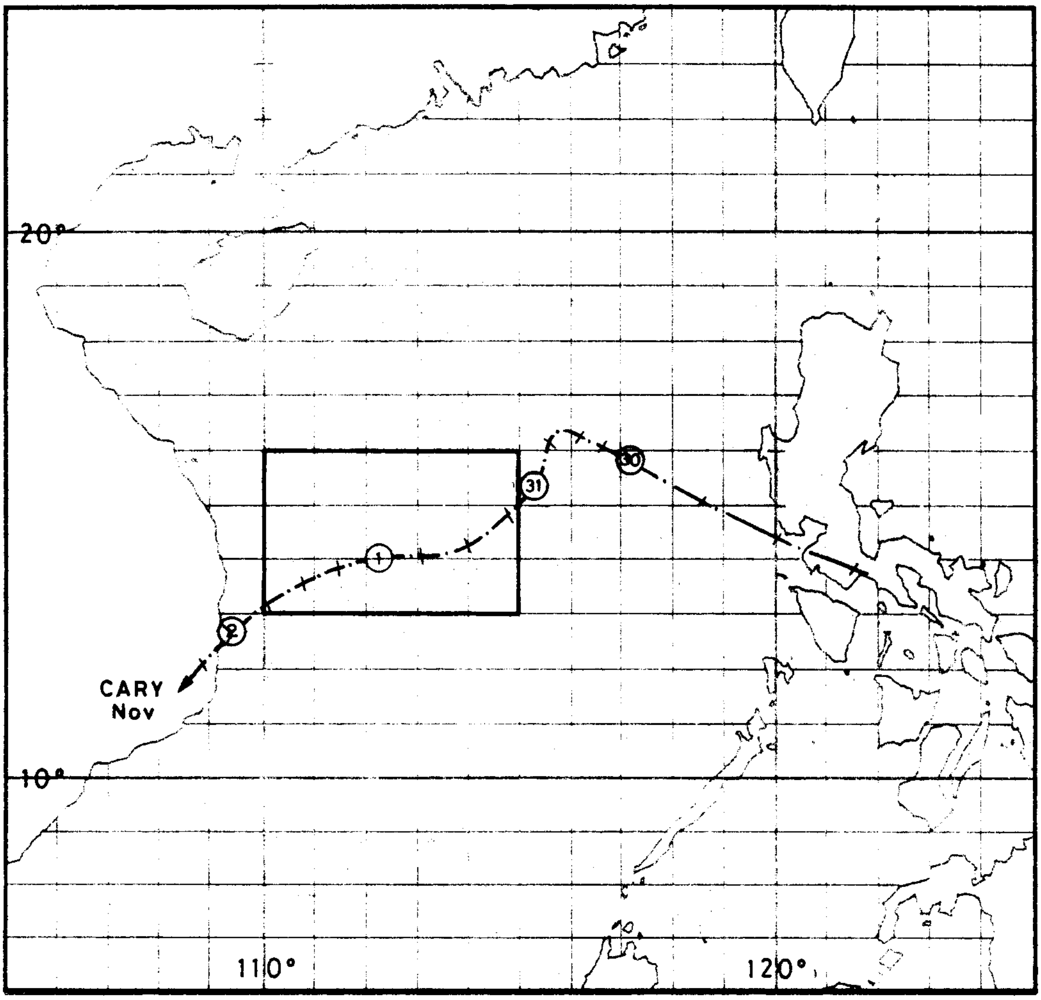
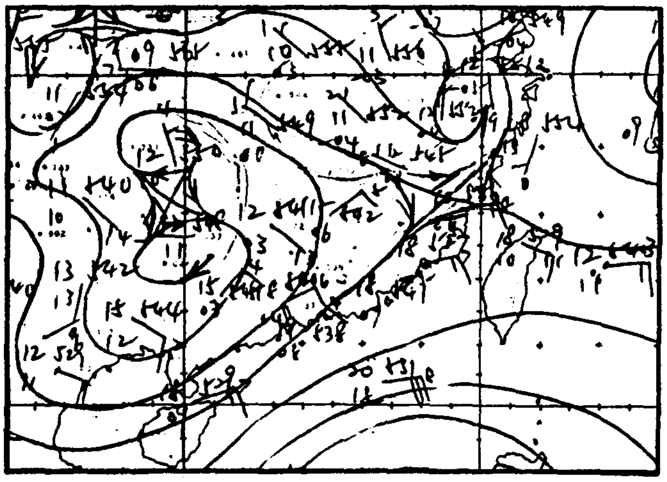
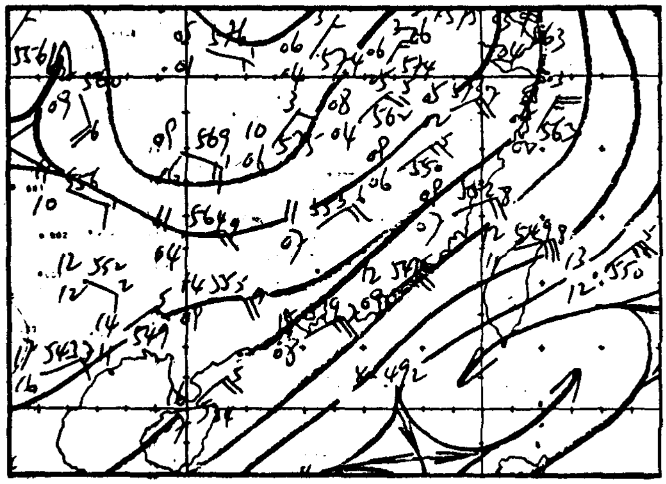


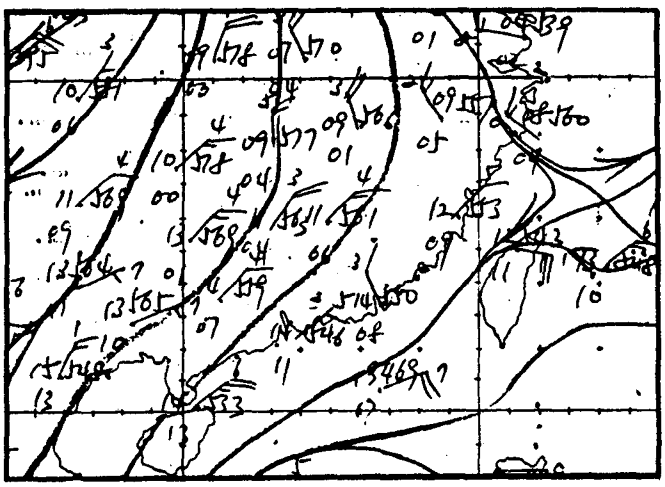
Figure 41. Track of Tropical Storm Cary.



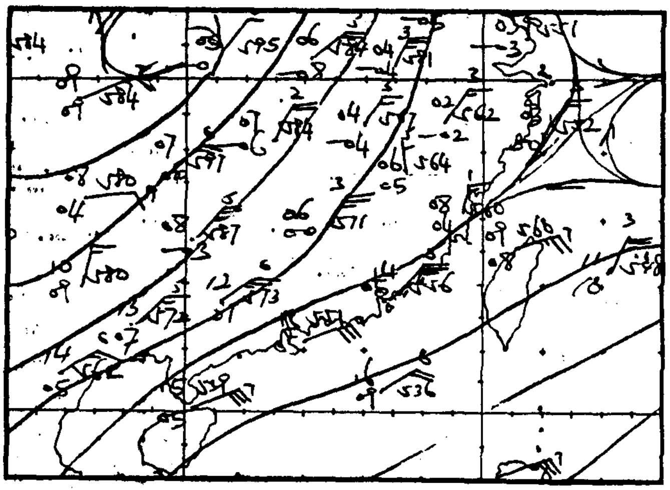
(a) 801031 00UTC



(b) 801101 00UTC

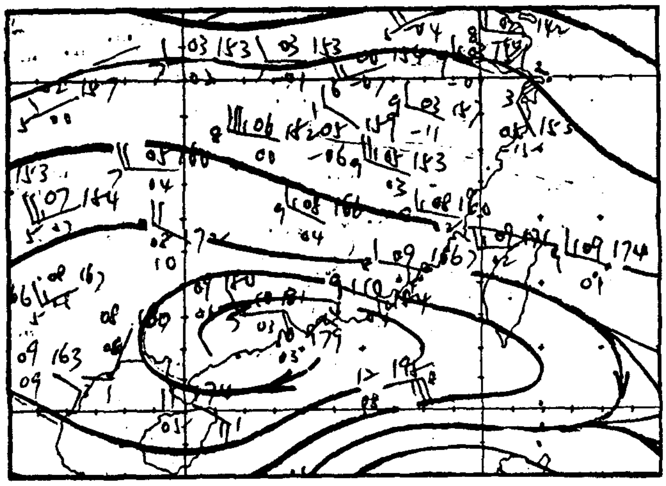


(c) 801102 00UTC

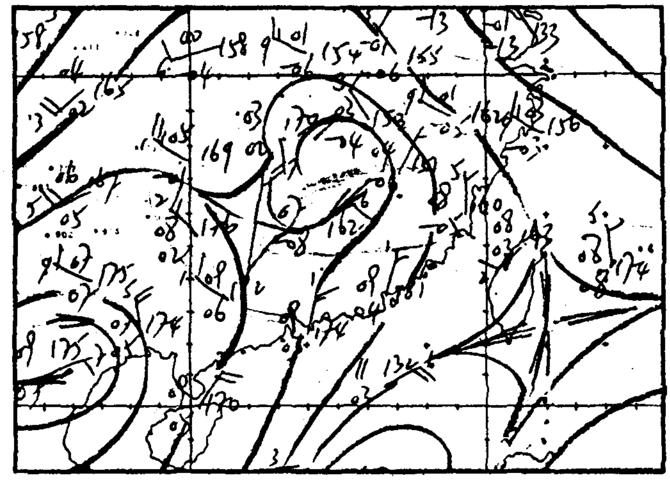


(d) 801103 00UTC

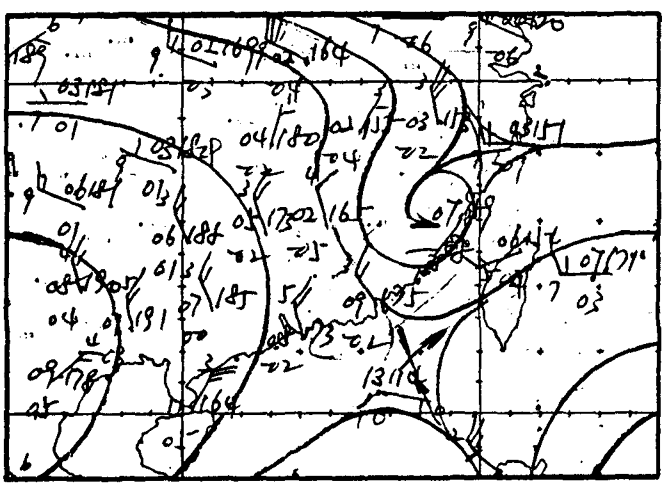
Figure 42. 850 hPa charts



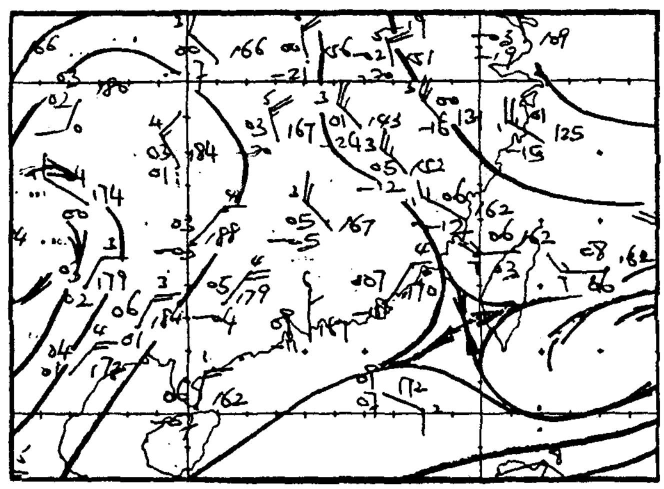
(a) 801031 00UTC



(b) 801101 00UTC



(c) 801102 00UTC



(d) 801103 00UTC

Figure 43. 700 hPa charts

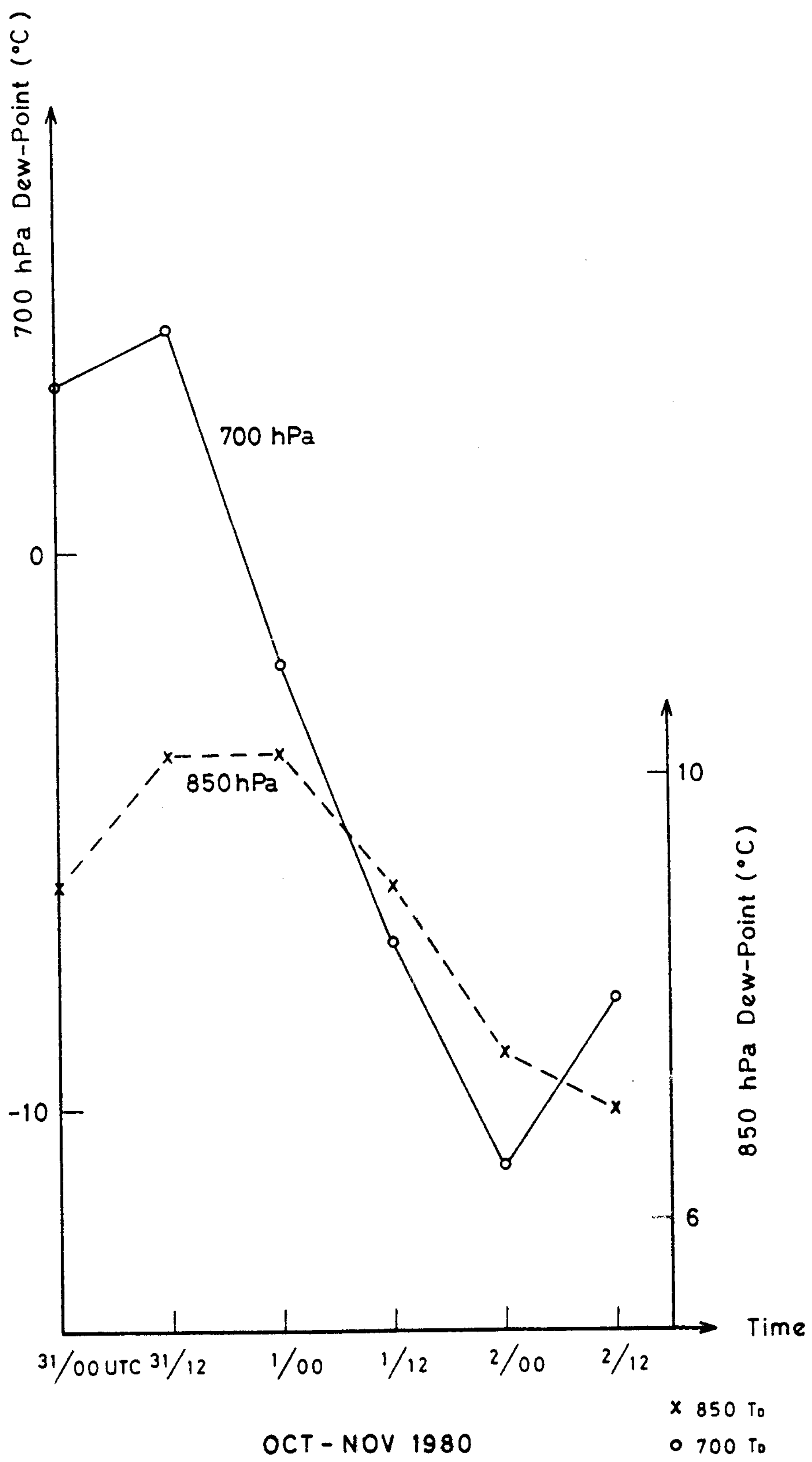


Figure 44. The change of dew-point at Hong Kong at 850 and 700 hPa levels.

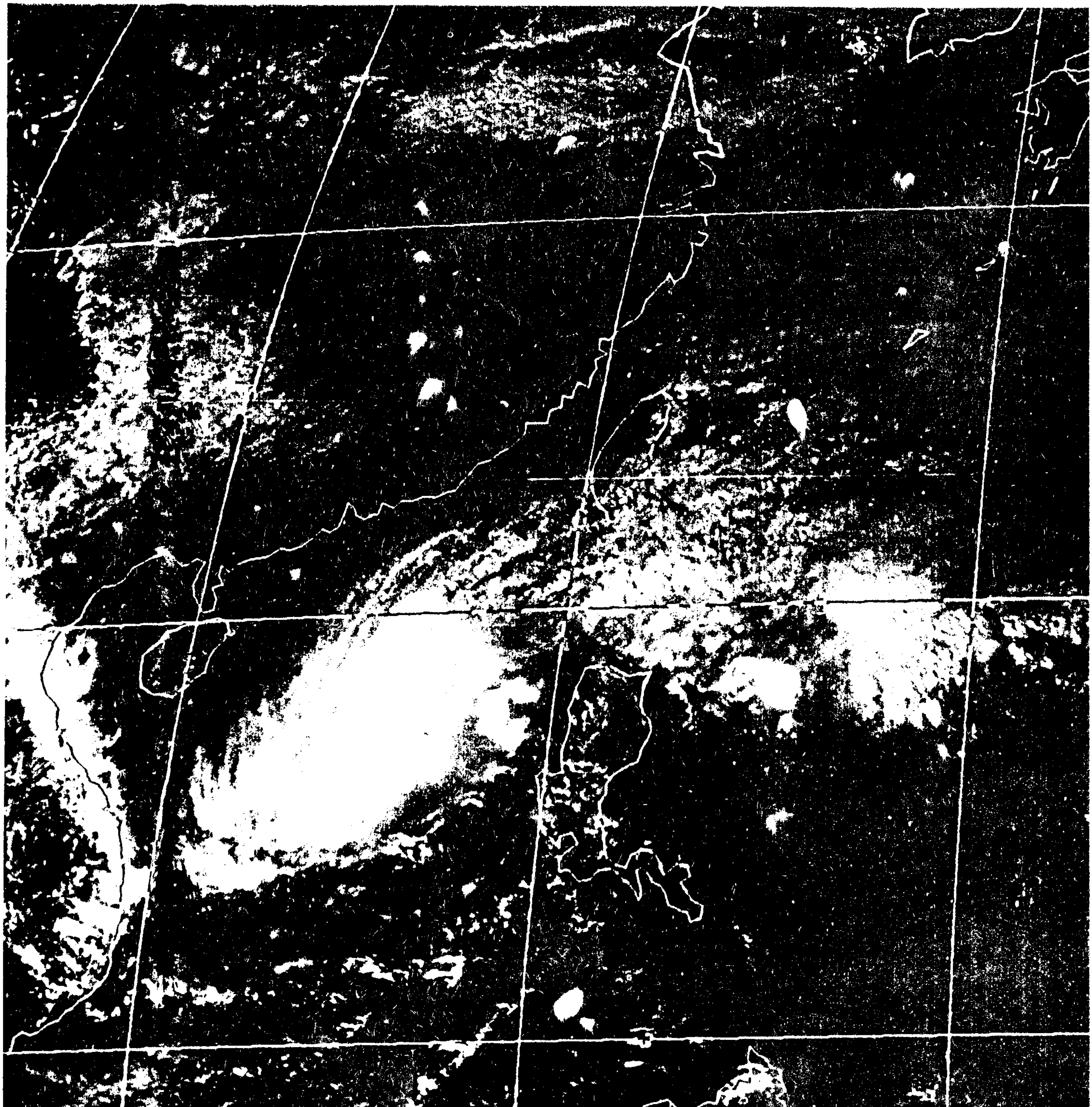


Figure 45. VS Satellite picture - 801030 06 UTC.

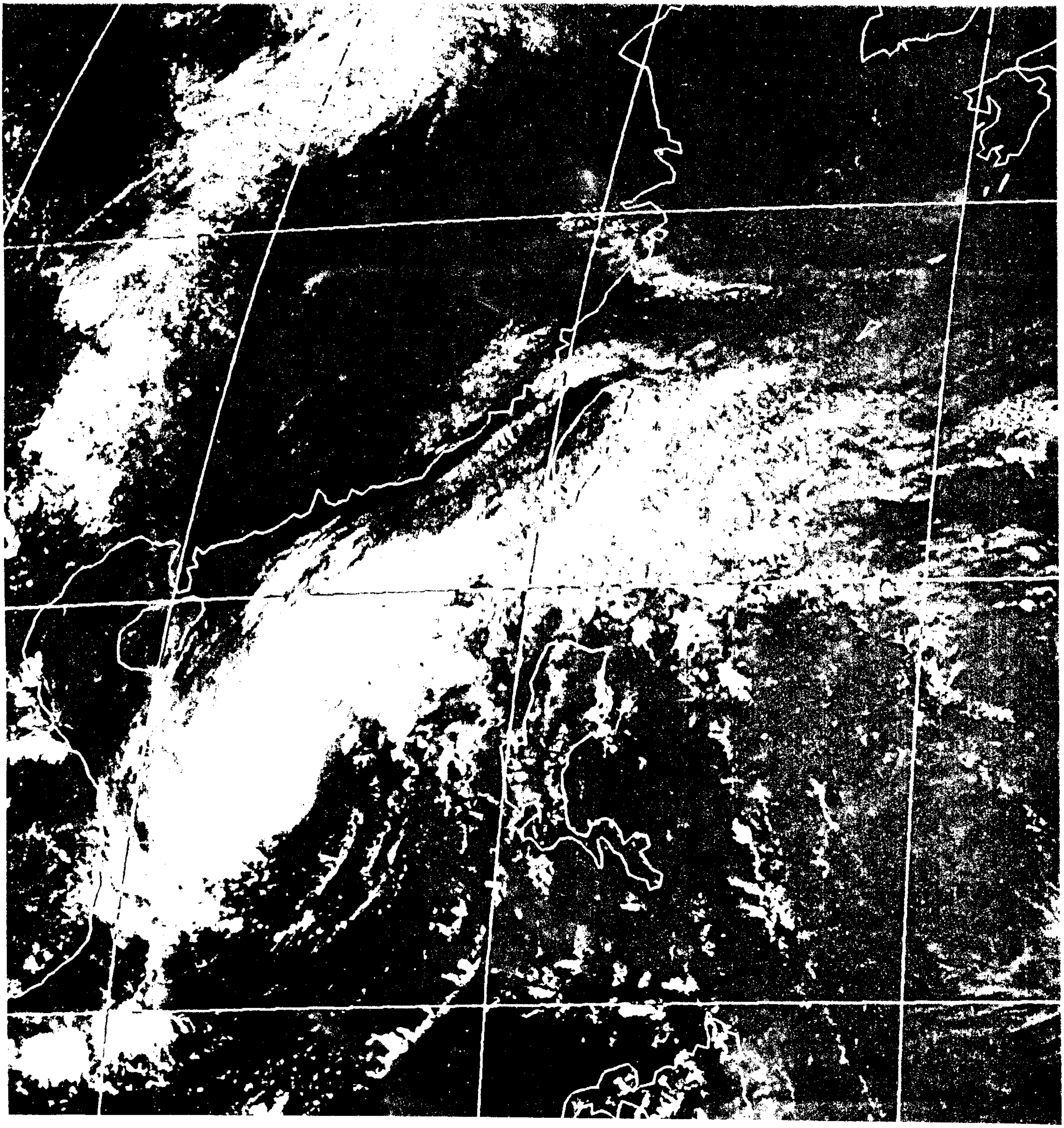


Figure 46. VS Satellite picture - 801031 06 UTC

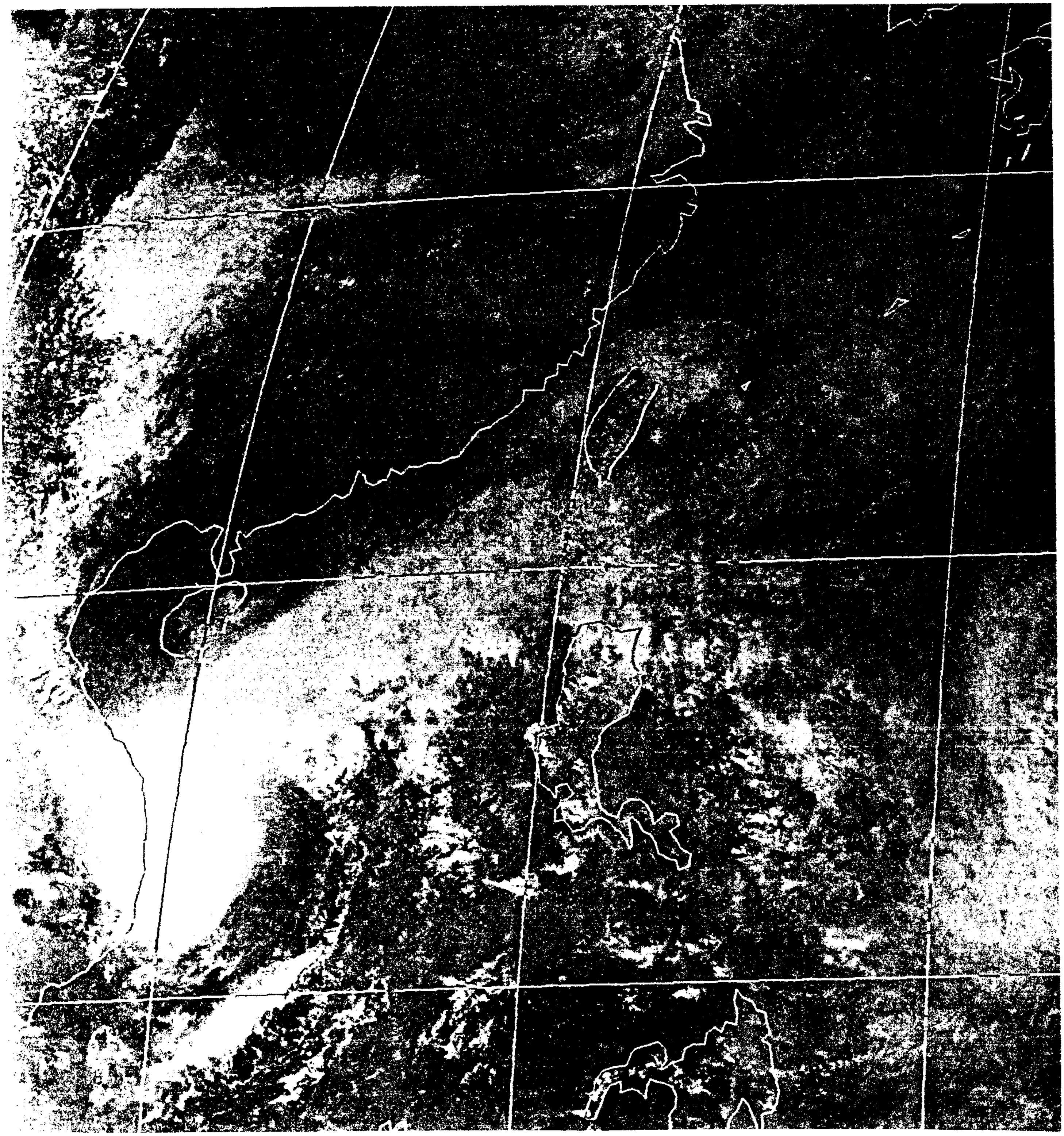


Figure 47. VS Satellite picture - 801101 06 UTC.

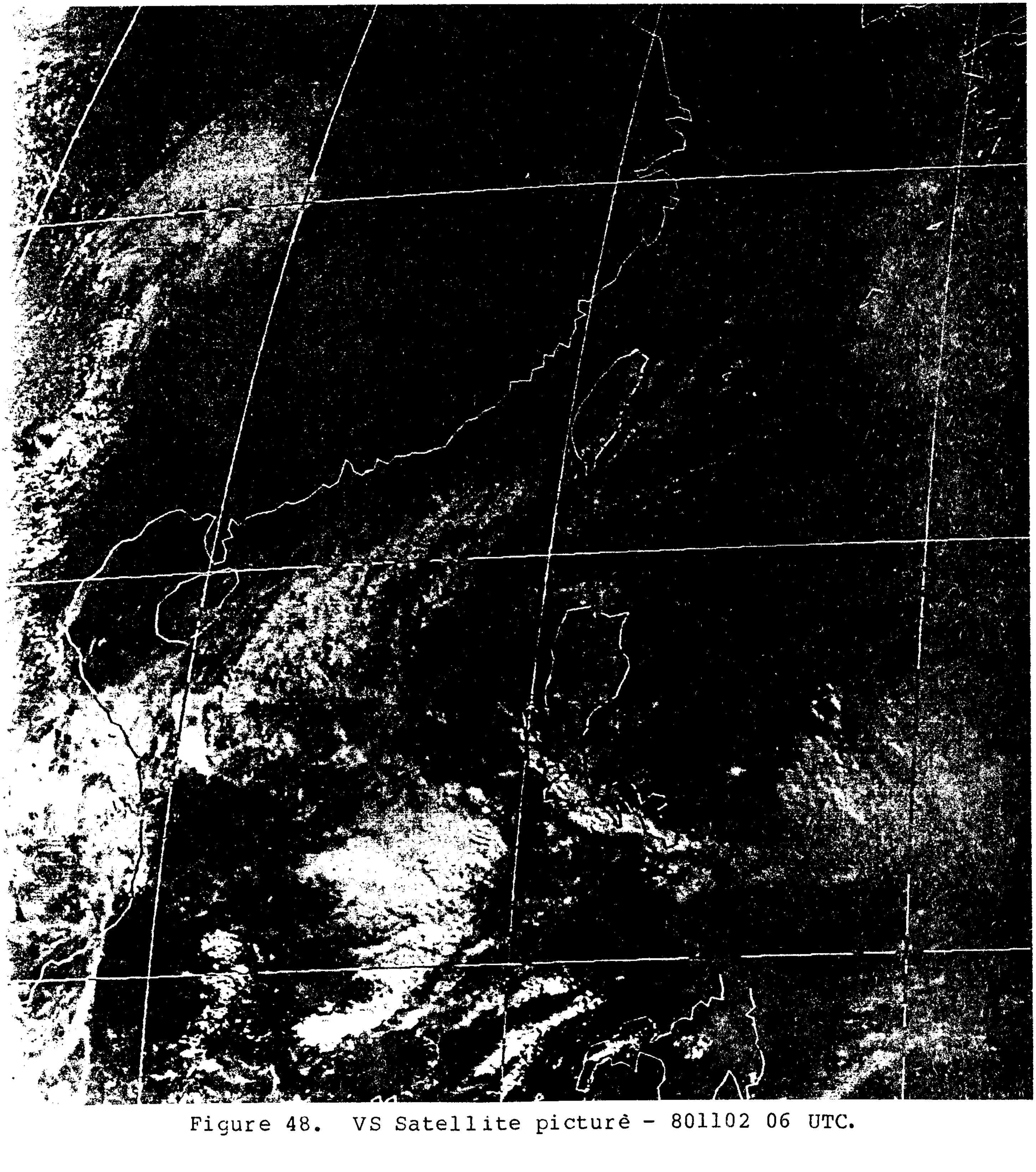


Figure 48. VS Satellite picturê - 801102 06 UTC.

8. CASE VI : AGNES, 5 - 7 NOVEMBER 1984

8.1 Weather sequence

Typhoon Agnes moved west-northwest across the South China Sea during this period (Figure 49). It traversed the Cuming area between 1200 UTC 6 November and 0600 UTC 7 November. Apart from slight increase in cloudiness on 6th, the weather in Hong Kong remained fine during the entire period. From satellite pictures, it could be seen that the circulation of Agnes was rather compact. The formation of a cloud plume to the northeast of its centre was very much restrained.

TABLE 7. WEATHER ELEMENTS ON 5 - 8 NOVEMBER 1984

Date	Rainfall (mm)	Bright Sunshine (hours)
5	—	9.8
6	—	6.2
7	—	10.0
8	—	9.0

8.2 Upper-air pattern

Hong Kong was under the influence of a 700 hPa ridge on 6th and winds at that level were northeasterly. However, this ridge moved westwards and the return flow of an anticyclone over the Bashi area set in during that evening and persisted until 7th. Should there be the formation of a cloud plume to the northeast of the centre of Agnes, the cloud plume would have been advected by the return flow to the South China coast on 7th.

Over the 850 hPa, a slow-moving anticyclone over South China brought east to northeasterly winds to Hong Kong during 6th and 7th. This anticyclone was the system responsible for the fine weather over South China during this period.

8.3 Observations

The circulation of Agnes was rather compact. The clouds to the northeast of its centre did not develop into a well-defined cloud plume to affect the South China coast as in Cases I - V. (The cloud plume in case V did not manage to reach the coastal areas.) During this period, no surge of the winter monsoon reached the South China coast, which apparently accounted for the non-development of a cloud plume.

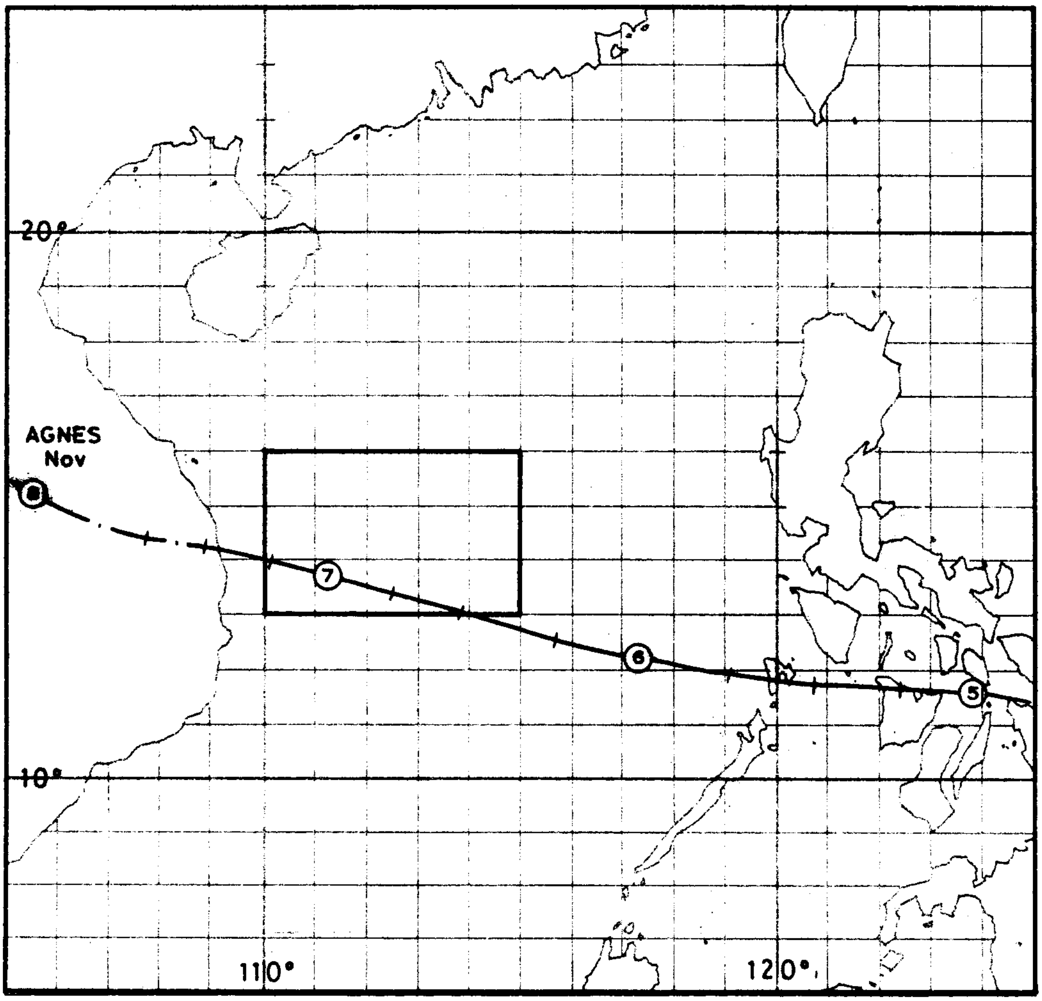
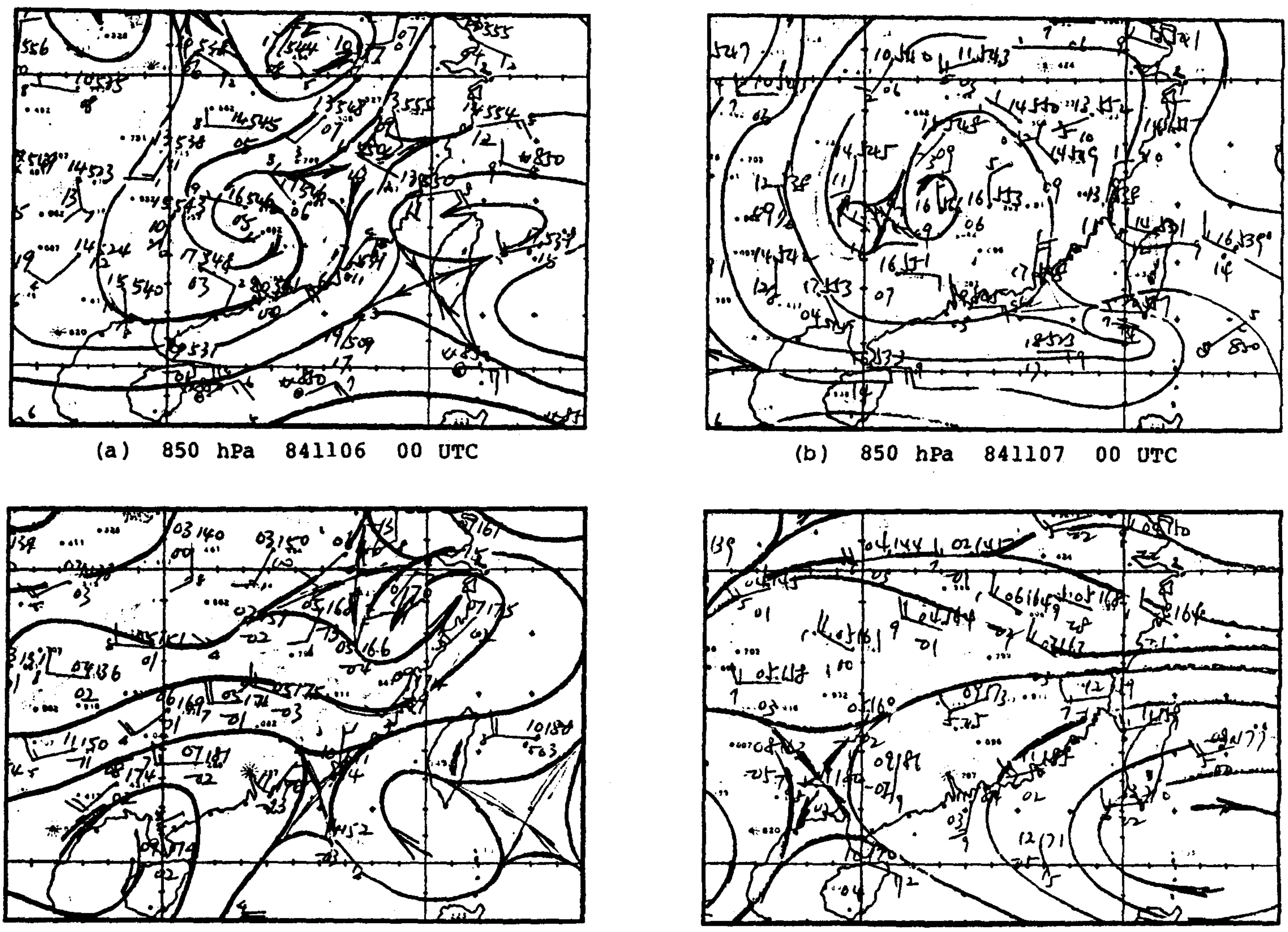


Figure 49. Track of Typhoon Agnes.



(a) 850 hPa 841106 00 UTC

(b) 850 hPa 841107 00 UTC

(c) 700 hPa 841106 00 UTC

(d) 700 hPa 841107 00 UTC

Figure 50. 850 & 700 hPa charts

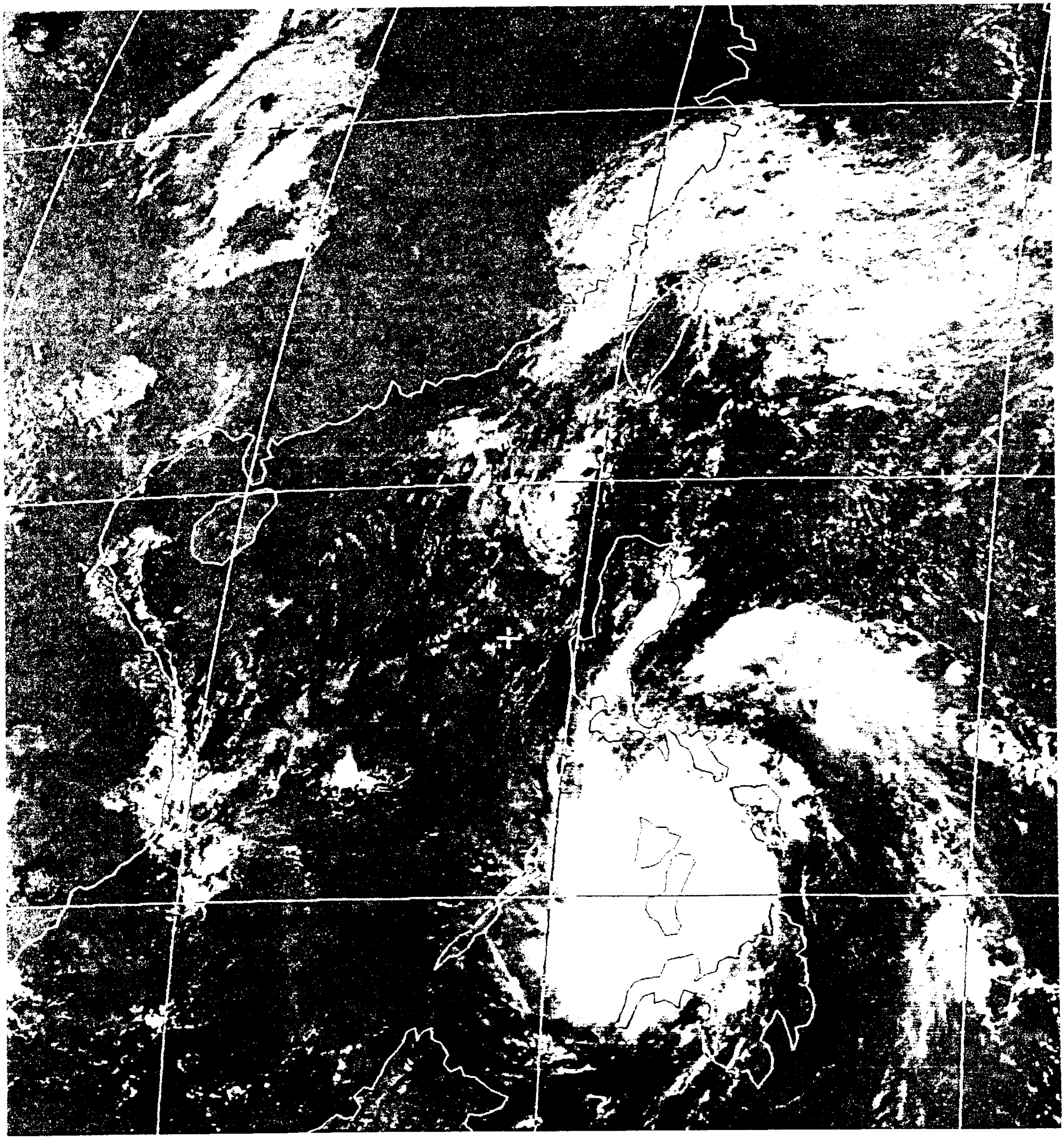


Figure 51. VS Satellite picture - 841105 03 UTC.

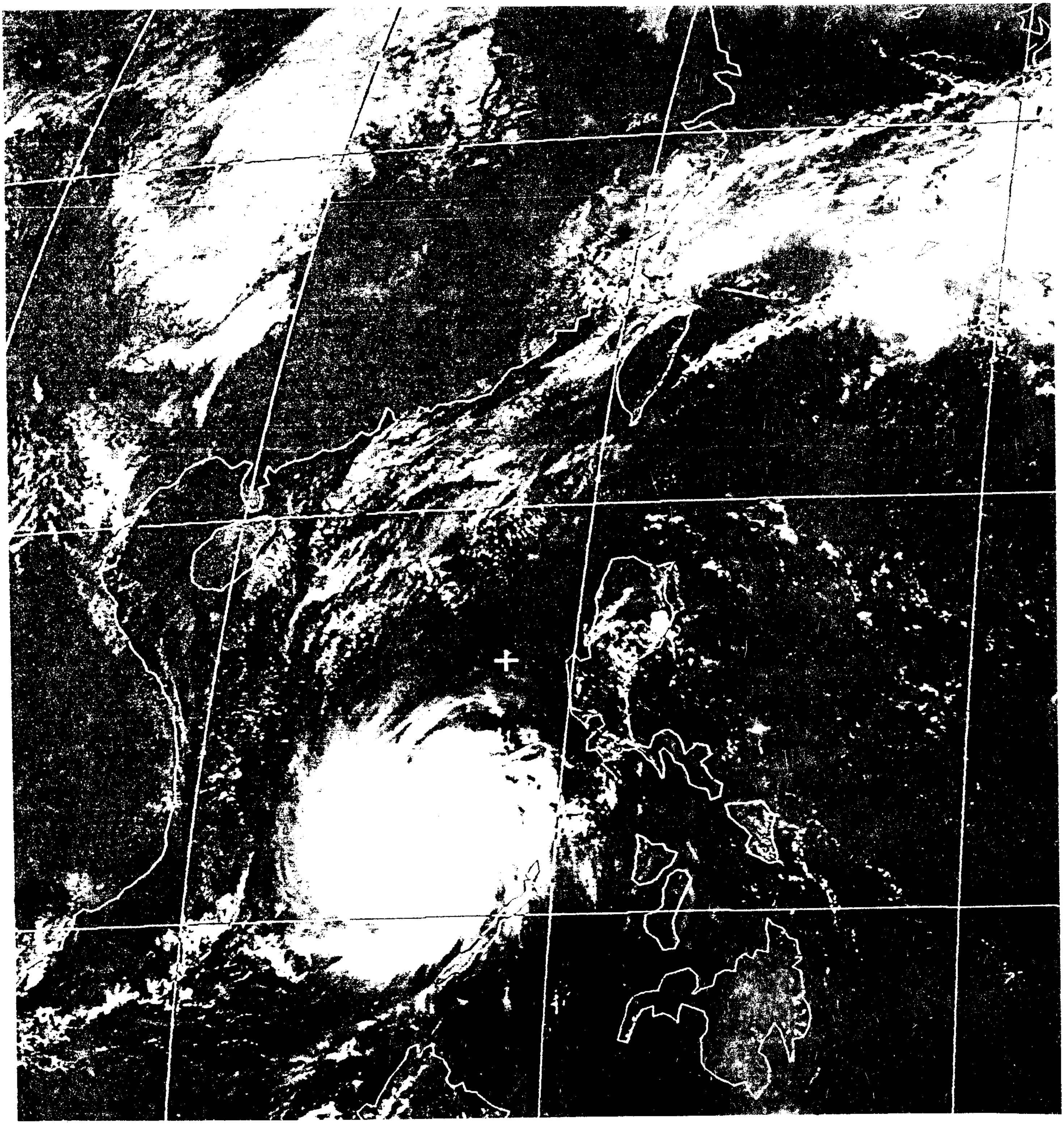


Figure 52. VS Satellite picture - 841106 03 UTC.

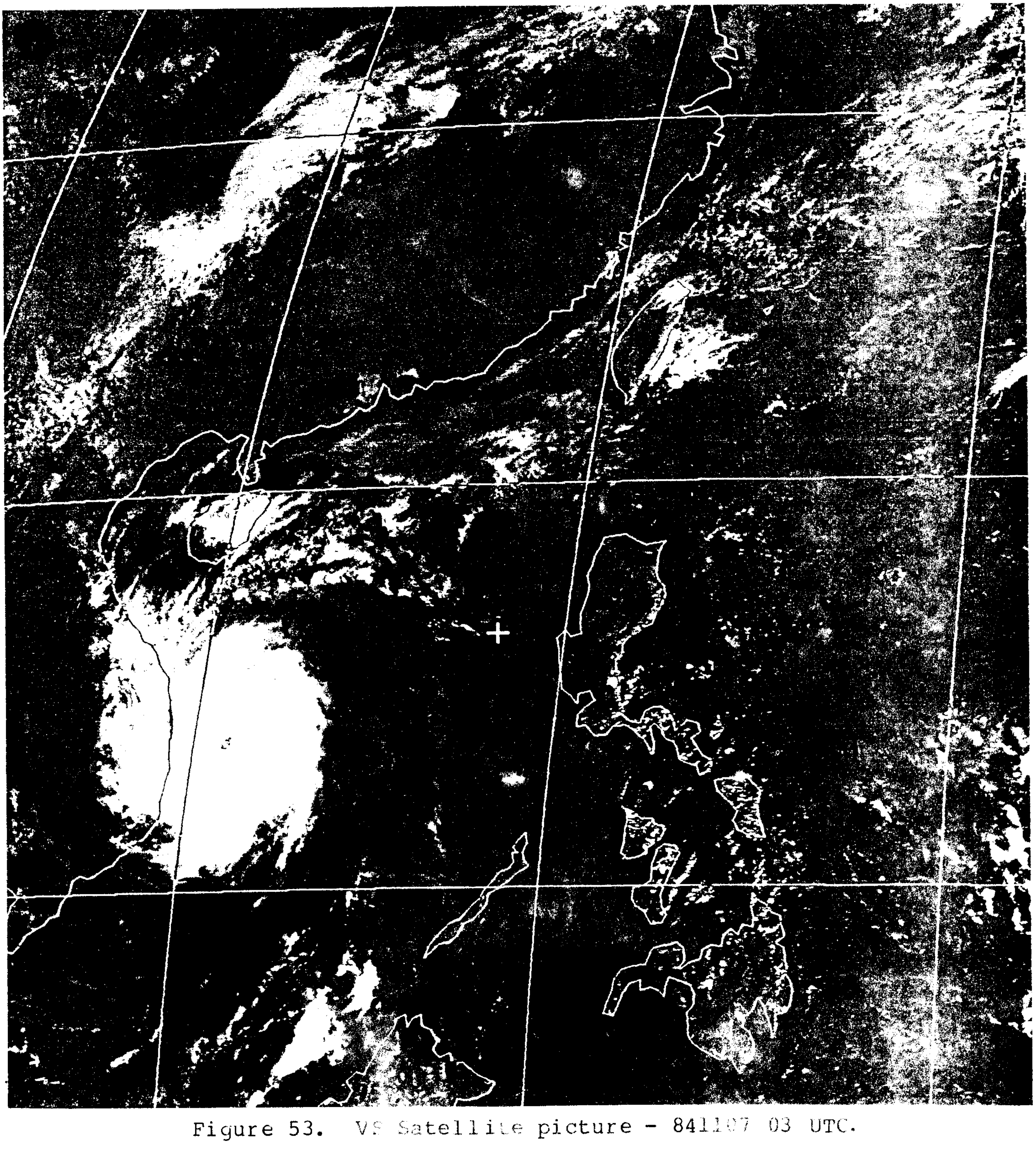


Figure 53. VS Satellite picture - 841107 03 UTC.

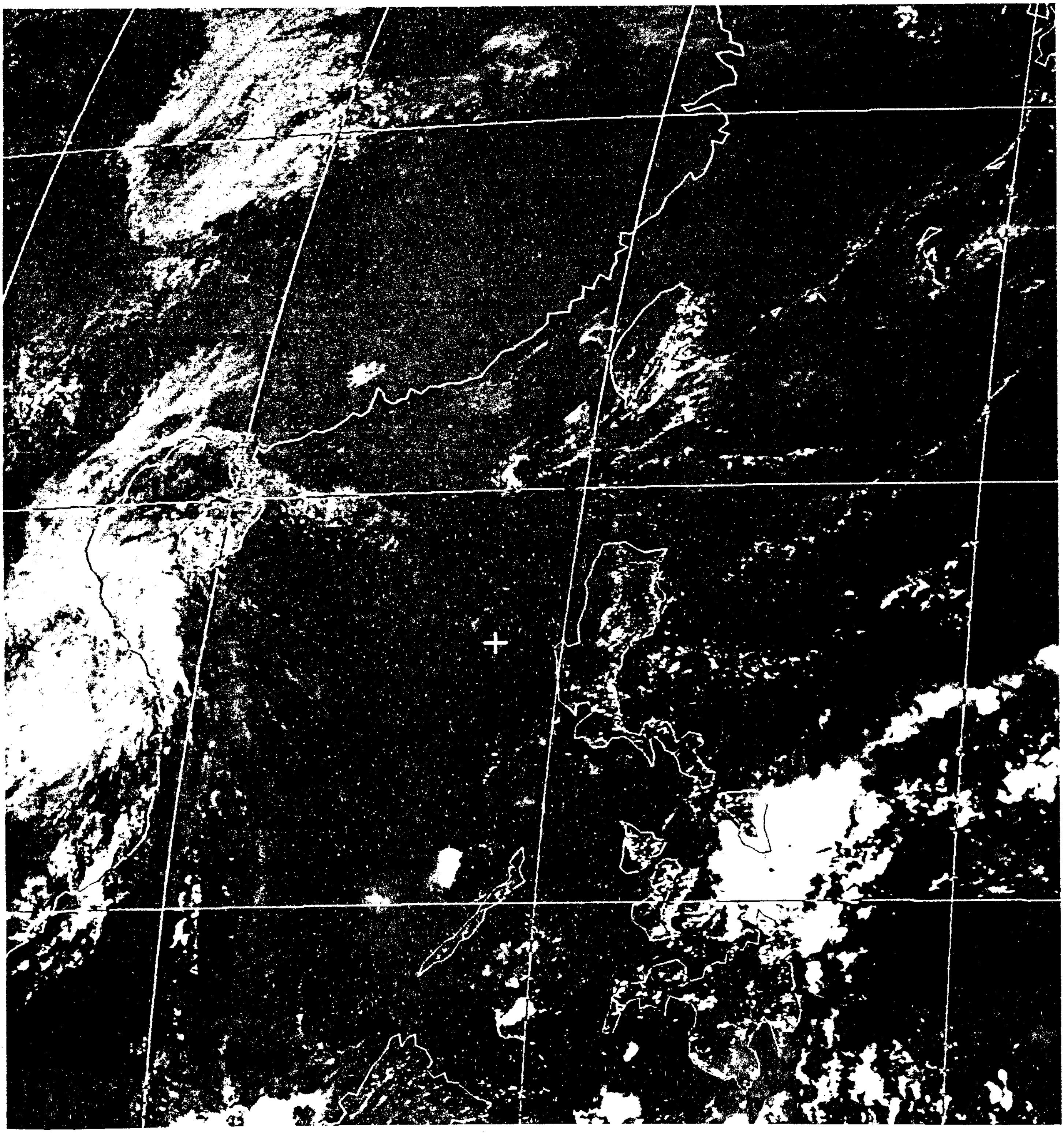


Figure 54. VS Satellite picture - 841108 03 UTC.

9. CONCLUSIONS

The original study of Cuming(1968) was purely statistical, carried out without the benefit of GMS pictures. With the advent of GMS pictures, the evolution and movement of individual cloud systems can be traced with a high degree of confidence. The satellite sequences of the six cases described in sections 3 - 8 amply illustrated that a rather extensive southwest-northeast oriented cloud mass will usually form in the northeast quadrant of a cyclonic circulation as it traverses westwards across the South China Sea in November and December. This rather extensive cloud mass has been referred to as "cloud plume" in the above discussions. As the cyclonic circulation moves westwards, the cloud plume invariably advances northwards. If this cloud plume manages to reach the South China coast, it will bring cloudy weather and sometimes even rain to Hong Kong. Cuming's statistical result merely points out that if a cyclonic circulation is centred within the Cuming area, the chance of the cloud plume reaching Hong Kong is considerably higher. However, there had been cases that the cloud plume did not reach as far north as the South China coast even though the cyclonic circulation was centred within the Cuming area.

The cloud plume is actually a manifestation of the interaction between mid-latitude and tropical weather systems. The baroclinicity will increase in the region where the two systems interact. More specifically, warm and moist air from the tropical region is lifted as it rises above cooler air coming south from the continent. This will result in the formation of the cloud plume. In Case I, the development of the cloud plume was most evident as a weak surge of the winter monsoon reached the South China coastal waters. In Case II, clouds associated with a westerly trough moving across South China were enhanced as they linked up with the cyclonic circulation. In case IV, the cloud plume reaching South China was further enhanced as reflected by the heavier rain over Hong Kong after the intrusion of shallow cold air from the north. In Case VI, the formation of a cloud plume was not evident since no mid-latitude weather system interacted with the cyclonic circulation.

Whether the cloud plume will reach the South China coast will depend on the relative intensity of the mid-latitude system and the cyclonic circulation. If the tropical circulation prevails over the mid-latitude system and South China comes under southeasterly flow at 850 and 700 hPa, (usually in the form of return flow of an anticyclone over the Ryukyu area), the plume will follow the southeasterly flow to reach the coast. In particular, if the tropical system dominates, Cuming effect can occur even when the centre of the tropical circulation is south of the Cuming Area.

However, if the influence of the mid-latitude system is larger, the plume may not be able to reach the South China coast even if the centre of the tropical circulation is inside the Cuming area. For instance, a ridge at 700 hPa over Southwest China, with northwesterlies at Hong Kong will hold the plume south of the coast (Case III). Intense winter monsoon manifests itself as dry air in depth will also push the plume southwards and may even dissipate it (Case V).

It may be worthwhile to point out again that the movement of the cloud plume seems to follow the 700 hPa level flow more than the 850 hPa flow as described in Case III.

While the above conclusions were drawn from observations based on a limited data set, they do provide a conceptual framework which forecasters may employ to help interpret the synoptic data in association with GMS pictures whenever a cyclonic circulation moves westward across the South China Sea during the cool season. In time, forecasters will be in a better position to assess the relative importance of the various factors involved.

10. ACKNOWLEDGEMENT

The author wishes to express his sincere thanks to Mr. C.Y. Lam and Dr. S.W. Fong for their stimulating discussions and invaluable advice during the preparation of this report.

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2. Lam, C.Y., 1982 The interaction between tropical circulations and the Asian Monsoon over the South China Sea as revealed by GMS data. Presented at the WMO/Met. Society Japan Regional Scientific Conference on Tropical Meteorology, Tsukuba, Japan, Oct., 1982.

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