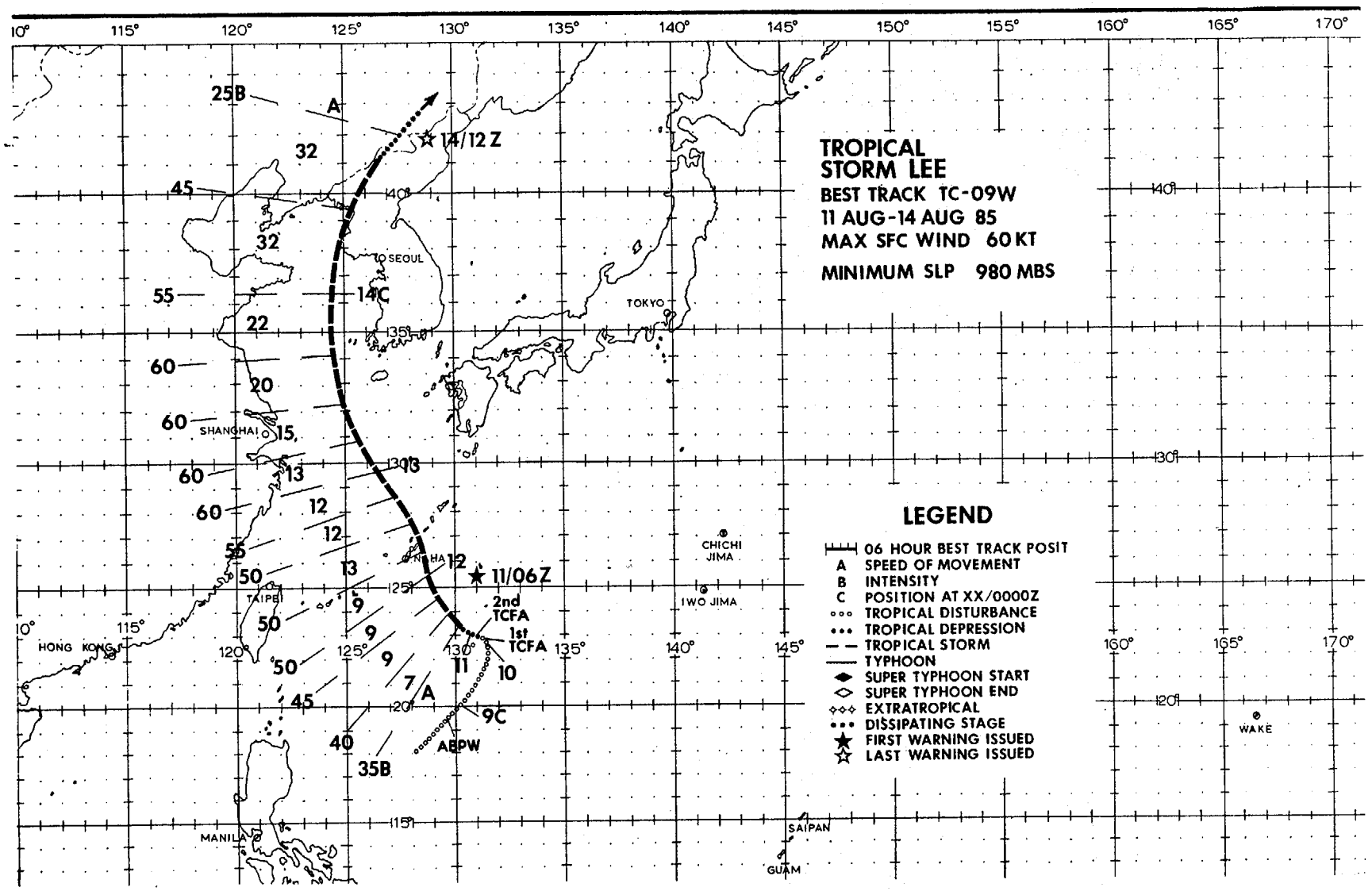
TROPICAL STORM LEE
BEST TRACK TC-09W
11 AUG-14 AUG 85
MAX SFC WIND 60 KT
MINIMUM SLP 980 MBS
LEGEND
06 HOUR BEST TRACK POSIT
A SPEED OF MOVEMENT
B INTENSITY
C POSITION AT XX/0000Z
TROPICAL DISTURBANCE
TROPICAL DEPRESSION
TROPICAL STORM
TYPHOON
SUPER TYPHOON START
SUPER TYPHOON END
EXTRATROPICAL
DISSIPATING STAGE
FIRST WARNING ISSUED
LAST WARNING ISSUED
14/12Z
11/06Z
2nd TCFA
1st TCFA
TO SEOUL
TOKYO
SHANGHAI
TAIPEI
HONG KONG
MANILA
CHICHI JIMA
IWO JIMA
WAKE
SAIPAN
GUAM
25B
35B
14C
9C
ABPW

Unlike its predecessors, Typhoons Irma, Jeff, and Kit, that developed on the northeast periphery of the southwest monsoon trough, Lee formed in the trough in the central Philippine Sea. Lee's initial development and movement within the monsoon trough was influenced by Typhoon Kit, which was located further to the north.

On the 31st of July, the monsoon trough was oriented southwest to northeast, extending from the central Philippine Sea eastward across the northern Mariana Islands. To set the stage, Typhoon Kit, which developed on the northeastern end of the trough, moved northwestward and intensified. As Kit's low pressure area migrated northwestward, the axis of the monsoon trough repositioned along with it until finally, on the 8th of August the monsoon trough was oriented almost north to south.

Ship reports at 081200Z indicated a broad circulation in the trough 480 nm (889 km) south of the island of Okinawa with a minimum sea-level pressure (MSLP) of 1002 mb. Satellite imagery also showed that the convection associated with this disturbance had some curvature. Since good outflow channels were present aloft to the south and southwest, the Significant Tropical Weather Advisory (ABPW PGTW) was reissued at 082000Z to include this system.

During the following 24-hours, as the disturbance moved to the north-northeast, the convection remained on the equatorward side of the circulation center, associated with the 15-25 kt (8-13 m/s) convergent low-level wind flow. Synoptic data showed only 5 kt (3 m/s) winds on the northwest side of the circulation. This area of lighter winds underwent a change on the 10th of August. The low-level subtropical ridge built back to the north of the disturbance and across the Rhukyu Islands in the wake of Kit and the pressure gradient increased over the north side of the disturbance. In response, the broad low-level circulation consolidated with increased winds of 10-15 kt (5-8 m/s) over the northwest quadrant (Figure 3-09-1). Simultaneously, the upper-level wind reports showed an anticyclonic circulation was developing over an area of comma-shaped convection. The cloudiness increased in

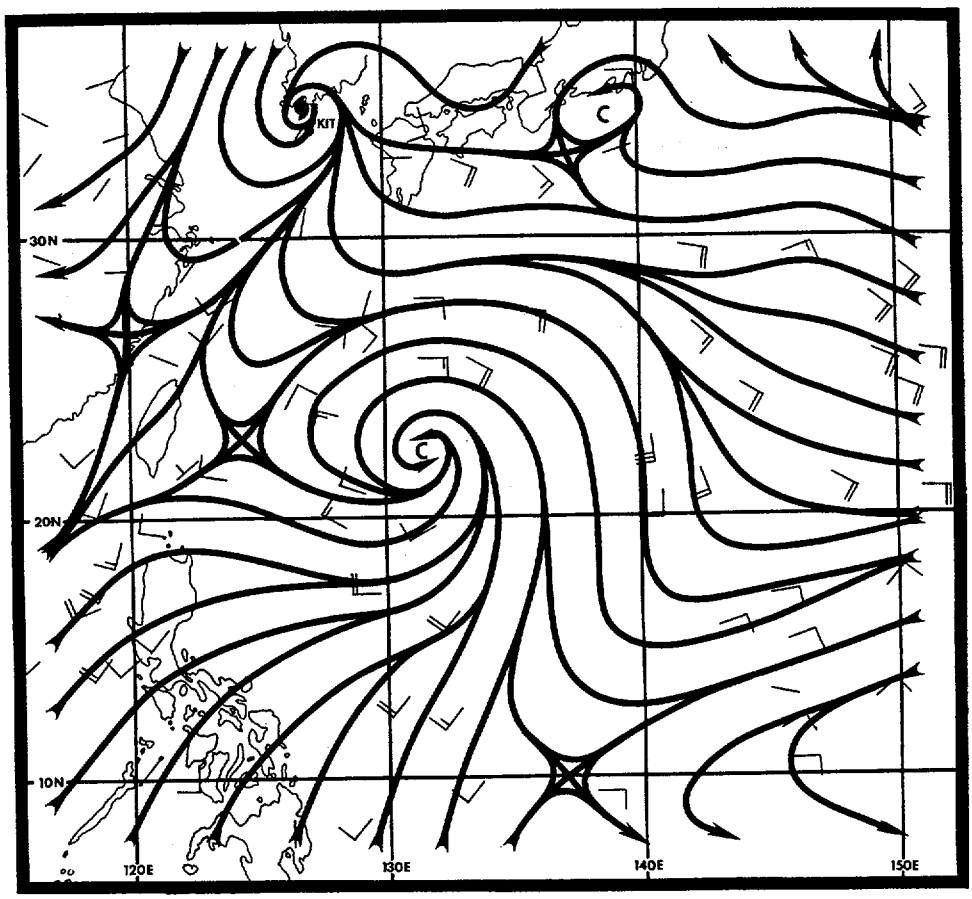

Figure 3-09-1. Surface analysis at 100000Z August showing the subtropical ridge which built across to the north of the disturbance in the wake of typhoon Kit. The monsoon depression is beginning to consolidate. The convergent flow is only on the south and east sides of the broad circulation center.

amount and was near the surface center. These events prompted the issuance of the first TCFA at 100230Z.

The initial aircraft reconnaissance mission, at 100650Z, into the disturbance reported a broad surface circulation with dimensions of 60 nm (111 km) north to south by 90 nm (167 km) east to west and a 997 mb MSLP. The new location of the circulation center, as determined by the aircraft, required the issuance of a second TCFA at 100800Z. The circulation center was relocated 115 nm (213 km) further to the east-southeast and outside of the original TCFA area which was based on an earlier position derived from visual satellite data.

During the following twenty-four hours, Lee turned towards the northwest, moved very slowly, and showed little intensification. This slow intensification could be related to the persistent strong flow aloft from the north over the disturbance (Figure 3-09-2). Satellite imagery for the same period is shown in Figure 3-09-3).

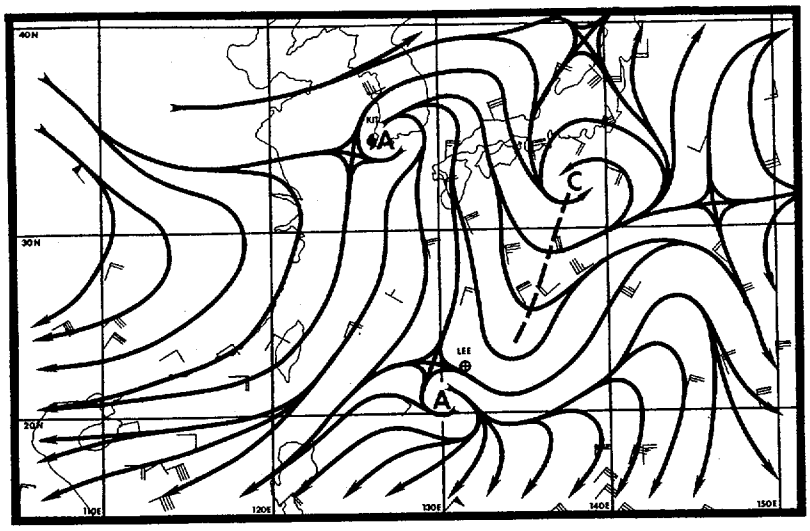

Figure 3-09-2. The 100000Z August 200 mb analysis showing the northerly flow aloft across the disturbance.

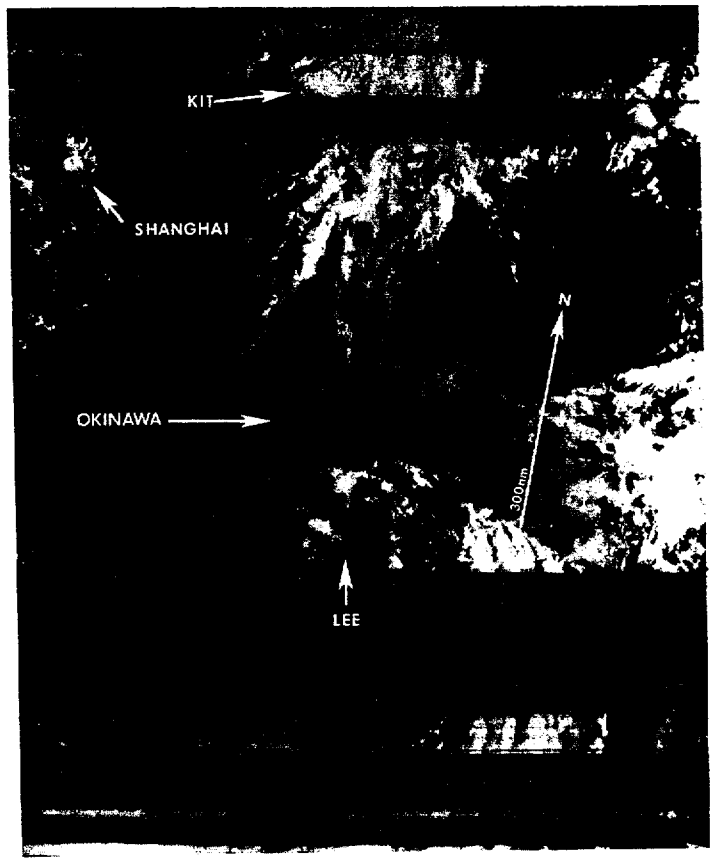

Figure 3-09-3. With the northerly flow aloft there is little convection on the poleward side of the disturbance's circulation center. The cloudiness persists over the low-level southwesterly flow (1001082 August DMSP visual imagery).

An aircraft reconnaissance flight into the disturbance at 110656Z found a 25 nm (46 km) diameter light and variable wind center with only 15 kt (8 m/s) maximum surface winds around it. However, the MSLP had dropped another 5 mb during the previous twenty-four hours to 992 mb. This supported maximum winds of 40-45 kt (21-23 m/s) based on the Atkinson/Holliday wind/pressure relationship. Aircraft, synoptic and satellite data indicated that stronger winds of 25-35 kt (15-18 m/s) were located in a band displaced 60-180 nm (111-333 km) to the east of the center. These data led to the issuance of the first warning at 110600Z. As a result, Kadena AB, Japan (WMO 47931) immediately set a Condition of Readiness III.

Fortunately, Lee continued to exhibit typical characteristics of a monsoon depression where the maximum surface winds and intense convection never consolidate at the surface center. Instead, the maximum surface winds remained in the eastern semi-circle. As a consequence, when Lee passed within 15 nm (28 km) northeast of Okinawa at 120430Z, the maximum sustained winds stayed well to the east of the island. In fact, the strongest winds experienced at Kadena AB were from the west-southwest at 22 kt (11 m/s) with 32 kt (16m/s) approximately twelve hours later. Naha (WMO 47936) located on an elevated and exposed part of the island of Okinawa reported highest winds (in association with the southwest monsoon flow) of 27 kt (14 m/s) with gusts to 40 kt (21 m/s) at 121948Z. At that time Lee was 170 nm (315 km) to the north-northwest of the station. Overall, Lee's track and asymmetrical wind distribution spared Okinawa, but the western coast of South Korea appeared to be the next target and preparations had begun for the tropical cyclone's approach.

On the synoptic scale, lower standard pressure-level heights prevailed over the East China Sea between the two ridges. As the mid-latitude trough (Figure 3-09-4) approached the Yellow Sea on the 13th of August, it came into phase with the short wave trough extending south-southwestward from a deepening Siberian low near 52N 116E. By 131200Z the trough was oriented along 118E longitude and the ridge over Japan continued to build northward across the Seas of Japan and Okhotsk. This caused the mid-level steering flow from the south to increase over Lee. In response, Lee steadily accelerated across the East China Sea and passed 240 nm (444 km) west of the island of Kyushu, Japan. Coastal stations on Kyushu reported 10-25 kt (5-13 m/s) sustained winds. Aircraft reconnaissance reported the band of 40-60 kt (21-31 m/s) maximum winds remained about 120 nm (222 km) west of the coast.

As Lee began to break free of the monsoon trough, it reached it's peak intensity of 60 kt

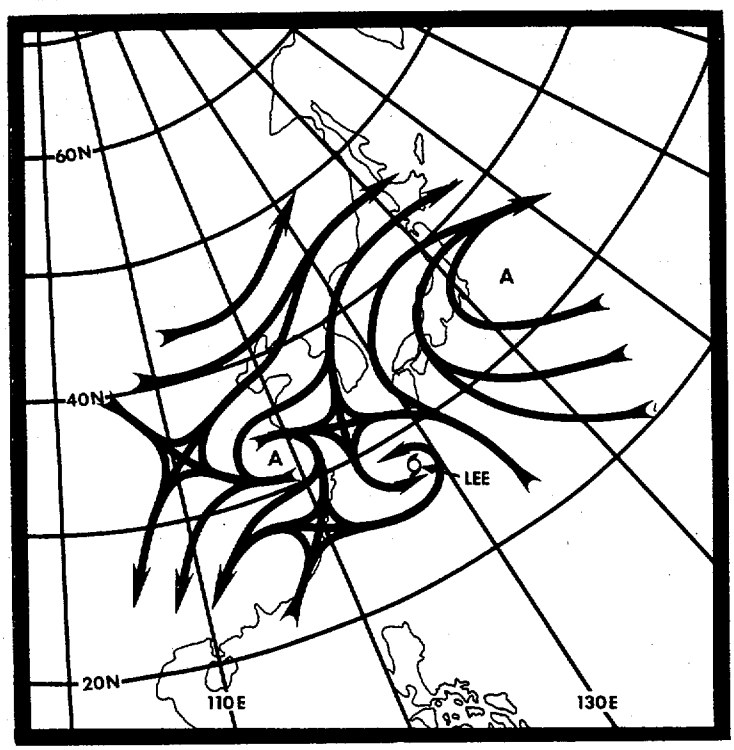

Figure 3-09-4. The 121200Z August 500 mb analysis with troughing in the subtropical ridge over the East China Sea.

(31 m/s) (Figure 3-09-5). Satellite imagery showed orientation of the supporting convection was changing, too. The strong upper-level westerlies were already pushing Lee's outflow to the northeast towards the southwest coast of South Korea.

Lee continued to accelerate and followed a northerly track across the Yellow Sea on 14 August, staying approximately 120 nm (222 km) offshore. This spared the coastline from any significant damage. A few reports of 35 kt (18 m/s) sustained winds were recorded at the southwest portion of the Korean peninsula. Later, Lee transited the North Korean coastline 60 nm (111 km) southeast of Sinuiju (WMO 54498) at 140600Z, and dissipated rapidly inland over the mountainous terrain. No reports of damage were available.

Of note, the tracks of Jeff, Kit, Lee, and later, Mamie in the Yellow Sea came under the influence of the same synoptic scale pattern during the first three weeks of August with ridging over Japan and troughing over northeast mainland China. This pattern maintained semi-persistent south-to-north mid-level steering flow over the Yellow Sea. Each tropical system in its own time recurved around the western periphery of the subtropical ridge and accelerated. Figures 3-09-6 and 3-09-7 show the approximate location and orientation of the synoptic scale trough with respect to the point of recurvature of each tropical system. The pattern shifted eastward from Jeff to Kit, then retrograded westward with Lee, and later, Mamie's track. The points of recurvature also indicate the western extent of the subtropical ridge in each case plus the northward displacement of the ridge axis which was well north of its climatological position.

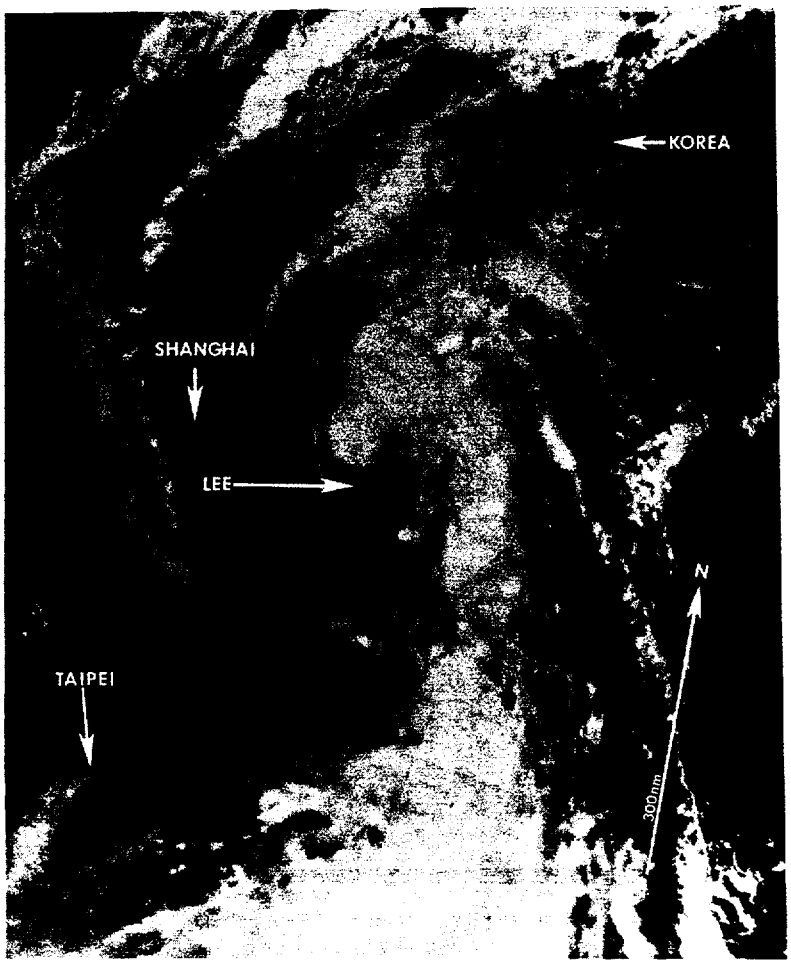

Figure 3-09-5. Tropical Storm Lee at its maximum intensity of 60 kt (31 m/s). The upper-level anticyclonic circulation displaced slightly to the northeast of the exposed low-level circulation center (130518Z August NOAA visual imagery).

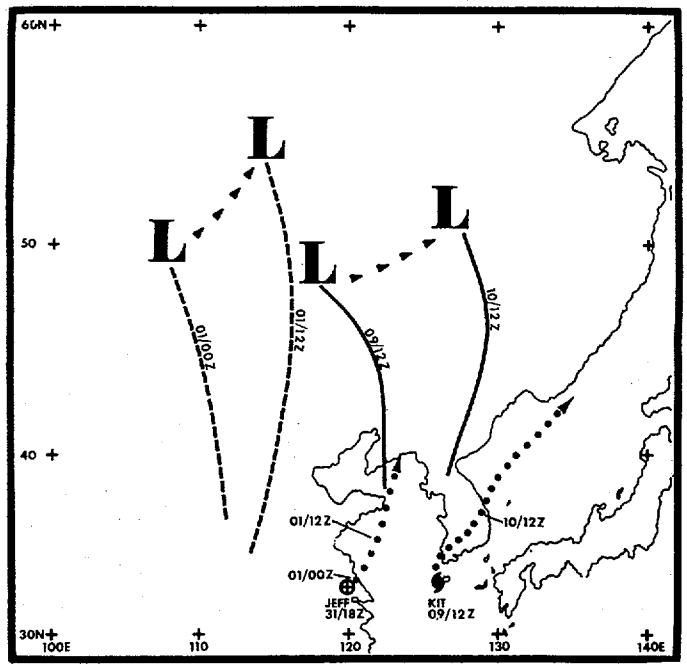

Figure 3-09-6. The best tracks (dotted line) of Jeff and Kit from the point of recurvature through the final warning are depicted. The times along the dotted lines at, or after, the recurvature point correspond with the respective positions of the mid-latitude troughs (dashed and solid lines). The arrows show the movement of the Siberian mid-level lows. Notice the Siberian low track is displaced further southeast during Kit.

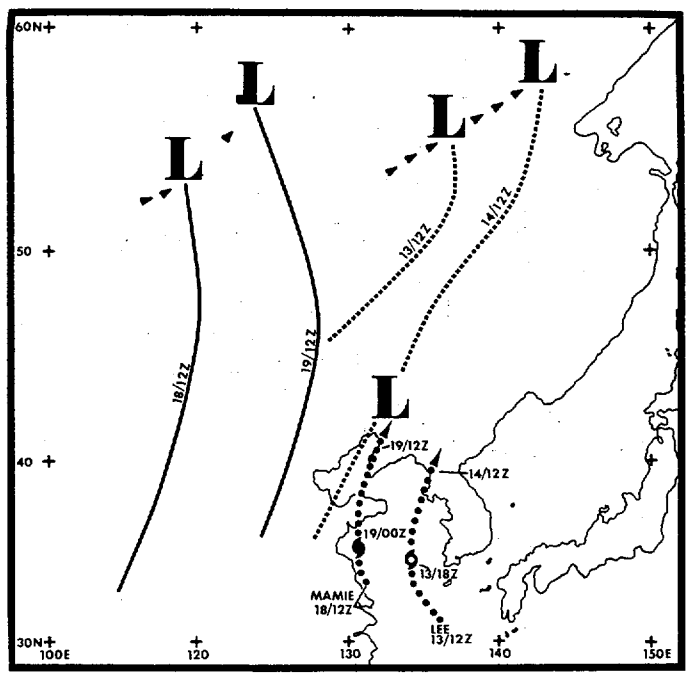

Figure 3-09-7. The best tracks (dotted line) of Lee and Mamie from the point of recurvature through the final warning are shown. The times along the dotted lines at, or after, the recurvature point correspond with the respective positions of the mid-latitude troughs (dashed and solid lines). Notice that the track of the Siberian lows retrogrades between the second and third week of August.