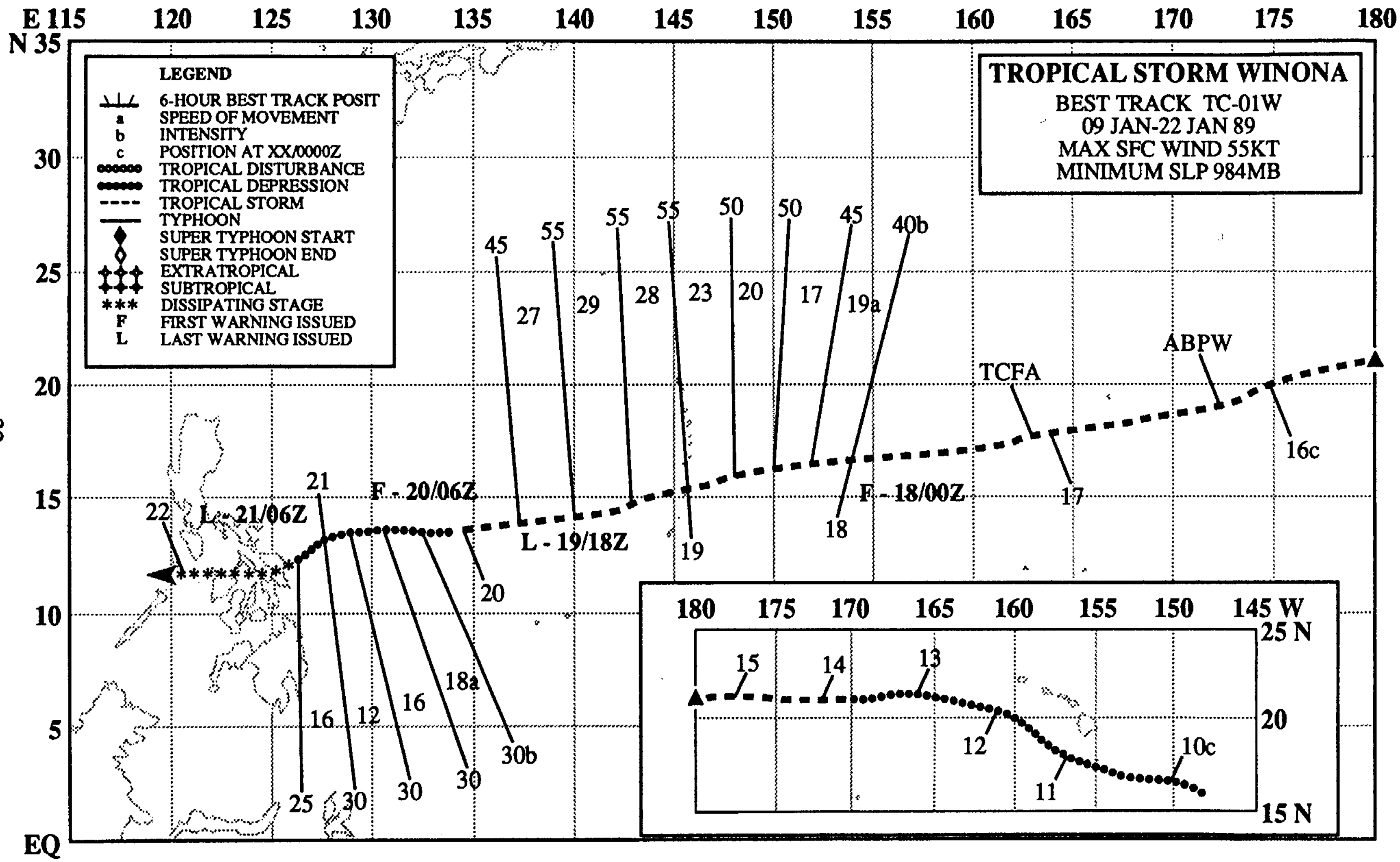
TROPICAL STORM WINONA
BEST TRACK TC-01W
09 JAN-22 JAN 89
MAX SFC WIND 55KT
MINIMUM SLP 984MB
LEGEND
6-HOUR BEST TRACK POSIT
a SPEED OF MOVEMENT
b INTENSITY
c POSITION AT XX/0000Z
TROPICAL DISTURBANCE
TROPICAL DEPRESSION
TROPICAL STORM
TYPHOON
SUPER TYPHOON START
SUPER TYPHOON END
EXTRATROPICAL
SUBTROPICAL
*** DISSIPATING STAGE
F FIRST WARNING ISSUED
L LAST WARNING ISSUED
E 115
120
125
130
135
140
145
150
155
160
165
170
175
180
N 35
30
25
20
15
10
5
EQ
TCFA
ABPW
F - 20/06Z
L - 21/06Z
L - 19/18Z
F - 18/00Z
16c
17
18
19
19a
20
21
22
40b
30b
18a
180
175
170
165
160
155
150
145 W
25 N
20
15 N
10c
11
12
13
14
15

TROPICAL STORM WINONA (01W)

The first western North Pacific tropical cyclone of 1989, Winona quietly began in the eastern North Pacific southeast of the Hawaiian Islands. The system was unusual because of its compact size and persistence. In two weeks it traveled over 5500 nm (10,185 km) before finally dissipating in the Philippine Islands.

At the start of the second week of January, 40-kt (21-m/sec) upper-level westerly winds funneled through a trough located just east of the Hawaiian Islands and created a broad area of divergence aloft to the southeast. In response, an area of deep convection persisted under the divergence and over the east-southeasterly winter trades. As the upper-level trough relocated eastward at 091200Z, a swirl of low-level cloudiness (Figure 3-01-1) became exposed, leaving behind its convective cloudiness, and moved to the west-northwest as a wave until 11 January. Then the supporting convection flared up (Figure 3-01-2), triggering flash floods on Kauai. As the system assumed a more westward track on 12 January, it again passed under another upper-level trough. This time, however, the central convection persisted. Sparse surface data indicated a small area of light westerly winds to the south of the circulation center and a minimum sea-level pressure center of 1010 mb.

On 16 January, the compact system still retained its deep convection. It had traversed the Central Pacific in the dead of winter at 20° north latitude and persisted, which is extremely unusual. In fact, Winona was so unique that the analog and climatological forecast guidance was not available, or very limited, for most of the tropical cyclone's lifetime. It had crossed the international dateline the day before and was now approaching Wake Island. At 160600Z, the Significant Tropical Weather Advisory mentioned its persistent circulation and central convection. Later, at 161800Z, it was 75 nm (140 km) south of Wake Island (WMO 91245),

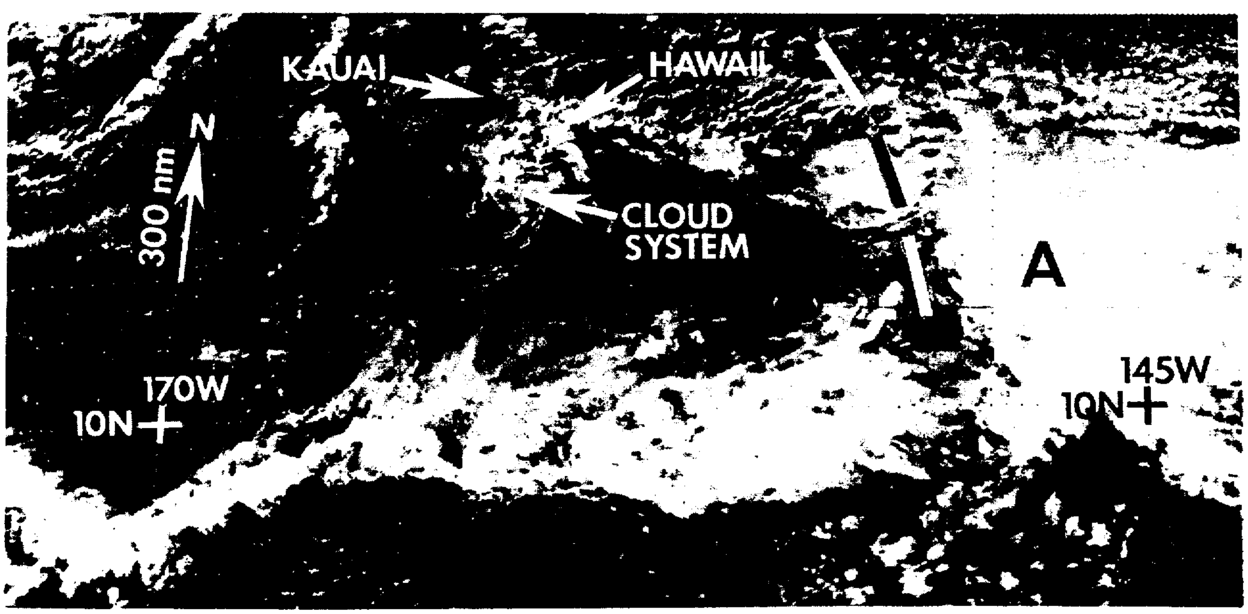

Figure 3-01-1. The low-level cloud system is passing south of the island of Hawaii. The area of bright cloudiness near point A is located east of the upper-level trough (102316Z January GOES West visual imagery courtesy of the National Weather Service Forecast Office, Honolulu, Hawaii).

which experienced maximum sustained surface winds of 25 kt (13 m/sec) and gradient-level winds (Figure 3-01-3) of 30 kt (15 m/sec).

After Winona passed Wake Island, a satellite intensity estimate of 25 kt (13 m/sec) coupled with the system's translational speed of more than 20 kt (37 km/hr) prompted a Tropical Cyclone Formation Alert at 170030Z. The subject of the Alert was upgraded to Tropical Storm Winona at 180000Z based on persistent central convection, the satellite intensity analysis and the cyclones rapid translational speed to the west, which would cause higher winds to the north of the circulation center. Since the tropical cyclone was embedded in broad easterly flow, a "straight runner" was forecast.

Just at the end of 18 January invaluable insight came from the ship **MV Williams** as follows, "Believe to have passed through center at 180700Z........Barometer pressure 991 (mb) max sustained winds 045 (gusts to) 65-70 kts, combined sea-swell 35 (ft)." This ship observation resulted in a warning and final best track intensity* increase (Figure 3-01-4). Without any additional direct measurements, satellite remote sensing tracked the cold cloud tops throughout the night. First light visual satellite data and later initial radar reports from Andersen AFB, Guam (WMO 91218) found Winona south and west of the expected track (Figure 3-01-5). The tropical storm (Figure 3-01-6) with peak winds of 55 kt (28 m/sec), passed just to the north of Saipan at 190000Z. The International Airport (91232) reported

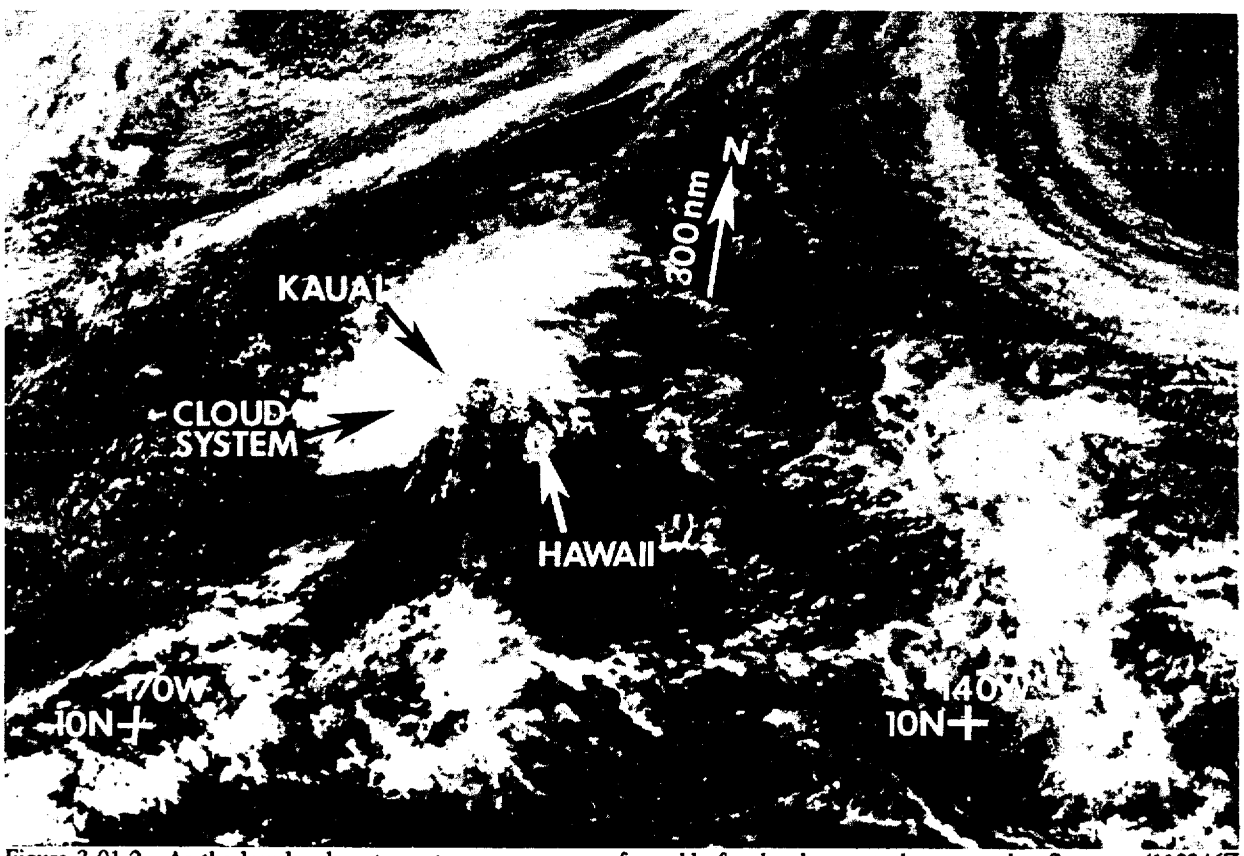

Figure 3-01-2. As the low-level vortex enters an area more favorable for development, the convection flares up (112346Z January GOES West visual imagery courtesy of the National Weather Service Forecast Office, Honolulu, Hawaii).

*This underscores a limitation of the Dvorak technique (1984), when applied to tropical cyclones that are moving along track at speeds greater than the climatic mean. Tropical cyclone forecasters should consider excess translational speed in addition to the intensity estimate, that is derived from the cloud signature, to better approximate maximum sustained surface winds.

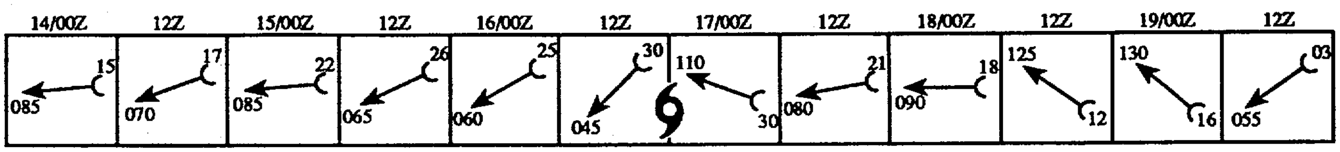

Figure 3-01-3. The gradient winds at Wake Island (91245) peak at 30 kt (15 m/sec) and undergo a directional change between 161200Z and 170000Z, as Winona passes to the south. Note the gradual speed increase from two days before Winona's passage and decrease for two days afterward.

winds of 25 kt (13 m/sec) with gusts to 35 kt (18 m/sec). No loss of life was reported Saipan.

Winona continued accelerating to the west-southwest along the southern edge of a shallow modifying polar air mass until the deep supporting convection was lost. A final warning was issued at 191800Z. However, the central convection flared up again and a regenerated warning followed at 200600Z. Just prior to landfall in the central Philippine Islands, Winona's deep central convection fell apart and the system was finalled at 210600Z.

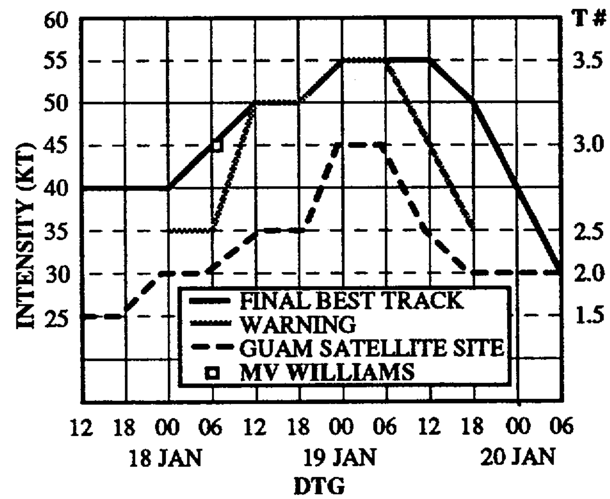

Figure 3-01-4. Impact of the ship MV Williams' 180700Z report on the warning and final best track intensities for Winona.

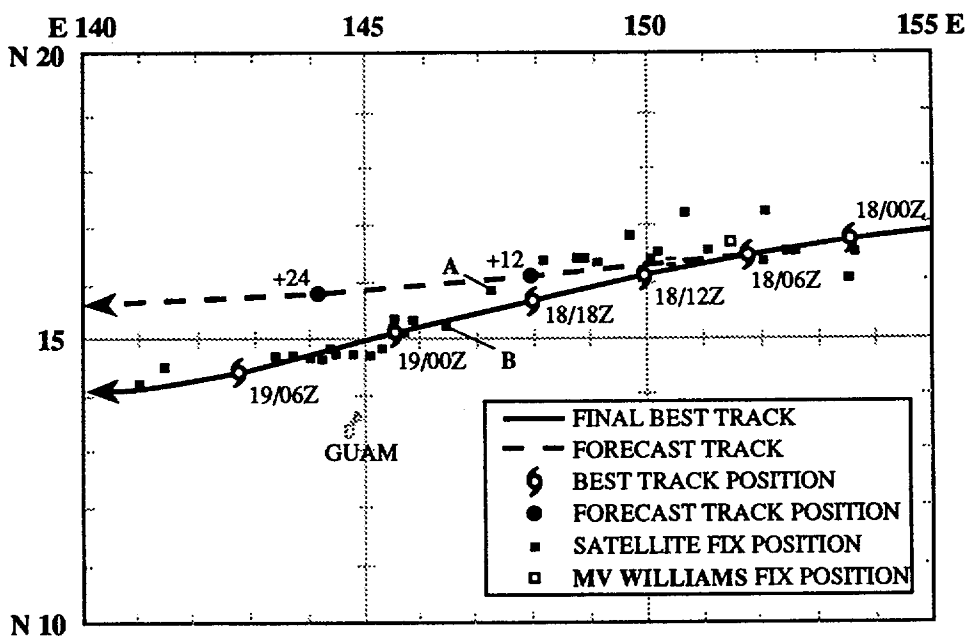

Figure 3-01-5. Comparison of expected track, raw fix data and final best track for Winona. The first daylight visual satellite fixes (A and B) were key elements in establishing Winona's continued movement to the west-southwest.

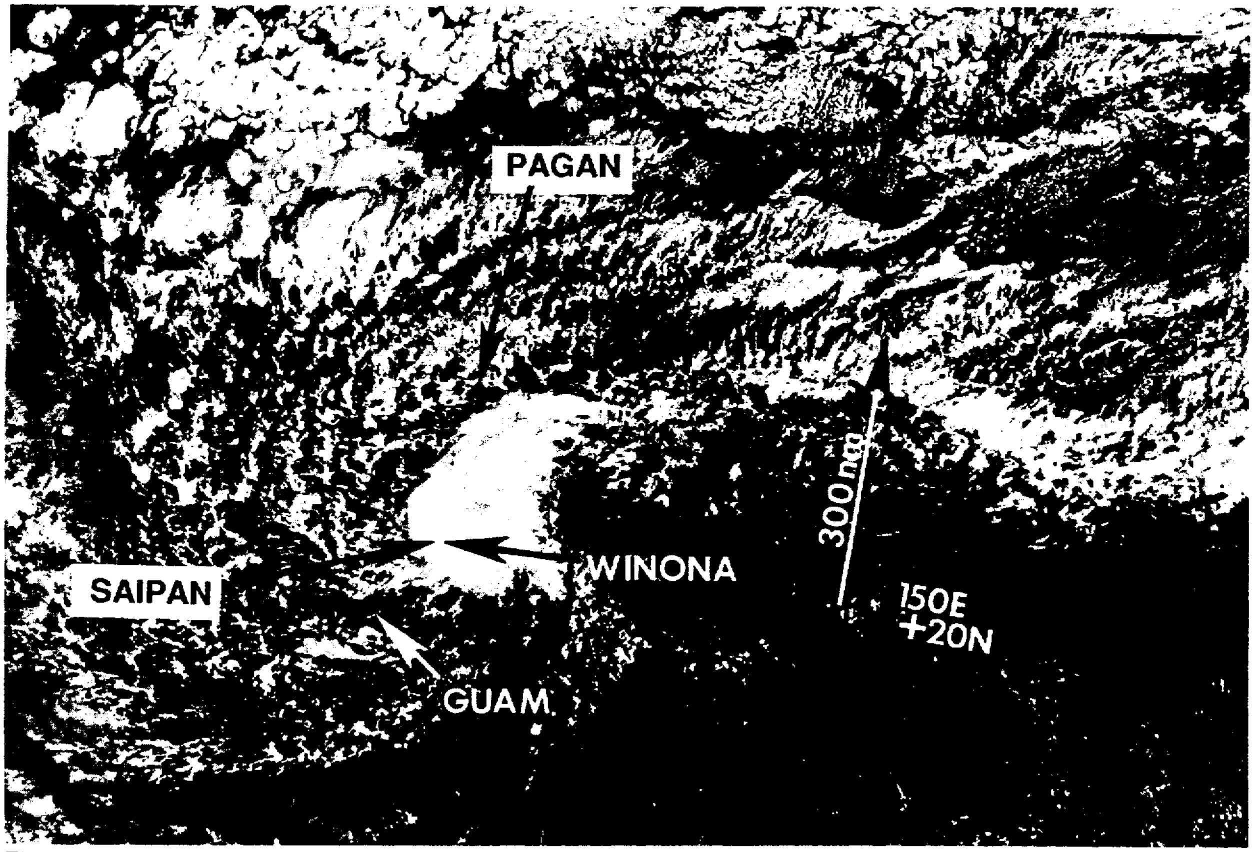

Figure 3-01-6. Tropical Storm Winona approaches Saipan. Note the compact size of the system (182321Z January DMSP visual imagery).