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TOWARD SMALLER SCALE OFFSHORE ANALYSIS
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West coast forecasters are well aware that objective analyses and numerical models are very poor during periods of high wind potential. The lack of data over the ocean is especially harmful due to the rapid speed and development of features in the vicinity of a strong jet stream. NMC analysts can and frequently do improve synoptic scale analyses with the use of satellite imagery, late ship reports and continuity. Subsynoptic analysis efforts in the field have proven productive over land where terrain knowledge and hourly surface data can be imposed. The following case will expose the need for greater effort and hope for better techniques to derive subsynoptic analyses in the data sparse offshore regions.

At 4:30 p.m. PST January 15, 1988 (00 UTC January 16, 1988), southeasterly wind gusts exceeded 34 knots near Grays Harbor on the south Washington coast and also near Olympia on south Puget Sound (Figure 1). By 7:00 p.m. the winds at the coast had peaked to sustained speeds near 40 knots with gusts around 70 knots. At the same time winds of similar force made their way into north Puget Sound. By 11:00 p.m. winds across western Washington had diminished everywhere except in the extreme north. Numerous power outages were reported, and the Hood Canal Bridge was closed to traffic for about an hour. Western Washington took a sharp blow from a small but rather intense low pressure system.

Centrally produced objective analyses during this event were understandably degraded. A 160 knot 250 millibar jet along 40 north formed a trough tilted westward with latitude through 45 north 135 west. The NGM 1200 UTC initial implied a weak non-developing surface low centered near 46 north 135 west (Figure 2). The NMC manual surface analyses tracked a developing low toward this point and northeastward along 130 west, a path that does not usually produce high winds in the Puget Sound lowlands (Figure 3). A local analysis at 1800 UTC using late arriving ship reports and satellite imagery improved the NMC analysis by detecting a second 996 mb low further southeast near 44 north 129 west (Figures 4a and 4b). On this basis timely gale warnings were issued for the coast and adjacent areas with the expectation that the low would curve northward very close to the coast.

The eventual intensity and path of the low center was revealed by local subsynoptic analysis at 0000 UTC and 0300 UTC (Figures 5a and 5b). The center continued deepening along the Oregon coast and moved inland north of Grays Harbor. It reached 993 mb as it reached the lee side of the Olympic Mountains. The radius of gale force winds was roughly 180 nautical miles (nm) and the radius of storm force winds 60 nm. High wind and storm warnings were issued for western Washington with lead times between 0 and 3 hours.

Pre-storm data of this case were reviewed to determine if better lead time was possible. A double structure system was tracked with satellite imagery for 24 hours moving along the jet (Figure 6). According to a local decision tree method (Reference 1), the track of the small southern comma cloud near 40 north 140 west, at 0446 UTC January 15, fit the characteristics of a typical Puget Sound windstorm while the path of the northern vortex associated with the analyzed surface low did not. Satellite interpretation schematics (Reference 2) would place a developing surface low near the back edge of the comma. However, the complexity of the pattern and underestimation of the intensity of the southern center discounted a high wind watch prior to 1200 UTC. A watch would have encouraged careful monitoring of the offshore data which follows.

The 1200 UTC NMC Pacific analysis correctly used satellite imagery to place a surface low near 43 north 134 west (Figure 3), but development was still slight. Stronger development was revealed by a time series of buoy 46002 (Figure 7). The pressure fell almost 6 mb in 3 hours by 1500 UTC and nearly recovered by 1800 UTC. No strong falls had occurred near buoy 46006 (located at 40.8 north, 137.7 west), and by 1800 UTC the pressure wave was beyond the data window provided by buoys 46002 and 46005. The observation at buoy 46002 could easily have been overlooked because it was not plotted by AFOS. By 1800 UTC, satellite imagery (Figure 6c) correlated well with ship reports, and the intense surface low was seen alarmingly close to the coast. The local forecast track of the low did not benefit from isallobaric continuity since no observations plotted at 1500 UTC showed the strong pressure falls. Data plotted at 2100 UTC did not reveal an intense small scale low, but satellite imagery (Figure 6d) located the low precisely, and continuity establishes an intensity and path toward Astoria, which ensures strong winds inland from the coast (Figure 8).

As seen above, information supporting of hazardous winds for western Washington was most apparent at 1500 UTC when the disturbance passed a buoy and at 2100 UTC when satellite imagery pinpointed the low center. These intermediate synoptic times are periods when west coast forecasters have little time for detailed analysis due to forecast composition and change of shift. A hindcast using the information at 3-hour intervals would likely improve the warning lead time between 2 and 7 hours.

This case demonstrates that careful analysis of late arriving offshore data at 3 hourly intervals using satellite imagery and continuity can significantly improve centralized products. It also shows that buoy observations are too sparsely available to support subsynoptic analysis of the offshore area but that the continuity provided by a time sequence is quite helpful. Future software programs which are written to provide this sequence should include the ability to alert the forecaster regarding missing reports, large pressure changes, and other locally determined threshold events.

References:

1. Ruscha, C., 1986: Forecasting Strong Winds in the Puget Sound Lowlands. Unpublished WSFO Seattle Paper.

2. Weldon, R., 1983: Synoptic Scale Cloud Systems. Weather Service Forecasting Handbook No. 6, NOAA, NWS and NESDIS.

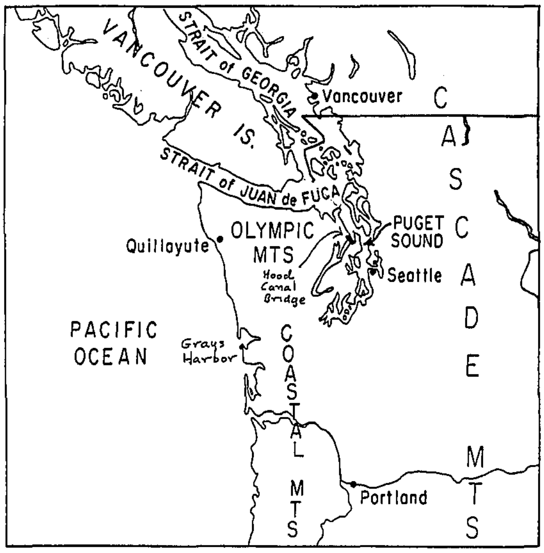

FIGURE 1. Geographic points of interest in western Washington

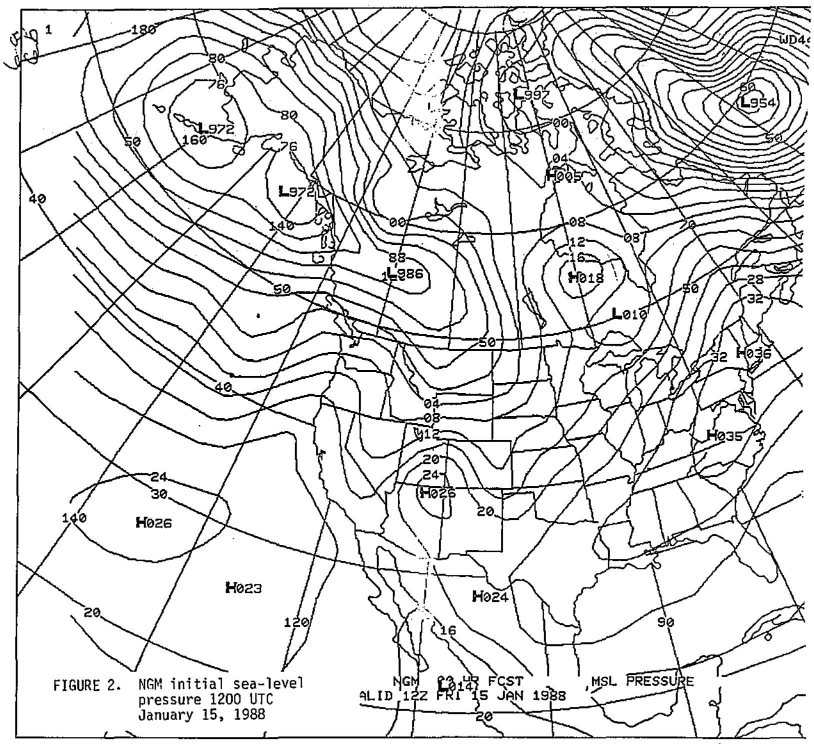

FIGURE 2. NGM initial sea-level pressure 1200 UTC January 15, 1988

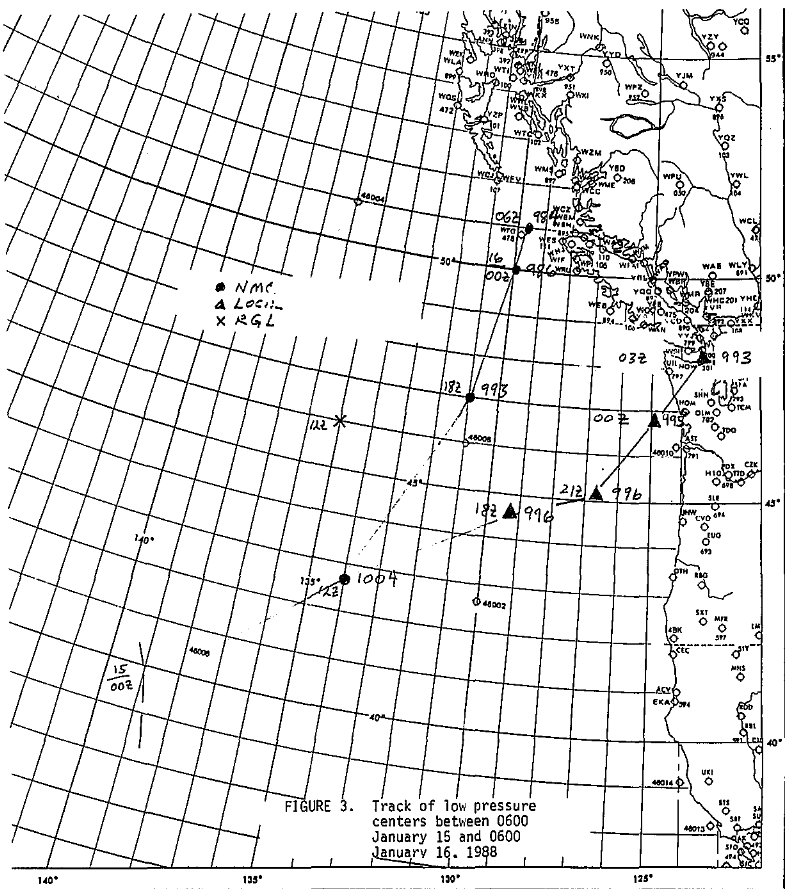

FIGURE 3. Track of low pressure centers between 0600 January 15 and 0600 January 16, 1988

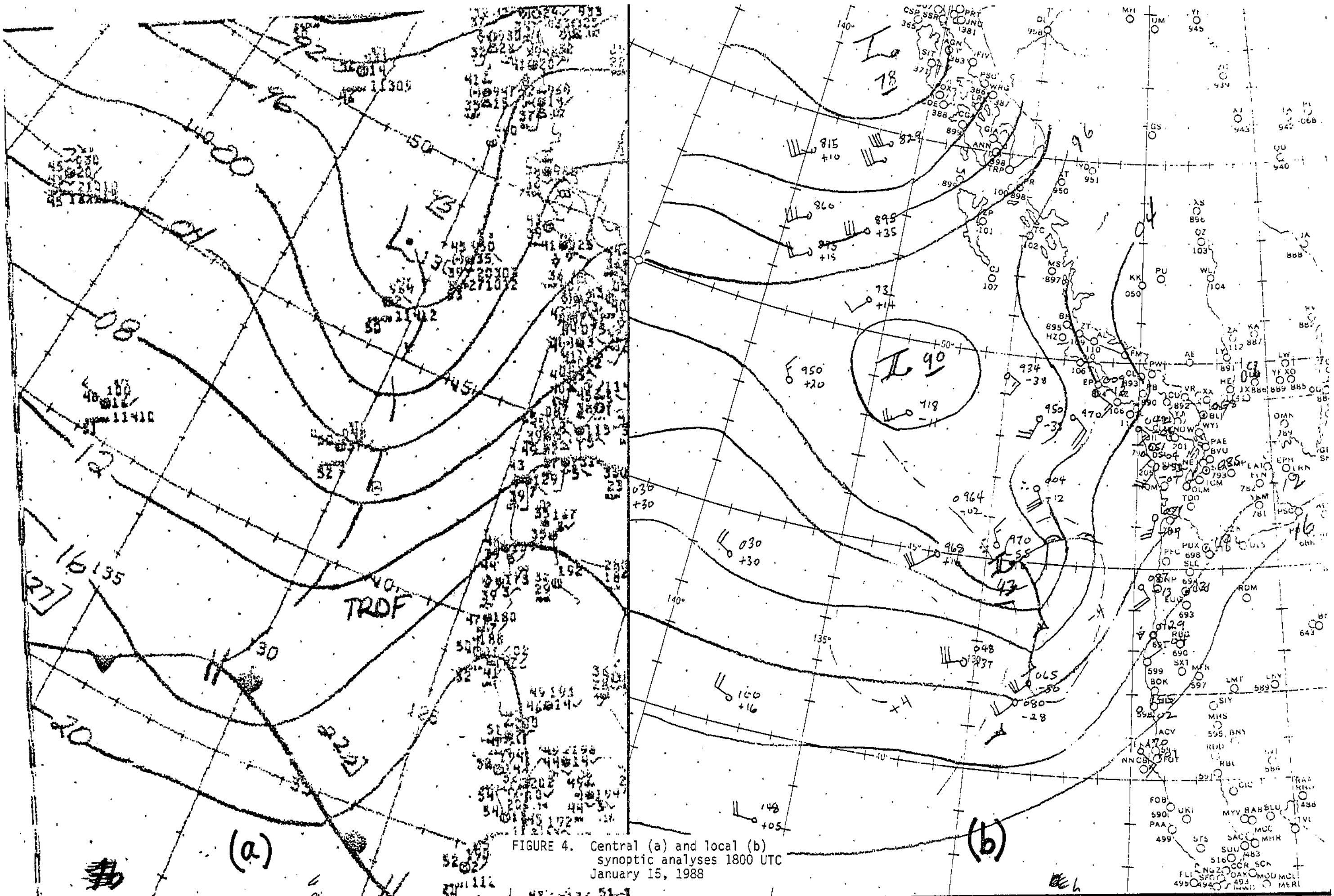

FIGURE 4. Central (a) and local (b) synoptic analyses 1800 UTC January 15, 1988

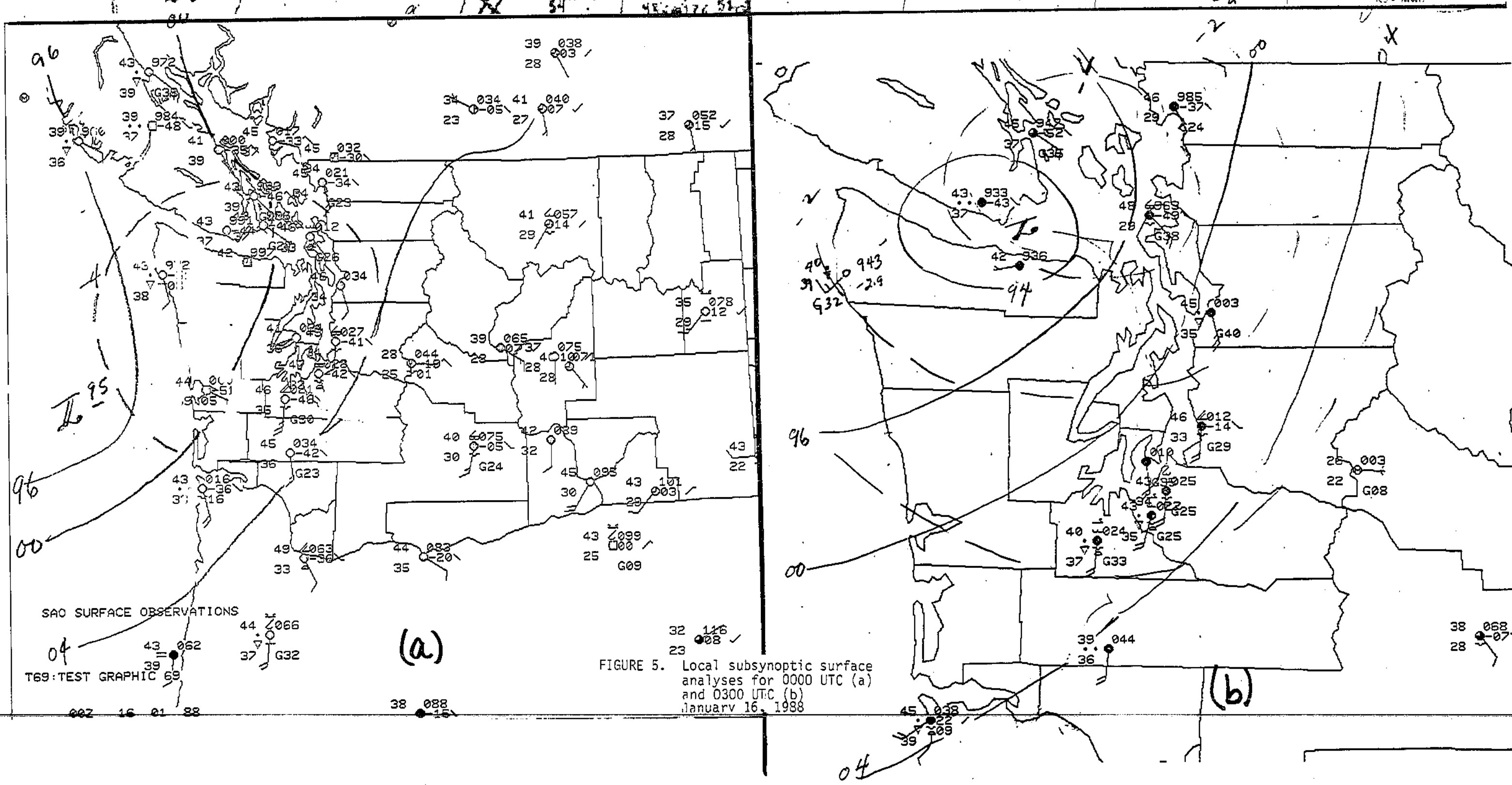

FIGURE 5. Local subsynoptic surface analyses for 0000 UTC (a) and 0300 UTC (b) January 16, 1988

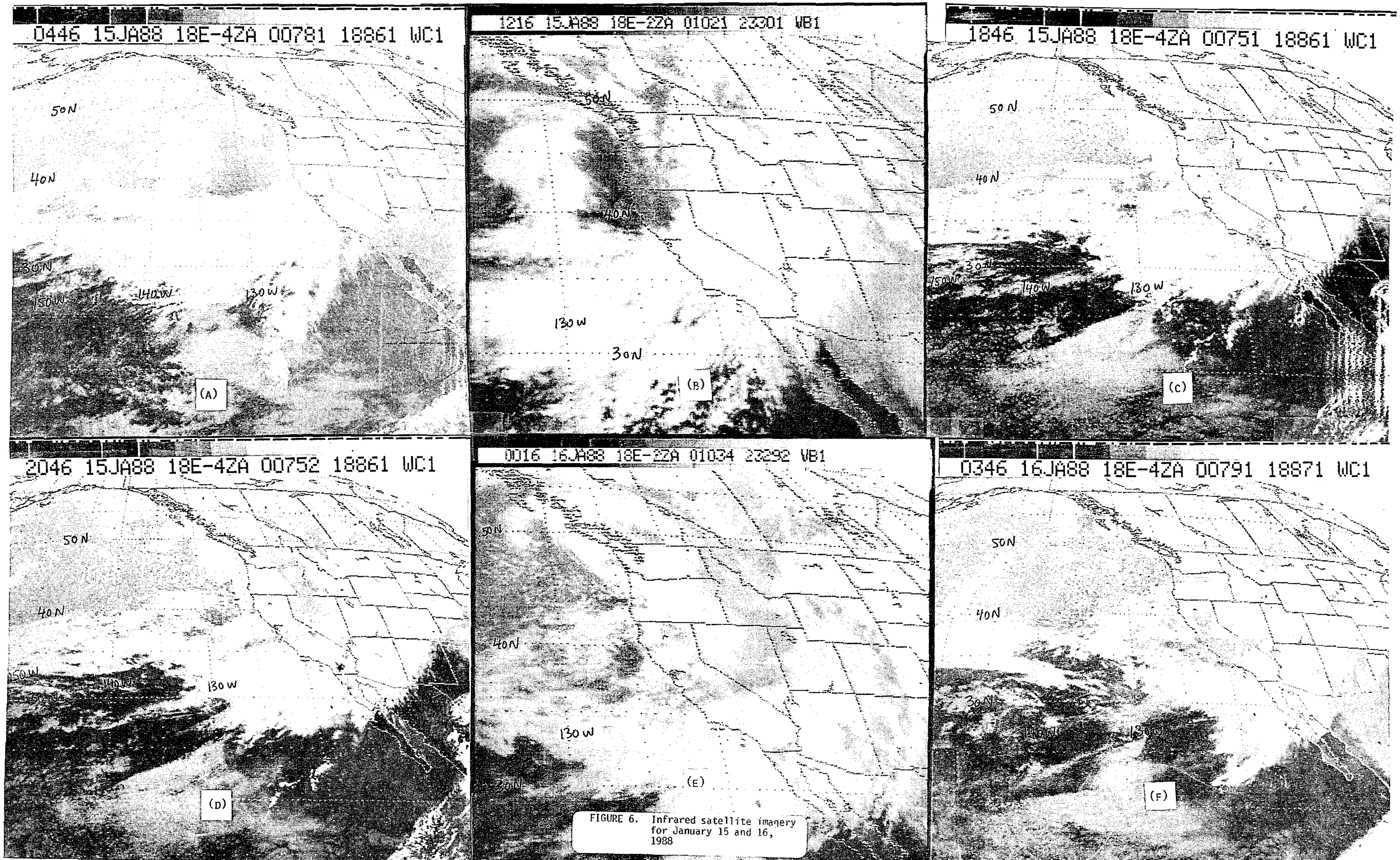

FIGURE 6. Infrared satellite imagery for January 15 and 16, 1988

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TTAA00 KSEA 140045
OBSERVATIONS FROM BUOY   5  LOCATION:  46.1N  131.0W

BOY 5 SA 0000 978/25/50/1120G99/ APP 2006 SEAS 1120
BOY 5 SA 2300 974/19/50/1120G99/ APP 9999 SEAS 1420
BOY 5 SA 2200 973/24/50/1120G99/ APP 9999 SEAS 1420
BOY 5 SA 2100 972/42/50/1120G99/ APP 2008 SEAS 9999
BOY 5 SA 2000 971/42/50/1120G99/ APP 9999 SEAS 9999
BOY 5 SA 1900 970/37/50/1120G99/ APP 9999 SEAS 1421
BOY 5 SA 1700 963/43/50/1120G99/ APP 9999 SEAS 9999
END
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BOY 5 SA 1600 959/51/50/1120G99/ APP 9999 SEAS 1119
BOY 5 SA 1500 966/42/50/0000G99/ APP 5341 SEAS 9999
BOY 5 SA 1400 971/52/50/0000G99/ APP 5341 SEAS 1419
BOY 5 SA 1300 977/[illegible]7/50/0000G99/ APP 5341 SEAS 9999
BOY 5 SA 1200 988/34/50/0000G99/ APP 5341 SEAS 1421
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BOY 2 SA 2000 065/51/52/2721G29/ APP 5341 SEAS 9999
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SEABOY002
TTAA00 KSEA 151845
OBSERVATIONS FROM BUOY   2  LOCATION:  42.5N  130.3W

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BOY 2 SA 1400 028/47/52/2033G45/ APP 5341 SEAS 9999
BOY 2 SA 1300 045/52/52/1925G33/ APP 5341 SEAS 9999
BOY 2 SA 1200 069/52/52/2125G31/ APP 5341 SEAS 9999
BOY 2 SA 1100 083/52/52/2121G27/ APP 5341 SEAS 9999
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END
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FIGURE 7. Time series of Buoy 46002 and 46005

FIGURE 8. Local offshore surface analysis 2100 UTC January 15, 1988