Western Region Technical Attachment
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SEVERE THUNDERSTORM OUTBREAK OF JUNE 15, 1989 IN IDAHO

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On June 15, 1989 a severe thunderstorm watch was issued by the National Severe Storms Forecast Center which included portions of central Idaho and western Montana. Specifically, the severe thunderstorm watch was for an area along and 80 miles north and south of a line from 65 miles north-northwest of Boise to 50 miles east-southeast of Great Falls (Figure 1).

During the latter part of the afternoon, between 2230Z and 2345Z, WSFO Boise issued severe thunderstorm warnings for parts of the extreme western portion of the watch area in Idaho. Severe weather reports in west-central Idaho included golf ball-sized hail at 2130Z at Cascade in Valley County (included in the warning area) which broke car windows, and two to three inches of hail which covered the ground at New Plymouth in Payette County between 2200Z and 2300Z. Strong winds downed many trees in the above counties. Intense thunderstorms also developed over north-central Montana during the evening.

The thunderstorms over north-central Montana developed where the thickness ridge was located, shown by the 00Z June 16 NGM initial analysis in Figure 2. Since the most unstable air is generally associated with the thickness ridge, the strong thunderstorms there were no surprise. However, the severe thunderstorms over west-central Idaho occurred well to the west of the thickness ridge. This Technical Attachment will investigate why this happened.

Meteorological Factors

The strength of the jet stream and upper level diffluence were important factors in generating the severe thunderstorms over west-central Idaho. In Figure 3, the 300 mb analysis for 00Z June 16 shows jet stream winds to 110 kts on an axis from Medford to Spokane. The strong upper level jet stream winds, combined with a favorable pattern of upper level diffluence, aided in the generation of intense thunderstorms over the western portion of the severe thunderstorm watch area. In Figure 3, a circle is drawn around the observations which indicate a pattern of upper level diffluence favorable for thunderstorm intensification, or indicative of thunderstorm activity already in the area at the time of this analysis.

These severe thunderstorms also formed along the leading edge of a surface frontal boundary where a strong temperature gradient existed. The 00Z surface chart for June 16 (Figure 4) indicates that temperatures within the frontal zone were in the

50's and 60's (Fahrenheit) while areas to the east were in the 80's to lower 90's. The enhanced visible satellite images at 2131Z and 2331Z (Figures 5a and 5b) show thunderstorms developing along the boundary between warm and cool air. (Note that the surface analysis in Figure 4 is a few hours after the thunderstorms first developed.)

The 850 mb analyses for 12Z June 15 and 00Z June 16 are shown in Figures 6a and 6b. The 850 mb analyses indicate no significant change in temperature over the western part of the watch area during the 12 hours between them. However, they do show destabilizing warm air advection over central Montana where the thickness ridge is located. Strong thunderstorms developed over north-central Montana during the evening, as shown by the 0131Z satellite image (Figure 7), in association with this warm air advection and the approaching front from the west.

Positive vorticity advection was not a significant factor in this thunderstorm outbreak. The initial 500 mb vorticity analyses from the NGM for 12Z June 15 and 00Z June 16 (not shown) indicated very weak positive vorticity advection over the extreme western portion of the watch area and very weak negative vorticity advection over central Montana. The 500 mb temperature analyses on June 15 and June 16 (not shown) indicated no significant cold air advection over the watch area at that level.

The 700 mb analyses (not shown) indicated no significant temperature or moisture advection across the watch area at this level. However, significant moisture at the surface was present in the area of the frontal zone where the thunderstorms formed. Surface dew point temperatures were mainly in the 50's on both sides of the frontal boundary.

Conclusions

The data from this weather event indicate that the intense thunderstorms in western Idaho formed along the leading edge of a strong low level baroclinic zone, west of the thickness ridge, and were fueled by a strong jet and apparent upper level diffluence. Neither destabilizing cold air advection aloft nor significant positive vorticity advection contributed to this severe weather outbreak.

As daytime heating decreased, satellite imagery (Figure 7) clearly shows that strong thunderstorms continued developing under the thickness ridge, over north-central Montana, where low level warm air advection was occurring. Meanwhile, the area between the baroclinic zone and thickness ridge, which had destabilized during the day due to surface heating, shows mainly weak thunderstorm activity at this time.

The data show that a combination of destabilizing daytime heating and upper level diffluence and jet location appeared to be the major contributors toward the development of the severe thunderstorms over west-central Idaho. The upper air winds provided favorable dynamics for severe thunderstorm formation while the low level baroclinic zone helped to focus the location where the thunderstorms formed. Low level warm air advection under the thickness ridge was an important factor in the thunderstorm development in central Montana after daytime heating subsided.

Areal Outline Of
Severe Thunderstorm Watch #500
Valid 2230Z June 15
To 0500Z June 16

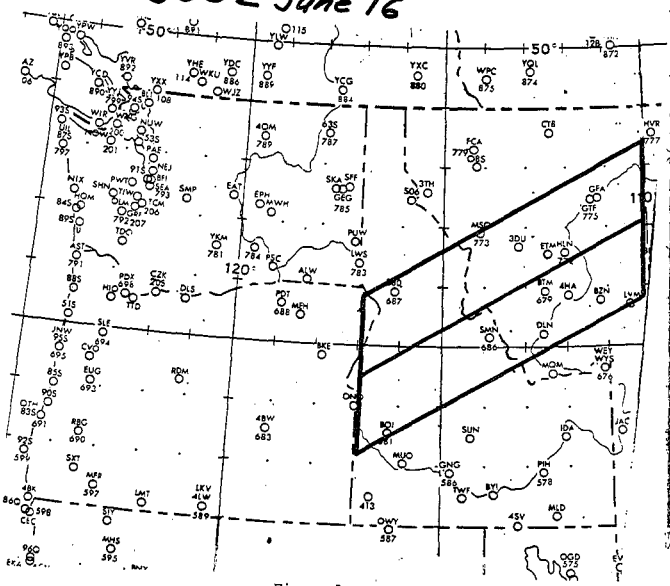

Figure 1

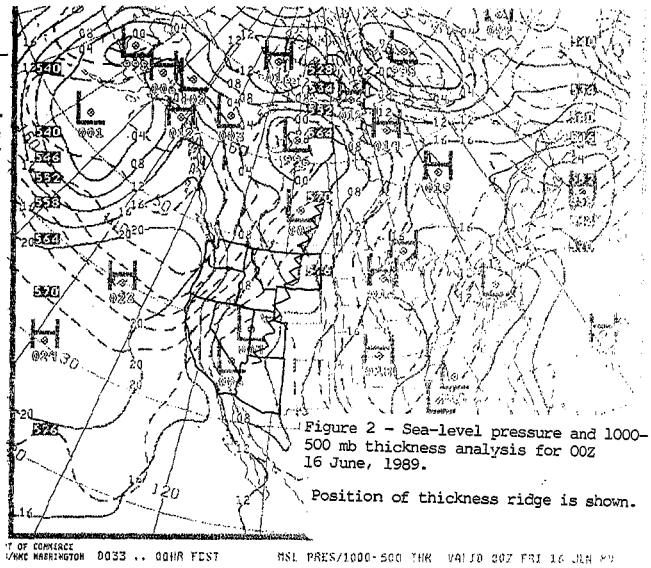

Figure 2 - Sea-level pressure and 1000-500 mb thickness analysis for 00Z 16 June, 1989.

Position of thickness ridge is shown.

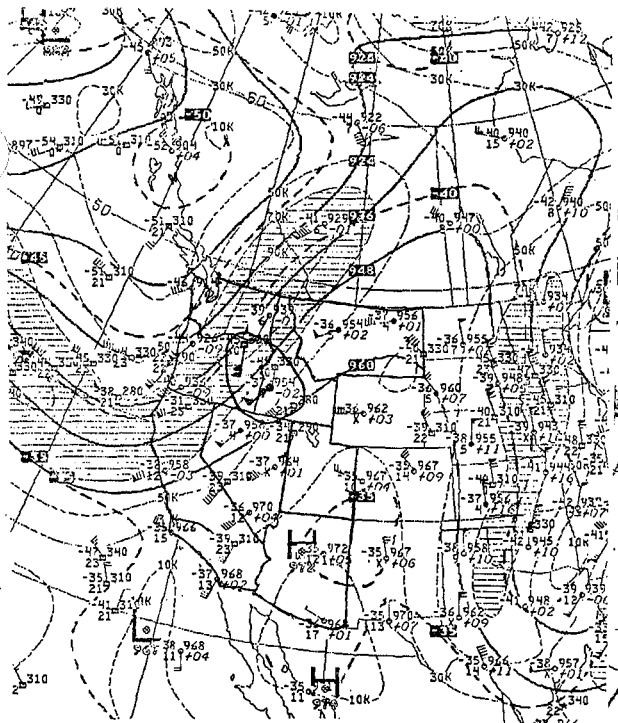

Figure 3 - 300 mb height and isotach analysis for 00Z 16 June. Observations of diffluent winds are circled.

300MB ANALYSIS HEIGHTS/ISOTACHS 00Z FRI 16 JUN 89

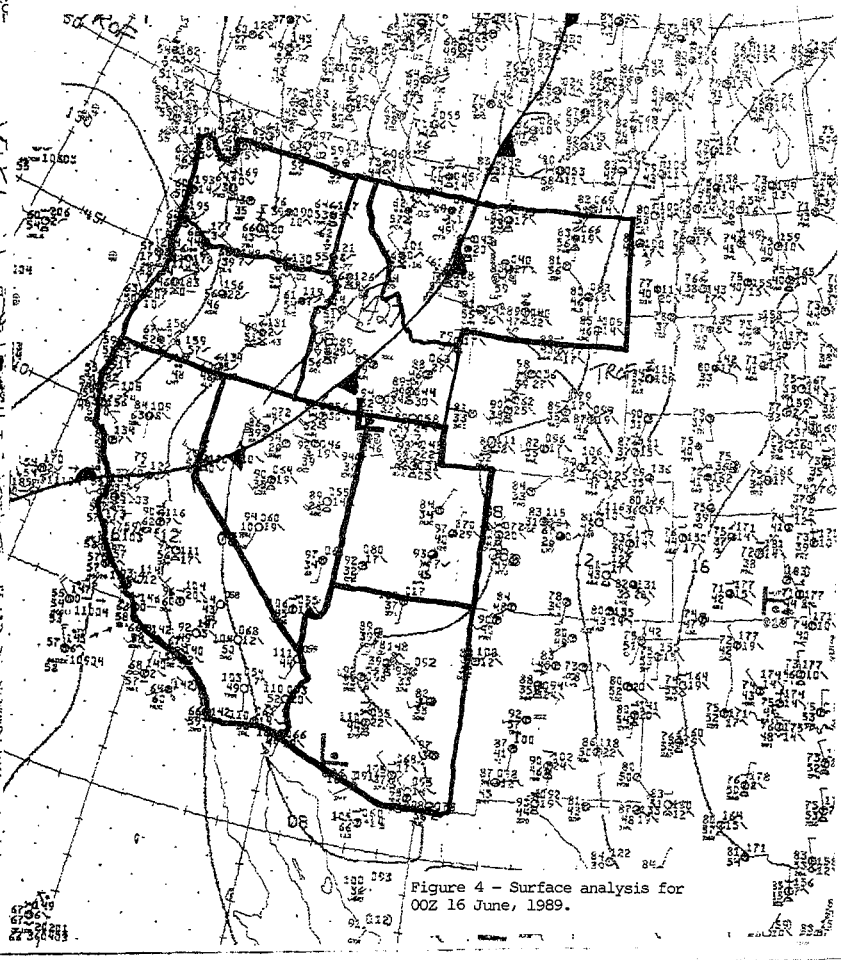

Figure 4 - Surface analysis for 00Z 16 June, 1989.

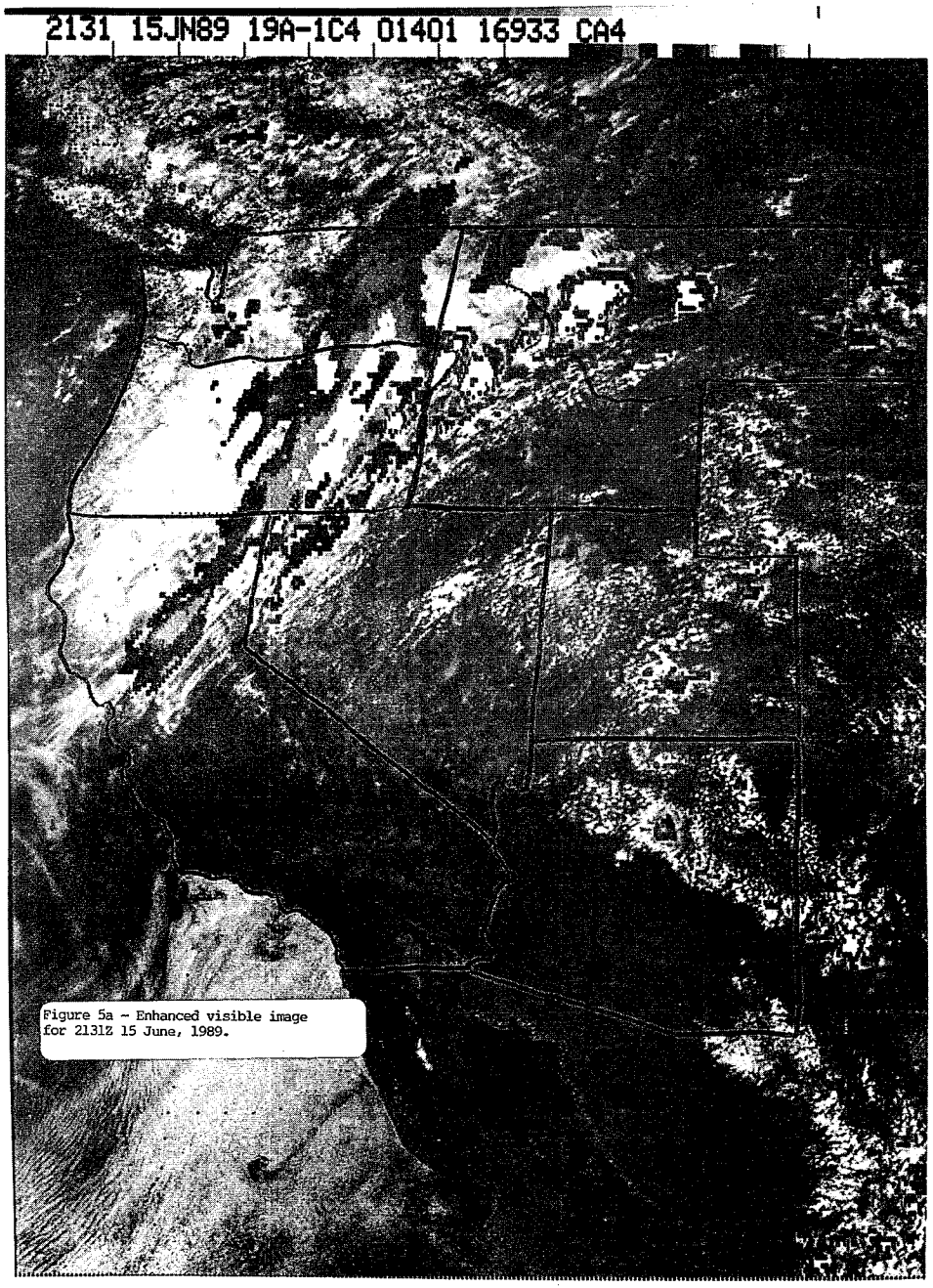

Figure 5a - Enhanced visible image for 2131Z 15 June, 1989.

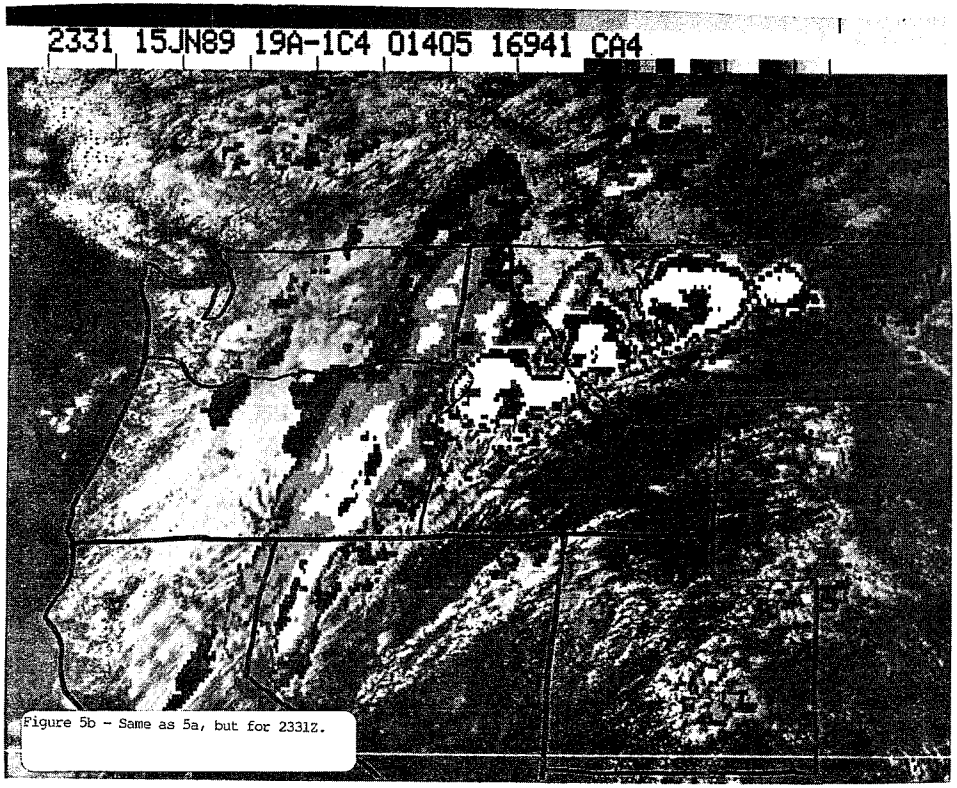

Figure 5b - Same as 5a, but for 2331Z.

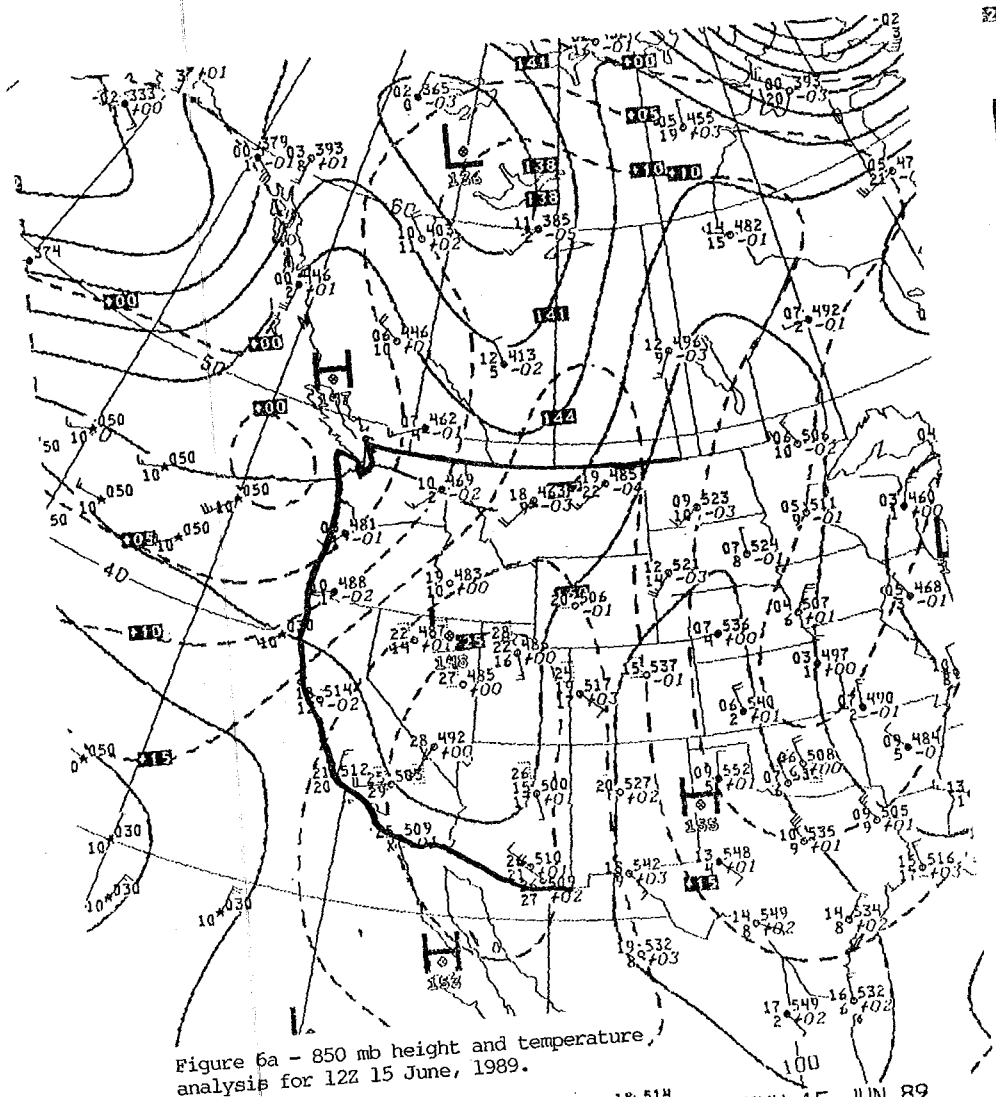

Figure 6a - 850 mb height and temperature analysis for 12Z 15 June, 1989.

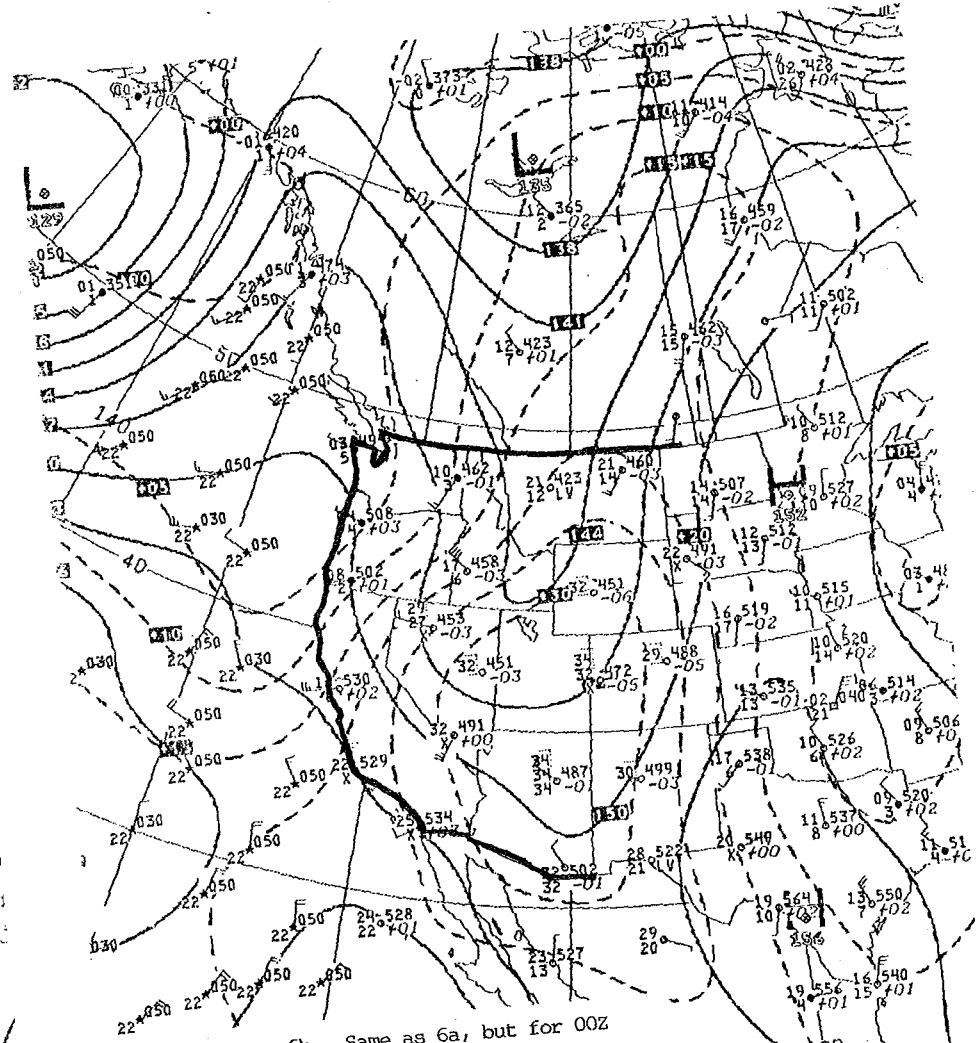

Figure 6b - Same as 6a, but for 00Z 16 June, 1989.

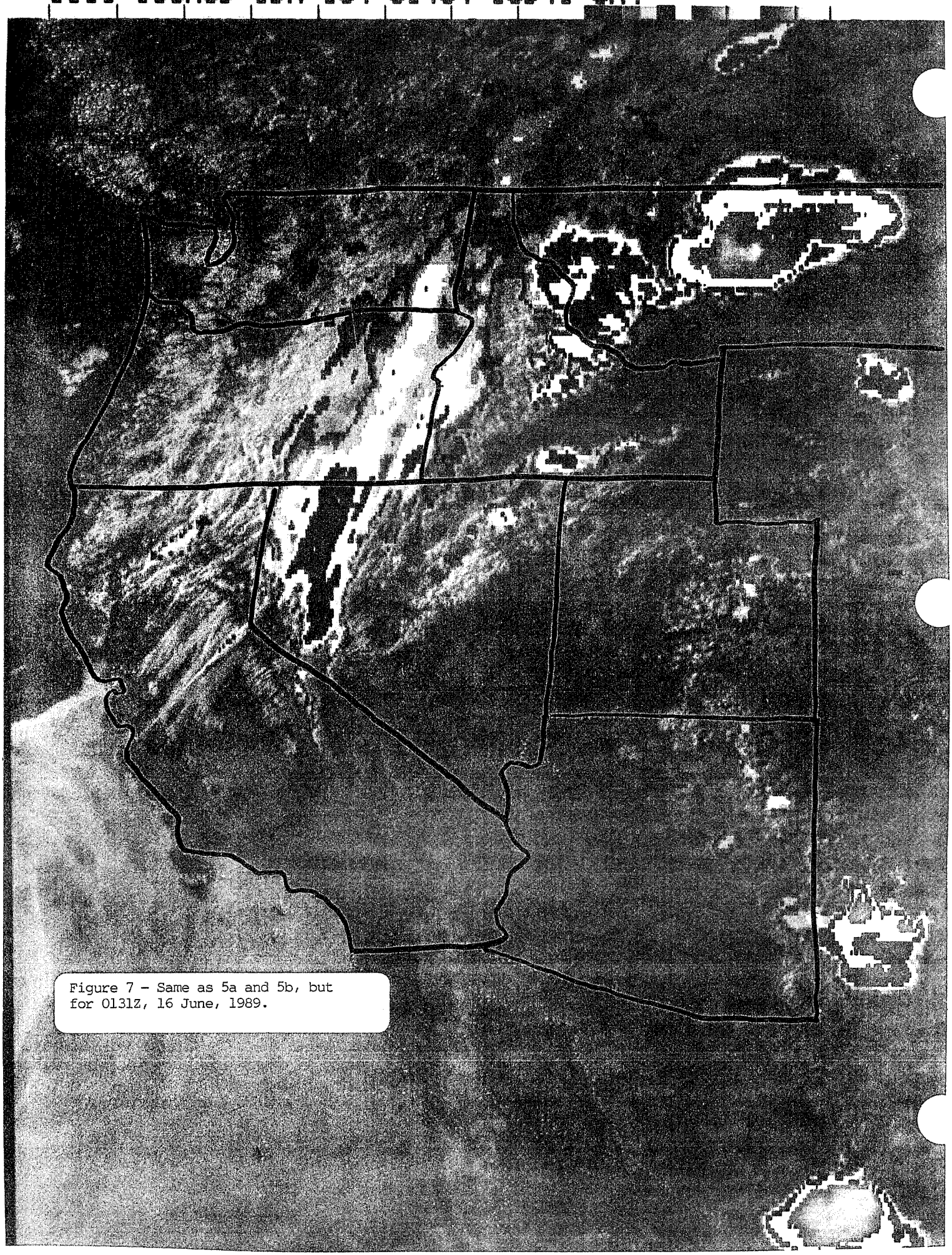

Figure 7 - Same as 5a and 5b, but for 0131z, 16 June, 1989.