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A CLASSIC EXAMPLE OF CYCLOGENESIS AS SEEN ON SATELLITE IMAGERY

Late in the week of August 25, 1991, we had an early season cyclogenesis event in the eastern Pacific, just off the coast of Washington and Oregon. The event produced surface winds of greater than 50 mph in some locations along the northwest coast. This was a classic example of how satellite imagery can aid in forecasting a cyclogenesis event and can also be used to estimate central surface pressure where surface data are very limited. Readers are referred to an article in Chapter 2 of "Satellite Imagery Interpretation for Forecasters" (Handbook 6) written by Frank Smigielski and Gary Ellrod and titled "Surface Cyclogenesis as Indicated by Satellite Imagery". The article was originally published as a NESDIS Technical Memorandum.

Figure 1 shows the event as it developed on satellite imagery through 16 hours, which is roughly from the incipient stage through maximum development. The change in character of this system as seen on satellite imagery fits the category of a rapidly developing cyclone. According to Smigielski and Ellrod, this is when the system evolves from incipient wave to full maturity in 18-24 hours. Most "normally developing" cyclones will take 48-72 hours to reach full maturity. In this case, the cyclone reached full maturity in at least 16 hours. However, the rate of surface pressure deepening was nowhere near the rate of explosive "bomb" development, which is 1mb/hr for 24 hours. In this case, the surface pressure deepened 10mb in 15 hours (see Fig. 2).

Figure 1a shows the incipient wave as it appeared on infrared imagery at 00Z on 8/29/91. At this stage, the cloud pattern fits the description of the classic baroclinic leaf oriented mostly in an east-west direction. The outline of the trough can be clearly seen near 145°W with evidence of cold air in the cumulus pattern. With very warm air in place over the late summer continent, there must certainly be a baroclinic zone forming in between. Jet streaks on the back side of the trough indicate the trough is still deepening, and there is already the hint of a weak comma shape in the cumulus field within the trough. At this time (00Z), all signs point to cyclogenesis along the baroclinic zone.

Nevertheless, the NGM from the 00Z run did not forecast any deepening of the surface pressure through 12Z the next morning (Fig. 3). The aviation run of the spectral model (AVN) on the other hand did forecast some deepening through the next 12 hours (Fig. 4). In this case, the AVN was correct. Over the next 12 hours, the central surface pressure deepened about 4mb (Fig. 2a-2c), the AVN predicted 5mb. It then deepened another 6mb over the next 3 hours (Fig. 2d). The NGM predicted basically no change in the central surface pressure through 12 hours.

Smigielski and Ellrod cited a method developed by Junker and Haller (1980) to estimate the central surface pressure based upon the character of the circulation seen on satellite imagery. The method is based upon a study of cyclogenesis events during the months of

October through April, but the method clearly works with this early season event as well. The pattern associated with pressures in the 990s (mb) (Fig. 5) resembles the baroclinic wave developing between 00Z and 06Z (Figs. 1a and 1b). The Junker and Haller method suggests that when a hook shape starts to emerge, the surface pressures should be dipping into the 980s (Fig. 5). By 12Z, this hook shape was evident on the satellite image (Fig. 1c), and surface pressures were in the upper 980s by this time (Fig. 2c). When the circulation makes one complete rotation around the center of the low, the surface pressure should be dropping into the 970s according to the method (Fig. 5). In this event, the cloud band never wrapped around the center completely; the 16Z image (Fig. 1d) shows the cloud band wrapped about 3/4 of the way around, which was as far as it got before the main center of circulation moved off to the northeast. The surface pressure deepened into the low 980s but never into the 970s (Fig. 2d) according to the analysis. There were not enough ship reports to verify pressures any deeper than this, but based on the few that were in this vicinity, these analyzed pressures appear to be accurate.

Not only can satellite imagery provide invaluable clues as to whether cyclogenesis will occur or is occurring, but it can also be used to estimate central surface pressures when little or no surface data are available. This was a classic example of the relationship between cloud pattern development and surface cyclogenesis.

References

Junker, N.W. and D.J. Haller, 1980: Estimation of Surface Pressure by Satellite Cloud Pattern Recognition, Proc. Eighth Conf. on Weather Forecasting and Analysis, June 10-13, 1980, Denver CO., Amer. Meteor. Soc. 119-122.

Smigielski, F. J. and G.P. Ellrod, 1985: Surface Cyclogenesis as Indicated by Satellite Imagery, NOAA Tech. Memo. NESDIS 9, 30pp.

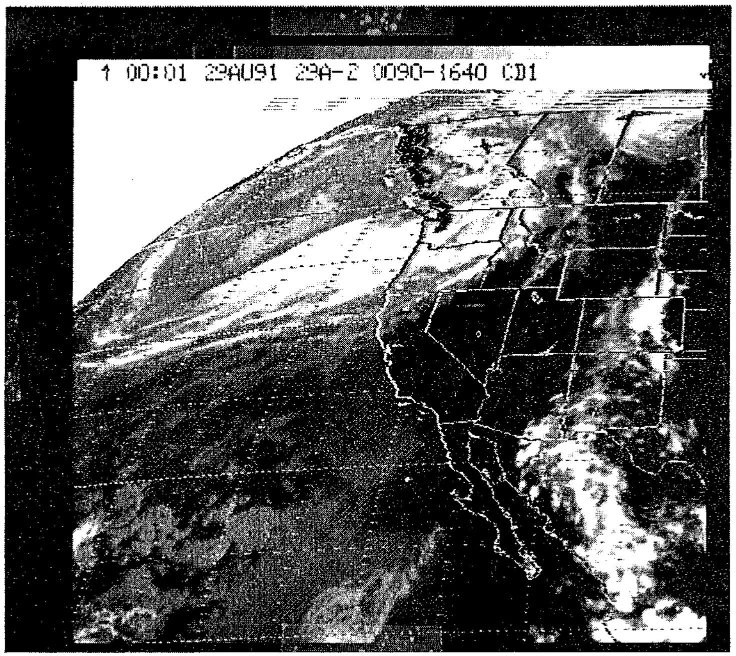


Fig. 1a 00Z 8/29/91

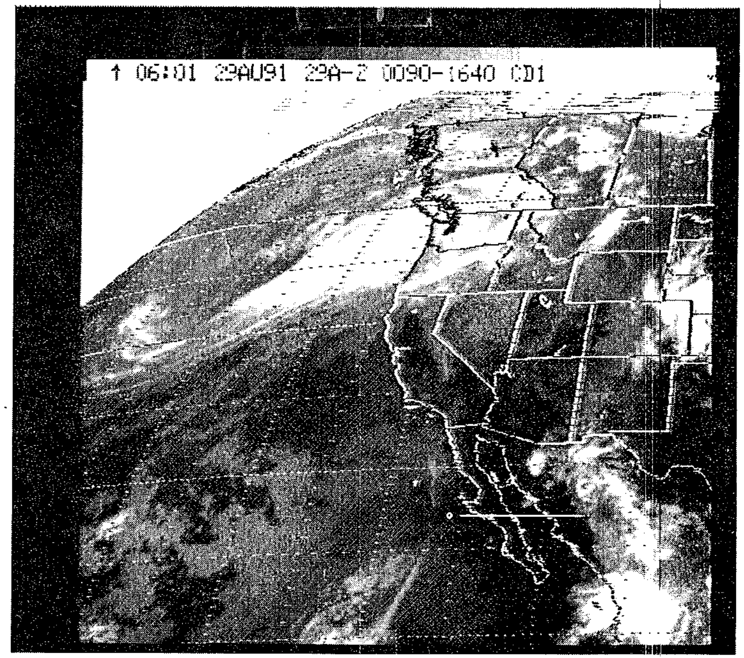


Fig. 1b 06Z 8/29/91

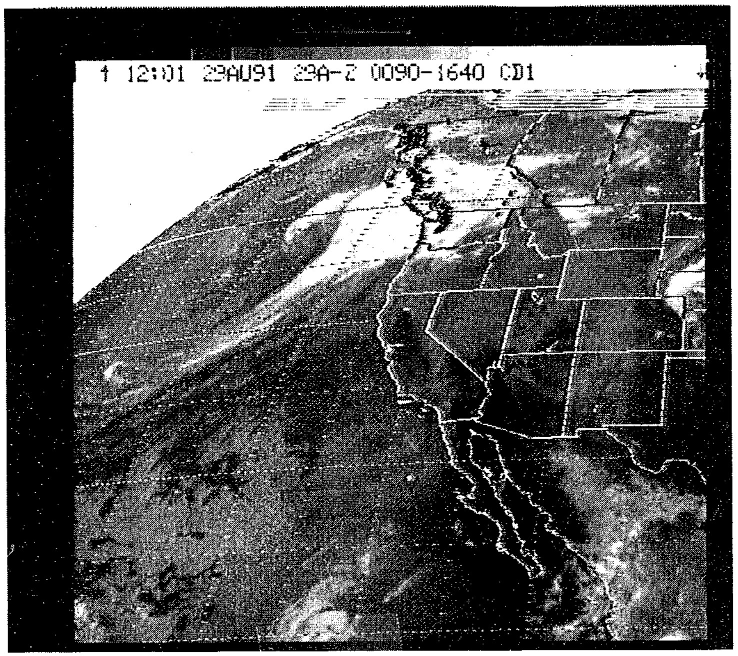


Fig. 1c 12Z 8/29/91

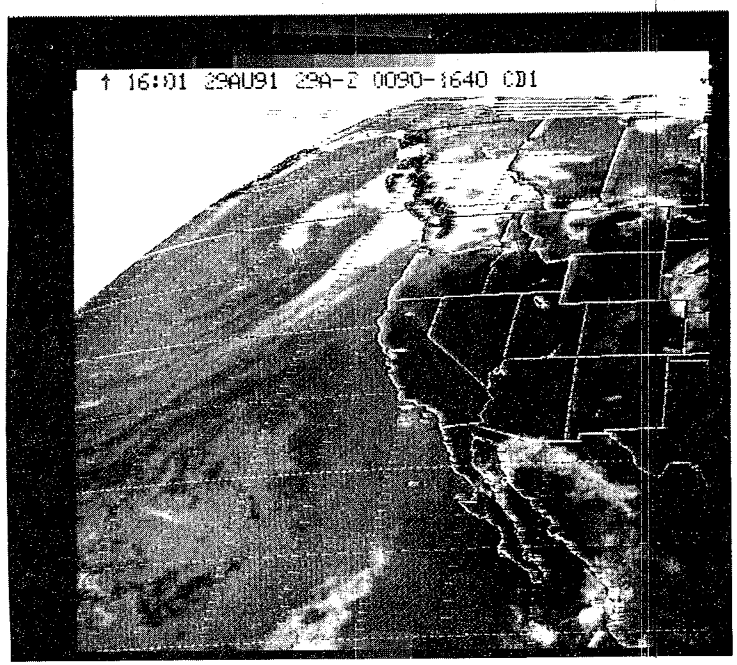


Fig. 1d 16Z 8/19/91

Fig. 1 IR Satellite imagery

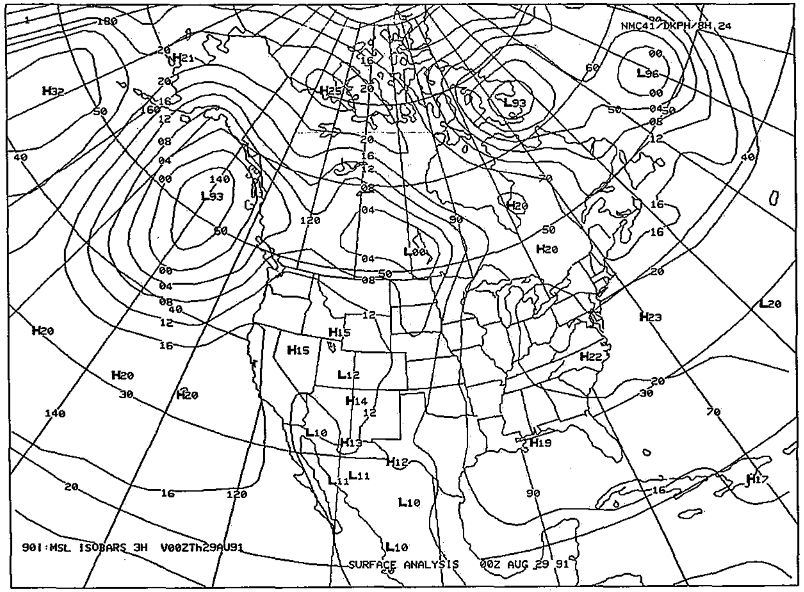


Fig. 2a 00Z 8/29/91

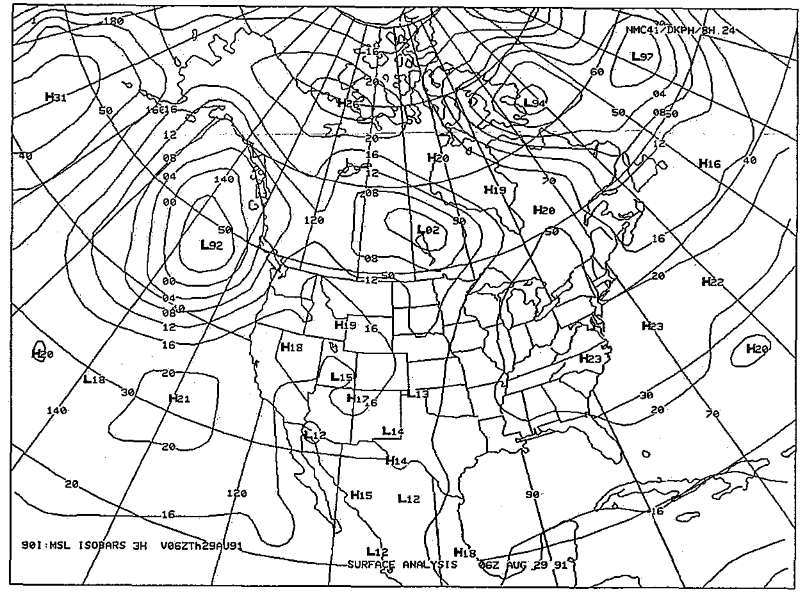


Fig. 2b 06Z 8/29/91

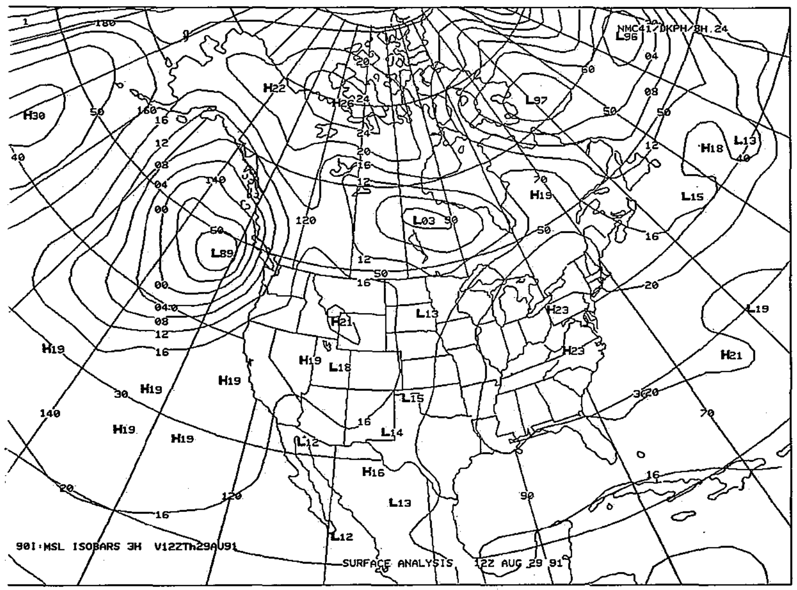


Fig. 2c 12Z 8/29/91

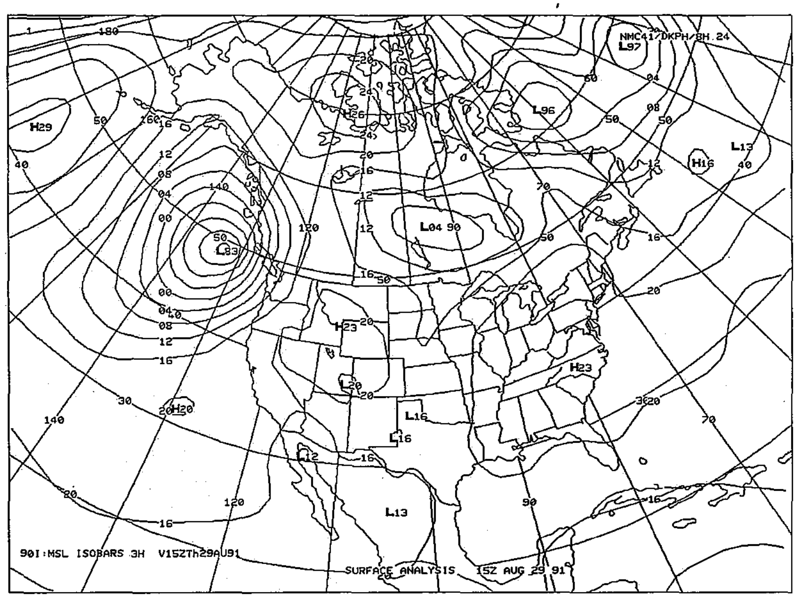


Fig. 2d 15Z 8/29/91

Fig. 2 Surface pressure analyses

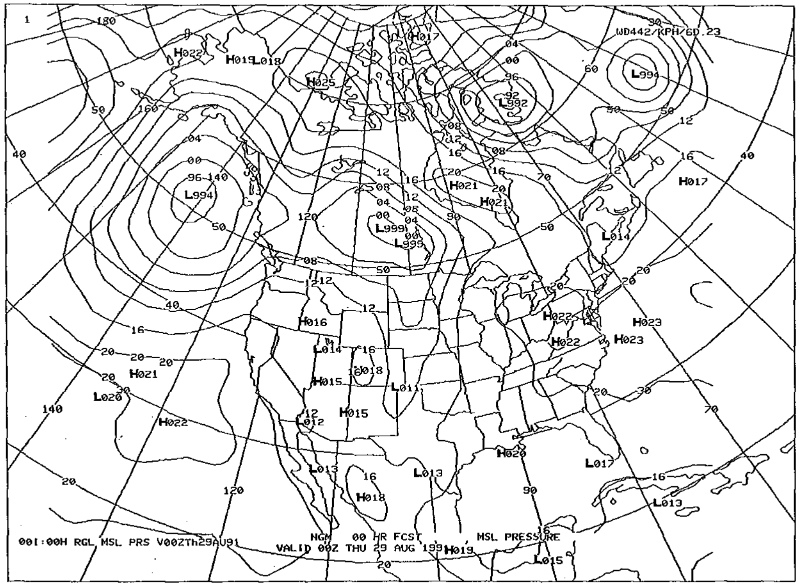


Fig. 3a NGM analysis
00Z 8/29/91

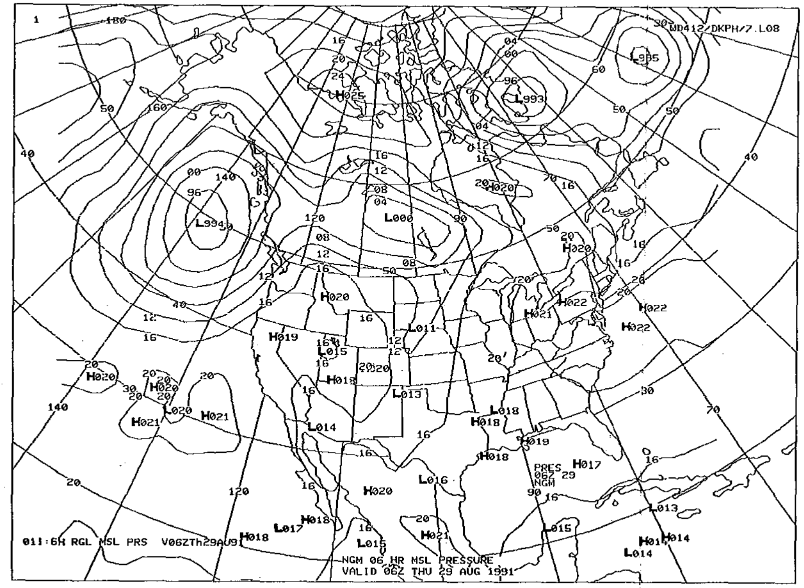


Fig. 3b NGM 6 hr fcst
06Z 8/29/91

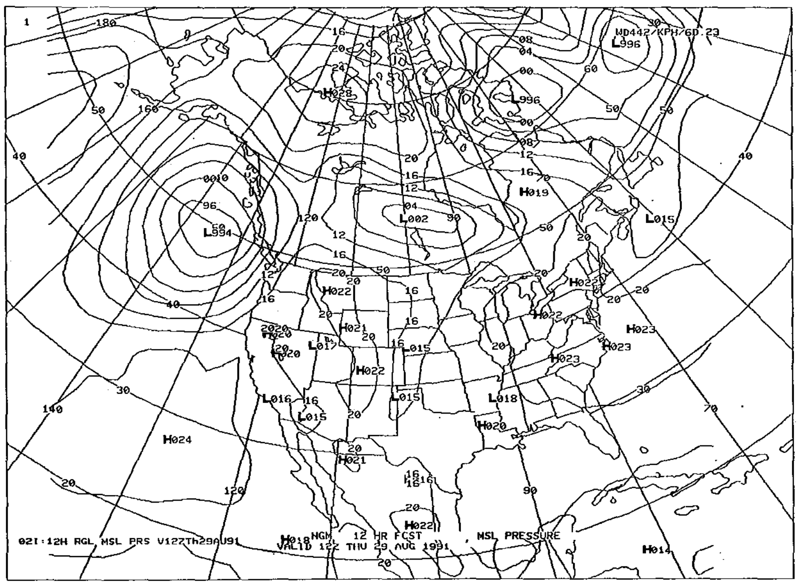


Fig. 3c NGM 12 hr fcst
12Z 8/29/91

Fig 3. Surface pressure

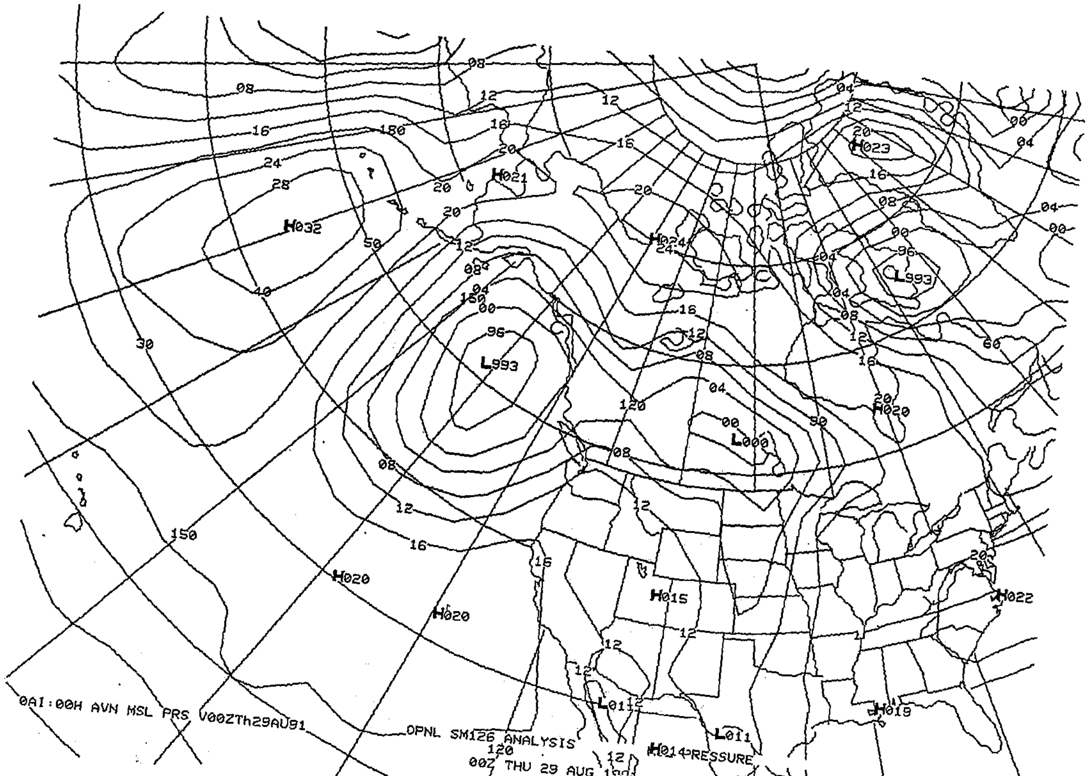


Fig. 4a Aviation analysis
00Z 8/29/91

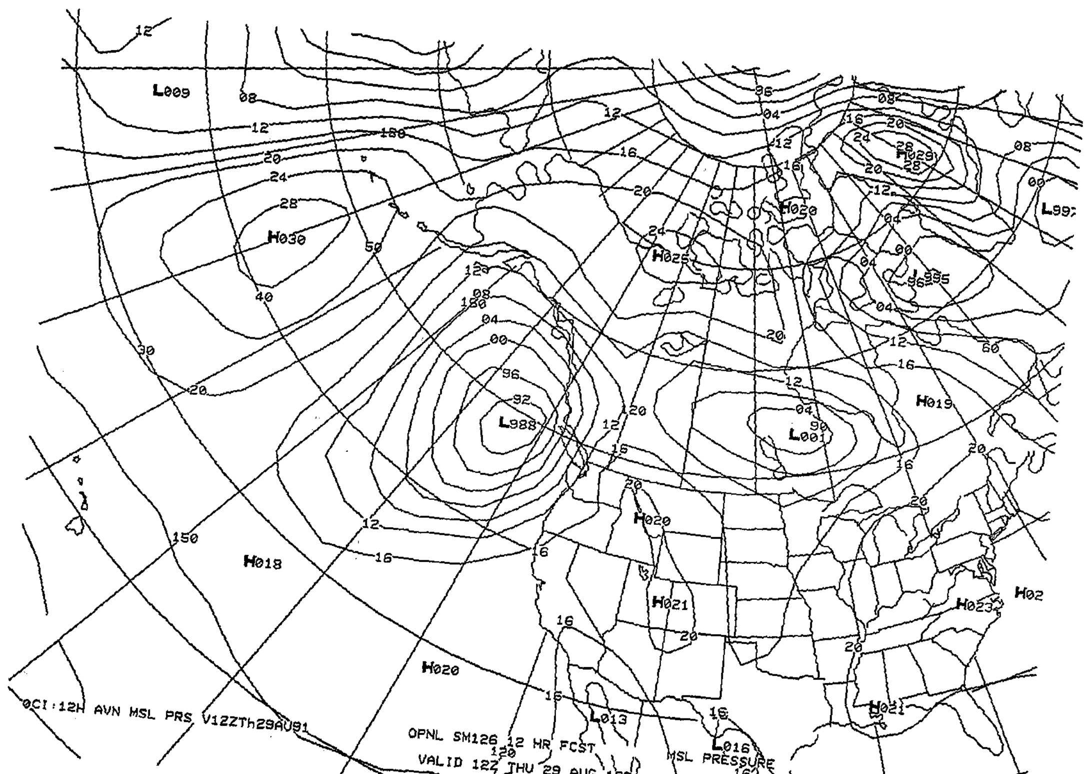
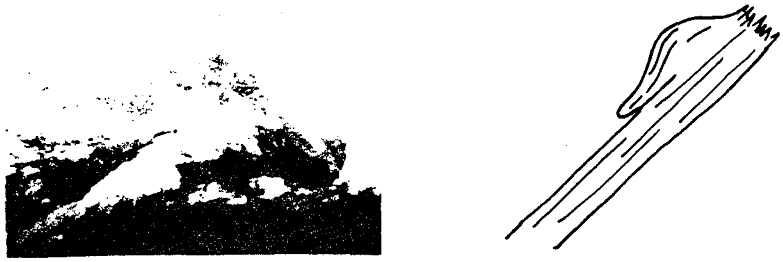


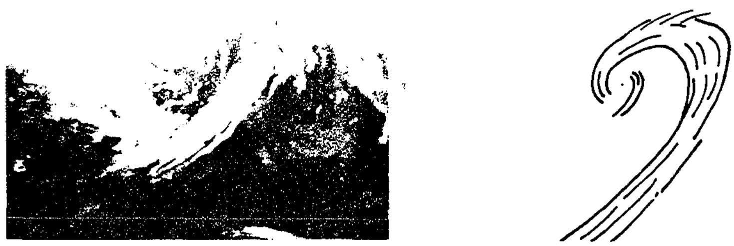
Fig. 4b Aviation 12 hr fcst
12Z 8/29/91

Fig. 4 Surface pressure



Patterns characteristic of pressures between 990mb-999mb. Note dry slot beginning to form on rear edge of cloud band.

When distinct hooked shaped pattern starts to emerge, pressures dip into 980's.



Pressures in 970's indicated by cloud band wrapped around center almost one time.

Pressure near 960mb, cloud band wraps completely around center 1 1/2 times.

Fig. 5