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STRONG WINDS WHIP FIRES IN FOUR STATES ON OCTOBER 16, 1991

Michael J. Oard - WSFO Great Falls

Introduction

Strong west to southwesterly winds are not unusual along the east slopes of the Montana Rockies during the cold season. Gusty winds in the western mountain valleys of Montana are also typical of strong Pacific frontal passages. Normally, mid-October is too early for winds strong enough to prompt a high wind warning, so any synoptic pattern at that time of year, which results in widespread high winds, is well worth studying.

The case of October 16, 1991, was unusual in that the high winds east of the Continental Divide significantly exceeded peak gust estimates from an objective aid. This objective aid estimates peak wind gusts along the east slopes 3 to 15 hours in advance and normally verifies well (Oard, 1980, 1982). The western mountain valleys of Montana also exceeded high wind warning criteria - a most unusual event.

Unfortunately, the forests and grasslands in the northern Rocky Mountain region were extremely dry. The strong winds whipped up fires in eastern Washington, northern Idaho, western and central Montana, and northern Wyoming. Numerous homes and structures were destroyed, and five people were killed either directly or indirectly by the wind or fires. Two of these people were killed in a plane crash near Missoula. A helicopter also crashed in Lake Pend Oreille, Idaho, but the pilots lived. In Belt, Montana, a 16-year old boy saved four children from being engulfed by flames when he ran through a burning field, picked up two children, grabbed the other two by the hand, and led them to safety.

Synoptic Pattern

A strong upper ridge dominated Montana and the western United States the afternoon before the event (Fig. 1). The 24-hr progs (not shown), valid at 12Z, October 16, forecast strong cyclogenesis in southern British Columbia. The 36-hr NGM progs, valid at 00Z, October 17, moved the upper trough inland (Fig. 2) and moved the deepening surface low into southeastern Alberta and southwestern Saskatchewan (Fig. 3). The NGM 36-hr 700-mb prog increased greatly the flow aloft over Montana (Fig. 4). The height gradient at 700-mb is highly correlated with winds along the east slopes of the Rockies, so high winds were anticipated for the 16th. This synoptic pattern is a "classic" high wind pattern in that an upper ridge pokes up into the northern Great Basin and Montana and then is quickly flattened by a fast-moving upper trough.

The Forecast Problem

The forecast problem was how much wind to forecast so early in the cold season, both east and west of the Continental Divide. An objective aid for the peak wind gust along the east slopes of the Rocky Mountains was applied to the NGM 36-hr 700-mb prog (Fig. 4). This objective aid is a 4-variable multiple regression equation, similar to the MOS equations (Oard, 1980, 1982). This equation was developed from 38 variables related to the peak gust at Great Falls, such as 700-mb height gradients, surface pressure gradients, and upper air and surface isallobaric gradients. Using a large sample of cases in prefrontal westerly flow, the four most independent variables were chosen for the regression equation. Based on the 700-mb prog the morning of the 15th of October, the equation estimated the following peak wind gusts for the next day: 1) Great Falls 40 kt, 2) Cut Bank 45 kt, and 3) Livingston 53 kt. Big Timber, East Glacier, and Choteau, Montana, normally gust significantly higher than Livingston. The equation normally is applied to an analysis. The initial analysis on the morning of the 16th only added 3 kt to each of the peak gust estimates above, so a peak wind gust of 43 kt (50 mph) was forecast by the objective aid for Great Falls that day.

Since a gust to 58 mph is required for a high wind warning with 75 mph in the windier areas along the front range of the Rockies, a special weather statement for strong winds was issued on the afternoon forecast shift of the 15th. Winds of 20 to 40 mph were forecast for the western mountain valleys of Montana. A high wind warning was eventually issued on the midnight shift for the east slopes of the Rockies. When strong winds began to blow at Spokane, Washington, and Kalispell, Montana, a high wind warning was also issued for west of the Continental Divide about noon on the 16th.

Verification and Discussion

Figures 5-7 show the verifying 500-mb, 700-mb, and surface analyses for 00Z, October 17. Except for being slightly slow, the NGM model (as well as the aviation model) from NMC forecast the development very well. Figure 8 presents the verifying peak wind gusts on October 16 for 14 stations in Montana. The peak wind gusts ended up significantly stronger than expected from the objective aid. Blowing dust, downed trees, broken power lines, and fires were widespread. Winds at the Great Falls airport peaked at 64 mph and Malmstrom Air Force Base, in east Great Falls, recorded a 72 mph gust. Missoula reached 61 mph, a very significant wind event for that area. Other locations in the western half of Montana had wind gusts that exceeded the high wind warning criteria. Choteau, Montana had the dubious honor of clocking the highest gust of 85 mph for a low elevations station. A RAWS station on a mountain ridge west of the Continental Divide recorded gusts to 88 mph. As the upper trough moved eastward in Montana, the winds lessened. The time of occurrence of the peak gust was rather variable because of the long duration of the winds. In general, the strongest winds occurred with the Pacific frontal passage.

Why were the winds so strong, especially west of the Continental Divide? I suggest two possibilities that forecasters at Great Falls have noticed over the years. These conditions usually result in higher winds than forecast by the objective aid. First, the air was quite warm ahead of the trough, even west of the Continental Divide, which is normally cool at low levels during cold-season upper ridges. Cold advection on the 16th resulted in more unstable conditions in the lower atmosphere, as illustrated on Fig. 9, the afternoon raob at Great Falls. As the Pacific front swept through Montana, the strong westerly winds aloft were better able to scour out the western mountain valleys and cause stronger winds than expected east of the Continental Divide. Second, the wind pattern was a "classic" wind pattern that is normally windier. This classic wind pattern is typified by a moderate fast-moving trough in the westerly flow aloft. Cyclogenesis in southwest Canada results. When the surface lows track through southern Alberta and Saskatchewan, the winds are even stronger. All these situations combined to cause the objective aid to miss the peak gust at Great Falls by 14 mph (22 mph if Malmstrom AFB is included). Hopefully, these subtle thermodynamic and synoptic features can be integrated into the objective aid and the forecasts of the future.

References

Oard, M.J., 1980: Regression equation for the peak wind gust 6 to 12 hours in advance at Great Falls during strong downslope wind storms. *NOAA Tech. Memo. NWS WR-154*, Salt Lake City, Ut, 9pp.

Oard, M.J., 1982: Peak wind gust regression equation for Great Falls 3 to 15 hours in advance during downslope wind storms. *9th Conference Weather Forecasting & Analysis,* American Meteorological Society, Boston, Ma, 372-5.

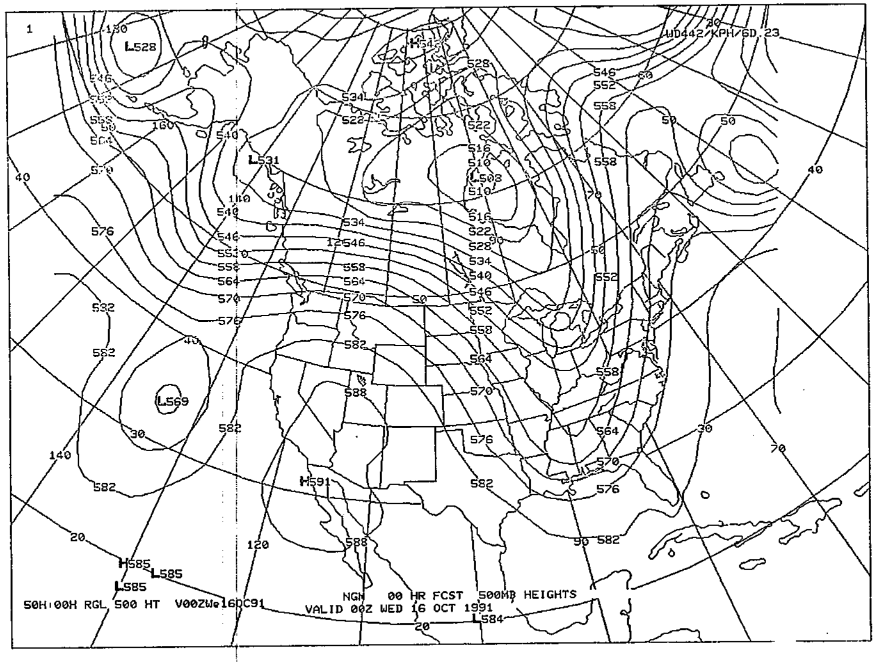

Fig. 1. NMC 500-mb analysis for 00Z, October 16, 1991. Strong upper ridges ahead of fast moving upper troughs are more conducive to strong winds.

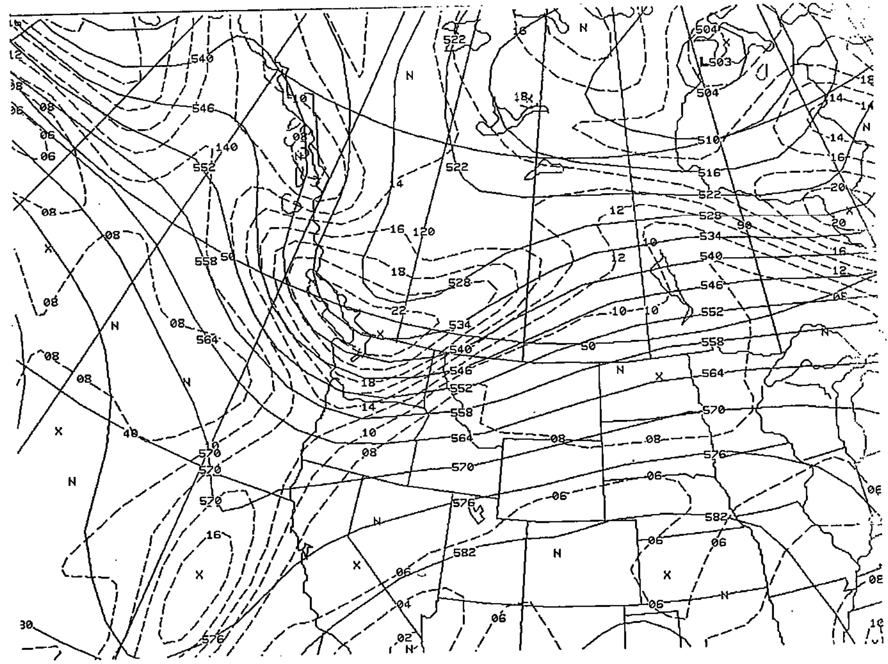

Fig. 2. NMC NGM 36-hr 500-mb prog (heights and vorticity) valid for 00Z, October 17, 1991.

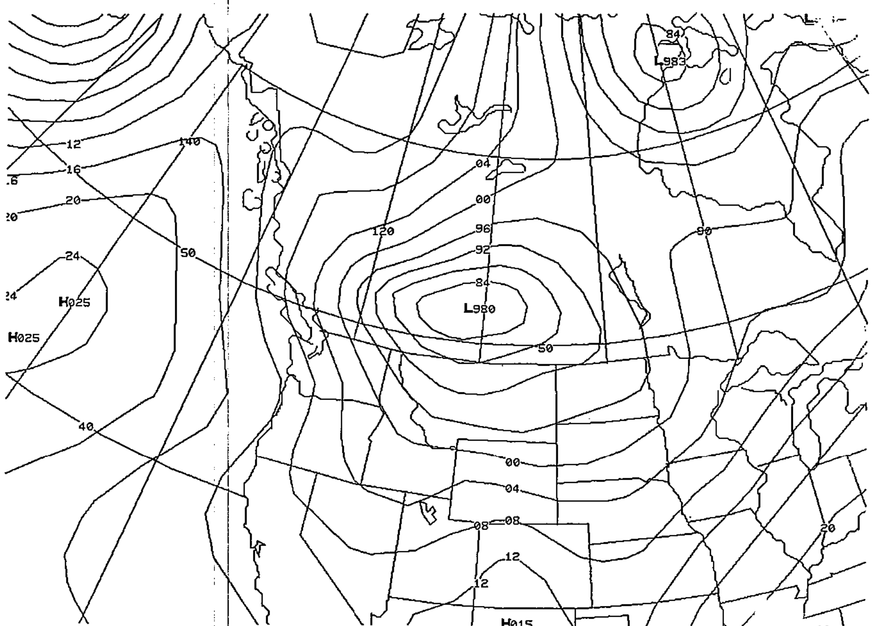

Fig. 3. NMC NGM 36-hr surface prog valid for 00Z, October 17, 1991.

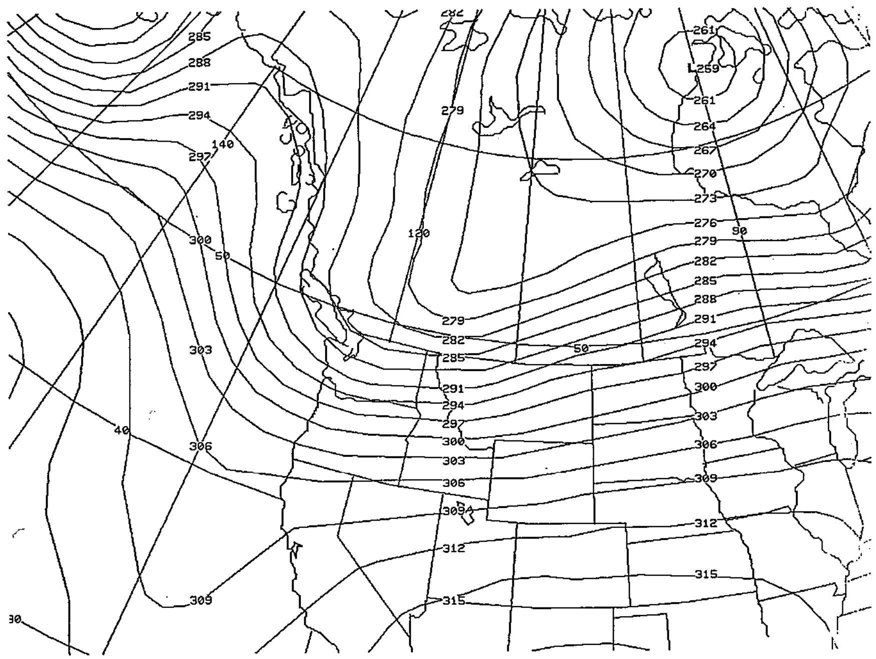

Fig. 4. NMC NGM 36 hr 700-mb prog valid for 00Z, October 17, 1991.

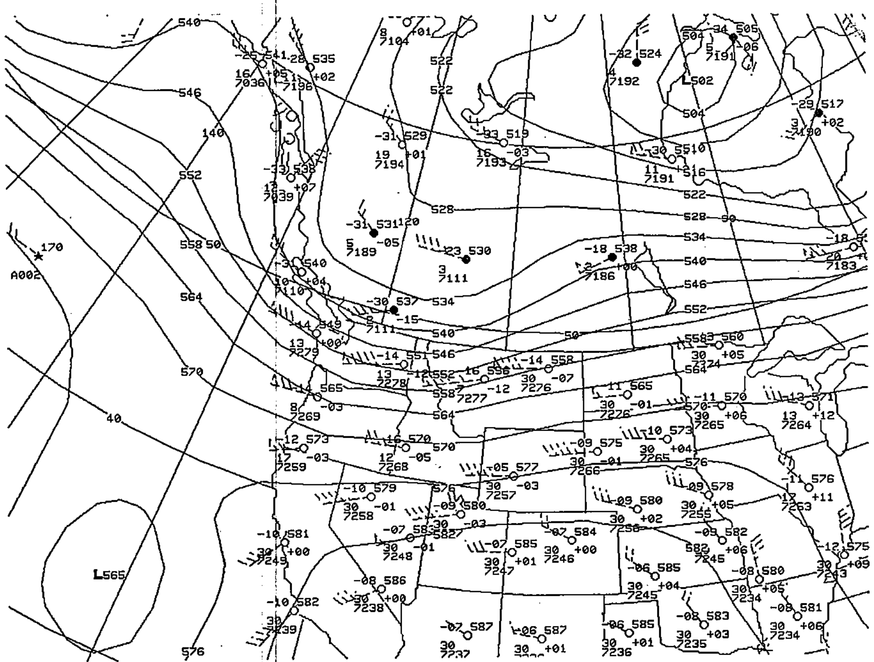

Fig. 5. NMC 500-mb analysis for 00Z, October 17, 1991.

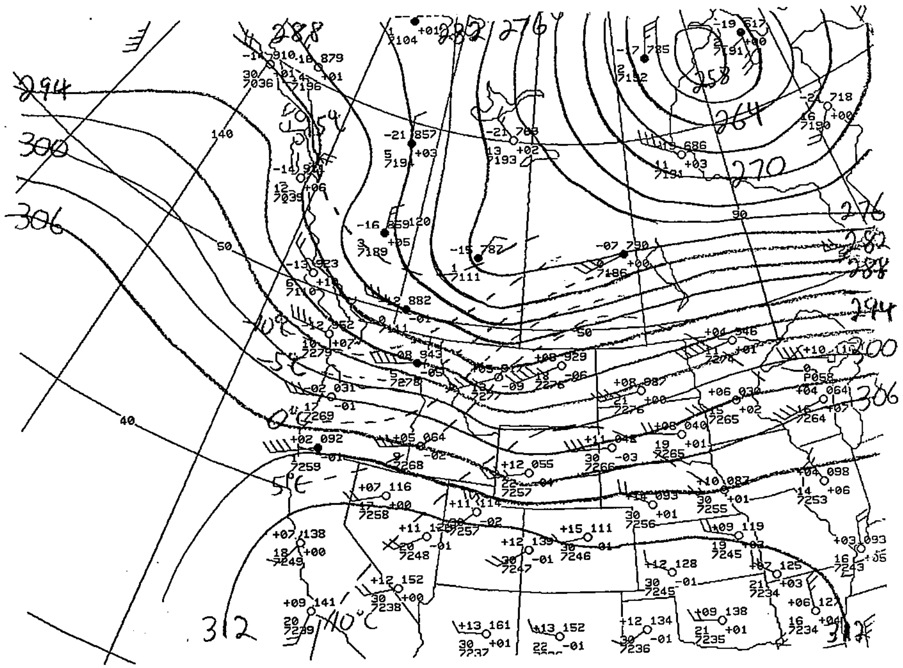

Fig. 6. 700-mb analysis (heights and isotherms) for 00Z, October 17, 1991. Most of the strong peak gusts occurred a little before this analysis.

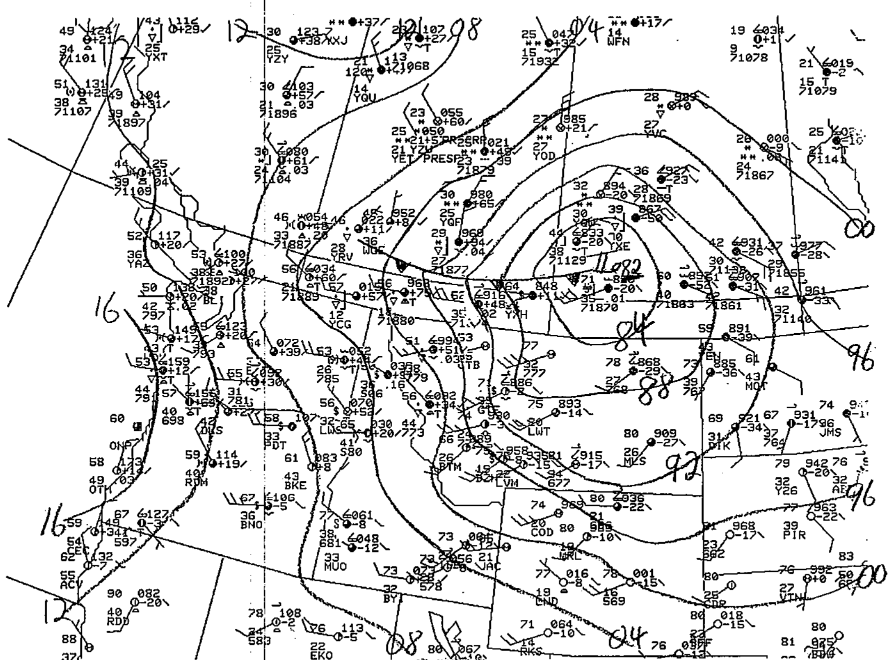

Fig. 7. Surface analysis for 00Z, October 17, 1991.

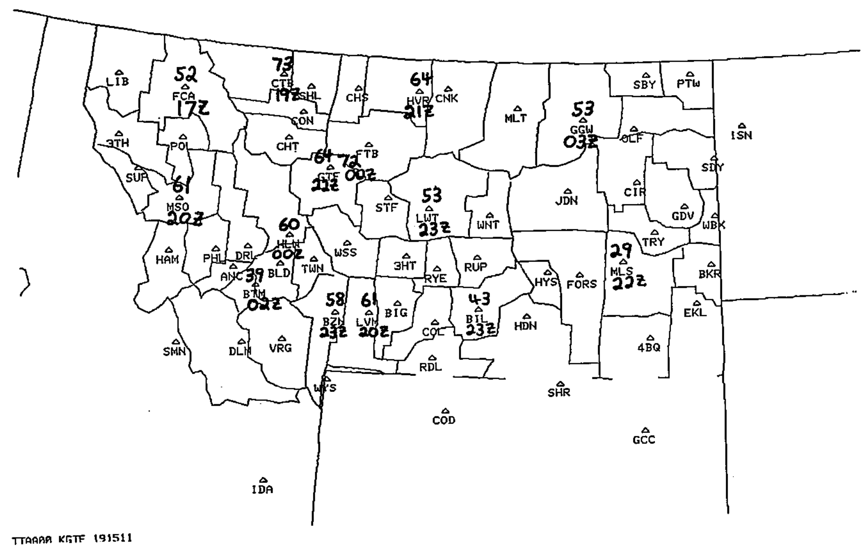

Fig. 8. Peak wind gust and time of occurrence (UTC) in mph for 14 Montana stations.

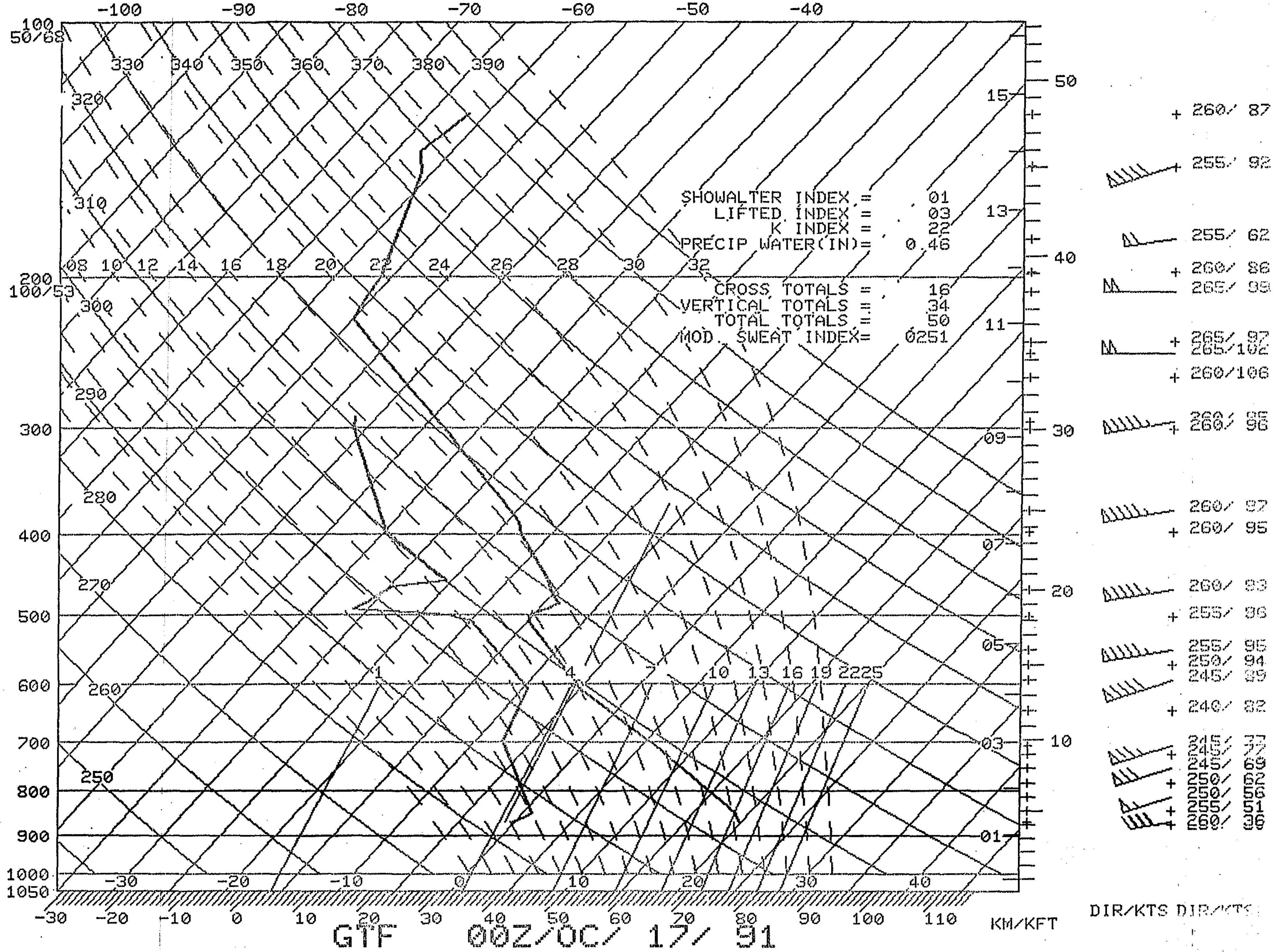

Fig. 9. Great Falls raob for 00Z, October 17, 1991. Notice the unstable atmosphere below 500-mb and the strong low-level winds.