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A COMPARISON OF HAINES INDICES USING PCGRIDS

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Introduction

The introduction of PCGRIDS data into the forecast office has helped in all areas of operational forecasting, including the fire weather program. It is possible, with gridded data, to get 12-hour forecasts of the Haines Index - a parameter receiving growing importance within the fire weather community.

The Haines Index is an index developed in 1988 by Donald Haines, research meteorologist for the United States Forest Service. The index attempts to forecast weather conditions which are favorable for extreme fire behavior - those wildfires which spread quickly, experience spotting, burn intensely, and often have large convective plumes. The Haines Index is simply a combination of a stability term and a moisture term. It is important to know that wind is not a component of this index. Donald Haines divided the country into three regional elevations: low, middle, and high elevations. The high elevation method is used in Nevada.

The Haines Index results from a simple equation:

HAINES INDEX = STABILITY TERM + MOISTURE TERM

The stability term is simply the 700-500 mb lapse rate. The moisture term is the 700 mb dew-point depression (T-Td). When these values are known, points are assigned for each term as shown below in Table 1.

HAINES INDEX

STABILITY TERM 700T - 500T	MOISTURE TERM 700T - 700Td
1 Point: 17°C or less	1 Point: 14°C or less
2 Points: 18 to 21°C	2 Points: 15 to 20°C
3 Points: 22°C or greater	3 Points: 21°C or greater

Table 1. High elevation Haines Index. Points assigned for the stability and moisture terms.

Clearly, the Haines Index has values ranging from 2 to 6. Extreme fire weather behavior potential is identified by values of 2 or 3 to indicate "very low" potential, 4 suggests "low" potential, 5 "moderate" potential, and 6 "high" potential. The later suggests that atmospheric conditions are such that intense burning with rapid spread can be expected even without considering the added influence of wind.

Example Computation of the Haines Index

The sounding shown in Fig. 1 was taken at Desert Rock (DRA), Nevada at 1200 UTC 18 September 1993. Using the coded mandatory data, the following information is obtained for calculating the Haines Index: The 700 mb temperature is 10.4° C, the 500 mb temperature is -11.5° C, and the 700 mb dew-point depression is 30.0° C.

The stability term then becomes 21.9° C and the moisture term is 30.0° C. Referring to Table 1, we find the stability term is assigned 3 points and the moisture term is also assigned 3 points. Using the equation on page 1, we obtain a Haines Index of 6, which indicates high potential for extreme fire behavior.

PCGRIDS Generated Haines Index

With PCGRIDS, it is possible to get forecast values of the Haines Index for six-hour intervals through the model run for both the Eta and NGM. This is helpful since forecast values of the Haines Index are included in all Reno fire weather forecasts. Each model takes the parameters making up the index and produces a display showing values ranging at intervals of 0.5, from 2.5 to 5.5. An example is shown in Fig. 2.

During August 1993, frequent differences were noticed between the Haines Indices calculated from the two models. The Haines Index calculated from the NGM gridded data was often higher across central and eastern Nevada than the Haines Index calculated with the Eta model gridded data. The 12-hour forecast values of the Haines Index made by the 1200 UTC model runs were recorded and compared to the actual values calculated manually. The 12-hour forecasts were chosen for my study since that would coincide with the afternoon portion of the morning fire weather forecast - the time of highest fire potential.

Two sites were selected for this study to determine if the Eta or NGM favored a particular station: Ely (ELY), NV (6262 ft msl) and Desert Rock (DRA), NV (3310 ft msl). These locations are also the highest and lowest sounding stations in Nevada.

Table 2 shows the data collected from 18 August to 13 September 1993, including the actual value of the index valid at each specified time. The forecast values from the PCGRIDS data were eye-balled which leads to a possible error of plus or minus 0.5 since the contours are at half values. Note: The data collected for Desert Rock, NV are not shown in Table 2.

PCGRIDS HAINES INDICES

Valid Time		12-Hour Forecasts ELY ETA	ELY NGM	Actual Index ELY
AUG 18/00Z	*	3.0	5.5	6
AUG 19/00Z	*	4.0	5.5	5
AUG 20/00Z		4.5	5.5	6
AUG 21/00Z	*	3.5	5.0	5
AUG 22/00Z	*	2.5	4.0	4
AUG 23/00Z		2.5	2.5	4
AUG 24/00Z	*	3.5	5.5	5
AUG 25/00Z	*	4.0	5.5	5
AUG 26/00Z	*	3.5	5.5	5
AUG 27/00Z		3.0	3.5	4
AUG 28/00Z		3.0	4.0	5
AUG 29/00Z		4.5	5.0	6
AUG 30/00Z		3.0	3.0	5
AUG 31/00Z		3.5	3.5	3
SEP 01/00Z		3.0	3.5	4
SEP 02/00Z		3.0	4.0	4
SEP 03/00Z	*	2.5	4.0	5
SEP 04/00Z		4.0	5.0	5
SEP 05/00Z		4.0	5.0	6
SEP 06/00Z		4.0	4.5	5
SEP 07/00Z		3.5	4.5	5
SEP 08/00Z		4.5	5.0	6
SEP 09/00Z	*	3.0	4.5	4
SEP 10/00Z		4.0	5.0	5
SEP 11/00Z		5.5	5.5	6
SEP 12/00Z		5.5	5.5	6
SEP 13/00Z		3.0	3.0	4

Table 2. 12-Hour forecasts of the Haines Index using the Eta and NGM models from 18 Aug-13 Sep 1993. Right column represents verifying indices calculated using 0000 UTC soundings. Asterisk indicates those days when the models differed by 1.5 or more.

For the 27 days above, the NGM consistently forecasted the same or higher values of the index at Ely than did the Eta. More importantly, on the 9 days that the models differed by 1.5 or more (indicated by an asterisk in Table 2), the NGM verified better each time. This difference is significant because the Eta model was forecasting low potential for extreme fire behavior while the NGM was forecasting the reverse. As for Desert Rock, NV (data not shown), there was no significant difference between the two models.

Case Study: August 18, 1993

This case study will focus on one of the days when there was a large difference between the Eta model and NGM for the Haines Index around Ely. Figures 3 and 4 illustrate the Haines Indices valid for 0000 UTC 19 August 1993 for both the Eta model and NGM, respectively. Notice that the Eta model was forecasting an index of approximately 4.0 (low potential) for Ely while the NGM was forecasting an index of 5.5 (high potential).

To explore a possible reason for this difference, the model forecasts of the parameters used to compute the Haines Index were examined. Figure 5 depicts the 700 mb temperature field forecasted by the ETA model (solid lines) and the NGM (dashed lines). It is evident that the NGM was forecasting slightly warmer temperatures at this level with values above 12°C across much of eastern Nevada. The 12°C contour on the Eta model barely extends into eastern Nevada. The forecast 500 mb temperature field (Fig. 6) shows that the NGM was forecasting slightly cooler temperatures near Ely since the -11°C isotherm extends farther south into Nevada than on the Eta model. These figures suggest that the NGM was forecasting a slightly greater 700-500 mb lapse rate near Ely.

Figures 7 and 8 show the 12-hour forecast of the dew-point depression at 700 mb for the Eta and NGM, respectively. The NGM was forecasting a larger depression over central and eastern Nevada than the Eta model. This is the major reason for the difference in Haines Indices computed by both models for this case. The actual sounding for this time (not shown) proved the NGM verified better. It must be noted that the Haines Index is sensitive to minor differences in the input values. Therefore, small differences in any of the input parameters, such as dew-point depression in this case, can result in significant differences in the value of the Haines Index.

Conclusion

This study shows that the Eta model and NGM gridded data can forecast large differences of the Haines Index - a parameter indicating the potential for extreme fire behavior. Since this index is now a part of all Reno fire weather forecasts, it is worthwhile to know which model verifies better. From the database collected, the NGM gridded data was more accurate at forecasting 12-hour Haines Indices than the Eta model around Ely, NV. Therefore, greater confidence will be placed on the NGM when forecasting the Haines Index for east-central Nevada. This conclusion does not suggest that the NGM forecasts the Haines Index better than the Eta model. The data collected for Desert Rock in southern Nevada revealed no significant difference between the two models. The study only suggests there may be areas where one model verifies better than another. For an operational forecaster, this is useful to know.

Reference

Haines, D.A., 1988. A lower atmospheric severity index for wildland fire. *National Weather Digest*, **Vol. 13**, No. 2, 23-27.

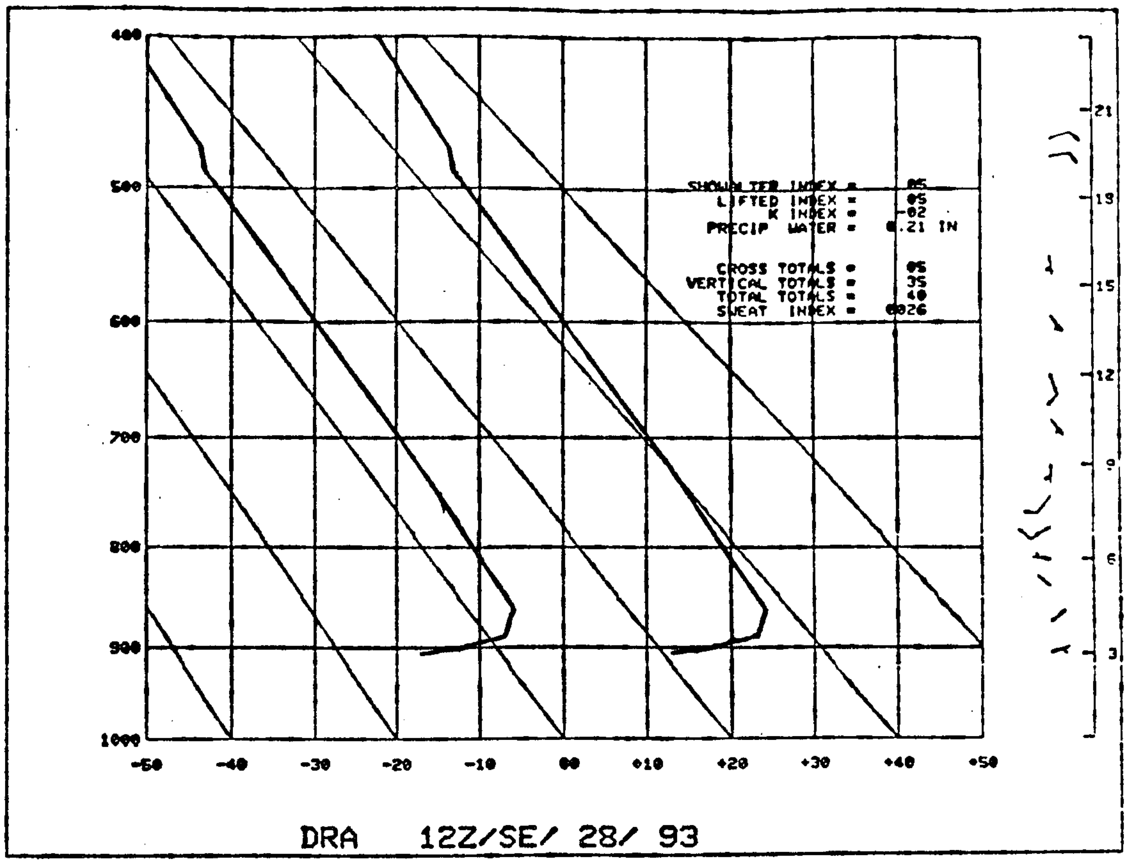

Figure 1. Atmospheric sounding for Desert Rock, NV at 1200 UTC 28 SEP 1993.

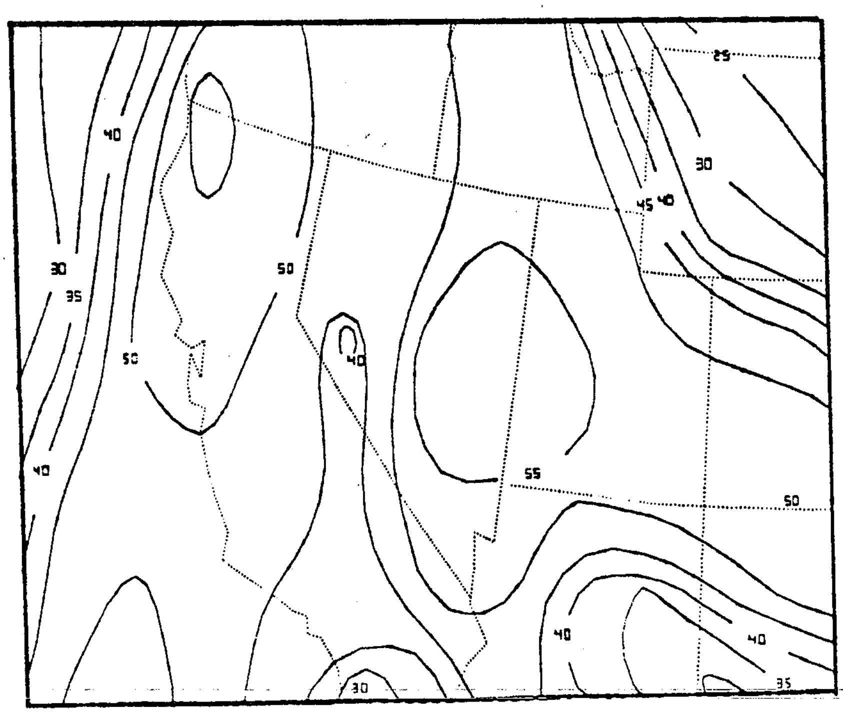

Figure 2. 12-hour forecast of Haines Index using NGM gridded data. Valid 0000 UTC 28 SEP 93. Values are multiplied by 10.

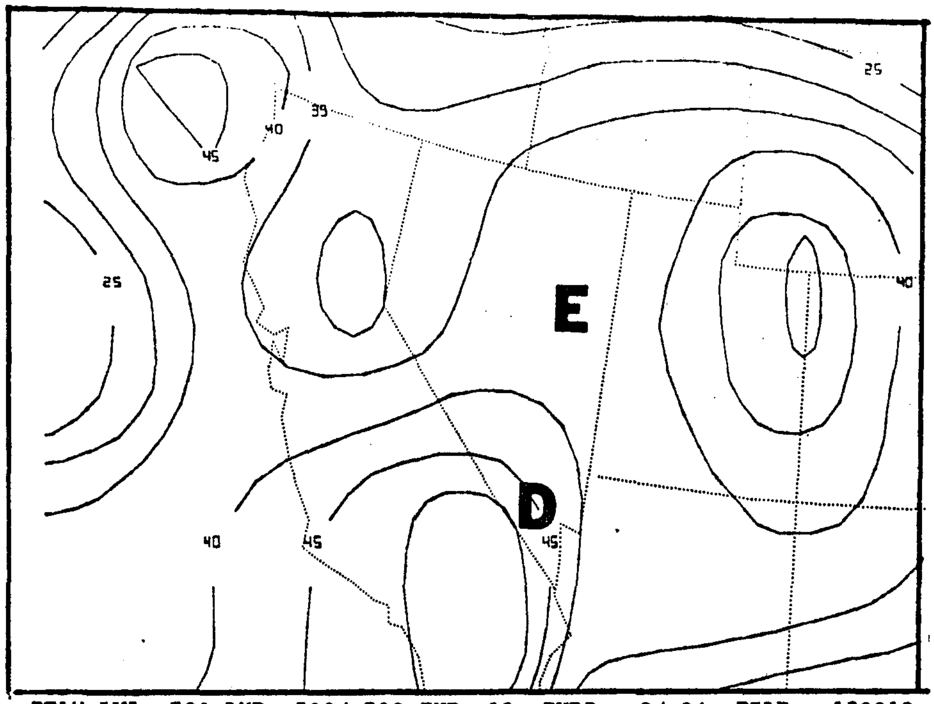

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Figure 3. 12-hour forecast of the Haines Index using the Eta model. Valid 0000 UTC 19 Aug 93. Values are multiplied by 10. Ely, NV (E) and Desert Rock, NV (D).

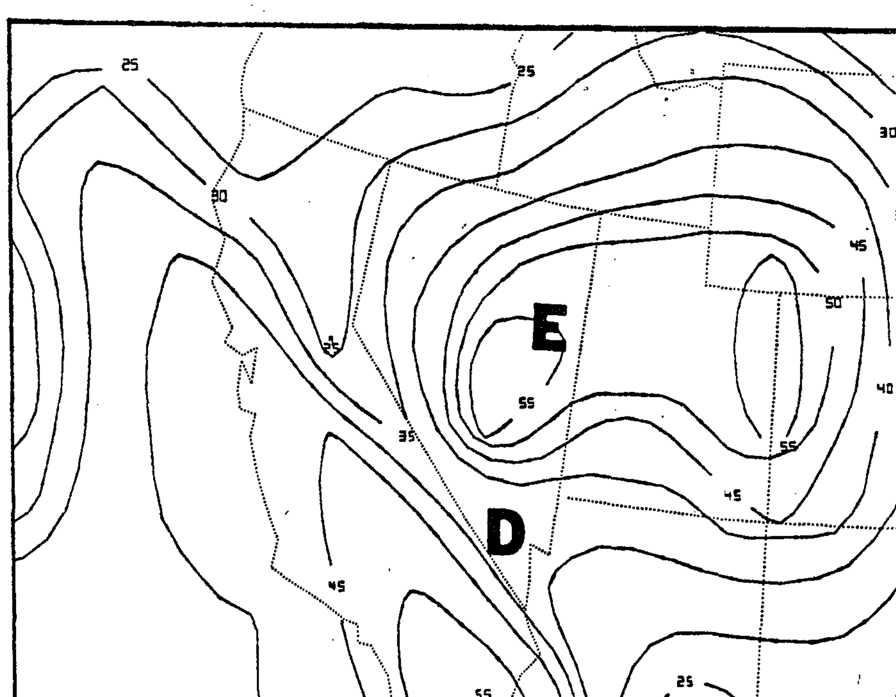

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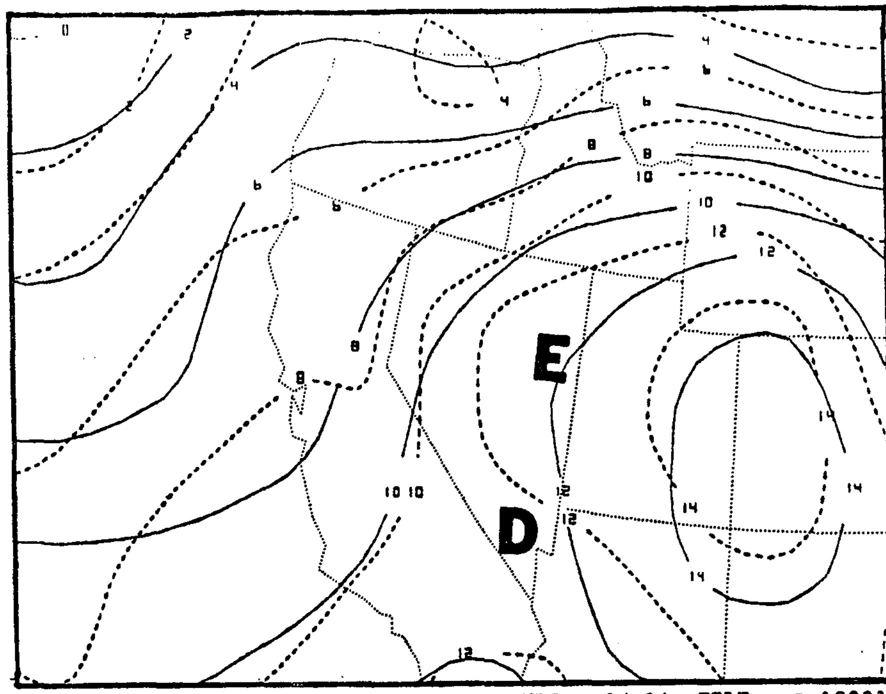
Figure 4. 12-hour forecast of the Haines Index using the NGM model. Valid 0000 UTC 19 Aug 93. Values are multiplied by 10. Ely, NV (E) and Desert Rock, NV (D).



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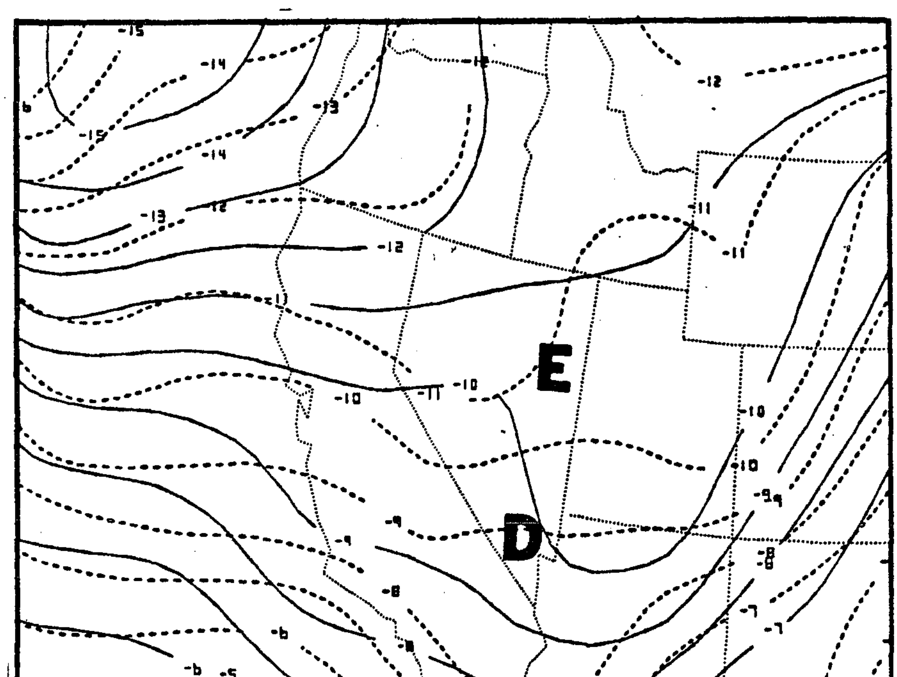
93/ 8/18/12--TEMP DASH&

Figure 5. 700 mb isotherms (°C) from the Eta model (solid) and NGM (dashed). Valid 0000 UTC 19 AUG 93.



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93/ 8/18/12--TEMP DASH&

Figure 6. 500 mb isotherms (°C) from the Eta model (solid) and NGM (dashed). Valid 0000 UTC 19 AUG 93.

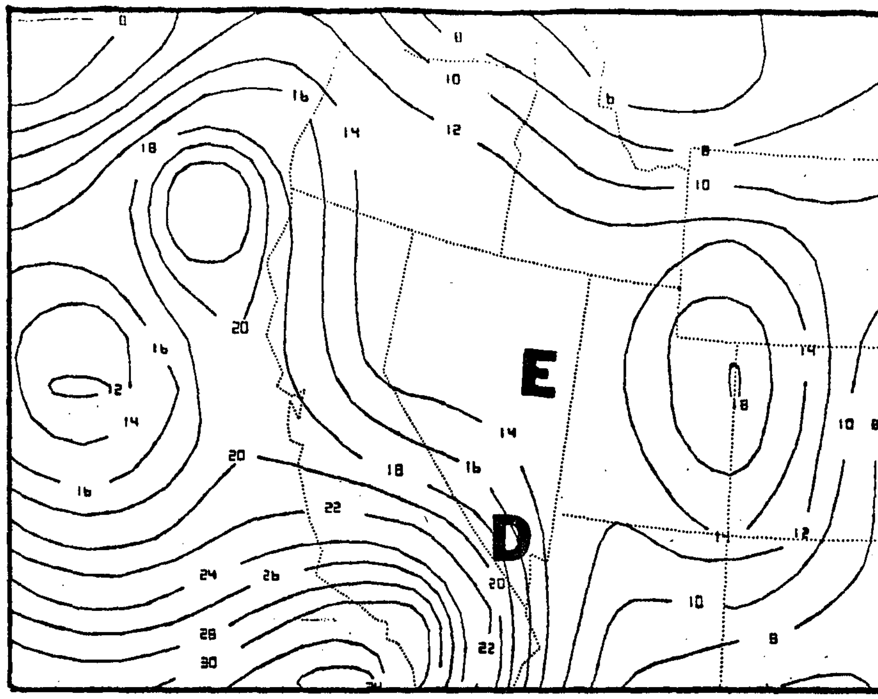

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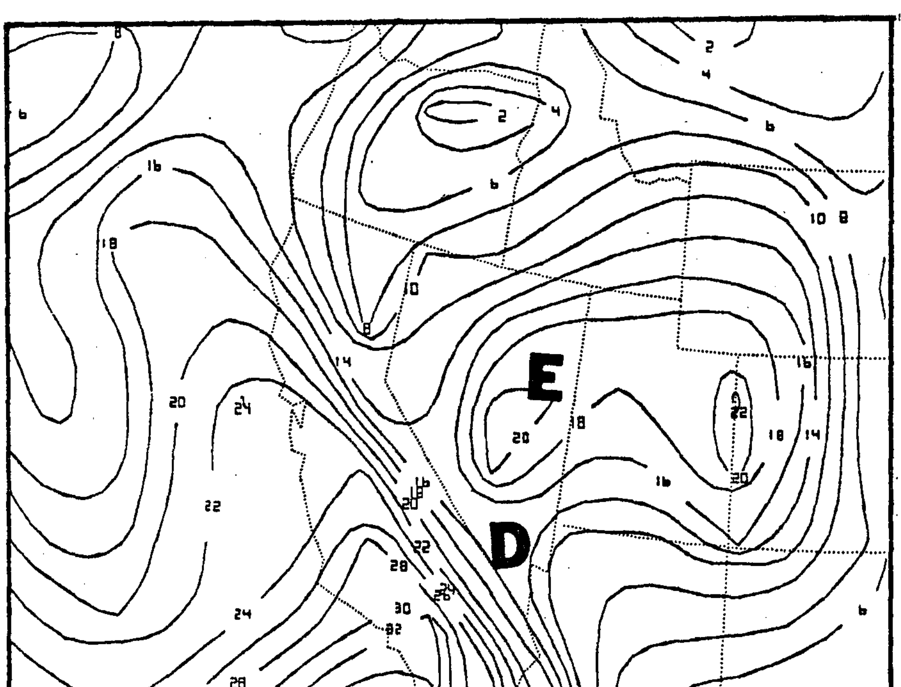
Figure 7. 700 mb dew point depression (°C) from the Eta model. Valid 0000 UTC 19 AUG 93.



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93/ 8/18/12--SDIF TEMP DWPT

Figure 8. 700 mb dew point depression (°C) from the NGM. Valid 0000 UTC 19 AUG 93.