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CONVECTION AND EQUIVALENT POTENETIAL TEMPERATURE

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BACKGROUND

The Forecast Office in Salt Lake City now has the capability to acquire gridded data for the NGM and ETA models. The data are collected from the NMC 9000 computer, and loaded into the PRIME computer at the Office of Hydrology. The data are then transferred to the PRIME computer at the Colorado Basin River Forecast Center (CBRFC) which is co-located with WSFO Salt Lake City.

The gridded data are usually available from four to five hours after the run time. A program called RA converts the data to a usable format, then the PCGRIDS program is used to display various diagnostic fields. The RA and PCGRIDS software was written by Ralph Peterson at NMC, and can depict numerous analysis and forecast fields. One such field, which has been useful during the 1992 convective season, is equivalent potential temperature (Θ_e). AFOS application programs (see WRPN's 93 and 97) are currently available that will perform the analysis of Θ_e, but the gridded data along with the PCGRIDS software can display Θ_e at 12-hour forecast intervals through 48 hours. The gridded data and appropriate software should be accessible to most Western Region WSFO's by the fall of 1992.

The following case study illustrates the usefulness of Θ_e as a forecast tool. All charts in this paper were generated by the PCGRIDS software.

A CASE OF ACTIVE CONVECTION

In the late afternoon and evening of May 12, 1992; thunderstorms erupted along an axis from south-central Nevada through northeast Utah. The satellite picture at 00Z May 13th (Figure 1) showed the convection along this axis with the coldest cloud tops over the central Utah mountains. The convection was focused along a weak low-level convergence boundary that had swept through the Northern Rocky Mountains as a cold front a few days earlier.

The 500 mb 12-hour forecast chart from the NGM model valid at 00Z May 13th (Fig. 2) indicated a weak west to southwest flow over the area of convection. There were no apparent vorticity maxima in the flow that would trigger active convection.

The 12-hour forecast of mean relative humidity from 850 mb to 500 mb for the same time frame (Fig. 3) indicated a swath of higher values from central Nevada through central Colorado. Humidity values across central Utah were generally under 50 percent, and such values are not typically associated with significant thunderstorm coverage. The forecast pattern of humidity did resemble the convective pattern that emerged in the late afternoon (see Fig. 1).

In many cases, the relative humidity charts fail to show an axis of higher humidity, especially in cases where high-based thunderstorms develop. A better field for detecting these subtle axes of convection in the intermountain region is Θ_e at 700 mb; Θ_e being a conservative property and 700 mb being a mandatory level above the terrain at all upper air stations in the intermountain region.

At 00Z May 13th, the 700 mb Θ_e forecast chart from the NGM model (Fig. 4) displayed a well-defined ridge from south-central Nevada through central Colorado. The Θ_e ridge is an axis of high potential energy where relatively warm and unstable air is located. A focusing mechanism or strong daytime heating often provides the fuel necessary to release the available potential energy.

The ideal environment for active convection in a Θ_e ridge is one in which the Θ_e values decrease with height. Decreasing Θ_e with height is indicative of a convectively (or potentially) unstable environment with a tendency for more lower level moisture than higher level moisture. There is an AFOS application program (see WRPN 97) which shows observed Θ_e in the vertical using cross sections. With PCGRIDS, the user can display forecast cross sections of Θ_e. In this case, a slice of the atmosphere was evaluated along 113°W between 35°N and 45°N (Fig. 5). This slice is defined on a planar surface by the line that runs north to south through Utah in Figure 4. The highest values of Θ_e at levels below 700 mb were located around 38.5°N, and a significant decrease in values occurred with height at this latitude.

The active convection observed in the satellite image (Fig. 1) correlated well with the Θ_e ridge axis as seen at 700 mb and in the cross section valid at 00Z.

CONCLUSION

The forecasters at WSFO Salt Lake City have had access to gridded data since early in 1992. The data have provided additional information, such as Θ_e forecasts, which are normally only available as analysis graphics through AFOS application programs (WRPN 93 and 97).

During the convective season, 700 mb Θ_e forecast charts have been useful at determining where thunderstorms will develop in the intermountain region. Ridges of Θ_e and values in excess of 327K (Kelvin) have worked well in the spring season at locating potentially active convective areas. During the summer when temperatures are warmer, higher Θ_e values may be necessary to trigger significant thunderstorms. Another condition which is often associated with active convection is decreasing Θ_e values with height.

References:

Chaston, Peter: "Graphical Guidance," 1992 edition, p. 126-136.

Tolleson, Paul, 1992: "Equivalent Potential Temperature Program for AFOS (EQP.SV)", Western Region Programming Note 93.

Tolleson, Paul, 1992: "Equivalent Potential Temperature Raob - Plotting Program for AFOS (THRP.SV)", Western Region Programming Note 97.

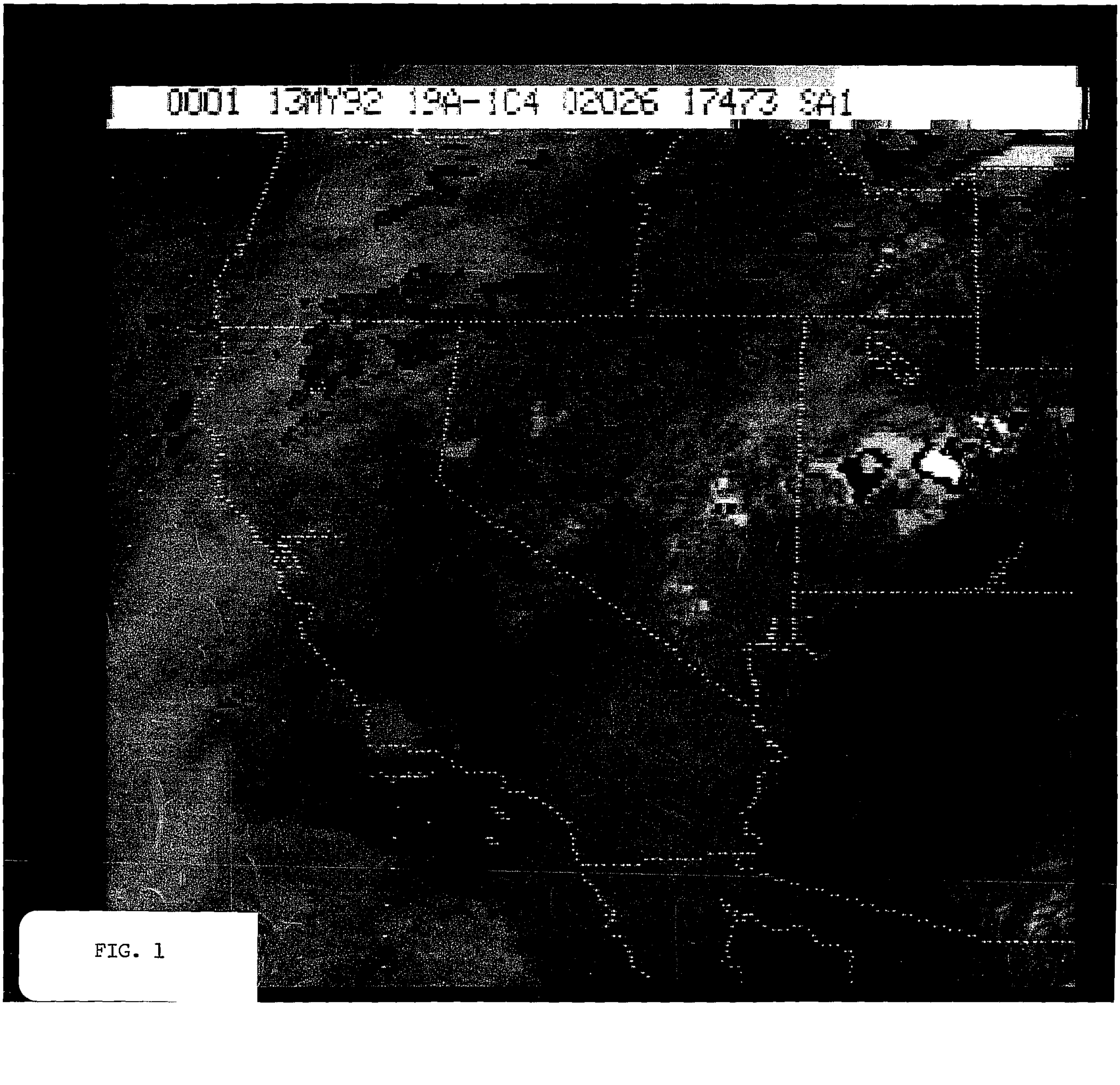

FIG. 1

RAFS:LVL= 500:LYR=1000/ 500:FHR= 12 :FHRS= 0/ 24::FILE=MY129212.RFS
92/ 5/12/12--HGHT CI60+VORT WIND CINX
MN= 5362.131
MX= 5854.529
AV= 5700.413
SD= 118.008

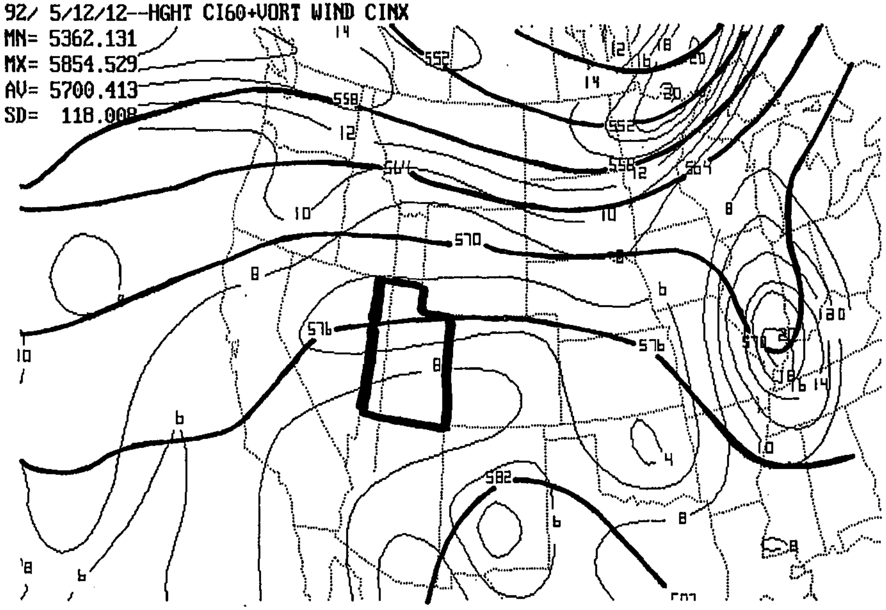

FIG. 2

RAFS:LVL= 500:LYR= 850/ 500:FHR= 12 :FHRS= 0/ 24::FILE=MY129212.RFS
92/ 5/12/12--RELH LAVE CINX
MN= 10.478
MX= 97.204
AV= 43.529
SD= 18.293

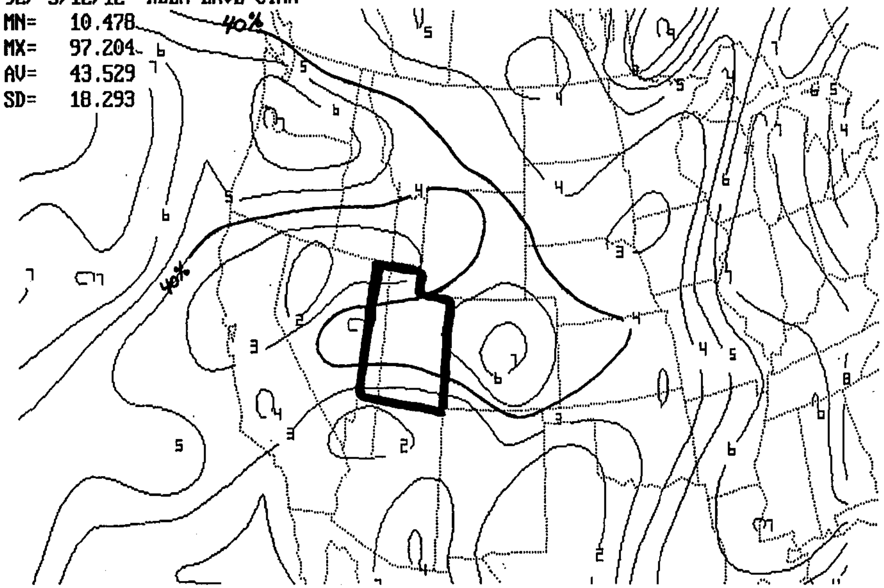

FIG. 3

RAFS:LVL= 700:LYR=1000/ 500:FHR= 12 :FHRS= 0/ 24::FILE=MY129212.RF S
92/ 5/12/12--THTE CIN3
MN= 284.465
MX= 334.803
AV= 312.472
SD= 11.653

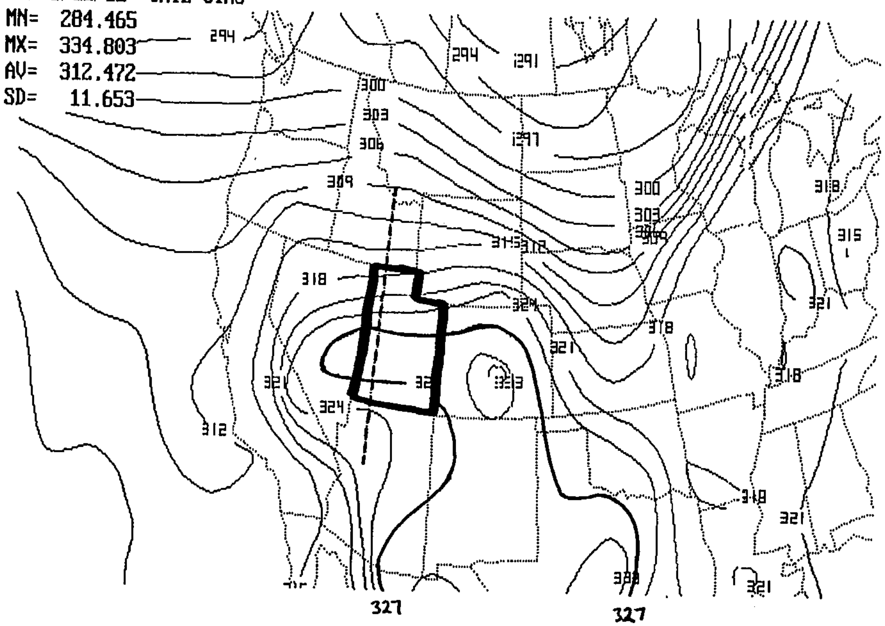

FIG. 4

RAFS:Lon/Lat113/45->113/35:FHR= 12 :FHRS= 0/ 24::FILE=MY129212.RFS
92/ 5/12/12--PRES CLRF+
MN= 100.000
MX= 1000.000

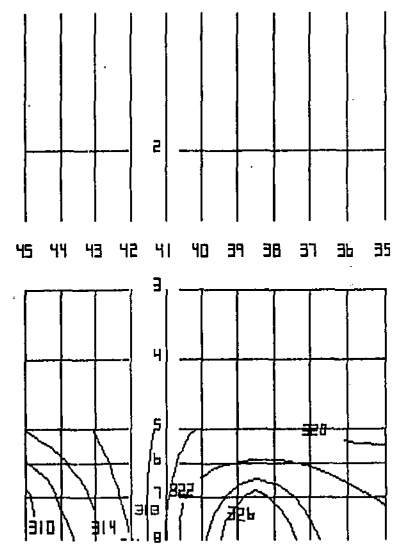

FIG. 5