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A 20-YEAR SYNOPTIC CLIMATOLOGY OF THE SOUTH PLAINS DEWPOINT / DRYLINE

Mark R. Conder[1], Arthur L. Doggett[1] and Richard E. Peterson[1]
[1]Department of Geosciences, Texas Tech University, Lubbock, Texas

1. INTRODUCTION

The dryline is a boundary separating two air masses of different moisture content. It is characterized at the surface as an extremely sharp horizontal moisture discontinuity over a very short distance (Schaeffer, 1986). Although the along dryline extent is readily measured and can stretch for hundreds of kilometers, the across-dryline region of the largest moisture gradient exists on a much smaller scale and requires observational data on finer resolution than the U.S. observing network currently can provide for analysis. For example, Ziegler and Rasmussen (1998) found that the dryline mixing zone varied between one to 10 km from mesoscale studies they conducted. Utilizing high-resolution data from instrumented vehicles, Pietrycha and Rasmussen (2001) found dewpoint gradients as large as 10°C per 185 m across the dryline. The origin of the dryline is also the subject of much current research. It is thought that the pattern of the upper-level flow, the east-west profile of sensible heating, the gradient of soil moisture from the Gulf Coast to the Mexican Plateau and the orientation of topography in the region all play important roles over how and where the dryline develops. While the dryline has long been known to have an important role in the initiation of convective activity – a study by Rhea (1966) concluded that convective storms often form within 200 n mi of the dryline – there have been few articles published on dryline climatology. The research described here attempts to utilize available archived surface data to examine the characteristics of dryline genesis and morphology.

2. PREVIOUS STUDIES

Rhea's research is perhaps the earliest published study of dryline climatology. He used 3-hourly surface charts and hourly radar summaries for the spring months (April, May and June) of 1959-1962 to examine the relationship of new radar echoes to the position of the dryline. His definition of the dryline was a "…organized dew-point discontinuity zone of at least 10 degrees F existing between one or more reporting points and the nearest neighboring reporting point(s)." He determined that a dryline occurred on 45% of the days in the study period. His results also showed that new radar echoes appear within 200 n mi of the dryline 70% of the time and the study concluded that the dryline is a preferred zone for convective storm initiation.

* Mark R. Conder, Texas Tech University, Department of Geosciences, Lubbock, TX 79409-2101; email: m8mrc@ttacs.ttu.edu

Schaeffer (1973) studied the dryline occurrence during the months of April, May and June of 1966, 1976 and 1968. He established a 15 X 15 grid over eastern NM, TX, OK, southern CO and southern KS with a grid spacing of approximately 100 km and objectively analyzed 3-hour NWS surface charts. His criteria were a east-west 10 degree F dewpoint difference between reporting stations, at least an 6-hour duration of the difference, and a roughly uniform moisture filed east of the dryline of at least 50 degrees F. His study revealed the presence of a dryline on 114 of the 278 days of the study (41%).

Peterson (1983) utilized Schaefer's criteria to analyze drylines during the April-June days of 1970-1979. His study concentrated on the West Texas region from OK to the Rio Grande and from 100°W to the NM border. He found that there were an average of 30 dryline days during the period, with a span of 26 to 58 days.

Other studies have used the 355K isopleth of equivalent potential temperature (Koch and McCarthy, 1982) and the 9.0 g kg^{-1} mixing ratio isohume (Grasso, 2000) to identify the dryline in observational and modeling studies.

3. DATA

All the data for this study originates in the DATSAVE2 surface archive from NCDC. The DATSAV2 is a quality-checked archive and it contains almost all of the records available from the United States surface weather observation network. The archive was converted to University Corporation for Atmospheric Research (UCAR)'s General Meteorological Plotting and Analysis Package (GEMPAK) program. In order to study the southern plains dryline, a study area of 92° W to 107° W and 25° N to 38° N was chosen. All the hourly records from this region during the 20-year period of 1975 to 1995 were used (over 175,00 records). For any given time, the number of available station data does vary considerably. Using GEMPAK, an objective analysis of the data was performed. GEMPAK utilizes a Barnes objective analysis scheme that provides recommended values for grid spacing and radius of influence based on the calculated average station spacing. In this case, the average station spacing was ~100 km. A 29 by 26 grid was established with a grid spacing of ~0.5 degrees at 33° N, 101° W. This gives an average grid spacing of approximately 50 km in the study area. The grid is shown in Figure 1.

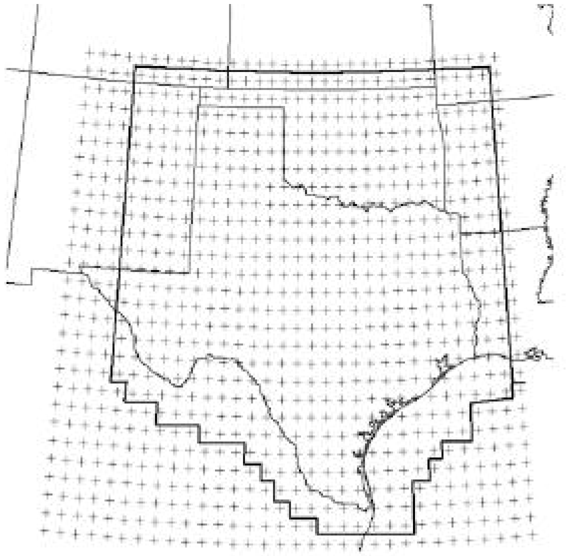
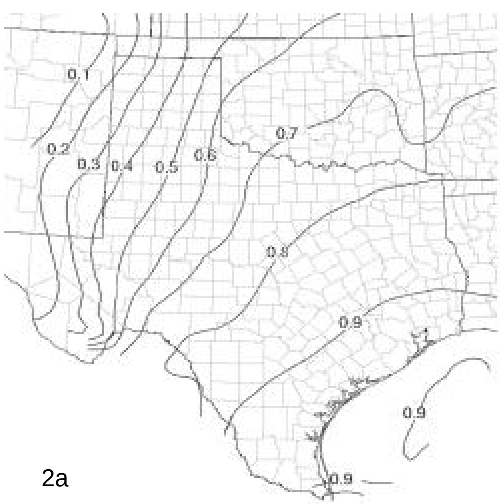


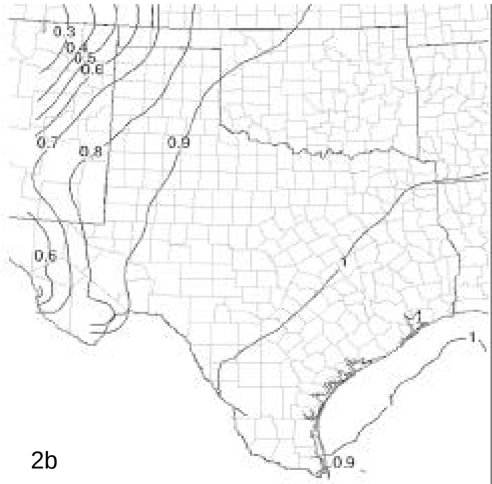
Figure 1. The grid used for the Barnes objective analysis scheme. The initial grid size is 28 by 32 and the spacing is 30 minutes. The region within the polygon is where the dewpoint and dryline algorithm was performed.

4. DEW POINT CLIMATOLOGY

In order to get an impression of the contribution of dryline to the regional moisture climatology it is reasonable to first look at the overall patterns of moisture. Dodd (1965) showed the distribution of average monthly dewpoint in the United States for the years 1949-1960 (data availability depending on station). The results of his study showed a dewpoint gradient that was greatest in the months of Mar, Apr and May over West Texas. For this study the average dewpoints at each grid point were compiled for monthly and seasonal time frames. The seasonal results are shown in Figures 2a through 2d.



2a



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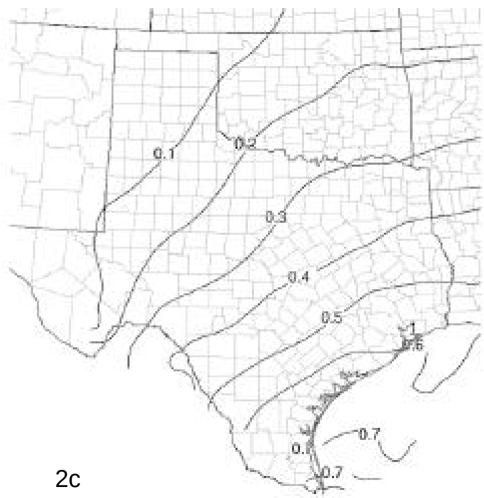

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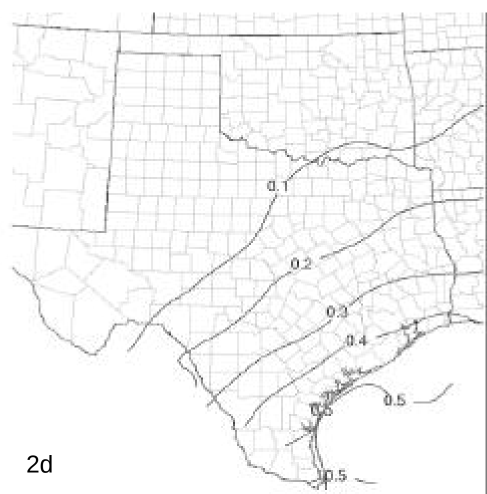


2d

Figure 2 (a-d). The average fraction of hours that have a dewpoint >= 52°F compared to the total number of hours for the months of (a) Apr, May, Jun (b) Jul, Aug, Sep (c) Oct, Nov, Dec and (d) Jan, Feb, Mar.

In the absence of strong synoptic-scale forcing, the dryline may diurnally oscillate or “slosh” mainly longitudinally across the south plains. This may be reflected in the morning and evening dewpoint distributions. Figures 3a and 3b show how in the morning there is an increase in moisture westward towards the Rocky Mountains. This effect is not very evident east of about 100°W longitude.

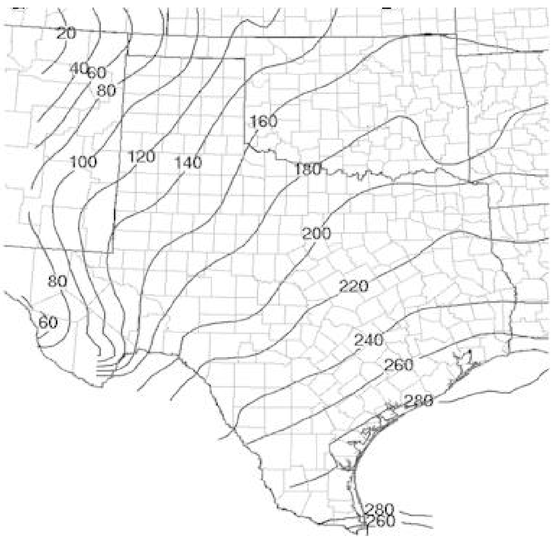


Figure 3a. The average number of days per year in which the dewpoint >= 52°F for the morning hour of 12Z.

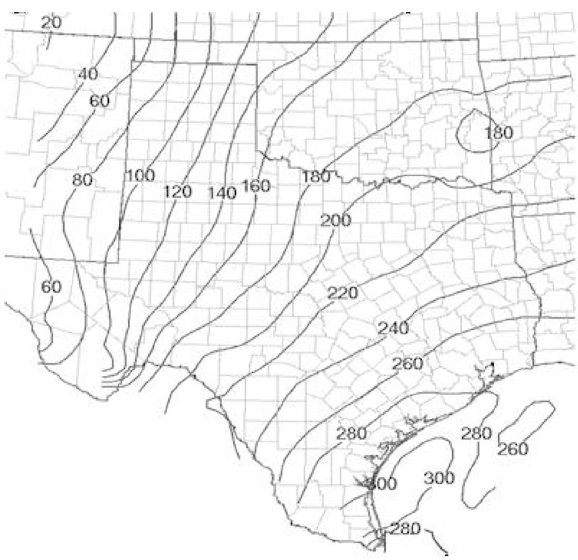


Figure 3b. The average number of days per year in which the dewpoint >= 52°F for the evening hour of 0Z.

5. DRYLINE CLIMATOLOGY

Although the 55°F isodrosotherm has been used historically to place the dryline because of the moisture criteria to support (severe) convection, several master’s thesis studies at Texas Tech (Mullen, 1992, Jones, 1998) have shown support for the placement of the largest dryline gradient at 50°F. After running several test cases, the 52°F isodrosotherm was chosen as the dryline delineator for this study – partly to account for smoothing by the objective analysis scheme. An algorithm was developed to compare a grid point with neighboring grid points to establish the presence of the dryline. In addition, the temperature, virtual temperature, and wind direction fields may be used to aid in dryline determination – the algorithms are currently being refined. It is difficult during the winter and early spring to distinguish drylines from some Pacific fronts. Using the 52°F isodrosotherm, the some of the results obtained over the 20-year period are shown in Figures 4 through 6.

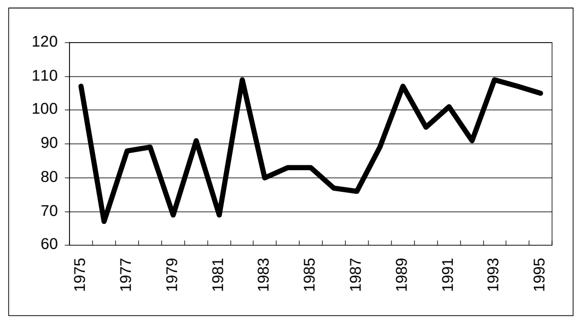


Figure 4. The total number of days per year that a dryline was identified within the grid (minimum of 3 adjacent grid points and 3 hour time continuity).

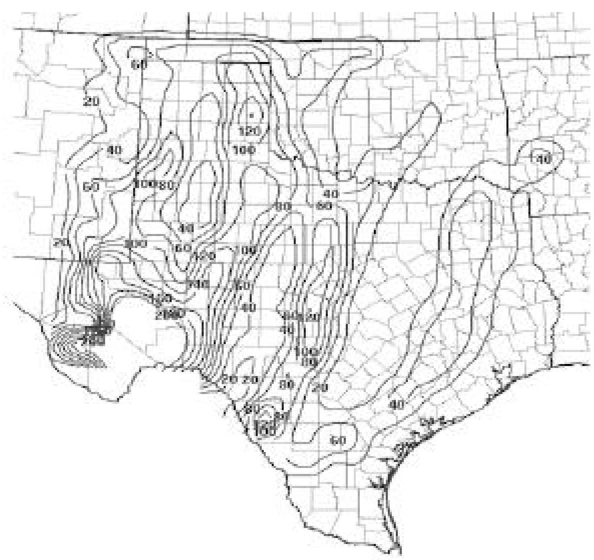
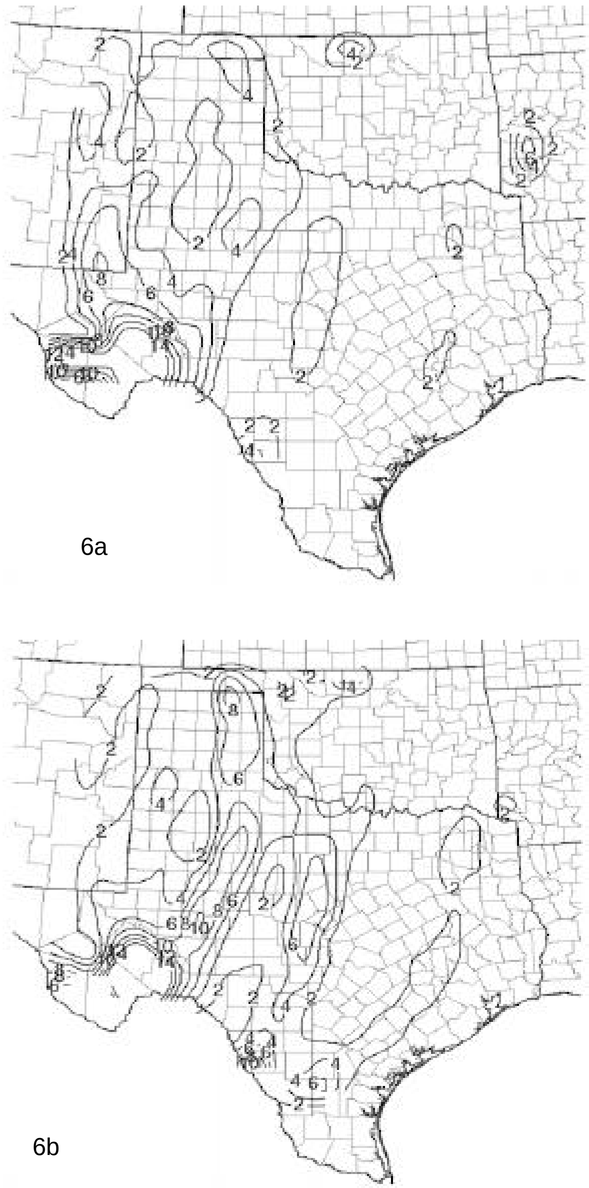


Figure 5. The average total number of drylines per year that were detected. Please note the erroneous maxima near the Big Bend region caused by the boundary conditions.



Figures 6(a-b). The average total number of dryline days detected per year for the (a) morning hour of 12Z and (b) the evening hour of 0Z. Again, please note the erroneous maxima near the Big Bend region caused by the boundary conditions.

6. FURTHER OBJECTIVES

The boundary conditions and the dryline detection algorithm will be refined. The grid will be recentered and expanded to include more of NM, CO and KS. Monthly averages will be compiled to circumvent seasonal biases and help to eliminate frontal passages. The sensitivity of dryline development and movement in relationship to the reference flow, soil moisture and land-use characteristics may be investigated. GIS software will be used to examine the statistical relationship of the dryline position to topography – especially along the abrupt elevation change of the Caprock escarpment.

7. ACKNOWLDGEMENTS

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8. REFERENCES

Dodd, A.V., 1965: Dewpoint distribution in the contiguous United States. *Mon. Wea. Rev*., **93**, 113-122.

Grasso, Lewis D, 2000: A numerical simulation of dryline sensitivity to soil moisture. *Mon. Wea. Rev*., **128**, 2816-2834.

Jones, A., 1998: A study of the relation between surface convergence and convective initiation along the dryline. Master's thesis, Texas Tech University, 83 pp.

Koch, S. E. and J. McCarthy, 1982: The evolution of an Oklahoma dryline. Part II: Boundary-layer forcing of mesoscale systems*. J. Atmos. Sci*., **35**, 1070-1096.

Mullen, M.T., 1992: Satellite detection of the dryline/dew point front. Master's thesis, Texas Tech University, 84 pp.

Peterson, R. E., 1983: The West Texas Dryline: Occurrence and Behavior, Preprints, *13th Conference on Severe Local Storms*, Tulsa, OK., Amer. Meteor. Soc., J9-J11.

Pietrycha, A. E. and E. N. Rasmussen, 2001: Observations of the Great Pains dryline utilizing mobile mesonet data. Preprints, *9th Conference on Mesoscale Processes*, Ft. Lauderdale, FL., Amer. Meteor Soc.

Rhea, J. O., 1966: A study of thunderstorm formation along dry lines., *J. Appl. Meteor.*, **5**, 58-63.

Schaefer, J. T., 1973: The motion and morphology of the dryline. NOAA Tech. Mem. ERL NSSL-66, 81 pp.

Schaefer, J. T., 1986: The dryline. *Mesoscale Meteorology and Forecasting*, P. S. Ray, Ed., Amer. Meteor. Soc., 549-572.

Ziegler C. L. and E. N. Rasmussen, 1998: The initiation of moist convection at the dryline: Forecasting issues from a case study perspective. *Wea. Forecasting*, **13**, 1106-1130.