Eastern Dryline Climatology and Synoptic-Scale Environment

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Introduction

Background

The dryline is an airstream boundary that typically sets up meridionally over the High Plains during spring. It marks a very strong moisture gradient between the hot, dry air from off the Mexican Plateau and the warm, moist air originating over the Gulf of Mexico. It is also a zone of enhanced convergence, which makes it a focal point for convective initiation (Schultz et al. 2007), and the focus of much research. A number of dryline climatologies have been created, however, the published climatologies (Hoch and Markowski 2005 and Rhea 1966) have all focused on the Great Plains drylines. This project is a study of the drylines that move atypically eastward.

Objectives

- Create a 5-year climatology of dryline passages east of 95°W [hereafter referred to as "eastern drylines"].
- Construct composites of synoptic conditions associated with eastern drylines.

Methods

- Five years (2007 – 2011) of data was used from the North American Regional Reanalysis (NARR) dataset to create the climatology.
  - 32 km grid spacing
  - 3-Hourly
- A computer algorithm was written that identified drylines according to three criteria:
  - A positive specific humidity gradient of at least 3×10^{-8} m^{-1} (3 g km^{-1} (100 $km)^{-1}$) across the boundary
  - Wind direction from 170° to 280° west of the boundary and wind direction from 80° to 190° east of the boundary
  - A temperature gradient of less than .02°C km^{-1}
- Parcels either side of the algorithm identified drylines were run through NOAA's Hybrid Single-Particle Lagrangian Integrated Trajectory, or HYSPLIT, (http://ready.arl.noaa.gov/HYSPLIT.php) model to visualize the parcel trajectories and verify the origins of the air parcels.
- Composite fields of eastern dryline days were created using the NCEP/NCAR Reanalysis Dataset through the Earth System Research Laboratory Physical Sciences Division (http://www.esrl.noaa.gov/psd/data/composites/hour/).

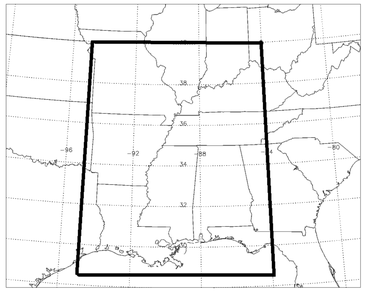

Figure 1: Domain of Study

Acknowledgements

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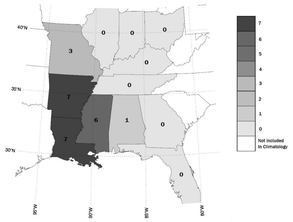
Results

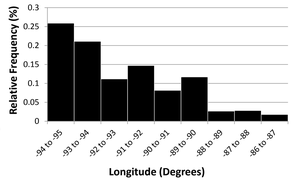
2007 – 2011 Climatology

A total of 17 dryline cases in the domain were identified from 2007 through 2011

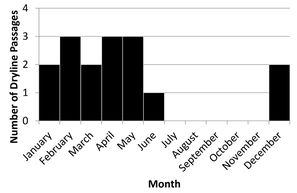
Dryline Passages by State, 2007 - 2011



Relative Frequency of Dryline Longitude Hits



Dryline Passages Through Domain By Month, 2007-2011



Synoptic Anomaly Composites

Composites are presented of mean synoptic anomalies that existed on the 17 eastern dryline days

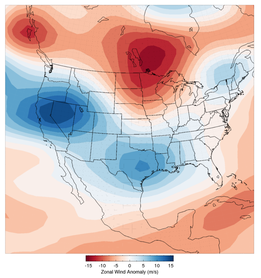


Figure 2a: 300mb Zonal wind anomaly composite

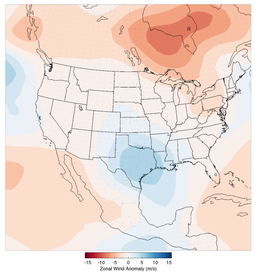


Figure 2b: 925mb Zonal wind anomaly composite

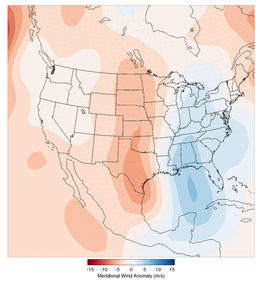


Figure 2c: 925mb Meridional wind anomaly composite

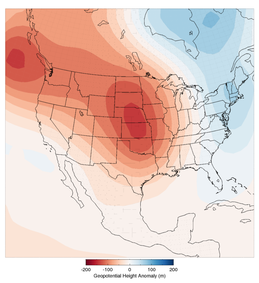


Figure 2d: 500mb Geopotential height anomaly composite

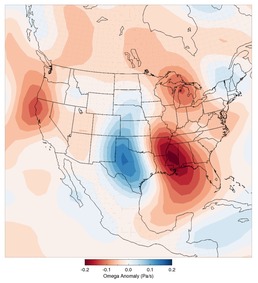


Figure 2e: 825mb Omega anomaly composite

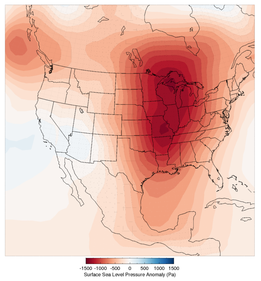


Figure 2f: Surface sea level pressure anomaly composite

Level	Variable	Feature	Central Drylines Feature Location	Eastern Drylines Feature Location
925mb	Zonal Wind	Positive Maxima	NM, AX, NW Mexico	East TX
925mb	Meridional Wind	Positive Maxima	East TX/OK	AL, MS, and Gulf of Mexico
300mb	Zonal Wind	Positive Maxima	Four Corners Region	East TX
500mb	Geopotential Height	Minima	Rockies	Central Plains
850mb	Omega	Positive Maxima	SW Texas	West Texas
850mb	Omega	Negative Maxima	East KS/NE/OK	MS
Surface	Sea Level Pressure	Minima	West KS/OK	MO/ Upper Peninsula MI

Table 1: Comparison of synoptic features associated with synoptically-active drylines in the south central US (Texas, Oklahoma) (Schultz et al. 2007) with features associated with synoptically-active drylines in the eastern domain of this study.

Case Study

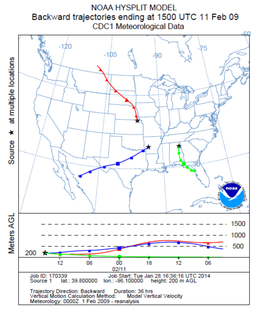


Figure 3: 36 Hour backward parcel trajectory for a Mississippi dryline on February 11, 2009 using NOAA's HYSPLIT model

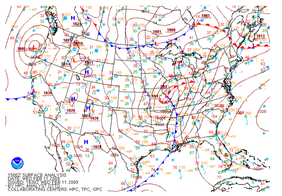


Figure 4: HPC Surface Analysis for February 11, 2009 15Z

- Backward parcel trajectories (Figure 3) show three different airmass sources for the parcels associated with this cyclone. The airmass to the west is a continental polar (cP) airmass, the airmass to the southwest is a continental tropical (cT) airmass, and the airmass to the southeast is a maritime tropical (mT) airmass.
- The boundary analyzed as a cold front in Figure 4 is the boundary between the cT and mT airmasses, so it is actually a dryline.
- This and other case studies reveal that drylines that move east of their typical domain are oftentimes analyzed as cold fronts

Severe Weather

Overlaid severe weather reports from the Storm Prediction Center are presented for the 17 eastern dryline days

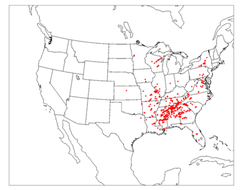


Figure 5a: Tornado Reports on the 17 eastern dryline days

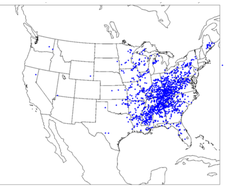


Figure 5b: Wind Reports on the 17 eastern dryline days

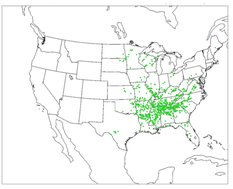


Figure 5c: Hail Reports on the 17 eastern dryline days

Conclusions and Future Work

Conclusions

- Dryline passages through the lower Mississippi River Valley region are perhaps more common than typically believed.
- These drylines occur in winter and spring. This is earlier than typical Great Plains drylines, which are most common in May (Hoch and Markowski, 2005). Their passages are associated with very active synoptic setups in the south central and southeast U.S. with strong jet streaks aloft, midlevel shortwave troughs, and surface cyclones.
- These drylines are oftentimes analyzed as cold fronts.
- There are oftentimes severe weather outbreaks on days when drylines move atypically eastward.

Future Work

- A full 30 year climatology will be made of eastern drylines using the computer algorithm
- The domain will be expanded northward to 47 ° N.
- Synoptic patterns will be further refined.
- The location of convective initiation on eastern dryline days will be examined in order to determine which boundary (if any) convection was initiated along.

References

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