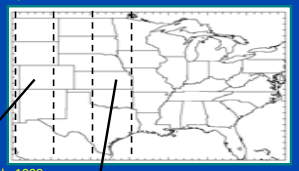
WARM SEASON PRECIPITATION CORRIDORS IN THE CENTRAL UNITED STATES

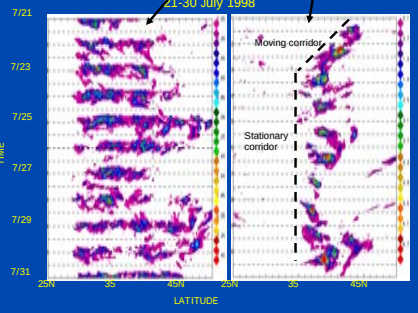
John D. Tuttle and Chris A. Davis
National Center for Atmospheric Research[1]

INTRODUCTION

Over the elevated terrain of the Rocky Mountains convection develops on a daily basis during the warm season often extending from Mexico to the Canadian border. Only a small fraction is long-lived and propagates into the central U.S. In the central U.S. the precipitation is often confined to a relatively narrow corridor ~3-4º wide. The corridor may be nearly stationary or drift N-S with time.

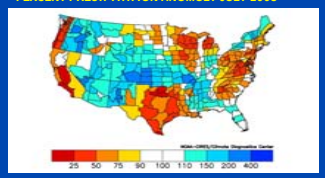
Radar derived rainfall are averaged in two longitude bands-continental divide (105-110W) and central plains (95-100W). Data are plotted in a time-latitude format.





The cumulative rainfall within a corridor can be substantial while precipitation in nearby regions may be below normal. Understanding the nature and synoptic conditions favorable for setting up a corridor thus has important implications for QPF and hydrological studies.

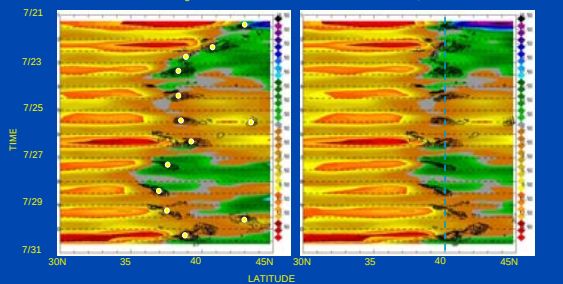
PERCENT PRECIPITATION ANOMOLY JULY 1998



METHODOLOGY

Combine radar and RUC (Rapid Update Cycle) model analysis to understand how the strength and location of precipitation corridors relate to environmental conditions. Shown below left is an 10-day time-latitude plot in the central plains of radar rainfall (contours) superimposed on the 900 mb meridional RUC wind (color filled). Note the formation of the nocturnal low-level jet (LLJ) on a daily basis. For each 24-hr period the centroid of the radar rainfall (yellow dots) is found and the radar and RUC data are shifted to 40ºN using the centroids as a reference. The shifted fields are shown on the left. Once the data are shifted, 5-year (1998-2002) averages for the months of July and August are computed, thereby obtaining a climatology of the RUC fields relative to the radar data.

V900/Radar Original | Data shifted to 40ºN using radar centroid as reference

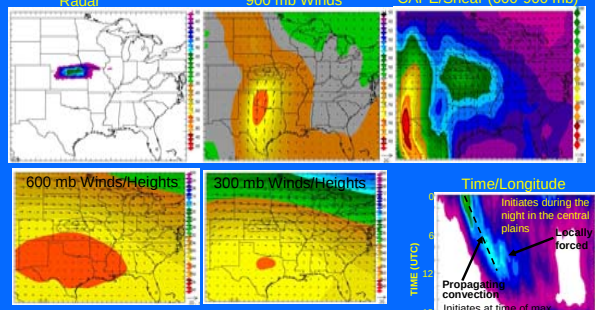


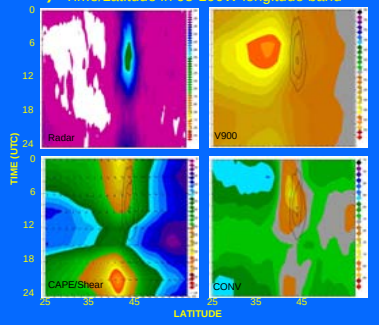
[1]The National Center for Atmospheric Research is sponsored by the National Science Foundation

RESULTS

5-YEAR AVERAGE JULY-AUGUST (310 DAYS)

Time/Latitude in 95-100W longitude band



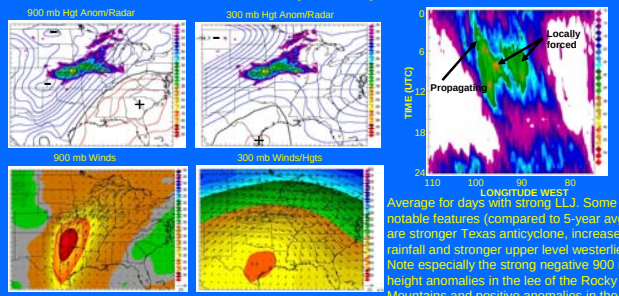


Time/Longitude

These plots represent a 5-year average of all days for July and August. Note the location of the convection just to the north of the exit region of the low-level jet (LLJ) and corridor of maximum CAPE values. Convection is situated on top of a large anticyclone centered over Texas.

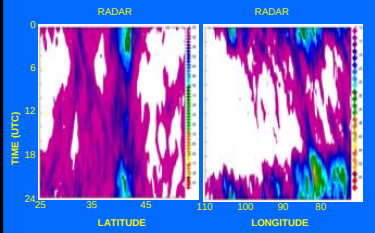
The rainfall peaks ~0800 UTC indicating that on average the rainfall is locked to the diurnal cycle and has a nocturnal maximum in the central plains. A significant portion of the nocturnal maximum is due to propagating convection, but some fraction also develops locally in the evening. Note location of convection near the exit region of the LLJ. Strong convergence is associated with the exit region.

DAYS WITH STRONG LLJ (>12 ms^{-1}) 45 DAYS OUT OF 310



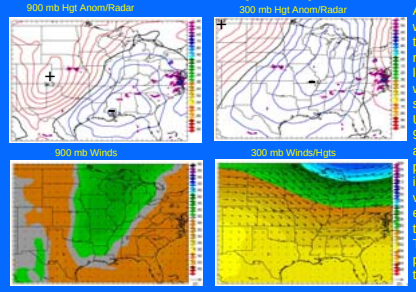
Average for days with strong LLJ. Some notable features (compared to 5-year avg) are stronger Texas anticyclone, increased rainfall and stronger upper level westerlies. Note especially the strong negative 900 mb height anomalies in the lee of the Rocky Mountains and positive anomalies in the southeast, acting to enhance the formation of the LLJ.

DAYS WITH WEAK LOW-LEVEL SHEAR (<10 ms^{-1})



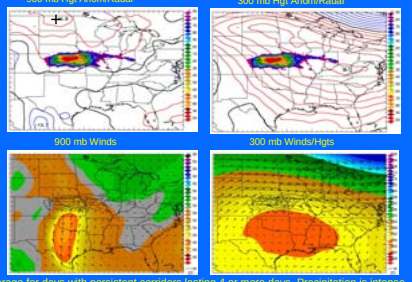
Average for days with weak low-level shear (600-900 mb). There is very little long-lived propagating convection and the convection that does form occurs near the time of maximum solar heating (between 2200 and 0200 UTC) as opposed to being nocturnal.

DAYS WITH WEAK LLJ (<5 ms^{-1}) 32 DAYS OUT OF 310



Average for days with weak LLJ. Rainfall for these days is much reduced and the upper level flow is northwesterly with the anticyclone shifted to the west over Utah and Arizona. The 900 and 300 mb height anomalies show strongly positive values (ridging) in the west and negative values (troughing) in the east, thus suppressing the formation of the LLJ. This height anomaly pattern is the opposite that for strong LLJ cases.

DAYS WITH PERSISTENT CORRIDORS



Average for days with persistent corridors lasting 4 or more days. Precipitation is intense and confined to a narrow east-west band. Positive 900 mb anomalies are evident north of the band implying an east-west stationary front just south of the corridor axis.

Corridors of precipitation are often associated with the exit region of the LLJ and are located on top of (north) an upper level ridge.

Stronger LLJs lead to increased precipitation and a greater percentage of the convection being locally forced. Strong LLJs occur under conditions of an enhanced trough in the lee of the Rockies and ridging in the southeastern U.S.

For days with weak low-level shear (<10 ms-1) long-lived propagating convection was nearly absent. Convection tended to be locally forced and tied to the time of maximum solar heating.

The cumulative rainfall in a persistent corridor can be substantial while nearby regions may be below normal. Persistent corridors seem to be associated with an E-W stationary front and a surface high to the north in Canada/northern plains.