How Do Low-Level Jets Lead to Precipitation Extremes?

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Introduction

PROJECT DESCRIPTION

This project is studying the interaction between the Low Level Jet (LLJ) and precipitation extremes during the hydrologic years of 2006 (HY06; a drought year) and 2007 (HY07; a flood year) over the southern Great Plains (SGP) region in the central US. This will give a unique opportunity to study two very dissimilar years in close proximity and to deduce the affects of the LLJ on precipitation.

BACKGROUND

The LLJ was defined by Bonner (1968) to occur when the wind in the lowest 3000 meters exceed 12 m/s and dropped off to at least half of the maximum value that was present by 3000m. Most or all LLJ studies since this time have relied on this definition or a very close derivative of it.

OBJECTIVES

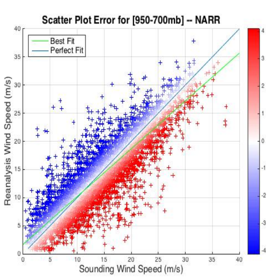
The goal of this project is to explain how the LLJ can lead to precipitation extremes. In addition, it is known that the LLJ affects precipitation because of the import of warm moist air. Therefore, in this study we also investigate where the LLJ came from, what altitude it is at, how much moisture it has, and more importantly, what is important link to the precipitation extremes.

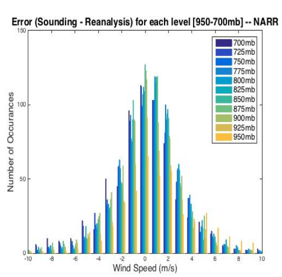
DATA AND METHODOLOGY

Previous studies have used sounding or wind profiler data, with a few using wind towers. These observations are point measurements and lack the ability to study the LLJ 3-dimensionally.

In this study we use NCEP North American Regional Reanalysis (NARR). Compared with sounding observations, NARR data products are unbiased and can reasonably represent LLJs although they cannot see convective systems in detail due to their relatively low resolution.

NARR versus Soundings observations

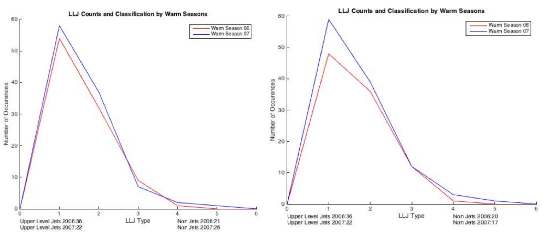




LLJ-Precipitation Interactions

LLJ FREQUENCY: HY06 VS. HY07

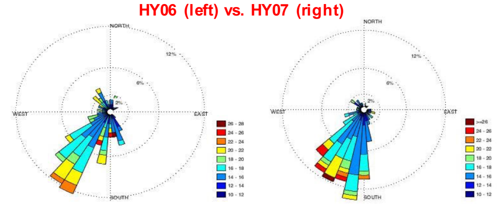
Existing Definition (left) & Revision (right)



HY07 (wet year) has more LLJs compared with HY06 (dry year). This is more obvious when speed drop off with height is ignored.

WIND ROSE PLOTS OF LLJS

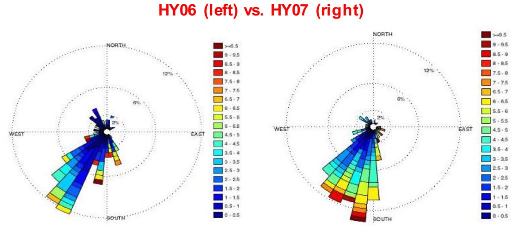
HY06 (left) vs. HY07 (right)



LLJs were stronger and more southerly in HY07 than in HY06.

PRECIPITATION WIND ROSE PLOTS

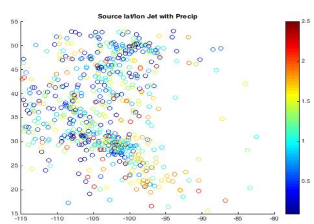
HY06 (left) vs. HY07 (right)



Southerly flow is more often associated with precipitation than other directions.

The source region of the LLJ (back traced 12 hours.)

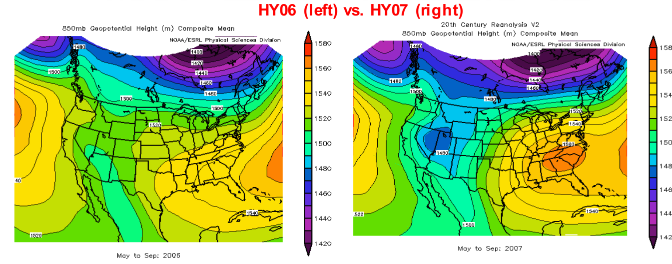
It is clear here that the direction of the LLJ is very important for precipitation production.



Preliminary Findings

SYNOPTIC DIFFERENCES AT 850MB HEIGHT LEVEL

HY06 (left) vs. HY07 (right)

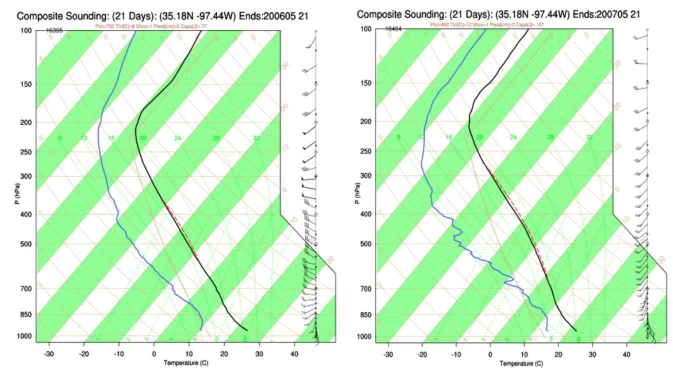


A strong area of high pressure was consistently located over the eastern USA during summer 2007 with a corresponding strong thermal trough over the western USA. This led to a strong southerly LLJ in HY07.

In 2006 the same general signal was present, but weaker as either the pressure systems were less intense or more transient. This led to a less robust southerly LLJ signal. Thus, moisture and instability were higher in HY07.

COMPOSITE SOUNDINGS

May 06 (left) vs. May 07 (right)



The LLJ was deeper, stronger, and more southerly in HY07 (wet year). **This led to less capping, more instability, higher RH in the boundary layer, and ultimately more precipitation and severe weather.**

SUMMARY AND MAJOR RESULTS

- LLJs are related to precipitation but this is difficult to see using the existing definition.
- A higher frequency of southerly LLJs leads to higher precipitation, indicating the direction of LLJ is important in predicting precipitation.
- There are discrepancies in large-scale synoptic patterns of LLJs between wet and dry years.
- When convection is present, a LLJ influences convection. Future work will investigate this in great detail.

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