A Study on the Initiation Process of an Elevated Convective System: Where is the Ascending Air Originated? Case Study: Storm on Kansas 2015

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Abstract

A storm in Kansas in 2015 was unpredicted and unprecedented in its data captured. A spontaneous elevated convective system, born seemingly out of nothing, is studied and analyzed to find the sources of ascending air: mainly from around the base and from the downdraft of another storm close in proximity. The hypothesis proves somewhat correct, though less in-depth and easier to understand.

Introduction

This study was on elevated convective system- elevated meaning above the planetary bound layer, and convective meaning a large interconnected series of several storms. The one studied in particular was in 2015, over Kansas. The reason why this storm was so significant was because it was one of the first ECS' studied by the dual doppler system VDRAS. Similarly, these ECS often have large impacts due to their unreliability and unpredictability, making them surprising and unexpected. As a modern weather mystery, the research question was just one step in finding out what the real cause behind them is, and the hypothesis was that the air will be from ground level and remaining from a separate storm. As seen in Figure 4, the air from the previous storm between DDC, SPOL, and ICT pushed air northwards, contributing to the storm currently being studied. Previously, these systems have been studied, but this particular storm with 50+

data sets will help gain a better understanding of this family of storm. The data analysis is mainly trend recognition and visualization, as well as navigating through different types of data analysis programs (Unidata IDV, XTerm, XQuartz, etc).

Materials and Methods

The data was gathered from PECAN (Plains Elevated Convection at Night) and dual VDRAS (Variational Doppler Radar Analysis System) doppler radar systems. There are dozens of doppler radar systems spread around the contiguous United States, typically at least 2 per state and up to 15. There exist 3 in Colorado, and at least 6 encompassed in the region that the storm swept through on June 26th, 2016. Though typically (as exhibited by most of the light green areas in Figure 2) air parcels reach an equilibrium level, which allows calming of turbulence and CAPE to go down, thunderstorms exist when the CAPE is higher.

Data analysis is done with two programs, Unidata IDV (Integrated Data Viewer), and Linux-based XQuartz and subprogram XTerm. These two programs will provide visuals for progress as well as final visuals for the presentation. Though the data processing is done with up to 8 gigabytes of RAM, the data is so complex and concentrated that it is still necessary to skip data points and certain plains altogether.

The data provided is from 2015-06-26, midnight to 5:00 am, ground level to about 12,600m up. I will be working on data analysis and trend-spotting. Through 3D Flow displays and ribbon vectors, I will observe where the air and certain parts of the storm originate and travel to. The main problems to overcome include learning the different parts of the applications.

First, load the data into Unidata IDV, making sure to assemble all of the time-points, which of are 10 minutes apart. Then, select certain settings, depending on which selection you would like to observe (including point vectors, 3D vectors, cloud concentrations, 3D ribbons, etc). Be sure to skip every other point, if not more, to prevent the amount of RAM from exceeding 8 gigabytes. Afterwards, load in some other background information and visuals, including altitude of surface level, and possibly humidity in a color gradient. Then, depending on the settings, observe where the ribbons and vectors (or whatever is being observed) begin and end.

It is very important to toy with the settings, as well as drag around 3D space inside the IDV, to find and observe from the best possible angle and capture the most advantageous visuals.

Figures

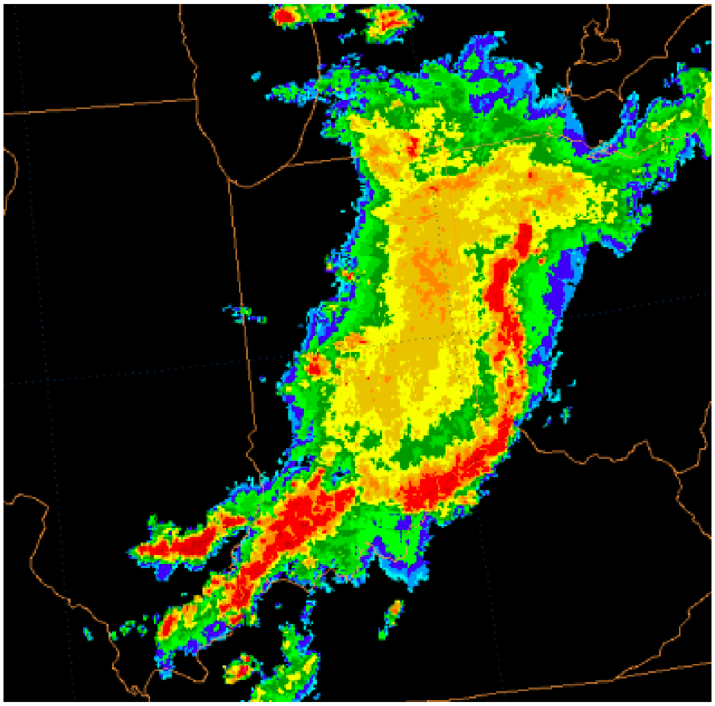

Fig. 1: An example of an elevated convective system

Fig. 2: An example of a doppler radar observer

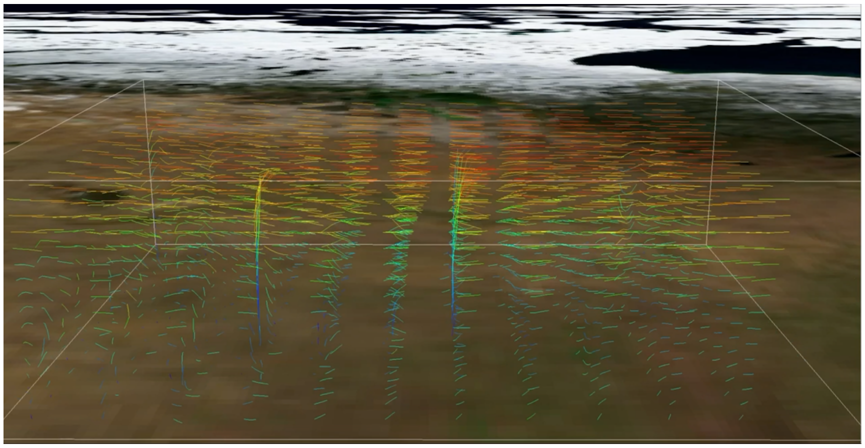

Fig. 3: Unidata IDV

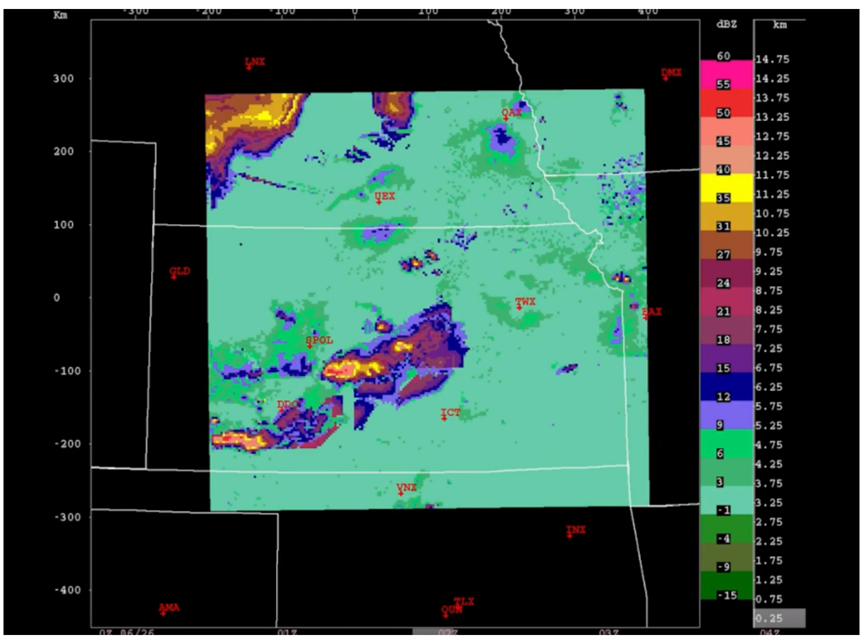

Fig. 4: XTerm

Results

The results were that the air from the storm originated from ground level (typical of a normal ECS) mostly from the remains of the previous storm that swept its way through a few hours earlier, but also from a certain ground area that (as seen in the graphic representations), likely due to thermal differences and imbalances causing buoyancy, shot a couple air parcels extremely quickly vertically, which mixed and conflicted with the moderate temperature air around it. This section's quick acceleration was quite unpredicted, and since it caused an elevated convective system, it just shows how a tiny bit of imbalance and air parcel movement can completely disrupt the larger scale of weather in a much larger area. The buoyancy of the air parcels that exhibited large upwards motion seen in Figure 1 show how sporadic air parcels can stir up turbulence and increase the lifted index.

Discussions / Conclusions

If this research were to be continued, one would study several more case studies of other examples of ECS to gain knowledge of the general type of storm rather than just one particular example. This would help one gain more knowledge on both the reliability of the data as well as the predictability of this type of severe weather.

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