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INITIATION OF DEEP CONVECTION ON MAY 24 AND JUNE 19, 2002 DURING IHOP

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1. INTRODUCTION

Airborne radar and lidar observations, dropsondes, and surface mesonet data are combined to document the initiation of convection on May 24 and June 19, 2002 during IHOP (International $H_2$0 Project). One of the primary objectives of IHOP was to focus all available platforms on convergence boundaries that were detectable by Doppler radars in the clear air. ELDORA (onboard a Navy P-3) flew elongated box-type patterns (75 – 80 km long) parallel to the boundaries in order to assess the along-frontal variability of the winds over a substantial distance. Each flight leg by the P-3 required approximately 15 min to complete. Rapid deployment of sondes (horizontal spacing approximately 25 km) from a LearJet flying perpendicular to the boundary provided kinematic and thermodynamic information on both sides of the boundary. In addition, vertical profiles of water vapor and aerosols were recorded on May 24 by the LASE lidar flown onboard the NASA DC-8.

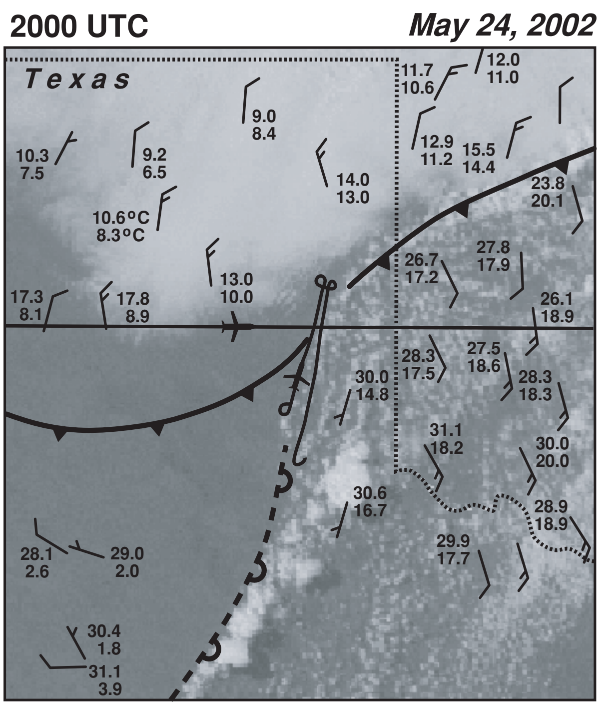

Fig. 1. Surface analysis at 2000 UTC 24 May 2002 superimposed onto a visual satellite image. The west-east and north-south lines represent the the DC-8 and P-3 flight tracks, respectively.

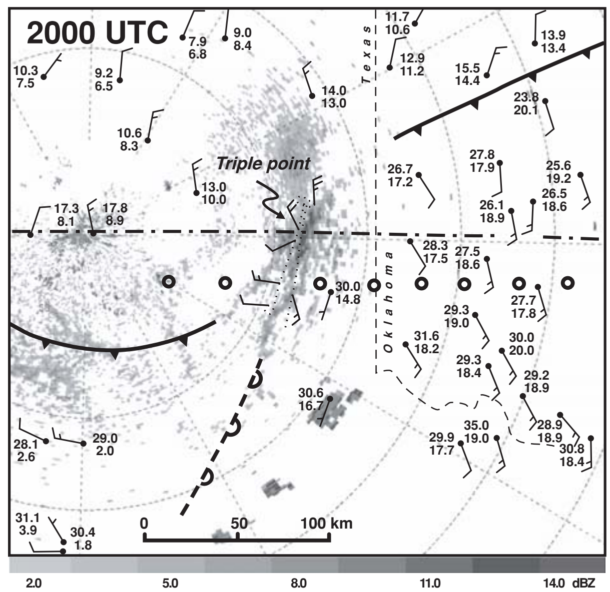

Fig. 2. Surface analysis at 2000 UTC 24 May 2002 superimposed onto a WSR-88D radar reflectivity image from Amarillo, Texas. The dashed and dotted lines represent the flight tracks of the DC-8 and P-3, respectively. The open circles represent the location of a series of dropsondes.

2. MAY 24, 2002

The case on May 24 is unique since it provided high-resolution data of the 'triple point' (the intersection between a cold front and dryline). A surface analysis superimposed onto a satellite image at 2000 UTC is shown in Fig. 1. The DC-8 flew directly over the triple point while the P-3 flew a box pattern around the dryline and triple point. The fine

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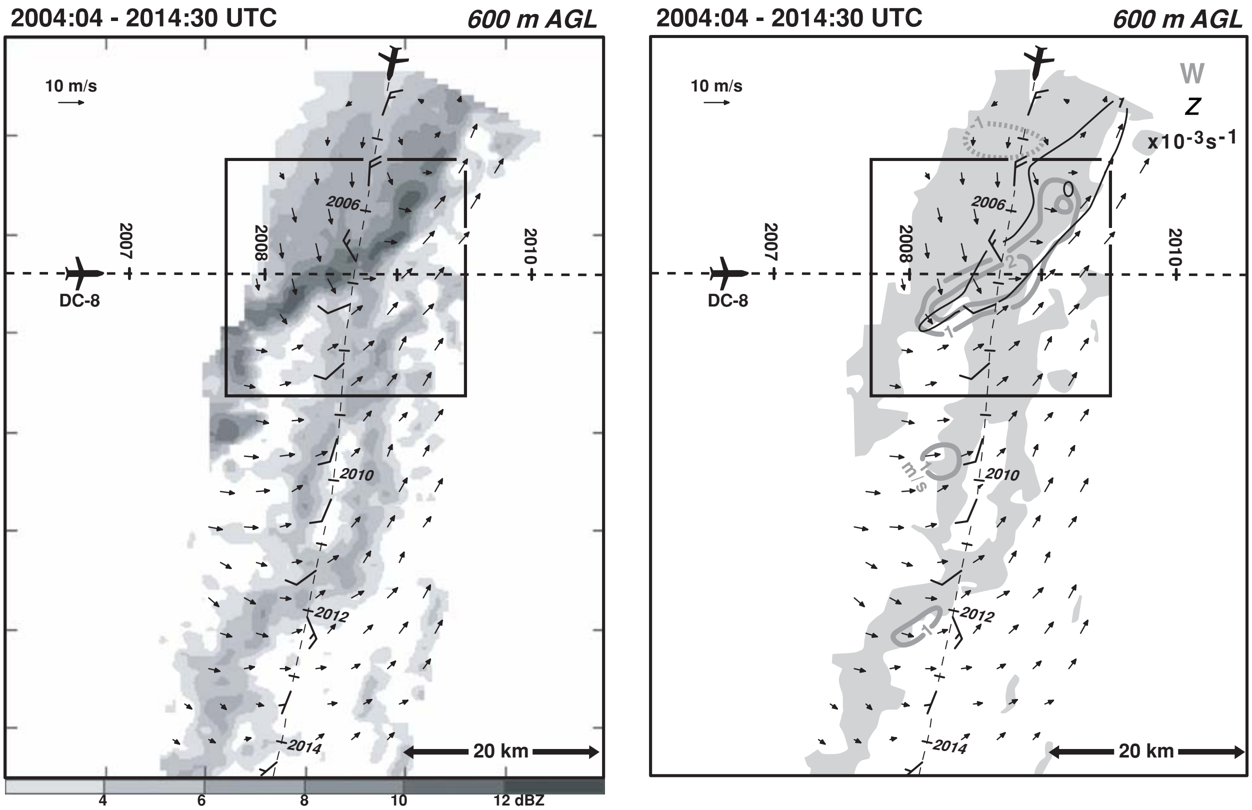

Fig. 3. Doppler wind synthesis for 2004:04 - 2014:30 UTC on May 24. The echoes stronger than 4 dBZ are shaded gray on the right. Vertical velocities and vorticity are shown on the right.

lines associated with the cold front and dryline are apparent in the Amarillo NEXRAD shown in Fig. 2.

A wind synthesis using ELDORA data is presented in Fig. 3. The dryline was characterized by a cellular structure and there were suggestions that two drylines existed simultaneously (see the fine line structure at 2010 UTC along the P-3 flight track). The winds north of the cold front were from a northerly direction while the winds shift from westerly (dry air) to southwesterly (moist air) across the dryline.

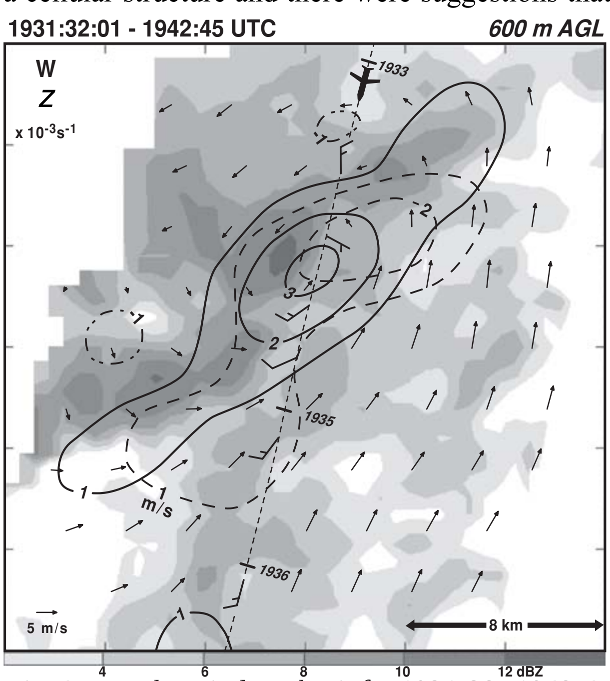

Fig. 4. Doppler wind synthesis for 1931:32 - 1942:45 UTC on May 24.

An earlier wind synthesis centered and enlarged at the triple point is shown in Fig. 4. A clear-air mesocyclone with a diameter of 30-40 km was observed at the triple point and was associated with vertical vorticity greater than 2 x $10^{-3}s^{-1}$ and updrafts >3 ms^{-1}. The origin of the circulation is currently under investigation.

Interestingly, the severe convection initiated ~50 km east of the dryline on this day. The LASE data combined with the thermodynamic information from the dropsondes (not shown but location of drops were indicated on Fig. 2) supports the location where convection first develops. The lidar detected both a moisture and aerosol plume in this region. The thermodynamic analysis revealed that the atmosphere located east of the dryline was associated with the largest potential instability.

3. June 19, 2002

Mobile IHOP platforms converged on a quasi-stationary dryline in northwest Kansas on June 19. Clear skies were quickly followed by cumulus congestus and thunderstorms along most of the line while numerous platforms collected data. The P-3 flew a box pattern along the fine line for several hours in order to document the kinematic changes to the dryline leading up to the initation of convection. One

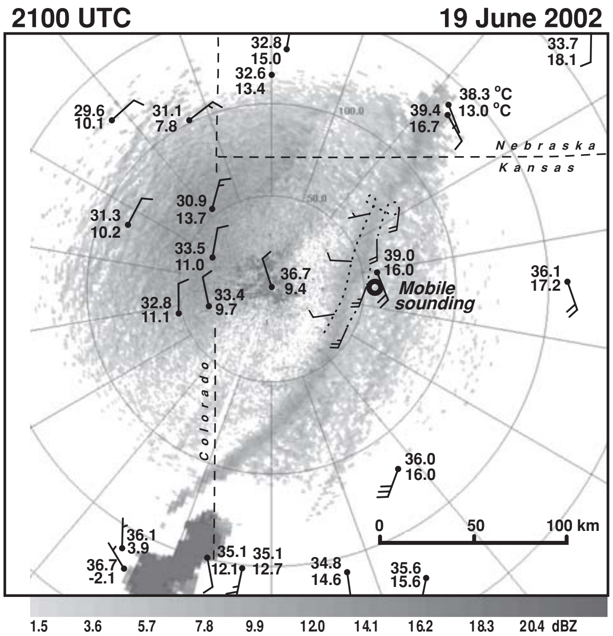

Fig. 5. Surface analysis and the P-3 flight track superimposed onto Amarillo WSR-88D radar reflectivity image at 2100 UTC.

of the box patterns is shown superimposed on a WSR-88D reflectivity image at 2100 UTC.

A wind synthesis based on ELDORA during the first pass (Fig. 6) revealed speed but little directional shear across the boundary. The dryline developed significant along-frontal variability later in the day as the first precipitation echoes began to form (Fig. 7). Misocyclones (small-scale cyclonic circulations less than 4 km with vertical vorticity $>2\times10^{-3}s^{-1}$) with horizontal spacing of ~10 km developed as shown in the figure and several tornadic-like vortices were visually observed by scientists from the ground and the aircraft.

The time evolution of at least one 'break' (i.e., a small segment where no fine line was detected by the radar) in the horizontal structure of the fine line was documented (not shown). In addition, plumes/parcels of clear-air echoes (owing to insects) were seen originating from the fine line and being carried aloft into the weak-echo vault of the developing storms. A vertical cross section of equivalent potential temperature perpendicular to the cold front (not shown) revealed that the entire region was potentially unstable, however, the storms initiated at the leading edge of the dryline owing to forced uplift.

Future plans include incorporating horizontal water vapor fields retrieved from a French DIAL system referred to as LEANDRE II.

Acknowledgements: Research results presented in this paper were supported by the National Science Foundation under Grants ATM-9912097 and ATM-9901688. LASE measurements during IHOP were supported by NASA

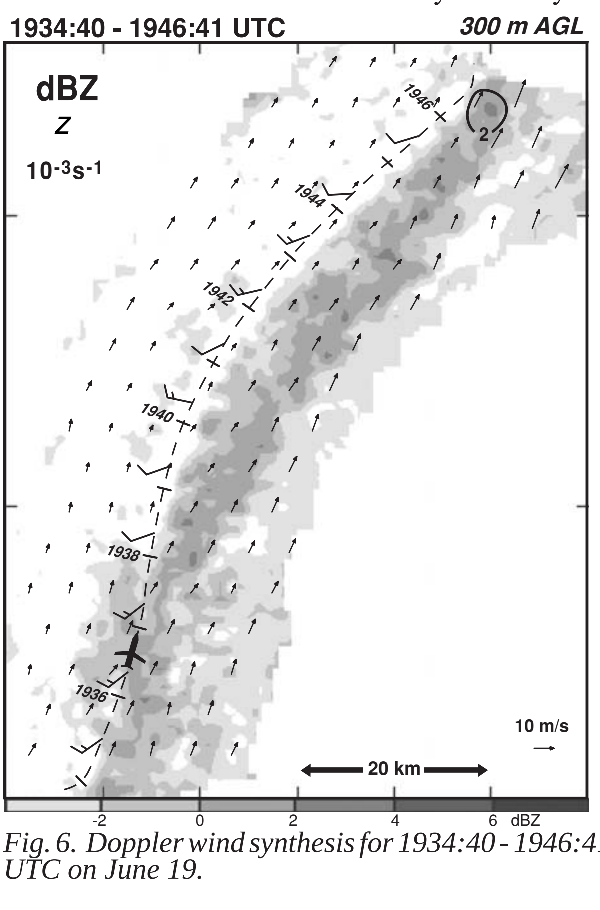

Fig. 6. Doppler wind synthesis for 1934:40 - 1946:41 UTC on June 19.

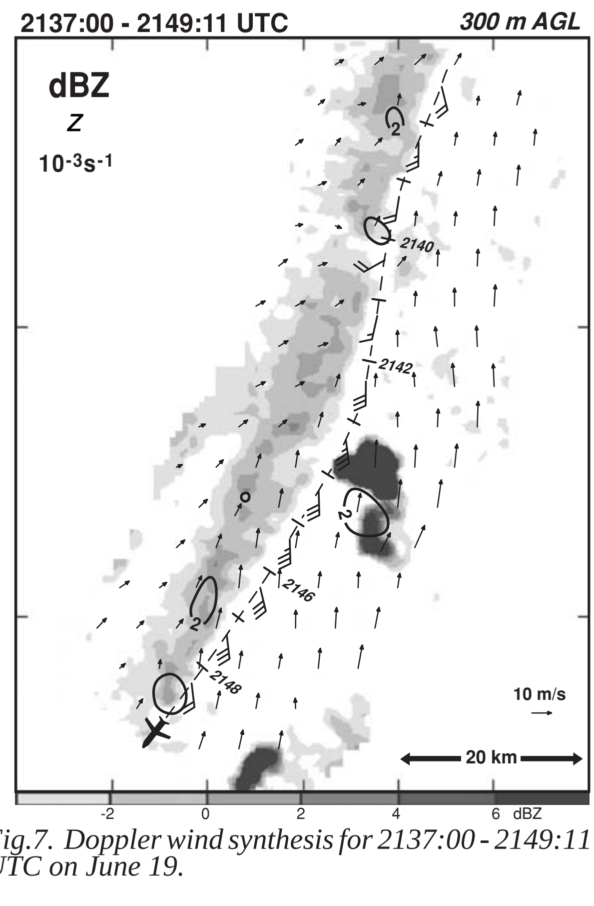

Fig.7. Doppler wind synthesis for 2137:00 - 2149:11 UTC on June 19.