1.B1 OBSERVATIONS FROM THE BOW ECHO AND MCV EXPERIMENT (BAMEX)

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1. Introduction

The Bow Echo and MCV Experiment (BAMEX) was a study using highly mobile platforms to examine the life cycles of mesoscale convective systems. It represented a combination of two related programs to investigate (a) bow echoes (Fujita, 1978), principally those which produce damaging surface winds and last at least 4 hours and (b) larger convective systems which produce long lived mesoscale convective vortices (MCVs) (Bartels and Maddox, 1991). MCVs can focus new convection and play a key role in multi-day convective events affecting a swath sometimes more than 1000 km in length with heavy to perhaps flooding rains. The main objectives regarding bow echoes were to understand and improve prediction of the mesoscale and cell-scale processes that produce severe winds. For MCV producing systems the objectives were to understand MCV formation within MCSs, the role of MCVs in initiating and modulating convection, the feedback of convection onto MCV intensity, and to improve the overall predictability of the vortex-convection coupled system.

http://www.atd.ucar.edu/dir_off/projects/2003/BAMEX.html

BAMEX utilized three aircraft, two equipped with dual Doppler radar capability, the third equipped with dropsondes, to map the mesoscale evolution of long-lived MCSs including the development of mesoscale vortices and rear-inflow jets. Dropsondes were used to document environmental structure, thermodynamic structure of the stratiform region (where rear-inflow jets and MCVs reside) and to capture the structure of mature MCVs in the absence of convection. In addition, a mobile array of ground-based instruments were used to document the thermodynamic structure of the PBL, including any existing convergence boundaries, probe the surface cold pool, and measure surface horizontal pressure and wind variations behind the leading convective line. The combination of aircraft and ground-based measurements is important for understanding the coupling between boundary-layer and free-tropospheric circulations within MCSs, and, in particular, how the rear-inflow penetrates to the surface in nocturnal severe wind cases.

2. Observing Strategies

The objective of the multiple aircraft coordinated flights of a mature bow-echo MCS was to map as much of the MCS circulation and structure as possible in the shortest time. The basic flight strategy for all three BAMEX aircraft is shown in Figure 1. To summarize:

- *NRL P-3:* The rapid scanning capability of the Electra Doppler Radar (ELDORA), relative to the NOAA P-3 tail radar, made it most suitable to observe the convective cores within the line. The NRL P-3 remained ahead of the line (i.e., generally to the east of an eastward moving line) and flew patterns roughly parallel to the line. Leg lengths were 50-125 km at an altitude around 1.5 km MSL. Where practical the legs of the NRL P-3 were synchronized with the legs of the NOAA P-3 for collecting "quad-Doppler" data or simultaneous observations of common points.
- *NOAA P-3:* The primary responsibility of the NOAA P-3 is to map the region to the rear (i.e., to the west) of the convective

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10. NSSL and University of Washington, Seattle
11. Purdue University, W. Lafayette, IN
12. UCLA, Los Angeles, CA

line. The typical altitude for this aircraft was 10,000 ft. Spiral ascent/descent patterns were occasionally flown to collect microphysical data.

☐ *Lear Jet:* The WMI Lear jet typically flew at nearly 40,000 feet and for 3-4 h. The jet sampled the environment ahead of MCSs and the stratiform region containing vortices and the rear-inflow current.

In addition to the aircraft, a mobile ground based observing system (GBOS) was forward deployed throughout the project. The GBOS included:

☐ *MIPS:* The University of Huntsville Mobile Integrated Profiling System, which contained a Doppler sodar, 915 MHz wind profiler, radiometer and ceilometer. Sounding capability was added to MIPS for BAMEX.

☐ *MGLASS:* Two Mobile GPS Loran Atmospheric Sounding Systems

☐ *Mobile Probe:* a vehicle instrumented to measure standard atmospheric parameters.

Typically the GBOS were deployed along a line parallel to an approaching MCS with MIPS in the middle. MGLASS were located on either side of any boundaries that existed ahead of the MCS. For MCVs, the GBOS deployed in a triangle on the downshear side so that the soundings from the triangles could be used to compute vertical motion.

At the time of the writing of this manuscript, a total of 8 intensive observing periods (IOPs) had occurred. The mission type(s) associated with each IOP are shown in Table 1. There were five mesoscale convective vortices sampled, on 24 May, 2 June, 5 June, 10 June and 11 June (IOPs 1, 4a and 5, 7b and 8). One MCV was particularly well sampled on 24 May. In Fig. 3 we show a plan view of the horizontal wind and temperature data from the dropsondes deployed by the Lear jet. The soundings covered the area of the MCV precipitation shield and delineated the vortex circulation well.

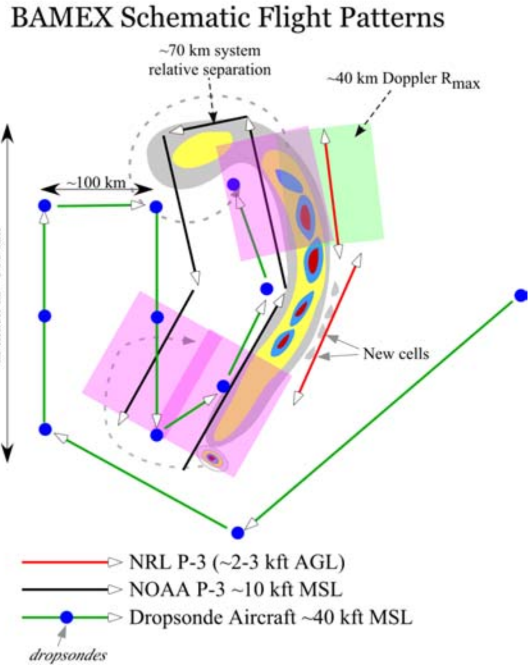

Figure 1. Schematic depiction of idealized flight patterns for the NRL P-3 (red lines with arrows), NOAA P-3 (black lines with arrows), and the dropsonde jet (green lines with arrows). Background field is radar reflectivity based on observations of bow-echoes. Shaded regions illustrate typical coverage by the tail Doppler radar systems of ELDORA (green area) and the NOAA P-3 system (magenta areas). Dashed lines with arrows indicate typical mid-level line-end vortices sometimes seen with bow-echoes.

In IOPs 2 and 3, the MCS formed in the area of Illinois and Indiana and featured a downshear tilt during most of its life cycle. During IOP-3, numerous tornadic supercell thunderstorms formed ahead of a cold front moving eastward through Illinois. The collective anvils from these storms congealed into a leading stratiform region and a quasi-steady structure persisted for 2-3 h. The convective available potential energy (CAPE) was minimal. There were no NWS soundings that showed significant CAPE, even those launched at 2100 UTC (1600 CDT). Only with the high-resolution dropsonde sampling did a longitudinally thin corridor of small CAPE (a maximum of 1200 J/kg) become apparent on the south side of the line.

IOPs 4 and 6 featured highly linear convective lines, along which small bowed segments, each associated with strong rear-inflow, periodically formed. The bowed structures were typically 20-30 km along the line. Rear inflow jets within these features were observed to exceed 25-30 m/s.

IOP 7a featured a severe nocturnal bow echo forming in eastern Nebraska, moving southeastward over Missouri. Most of the damaging wind was confined to eastern Nebraska and extreme western Iowa. Rear inflow jets of 40 m/s were observed in this case. CAPE was high (~3000 J/kg for the

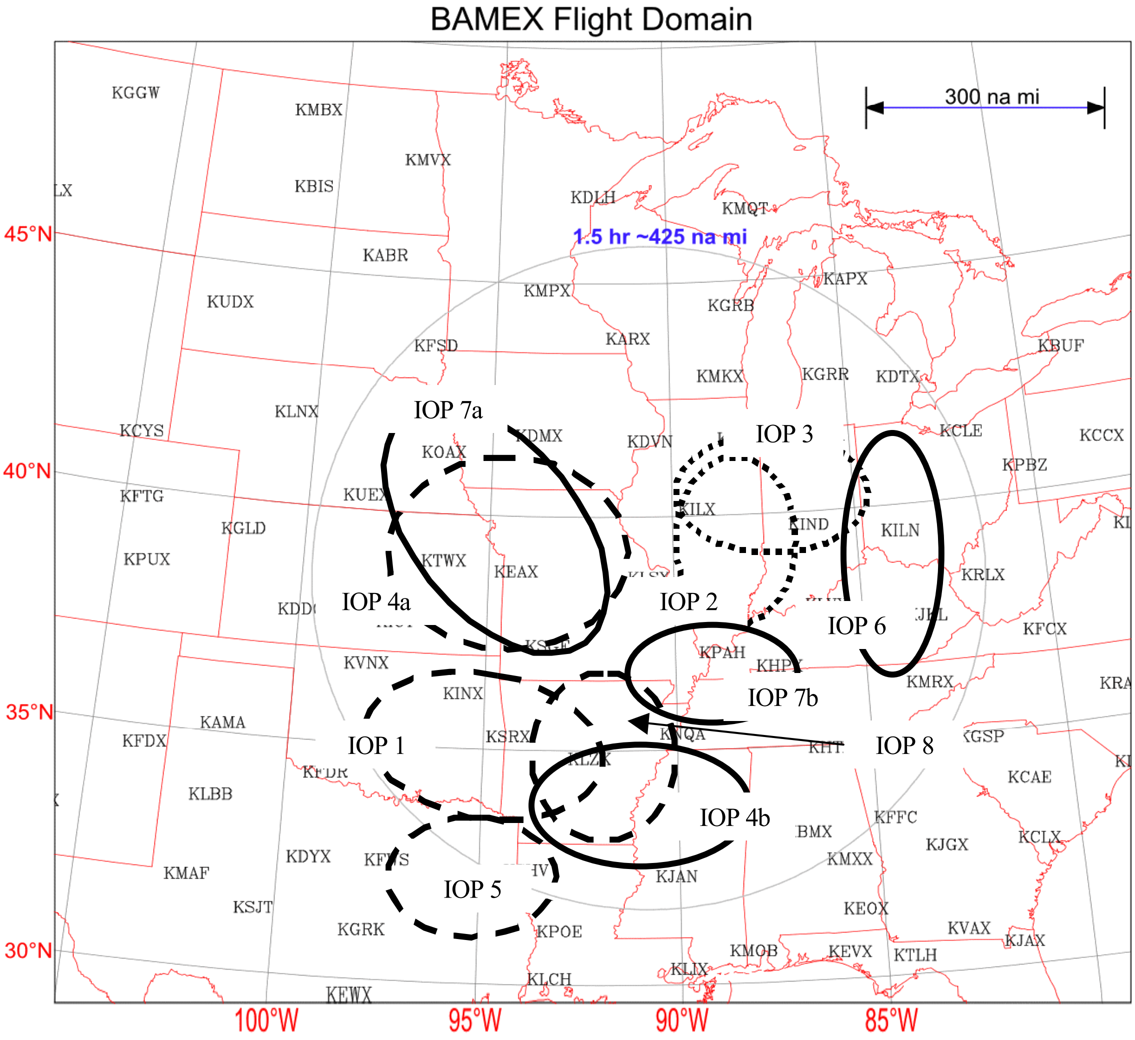

Figure 2. BAMEX domain (large, thin circle) and approximate areas covered by each IOP. Broken ellipses indicate MCV missions, dotted circles indicate leading stratiform MCSs and solid lines indicate trailing stratiform MCSs.

first time during the project.

Additional cases from BAMEX will be summarized at the conference.

Acknowledgments

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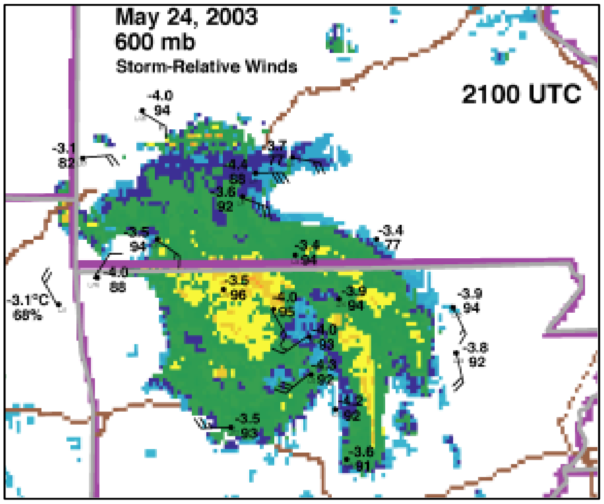

Figure 3. Composite reflectivity and 600 mb dropsonde data, corrected for storm motion and with system relative winds shown for 2100 UTC 24 May. Also plotted are temperatures and relative humidity.

IOP	Non-bow-echo MCS	Mature MCV	Forming MCV	Weak-Mod. Bow Echo	Strong Bow Echo
1 24 May		X			
2 28 May	X			X (tail end of event)	
3 30 May	X				
4 2 June		X		X (small-scale bows)	
5 5 June		X (retriggering)	X (uncertain)		
6 8 June	X				
7 9-10 June	X		X	X	
8 11 June		X (retriggering)			

Table 1. List of IOPs during first half of BAMEX and major foci of each.