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Session II. Case Study

N91-24171

Model Comparison of July 7, 1990 Microburst
Dr. Fred Proctor, MESO

THIRD COMBINED MANUFACTURERS' AND TECHNOLOGISTS'
AIRBORNE WIND SHEAR REVIEW MEETING

THREE DIMENSIONAL NUMERICAL SIMULATION OF THE 7 JULY 1990 ORLANDO MICROBURST

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7 JULY 1990 ORLANDO, FL SIMULATIONS

INPUT DATA / ASSUMPTIONS

SOUNDING OBSERVED APPROX. 2 HRS BEFORE STORM (FROM SPECIAL RAWINSONDE LAUNCH 1655Z)

LOW-LEVEL WINDS MODIFIED USING AIRCRAFT MEASUREMENTS TAKEN NEAR THE TIME AND LOCATION OF THE STORM

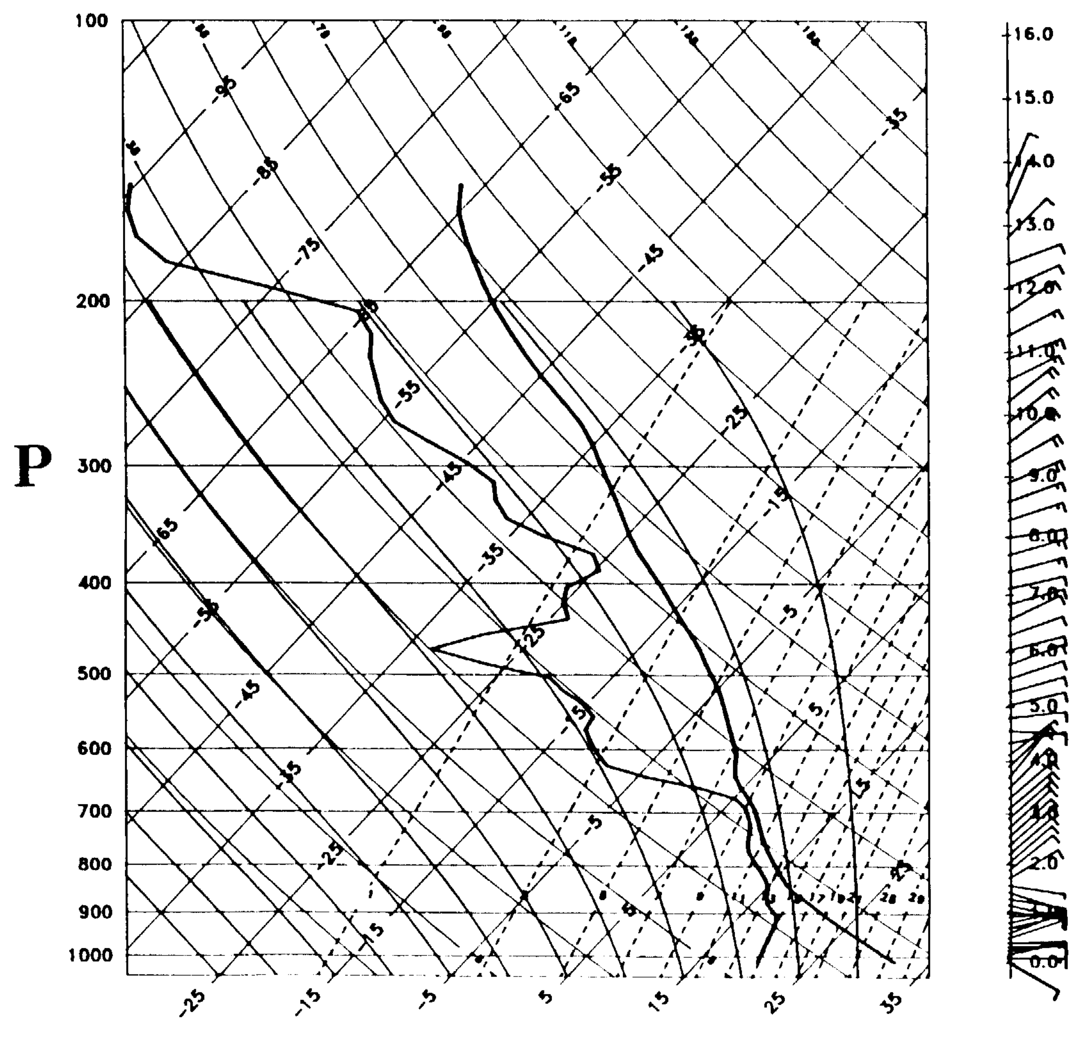
COMPUTATIONAL RESOLUTION

- HORIZONTAL - 125 M (103 X 103 GRID POINTS)
- VERTICAL - 70 M NEAR GROUND STRETCHING TO 420 M AT 14 KM (62 LEVELS)

PHYSICAL DOMAIN SIZE

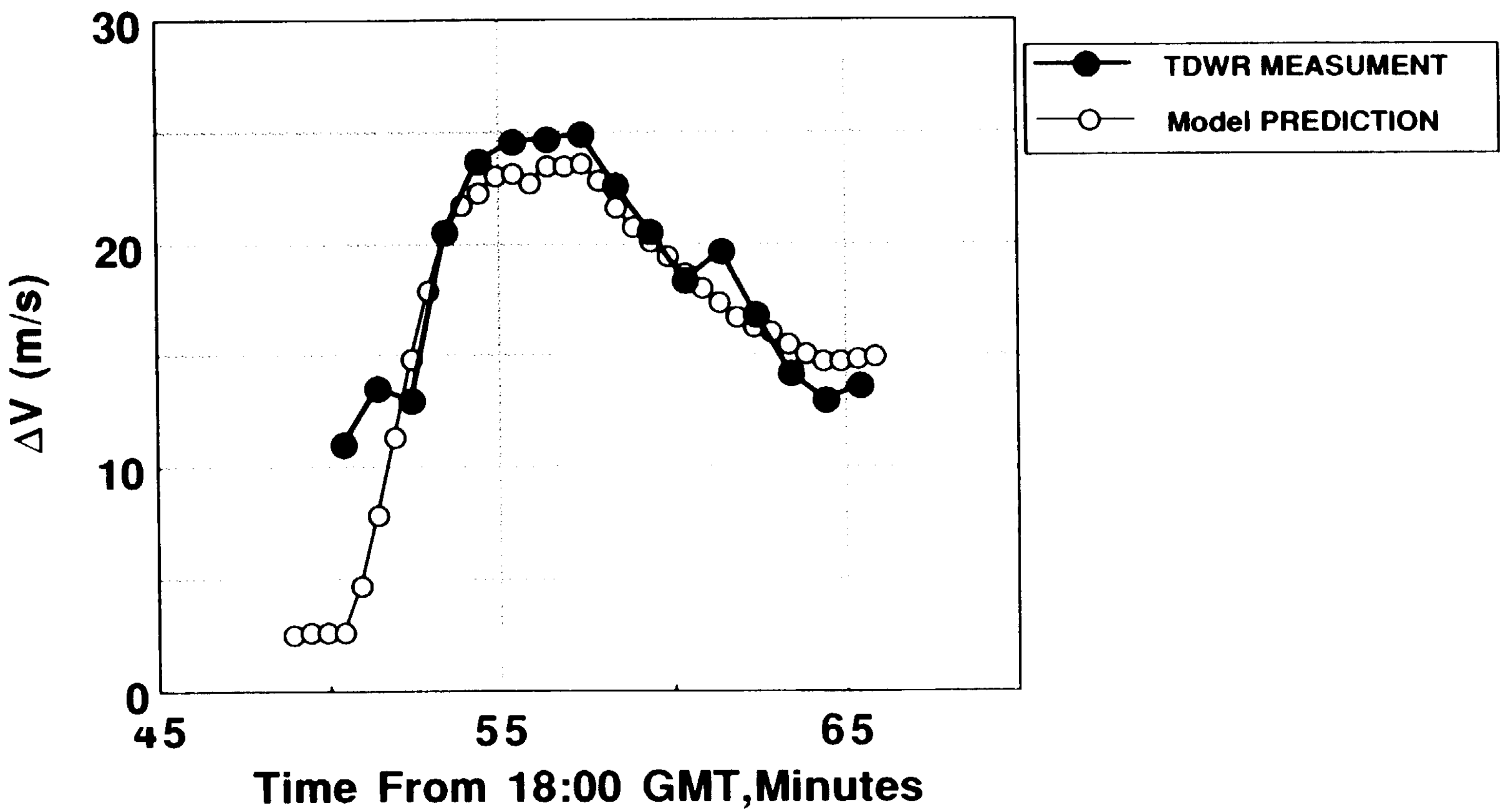
- SPHEROIDAL THERMAL IMPULSE
- DIMENSIONS - 5 KM HORIZONTAL x 1.5 KM VERTICAL
- AMPLITUDE - 1.5° C

MODEL INPUT SOUNDING FOR 7 JULY 90 ORLANDO CASE



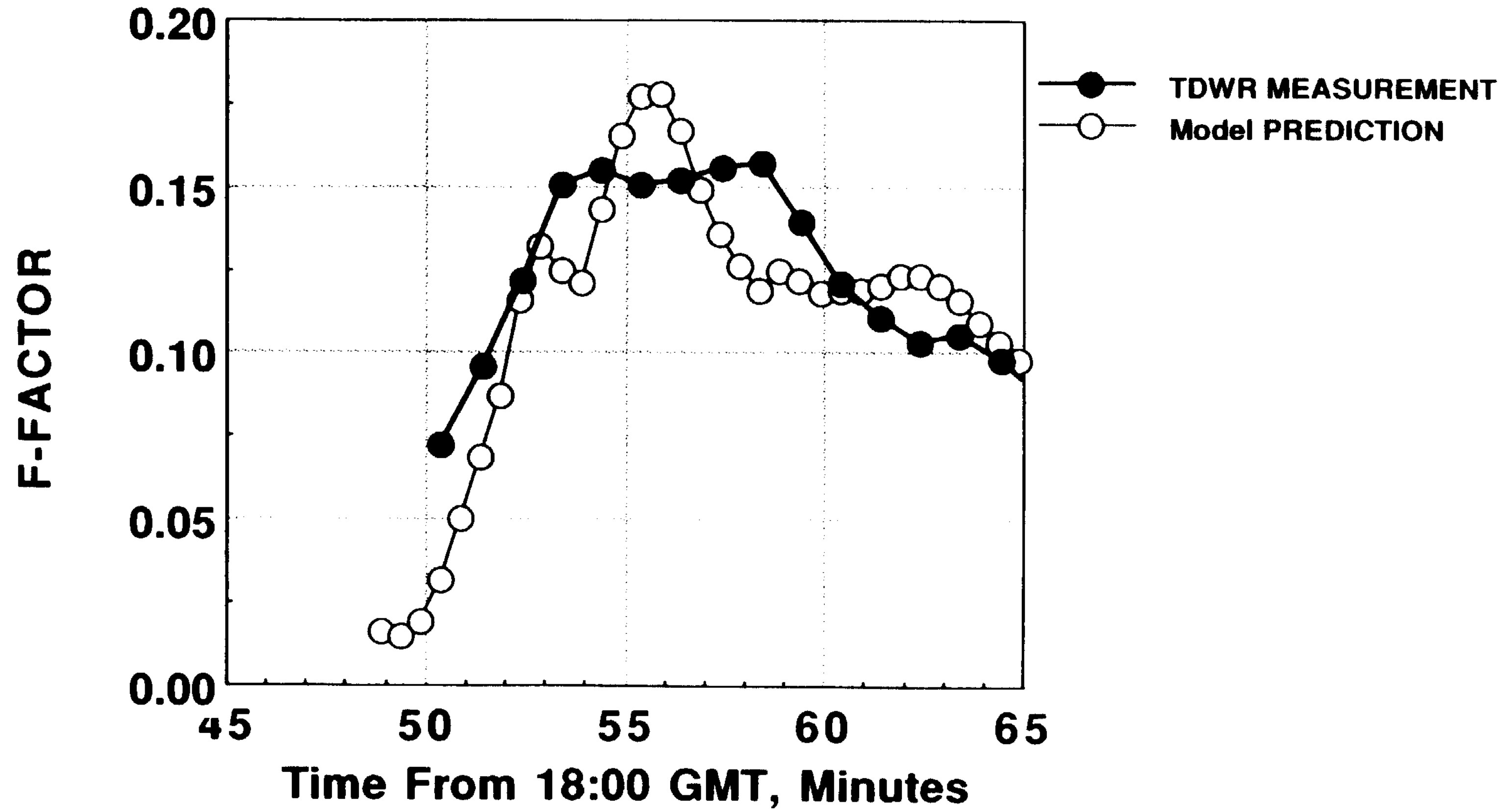
7 JULY 1990 ORLANDO MICROBURST

DIFFERENTIAL OUTFLOW COMPARISON BETWEEN DOPPLER RADAR DATA AND NASA MODEL SIMULATION



7 JULY 1990 ORLANDO MICROBURST

F-FACTOR COMPARISON BETWEEN DOPPLER RADRR DATA AND NASA MODEL SIMULATION



COMPARISON OF SIMULATED AND OBSERVED CHARACTERISTICS OF MICROBURST EVENT

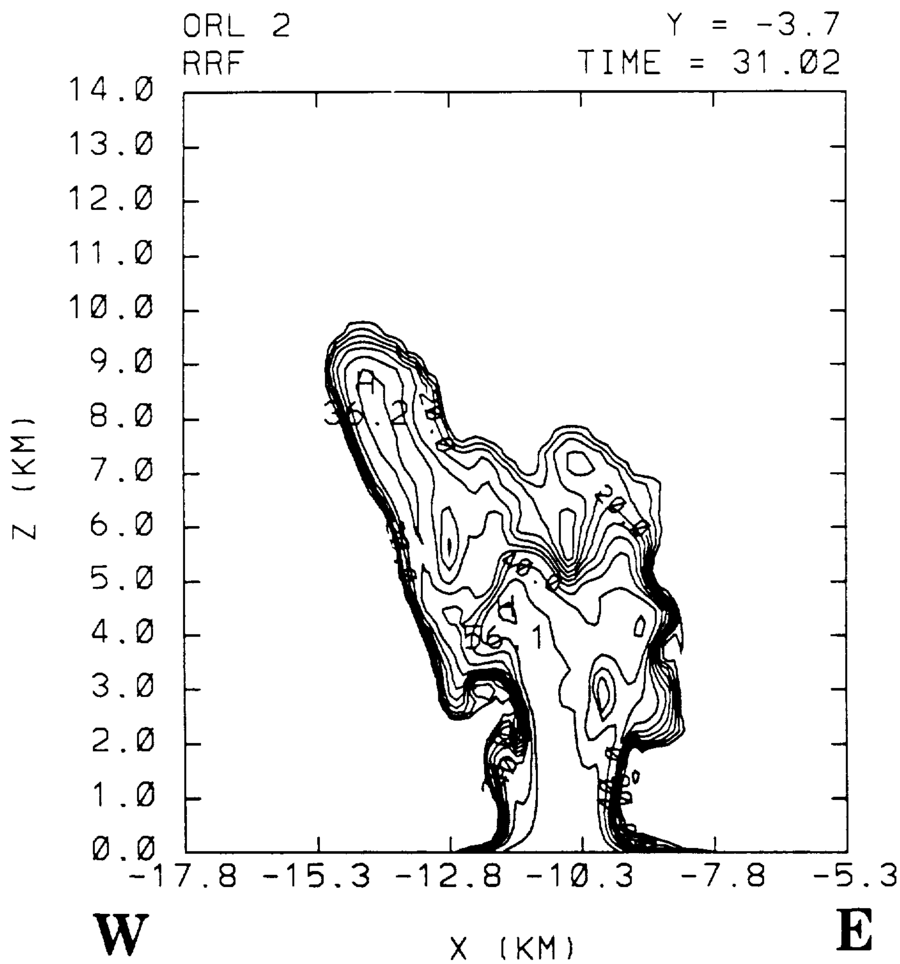
	SIMULATED	OBSERVED
MAXIMUM N-S DV	23.6 m/s at 1856:30	24.9 at 1857:25
MAXIMUM (1-km averaged) F-FACTOR	.178 at 1855	.168 at 1857:25
STORM TOP	10.5 km at 1857	10 km at 1855
PEAK RADAR REFLECTIVITY	57.6 dBZ at Z= 5 km & 1847	68 dBZ at Z = 5 km &1846
PEAK RAINFALL RATE	5.64 in/hr at 1856	7.80 in/hr at 1857
MAXIMUMTEMPERATURE DROP	-10.4°C at 1900:30	-11.5°C at 1901

MODEL TIME CONVERSION
1850 GMT = 25 MIN MODEL TIME

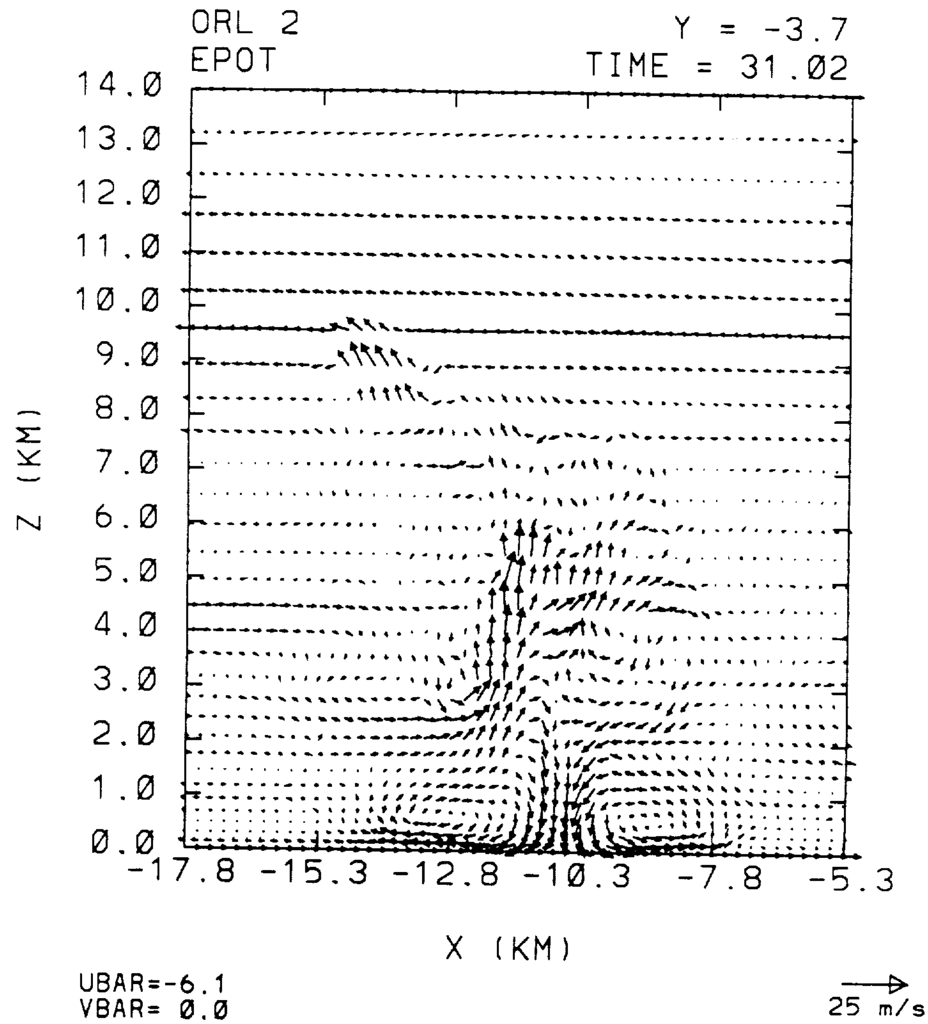
COMPARISON OF SIMULATED AND OBSERVED CHARACTERISTICS OF MICROBURST EVENT CONTINUED

	SIMULATED	OBSERVED
PEAK LOW-LEVEL WIND GUST	20.2 m/s at 1855	12 m/s at 1855
TIME PRECIPITATION FIRST MEASURED AT GROUND	1848:51	1848
STORM TRANSLATION 18:28 - 18:55 GMT	(u, v) = -6.1, -2.3 m/s	(u, v) = -7.4, -2.4 m/s

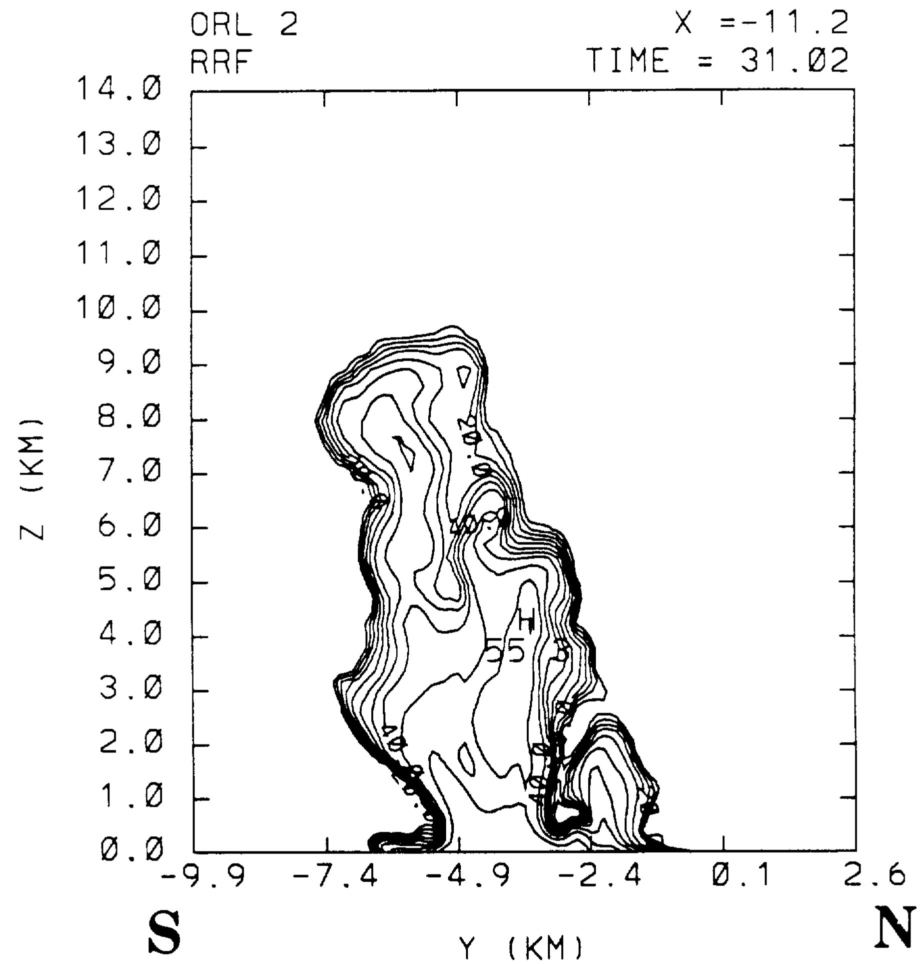
MODEL TIME CONVERSION
1850 GMT = 25 MIN MODEL TIME



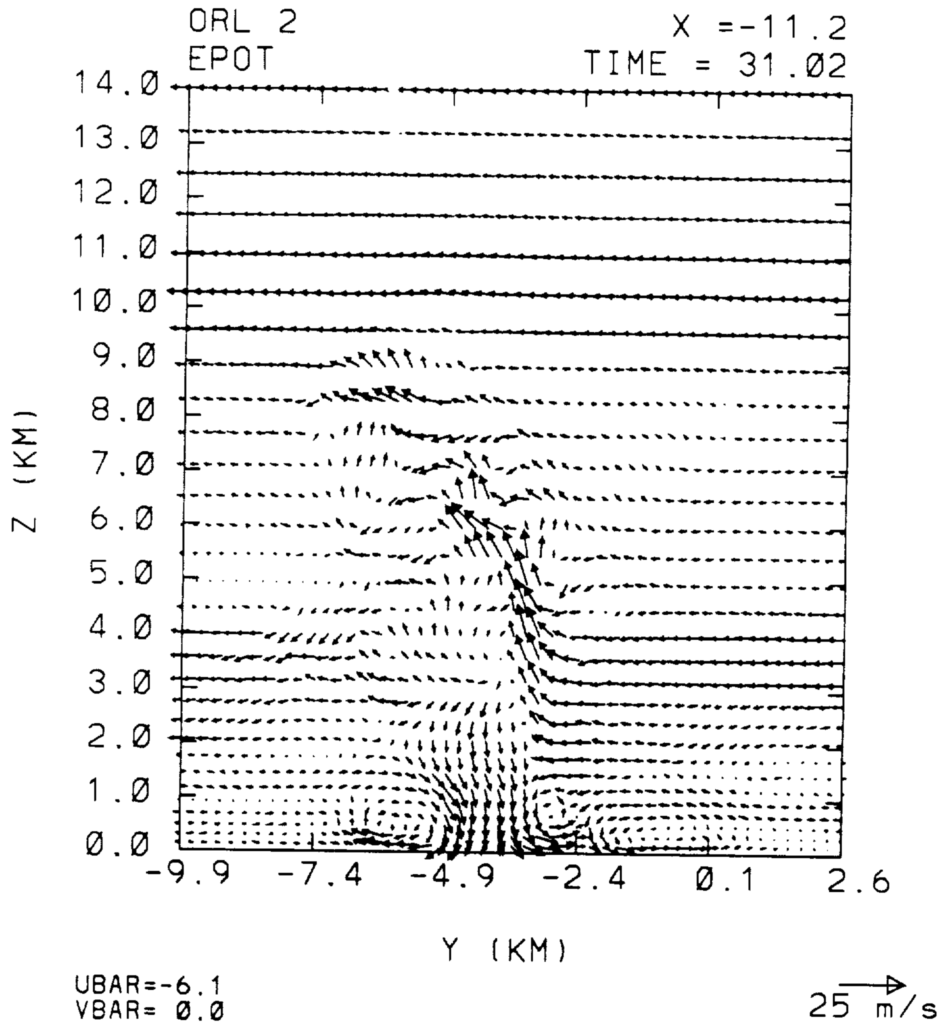
SIMULATED EAST - WEST CROSS SECTION
RADAR REFLECTIVITY (CI = 5 dBZ)



SIMULATED EAST-WEST CROSS- SECTION STORM RELATIVE WIND VECTOR



SIMULATED NORTH - SOUTH CROSS SECTION
RADAR REFLECTIVITY (CI = 5 dBZ)

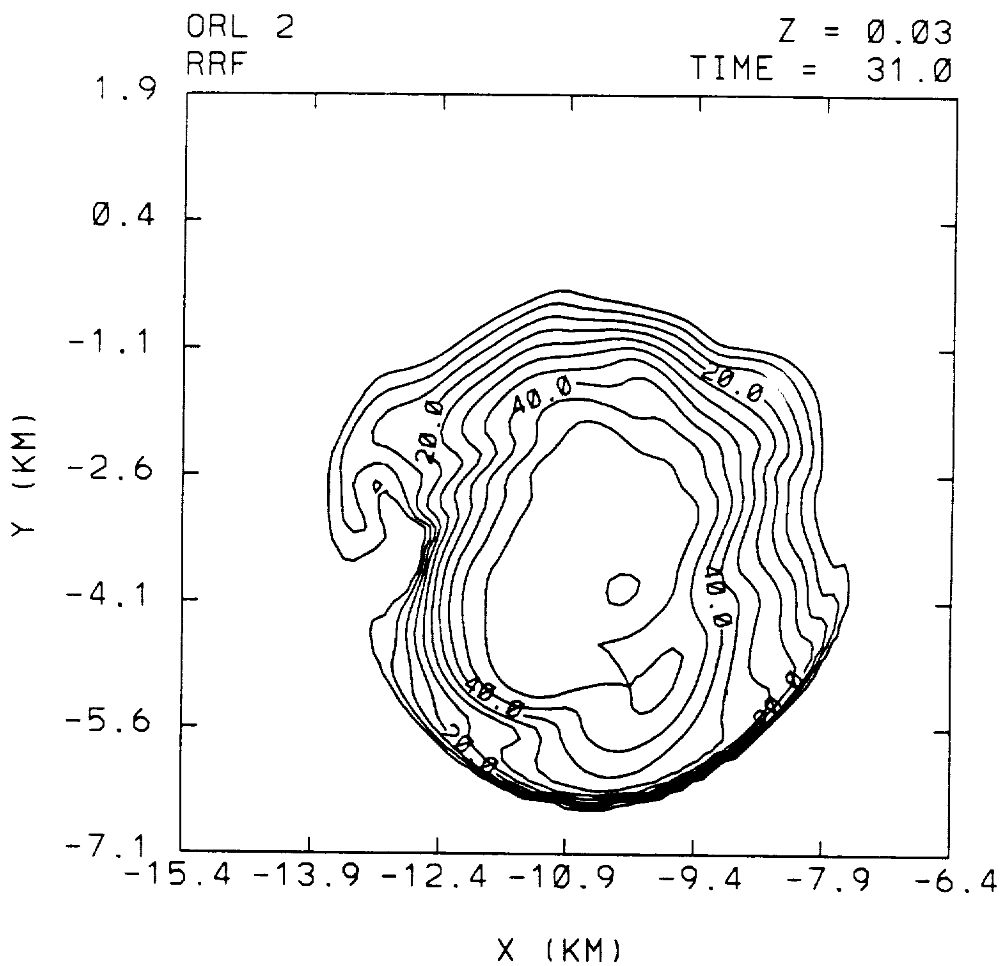


SIMULATED NORTH - SOUTH CROSS SECTION
STORM RELATIVE WIND VECTORS

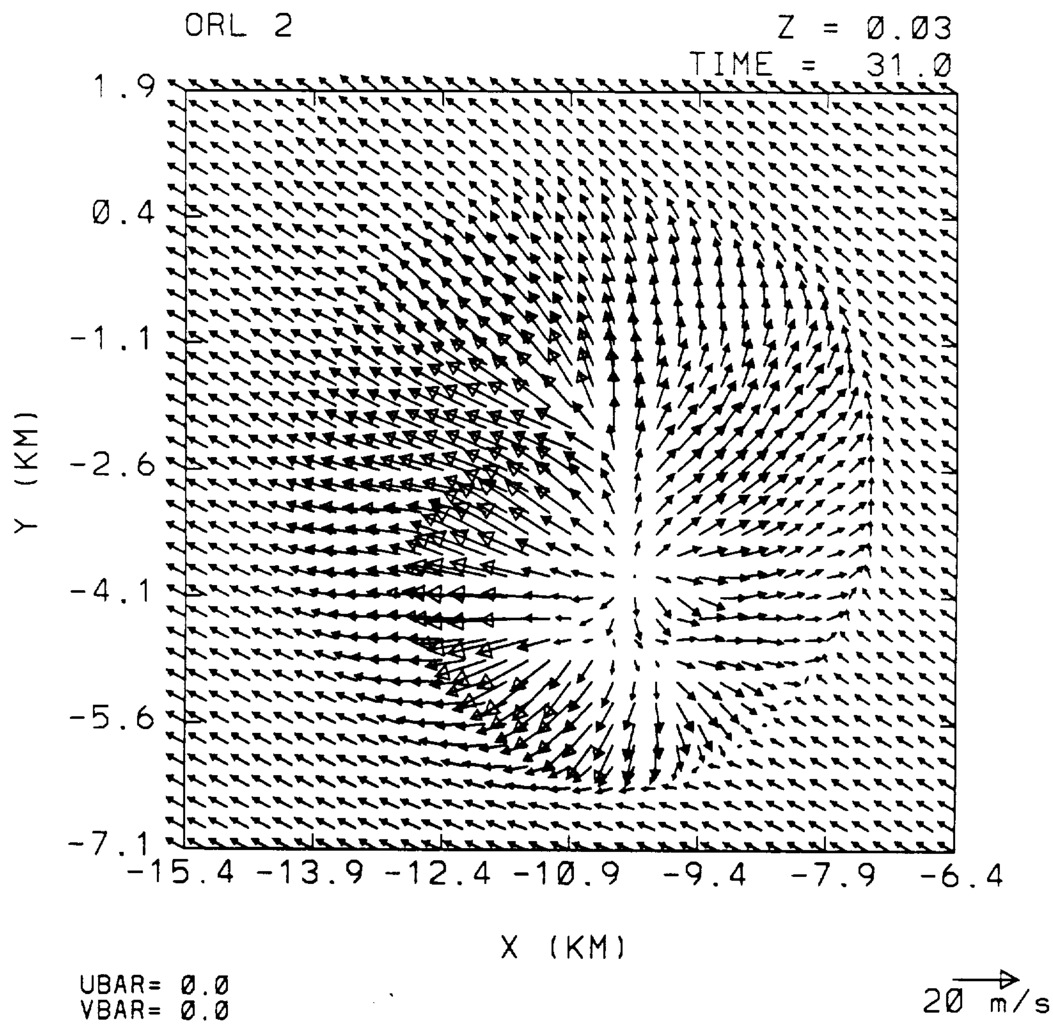
7 JULY 1990 ORLANDO MICROBURST SIMULATION

UNIQUE FEATURES

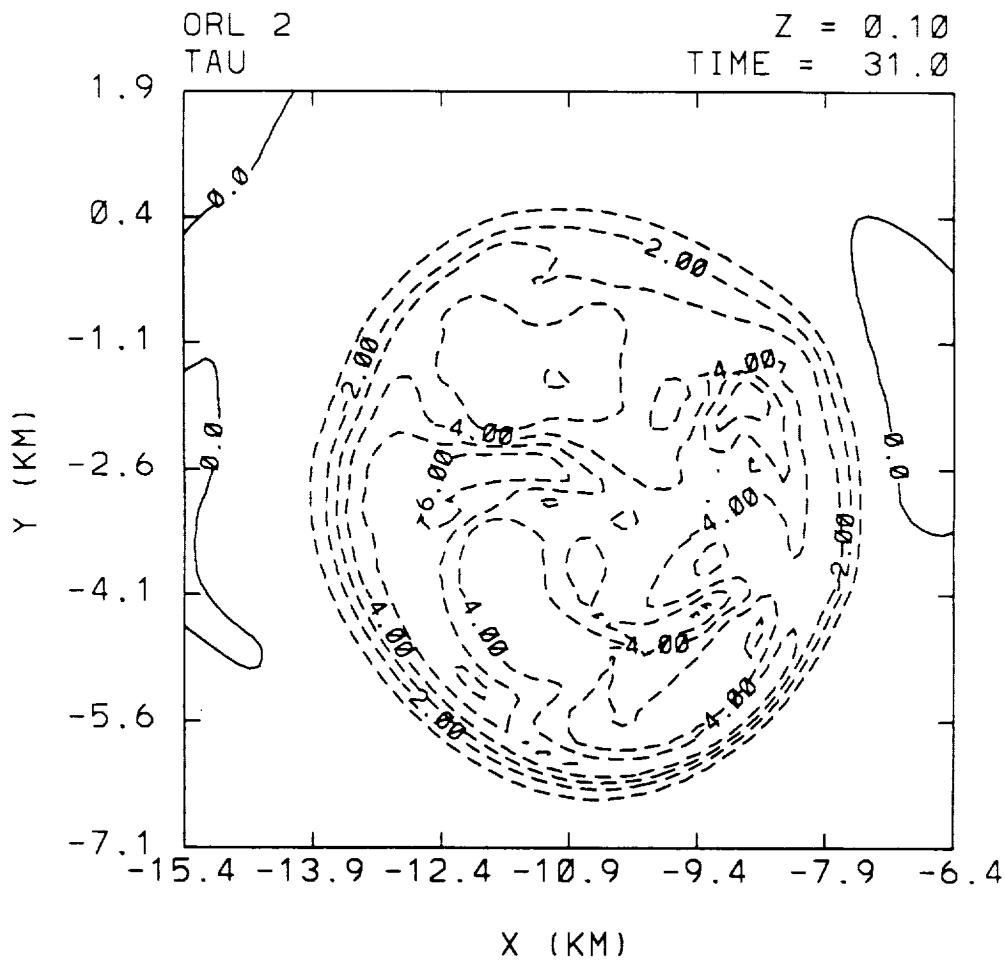
- O MULTIPLE DOWNDRAFT CENTERS
  - 4 MAJOR CENTERS -
- O NON CLASSIC F-FACTOR FIELD
  - PERFORMANCE INCREASING AREAS EMBEDDED WITHIN OUTFLOW (CONFIRMED FROM AIRCRAFT) -
- O F-FACTOR COMPUTED FROM PEAK ∇V RESULTS IN UNDERESTIMATE



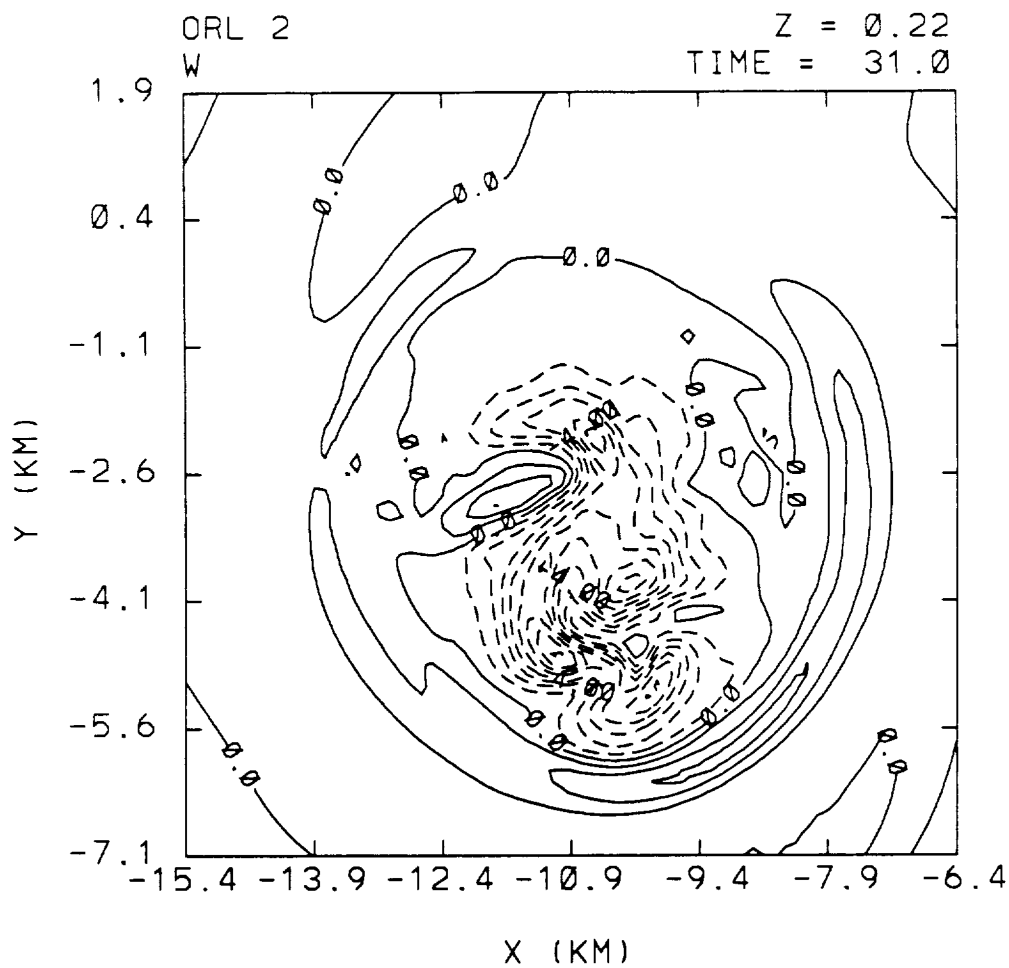
SIMULATED RADAR REFLECTIVITY AT 30 M AGL, CI = 5 DBZ



SIMULATED HORIZONTAL WIND VECTORS AT 30 M AGL

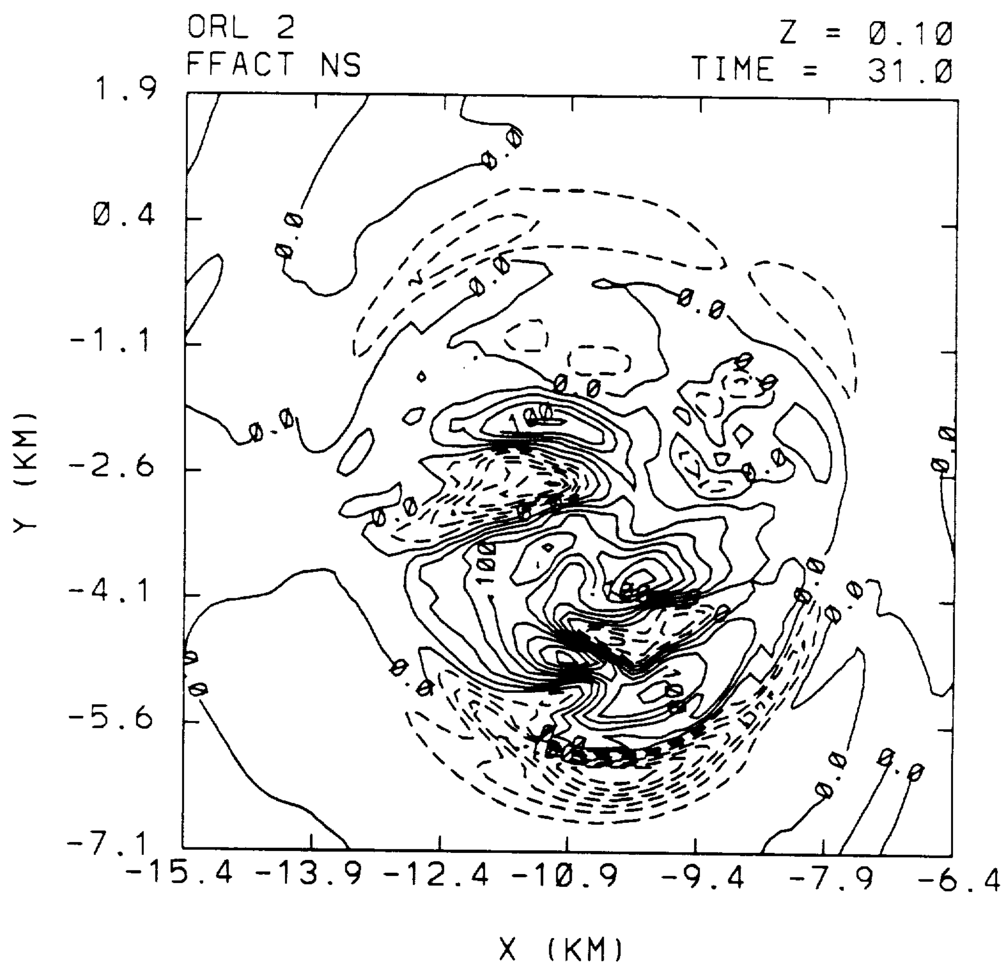


SIMULATED TEMPERATURE DEVIATION AT 100 M, CI = 1 ° C



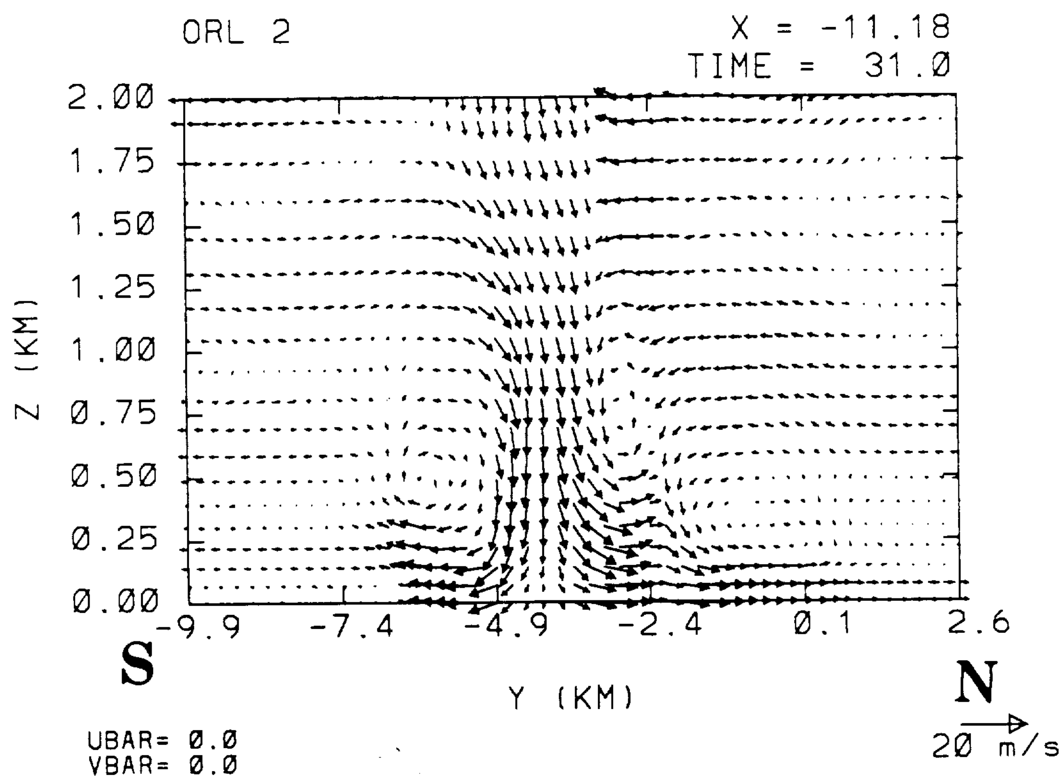
SIMULATED VERTICAL VELOCITY AT 220 M AGL CI = 1 M / S

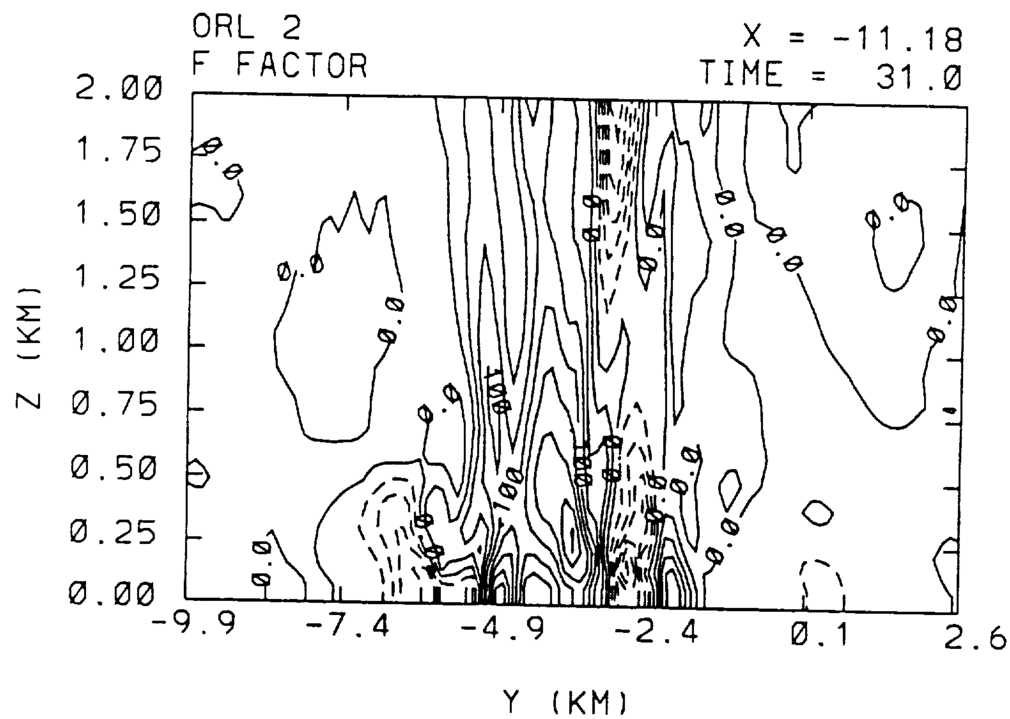
C-2



SIMULATED F-FACTOR AT 100 M AGL, CI=.025
(ASSUMES LEVEL FLIGHT PATHS ALONG NORTH SOUTH TRAJECTORIES)

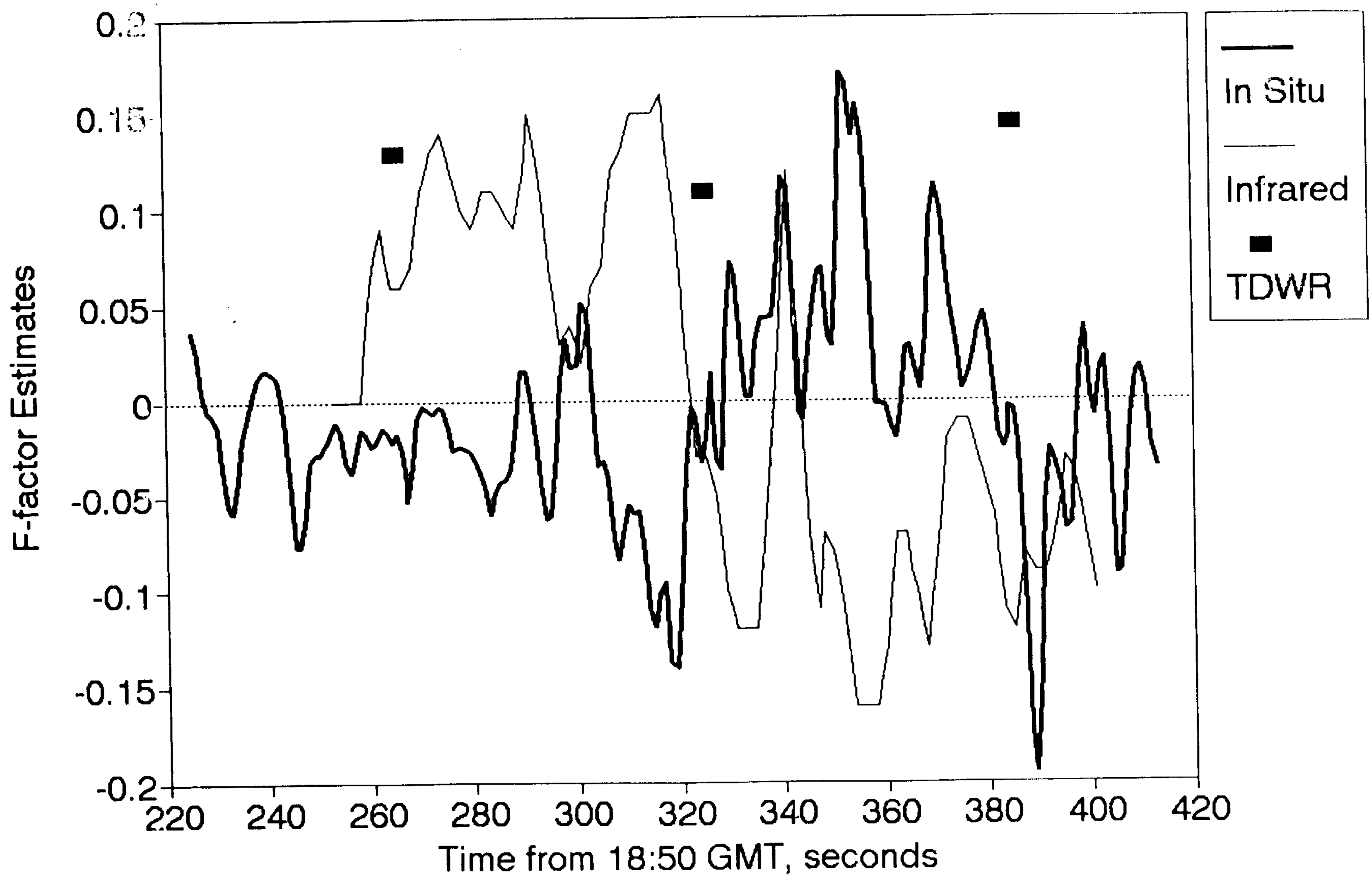
SIMULATED NORTH - SOUTH CROSS SECTION WIND VECTORS





NORTH-SOUTH VERTICAL CROSS SECTION OF SIMULATED F-FACTOR, CI=.025

(ASSUMES LEVEL FLIGHT PATHS ALONG NORTH SOUTH TRAJECTORIES)



CITATION AIRCRAFT IN SITU F-FACTOR ANALYSIS PENETRATION OF THE 7 JULY ORLANDO MICROBURST

SUMMARY

- O WET MICROBURST WITH HAZARDOUS WIND SHEAR

- O GOOD AGREEMENT BETWEEN SIMULATION AND OBSERVATION OF EVENT

- O COMPLEX MICROBURST STRUCTURE:
  1. MULTIPLE DOWNDRAFT CENTERS
  2. AREAS OF UPWARD MOTION EMBEDDED WITHIN OUTFLOW
  3. NON CLASSIC OUTFLOW AND F-FACTOR PROFILES

- O PEAK ΔV OF 28.7 M/S ALONG EAST-WEST SEGMENT VS. 23.6 M/S ALONG NORTH-SOUTH SEGMENT

- O TEMPERATURE DROP OF $\sim 6^{o}$ C AT TIME OF MICROBURST PEAK INTENSITY CONFORMS WITH PEAK ΔV OF 28.7 M/S; HOWEVER LARGER TEMPERATURE DROPS OCCUR NEAR THE GROUND DURING THE DISSIPATION STAGE

- O PEAK VELOCITY CHANGE OCCURS $\sim$8 MIN AFTER PRECIPITATION FIRST REACHES THE GROUND

- O RAINFALL RATES EXCEED 5 IN/HR AND F-FACTORS EXCEED .15

Model Comparison of July 7, 1990 Microburst - Questions and Answers

Q: CLEON BITER (NCAR) - Is there a reference that discusses the rule of thumb relationship that relates microburst velocity change to temperature drop?

A: FRED PROCTOR (MESO) - Yes. Journal of Atmospheric Science, Volume 46, 1989, Page 2143. This relationship is, the peak velocity change in meters per second is equal to the 5 times the value of the peak temperature drop in degrees C. Now, note that the peak velocity change and the temperature drop do not necessarily occupy the same place. In other words, the velocity change could be at a different elevation and position than the temperature. But anyway, we conducted a series of experiments with the asymmetric TASS simulation to examine this relationship and found that it worked very well in a number of cases. Although it certainly had several exceptions, those being when there were stable layers present, or if there were dry microbursts, or microbursts which originated as sublimating snow. This relationship doesn't tend to hold in decaying microbursts. In the case of decaying microbursts, you can still maintain some very cold temperatures near the ground, especially right along the surface where your getting evaporation of rain from the wet ground, yet the velocity changes begin to decrease.

Q: PETER ECCLES (MITRE Corp.) - Your model showed a temperature drop of about 10.2° C but your summary slide showed a temperature change of 6° C. Why is there a difference?

A: FRED PROCTOR (MESO) - The summary slide should read a 6° temperature drop during the peak intensity of the event and again, just for the reasons I mentioned before, the temperature at the surface in the simulation tended to decrease as the microburst decayed due to the evaporation of the wet ground. However, if you were to look up at a slightly higher elevation, you probably would not see much of a temperature drop.

Q: ED LOCKE (Thermo Electron Technologies): - Would you expect to see as good a correlation between the model and TDWR data for a dry microburst?

A: FRED PROCTOR (MESO) - Yes, in fact I'll be presenting results next week at the Severe Storms Conference in which we did a simulation of the Denver 11 July microburst, which was a borderline dry microburst, it had peak radar reflectivity of about 40 dBZ in the microburst. We seem to get very good velocity correlation with the TDWR.

Q: FRED REMER (University of North Dakota): - What is the forcing mechanism for the initiation of the July 7 microburst?

A: FRED PROCTOR (MESO) - I haven't evaluated the mechanisms for the forcing of this case, but looking at some of the data it certainly appears that loading is a significant factor. There was about 9 grams per cubic meter of rain water as the microburst came down. The mass loading from that amount of rain water would be equivalent to the same affect of a temperature drop of about 3 degrees. Certainly evaporative cooling would still play an important role as the down draft began to propagate below the cloud base level where the lapse rates were more or less adiabatic. Since there was little ice in this event I expect that the effects of melting and sublimation to be almost negligible. Certainly for other cases and events the mechanisms such as loading and sublimation would have various intensities.

Session III. Flight Management