



NWS-CR-TA-89-18

CRH SSD
JUNE 1989

CENTRAL REGION TECHNICAL ATTACHMENT 89-18

DAR³E-I NOWCASTING - A REVIEW OF A STAPLETON (DEN) WIND PROFILER
TIME SERIES DURING THE DECEMBER 14-15, 1988 FRONT RANGE SNOW EVENT

J. Michael Looney
National Weather Service Forecast Office
Denver, Colorado

1. Introduction

The Denver WSFO enjoys the privilege of using, in an operational environment, the technologies which will be primary components of the AWIPS-90 era WFO. The present work station, DAR³E-I, will be replaced by DAR³E-II during the summer of 1989. Upon the commissioning of DAR³E-II, AFOS will be removed from the WSFO.

Among the "horizon" technologies available in the DAR³E-I work station is data from Doppler wind profilers at Stapleton, Platteville, and Flagler, Colorado. In addition, a plotted sounding from the radiometric thermodynamic profiler is available from the Stapleton system.

A time series of the Stapleton Doppler profiler has been prepared from a mid-December 1988 snow event which affected the Colorado Front Range region (Figure 1). Baseline annotations on Figure 1 indicate when snow began at Denver Stapleton, the duration of a pressure surge, and when snow ended at Stapleton.

Three WSFO meteorologists (Larry Dunn, Eric Thaler, and Jim Wiesmueller) were asked to review the profiler time series. After review, these forecasters were asked to comment on what they could glean from the output that might be utilized operationally. Their comments are understandably directed to the particular aspects of the Denver forecast problem and will not necessarily be applicable anywhere else in the country. It should also be understood that their comments are addressed to this single profiler output. This exercise might be analogous to a single station surface analysis. Operationally, this input would be used in conjunction with the Flagler and Platteville profilers and numerous other data sets. Even with these limitations considered, their comments should provide some insight into what we (NWS) forecasters can anticipate from the wind profiler network.

2. The Event

The December 14-15, 1988 event was one variety of anticyclonic storms which are not infrequent occurrences along the Colorado Front Range. Storms of this



CR TA 89-18
JUNE 1989

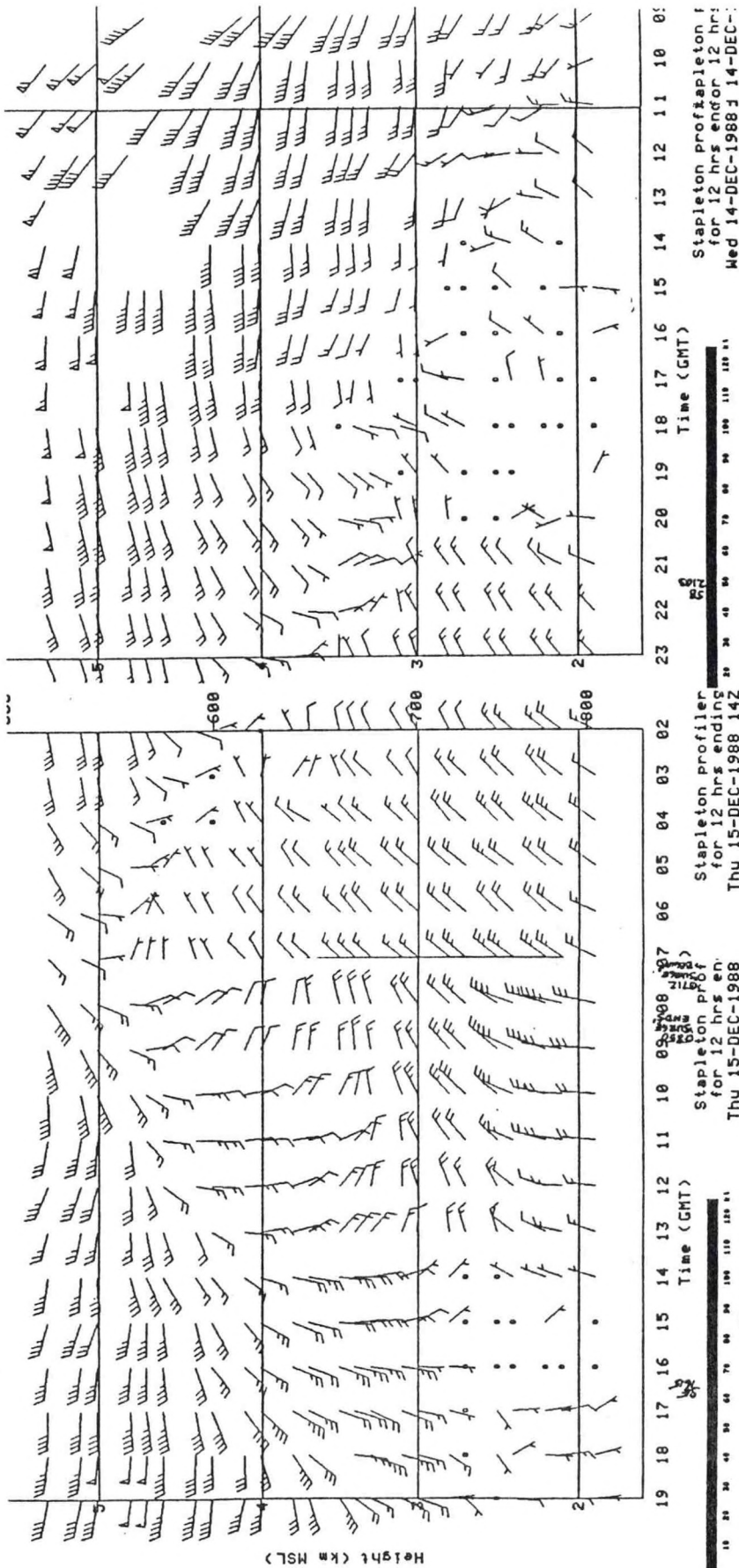


FIGURE 1.



nature are not associated with an organized surface low pressure system; orographic upslope flow is the primary component in snow production.

The distribution of snow with this event differed from the cold air damming anticyclonic storm described by Dunn (1987). This storm featured a general 6 to 12 inch snow accumulation over a rather widespread area. However, the depth and duration of the easterly upslope was "moderate" and taken alone is not consistent with the observed snow accumulations. This event was also accompanied by rather strong dynamics. This is evidenced from the NGM-derived 300-700 mb divergence of Q vector analysis for 00Z December 15 (Figure 2). The Q-divergence product is generated by RROFS and used operationally by the Denver forecast staff. For an in-depth description of this Omega equation derivative see Durran and Snellman (1987).

This storm offered a particularly interesting sequence of events. Snow from onset until around midnight was of the "greeting card" variety featuring light to moderate snow and light wind. Then a pressure surge traversed the Denver Metropolitan area around midnight producing near blizzard conditions. This sequence lasted no more than two hours. Forecaster NOWCAST response to this aspect of the storm will be addressed later.

3. Review of the Stapleton Profiler Time Series

The following are the features noted by those forecasters asked to review the time series:

1. A weak surface frontal passage occurred around 11Z on the 14th.
2. Cold advection is implied at low to mid levels due to the backing of wind with height, 11Z-14Z on the 14th.
3. The wind profile below 700 mb was "confused" (less than 5 kts, no consistent direction) for a 3-5 hour period followed by deepening easterlies.
4. Snow began at Stapleton within two hours of easterlies extending to 700 mb.
5. Lower level easterlies (below 700 mb) increased in strength as westerlies above 5 km decreased in strength around 21Z.
6. A surface pressure surge is suggested at 21Z which becomes stronger through 09Z.
7. Easterlies continued to deepen until an upper level short wave trough passed around 07Z after which the easterlies began to break down.
8. The surface pressure surge and associated increase in wind speed between 07Z and 09Z coincided with the passage of the upper trough.

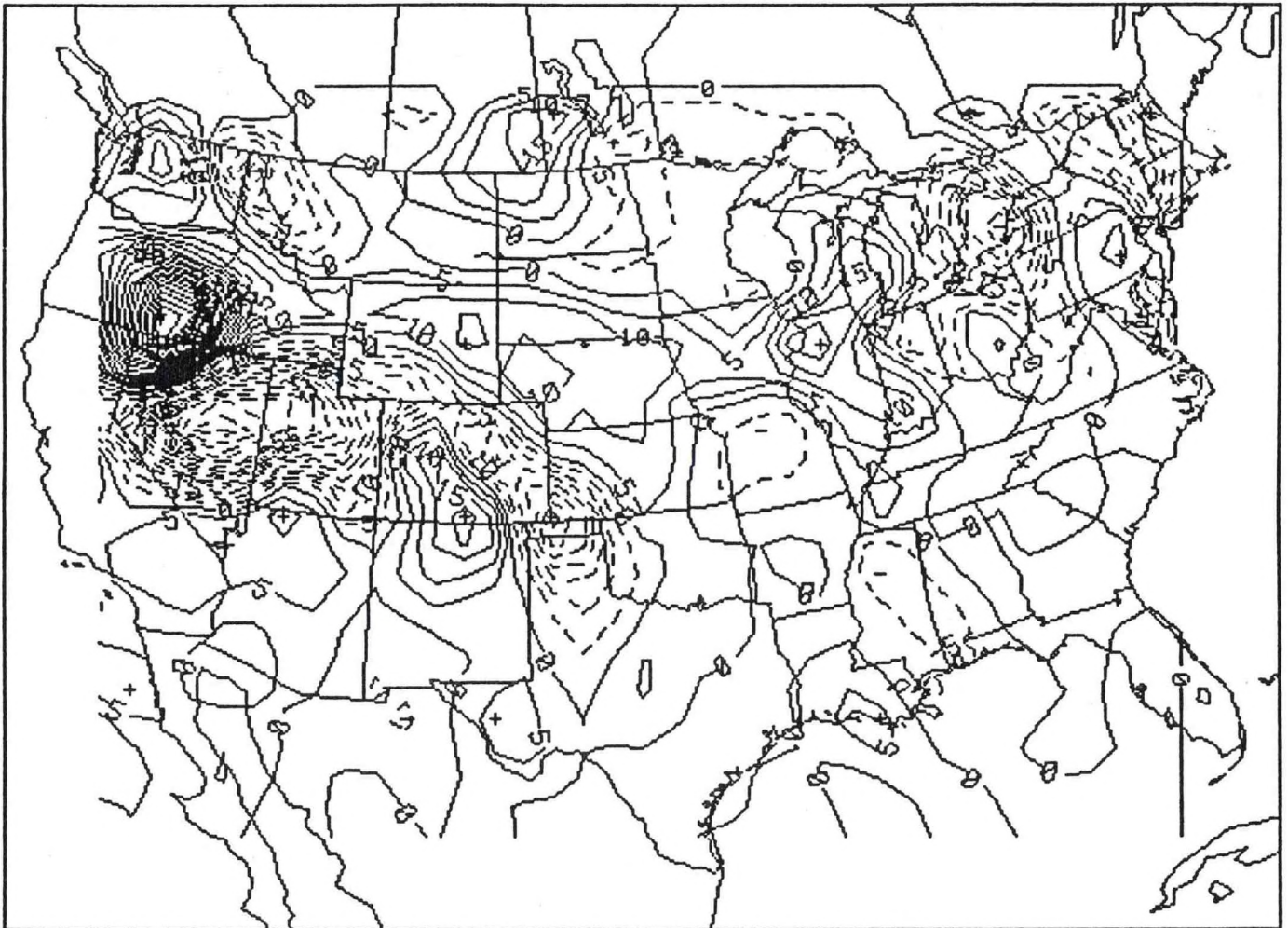


FIGURE 2.

MAPS Anal 300-700 mb Q-divg (mb**3/sec) 15-Dec-1988 00:00



9. The short wave trough or closed low passed through the region quickly with a return to westerly flow and warming aloft by late in the period.
10. Winds at mid levels veer from easterly to southerly after 12Z on the 15th, winds veer with height from southeast to southwest to west implying warm advection aloft.
11. Upslope ends at 15Z on the 15th.
12. Wind profile below 700 mb was again "confused" two to three hours before snow ended at Stapleton.
13. The onset, depth, and cessation of easterlies describe a "snow envelope" in a temporal sense.
14. The depth of the westerlies approximates a sine curve.

These are the comments of three forecasters. No doubt, comments from others on the forecast staff would yield many more useful observations.

4. NOWCASTING in the DAR³E-I Environment

Profiler information provides useful nowcast input. Other DAR³E-I components are also useful in the short term forecast routine. Among them are Doppler velocity and reflectivity imagery and the Northeast Colorado MESONET observational network.

For this discussion, refer to the surface pressure surge which was evident on the profiler between 07Z and 09Z on the 15th. As mentioned earlier, the duration of this surge was approximately two hours and altered the light snow and light wind conditions to a near blizzard environment. This feature was evident on the MESONET display as well as Doppler imagery.

Denver forecasters have exhibited skill in using these data sets in the preparation of specific and timely special weather statements during the winter as well as during the convective season. Two statements issued during the evening of the pressure surge are offered as Exhibits 1 and 2.

The earlier of the statements delineates expected snow accumulations across the metro area and describes the effects of the Arctic surge anticipated within two hours. The later statement is an excellent nowcast by accurately describing the expected changes in snow intensity, wind velocity and visibility. In addition, this statement mentions the short-lived nature of the event.

The timeliness and accuracy of these statements speak favorably of the utility of the new technology. By contrast, consider, as a forecaster, the degree of accuracy typically afforded by WSR-57 radar during a snow event and the often sparse conventional observation network during the night.



CR TA 89-18
JUNE 1989

NATIONAL WEATHER SERVICE DENVER CO
10 PM MST WED DEC 14 1988

...SNOW PILING UP IN THE DENVER METRO AREA...

A WINTER STORM WARNING REMAINS IN EFFECT FOR WESTERN PORTIONS OF THE DENVER METRO AREA TONIGHT AND EARLY THURSDAY...WHILE A SNOW AND BLOWING SNOW ADVISORY CONTINUES FOR THE EASTERN METRO AREA.

ACCUMULATIONS OF 6 TO 12 INCHES ARE EXPECTED IN THE WESTERN METRO AREA BY EARLY THURSDAY...WITH 4 TO 6 INCHES EASTERN AREAS.

LIGHT TO MODERATE SNOW WAS FALLING OVER CENTRAL AND EASTERN METRO AREAS LATE WEDNESDAY EVENING...WITH DOPPLER RADAR AND SURFACE REPORTS SHOWING HEAVIER SNOW WEST OF INTERSTATE 25. AS OF 10 PM 2 INCHES WAS MEASURED ON THE GROUND AT STAPLETON AIRPORT...WITH AT LEAST 4 INCHES IN THE WESTERN SUBURBS.

IN ADDITION ARCTIC AIR WAS SURGING SOUTH OUT OF WYOMING AND NORTH TO NORTHEAST WINDS ARE EXPECTED TO INCREASE TO BETWEEN 15 AND 25 MPH BEFORE MIDNIGHT. THIS WILL FURTHER AGGRAVATE THE SITUATION BY CAUSING AREAS OF BLOWING AND DRIFTING SNOW. TEMPERATURES WILL ALSO DIP INTO THE TEENS WITH BELOW ZERO WIND CHILLS.

MOST ROADWAYS THROUGHOUT THE METRO ARE WERE BECOMING ICY AND SNOWPACKED WEDNESDAY EVENING AND MOTORISTS ARE URGED TO EXERCISE EXTREME CAUTION OR POSTPONE TRAVEL. CONDITIONS MAY NOT IMPROVE BY THE MORNING RUSH HOUR...BUT SNOW SHOULD DIMINISH BY THURSDAY AFTERNOON.
JLW

Exhibit 1.



CR TA 89-18
JUNE 1989

DENSO DEN
:DEN: FTAA000 MDEN 150628

SPECIAL WEATHER STATEMENT
NATIONAL WEATHER SERVICE DENVER CO
1120 PM MST WED DEC 14 1988

...SNOW AND WINDS TO PICK UP OVER DENVER AREA...

AT 1115 PM...DOPPLER RADAR AND SURFACE OBSERVATIONS INDICATED LOCALLY HEAVY SNOW AND GUSTY WINDS MOVING INTO THE DENVER AREA FROM THE NORTH. NORTH WINDS 20 TO 35 MPH AND VISIBILITIES NEAR ZERO WILL SPREAD ACROSS THE METRO-AREA DURING THE NEXT HOUR OR TWO... SEVERELY HAMPERING DRIVING CONDITIONS. SEVERE WIND CHILL TEMPERATURES FROM 10 TO 20 BELOW ZERO ARE ANTICIPATED...ALONG WITH BLOWING AND DRIFING SNOW. THE WESTERN PARTS OF THE AREA INTO THE FOOTHILLS WILL BE MOST AFFECTED...WHERE TOTAL ACCUMULATIONS OF 6 TO 12 INCHES ARE POSSIBLE.

THE MOST SNOWFALL REPORTED SO FAR IN THE AREA HAS BEEN 7 1/2 INCHES ON TABLE MESA NEAR BOULDER.

THESE SEVERE WINTER WEATHER CONDITIONS SHOULD BE RELATIVELY SHORT-LIVED...WITH AN IMPROVEMENT ON THE WAY FOR LATER THURSDAY INTO THURSDAY NIGHT.

DULONG

Exhibit 2.



5. Summary

The profiler offers an almost continuous upper air sample. The advantages of using these data to augment the twice daily rawinsonde observations should be obvious. In addition to providing a finer observational network, and, in turn, opportunities for refined computer modeling, profiler information in conjunction with the new technologies now available in DAR³E-I will prove invaluable in the nowcast environment.

The observations offered herein from forecasters with a degree of experience in the use of profiler output and other DAR³E-I technologies is presented as a preview for our contemporaries.

6. References

- Dunn, L. B., 1987: Cold air damming by the front range of the Colorado Rockies and its relationship to locally heavy snows. Wea. and Forecasting, 2, 177-189.
- Durran, D. R., and L. W. Snellman, 1987: The Diagnoses of synoptic-scale vertical motion in an operational environment. Wea. and Forecasting, 2, 17-31.