

# Validation of Atmospheric Radiation Measurement Single-Column Model Intensive Observation Period 2D-Wind Divergence Profiles with WSR-88D Radar Data

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## Motivation

- Assessment of the quality of the two-dimensional wind divergence profiles from data collected during the Single-Column Model Intensive Observation Periods (SCM IOPs) are made possible by the availability of National Weather Service (NWS) Weather Surveillance Radar - 1988 Doppler (WSR-88D) radar data and algorithms that can provide radar-derived values of wind divergence at multiple heights and scales.
- Additional data are made possible with the radar algorithm outputs of vertical profiles of the mean wind and vertical velocity (at multiple scales).
- The data set provided by the radar algorithms could serve as an independent source of scientific investigation, not just for verification of other data sources.
- Data could serve scientific utility to the SCM effort during and between SCM IOPs.

## Data Analysis Summary

- Data from three WSR-88D radars within the Southern Great Plains Cloud and Radiation Testbed (SGP CART) domain were processed using a Velocity-Azimuth Display (VAD) analysis to generate divergence estimates. Also, estimates of the mean wind and vertical velocity were produced.
- The VAD analysis algorithms used were made available by use of a modified version of the WSR-88D Algorithm and Display System (WATADS) software. The software was provided by the Stormscale Research and Applications Division of the National Severe Storms Laboratory (NSSL) and in cooperation with the NWS's Operational Support Facility (OSF).

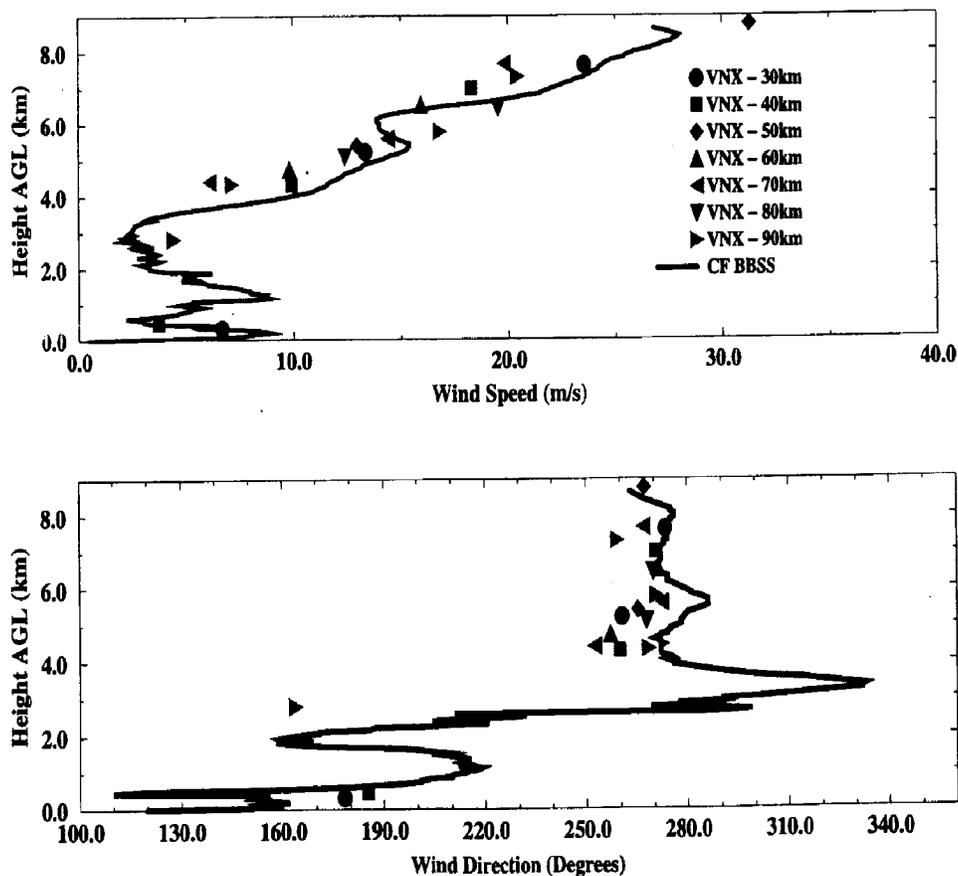
- Comparisons of the WSR-88D data were made to SCM divergence data available on the SCM Home Page and to Central Facility Balloon-borne Sounding System (CF BBSS) data.

## VAD Analysis (Brief Overview)

- The method is based on processing radial velocity data at a constant range and elevation angle. The divergence estimates can be directly obtainable from the radial velocity data about a circle at a given range and elevation. Divergence profiles can be “built” for a given radius by computation of divergence at various elevations at a given range (not to be confused with the radar slant range). Vertical velocities can be estimated using the information about the vertical profile of divergence. Information about the mean wind (speed and direction) can be obtained with additional assumptions about the wind field (e.g., linear). See references for more detailed discussions of the VAD analysis techniques.

## Results of Preliminary Data Analysis

- Wind speed and direction estimates from the WSR-88D at Vance Air Force Base (AFB) on September 24, 1995, showed good comparisons to a BBSS launch at the Atmospheric Radiation Measurement (ARM CF) (Figure 1). The comparison was good for a variety of scales of the radar data analysis (from 30 km to 90 km) and may indicate relatively homogeneous vertical wind profiles across the area. Comparisons of radar-derived wind profiles and radiosondes have been previously studied (literature not cited here) and are not without discrepancies, especially during strong wind shear events (e.g., the low-level jet).

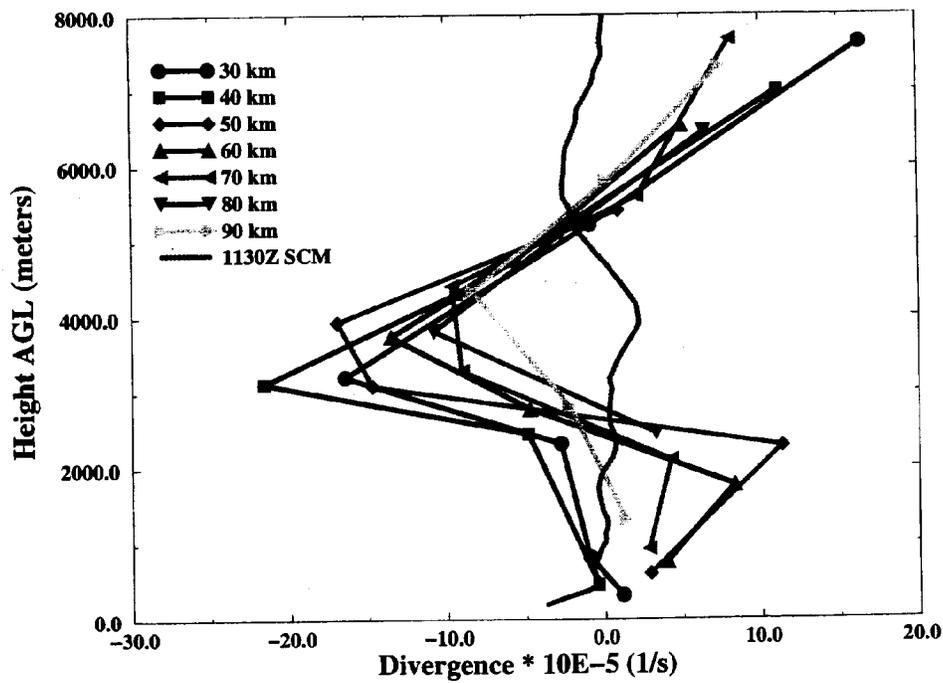


**Figure 1.** Mean wind estimates from the Vance AFB WSR-88D and an ARM CF launch compare well. The radar profile contains information from multiple scales (30 km to 90 km) and indicates that the mean wind was rather uniform within that range. Such wind profiles are available from a radar at a frequency of 1 per 10 minutes.

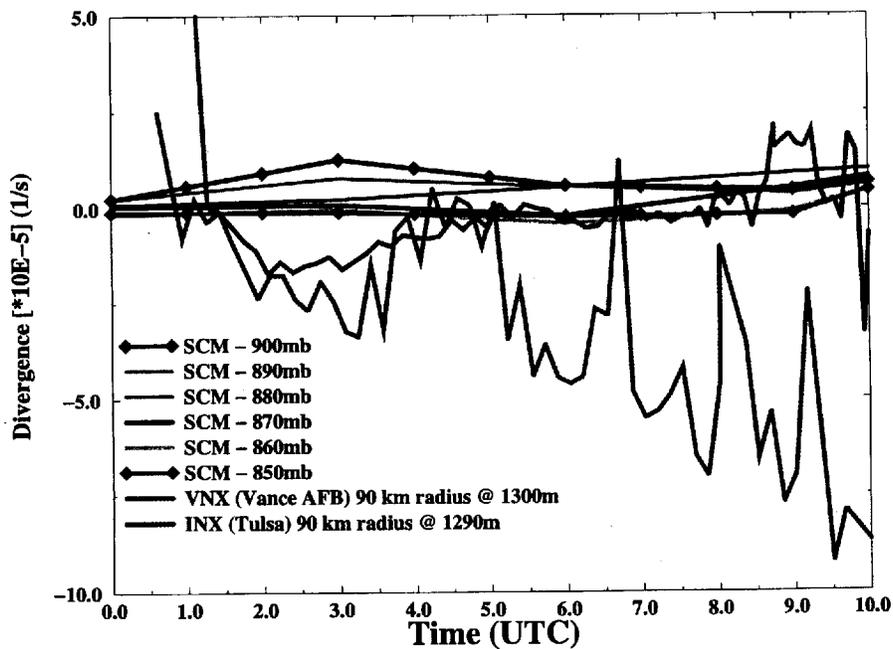
- Comparisons of divergence estimates (both profile and time-series comparisons) between WSR-88D and SCM values (as well as WSR-88D vs. WSR-88D) do not yet show definitive results. Divergence profiles from a variety of radar ranges from Vance AFB on September 24, 1995, 1135Z show (internal) consistency between ranges in Figure 2, with a trend toward a decreased amplitude in divergence with increased range (as might be expected). Figure 3 depicts a time series comparison (for that same day) of divergence estimates at a single level from both the Vance AFB and Tulsa radars to nearby SCM computational levels. Comparison to the SCM divergence profile does not show a good correlation. However, appropriate averaging (spatial and/or temporal) should produce better comparisons.
- Figure 4 depicts vertical velocity time series from the Vance AFB and Tulsa radars on September 23, 1995, and shows a feature in the vertical velocities that appears to affect both sites (a rapid decrease and increase in the vertical velocities at 1300 m).

## Comments on Initial Results

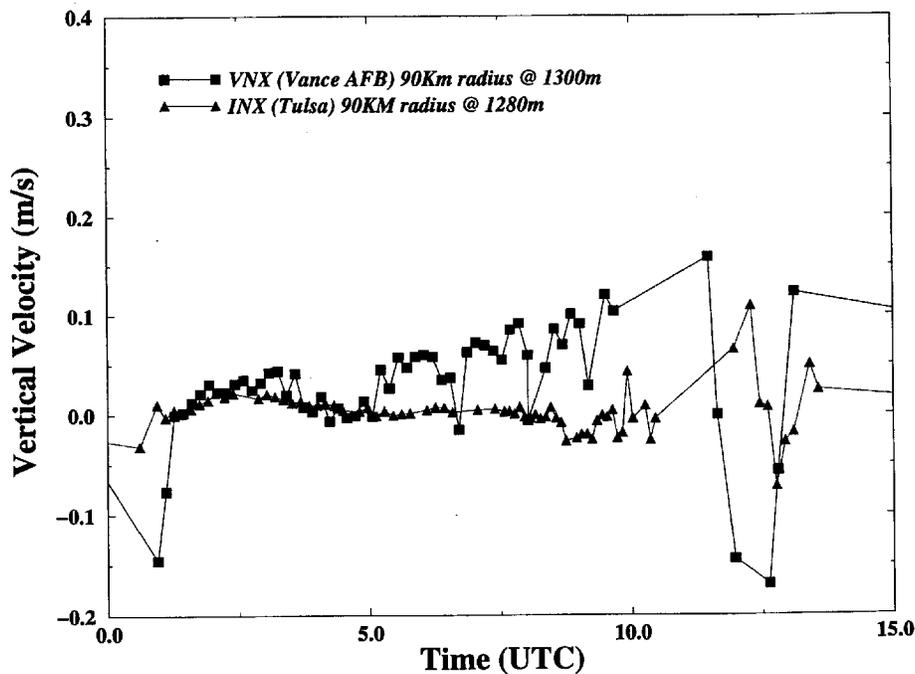
- Preliminary analysis shows promise for the WSR-88D to provide a useful data set including divergence, and mean wind speed with vertical resolution and multiple spatial scales. Uses could range from verification of current ARM data streams to supplementation of them. Some of the data streams could be integrated into more complex data analysis schemes such as variational analysis methods.



**Figure 2.** Divergence profiles from a variety of radar ranges from Vance AFB on September 24, 1995.



**Figure 3.** Time series of divergence estimates at a constant level from the Vance AFB and Tulsa WSR-88D radars show rapid changes at even the 90 km scale, but do not compare well to SCM divergence estimates at similar heights.



**Figure 4.** Vertical velocities, which are derived from the divergence profile estimates, are shown from a constant altitude from Vance AFB and Tulsa. A similar feature (a sharp drop and rise) is noted in each time series and could be associated with a phenomena advecting through the site.

- Data from other WSR-88D sites within the SGP CART site would aid in creating radar-derived divergence products that are more comparable to the SCM products. Averaging divergence data from the Wichita, Vance AFB, and Twin Lakes Oklahoma City sites might prove to be the optimal set. The current data set includes data from Vance AFB, Tulsa, and Twin Lakes, which do not extend into the northern portion of the CART site.
- The radar-WSR-88D-derived estimates can provide data at a higher temporal frequency than currently available, and can provide information at multiple scales. The data, though, does not have as high a vertical resolution or the vertical extent as the current SCM data set.

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