Fundamentals of Doppler Velocity Analysis

INTRODUCTION

L. Jay Miller presented a series of three interactive talks on the fundamentals of Doppler velocity analysis. These talks covered the requisite knowledge and procedures to create robust wind field syntheses from real-world Doppler data.

The main emphasis of the first lecture-discussion will be the nature of single radar measurements, especially those characteristics of importance to the analysis of "observed Doppler velocities" and their assimilation into numerical models.

The second presentation will cover gridding of multiple Doppler radar datasets to be used in a wind syntheses within the NCAR Custom Editing and Display of Reduced Information in Cartesian Space (CEDRIC) software program. The main focus will be on using the NCAR Sorted Position Radar INTerpolation (SPRINT) and REORDER software programs, not on interpolation in general. However, some considerations for these two programs will apply equally to other gridding or interpolation methods.

The final presentation will cover the synthesis for four-dimensional (space and time) winds from the interpolated datasets covered in the second lecture. This wind-synthesis approach to be covered will focus on the traditional formulation. Brief mention will be made concerning newer, more robust variational schemes.

It is hoped that this series of lectures will stimulate additional dialogue among observationalists, modelers, and radar engineers.

FIRST LECTURE/DISCUSSION (March 17, 2011; continued on March 23, 2011)

Some Fundamentals of Doppler Radar Velocity Analysis

Introductory comments about the broad topics of the three-part lecture/discussion series and a brief history of the early developments in the analysis of Doppler radar data and wind synthesis was presented (Slides 1-9):

1. Doppler Data Characteristics and Error
2. Data Preparation and Interpolation
3. Two- and Three-Doppler Wind Synthesis

The remaining slides (10-43) covered the following:

Single Doppler Radar Data - Characteristics and Analysis

The remaining slides (10-43) included the following specific topics:

- A brief review of pulsed Doppler radar
- Coordinate systems involved (RAE and XYZ)
- What the measured fields represent
- Artifacts within the measured fields
- Ways to clean up the data
- Quality of the radar measurements
- Noise or errors, both random and bias
- Temporal and spatial scales that are resolved

SECOND LECTURE/DISCUSSION (May 19, 2011)

Data Preparation and Gridding for Wind Synthesis; Using REORDER, SPRINT, and CEDRIC Programs

Specific topics included:

- Traditional formulation of the steps in wind synthesis
- Considerations before gridding
- STEPS 2000 radar (NWS/KGLD, NCAR/SPOL, and CSU/CHILL) datasets
- Considerations for gridding
- REORDER and SPRINT gridding algorithms
- Local unfolding and QUAL parameter
- Radar scan resolutions (azimuth-elevation and range-height)
- Detailed comparison of SPRINT and REORDER gridded results
- Summary comparison

THIRD/FINAL LECTURE/DISCUSSION (August 5, 2011)

Using the CEDRIC Program for Wind Synthesis and Other Analyses

Specific topics included:

- Brief history of CEDRIC development early 1980s
- Software system for the merger, analysis and display of three-dimensional gridded dataset
- Primarily for analysis of radar measurements
- Preparation of individual Doppler radar datasets
- Synthesis of multi-Doppler radar radial velocities into winds and particle fallspeed
- Using radar reflectivity factor in power-law relation to obtain particle fallspeed
- Two- and Three-equation solutions for particle (or air) motion components
- Vertical integration of horizontal wind convergence in the mass continuity equation to obtain vertical air motion
- Overview of using CEDRIC to incorporate non-radar gridded datasetsts such as numerical model results