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Mesocyclone Detection Algorithm (MDA) Operational Update

Introduction: As part of the continuing evolution of the WSR-88D algorithm and product suite, the legacy Mesocyclone (MESO) algorithm is being phased out and is being replaced with a newer, more sensitive algorithm known as MDA. The major improvement offered by the MDA is that its robust detection techniques allow for the identification and classification of a broader spectrum of storm-scale circulations with different strength and spatial characteristics. The MDA also provides tracking and trend data. (Refer to the Warning Decision Training Branch training material at http://www.wdtb.noaa.gov/buildTraining/Build9/index.html for additional information.)

Background: This replacement is being implemented over three phases to ensure no degradation in operational services.

The first phase was implemented in Build 5 (released in the Spring of 2004) and continued through Build 8 (released in the Spring of 2006). This phase introduced the MDA and the new Mesocyclone Detection (MD) and Digital Mesocyclone Detection (DMD) products into the RPG baseline software. For this phase, the MDA was added as a complement to the legacy MESO algorithm. This period was used to verify the MDA performance, identify and address deficiencies, and allow the opportunity to evaluate the MDA while still retaining the legacy MESO algorithm output for the Combined Attributes Table (CAT) and Alerting Function.

The second phase spans Builds 9 (released in the Summer of 2007) and 10 (currently scheduled for release in the Summer of 2008). For this phase, the legacy MESO algorithm and product will still be available, however the MDA output replaces the MESO output as the information source used to populate the CAT. Additionally, a new alert category (MDA Strength Rank) was added in Build 9 to take advantage of the MDA's more robust identification and classification processing.

In the final phase, which is planned for Build 11 (currently scheduled for release in late 2009 or early 2010) the legacy MESO algorithm and product will be removed from the baseline RPG software. With the removal of the legacy MESO algorithm, the MDA will become the only storm-scale circulation identification algorithm in the RPG algorithm suite.

MDA and "False Alarms": The MDA was designed to identify and classify all storm-scale circulations, not just large, well defined mesocyclonic shear regions. This design allows the MDA to not only detect mesocyclones, but also detect smaller shear regions like those associated with low-topped tornadic shears and waterspouts.

To achieve the goal of identifying these small shear features, the MDA feature identification criteria are far more lenient than the legacy MESO algorithm. These more

lenient criteria provide a significant operational advantage by being able to identify and classify weak, small-scale shear regions. However, this design also increases the likelihood of identifying shear regions that are not operationally significant (false alarms).

The majority of the operationally insignificant features (false alarms) appear to be caused by noisy velocity fields in weak reflectivity areas. Velocity estimates in weak return (low SNR) tend to be noisy. The noisiness is exacerbated by:

- Velocity dealiasing errors, especially near the radar, since the introduction of ORDA (e.g. highway traffic is more readily seen).
- Faster antenna scanning rates with VCPs 12, 212 and 121 (variance of velocity estimate is increased).
- GMAP clutter filtering: When clutter, weak weather signal, and biota, such as birds, are present, GMAP may retain the birds as a valid velocity rather than the weak weather.
- Velocity dealiasing errors due to use of a PRF with a relatively low Nyquist velocity (25 m/s or lower).
- SZ-2 data recovery (VCPs 211, 221 and 212) in the weak trip echoes (variance of velocity estimate is increased).
- ORDA signal processing using a Hamming window rather than a Rectangular window (variance of velocity estimate is increased).
- Certain RDA failures (alarm conditions) that cause poor data quality but do not force an RDA INOP state or disable data collection.

Additionally, the denser vertical sampling with VCPs 12 and 212 may lead to more 3D feature detections due to vertical coupling of random 2D features identified in noise. However, results from our testing have not indicated a notable increase in false alarm rates when using either VCP 12 or VCP 212.

New for Build 9: The vast majority of the identified circulations that are not deemed operationally significant (false alarms) are classified by MDA as "Low Core" circulations. To help reduce the number of "Low Core" circulations presented on operational products, a 20km association range parameter was added to the MDA processing logic. This new logic requires a "Low Core" circulation be located within 20km of a Storm Cell Identification and Tracking (SCIT) algorithm identified cell to be included on the MD, DMD or CAT products. If a "Low Core" circulation is not within the 20km association range, it will not be included in any operationally displayed product. ***Note:*** *Under certain conditions, when there are no MD features detected (the MD and DMD products, if generated, would be "blank"), the RPG fails to generate the MD and DMD products.* ***This ONLY occurs when there are no MD features found for the volume scan.***

Conclusion: The MDA's ability to detect many storm-scale circulations that would have previously gone undetected will aid in the identification of small, relatively weak mesocyclones. However, this increased sensitivity also means MDA will detect circulations that may not be operationally significant in many meteorological situations. Forecasters must continue to actively interrogate base products to verify the existence and strength of mesocyclonic circulations.