Hydrometeor Classification Algorithm 2 (HCA2)

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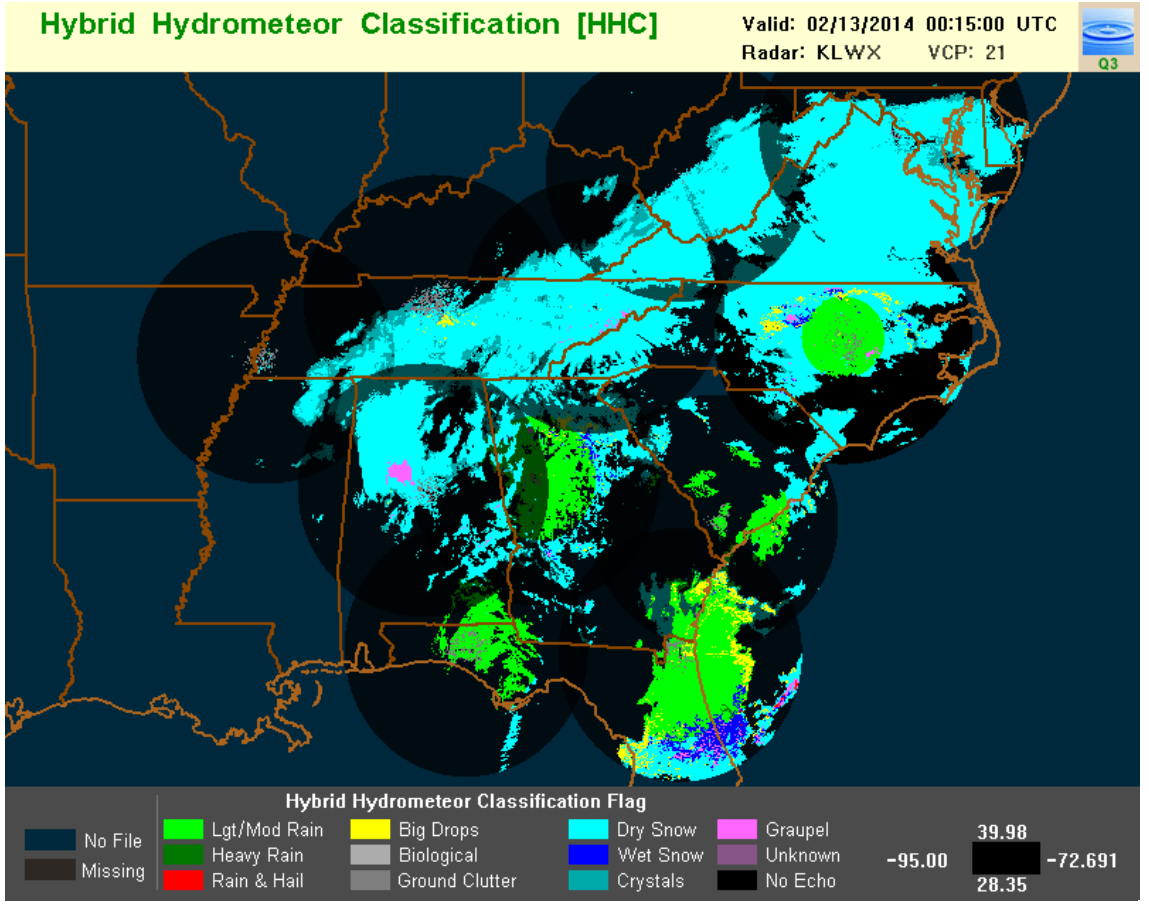
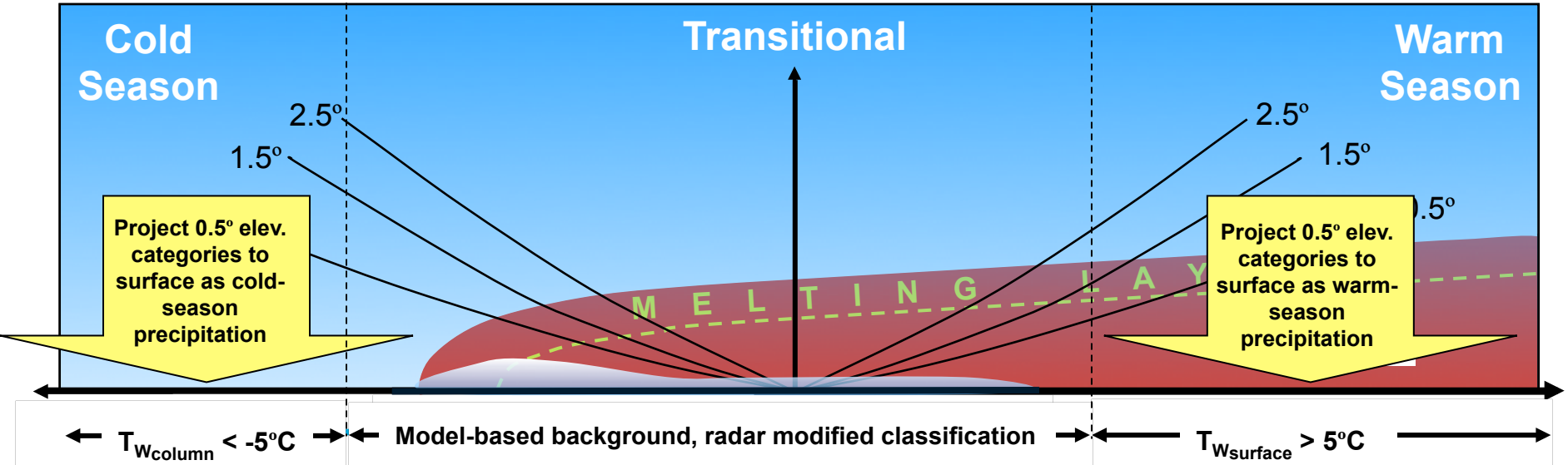
Existing Hydrometeor Classification Algorithm (HCA)

- Developed primarily for warm season precipitation
- Provides classification on conical surfaces. Not always representative of precipitation type observed at ground level
- Does not include precipitation categories such as freezing rain and ice pellets
- Radar by radar product. Significant “no data” gap frequently exists between radars



New concept: Model-based background precipitation type classification that is modified, when necessary, by radar observations.

Vision: Develop an "all-season" surface-based HCA

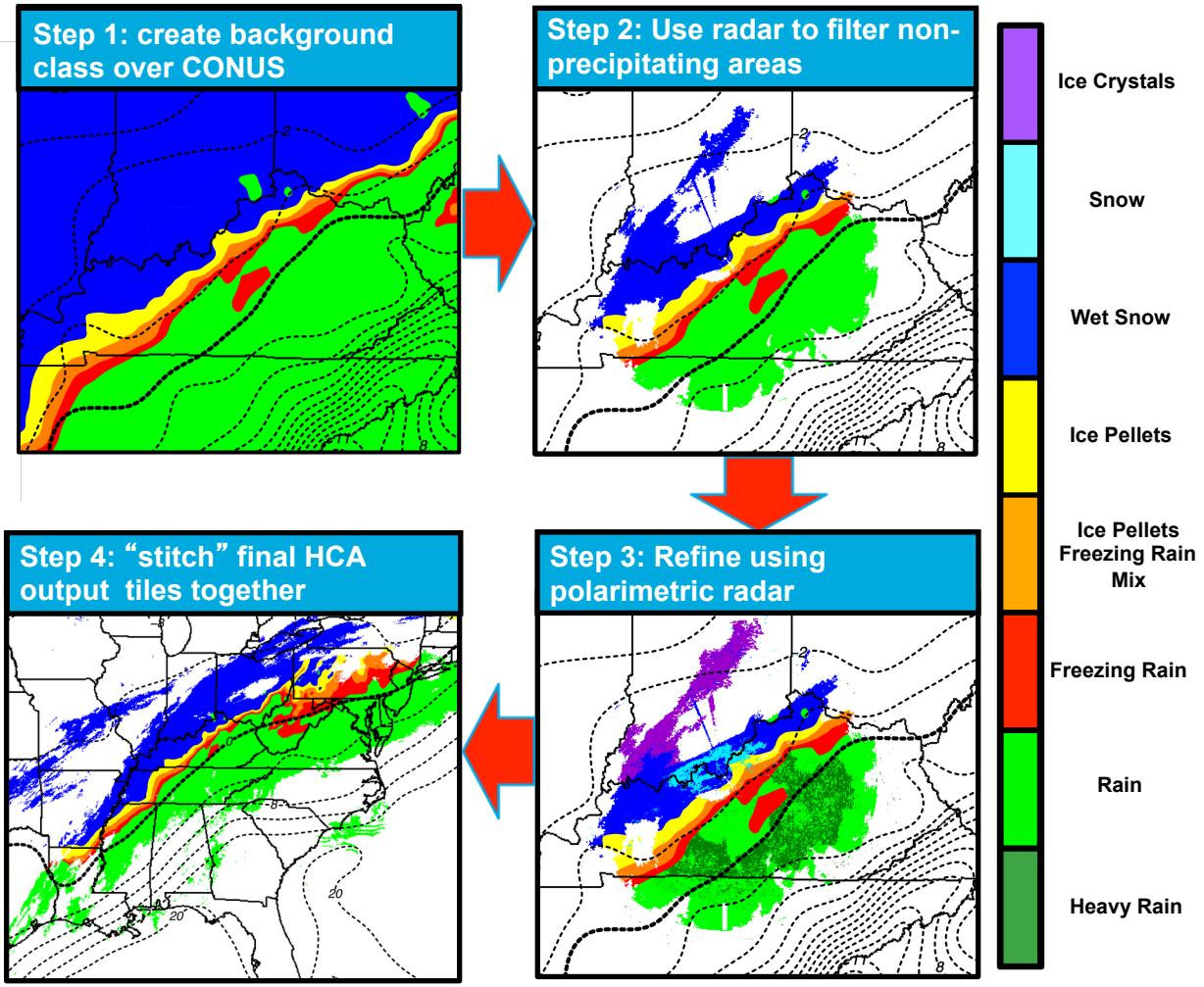


- Run fuzzy-logic based HCA algorithm. Project the classification results to the surface.
  - If T_w < -5ºC for entire column, ice categories projected from the 0.5º elevation to surface as ice crystals or snow.
  - If $T_{w_{Surface}}$ > 5ºC, ice categories are projected from the 0.5º elevation to the surface as rain, big drops, or hail.
- For intermediate "transitional winter weather" conditions, the background classification is determined from the HRRR model. Polarimetric radar observations are then used to either modify or provide value-added information to the model-based background classification.

Model-based Background Classification

Model-based background classification produced from the High Resolution Rapid Refresh (HRRR) model. Three techniques have been explored:

- Explicit determination of surface precipitation type from HRRR wet-bulb temperature profiles
- Statistical "random forest" technique that uses attributes derived from the HRRR
- Spectral bin model where processes of melting, ice nucleation, and refreezing are treated explicitly

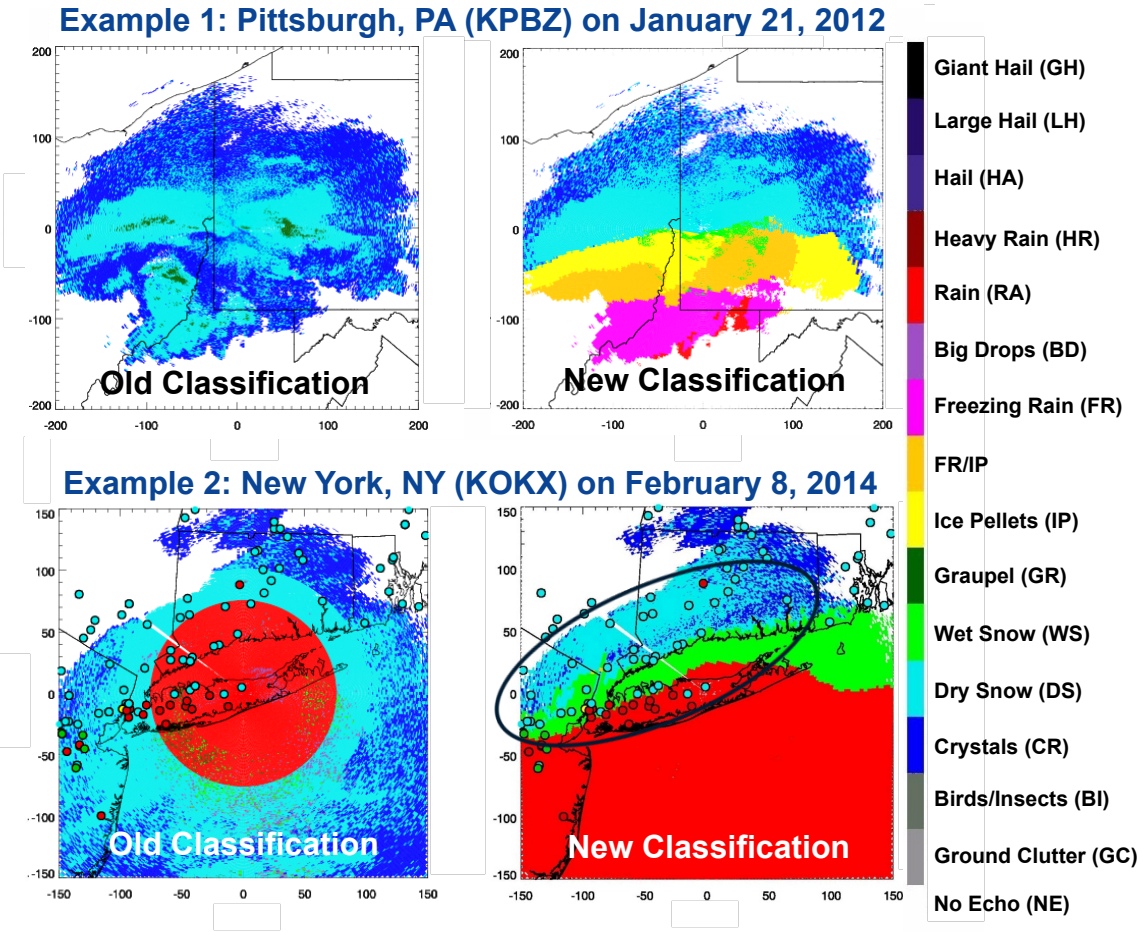


"Bakeoff" continues to determine the optimal background classification

Radar-based Modification

The radar-based modification of the background classification is accomplished in a variety of ways:

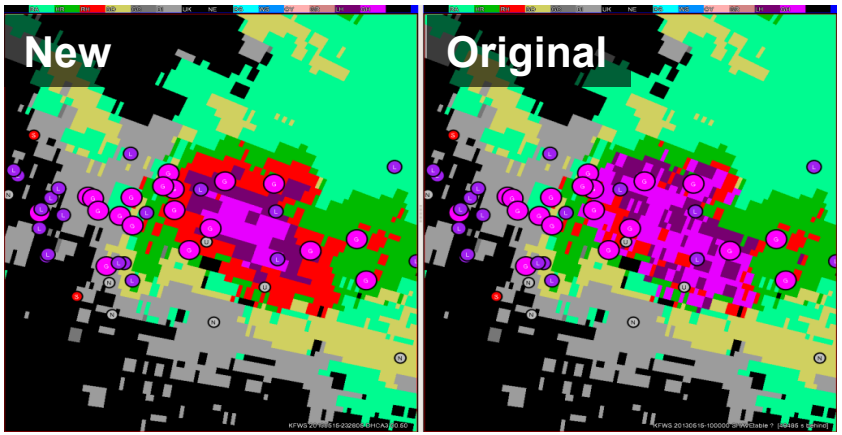
- Using radar-based detection of the melting layer (ML) to determine whether or not the underlying background classification is consistent with observations
- Identifying regions of wet snow where the ML reaches the ground
- Utilizing the newly-discovered "refreezing signature" to identify regions of sleet
- Using Z-Z_{DR} scatterplots to discriminate between sleet and freezing rain

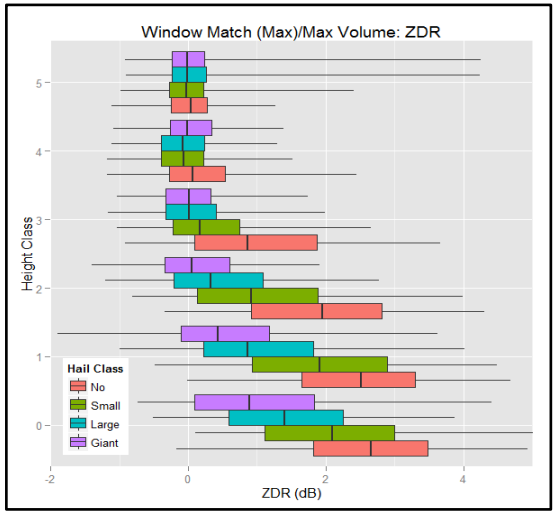


Classification results are validated using precipitation type observations collected by the *Meteorological Phenomena Identification Near the Ground (mPING)* project.

Hail Size Detection Algorithm (HSDA)

Example: Fort Worth, TX (KFWS) on May 15, 2013



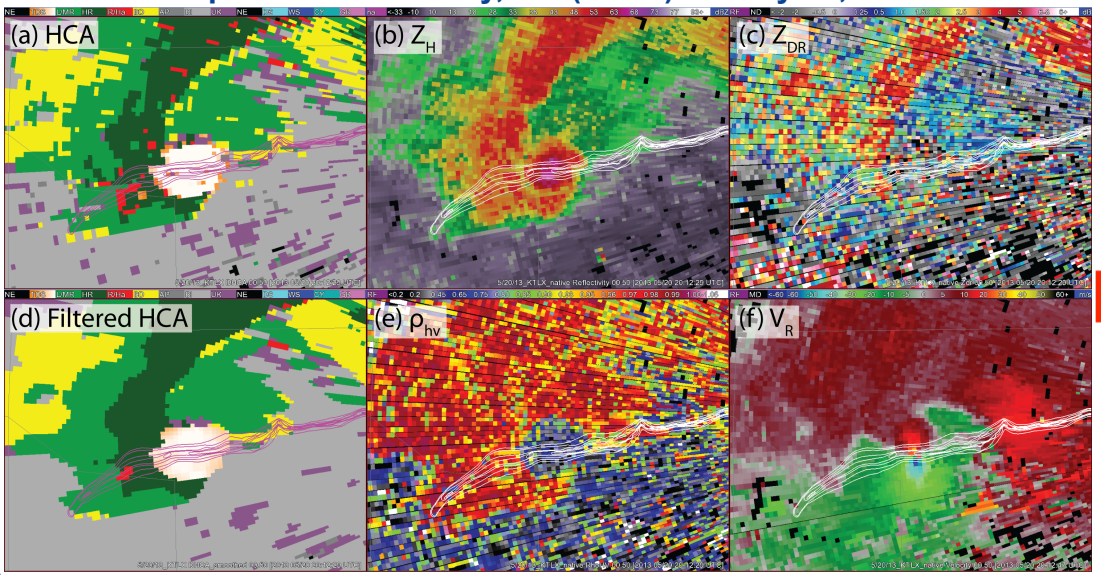


- Reports collected by Severe Hazards Analysis and Validation Experiment (SHAVE, team of students "cold calling" the public to obtain high-resolution data)
- 3,257 hail reports compared to dual-pol variables and HSDA output
  - 1,115 'no hail' and 1,150 non-severe reports
- Through evaluation, the HSDA has been modified to reduce large areas of giant hail detection
- Modifications have greatly reduced False Alarm Rate while maintaining a similar overall skill

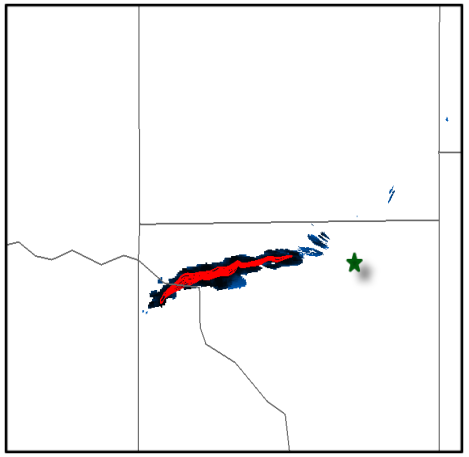
Tornadic Debris Signature (TDS)

- Polarimetric radar provide a distinct signature associated with debris lofted by tornadoes
- The fuzzy-logic classification scheme of the HCA has been modified to use polarimetric variables and azimuthal shear to provide a new TDS category
- The new TDS category can be added to the final HCA product to help operational forecasters verify and track tornadoes

Example: Oklahoma City, OK (KTLX) on May 20, 2013



Black – Damage path from polarimetric TDS detections
Red – Verification of damage path from storm survey



Summary

- The fuzzy-logic Hydrometeor Classification Algorithm (HCA) that is currently deployed on the WSR-88Ds provides precipitation type designations on a conical surface. In transitional winter weather, these designations are not always in agreement with the precipitation type observed at ground level.

- A new surface-based HCA (referred to as HCA2) is being developed. With HCA2, polarimetric radar data are used to modify and provide value-added information to a model-based background classification.

- Additional algorithms under development will help operational forecasters gauge maximum hail size, as well as verify the occurrence and real-time damage path of ongoing tornadoes.