Dual-Polarization Radar Data Simulator for the WRF Model

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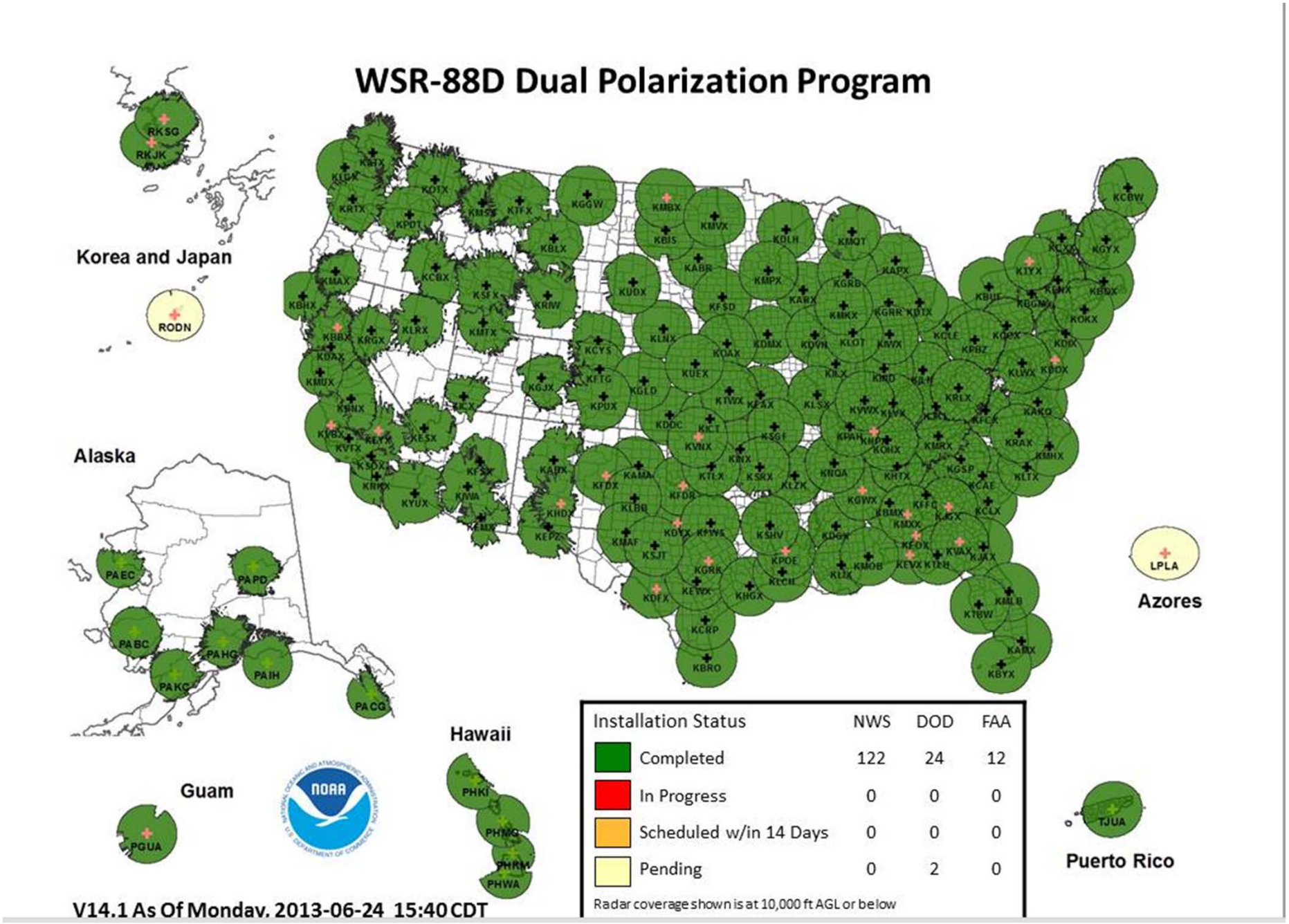
Application of Polarimetric Radar Data (PRD)

- Dual-pol observations are proven to be useful in hydrometeor classification, quantitative rain estimation, and radar data quality control.

- The dual-polarization radar upgrade to the WRS-88D network was completed in 2013.

- Application of such data in the Numerical Weather Prediction is still limited.
  - Verification of numerical weather forecast
  - Study of storm dynamics, thermodynamics, and microphysics
  - Better forecast through data assimilation
  - Help interpret model output more intuitively
  - Evaluation of radar-based algorithms



http://www.roc.noaa.gov/wsr88d/PublicDocs/DualPol/DPstatus.pdf

PRD Simulator (CAPS-POL)

- PRD simulator converts the model state variables to the form of observations. For direct comparison of PRD with NWP model output or DA of PRD, PRD simulator is necessary.
- Jung et al. (2008; 2010)
- Applied to various studies
  - Journal articles: Jung et al. (2012), Putnam et al. (2014), Dawson et al. (2013; 2014)
  - Conferences and Workshops: Supinie et al. (2015), Johnson et al. (2014), Putnam et al. (2013), Snyder et al. (2012)

Verification using PRD

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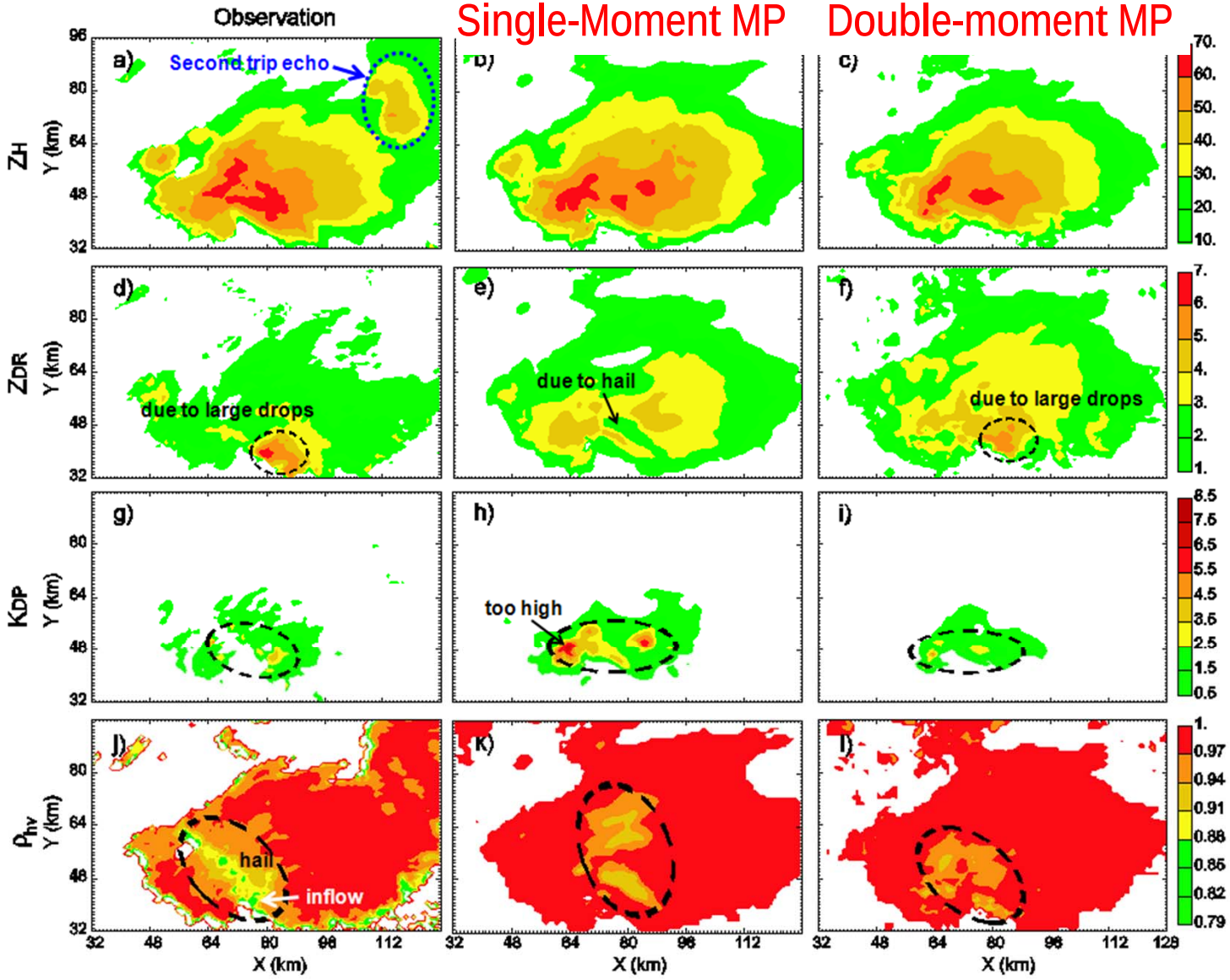
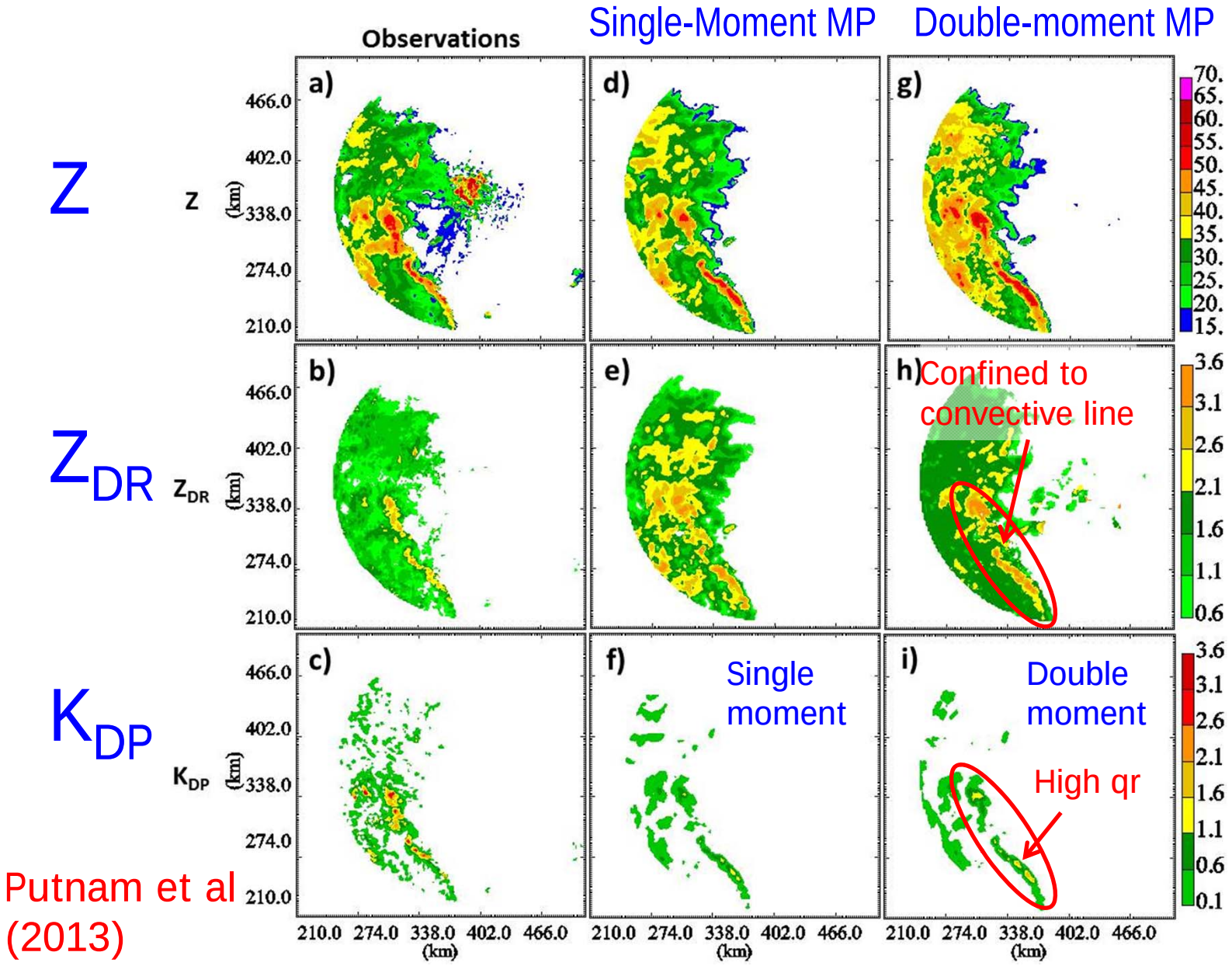
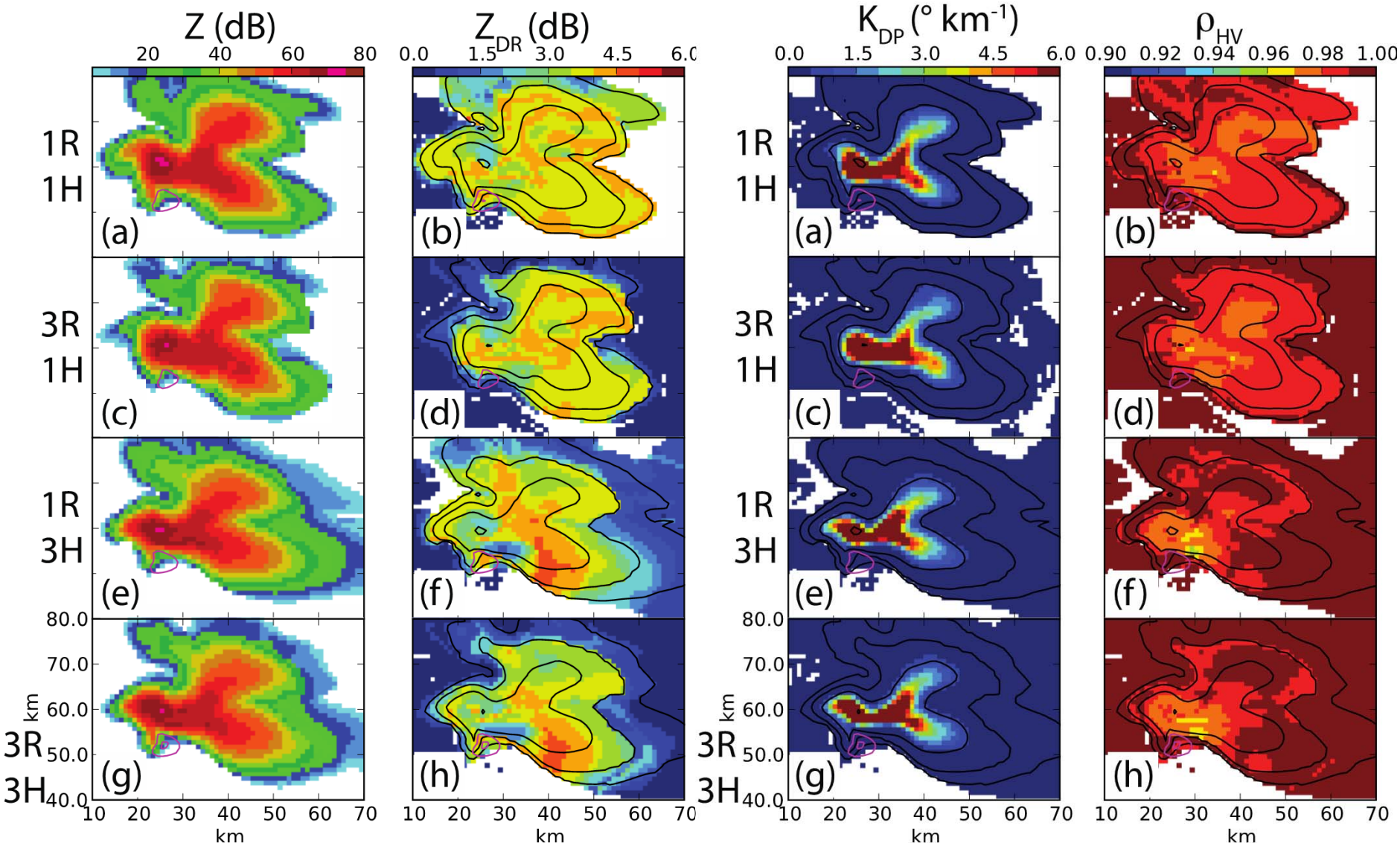


Jung et al. (2012)

EnKF Analyses of Dual-Pol Variables at 0.5 tilt



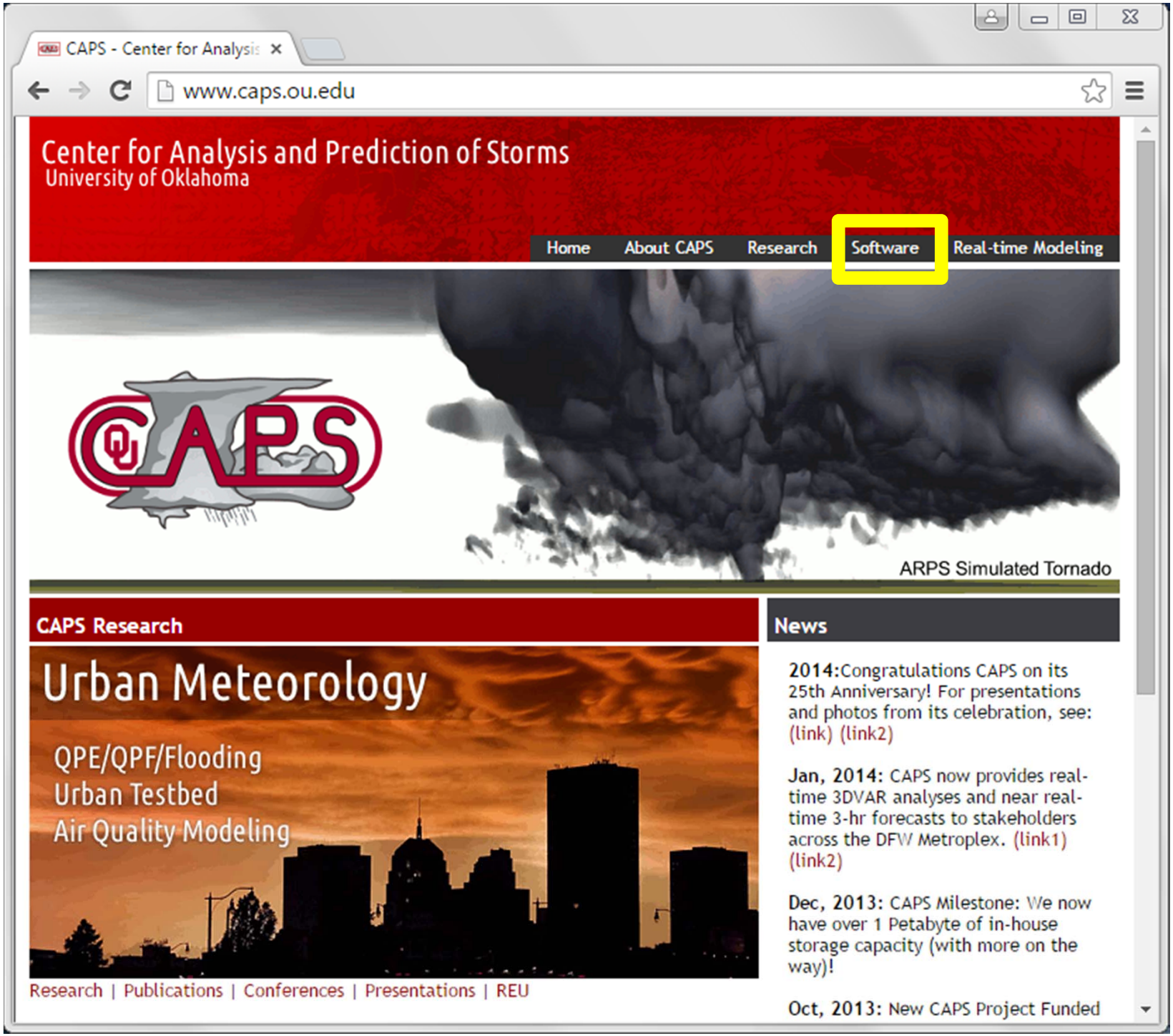
Putnam et al (2013)



Dawson et al. (2013)

CAPS-POL

- Python-based stand-alone package
- Supporting microphysics schemes: WDM6, Thompson, Morrison, Milbrandt and Yau, NSSL
- Easily expandable and easy to learn
- Some key options:
  - Melting layer model: model mixing ratio-based (no-size dependent or size-dependent melting fraction) or model temperature-based melting treatment
  - Plot slice: 2D (xy, xz, yz plane) or radar sweep surface
  - For radar sweep surface: Gaussian power-gain weighting function or two-layer interpolation
  - Plot variables: model microphysical state, polarimetric variables, mean size, melting fraction, hydrometeor density
  - Store dual-pol variables in netCDF file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2014:Congratulations CAPS on its 25th Anniversary! For presentations and photos from its celebration, see: (link) (link2)
Jan, 2014: CAPS now provides real-time 3DVAR analyses and near real-time 3-hr forecasts to stakeholders across the DFW Metroplex. (link1) (link2)
Dec, 2013: CAPS Milestone: We now have over 1 Petabyte of in-house storage capacity (with more on the way)!
Oct, 2013: New CAPS Project Funded


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CAPS Polarimetric Radar Data Simulator (CAPS-POL)
CAPS-POL is a general purpose polarimetric radar data simulator developed at CAPS for nonhydrostatic weather prediction models with explicit microphysics schemes. User interface and driver are written in Python while complex scattering amplitude calculation makes use of Fortran code.
Current CAPS-POL is a beta version 0.0 and was released to the public, furnished as it is, in 2015.
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References
Dawson, D. T., E. R. Mansell, Y. Jung, L. J. Wicker, M. R. Kumjian, and M. Xue, 2014: Low-level ZDR signatures in supercell forward flanks: The role of size sorting and melting of hail. J. Atmos. Sci., 71, 276-299, doi:10.1175/JAS-D-13-0118.1.
Jung, Y., G. Zhang, and M. Xue, 2008: Assimilation of simulated polarimetric radar data for a convective storm using ensemble Kalman filter. Part I: Observation operators for reflectivity and polarimetric variables. Mon. Wea. Rev., 136, 2228-2245.
Jung, Y., M. Xue, and G. Zhang, 2010: Simulations of polarimetric radar signatures of a supercell storm using a two-moment bulk microphysics scheme. J. Appl. Meteor. Climatol., 49, 146-163.
Vivekanandan, J., W. M. Adams, and V. N. Bringi, 1991: Rigorous approach to polarimetric radar modeling of hydrometeor orientation distributions. J. Appl. Meteor., 30, 1053-1063.
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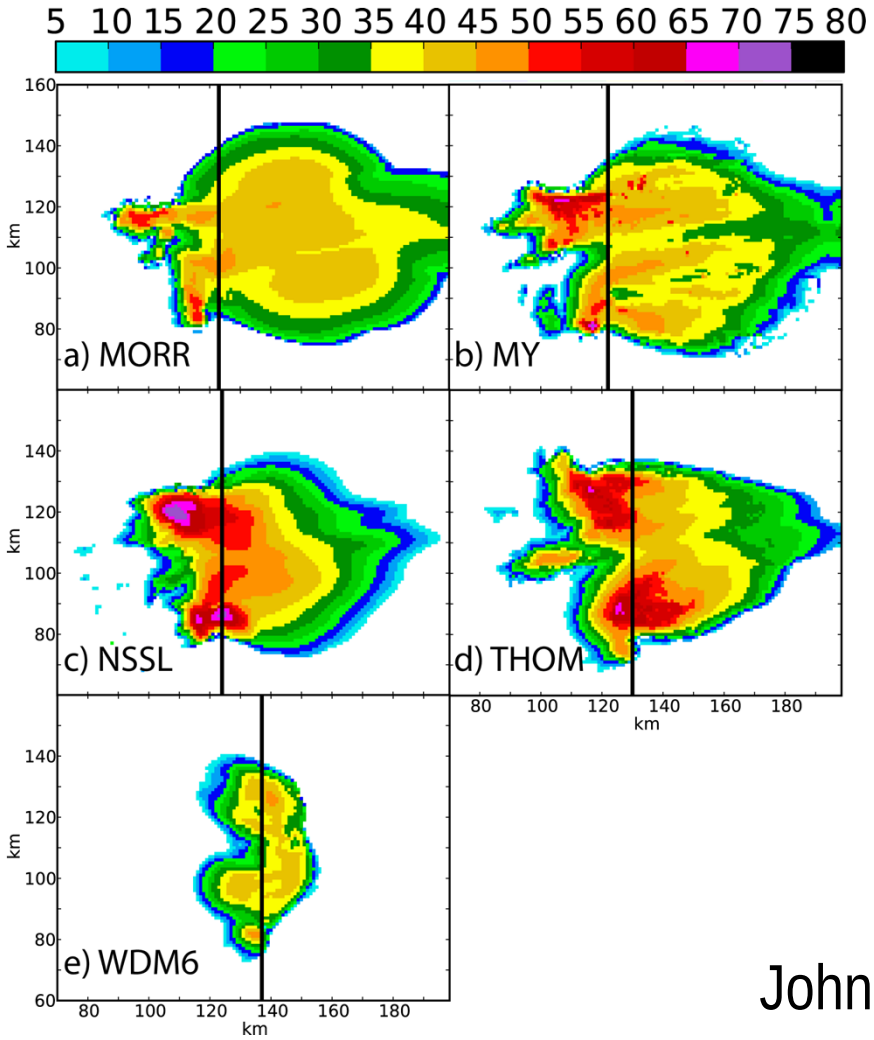
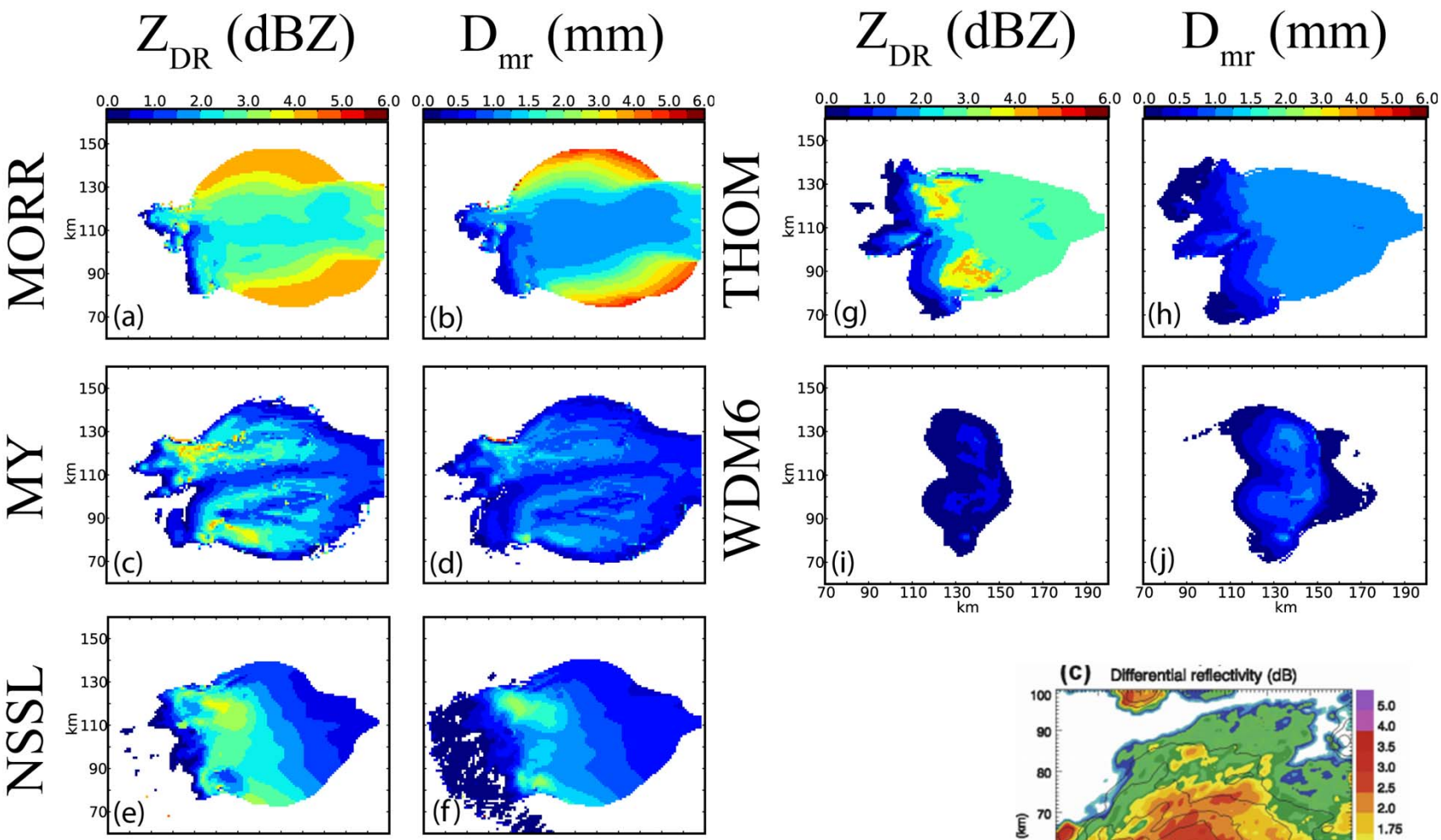
Demonstration

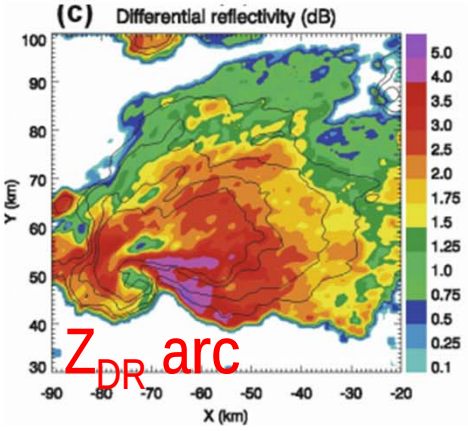
Evaluation of Microphysics schemes (example)



Johnson et al. (2015)



Johnson et al. (2015)



Kumjian and Ryzhkov (2008)

References

Referred Publications

- Jung, Y., G. Zhang, and M. Xue, 2008a: Assimilation of simulated polarimetric radar data for a convective storm using the ensemble Kalman filter. Part I: Observation operators for reflectivity and polarimetric variables. Mon. Wea. Rev., 136, 2228-2245.
- Jung, Y., M. Xue, G. Zhang, and J. Straka, 2008b: Assimilation of simulated polarimetric radar data for a convective storm using the ensemble Kalman filter. Part II: Impact of polarimetric data on storm analysis. Mon. Wea. Rev., 136, 2246-2260.
- Jung, Y., M. Xue, and G. Zhang, 2010a: Simultaneous estimation of microphysical parameters and the atmospheric state using simulated polarimetric radar data and an ensemble Kalman filter in the presence of observation operator error. Mon. Wea. Rev., 138, 539-562.
- Jung, Y., M. Xue, and G. Zhang, 2010b: Simulations of polarimetric radar signatures of a supercell storm using a two-moment bulk microphysics scheme. *Appl. Meteor. Climatol.* 49, 146-163.
- Jung, Y., M. Xue, and M. Tong, 2012: Ensemble Kalman Filter Analyses of the 29-30 May 2004 Oklahoma Tornadic Thunderstorm using One- and Two-Moment Bulk Microphysics Schemes, with verification against polarimetric radar data. *Mon. Wea. Rev.*, **140**, 1457-1475.
- Dawson, D. T., E. R. Mansell, Y. Jung, L. J. Wicker, M. M. Kumjian, and M. Xue, 2013: Low-level Z_{DR} signatures in supercell forward flanks: the role of size sorting and melting of hail. J. *Atmos. Sci.*, **71**, 276-299.
- Dawson, D. T., L. J. Wicker, E. R. Mansell, Y. Jung, and M. Xue, 2014: Low-level polarimetric radar signatures in EnKF analyses and forecasts of the 8 May 2003 Oklahoma City tornadic supercell: Impact of multi-moment microphysics and comparisons with observations, Adv. Meteor., http://dx.doi.org/10.1155/2013/818394.
- Putnam, B. J., M. Xue, Y. Jung, N. A. Snook, and G. Zhang, 2014: The Analysis and Prediction of Microphysical States and Polarimetric Variables of a Mesoscale Convective System Using Double-Moment Microphysics, Multi-Network Radar Data, and the Ensemble Kalman Filter. *Mon. Wea. Rev.*, **142**, 141-162.

Conferences and Workshops

- Snyder, Jeffrey C., H. B. Bluestein, Y. Jung, 2012: Simulated polarimetric signatures associated with supercells in different kinematic environments, *25th Conference on SLS*, Nashville, TN
- Putnam, B., M. Xue, G. Zhang, and Y. Jung, 2013: Simulation of polarimetric radar variables from the CAPS Spring Experiment Storm Scale Ensemble Forecasts, *36th Conference on Radar Meteorology*, Breckenridge, CO
- Snyder, J., H. B. Bluestein, D. T. Dawson II, and Y. Jung, 2013: Examining the effect of the vertical wind shear environment on polarimetric signatures in numerically-simulated supercells, *36th Conference on Radar Meteorology*, Breckenridge, CO
- Supinie, T., D. T. Dawson, and Y. Jung, 2015: A python-based plotter for model-derived polarimetric radar variables, *95rd AMS Annual Meeting*, Phoenix, Arizona