Data Quality Control for MC3E and Selected Case Studies

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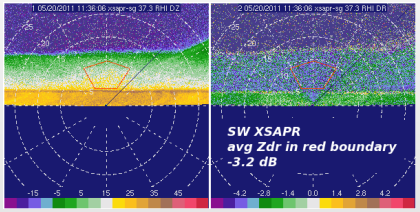
Introduction

The array of X- and C-band polarimetric radars sited around the SGP provide an opportunity to regularly analyze kinematic and microphysical processes within all types of precipitation. After assessing the quality of the polarimetric data, hydrometeor identification algorithms can be applied to determine microphysical processes. With two or more X- or C-band radars, dual-Doppler techniques can be used to derive 3D wind fields, and specifically vertical velocities. Storms can additionally be categorized into convective and stratiform components, and statistics can be applied to the subcategories.

Data Quality Control

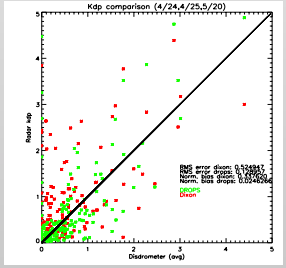
Z_{dr} Bias Estimation

-Z_{dr} is important for classification of hydrometeors, and can be used in rainfall estimation
-Using elevations close to 90º, Z_{dr} bias is estimated
  -SE +0.29 dB on 20 May 2011
  -SW -3.2 dB on 20 May 2011
  -SW -4.2 dB on 20 February 2013
-Stability over time needs further investigation



K_{dp} Calculation

-K_{dp} is important for quantitative estimation of rainfall, attenuation correction, hydrometeor identification (particularly in winter)
-Calculation from XSAPR is complicated by non-Rayleigh delta effects as well as phase folding
-"Dixon" uses a iterative impulse response filter for differential phase
-"DROPS" uses Wang and Chandrasekar (2009)
-Comparison with 2DVDs from MC3E during 3 cases shows better error statistics for DROPS method

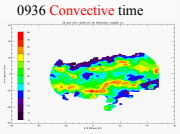


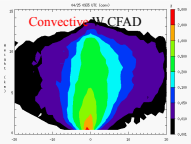
25 April 2011 MC3E Case

Kinematics

Dual-Doppler wind synthesis was performed between XSAPR SW and SE. Volumes were then categorized into convective and stratiform elements using Steiner and Houze methodology.

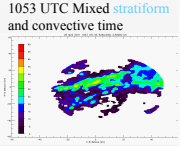
0936 Convective time

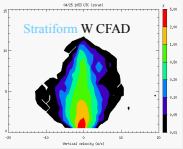




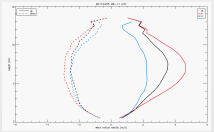
- Broad distribution of vertical velocities
- Frequency of strong upward (and downward) velocities is concentrated in the mid-levels
- Occurrences of w > |10| ms^{-1}

1053 UTC Mixed stratiform and convective time





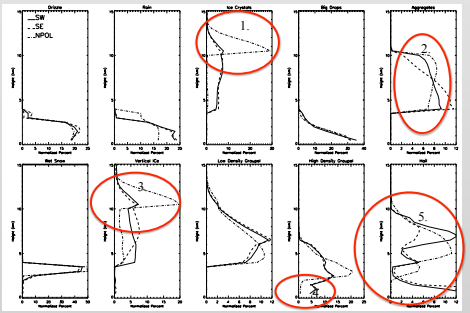
- Narrow distribution of vertical velocities
- Generally w < |10| ms^{-1}



- Mean up (+) and down (-) vertical velocities over the 3 hour period from 08-11 UTC
- As expected, convective updrafts (especially in the mid-levels) much stronger than stratiform
- Stratiform velocities relatively small

Microphysics

-HID based on Dolan and Rutledge (2009) was applied to both SW and SE XSAPR as well as the NASA S-band polarimetric radar, NPOL
-Frequency of hydrometeor type over a 3 hour period on 25 April 2011 is examined
-In general, XSAPRS do a comparable job to NPOL which is being used for comparison due to high quality polaimretric data and less complications from non rayleigh scattering
-XSAPR better at differentiating ice crystals and aggregates



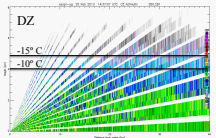
1. NPOL identifies a large gradient in Ice Crystals at 10 km (coincident with sharp decrease in Aggregates) that is likely due to strong temperature weighting in the algorithm. XSAPR is more realistic with distribution of Ice crystals throughout the column.
2. XSAPRs show aggregates increasing with decreasing height as would be expected, while NPOL does not capture this effect
3. NPOL sees large percentage of vertical ice crystals (indicative of charging) above 10 km – much less in XSAPR possibly due to scanning strategy
4. XSAPRS identify a non-zero amount of high-density graupel below the melting layer while NPOL does not – likely from complications due to non-Rayleigh scattering
5. Distribution of hail throughout the column is significantly different between the XSAPRs and NPOL, including hail reaching the surface, likely complications from non-Rayleigh scattering

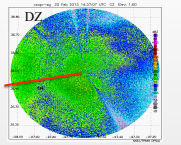
20-21 February 2013 Winter Case

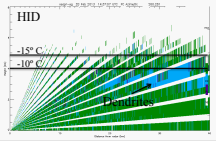
On 20-21 February 2013, a winter storm brought widespread precipitation to Oklahoma. With surface temperatures hovering around zero, precipitation type fluctuated between snow, sleet and rain. Locations around the Southern Great Plains site (Enid and Ponca City) reported receiving close to 4" of snow by mid-day on 21 February. Using the winter hydrometeor identification algorithm (HID) developed by Thompson et al. (2013), we have preliminarily analyzed the microphysics using the SW XSAPR.

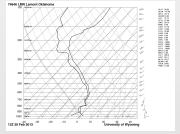
1437 UTC 20 February

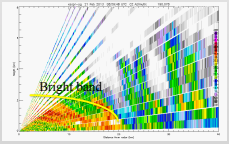
-Widespread light precipitation
-Enid reports continuous light snow
-LMN 12 UTC sounding is all < 0º C except right at the surface
-Reconstructed RHI of HID shows a region of dendrites (blue) just below the -10º C isotherm (from the 12 UTC LMN sounding) among broad region of aggregates (green) suggesting a dendritic growth zone which may enhance surface snowfall

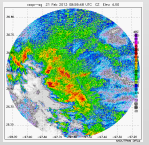


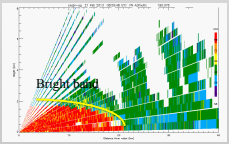


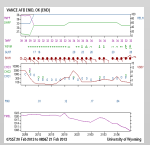












0859 UTC 21 February

-Much more complex situation
-Over the course of the 08 UTC hour, END reports light snow, rain /snow mix, drizzle, light rain and thunder
-Reconstructed RHI identifies a veritcal bright band about 20 km to the south of SW XSAPR with rain near to the radar and snow types (aggregates) at farther ranges
-HID hints at vertical / sloped bright band with wet snow pixels (yellow)

Conclusions and Future Work

- Extensive quality control necessary to be able to use polarimetric data from XSAPR
- Think XSAPR can give us information about microphysics, particularly in ice phase, with some limitations due to non-Rayleigh scattering and scanning coverage
- Bring in CSAPR analysis for dual-Doppler and microphysics
- Derive kinematic statistics for more storms (e.g. 20 May 2011, 11 May 2011, 24 April 2011)
- Look at other winter cases such as the 25 February 2013 winter storm

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