Gridded Scanning ARM Cloud Radar BL-RHI Observations and New Scientific Opportunities

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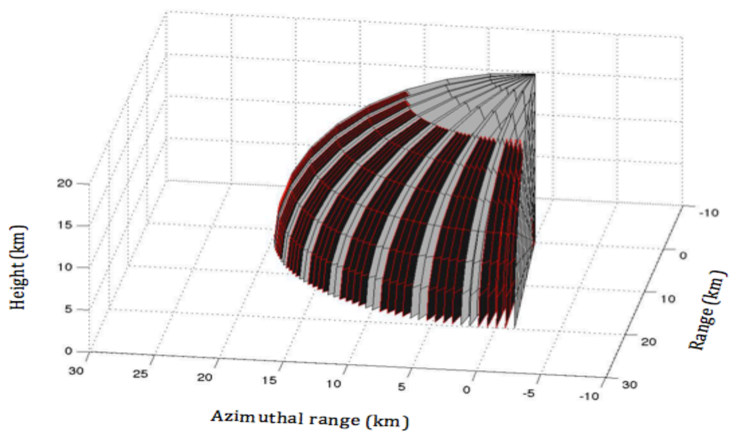
Introduction

Recent advancements in radar technology enabled the deployment of scanning cloud radars, that can provide off-zenith view of the cloudy atmosphere. Reconstructing the 3-D cloud structure evolution will enable the study of cloud life cycle, cloud scale turbulence, cloud field anisotropy, evaluate plane-parallel approximation in radiative transfer and improve cloud sub-grid variability parameterization in numerical models.

Observations

15 September 2012: Atmospheric Radiation Measurement (ARM) program fixed site in Oklaoma[1]

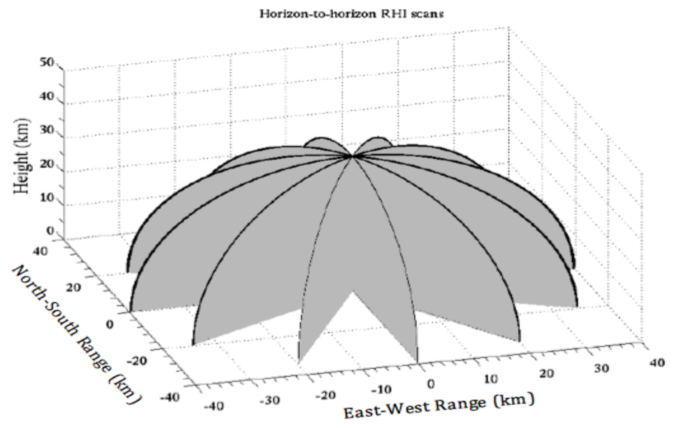
- Continental stratocumulus cloud observation
- SACR observations are corrected for non-atmospheric returns, gas attenuation, velocity aliasing, insects filtering and second trip echo contamination. (Kollias et al. 2013b, in early release).



SACR operating BL-RHI scans:
RHI scans from 0-90°elevation at fixed azimuth
Repeated every 3° azimuth to cover a 60° sector in 5 min
Cycle repeated 4 consecutive times

Scientific objective: 3-D cloud life cycle (4-D)

SACR operating HS-RHI scans:
RHI scan from 0-180° elevation at fixed azimuth
Repeated every 30° azimuth to cover a 360° sector in 3 min.
Cycle repeated every 30 min



Scientific objective: Document horizontal wind speed and direction

References

Kollias, P., N. Bharadwaj, K. Widener, I. Jo & K. Johnson (2013a, in early release) Scanning ARM Cloud Radars – Part I: Operational Sampling Strategies. Journal of Atmospheric and Oceanic Technology.

Kollias, P., I. Jo, P. Borque, A. Tatarevic, K. Lamer, N. Bharadwaj, K. Widener, K. Johnson & E. Clothiaux (2013b, in early release) Scanning ARM Cloud Radars – Part II: Data Quality Control and Processing. J. of Atmospheric and Oceanic Technology.

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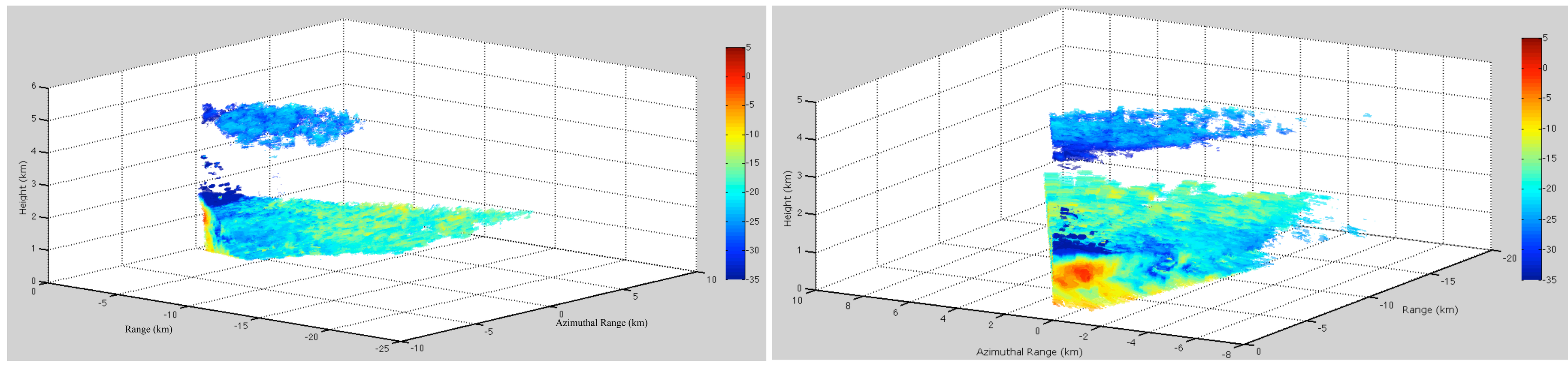
3-D BL-RHI Gridding

- Polar coordinate observation =>Need Cartesian coordinate to ease interpretation.
- No gaps in range-height
- Compute, for each observed cloud pixel, the Cartesian coordinates of the radar resolution volume assuming the standard beam propagation model (Doviak and Zrnic 1993)
- Compute the smallest possible 3-D radius of influence to locate all influenced grid cells. Grid cells may be influenced by multiple observations
- If radar volume is larger than grid resolution, all surrounding grid cells within grid resolution will be influenced.
- If radar volume is smaller than grid resolution, only grid cells within the radar volume will be influenced.
- Populate grid cells using interpolation of all influencing observational value and their distance from the grid cell
- **User defined resolution grid and interpolation scheme (Barnes, Cressman, Maximum value, Mean value), gridding of all radar observables.**

Figures:
Ka-SACR
BL-RHI
Gridded Reflectivity
Multiple viewing
angles



Mean horizontal wind speed and direction from HS-RHI

- Observed velocity is composed of horizontal wind velocity and particle vertical velocity

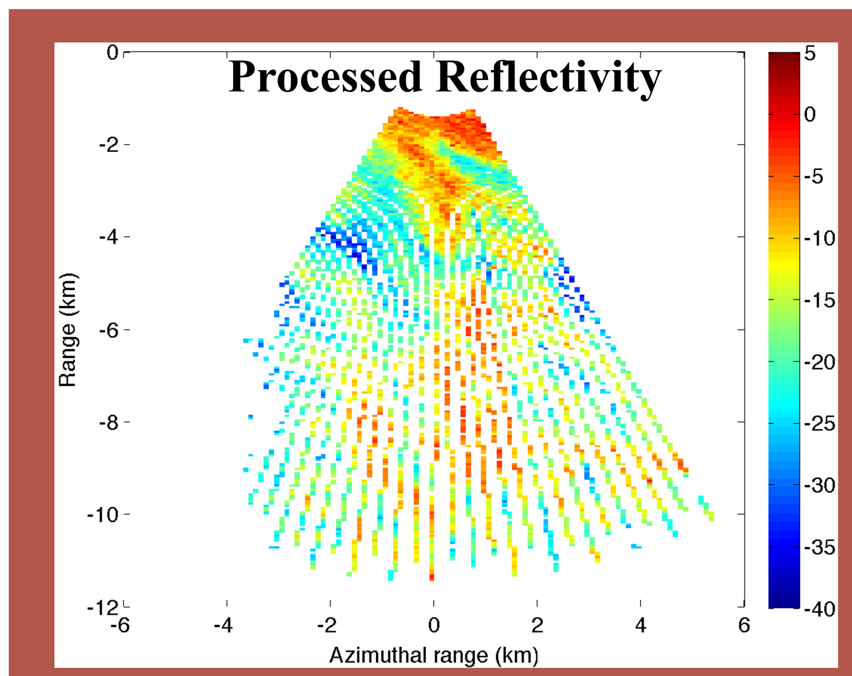
=>Need to know the environmental flow to perform tracking or,
=>Need to remove the mean wind contribution and the angular dependency to observe horizontal circulations

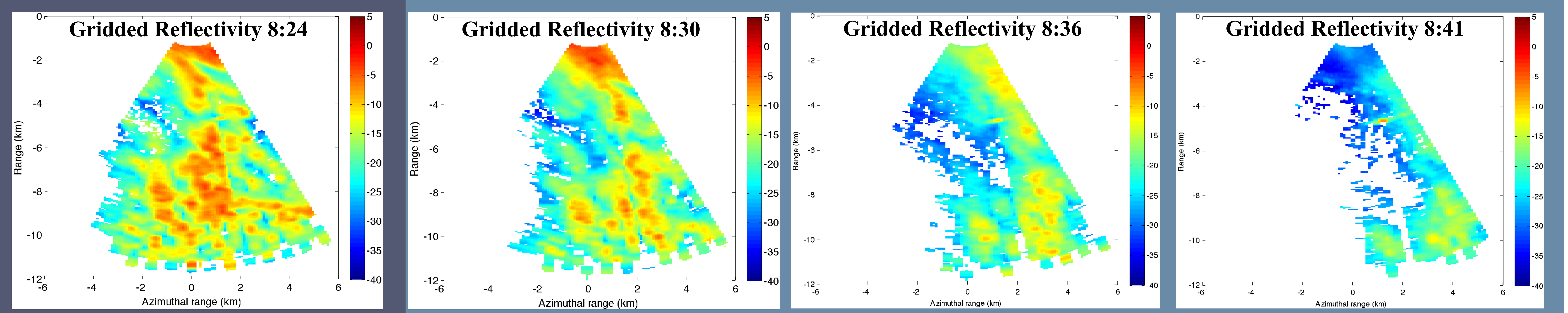
- Low frequency of soundings and high variability of winds no proper to retrieve horizontal wind
- Use the previous HS-RHI scan and the VAD technique to retrieve the mean horizontal wind speed and direction (Kollias et al. 2013b, in early release).

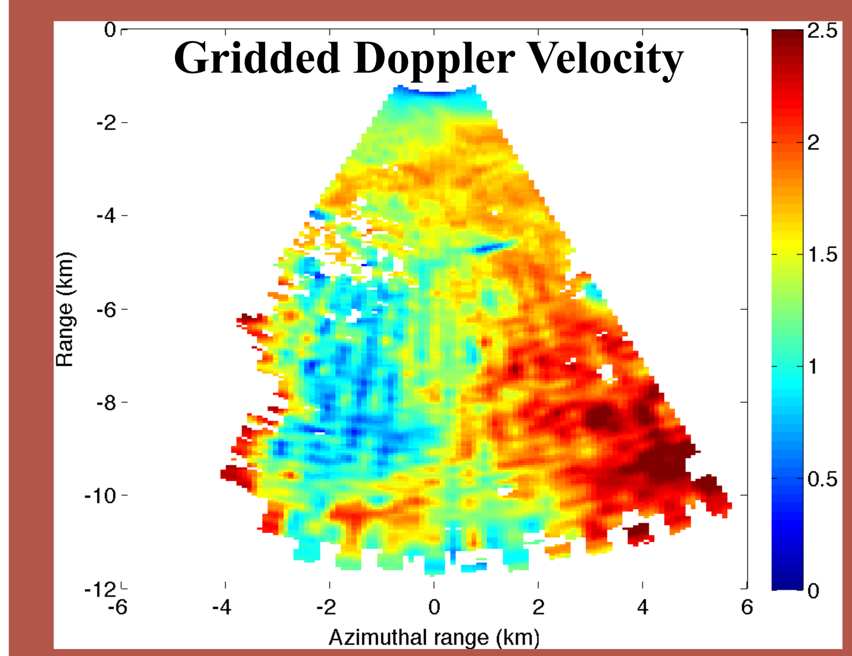
New scientific opportunities

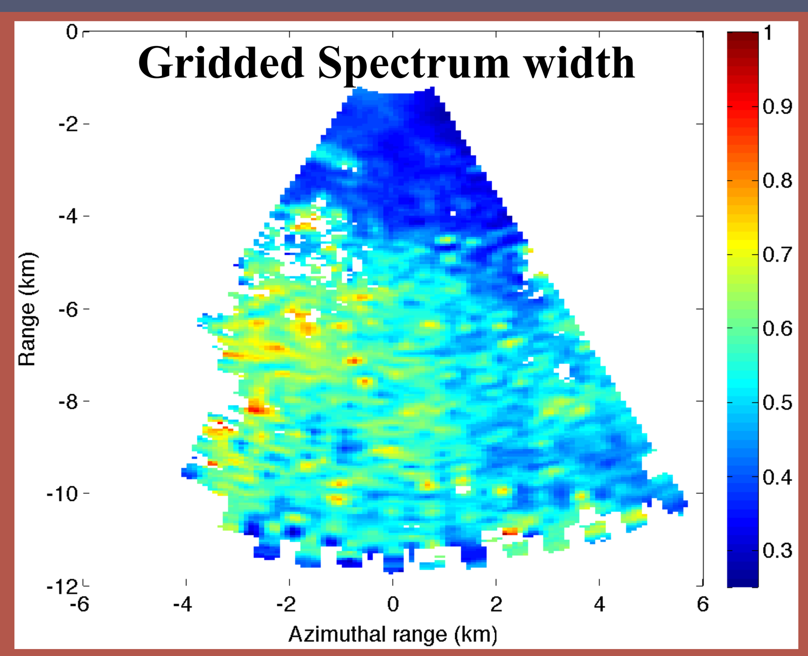
Figures: Ka-SACR BL-RHI Gridded Moments
Constant height 875m

Temporal evolution over 20minutes [4 consecutive BL-RHI scans]









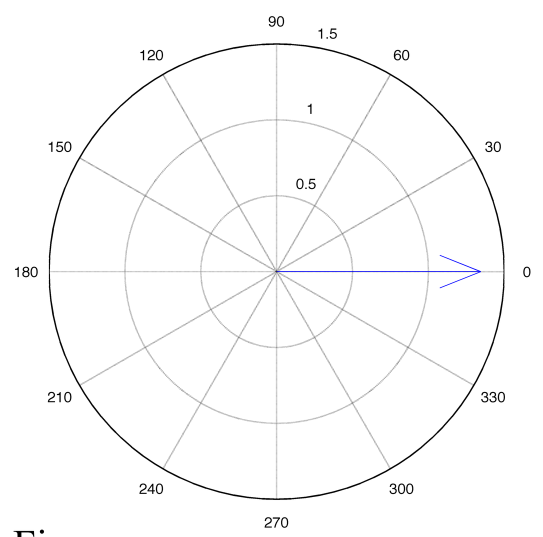


Figure:
Wind speed and direction at 875m
retrieved from KaSACR HS-RHI

Temporal evolution of 3-D gridded observations

All radar moments: Reflectivity, Doppler velocity and Spectrum width
Large domain: 20km range, 60 degree sector ≈ 120 000km²

✓ Could be compared to LES domains

Combination of HS-RHI to retrieve mean horizontal wind speed and direction and tracking algorithms

✓ Could be used to follow cloud life cycle