

# Retrieving Liquid Water Contents of Boundary-layer Clouds at MAGIC Using Dual-frequency Cloud Radars

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# Outline

- Brief History
- Advantages
- Case Selection Criteria
- MAGIC Case
- Sources of Error
- Future Work

# Brief History

- Millimeter-wave attenuation is proportional to path-integrated liquid water [Sekelsky 1996]
- Large error in liquid water content (LWC) results due to precision of reflectivity measurements [Hogan 2008]
- Decrease error sensitivity using total variation regularization techniques [Huang 2009]

# Advantages of Retrieval

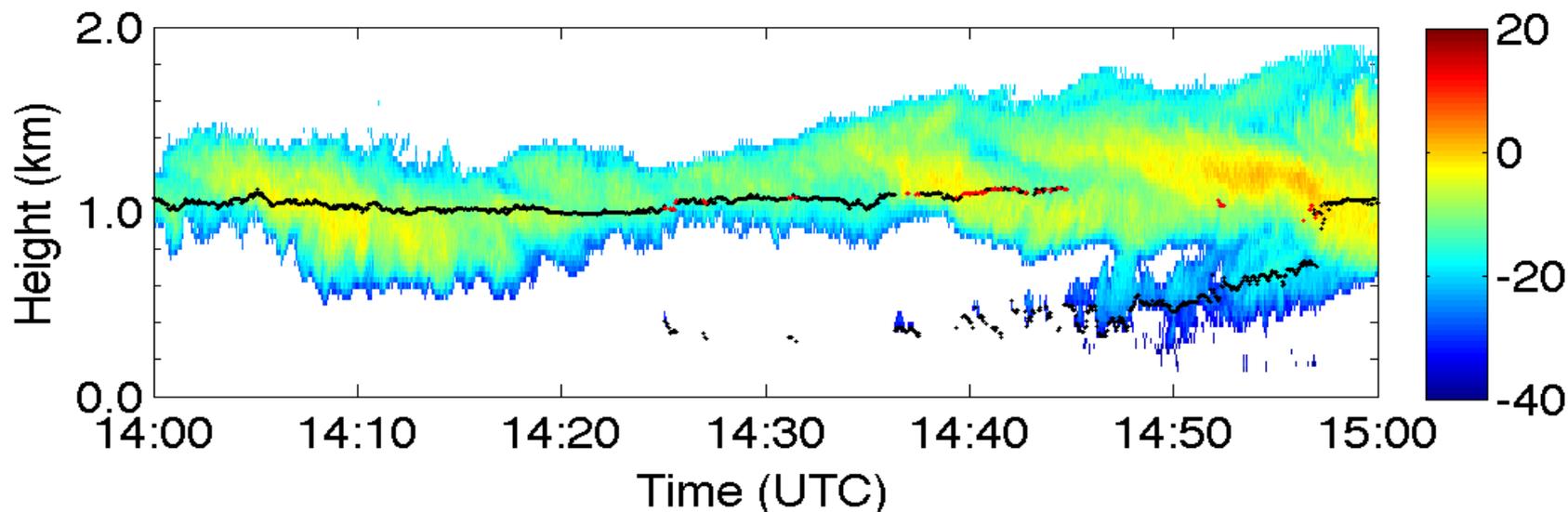
- LWC derived without assumptions of droplet size distribution
- No need for radars to be calibrated
- Captures cloud base height of drizzling clouds

# Selection Criteria

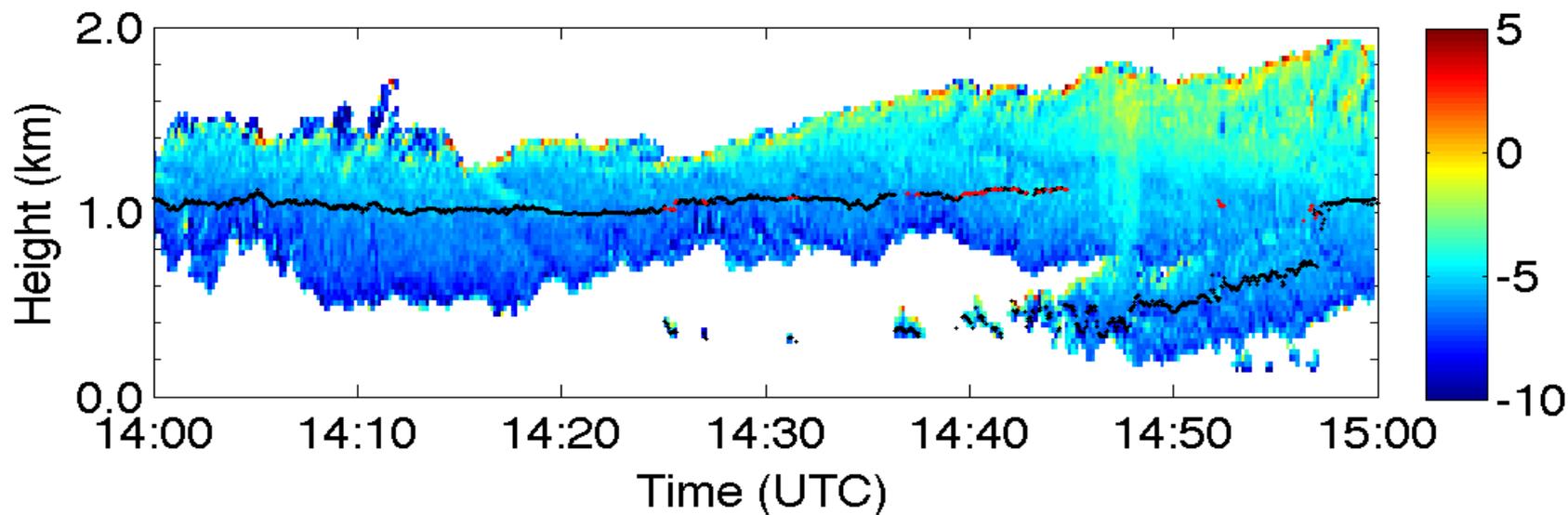
- Boundary level clouds – warm enough to be liquid only
  - Ice can dominate reflectivity yet contribute little to LWC
- Cloud drops small enough to scatter within Rayleigh regime ( $< 0.5$  mm)
  - Anything larger causes w-band reflectivity to drop

# MAGIC Case: 20121126 14:00-15:00 UTC

KAZR (dBZ)

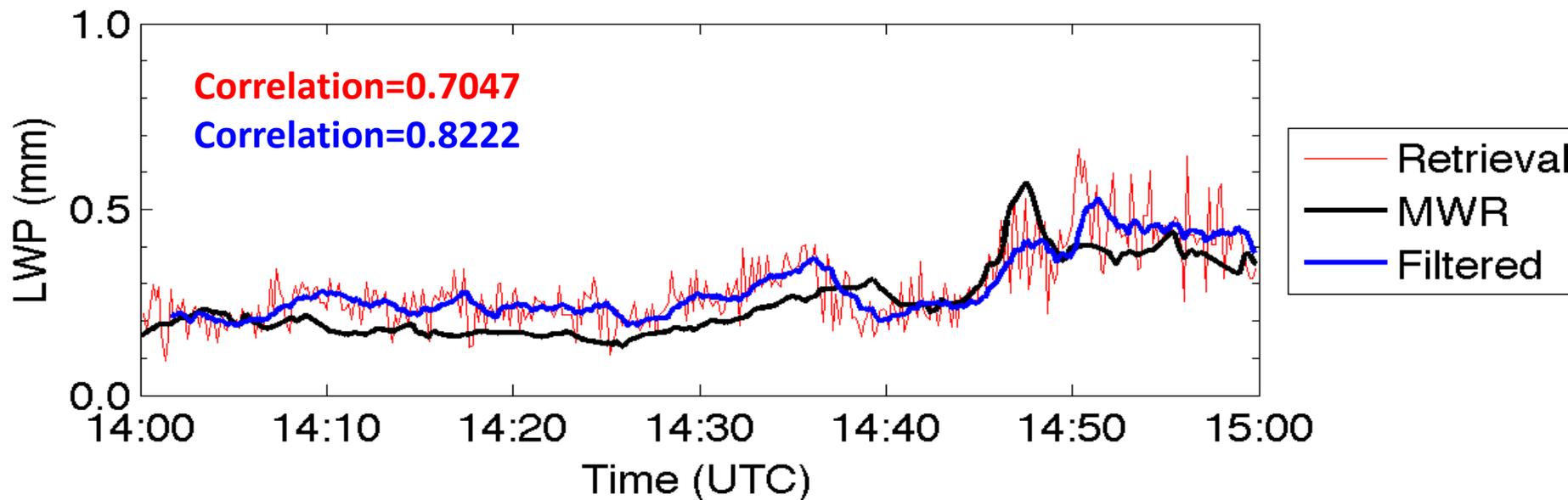
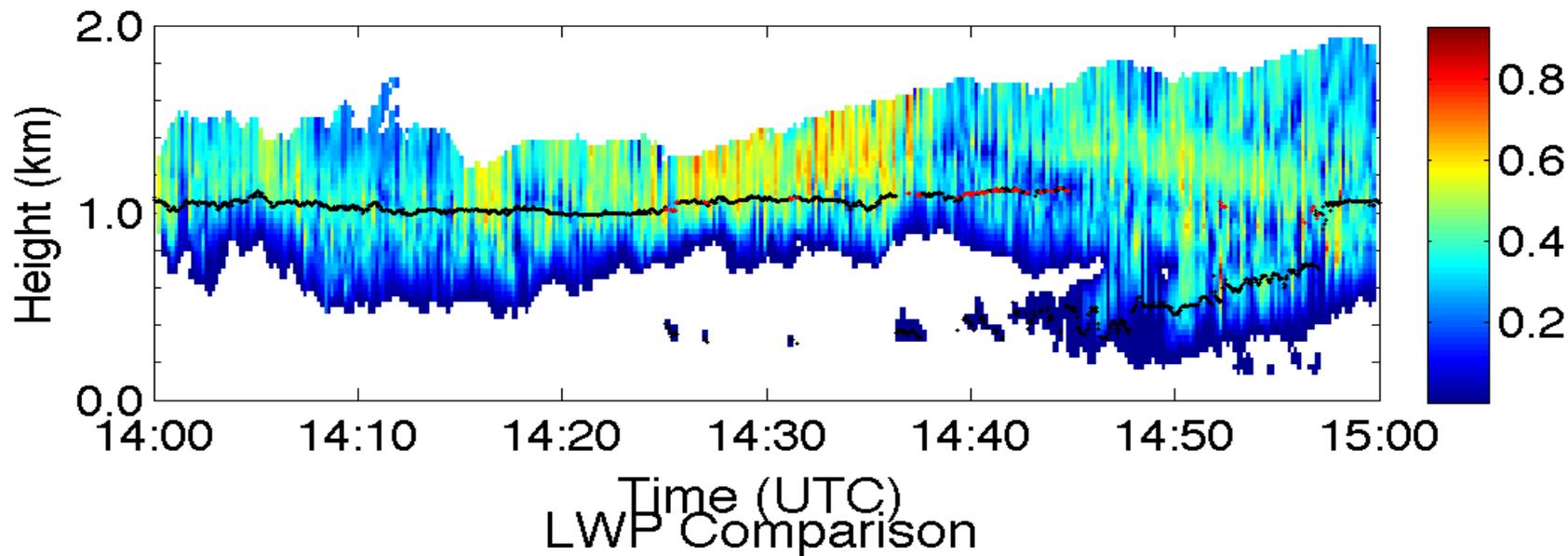


DFR (dB)

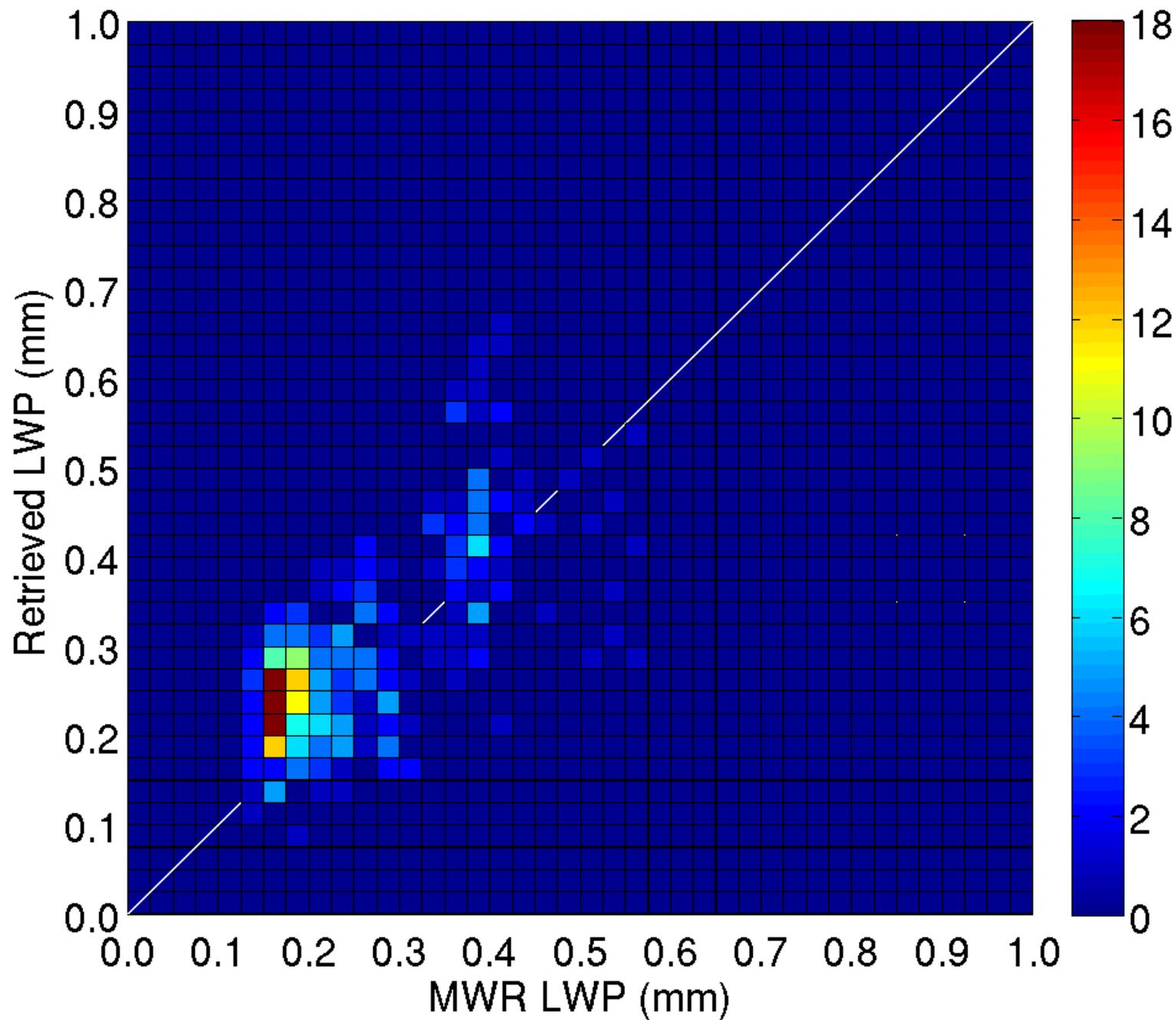


# MAGIC Case: 20121126 14:00-15:00 UTC

LWC ( $\text{g/m}^3$ )



MAGIC 20121126 Time (UTC): 14:00-15:00



# Sources of Error

- LWC accuracy depends on:
  - Precision in reflectivity measurements
    - Long radar dwell time or average over many gates is needed to reduce random noise in radar data
  - Accuracy of temperature profile from radiosondes together with temperature dependent absorption coefficients of oxygen, water vapor, and liquid water
  - Validity of Rayleigh scattering assumption
  - Overlap of the sample volumes of the radars
    - If the two radars are separated, have pointing errors, or range offsets, errors arise from cloud inhomogeneity

# Future Work

- Understand sources of error and estimate their magnitudes
- Assess satellite retrievals of cloud properties in the vicinity of the MAGIC ship tracks
  - Found one close coincidence during the first MAGIC period but there were no clouds
  - Second MAGIC period?