3D Cloud Reconstructions

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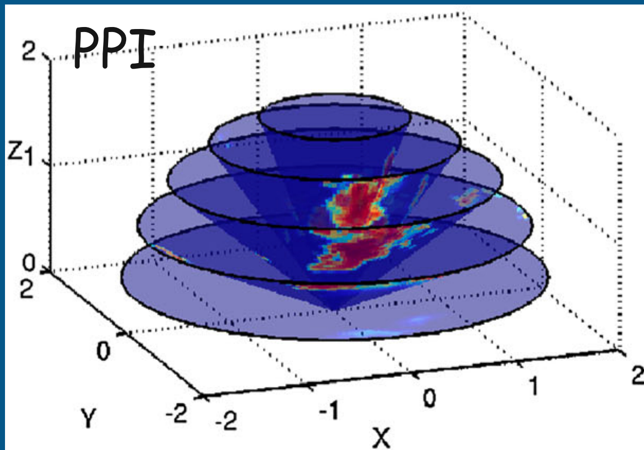
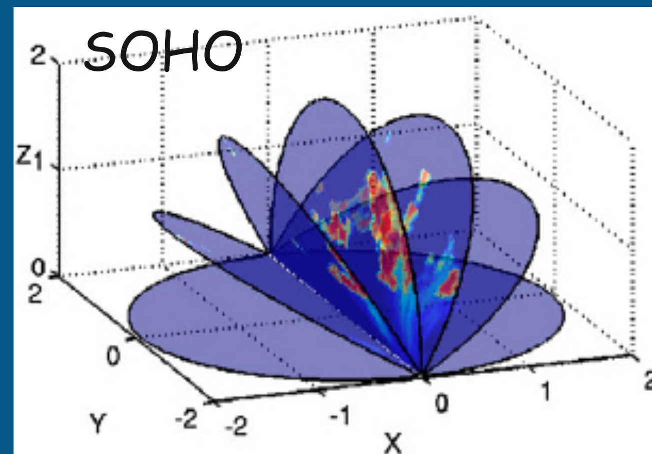
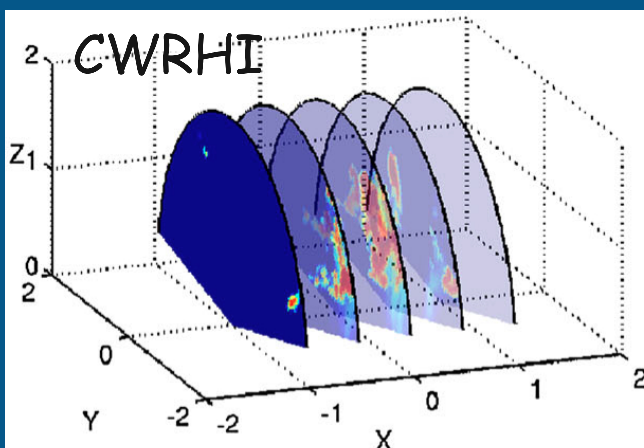
Scan strategy used in 3D cloud reconstructions



plan position indicator (PPI)

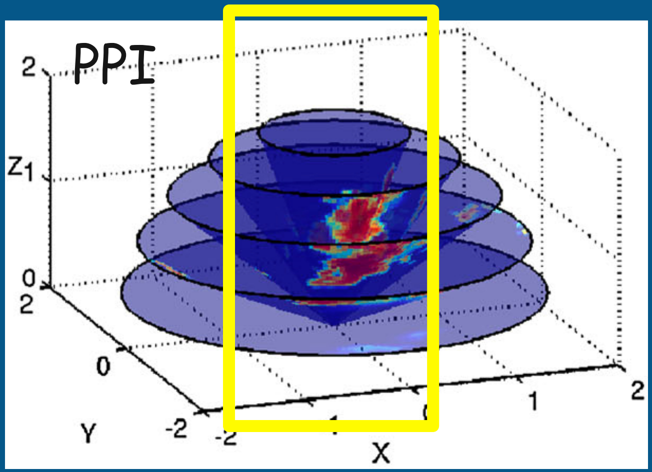




cross wind range-height indicator (CWRHI)

Fielding et al., 2013, 3D cloud reconstructions: Evaluation of scanning radar scan strategy with a view to surface shortwave radiation closure, JGR, doi:10.1002/jgrd.50614.

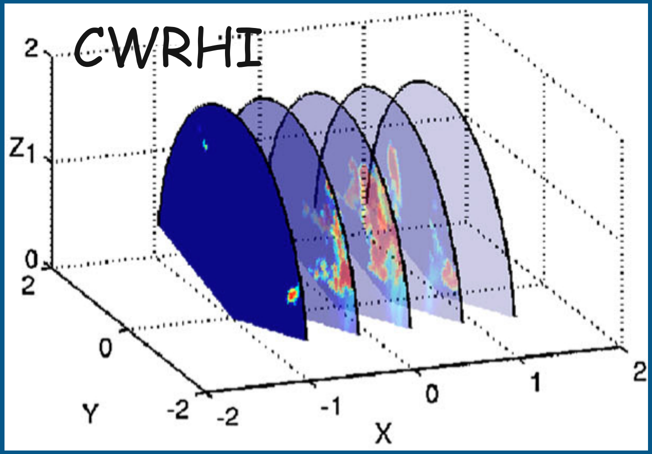
Scan strategy used in 3D cloud reconstructions



plan position indicator (PPI)

parameter	PPI	BLRHI
Elevation (°)	0: 3: 42	0: 45
Azimuth (°)	90 – 270	75: 2: 165
Time (min)	8	5.3

Courtesy of Zuidema



cross wind range-height indicator (CWRHI)

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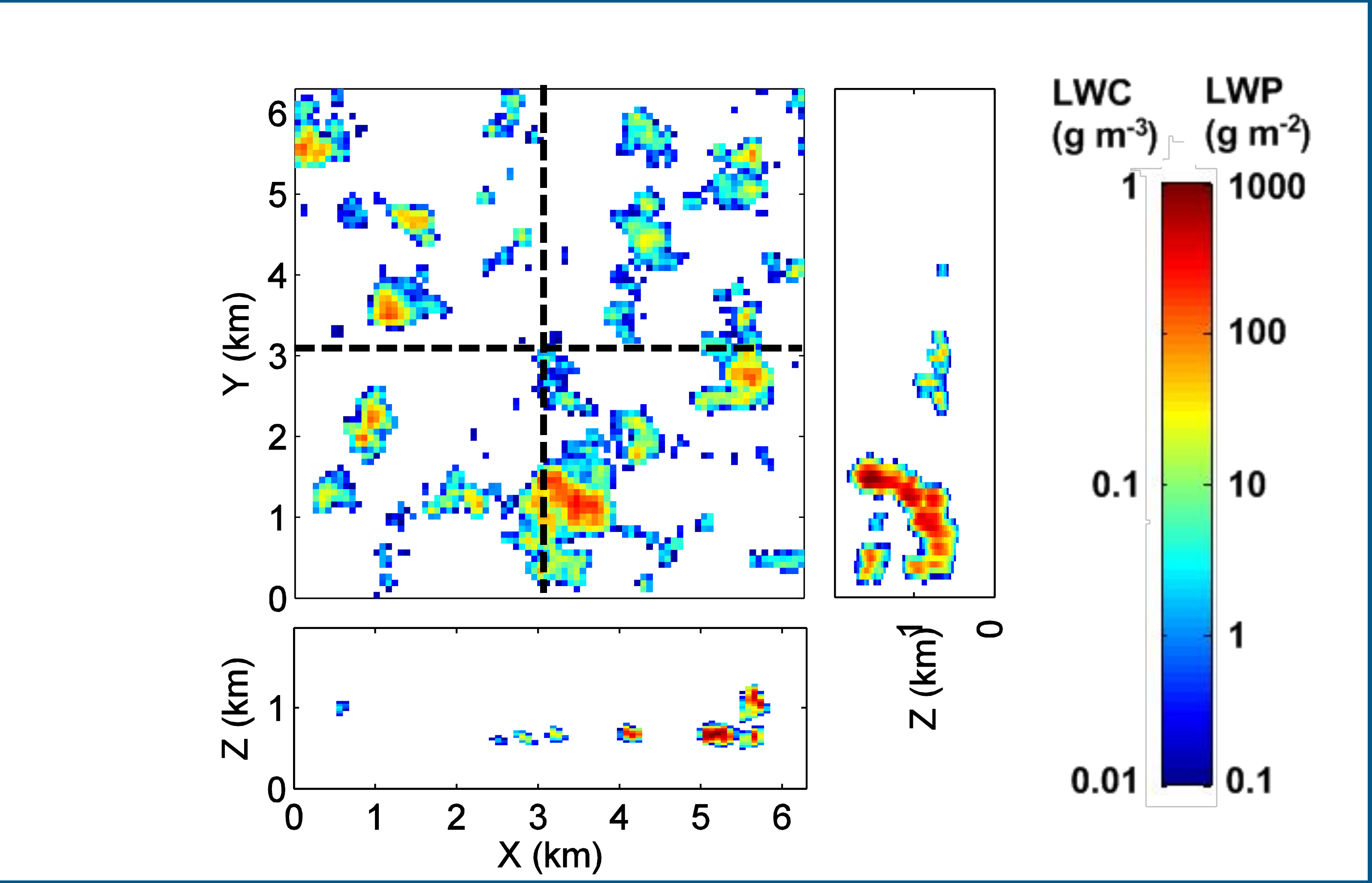
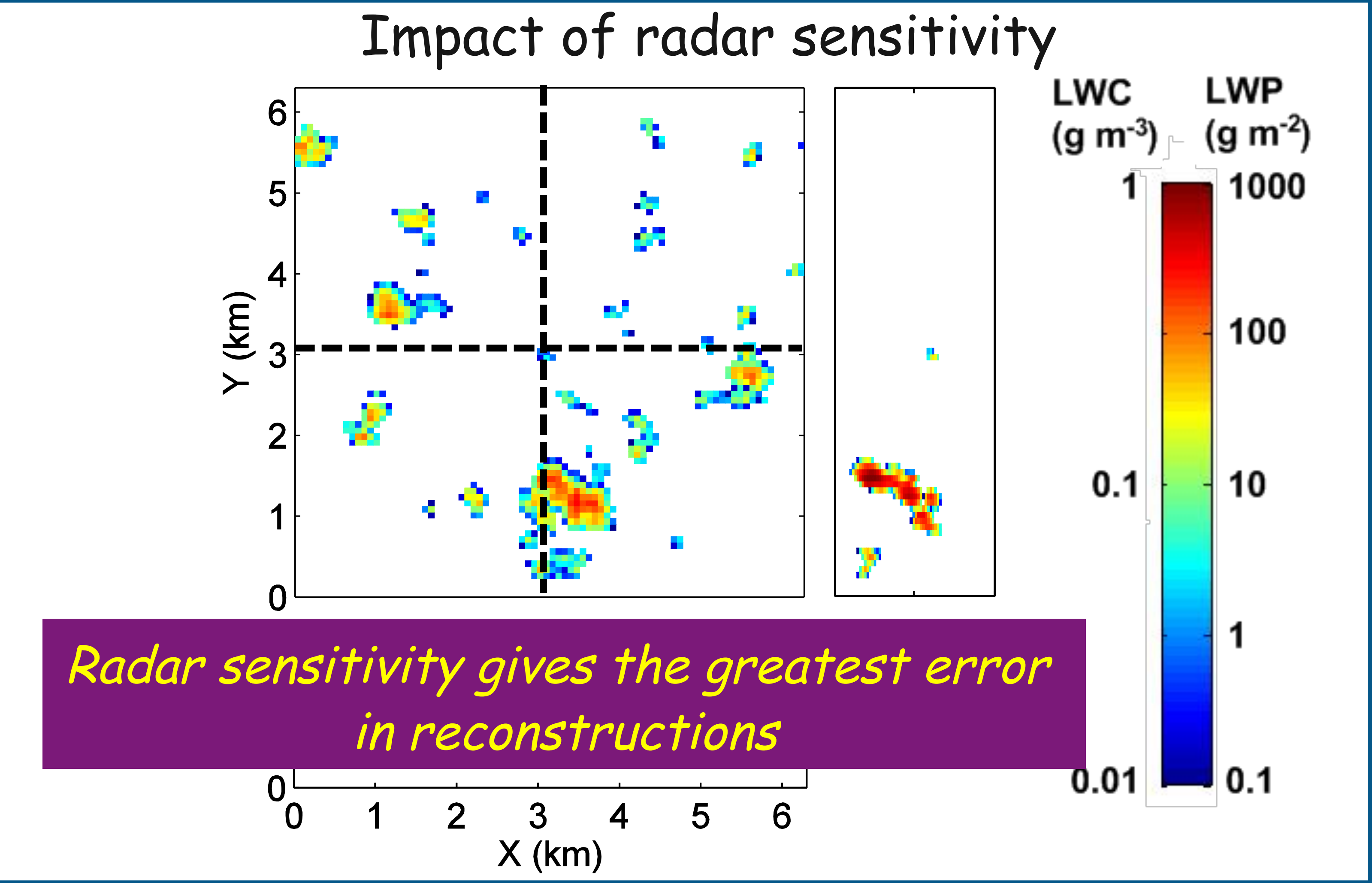
Small and thin clouds will be easily missed by old scanning cloud radar



Fielding et al. (JGR, 2013)

Small and thin clouds will be easily missed by <u>old</u> scanning cloud radar



Radar sensitivity gives the greatest error in reconstructions

Fielding et al. (JGR, 2013)

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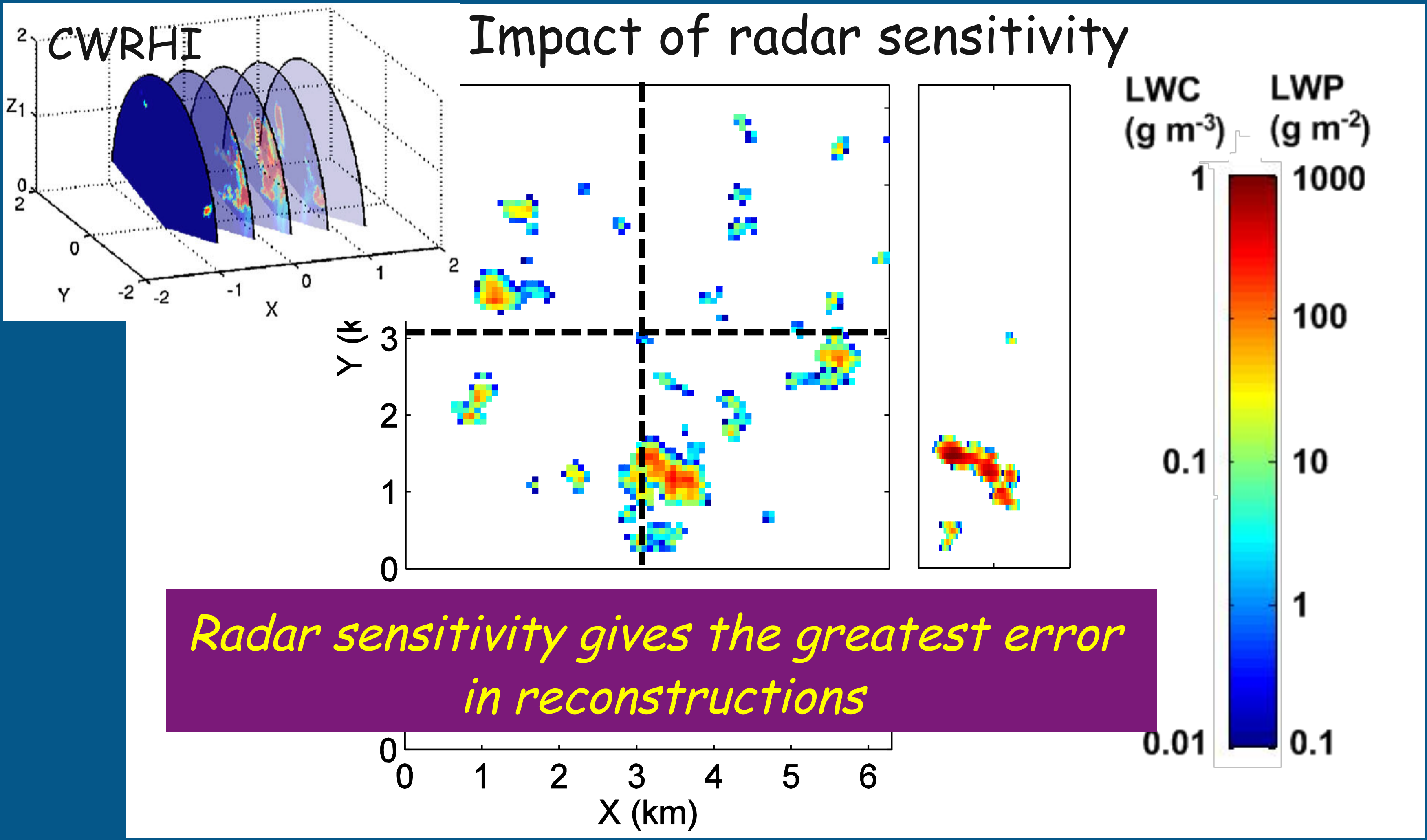
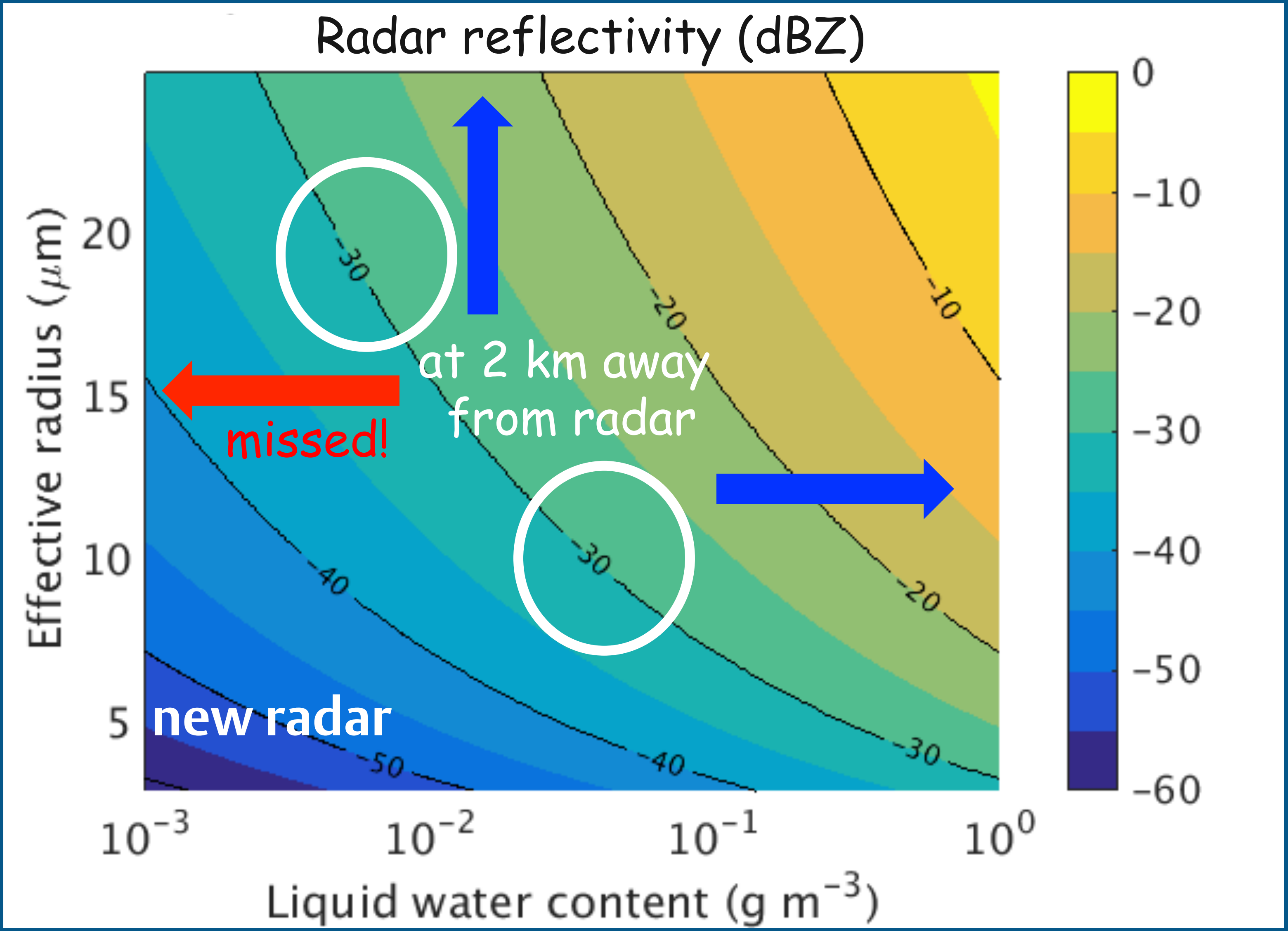


Radar sensitivity gives the greatest error in reconstructions

Fielding et al. (JGR, 2013)

Sensitivity of scanning cloud radars



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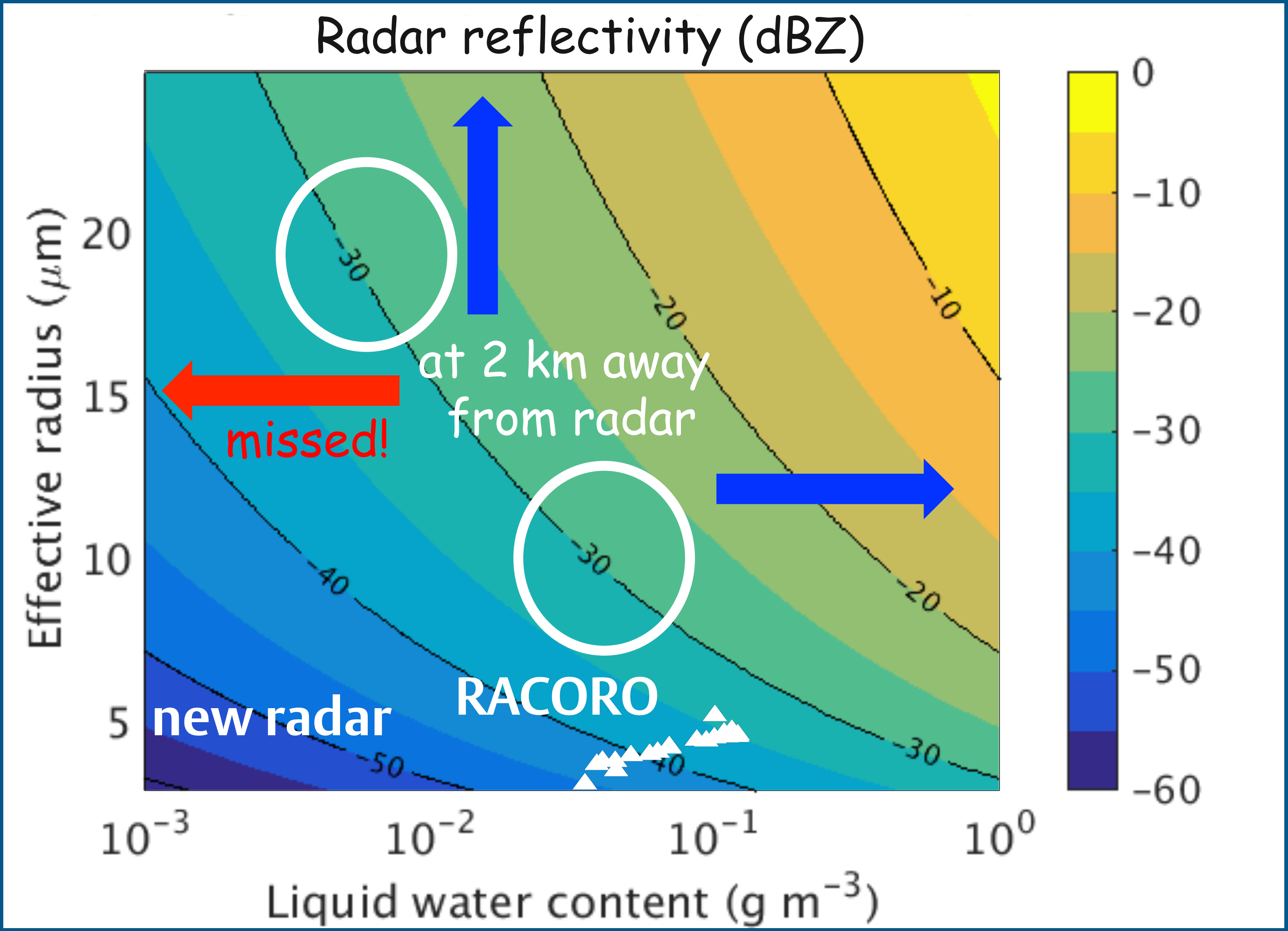
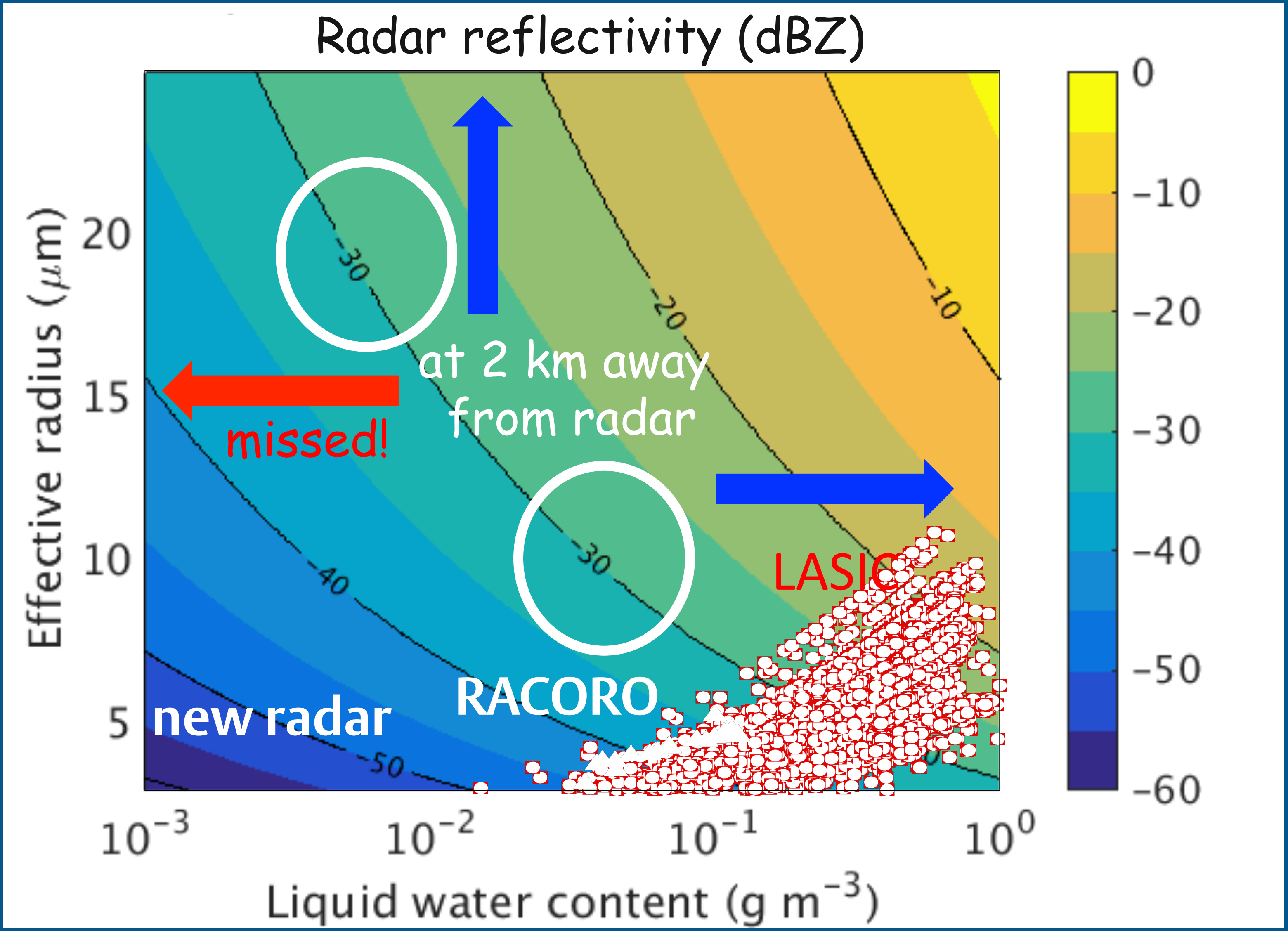
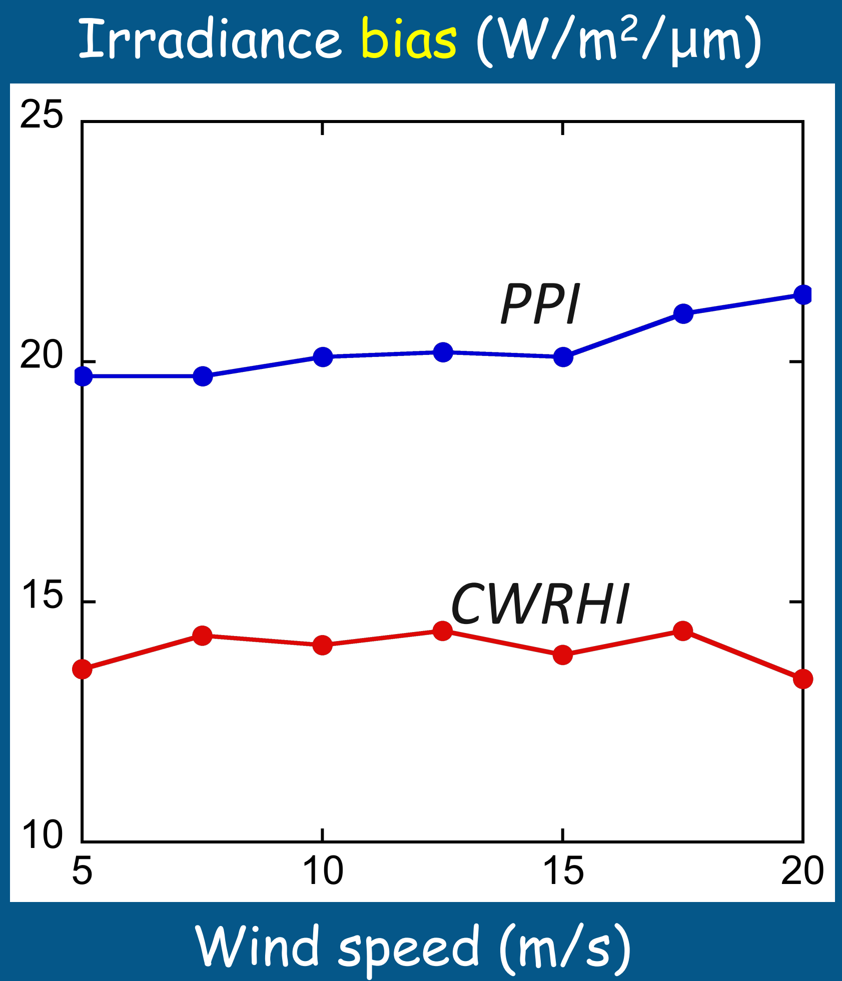
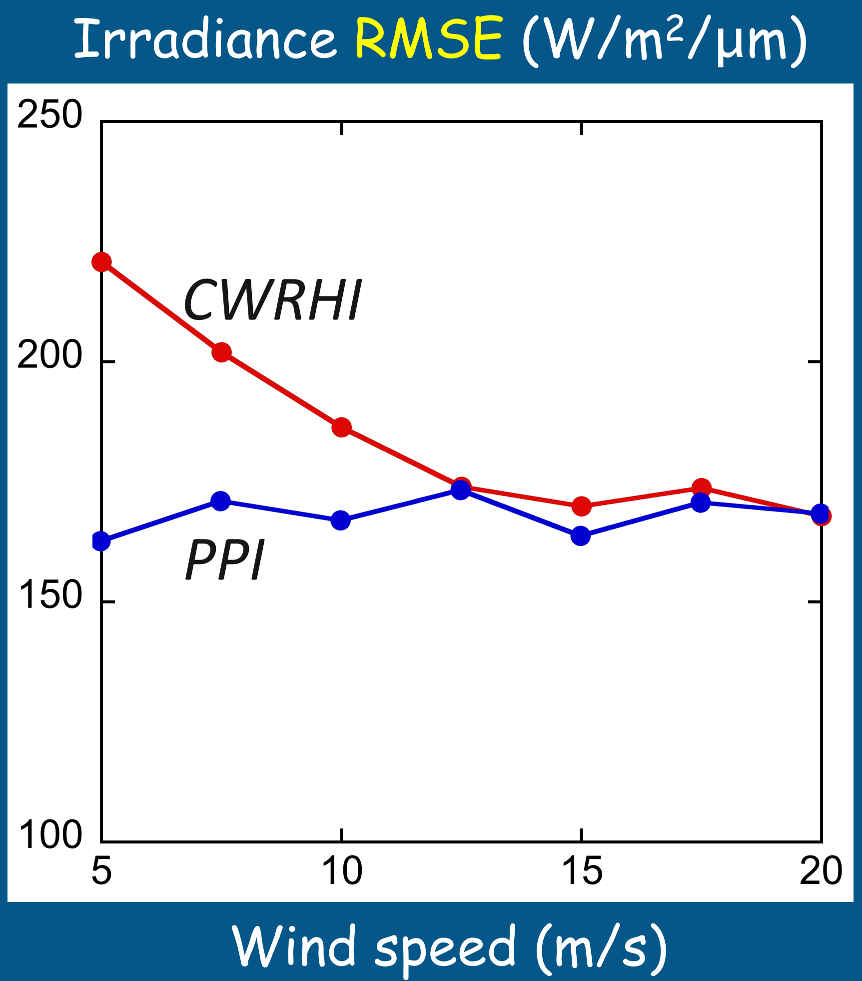


Sensitivity of scanning cloud radars



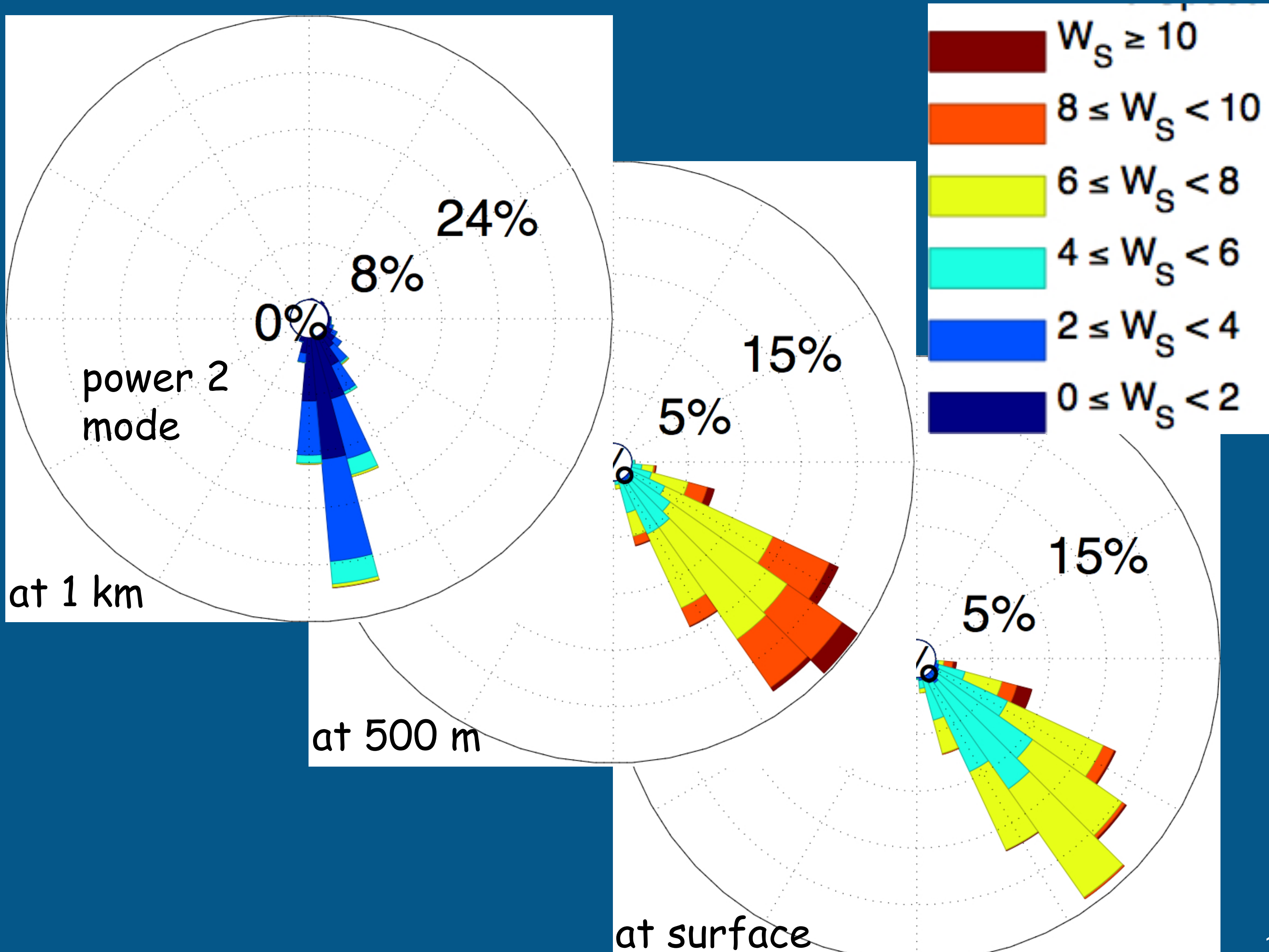
Low wind speed conditions could potentially lead to a poor reconstruction





Fielding et al. (JGR, 2013)

Wind conditions during LASIC



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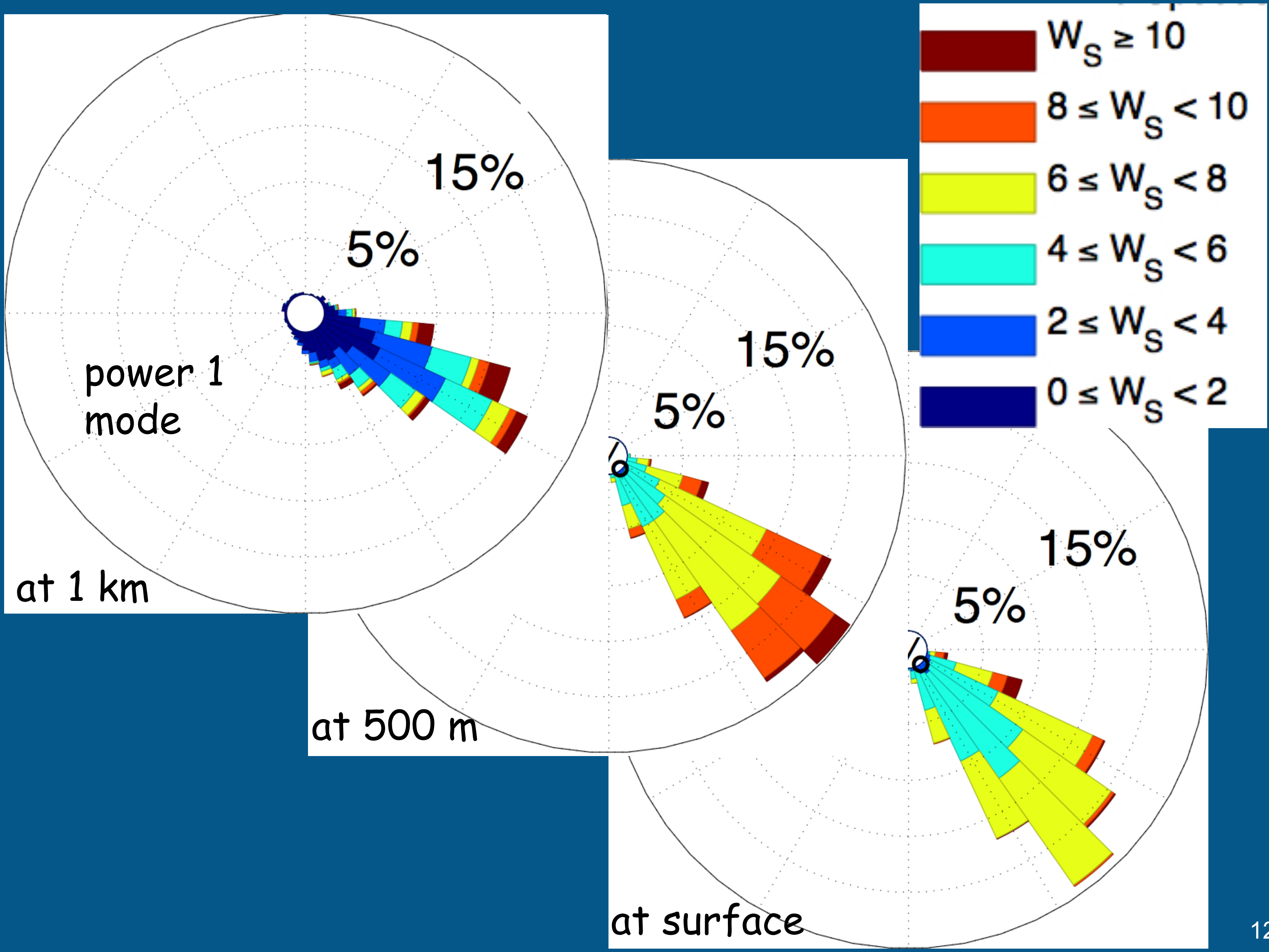
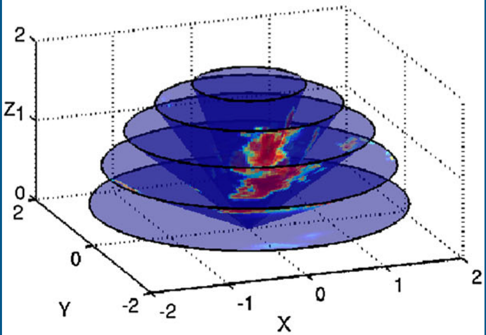
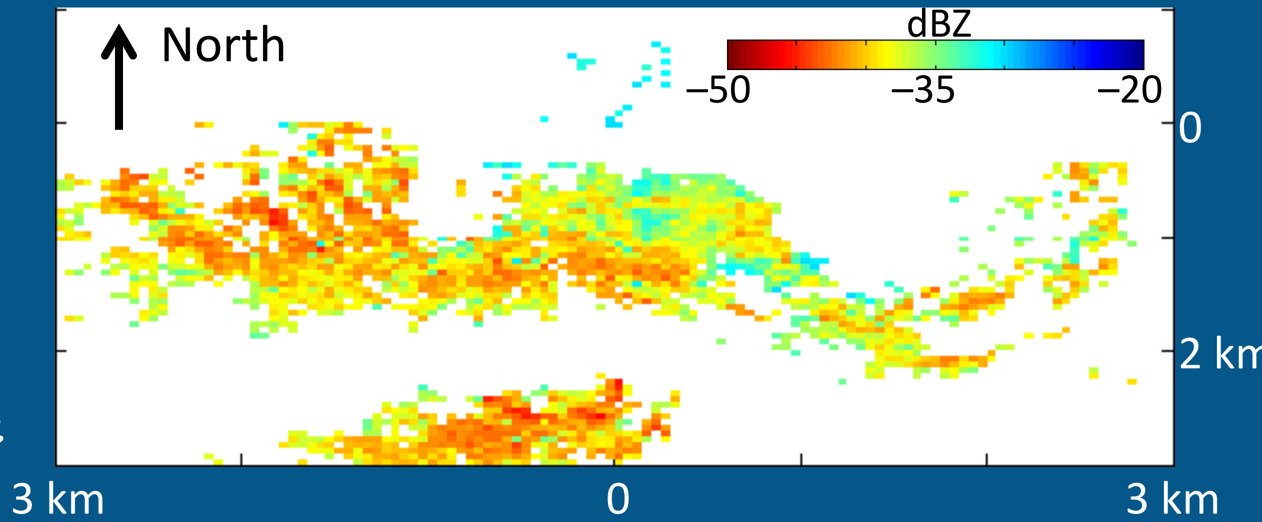


Reconstructed cloud fields from LASIC

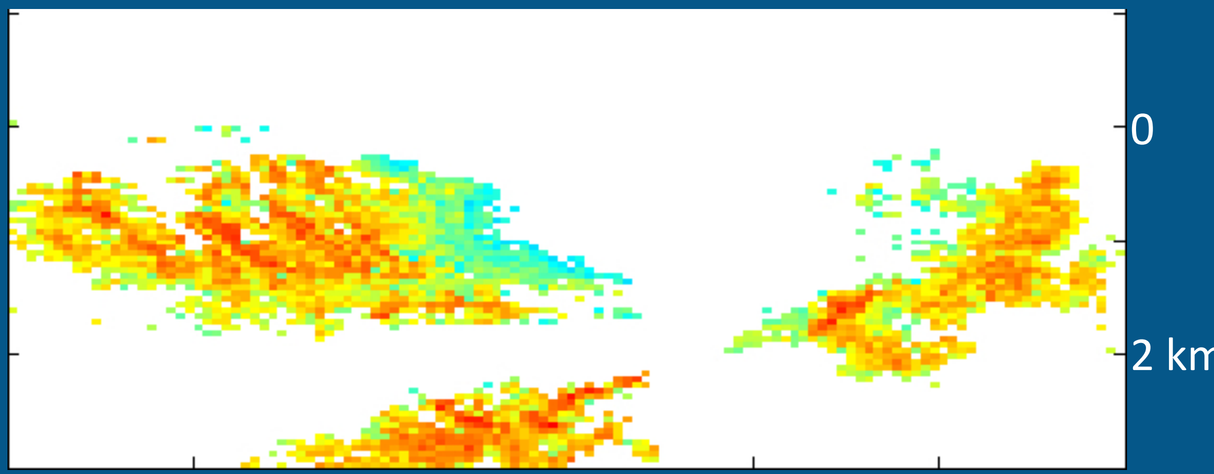
- Reconstructions rely on sufficiently good wind radar data



High-power mode



Low-power mode



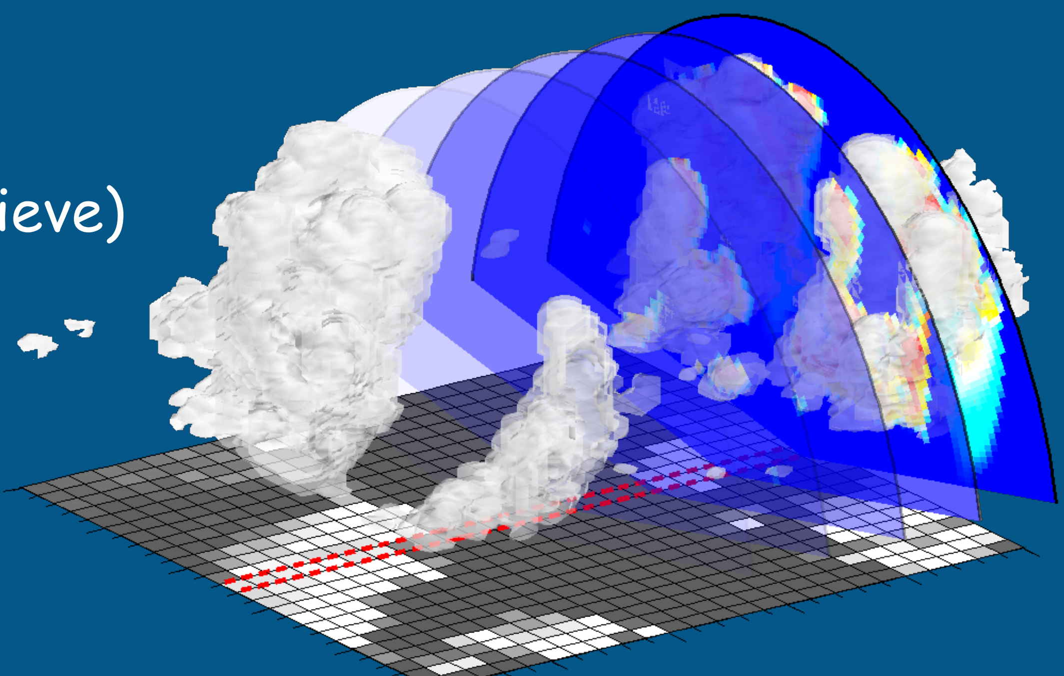
July 22, 2016

Novel 3D cloud retrieval (ENCORE)

- Combine scanning cloud radar and shortwave radiometer obs.
- Include 3D radiative transfer as a forward model
- Use the Iterative Ensemble Kalman Filter as an optimal estimation framework

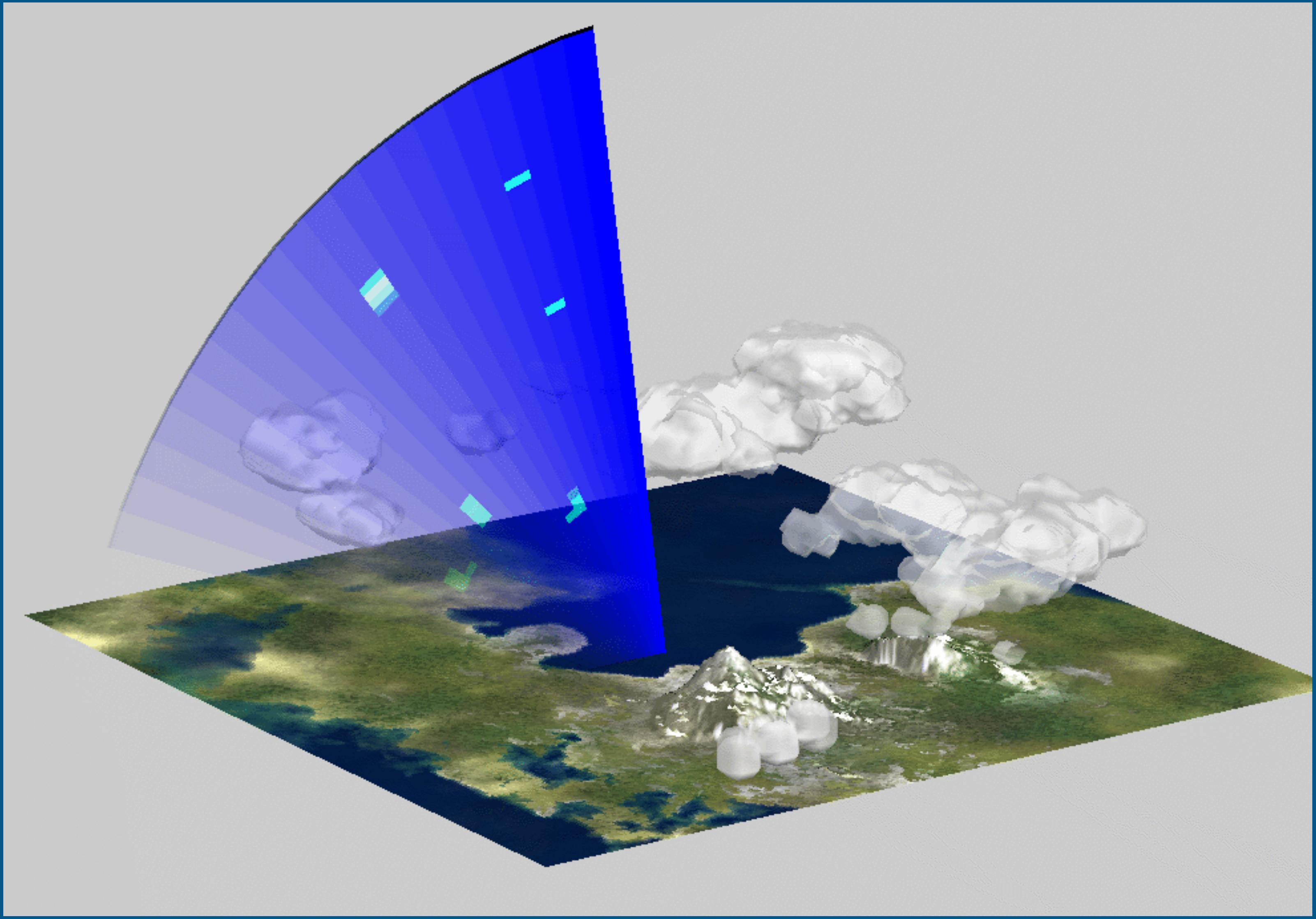
State vector (what we retrieve)

- *Total cloud droplet number concentration*
- *Cloud water content*
- *Cloud effective radius*

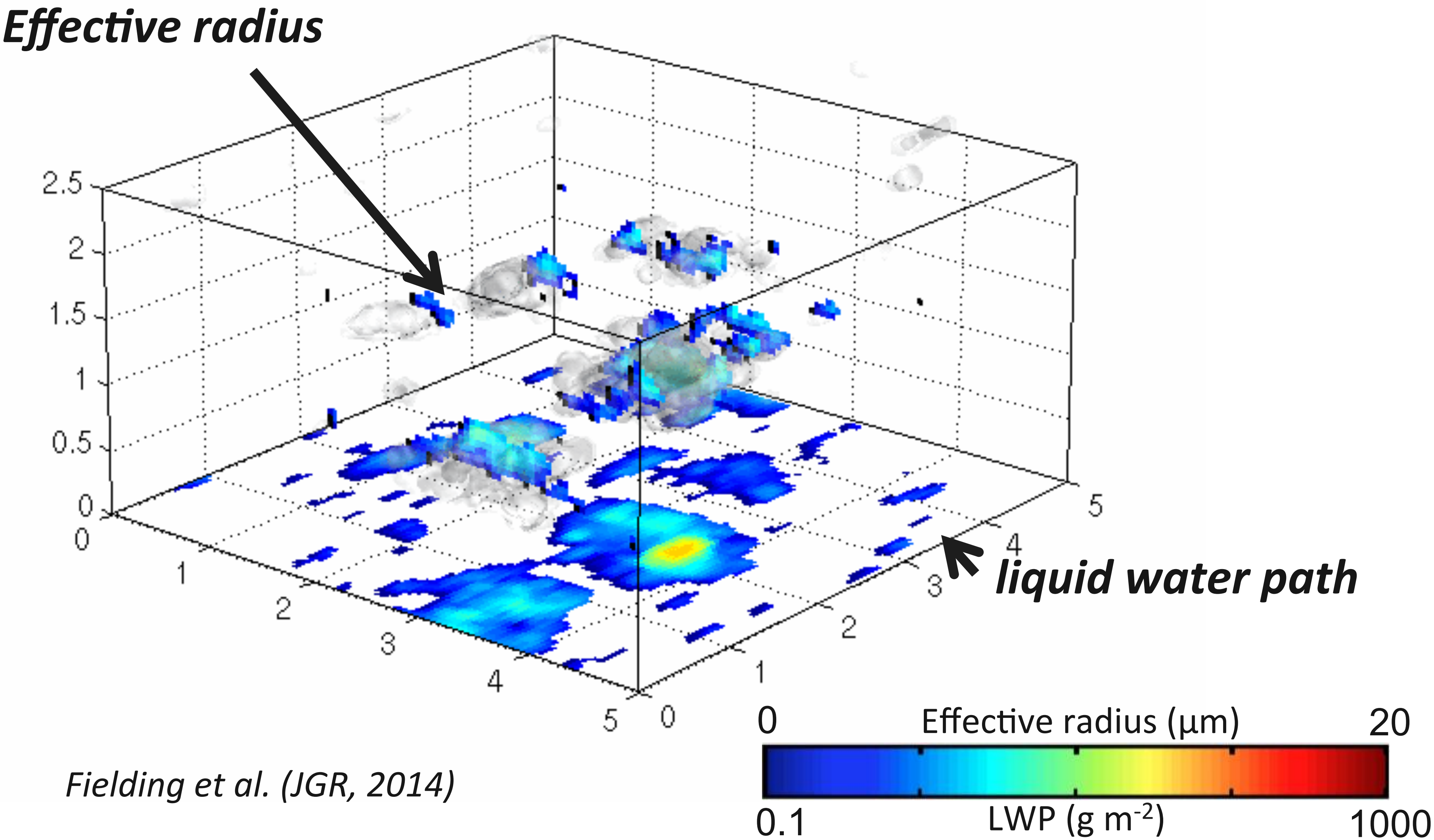


Fielding et al., 2014, A novel ensemble method for retrieving properties of warm cloud in 3-D using ground-based scanning radar and zenith radiances, JGR, doi:10.1002/ 2014JD021742.

Examples from the ARM Mobile Facility deployment at the Azores



Shallow cumulus at the Azores



Fielding et al. (JGR, 2014)

Radiation scheme incorporating 3D effects

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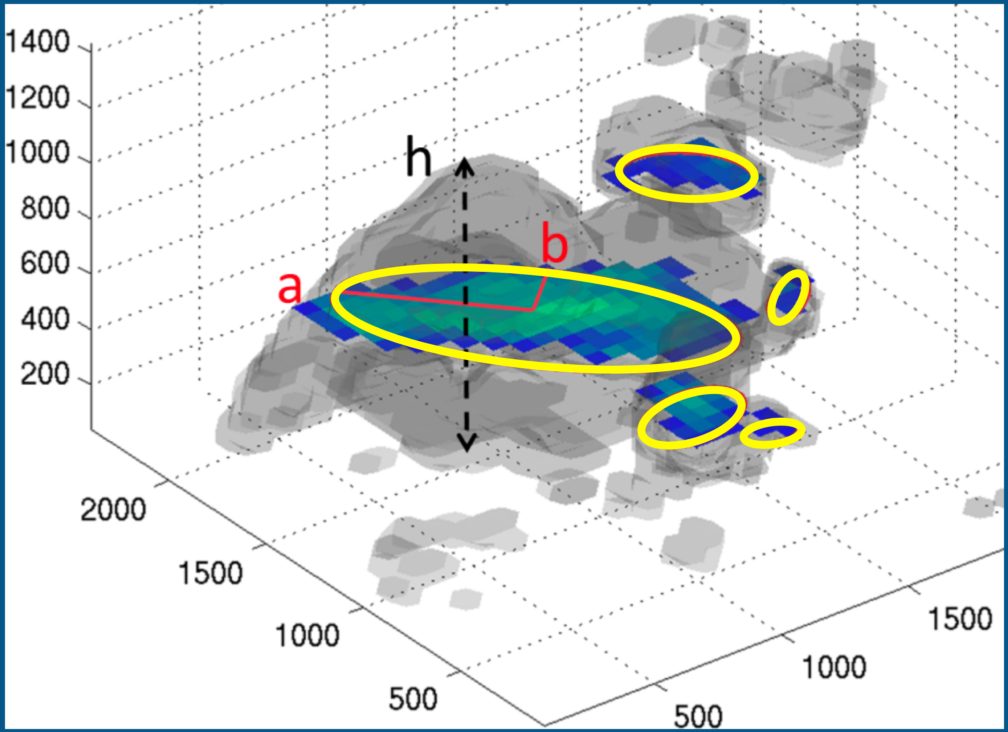
- Speedy Algorithm for Radiative TrAnsfer through CloUd Sides (SPARTACUS; Hogan and Shonk, 2013)

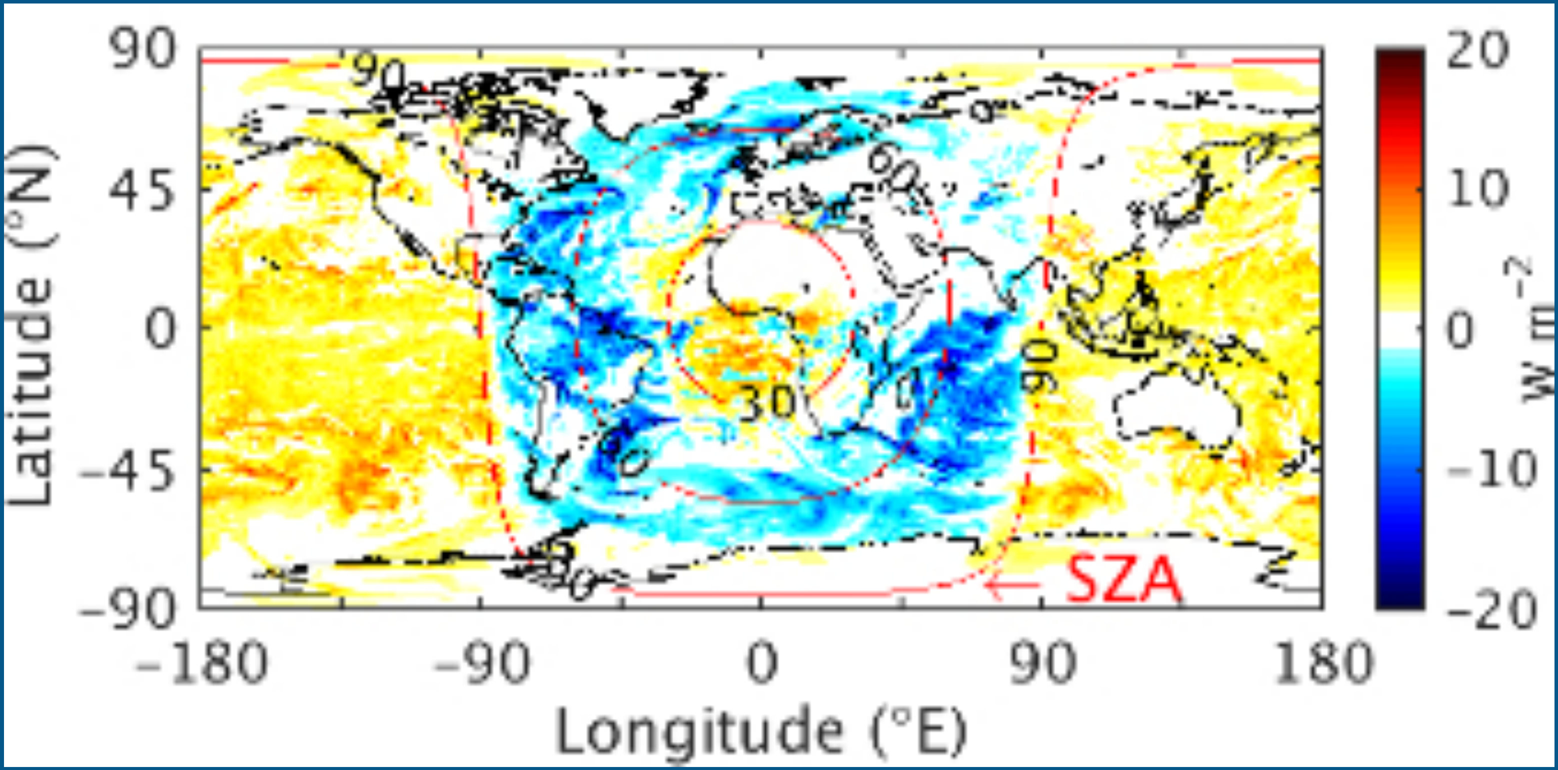
- Variables needed for this fast scheme
  - *cloud water content*
  - *cloud effective radius*
  - *cloud fraction*
  - *cloud inhomogeneity*
  - *overlap*
  - *Cloud-side length*

Schäfer et al. (JGR, 2016)
Hogan et al. (JGR, 2016)



An example snapshot of 3D cloud effect

Difference in net cloud radiative effect at surface
(with minus without 3D)



Schäfer (PhD Thesis, 2016)

Summary

- Proper 3D cloud reconstructions allow us to characterize cloud populations for radiation schemes, and to track individual clouds for studying their life cycles

- The current scanning cloud radar appears to have sufficient sensitivity to capture cumulus clouds (with 5 microns effective radius)

- We need to resolve the issue with wind radar profiler products