Statistics of Vertical Velocity in Congestus, Deep and Over-shooting Clouds

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Australian Government
Bureau of Meteorology

The Centre for Australian Weather and Climate Research
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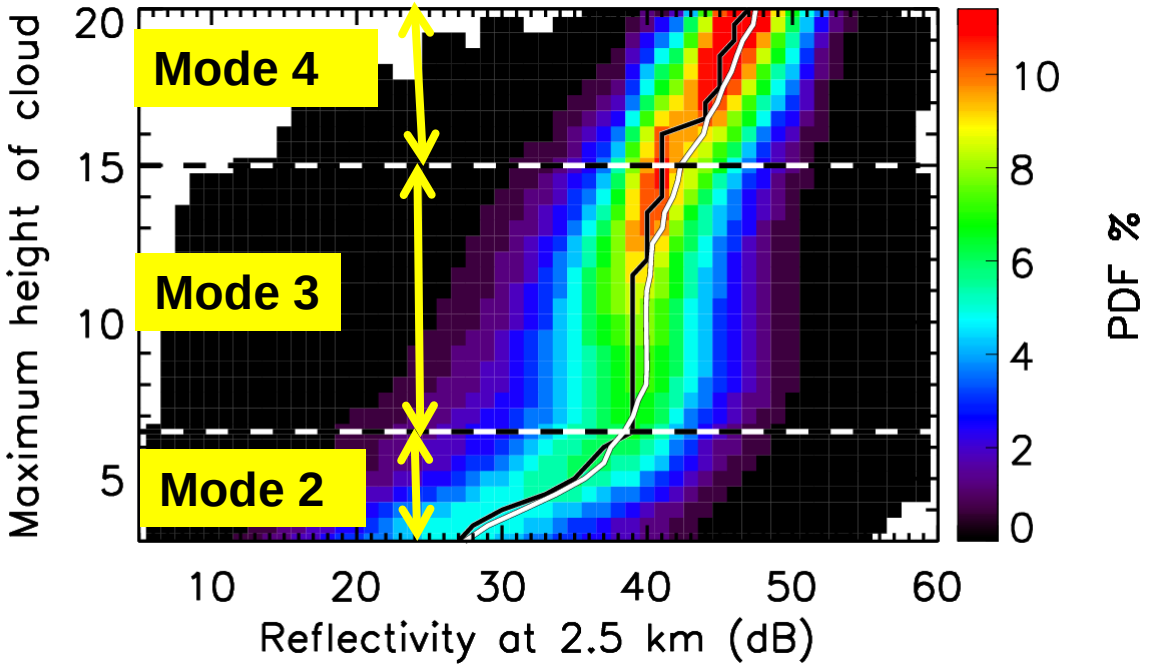
CSIRO

PDF of cloud cell reflectivity from the 2.5 km height level as a function of cloud top height (CTH)



The data is from the 2.5 km height. Selecting only reflectivity pixels that belonged to given CTH bin and then constructing a PDF of the data

Mode 2: Congestus cloud category, with highest level of mid-level stability (30 %)

Mode 3: Normal deep convective cloud, air in this region is radiatively cooling (64 %)

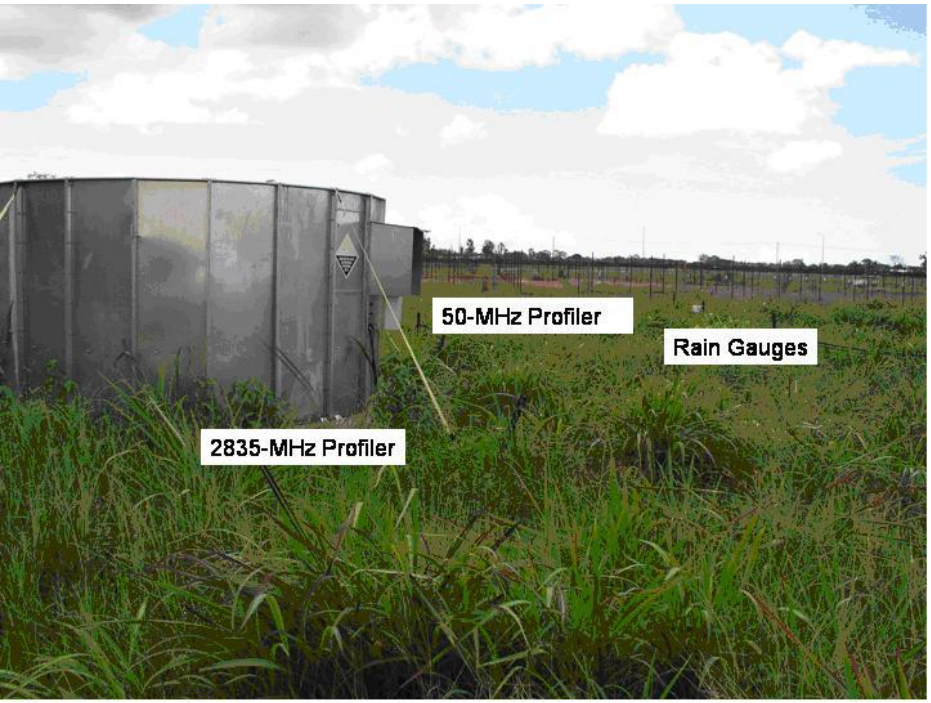
Mode 4: Over-shooting deep convection, air is this is region is radiatively heated (6 %)

See our poster for more details

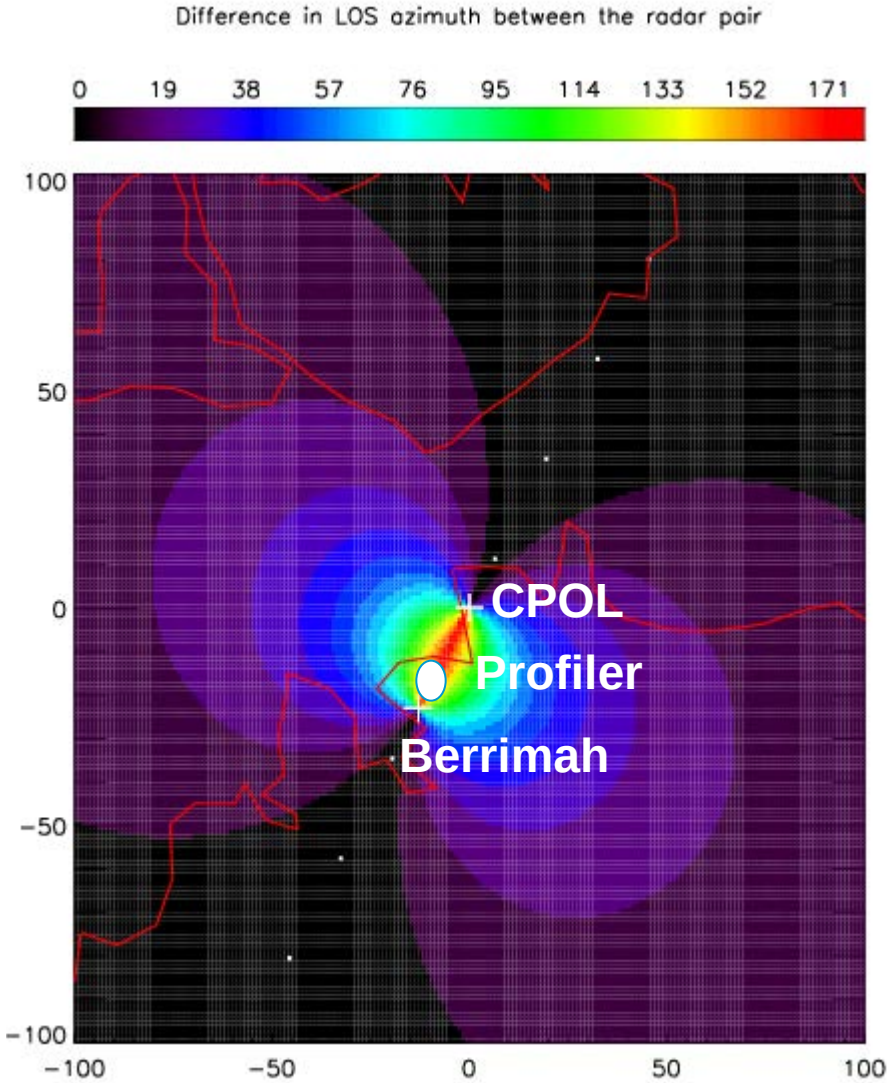
Measurement of vertical motion in cumulus clouds



Using the Darwin 50 and 920 MHz wind profiler combinations



Using the Darwin C-band radar pair

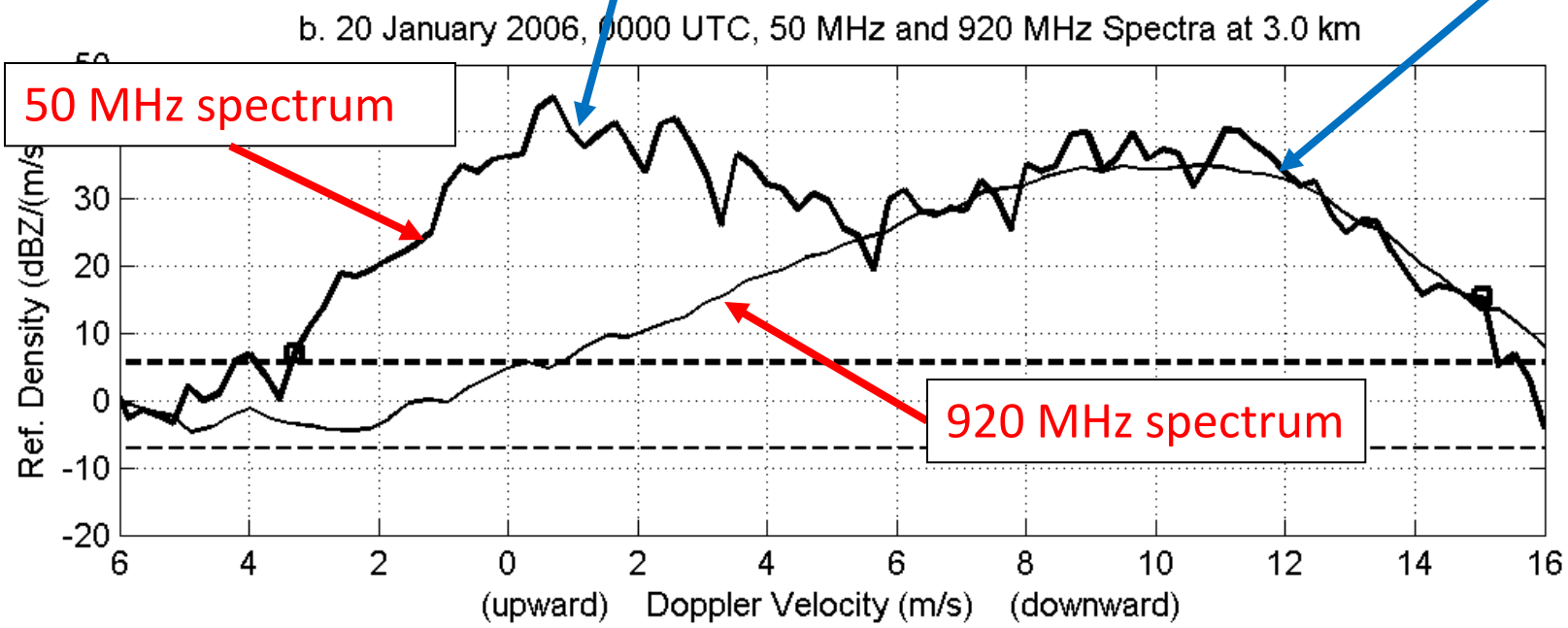


Vertical winds from the wind profiler combination

This peak due to Bragg Scattering

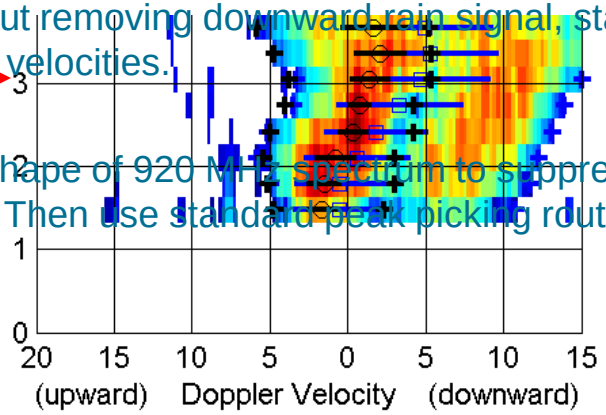
50 MHz Profiler

This peak due to Rayleigh Scattering

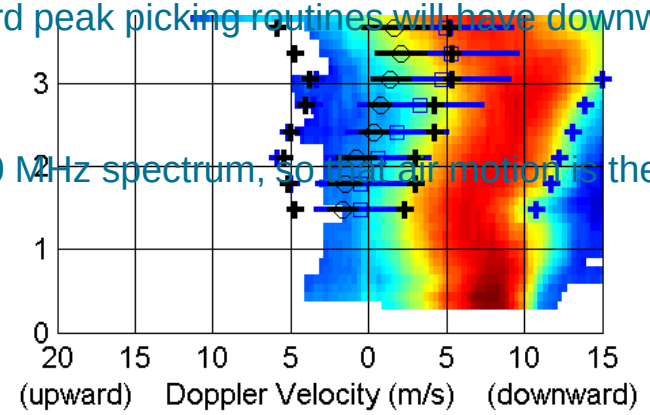


Without removing downward rain signal, standard peak picking routines will have downward biased mean velocities.

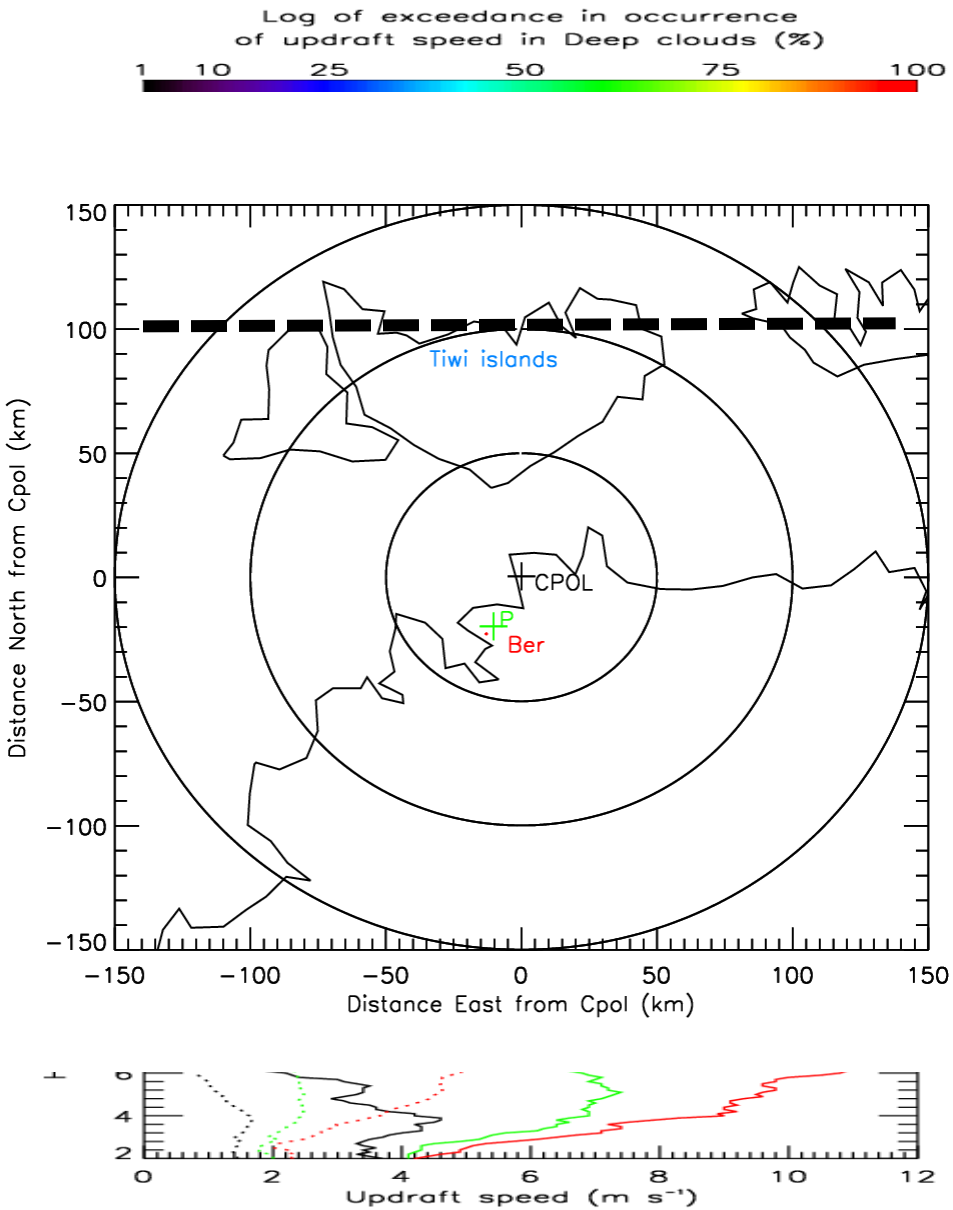
3 km



Use shape of 920 MHz spectrum to suppress 50 MHz spectrum, so that air motion is the dominant peak. Then use standard peak picking routines.

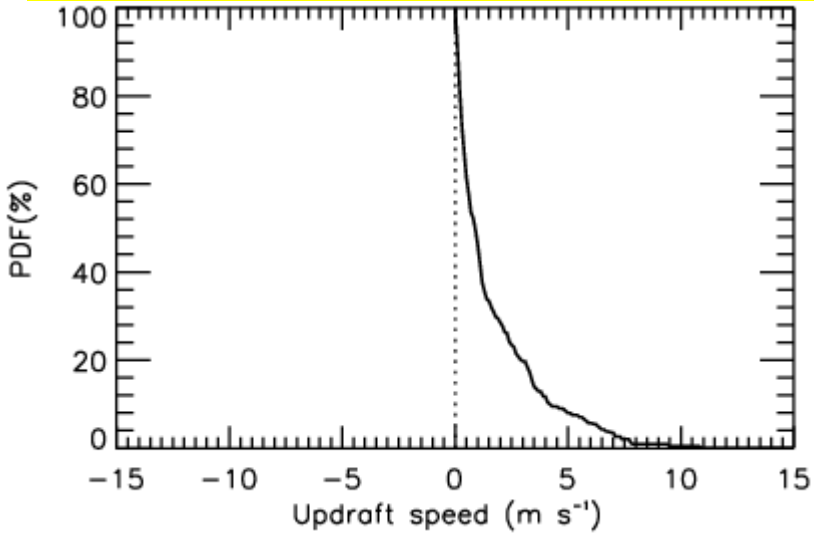


Statistics of vertical velocity in the three cumulus modes.



1. The CTH information over the Wind Profiler site is

PDF of Updraft speed at 4 km height

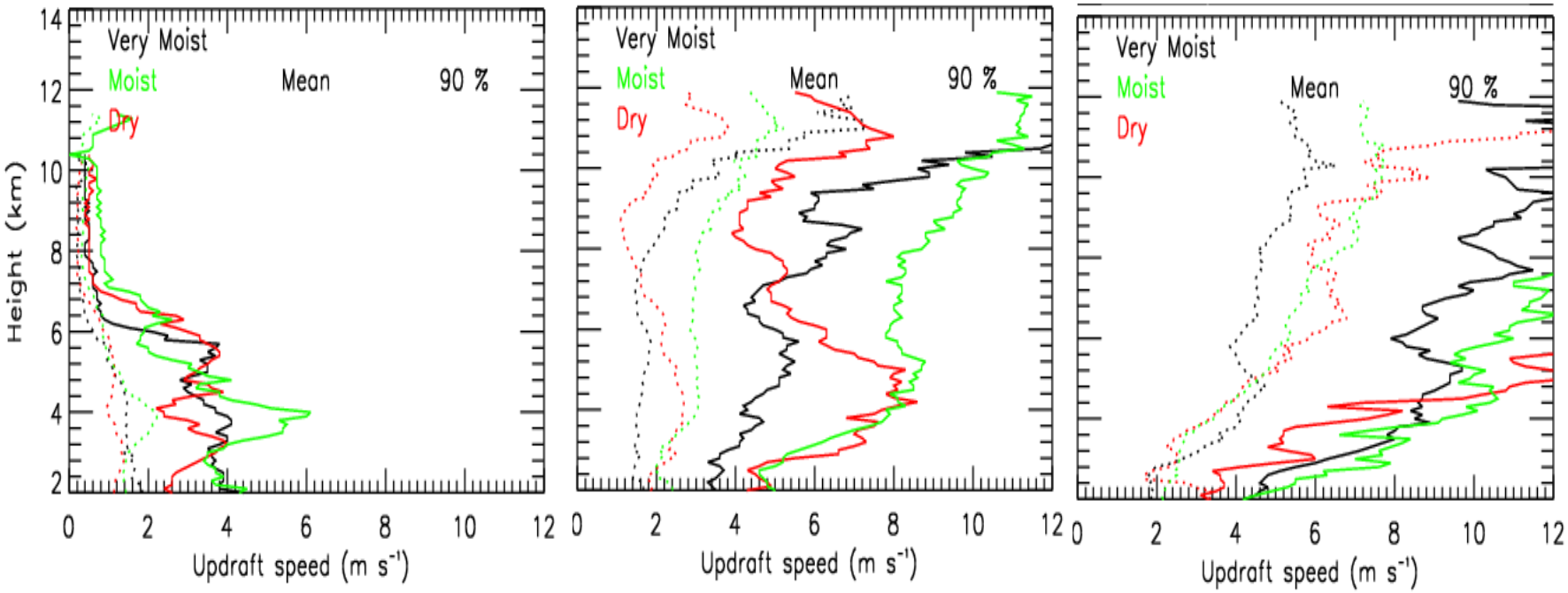


3. Taking only the positive updraft values, the draft eight

Mean is dashed lines
90% is solid lines

Statistics of vertical velocity in the three cumulus modes and separately for different moisture levels.

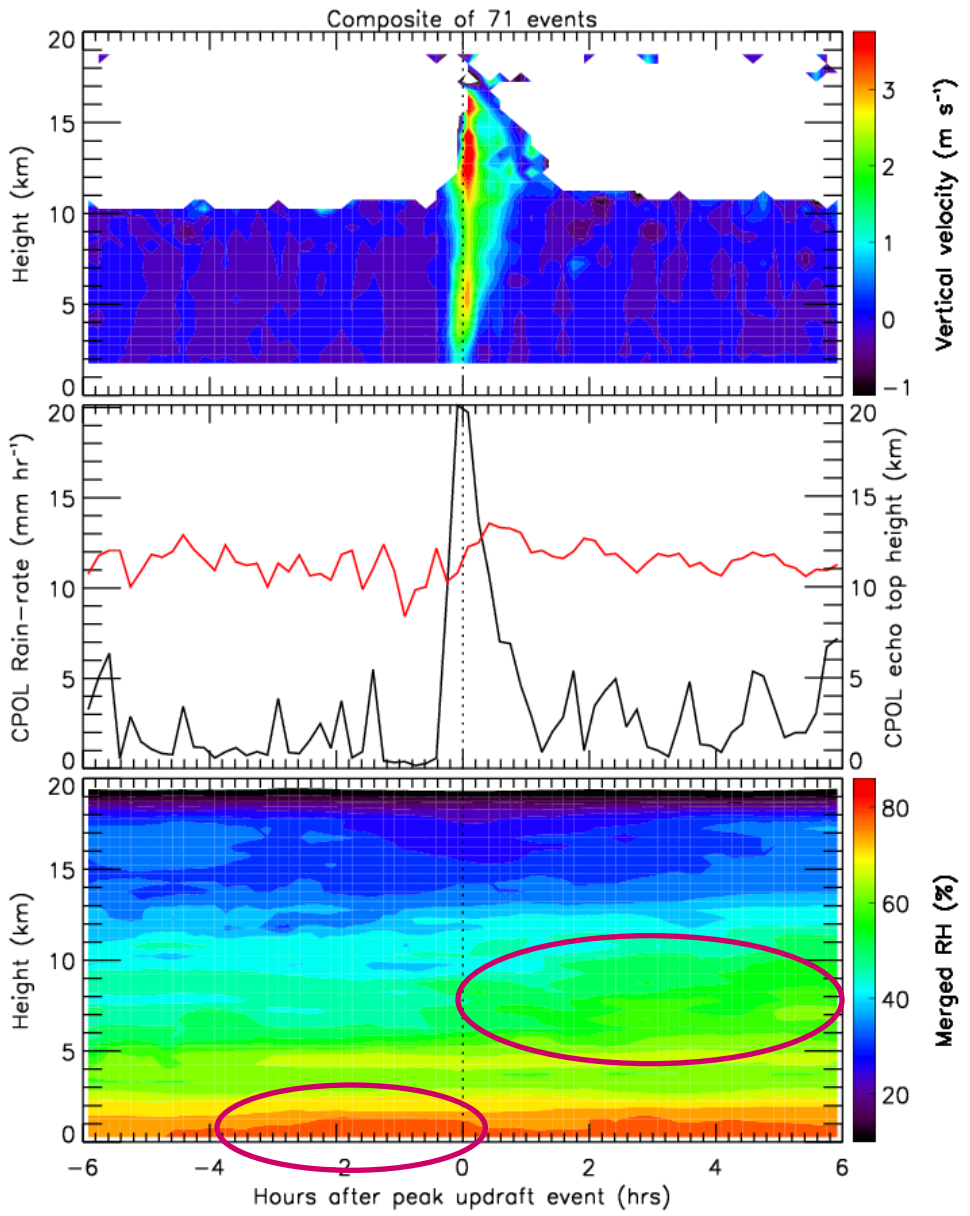
Congestus (136 Cases)	Deep (494 Cases)	Overshooting (101 Cases)
41 cases RH > 80%	181 cases	40 cases
54 cases 60 %< RH < 80%	186 cases	35 cases
41 cases RH < 60 %	127 cases	26 cases



In a very moist atmosphere, relatively smaller updraft strength are sufficient to support for the vertical growth of deep clouds.

In a moderately moist or dry atmosphere stronger updraft speeds are observed to occur in the low levels.

Vertical extent of cumulus clouds: Moistening and/or updraft.

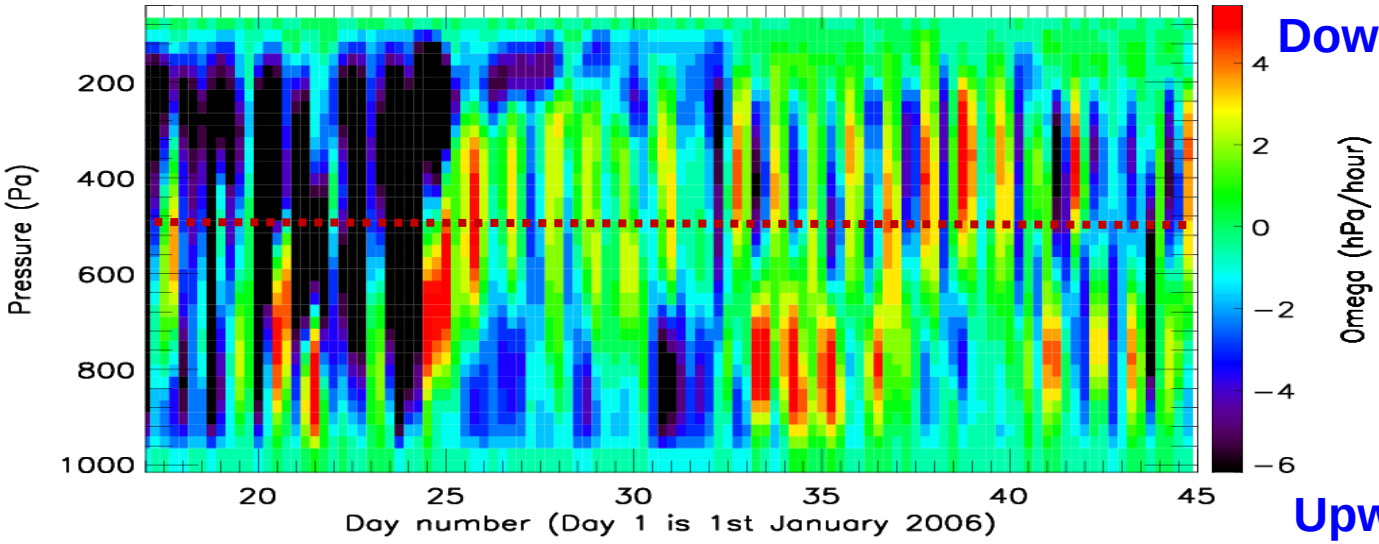


"The chicken and egg story"

The figure shows the composite response of merged radiosounding relative humidity data (10 min resolution) and CPOL rainfall properties for 6 hrs on either side of 71 strong, sudden burst in convective updraft events (wind profiler).

These events are identified using a temporal filter

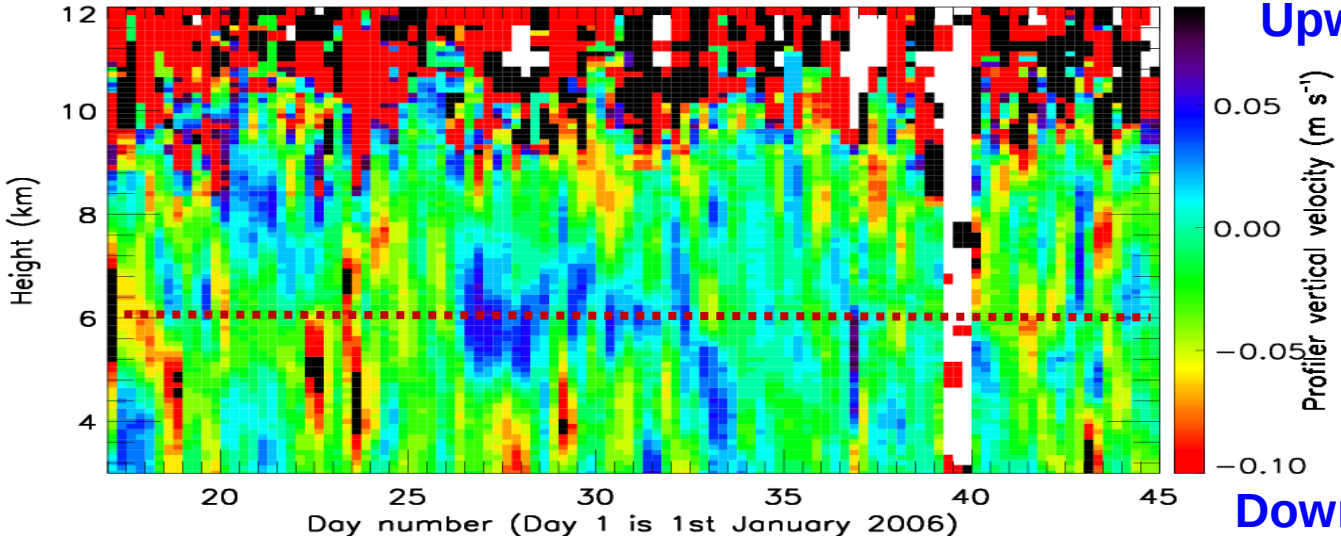
Large-scale vs small scale vertical velocity (TWP-ICE Period)



Downward

Upward

Large-scale vertical velocity developed using variational budget analysis. (Jakob et al., 2012)



Upward

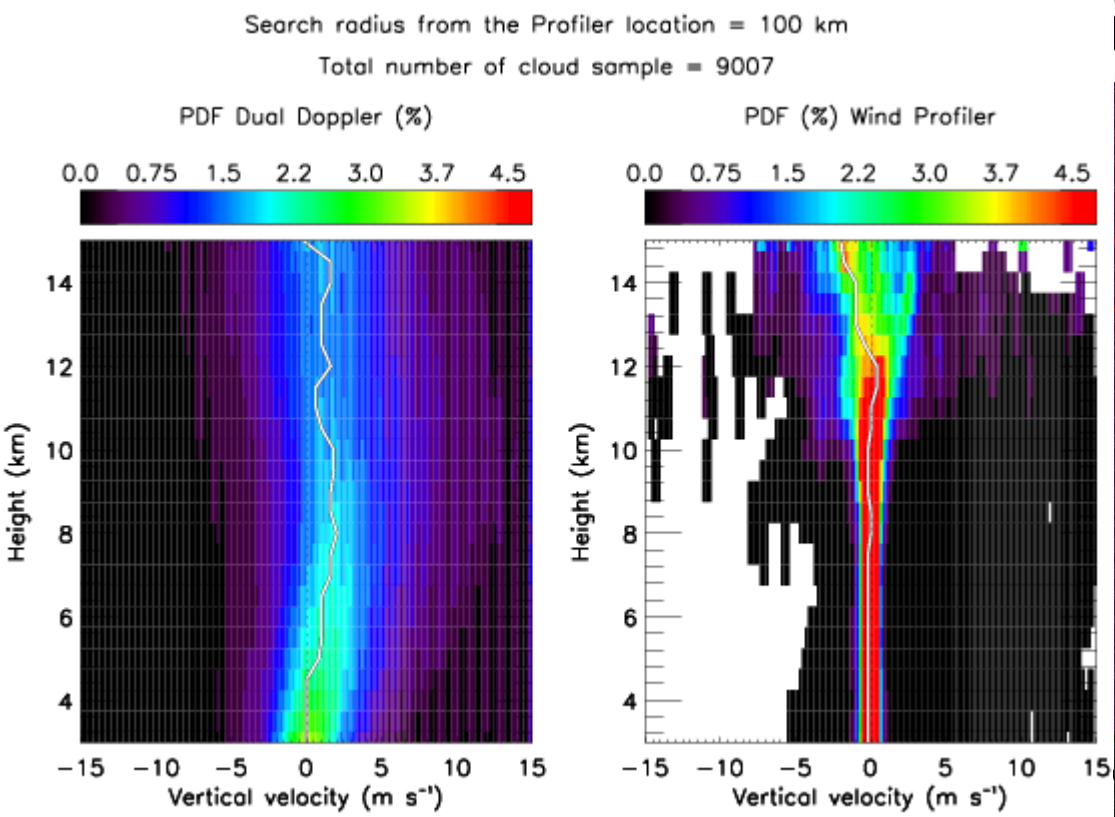
Downward

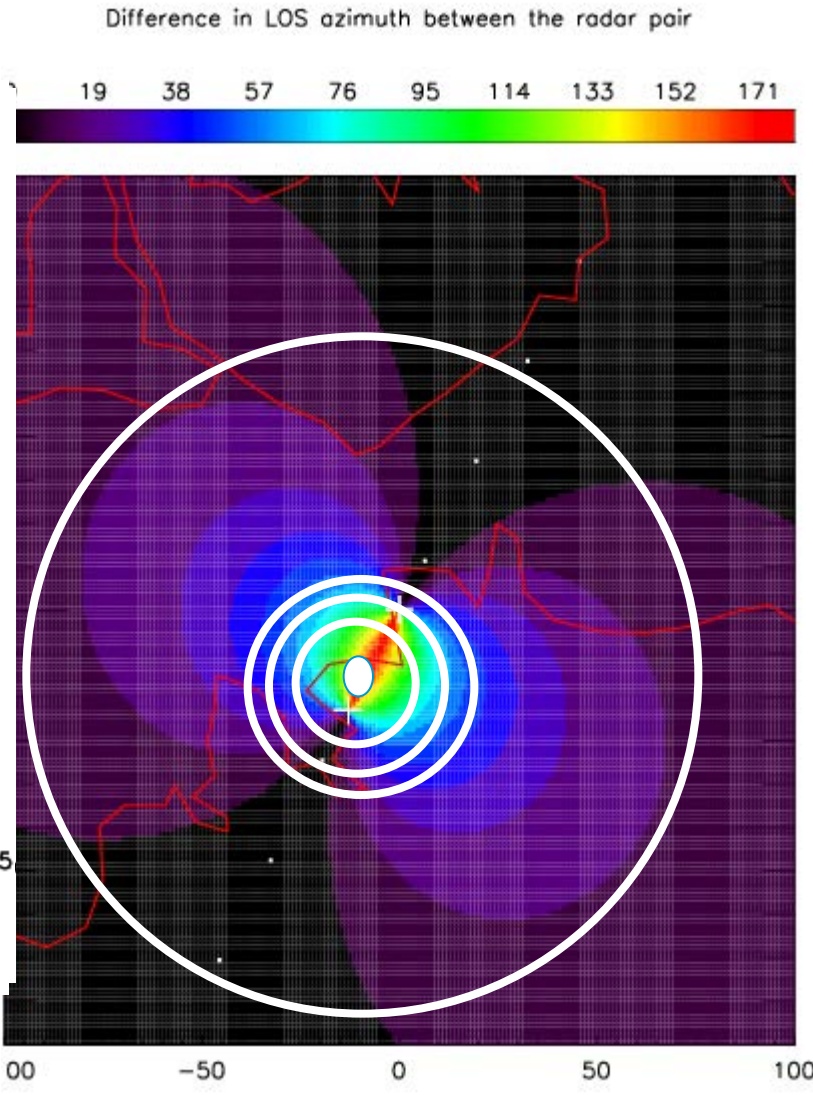
Small-scale vertical velocity from the wind profiler

Comparing vertical velocity statistics from Dual Doppler vs profiler in convective clouds.

Dual Doppler

Wind Profiler





Conclusion

- The updraft speed is the largest in over-shooting clouds, followed by in the deep clouds and the smallest in congestus clouds
- Stronger low-level updraft speeds are needed to grow clouds in regions that are relatively drier compared to moist environments.
- Prior to the onset of stronger updraft events, the moisture in the lower troposphere is larger than the background. After these updraft events, there is drying in the lower levels while the mid-level moistening becomes relatively larger.
- Vertical velocity retrievals from the Dual Doppler technique are found to be comparable with wind profiler measurements.

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CSIRO

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Thank you

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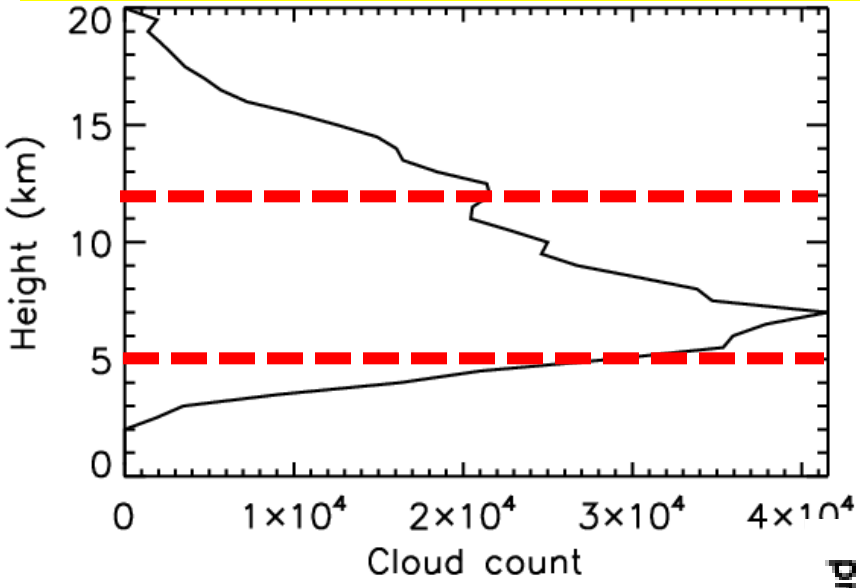
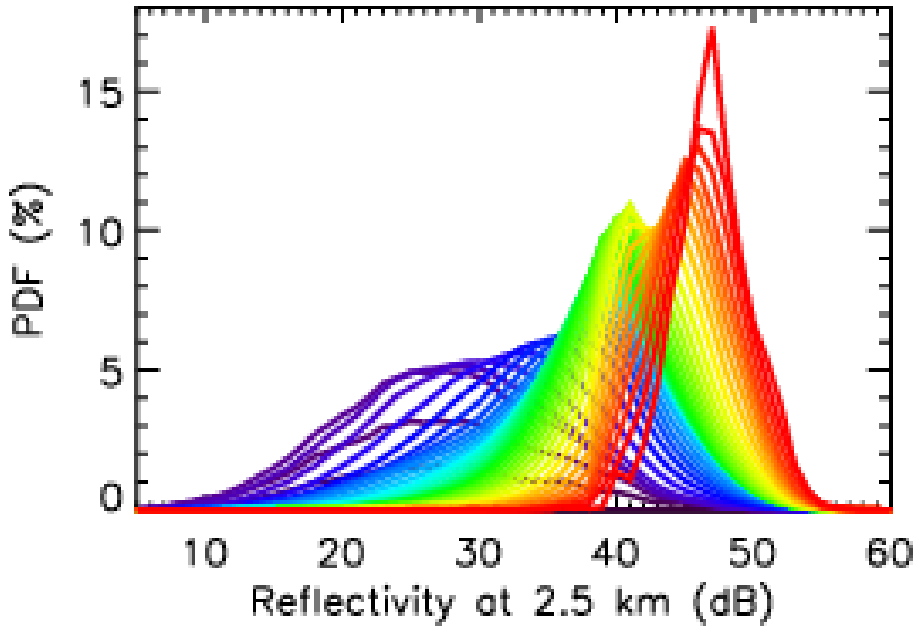
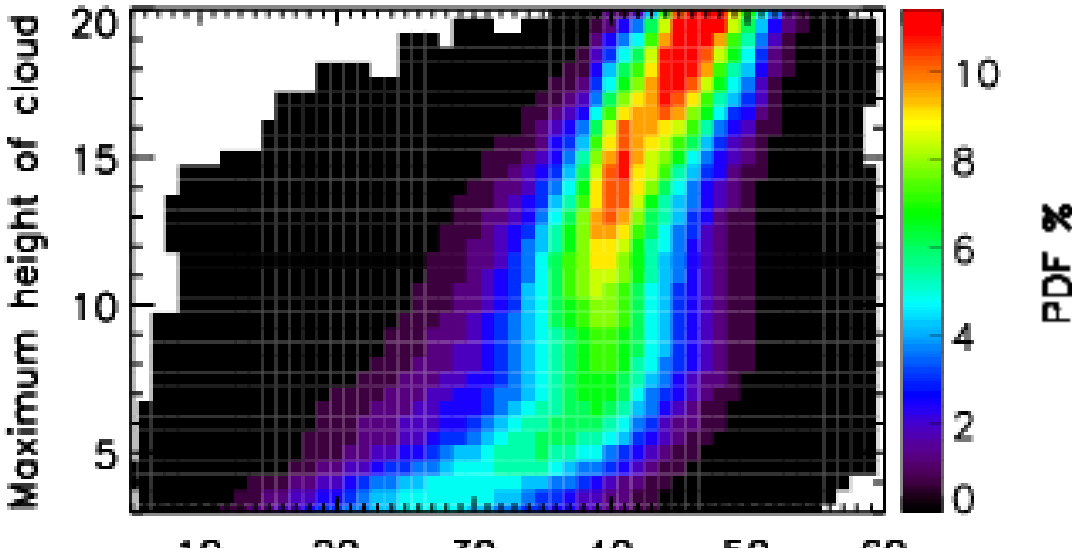
Identification of the three cumulus modes using radar observations (See post

CAPPI data (min height in 2.5 km)







This figure shows an occurrence p
no clear evident of third peak asso

Of course the dominant peak is as