HAIC-HIWC Science Team Meeting
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High Ice Water Content Research Update (BOM)

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Australian Government
Bureau of Meteorology

The Centre for Australian Weather and Climate Research
A partnership between CSIRO and the Bureau of Meteorology

CSIRO

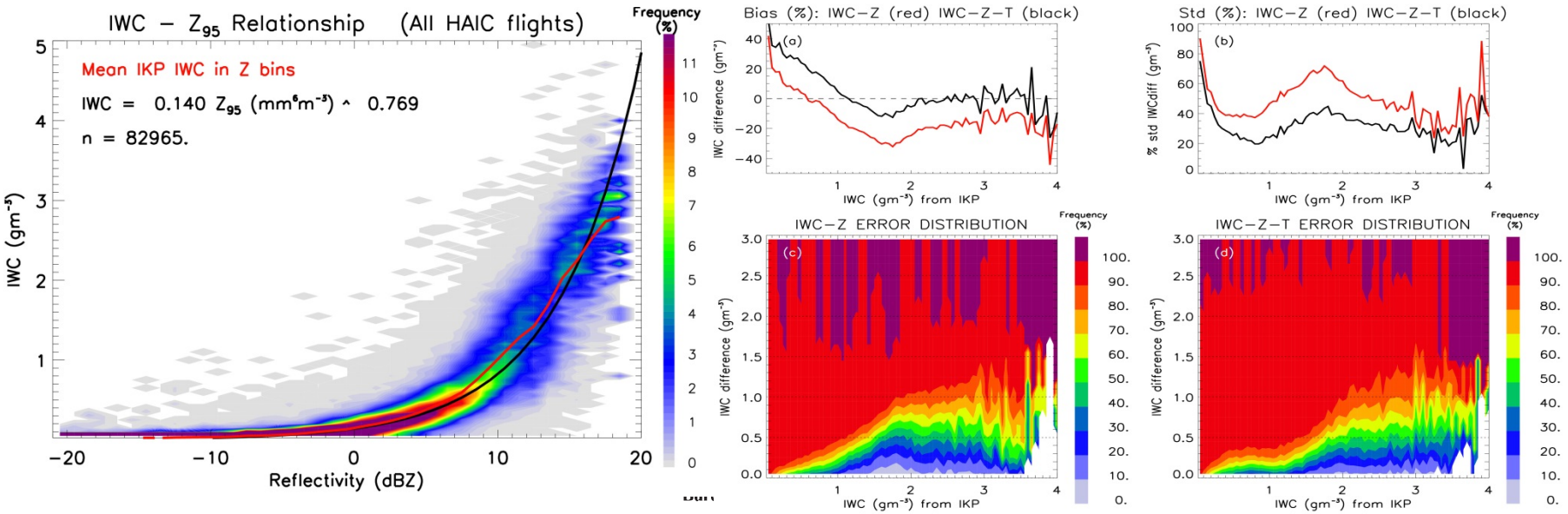
IWC from Z, T



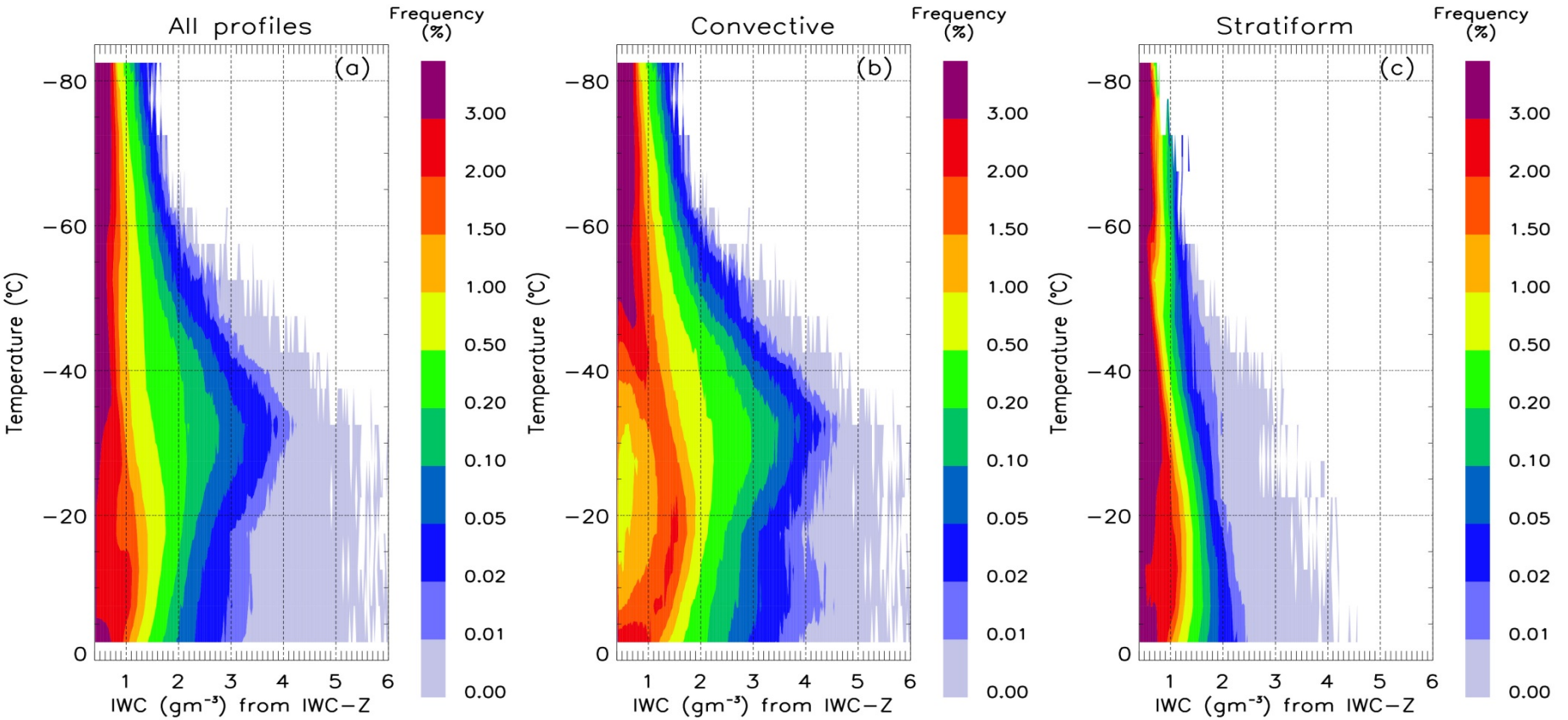
Protat et al. (2015) paper submitted to JAMC → reviews received 4 days ago
Not bad, but one big problem (to be discussed at this meeting)

Main results :

- IWC – Z varies a lot with T
- IWC can be obtained from Z and T with ~ 20% bias and 40% std
- Using convective / stratiform classification (convective index with RASTA) reduces these errors further for convective regions (10% bias, 30% std)
- Larger errors in the [-10 ^{0}C - 0^{0}C] range.
- Darwin dataset :



Darwin IWC stats with RASTA IWC-Z-T



IWC > 4 gm^{-3} (5 gm^{-3}) not found at all at temperatures colder than -50°C (-35°C)

IWC > 4 gm^{-3} exclusively found in convective profiles

IWC > 3 gm^{-3} almost exclusively found in convective profiles for T < -25°C

At the -50°C level IWC > 1.5 gm^{-3} exclusively found in convective profiles !

How do we reconcile this with the view that HIWC is expected ~ 20-30 nm out of convective cells (Matt and Jeanne's work)

High-resolution modelling of Flight 23

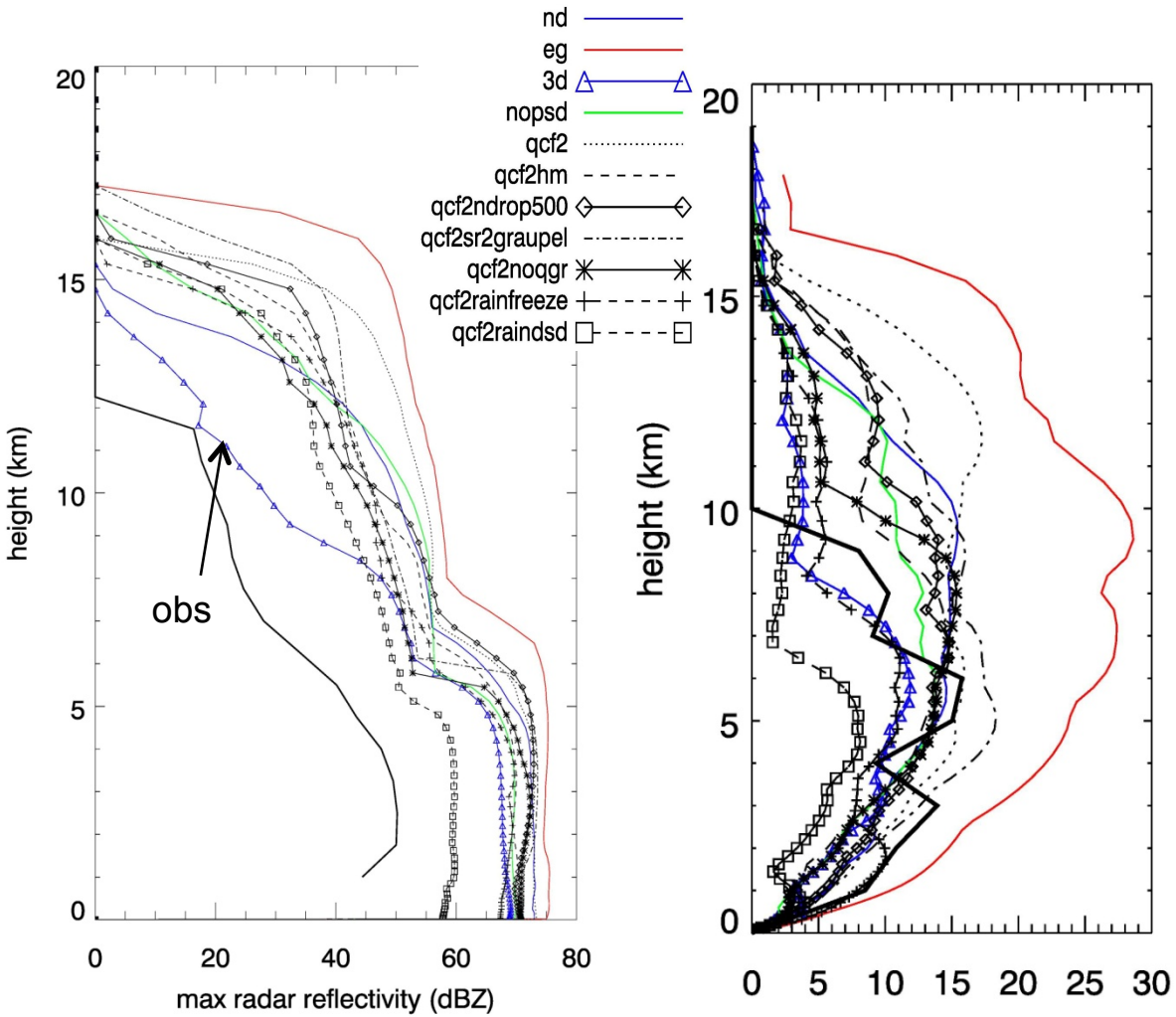


- Evaluate UM 1km simulations of tropical convection (8.5 PS32 L80)
- Investigate the controls on phase composition in the model
- Examine the effects of dynamics, turbulence and microphysical parameterisations

nd	= control, PS32 using new dynamics
eg	= ENDGame even newer dynamics
3d	= 3d Smagorinsky rather than blended vertical diffusion
nopsd	= no generic ice size distribution parameterisation
qcf2	= nopsd but with additional ice prognostic
qcf2hm	= qcf2 but with Hallett-Mossop ice splintering parameterisation
qcf2ndrop500	= qcf2 but with cloud droplet number of 500 not 100
qcf2sr2graupel	= qcf2 but without snow-rain collisions producing graupel
qcf2noqgr	= qcf2 but without graupel
qcf2rainfreeze	= qcf2 but with freezing rain a source of graupel
qcf2raindsd	= qcf2 but with Marshall-Palmer rain drop size distribution

- Darwin mesoscale convective system case study February 18 2014
- Evaluation using CPOL radar, radiosonde, satellite and aircraft obs

Convective updraft reflectivity and velocity



- Strong updrafts loft large particles producing profile of constant max dBZ
- Large sensitivity in updrafts from dynamics, turbulence and microphysics
- Effect of turbulence change on max w the same as rain freezing parameterisation

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Summary

Bias	Development
Excessive areas with high reflectivities	Reduced ice sizes, freezing rain, additional ice prognostic variable, 3D Smagorinsky turbulence
Too much rain above the freezing level	Heterogeneous rain freezing parameterisation
Too little entrainment with too much detrainment in the upper troposphere	Change turbulence parameterisation, smaller ice sizes
Too little stratiform rain area	Increased turbulent mixing
Too efficient depositional growth of ice	Reduced vapour deposition

Next steps - Discussion

95 GHz attenuation work from Julien suggests that this effect may have been underestimated in the literature : need to revisit that ! Impacts our statistics … Use of Cayenne dataset will be very informative (NAWX most obvious ! RDR-4000 too).

Problem with non-Rayleigh scattering during particle aggregation. Z decreases with increasing particle size (T) → the IWC – Z relationship changes. Need to study this.

Darwin versus Cayenne IWC – Z – T ? Also IWC – Z – T using X-band radar data.

Extension of Appendix D/P statistics using RASTA IWC (and MMD ?)

Statistics of graupel fall speed and IWC from graupel episodes of HAIC – HIWC flights. Has anyone developed a graupel detection from in-situ data ?

Use NASA OT detection and RASTA retrievals to better understand the variability of HIWC microphysics as a function of distance to convective cores.