Karen Hughes

From: Alain Protat
Sent: Tuesday, 24 July 2012 14:37
To: Harald Richter; 'Scott Collis'; Peter May; Tom Keenan; Justin Peter; Ken Glasson; Brad Atkinson
Subject: Draft of talk for the Queensland regional office visit [SEC=UNCLASSIFIED]
Attachments: 20120727_Protat_CAWCR_Radar_Research.ppt

Security Classification:
UNCLASSIFIED

Hi everybody,

Here is a draft of the talk I prepared for the visit this friday to the QLDRO. Comments welcome ! Seems long for a 20 minutes talk, but I will go through most of them quickly.

Peter and Tom, can you also tell me if the last slide is in line with the message you want to convey with these meetings ? That's my personal opinion but it may not be something you want to see hlighlighted in individual talks ?

Cheers,
Alain

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Visit to Queensland Regional Office, 27 / 07/ 2012

Cloud and Convection Research using the CAWCR weather radars and the ARM observations

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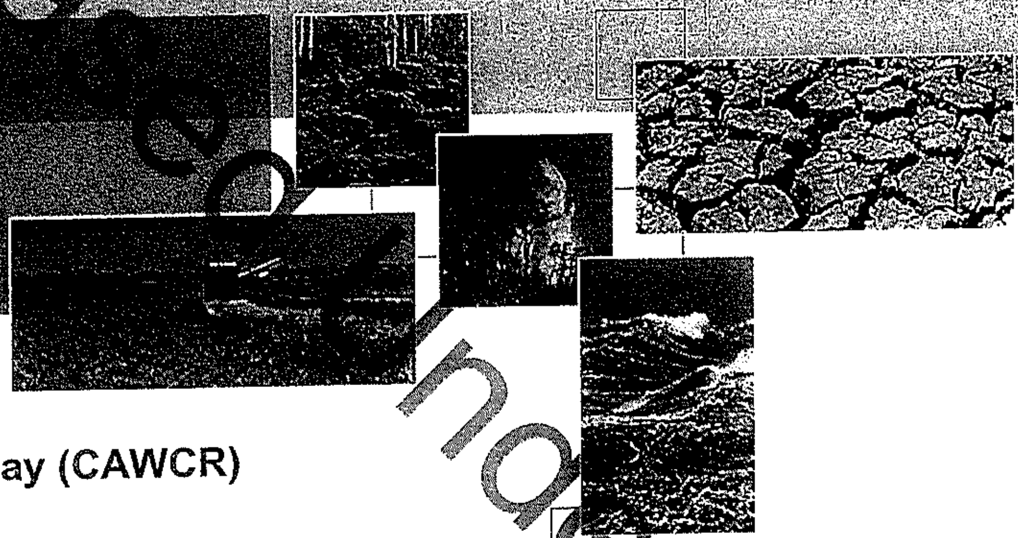

Alain Protat and Peter May (CAWCR)

CP2 : K. Glasson, H. Richter, S. Collis, J. Peter
CPOL : B. Atkinson, V. Kumar, G. Penide, J. Peter

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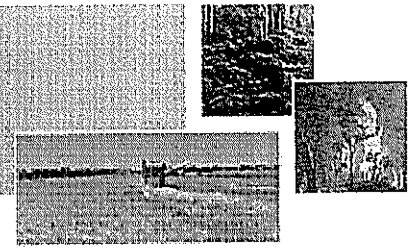
Introduction



Convective and non-convective clouds (« cloud systems »)
play a major role in water and energy cycles, weather and climate change processes

Clouds interact with radiation → major role in the thermal balance of the troposphere.

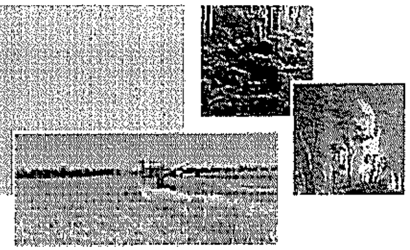
Convective systems produce precipitation, redistribute energy vertically, modify the large-scale dynamics and thermodynamics

Cloud systems are still a challenge for weather and climate forecasts : main reason for inter-model spread in climate projections, forecast of extreme weather very challenging

This is mainly due to a lack of understanding of the processes governing cloud evolution and the cloud / radiation / aerosol / dynamics interactions.

The complexity is in part due to the different scales involved and lack of relevant observations in some regions (e.g., Southern Ocean, tropical oceans).

Our Scientific Objectives



Characterize the morphological, microphysical, dynamical, and radiative properties of cloud systems (=non-precip clouds & convection) and the variability in response to different large-scale forcing / environment

Diurnal and vertical variability of the previous properties as well

Investigate the capability of cloud-resolving and large-scale models to reproduce this observed response of the atmospheric system to different large-scale forcings and contribute to the improvement of cloud / convective parameterizations in atmospheric models

Extend the ground-based studies regionally (and at global scale) using A-Train (and later GPM) satellite observations validated with the ground-based studies

General Principles :

- Taking a Statistical Approach
- Using radars !

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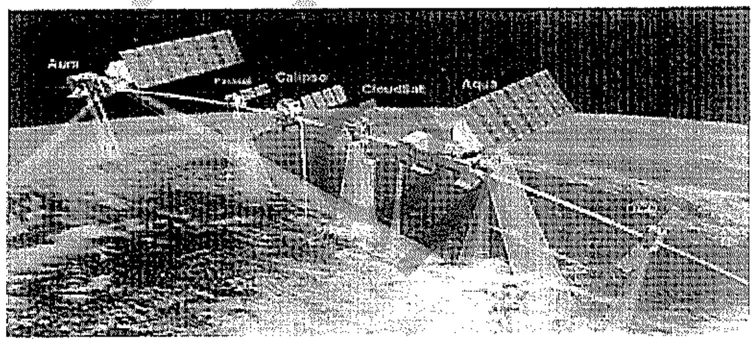
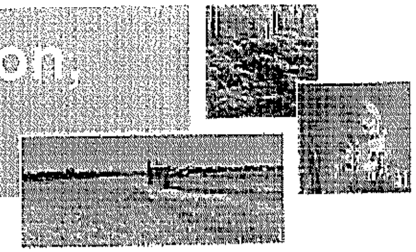


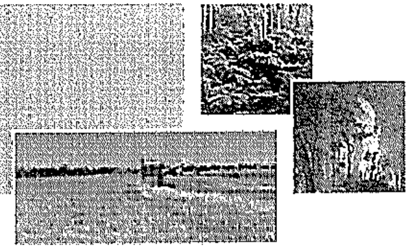
Radars : conventional, Doppler, dual-polarization, dual-frequency



Radars at different frequencies are the masterpiece of this research. Why ?

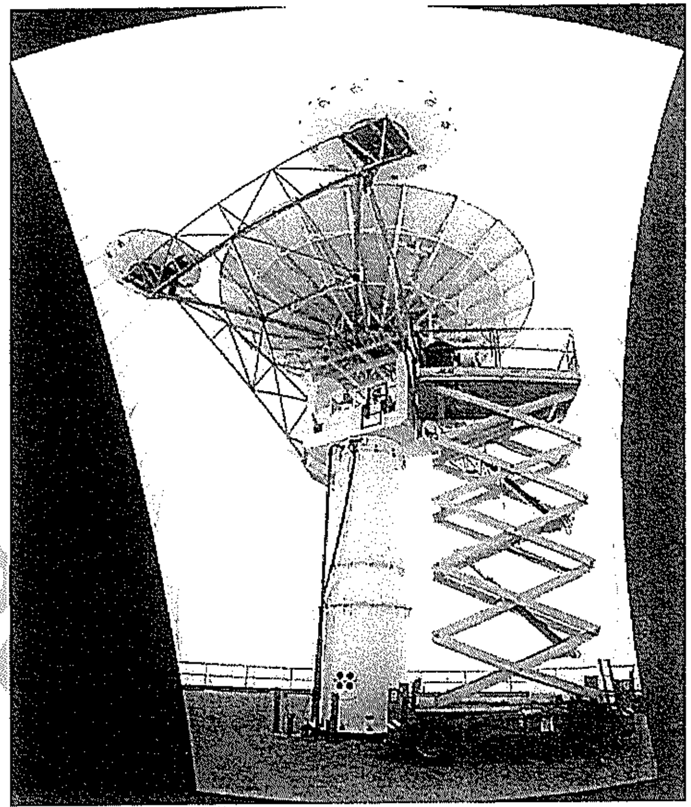
- Weather radars cover a mesoscale area, which is the scale at which convective systems organize and produce extreme weather
- Radars allow for a description of the vertical distribution in cloud systems (process studies)
- Radars at different frequencies allow for all components of cloud sytems to be sampled
- Radars in networks to study the mesoscale dynamics of storms (multi-Doppler) and potential extreme weather threat around airports and cities (microbursts, gust winds, hailstorms, floods)
- Radars with dual-polarization are the ultimate weapon for extreme weather detection (hail because high Z, low ZDR, high <0 KDP; flooding because better rainfall retrievals)
- Radars with dual-frequency and dual-polarization allow for better microphysics retrieval (instantaneous rainfall & accumulation, ice water content, hydrometeor ID, hail size)

Playground 1 : Brisbane (CP2+ancillary)

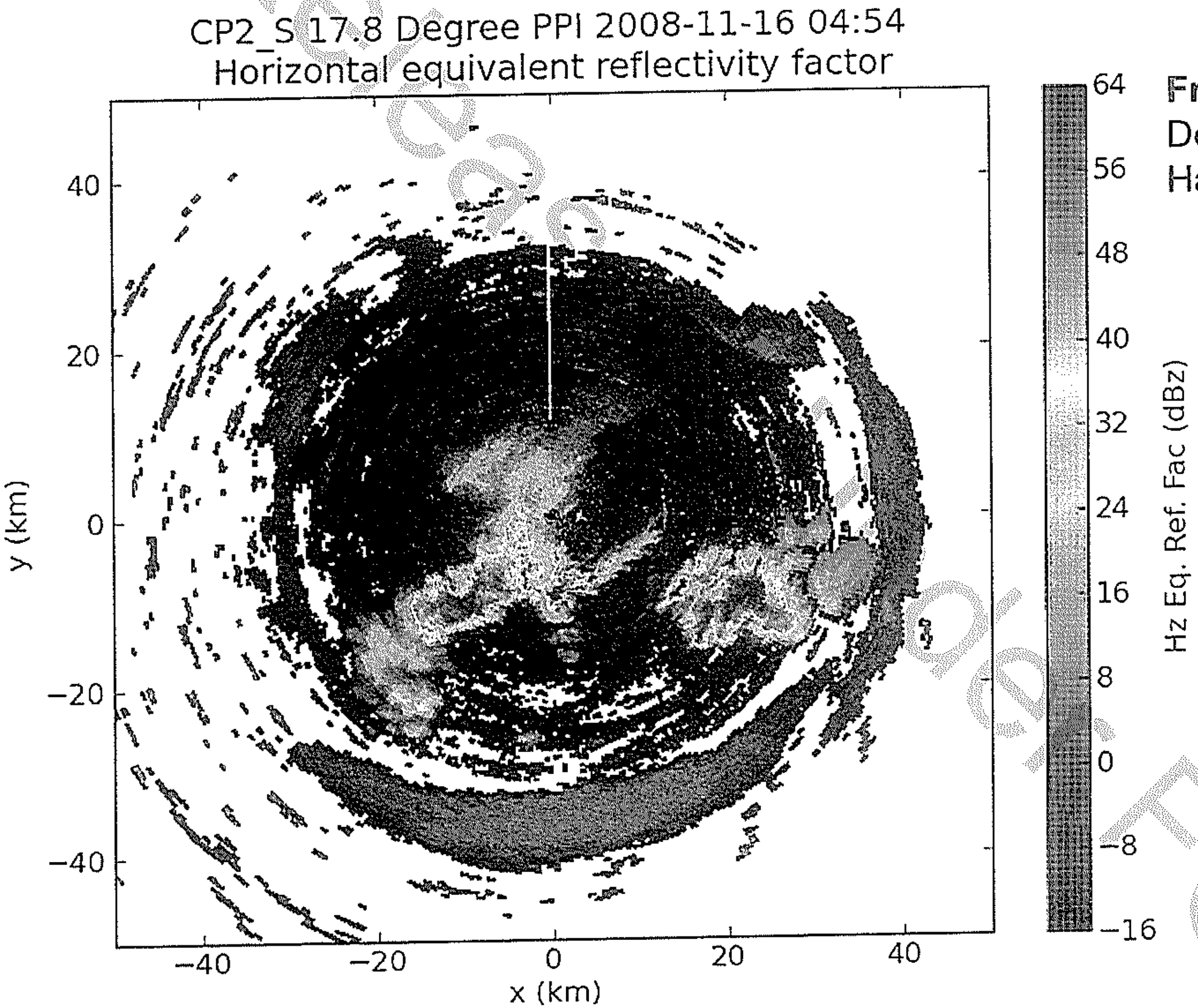


- **CP2 radar**
- Dual frequency (S, X), dual polarization
- Recent upgrade of antenna
- Under repair – should be operating later this year
- Include 2DVD, rain gauge network

- Samples severe storms including large hail
- Dual Doppler with Mt Stapylton radar



The Gap Storm (16/11/2008)



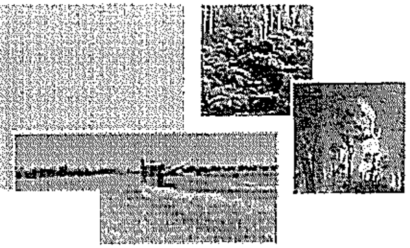
From 0624 to 0642 LT

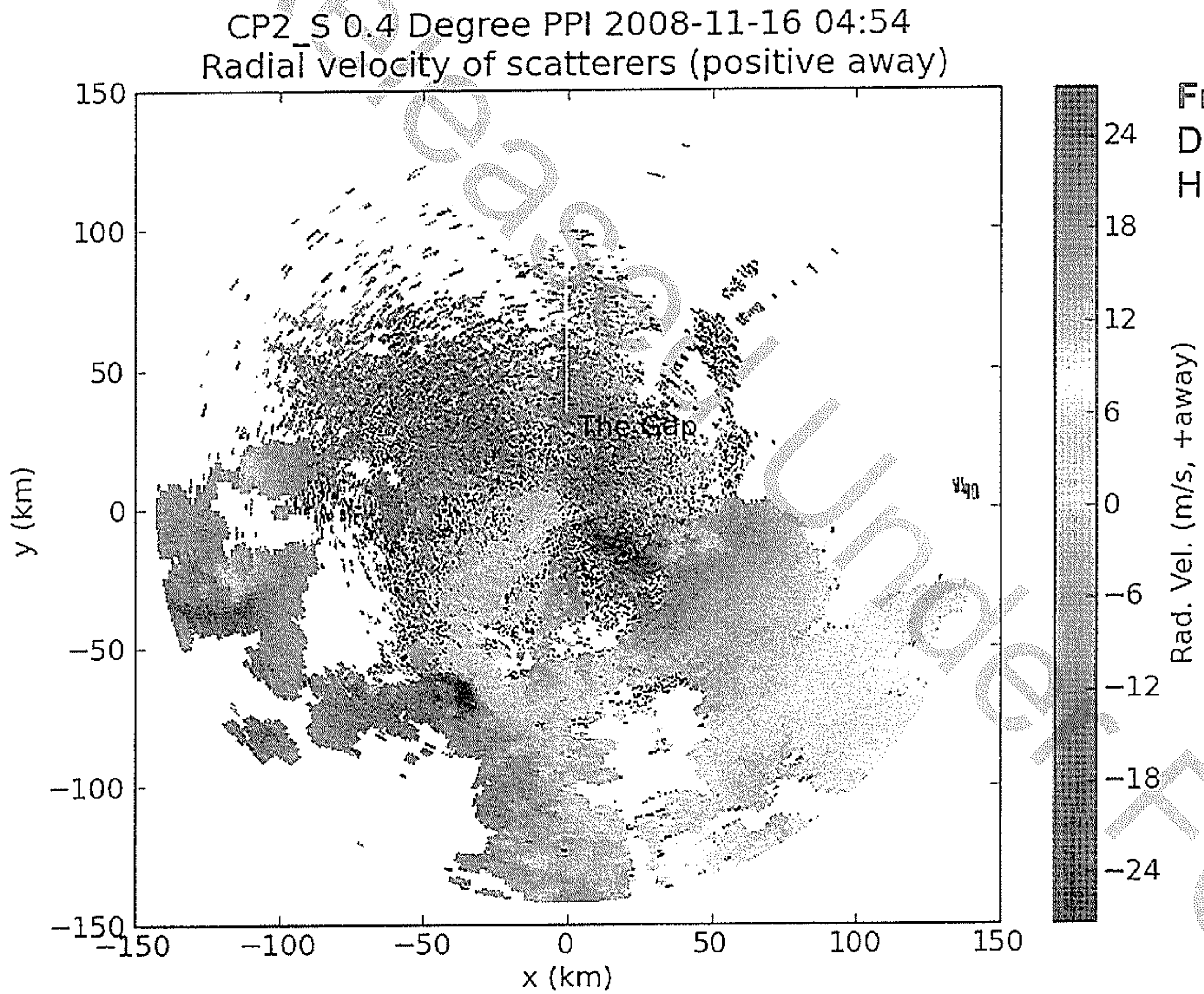
Destructive low-level winds

Hail reported

Work by Richter, Collis, Peter

The Gap Storm (16/11/2008)





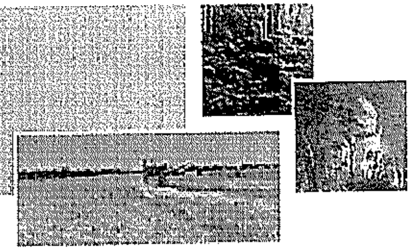
From 0624 to 0642 LT

Destructive low-level winds

Hail reported

Work by Richter, Collis, Peter

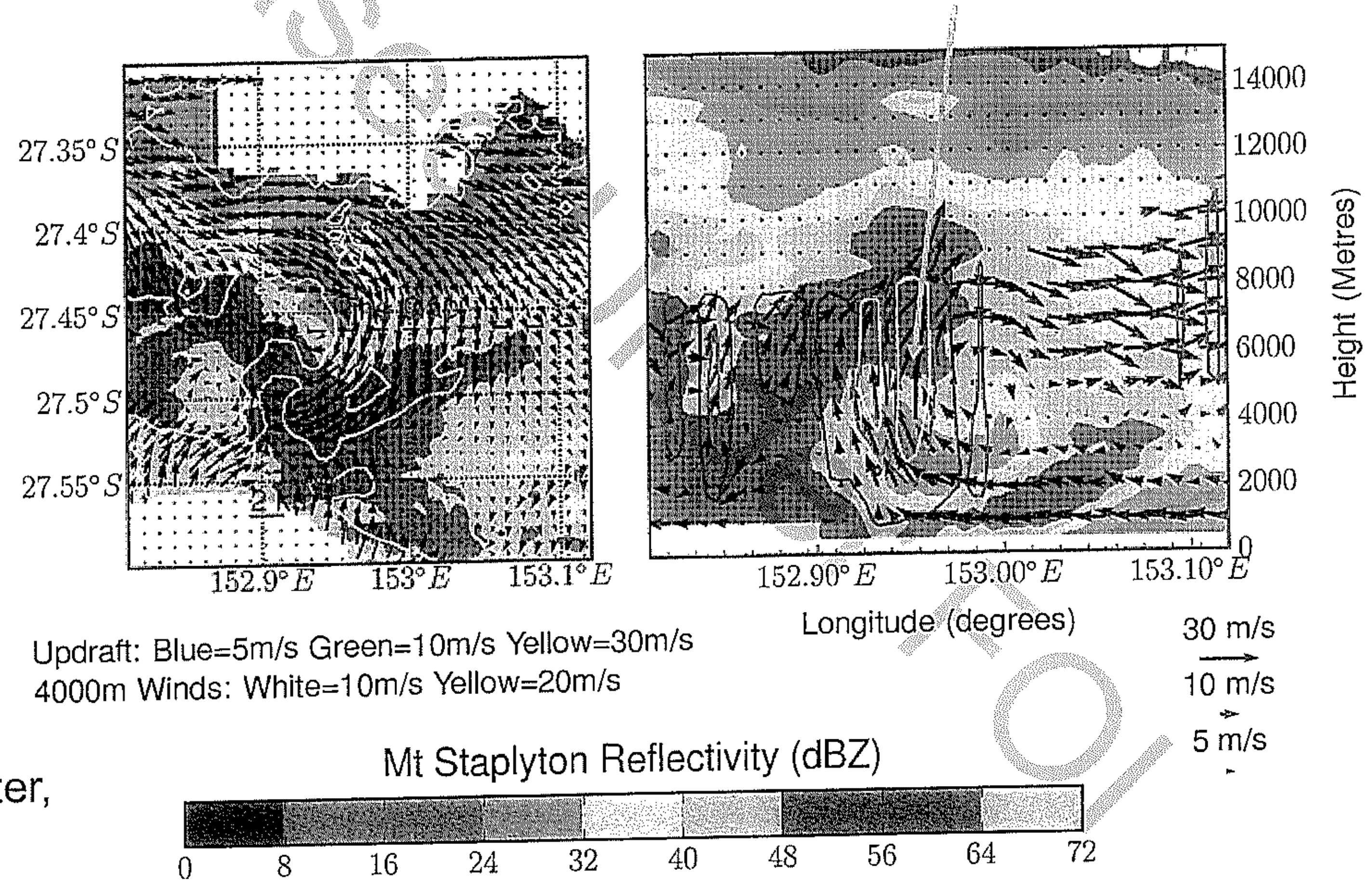
The Gap Storm : CP2 radar analysis



Storm dynamics : destructive gust winds well captured by CP2 + Mt Stapylton radars

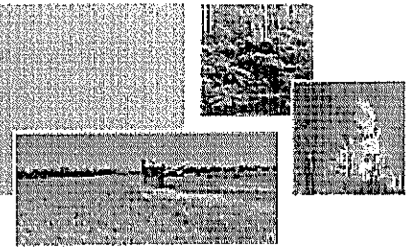
Genesis Stage

30 m/s + updraft allows hail growth
(see pocket of high reflectivities)



Work by Richter,
Collis, Peter

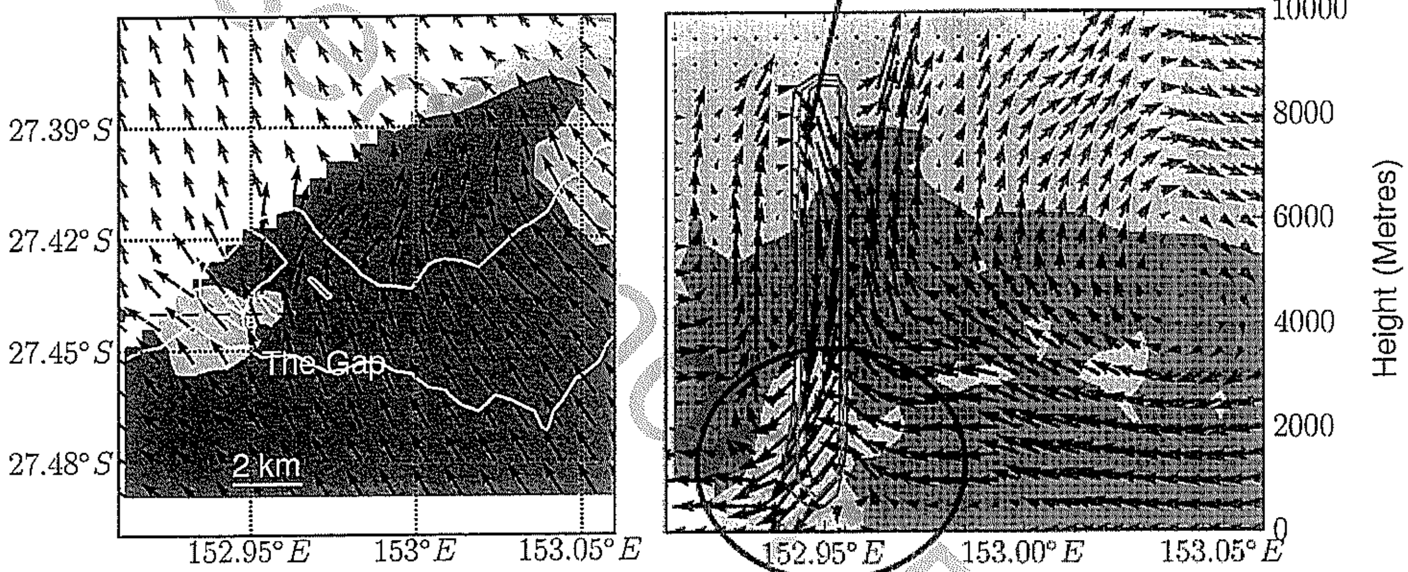
The Gap Storm : CP2 radar analysis



Storm dynamics : destructive gust winds well captured by CP2 + Mt Stapylton radars

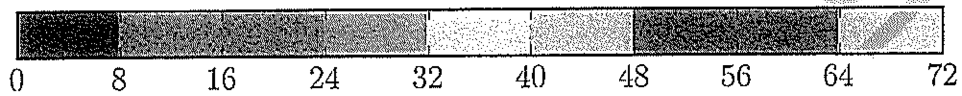
Hail + Outflow + Gust Stage

-20 to -30 m/s downdraft associated with subsidence of hail pocket



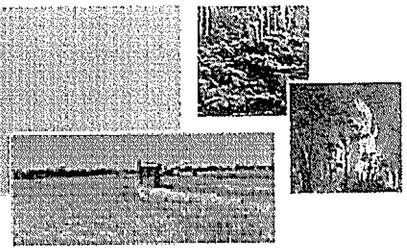
Downdraft: Blue=10m/s Green=15m/s Black=20m/s
500m Winds: White=20m/s Yellow=25m/s

Mt Staplyton Reflectivity (dBZ)



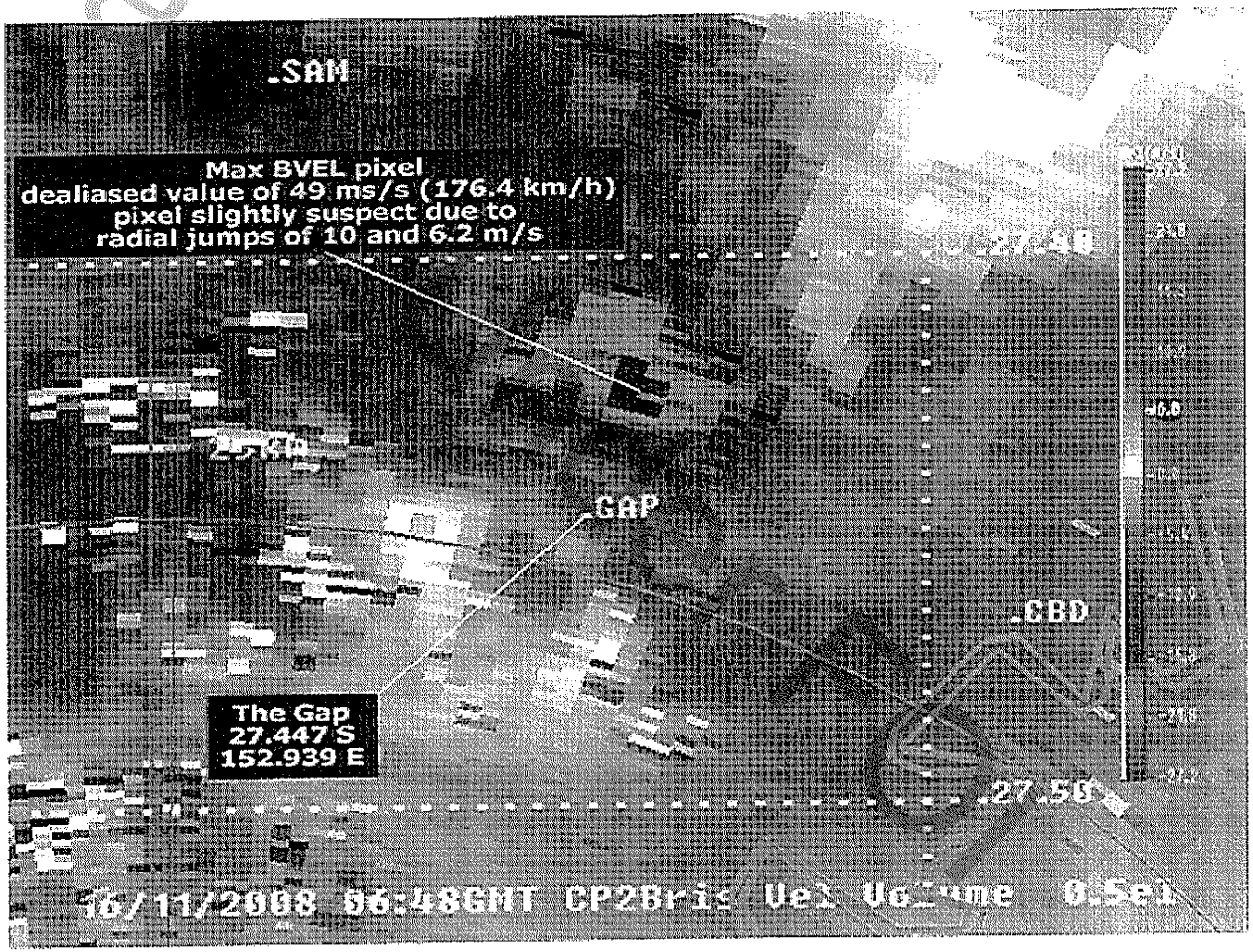
Work by Richter, Collis, Peter

The Gap Storm : CP2 radar analysis



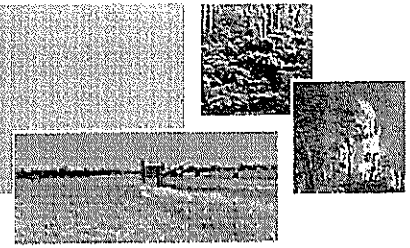
Storm dynamics : destructive gust winds well captured by CP2 + Mt Stapylton radars

Zoom in of radar image at gust wind stage

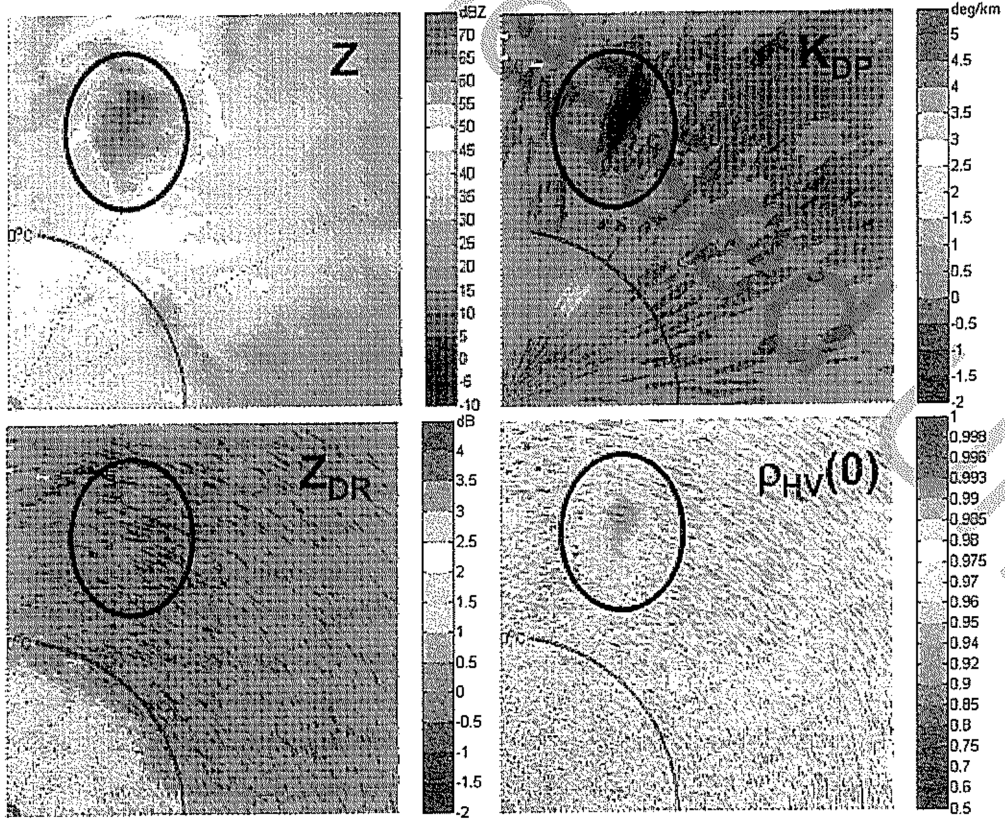


Work by Richter, Collis, Peter

The Gap Storm : CP2 radar analysis

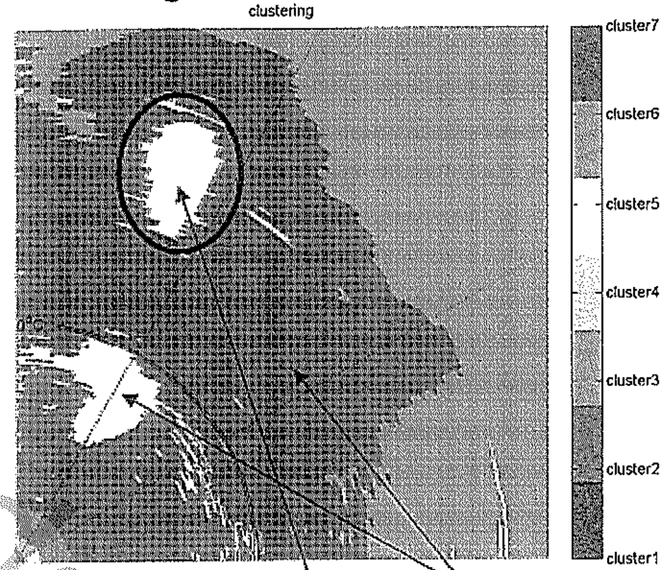


Storm microphysics : Hail detected by CP2 radar



Dual – Polarization Signatures of Hail

New Particle ID retrieval method using Cluster Analysis



Great help for operation warning decision on winds, tornado, hail ?

Work by Wen, May, Protat

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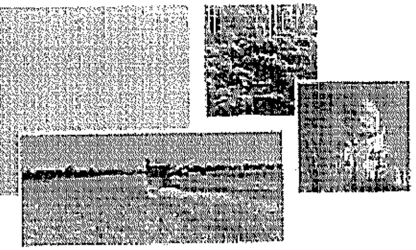
The Cloud Seeding Research Program (CSRP)



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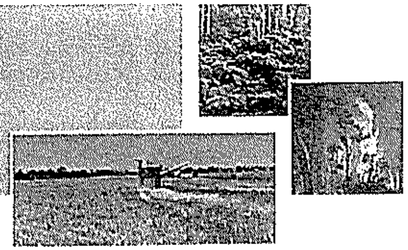
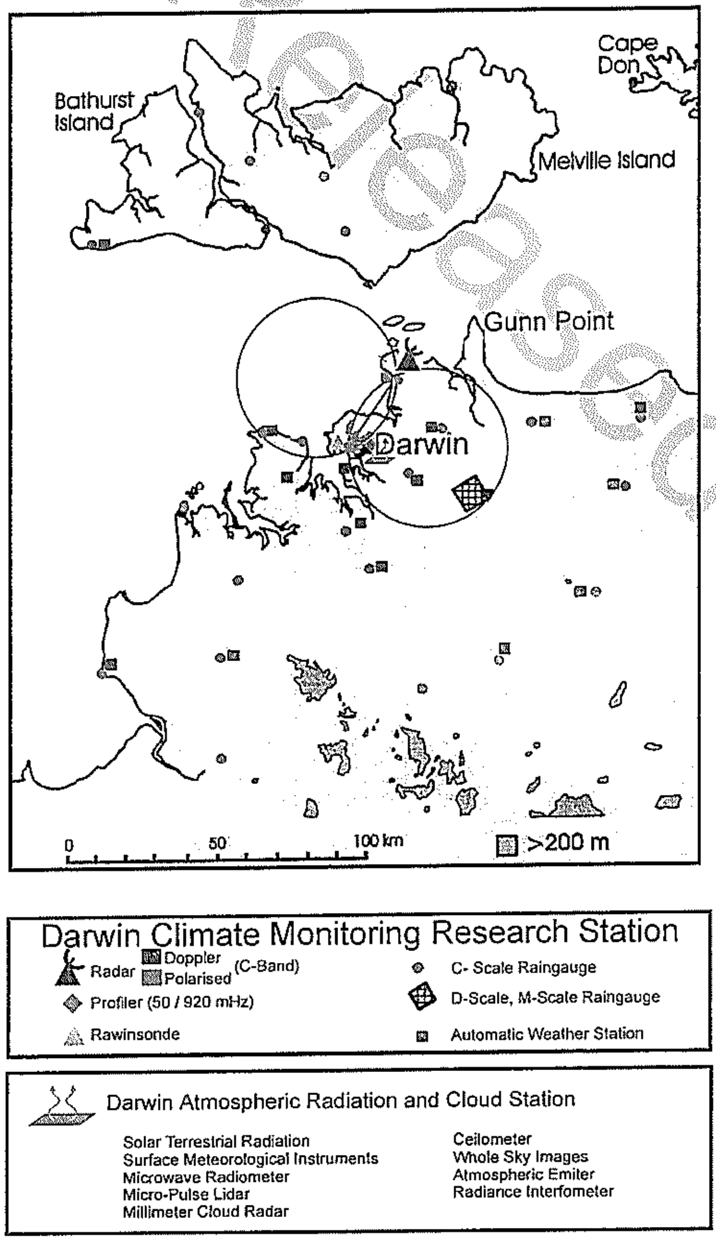
Playground 2 : Darwin (DCRS+ARM sites)





CAWCR data sets:
CPOL Polarimetric Doppler radar (5cm)
Berrimah Doppler weather radar
Profilers (50 and 920 MHz)
LW, SW Radiation
NWP (ACCESS-Darwin in preparation)

US DoE ARM operational:
MMCR, KAZR (35 GHz Doppler Radar)
SACR (10+35 GHz Doppler Radar) - 2011
MPL, Raman (Lidars)
Lidar Ceilometer
Rainfall (2DVD+JWD)
AERI
MWR (2 and 3 channel Microwave Radiometers)
Total Sky Imager
Surface Met
LW, SW Radiation

Space : A-Train (**CloudSat 95 GHz radar, CALIPSO lidar**, MODIS/PARASOL/IIR/AIRS)

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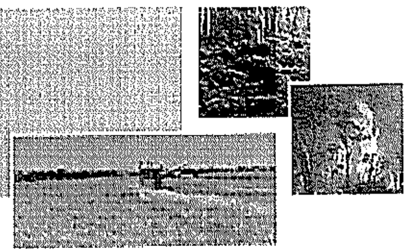
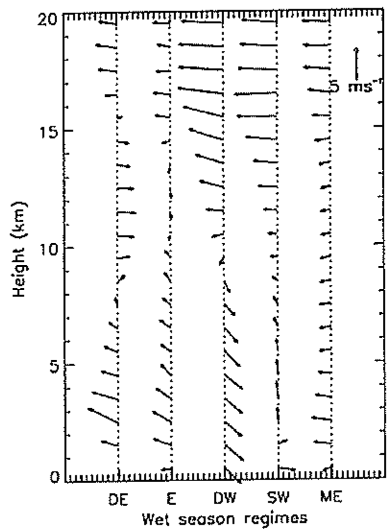
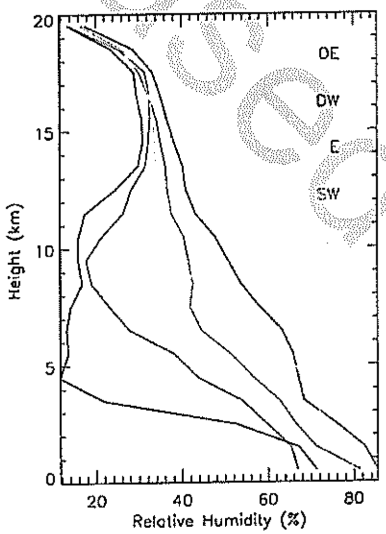
Large-scale regimes around Darwin



Follows Pope et al. (2009) : 5 objectively-defined regimes for Darwin weather

Basic framework for our variability studies





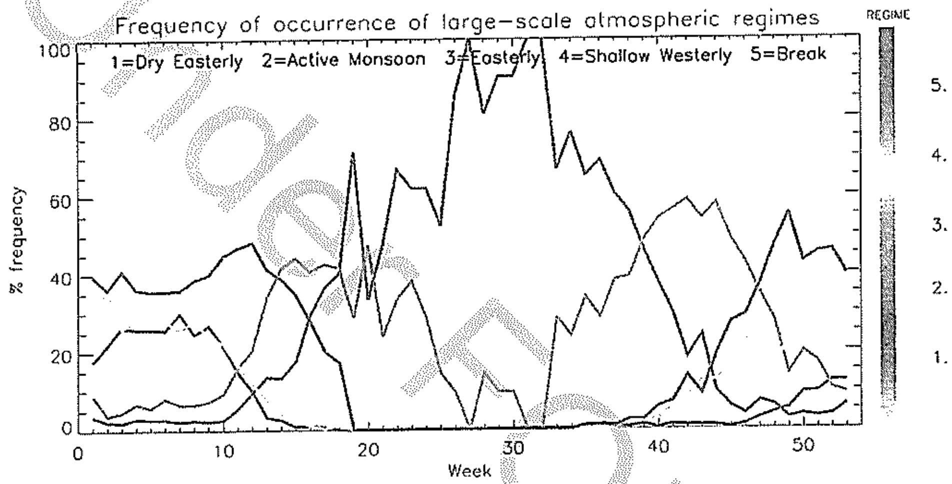
DE : Dry Easterly

E : Easterly

ME : Moist Easterly (Break)

DW : Deep Westerly (Monsoon)

SW : Shallow Westerly



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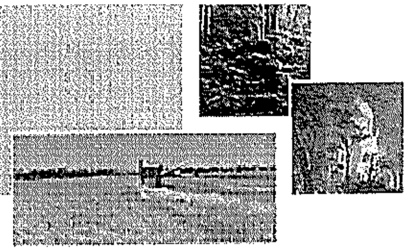
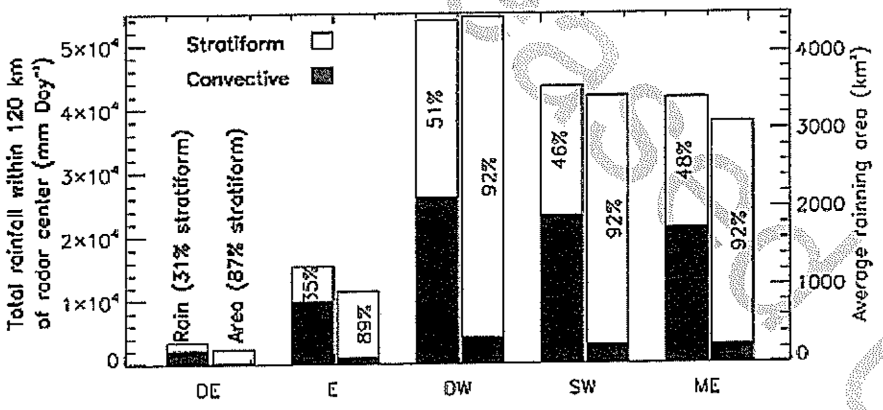
Darwin convective / stratiform rainfall variability

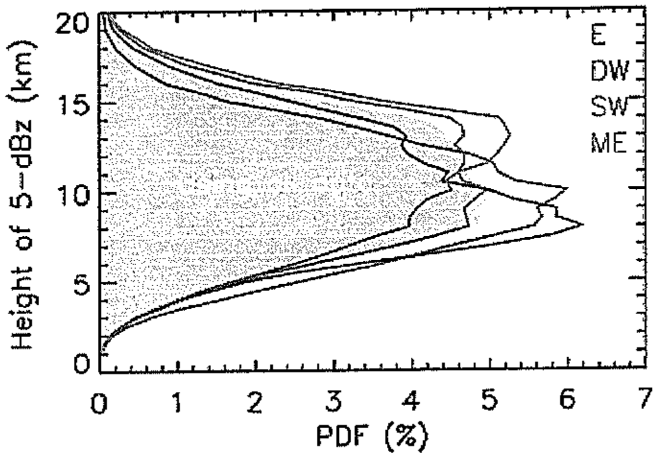


Polarimetric radar = accurate rainfall estimates (using Zh, Zdr, Kdp)

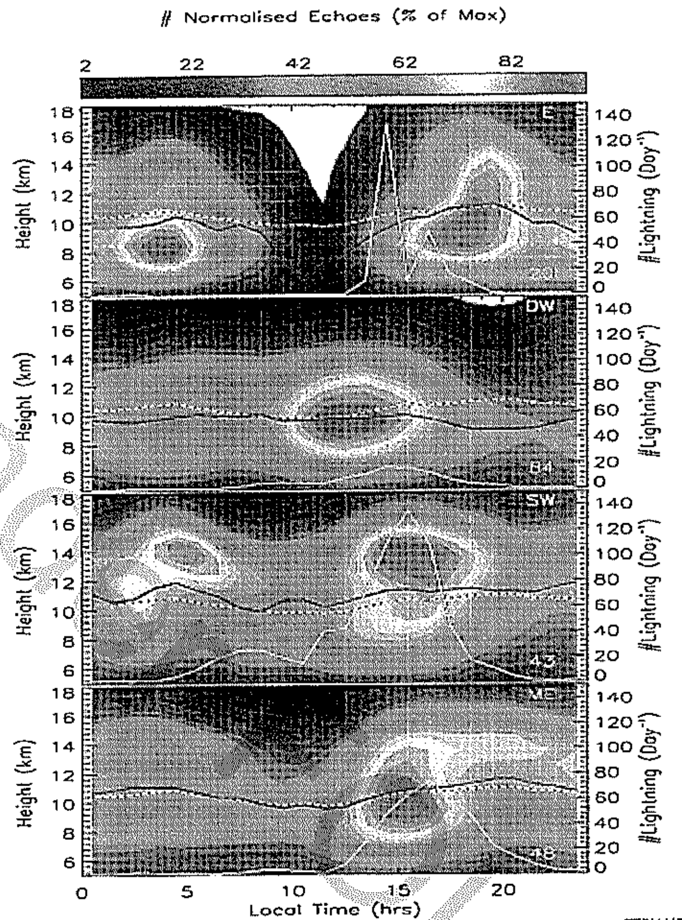
Rainfall Properties



Convective Cloud Top Height PDF



Diurnal Variability of Convection



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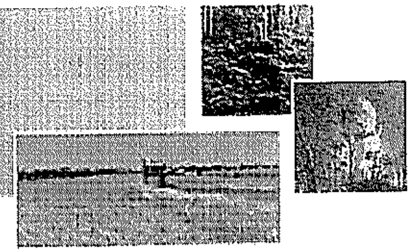
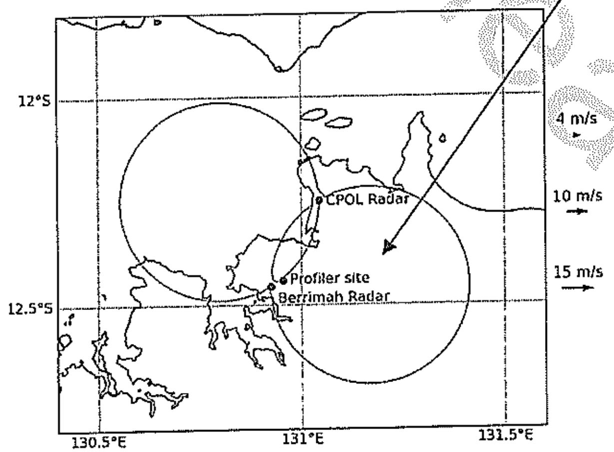
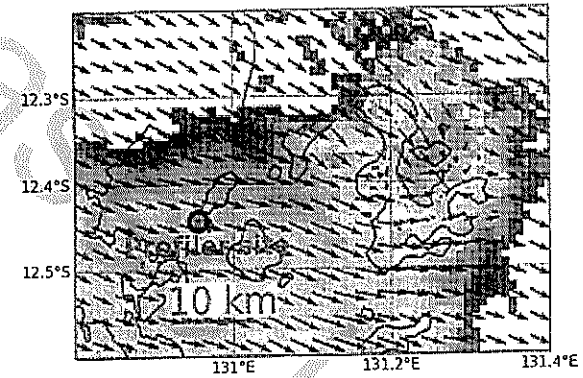
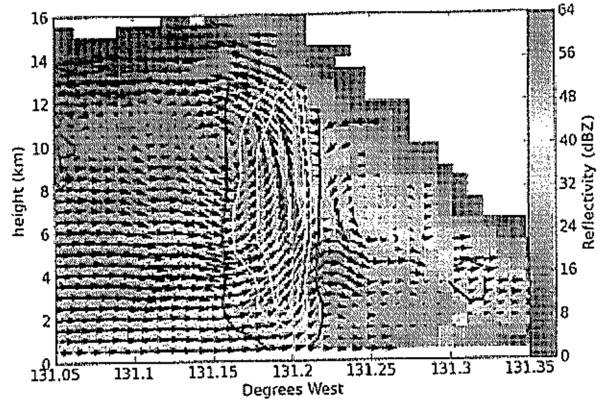
Darwin Convective Storm Dynamics



2 Doppler weather radars → Variational 3D wind retrieval
(e.g, Protat and Zawadzki 1999, JAOT)

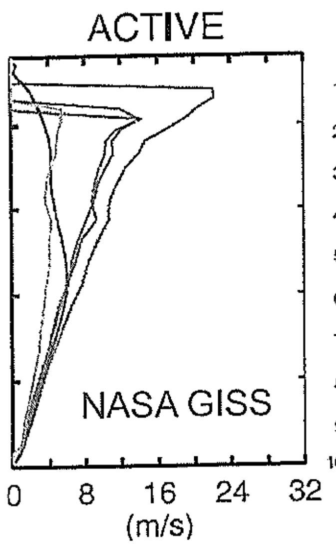


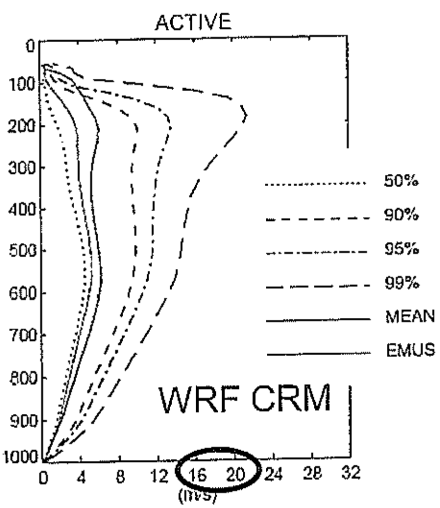


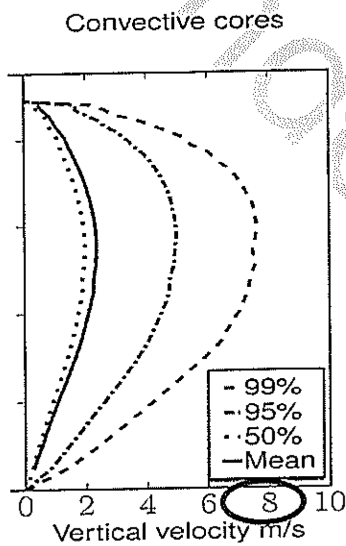


Verification using UHF/VHF profiler retrievals

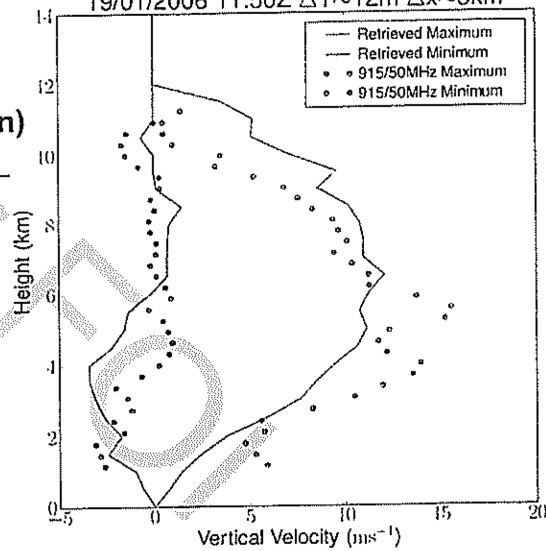
Wu, Del Genio, 2009, JGR



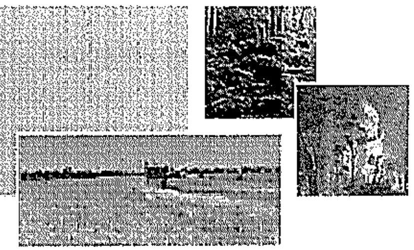




Stats (monsoon)

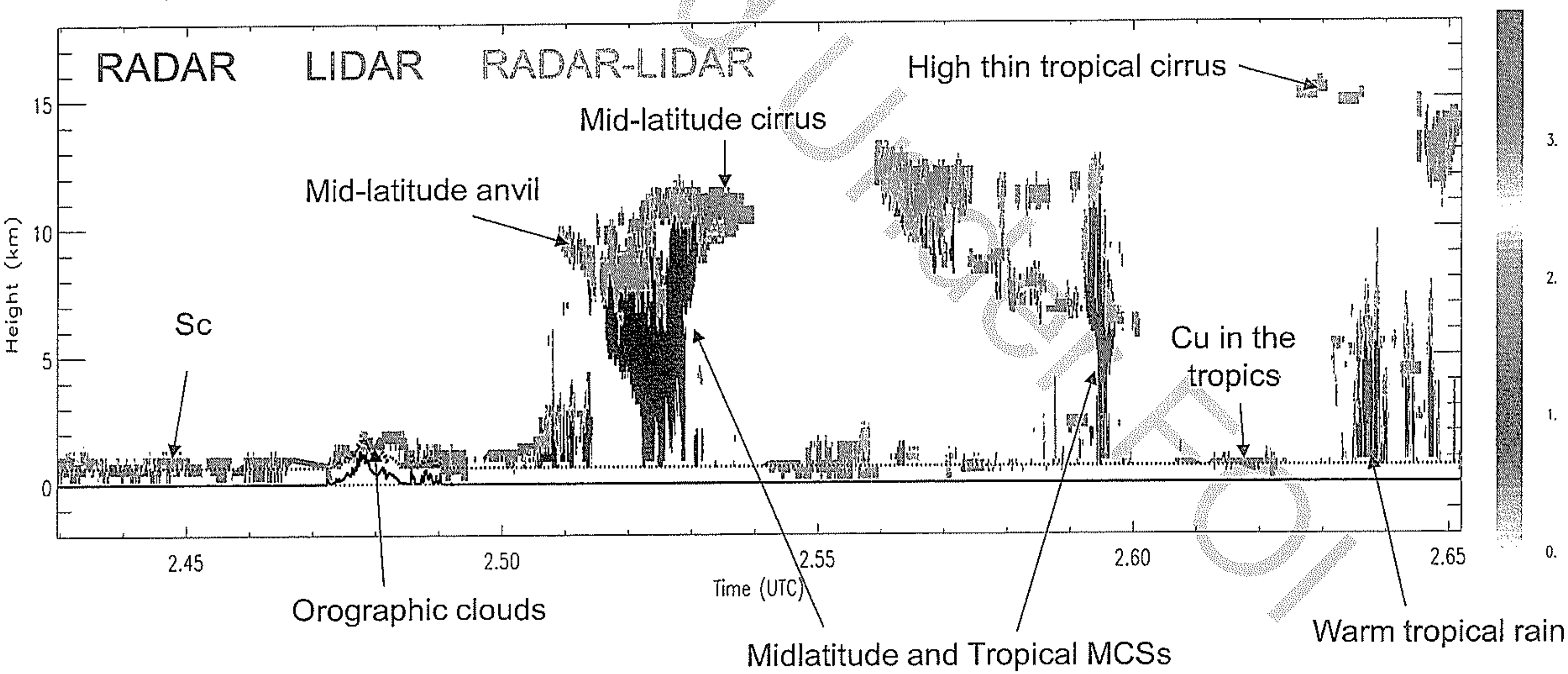


Darwin Tropical Ice Cloud Properties

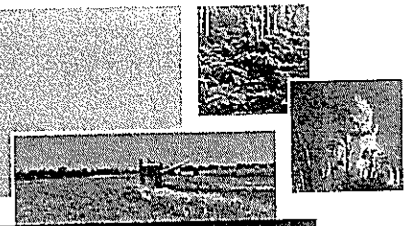


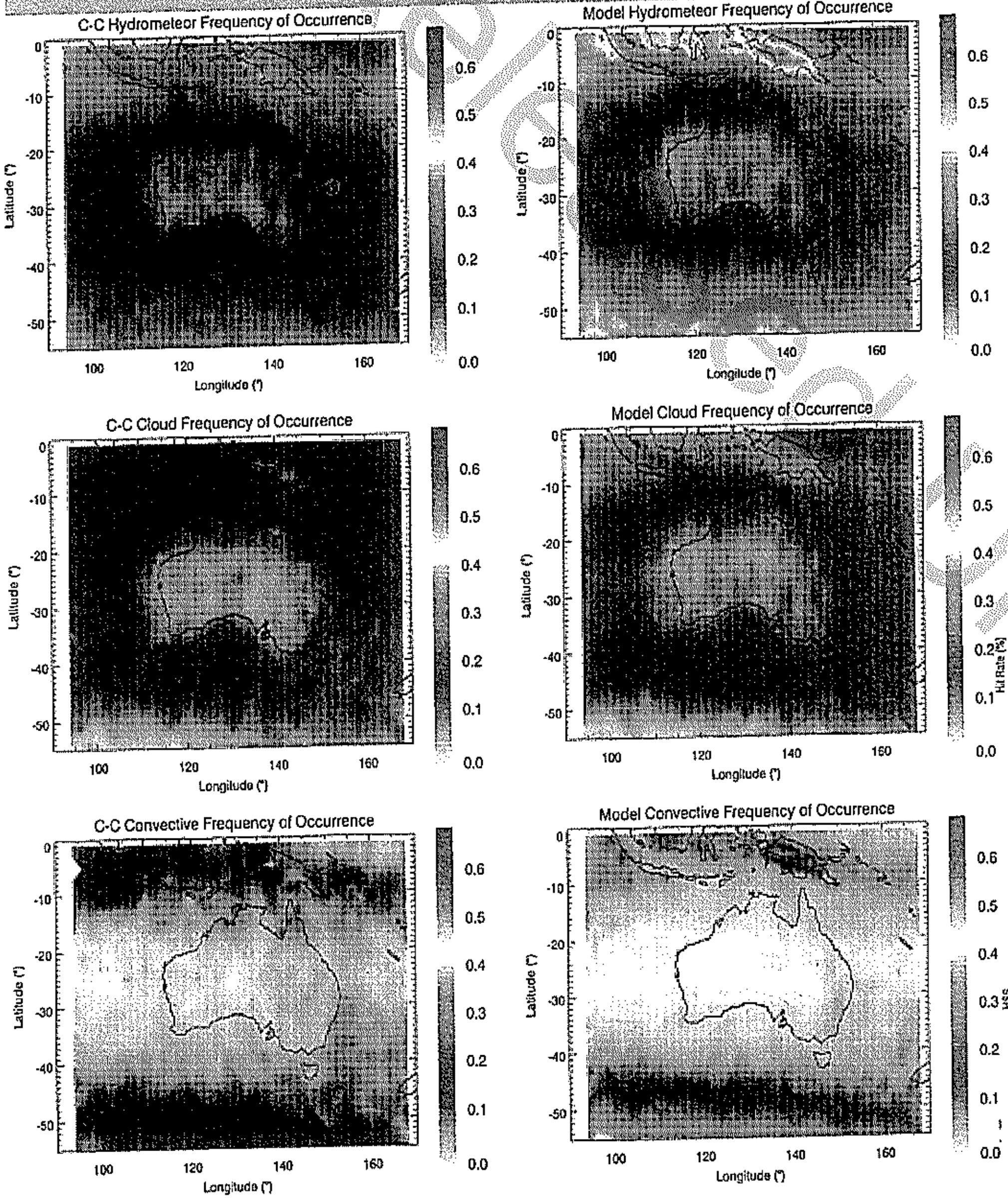
Convective storms detrain large and long-lasting cloud systems at different heights, mostly thick anvils and cirrus layers. These have significant radiative impact on the Earth radiative budget. Characterizing their microphysical properties is a priority because it determines the radiative effects of clouds !

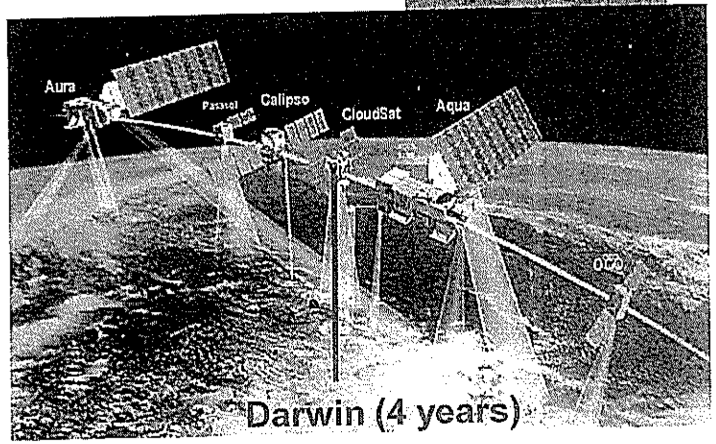
This cannot be characterized with weather radars but with Doppler cloud radar (35 or 95 GHz) / lidar (visible wavelengths). Crucial to use both cloud radar and lidar (complementarity).

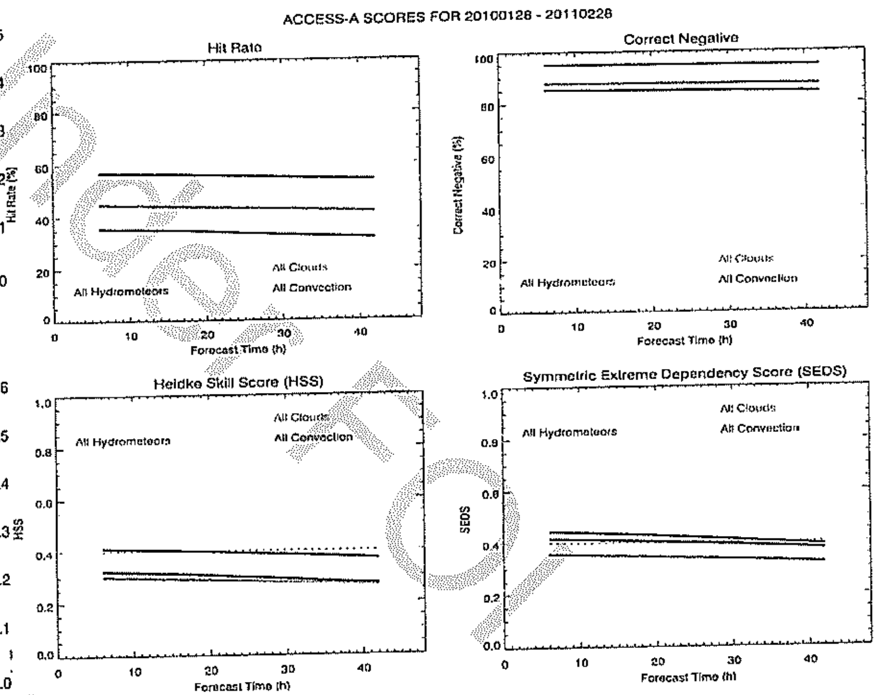


Local and Regional characterization
→ ACCESS Model Verification

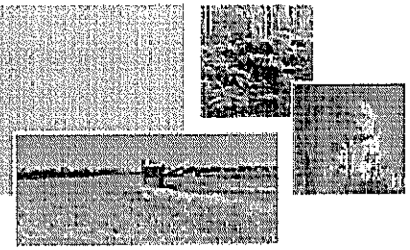








Conclusions and Perspectives



CAWCR research radars and Darwin ARM observations (and soon the weather polarimetric radar on the CSIRO research vessel) are ideal tools to investigate extreme weather events and develop techniques to characterize them quantitatively in near real-time.

Ongoing (TRMM, A-Train) and future (GPM, EarthCARE) satellite missions, validated with our ground-based observations are ideal tools to extend these studies regionally and globally.

CAWCR is actively working on the ACCESS model(s) evaluation and improvement and on the development of techniques to better nowcast extreme weather events

CAWCR and ROs need to define a framework to accelerate the transfer of knowledge acquired from research towards applications / operational warning, especially in areas sensitive to severe weather like Queensland and the NT, and around airports.

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Cloud and Convection Research using the CAWCR weather radars and the ARM observations

Tel : [redacted]

Thank you

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