Cloud properties in a monsoon environment

www.cawcr.gov.au

Peter May

Deputy Director CAWCR

Alain Protat, Chuck Long (PNNL), Christian Jakob,

Vickal Kumar (Monash University) Guillaume Penide (Université Lille)

Scott Collis (ANL)

Australian Government

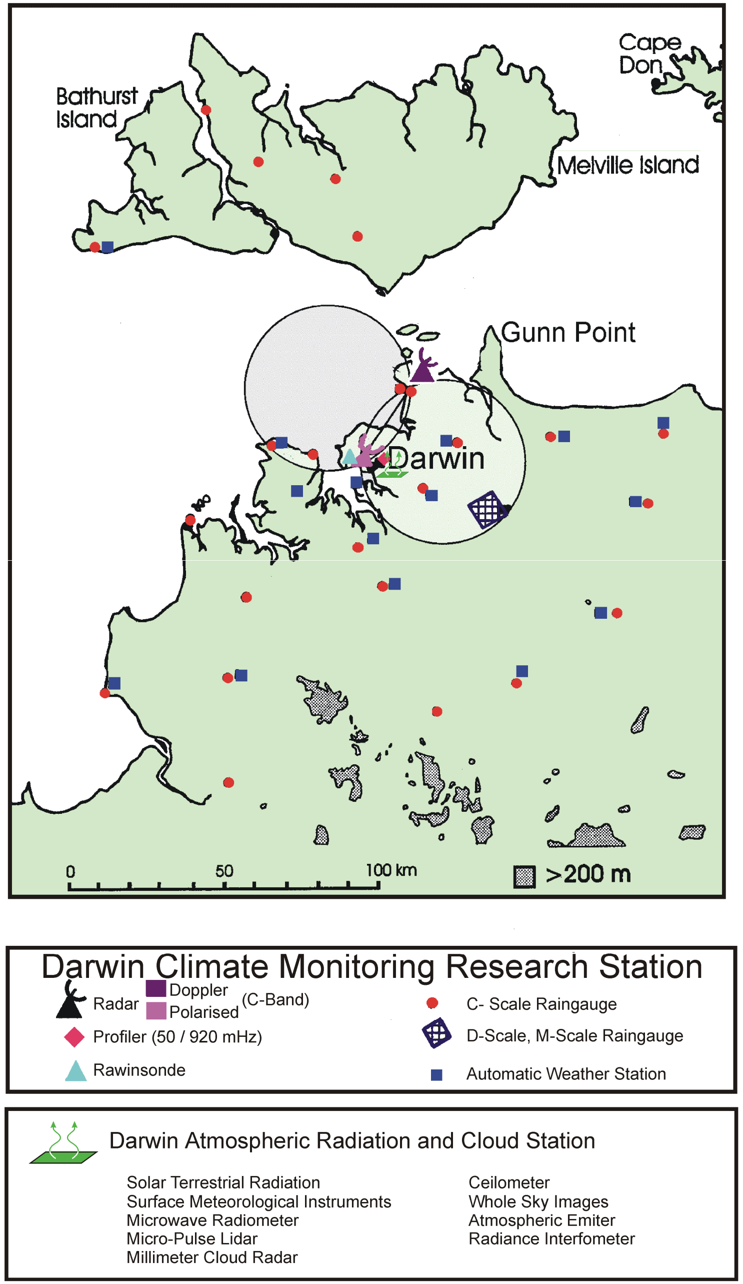
Bureau of Meteorology

The Centre for Australian Weather and Climate Research

A partnership between CSIRO and the Bureau of Meteorology

CSIRO

Background - The DCRS/CSIRO/ARM sites



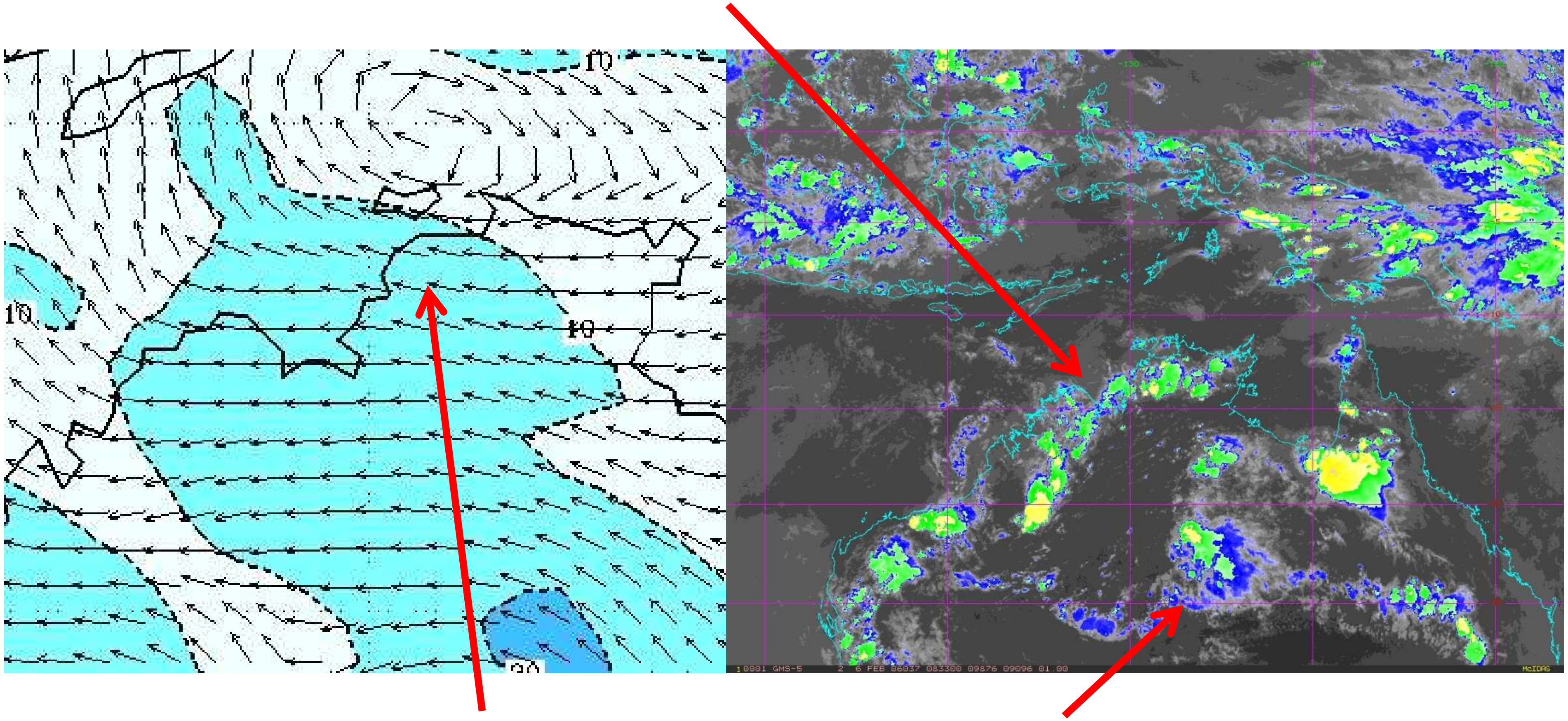
Polarimetric radar (5cm)
Doppler weather radar
Profiler (50 and 920 MHz)
AVHRR, **MTSAT**
LW, SW Radiation
NWP
Soundings
Cimel
GHG measurements in late 2009
ARM operational:
MMCR (Doppler 35 GHz Cloud Radar) MPL (Lidar)
Lidar Ceilometer
AERI
MWR (Microwave Radiometer)
WSI
Surface Met
SkyRad: PSP/PIR UVB Global PSP MFRSR IRT
and now a dual frequency scanning cloud radar, Raman lidar , IR Doppler lidar, aerosol labs, GHG

stralian Government
ureau of Meteorology

CSIRO

Break – convection suppressed on large scale

Afternoon storms on sea breeze convergence lines



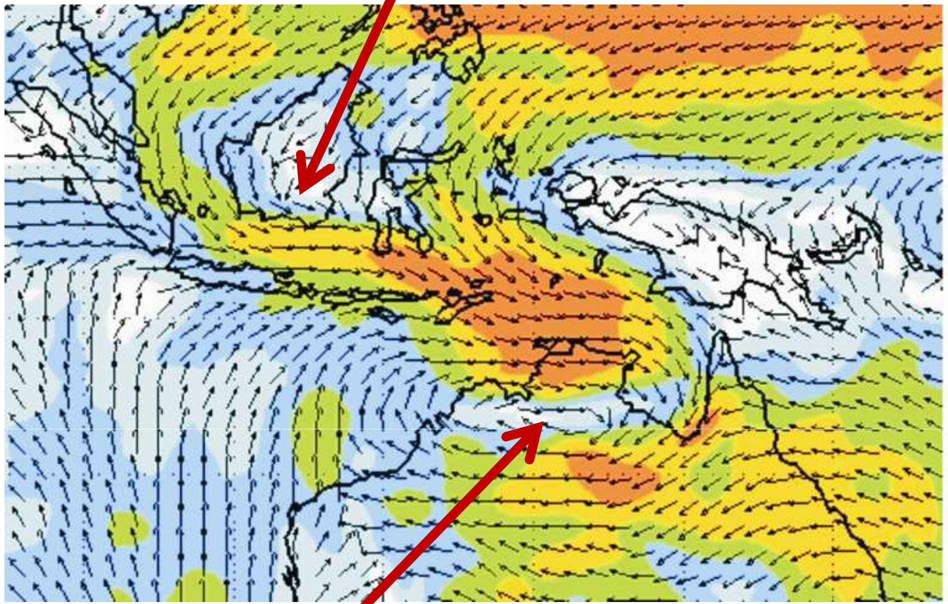
Monsoon trough to north, in easterlies

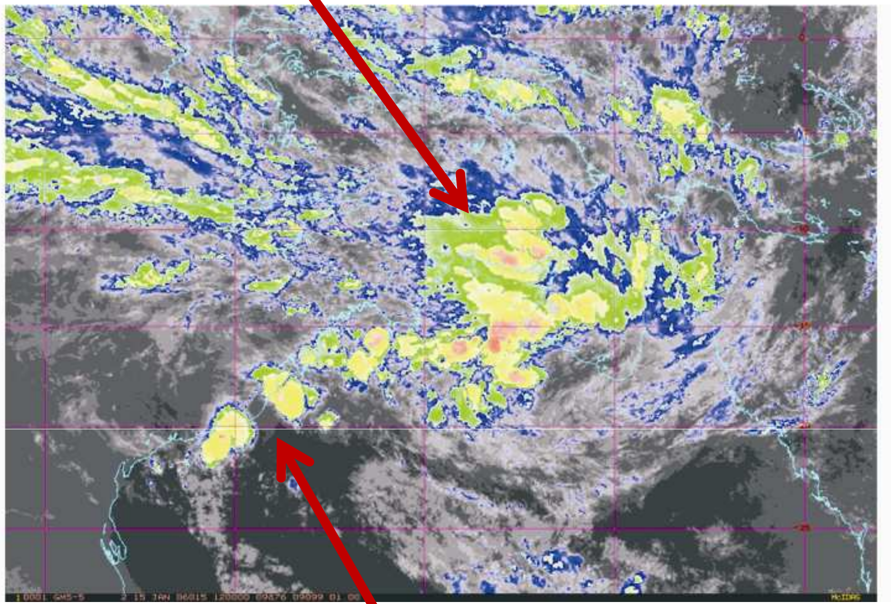
Dry line

Monsoon – large scale support for convection

Cross equatorial flow feeding westerlies

Widespread convection

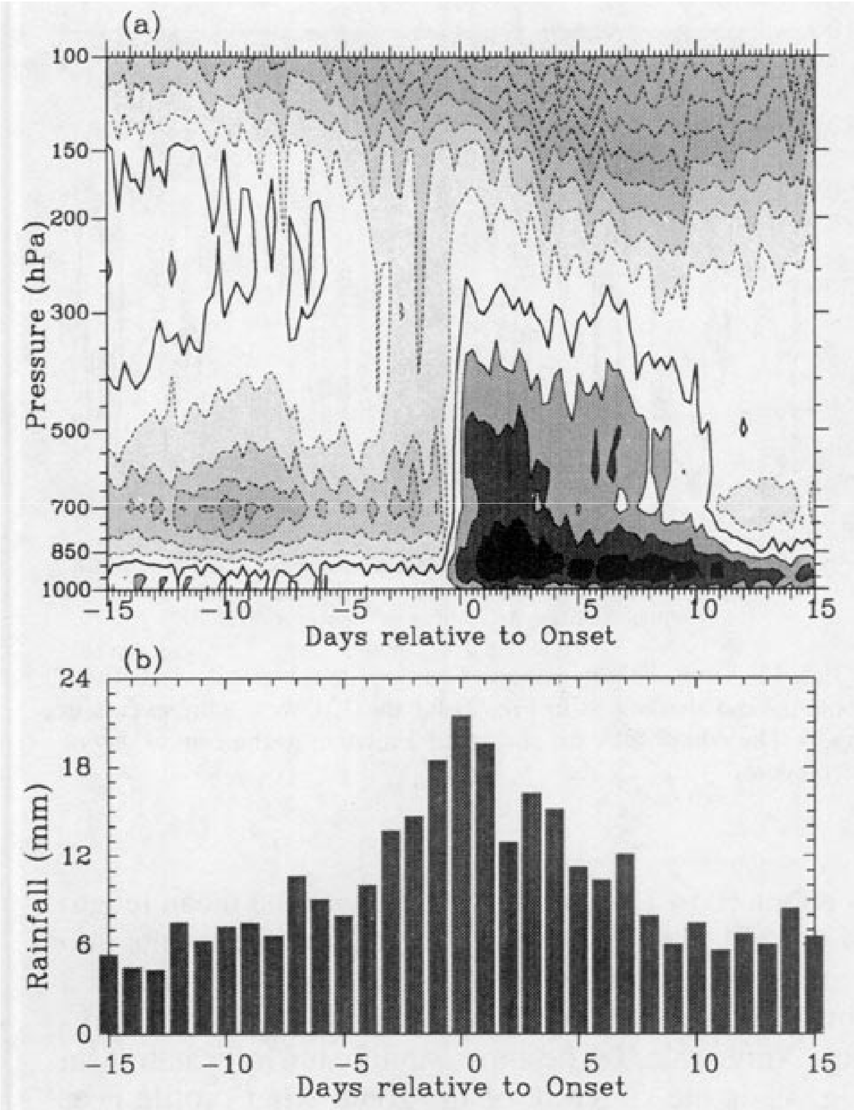




Monsoon trough

Coastal convection south of the trough

Drosdowsky, 1996: Note sudden change in regime on onset

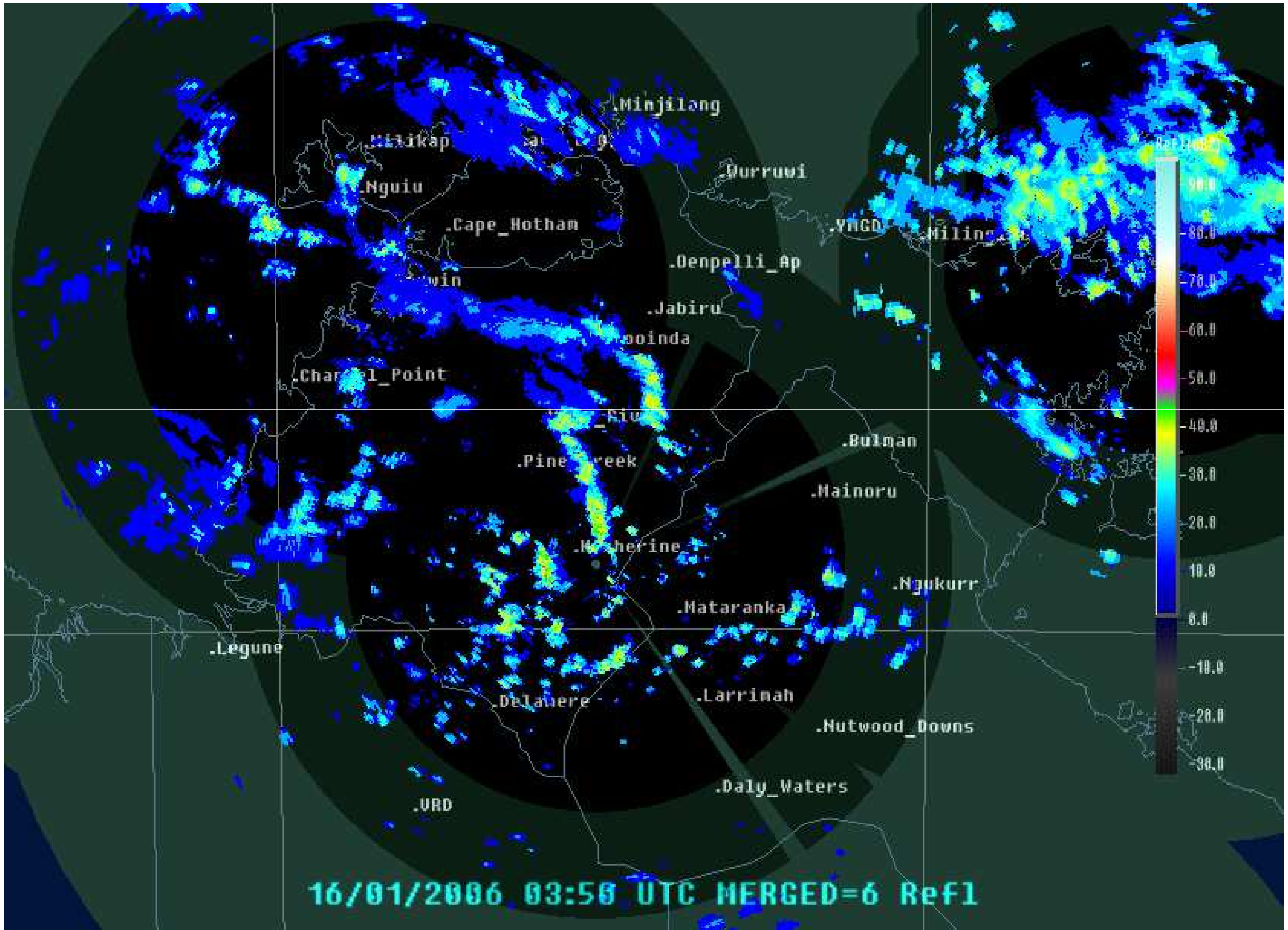


Monsoon periods last ~ 1 -4 weeks
Interspersed by break periods

Intra-seasonal variation of OLR of
similar magnitude as seasonal cycle

FIG. 7. Composites about onset dates for the 35 seasons given in Table 1 of (a) time–height section of 6-h Darwin zonal winds (with contours and shading as in Fig. 2) and (b) six station area-average rainfall.

What is special about the environment that controls this?

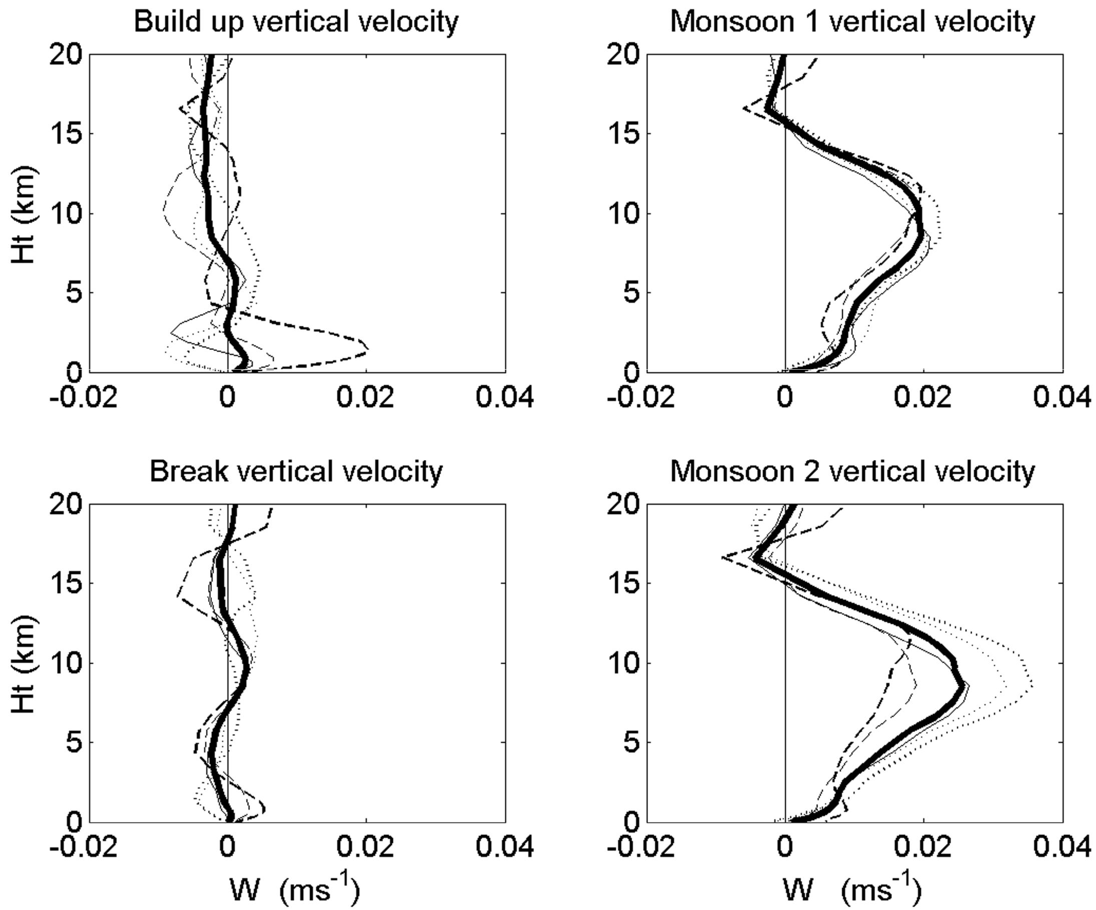


Australian Government
Bureau of Meteorology

CSIRO

1. Large scale vertical motion in the regimes

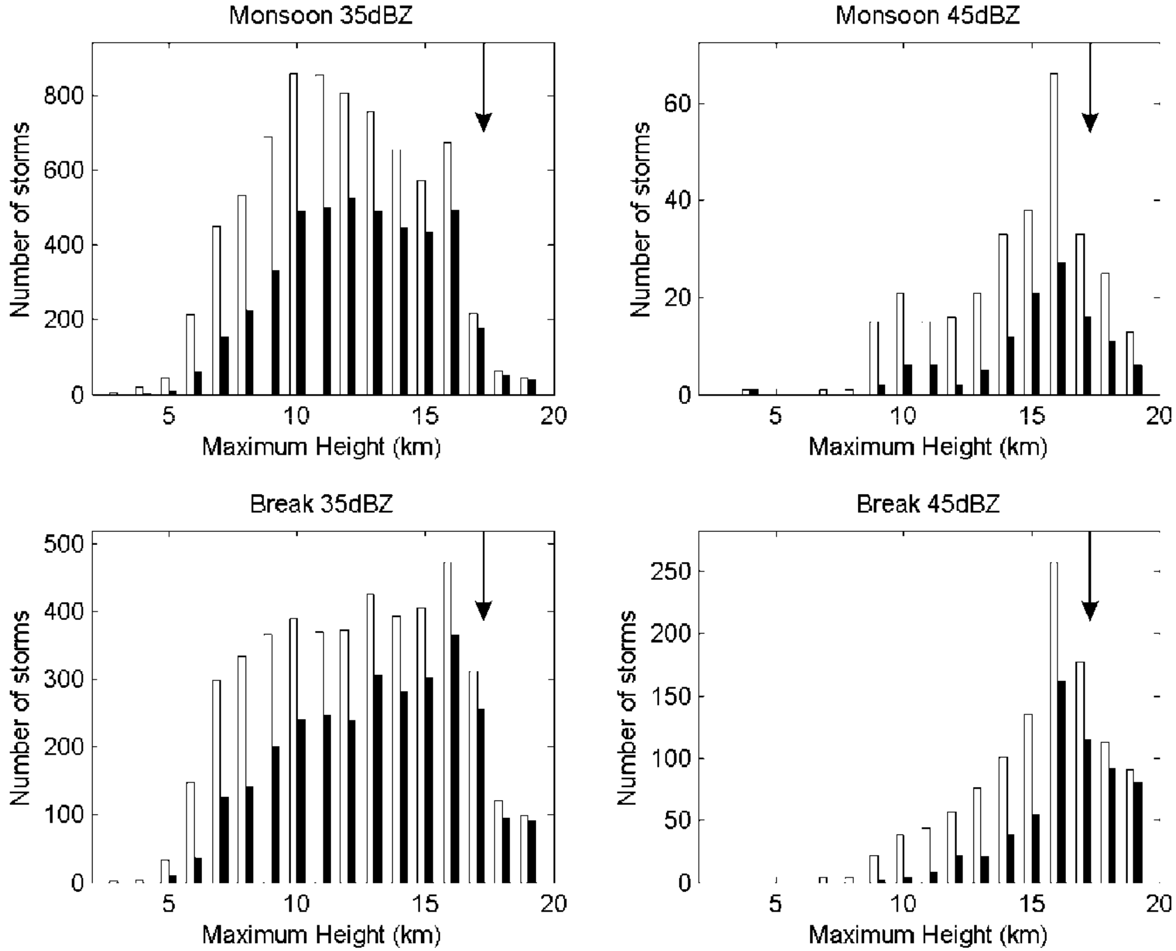
For grid points near Darwin from operational NWP



After May and Ballinger, 2007

Different regimes have well documented systematic differences in storm statistics

e.g. Distribution of storm cell max heights

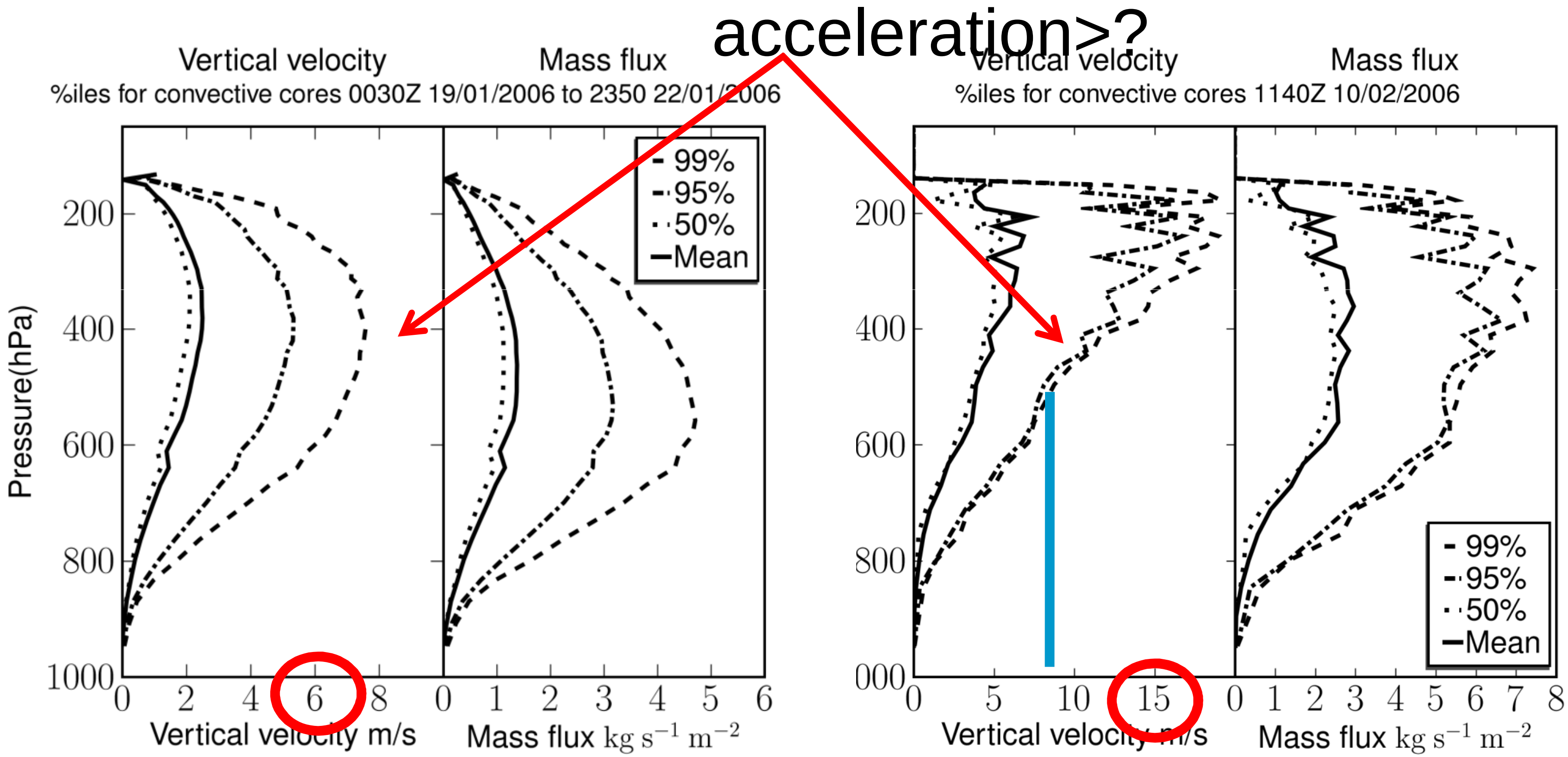


From May and Ballinger, 2007

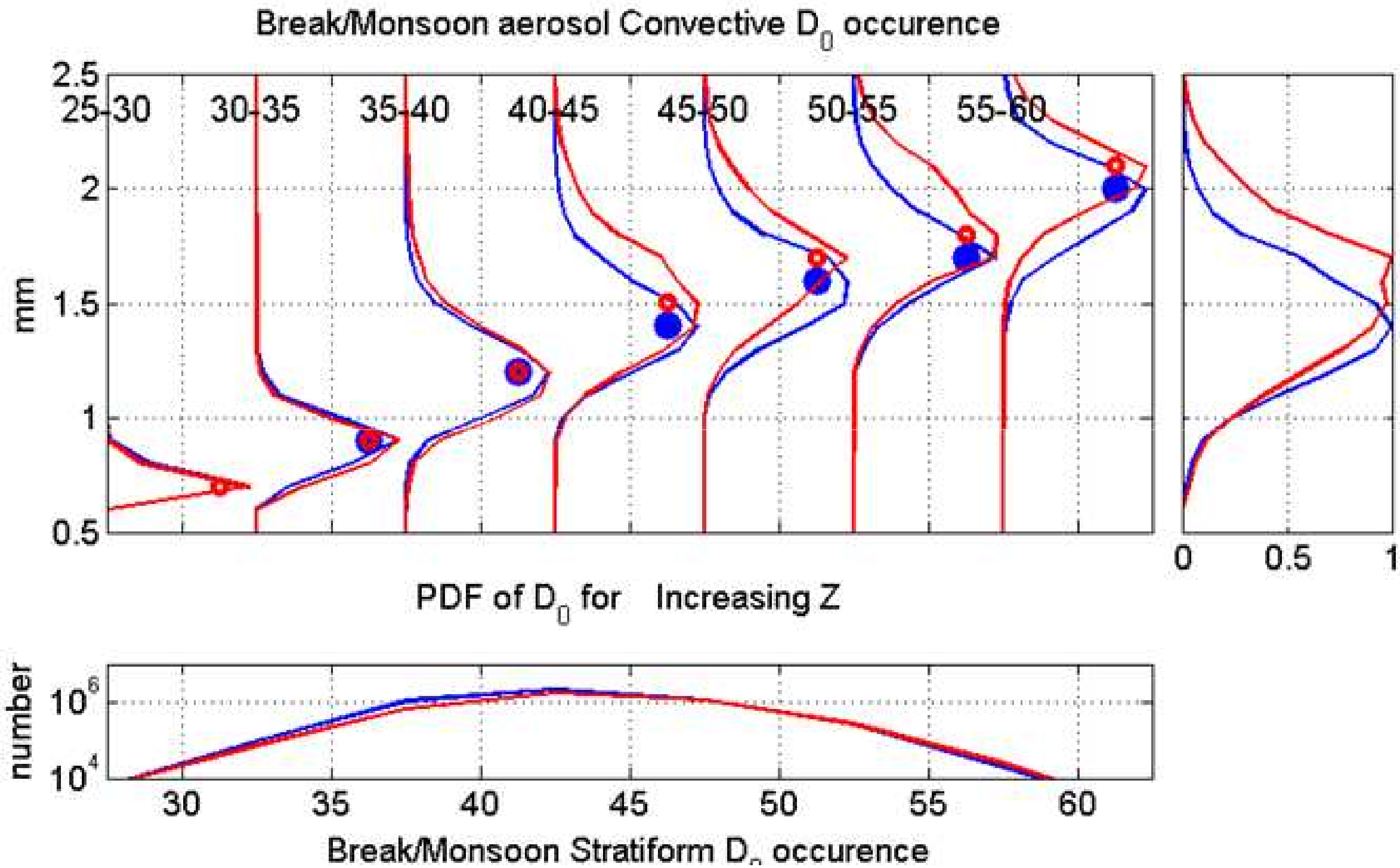
Australian Government
Bureau of Meteorology

PDF’s of vertical motion from Dual Doppler analysis

Monsoon (1 week) / Break (1 (weak) case)



Example of PDF’s of DSD’s (Red: break, Blue: monsoon) from polarimetric estimation



Implications?

Larger vertical motions at FZL –

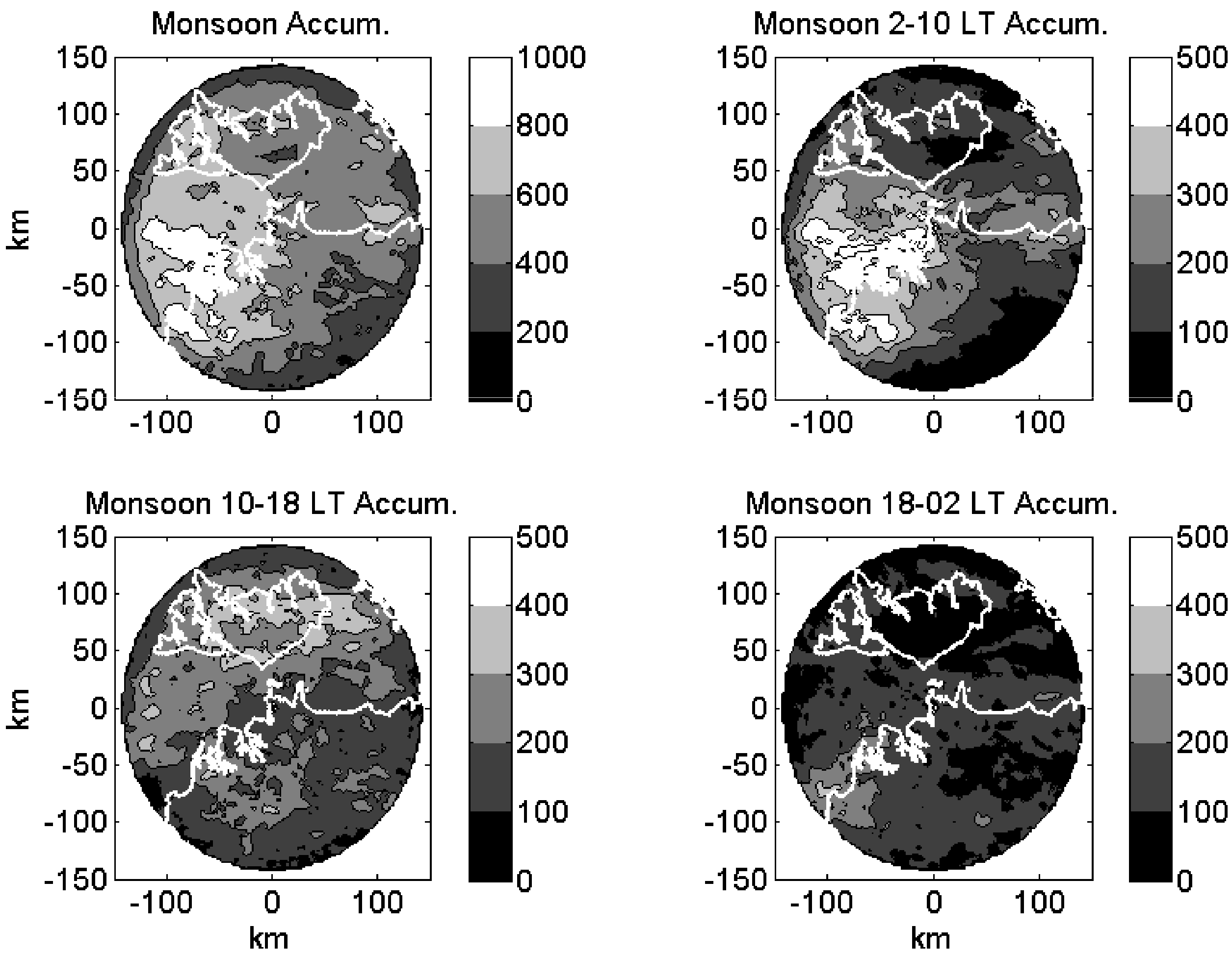
- Consistent with far more lightning activity in break
- Ice processes become more important
- Impacts on rain DSD's, cloud properties

  - Use polarimetrically estimated DSD estimates
  - Polarimetric hydrometeor classifications – e.g. quantify more hail in break

- Detrainment over much deeper later
- Impacts on anvil properties

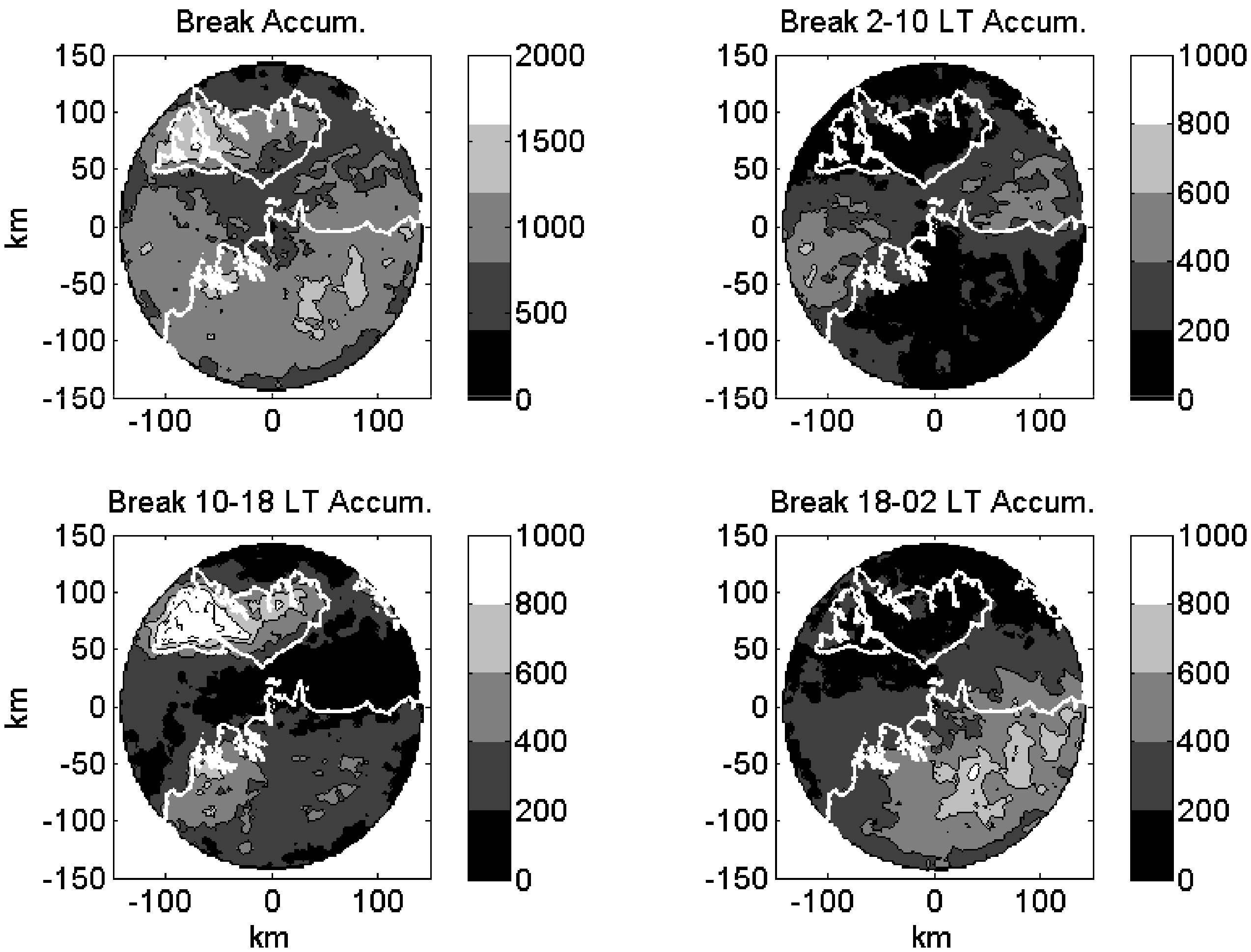
  - Use cloud radar and lidar retrievals

Rainfall distribution and diurnal cycle – Monsoon (2005-6)



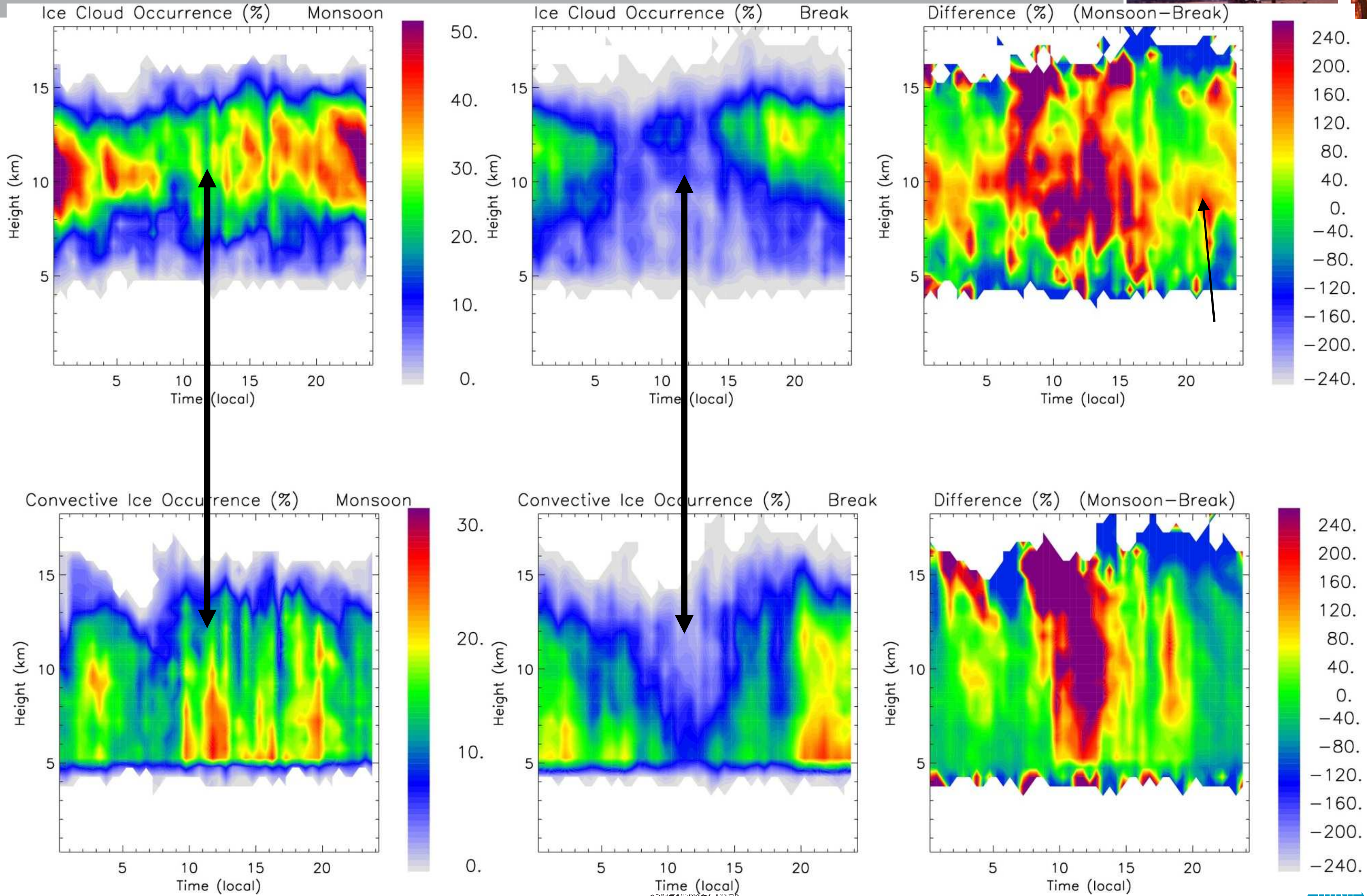
From May, et al, 2012

Rainfall distribution and diurnal cycle – Break (2005-6)



From May et al, 2012

Monsoon versus Break : frequency of occurrence



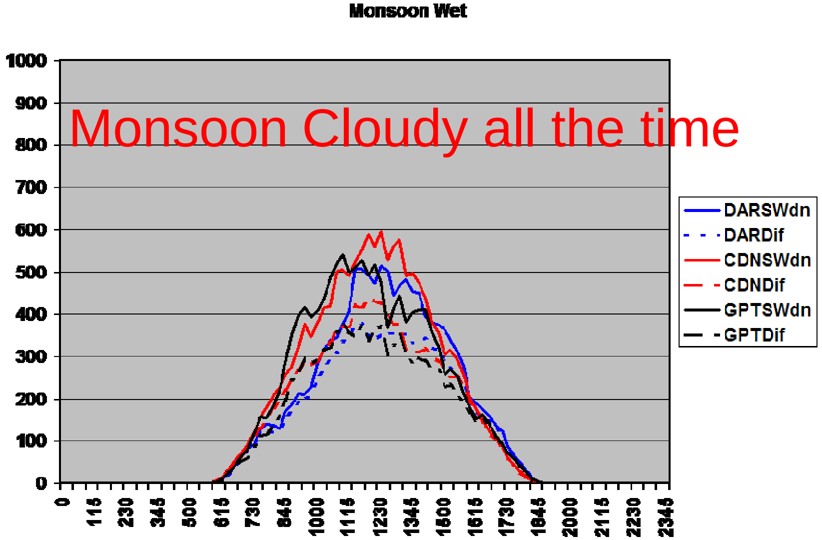
Australian Government
Bureau of Meteorology

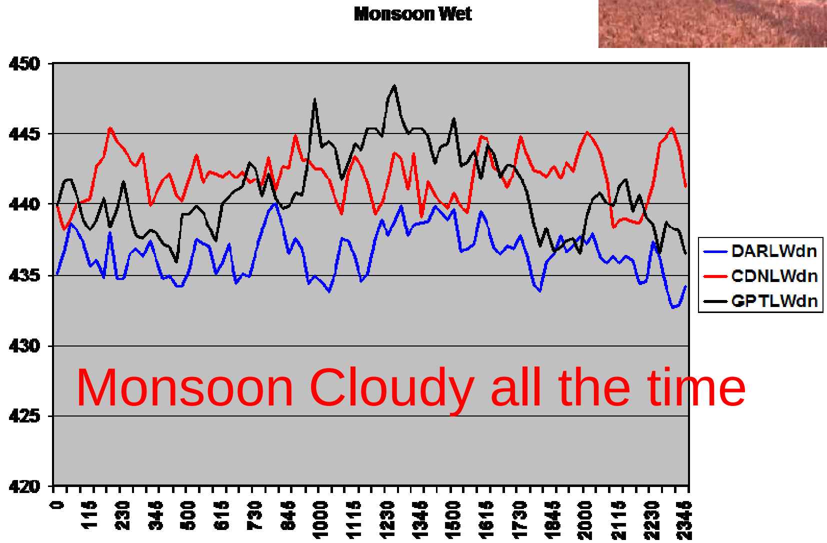
CSIRO

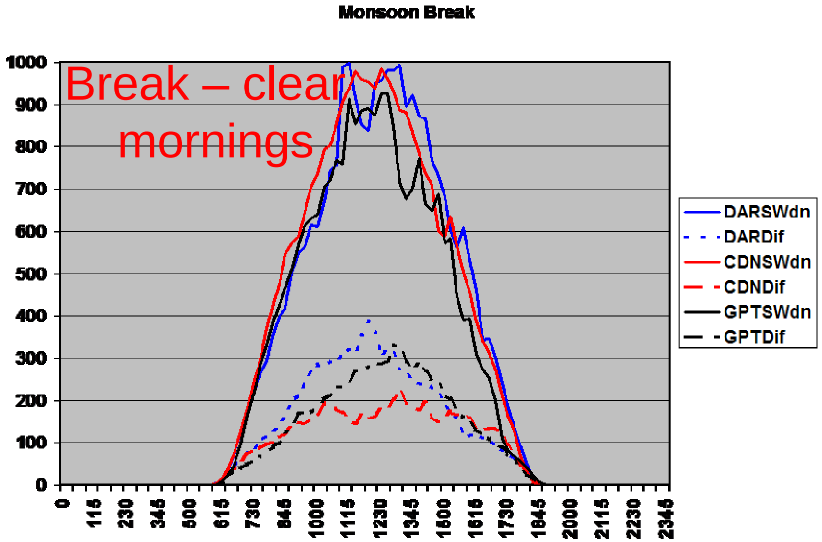
Impact of clouds on radiation 3 sites in TWPICE –

Short wave

Long Wa







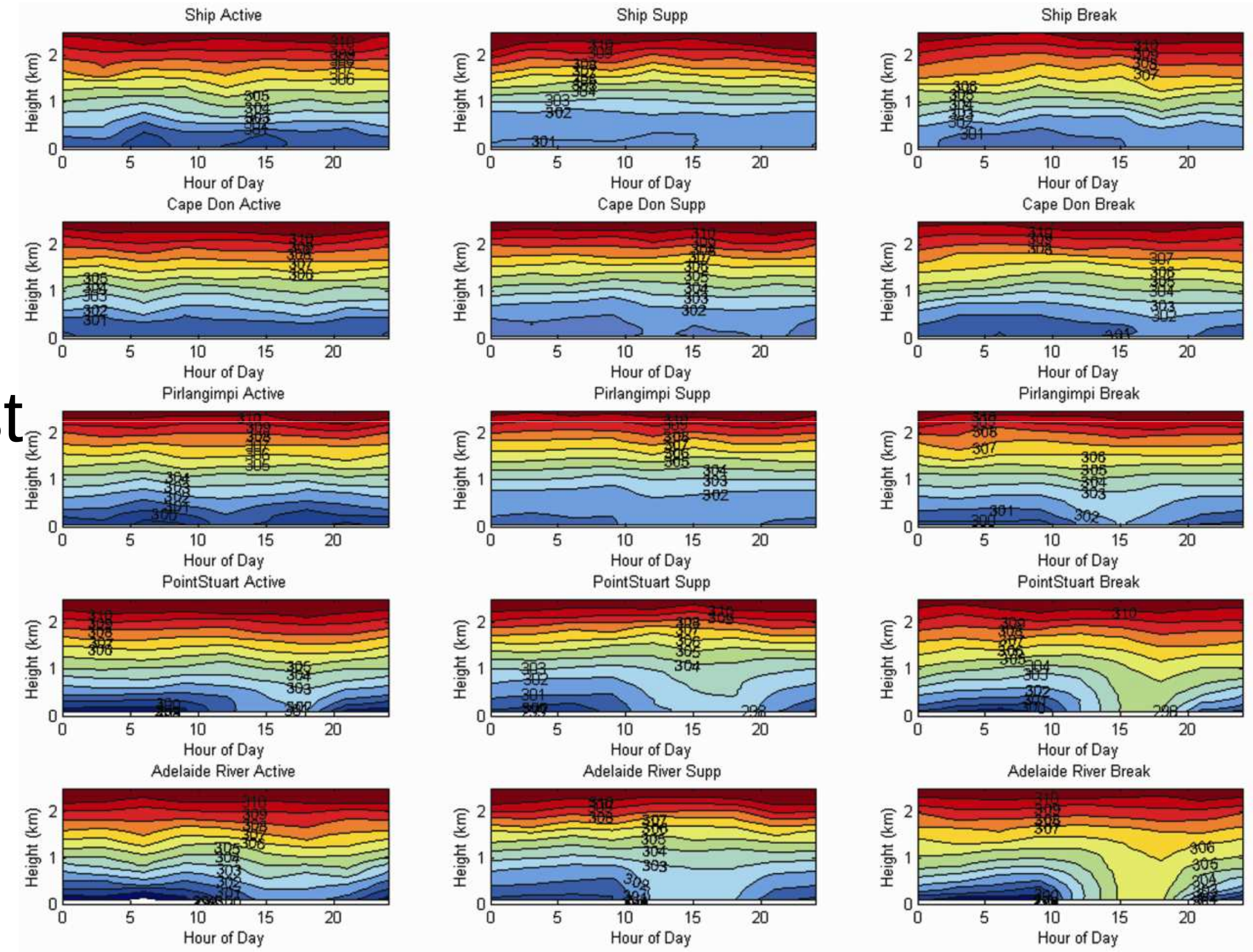
Impact on BL structure, diurnal cycle θ up to 2.5 km

Active monsoon | Suppressed monsoon | Break

Ocean

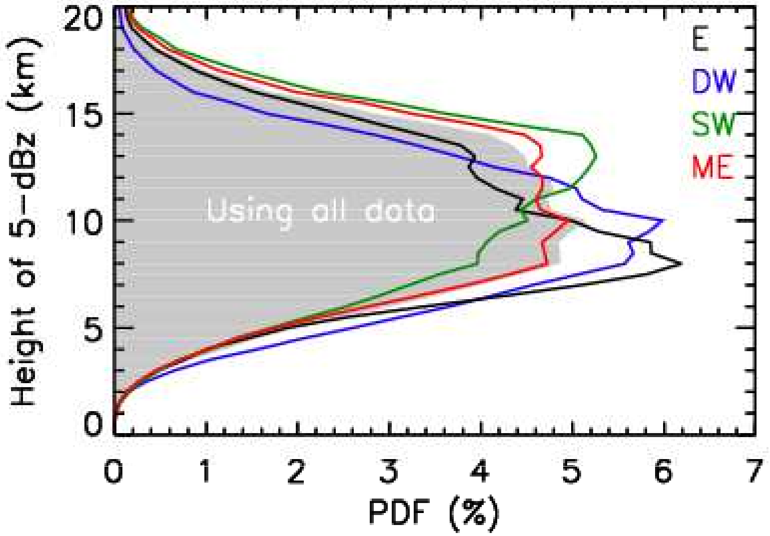
Coast

Land

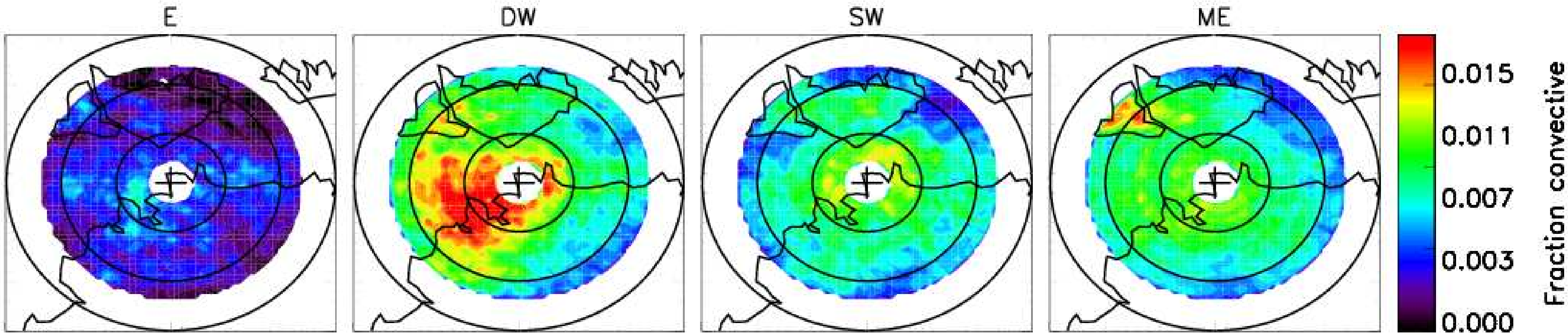


Australian Government
Bureau of Meteorology
The Centre for Australian Weather and Climate Research
A partnership between CSIRO and the Bureau of Meteorology
CSIRO

Now concentrating only of convective cloud properties during the five regimes



All the four large-scale atmospheric regimes show a single peak occurrence in the cloud top heights. The E regime (black) has the lowest peak at ~8 km and the SW regime (green) has the deepest convective clouds with a peak occurrence at ~14 km.



Frequency of convective pixel around Darwin. A bin size of 5 km x 5 km is used here, and the counts are expressed as a fraction of maximum number of measurements per bin.

Diapositive 17

---

vk1 Mention the Dry east regime is not shown due to poor statistics
vkumar; 13/06/2012

Concluding comments

Comprehensive observational capability in a monsoon environment
Data freely available

Monsoon and break have different convective intensity
Reflected in cloud macro structure (not shown) and microphysicso

Documentation of diurnal cycles
    Tests of for model validation, physics

Future: Environmental regimes
    Cloud properties as a function of kinematic and thermodynamic regimes
    More model testing
    Informing paramaterisation development