ARM

Atmospheric Radiation Measurement

Observed Large-Scale Structures and Diabatic Heating Profiles during TWP-ICE

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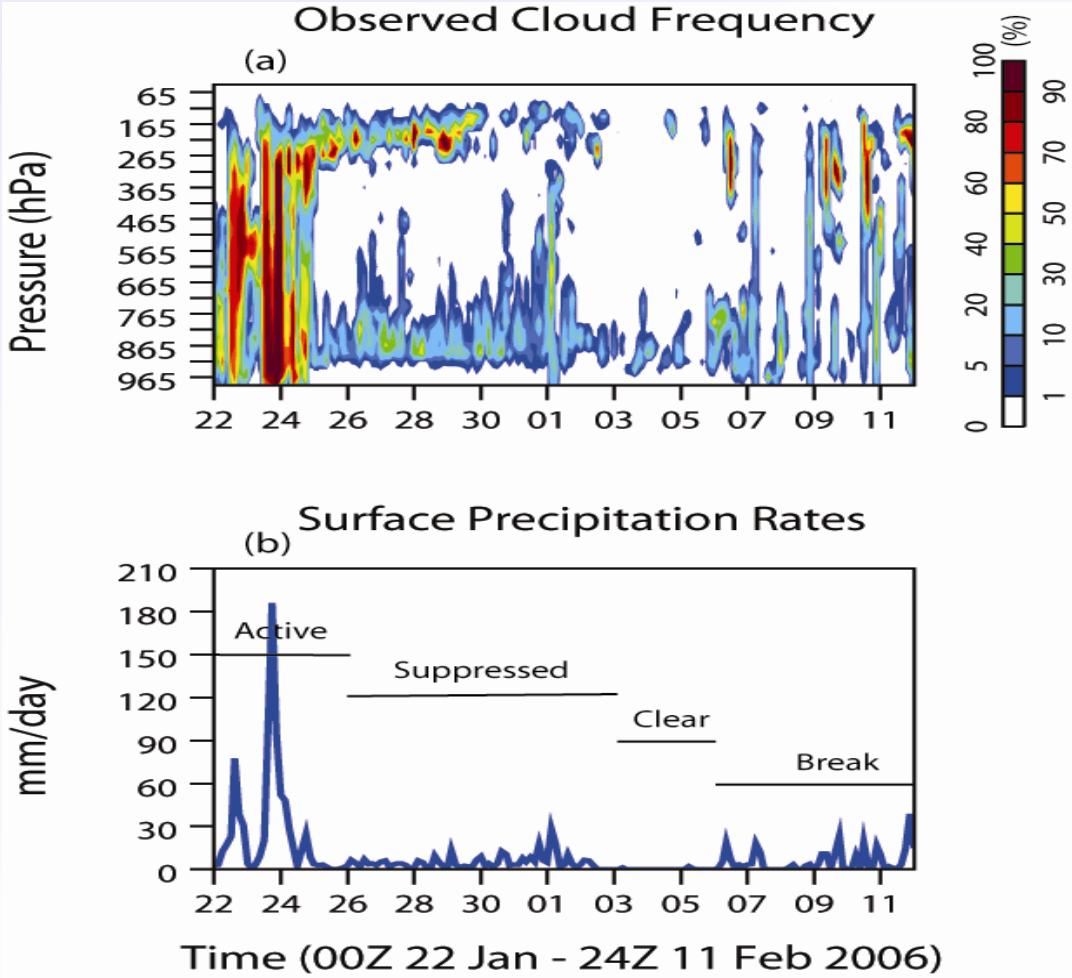
Four Distinct Synoptic Regimes Defined by May et al. (2008)



- ***Active: 1/22-1/25***
  - ***Oceanic origin***
  - ***Monsoon systems with heavy rainfall***
- ***Suppressed: 1/26-2/2***
  - ***Shallow convection with lower precipitation***
- ***Clear: 2/3-2/5***
- ***Break: 2/6-2/13***
  - ***Coastal and island-initiated convection***

- ***How do mean structures and diabatic heating profiles vary within the four observed regimes?***

- ***What are differences in diurnal variations of monsoonal, coastal, and island-initiated convective systems?***

Objective Analysis

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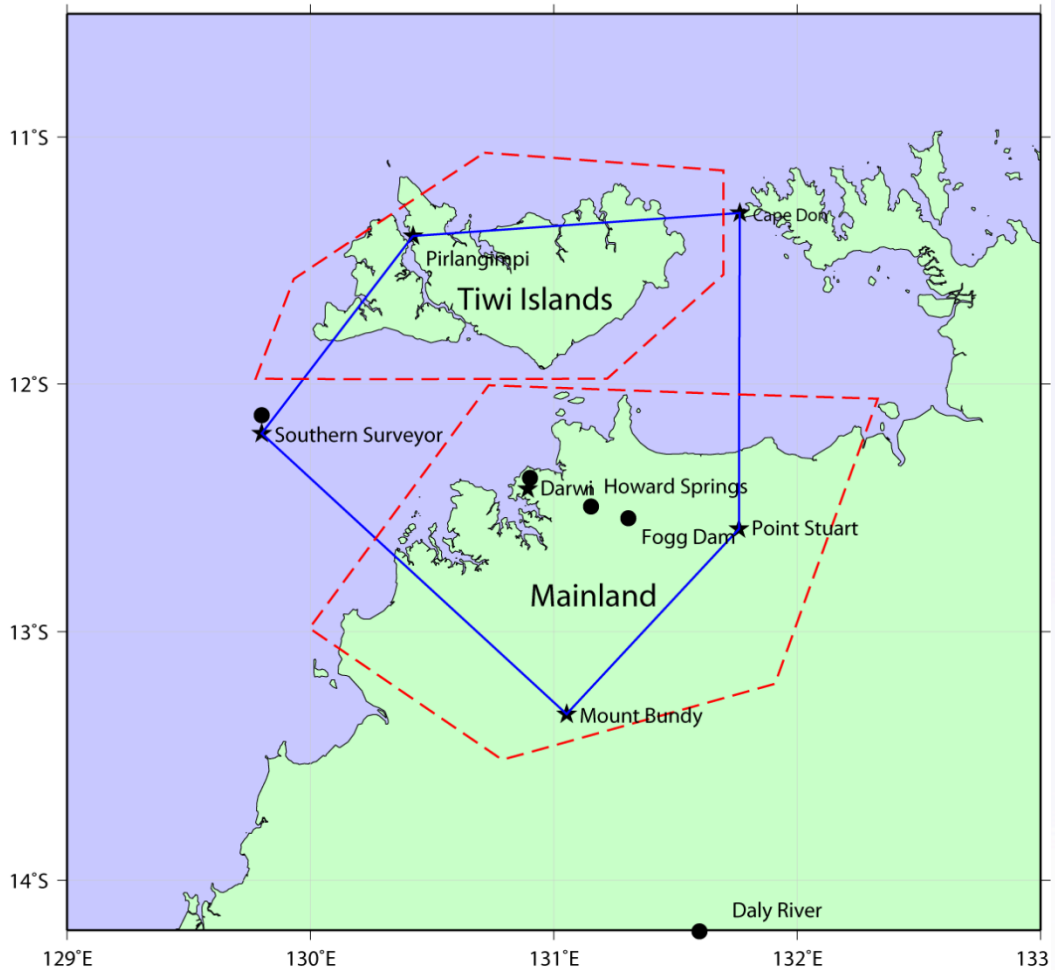
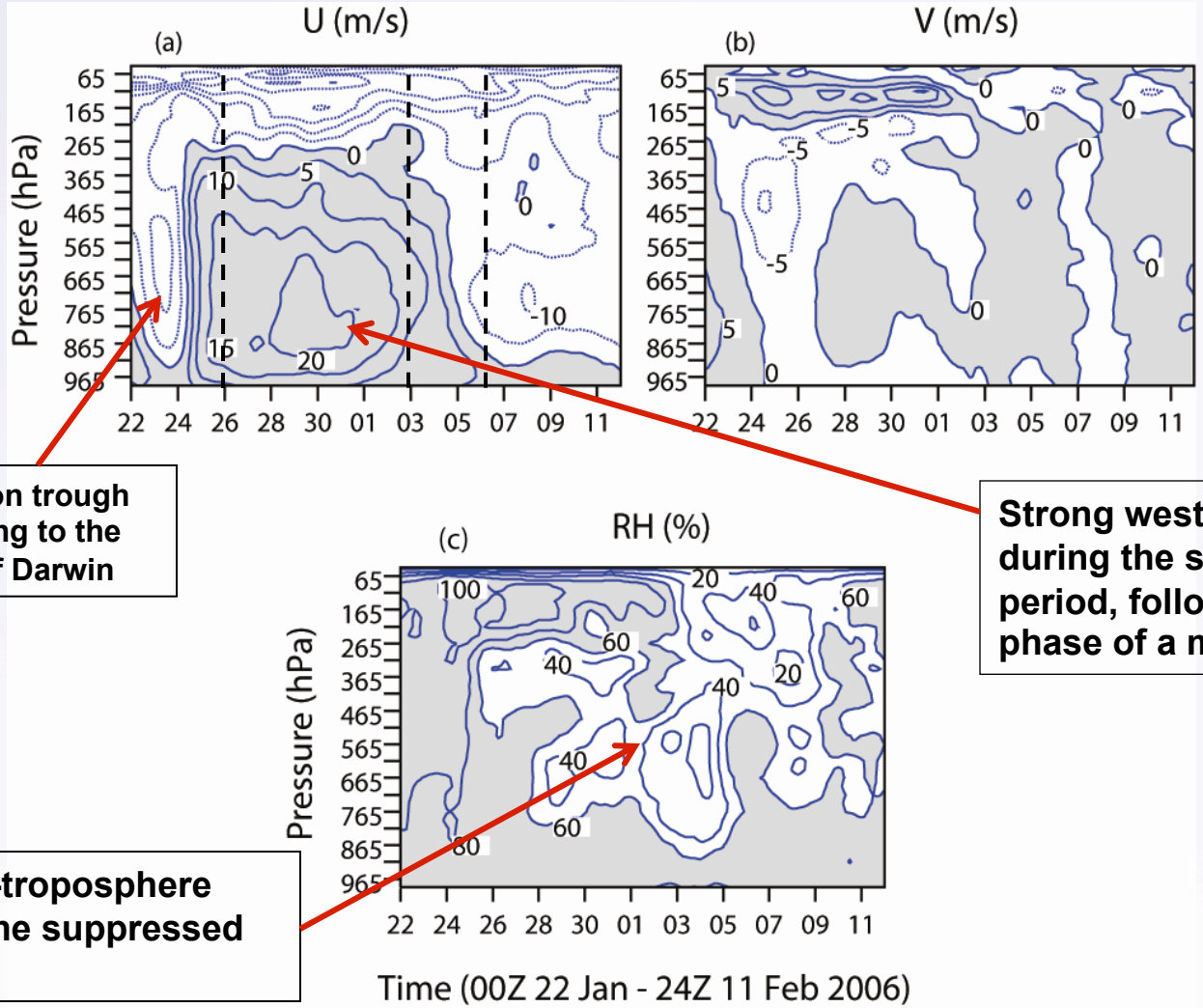
Analysis Domain



- ***Variational Analysis (Zhang and Lin 1997)***
  - ***Constrained by surface and TOA observations***
  - ***Sounding domain and two sub-domains (Mainland and Tiwi Islands)***
  - ***Dry biases corrected***
- ***Sounding IOP 1/22 – 2/13***
  - ***8 times/day, allows to study the diurnal cycle of the cloud systems***

Typical Monsoonal Flow

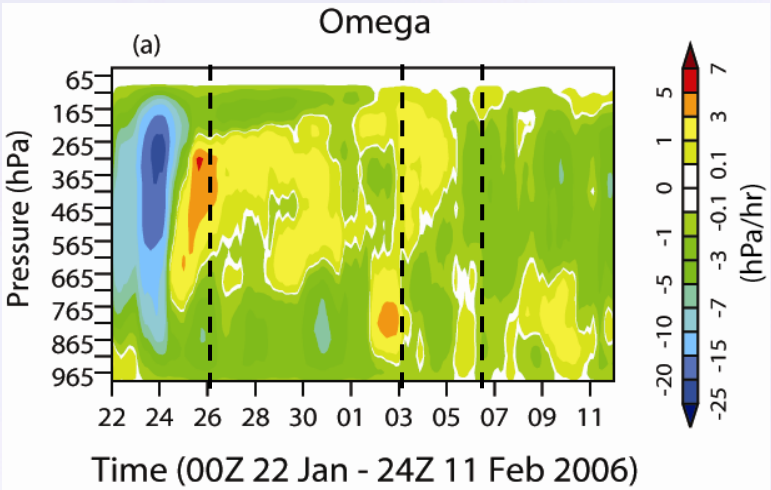


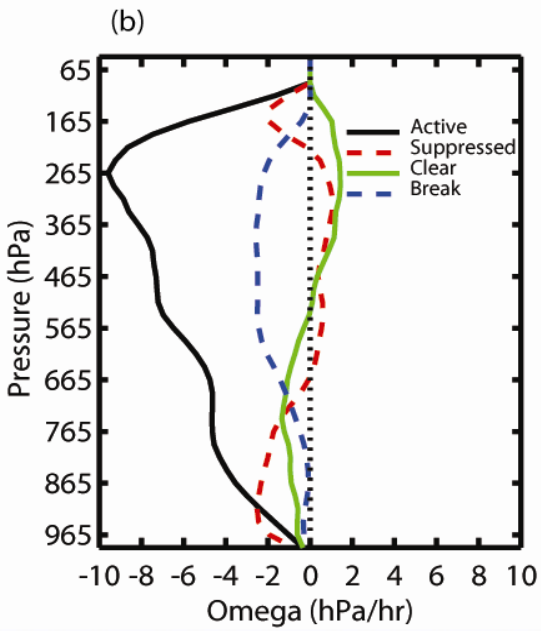
Monsoon trough retreating to the north of Darwin

Strong westerly wind burst during the suppressed period, following the active phase of a major MJO event

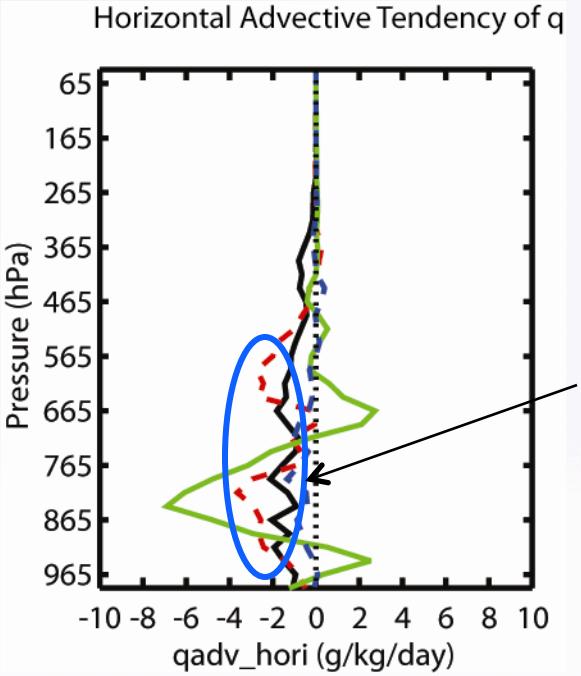
Dry mid-troposphere during the suppressed period

Omega varies over the four regimes



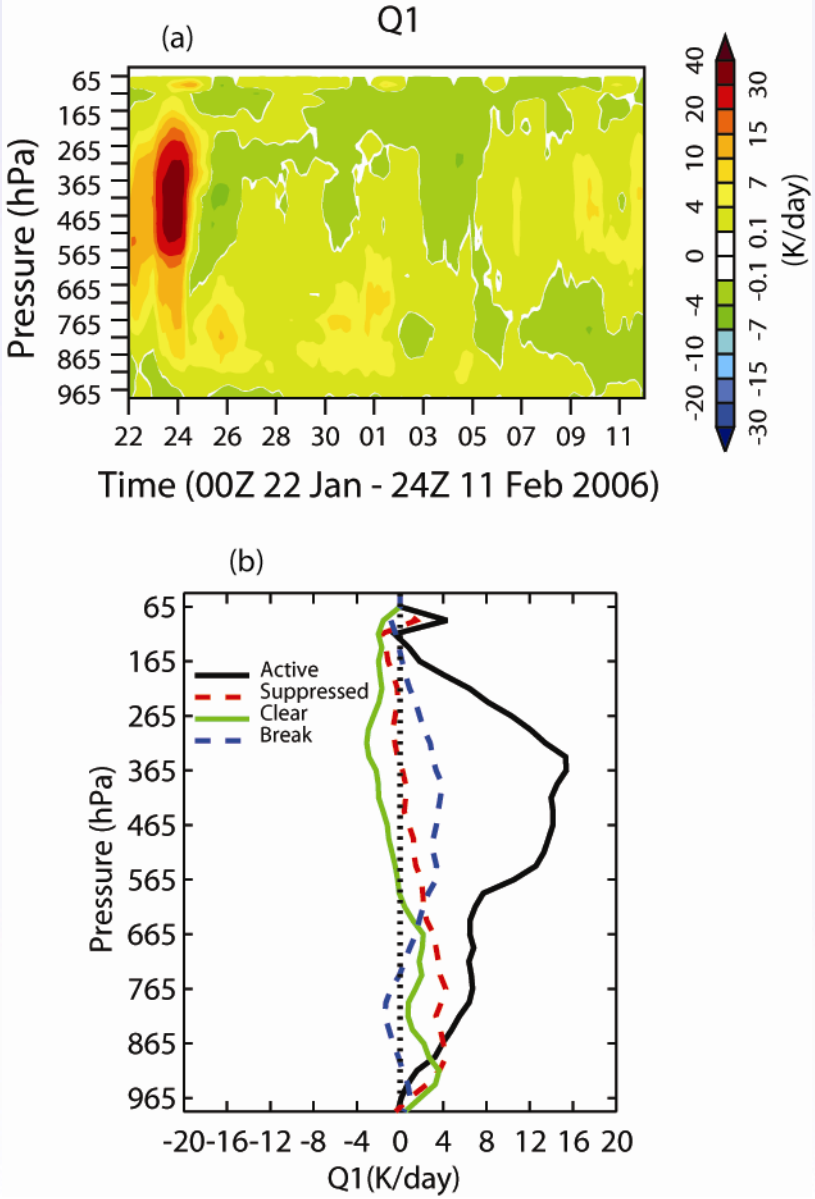


- **Active: strong upward motion through the troposphere**
- **Suppressed : subsidence above 665 hPa**
- **Break: upward motion above 765 hPa**



Dry horizontal advection

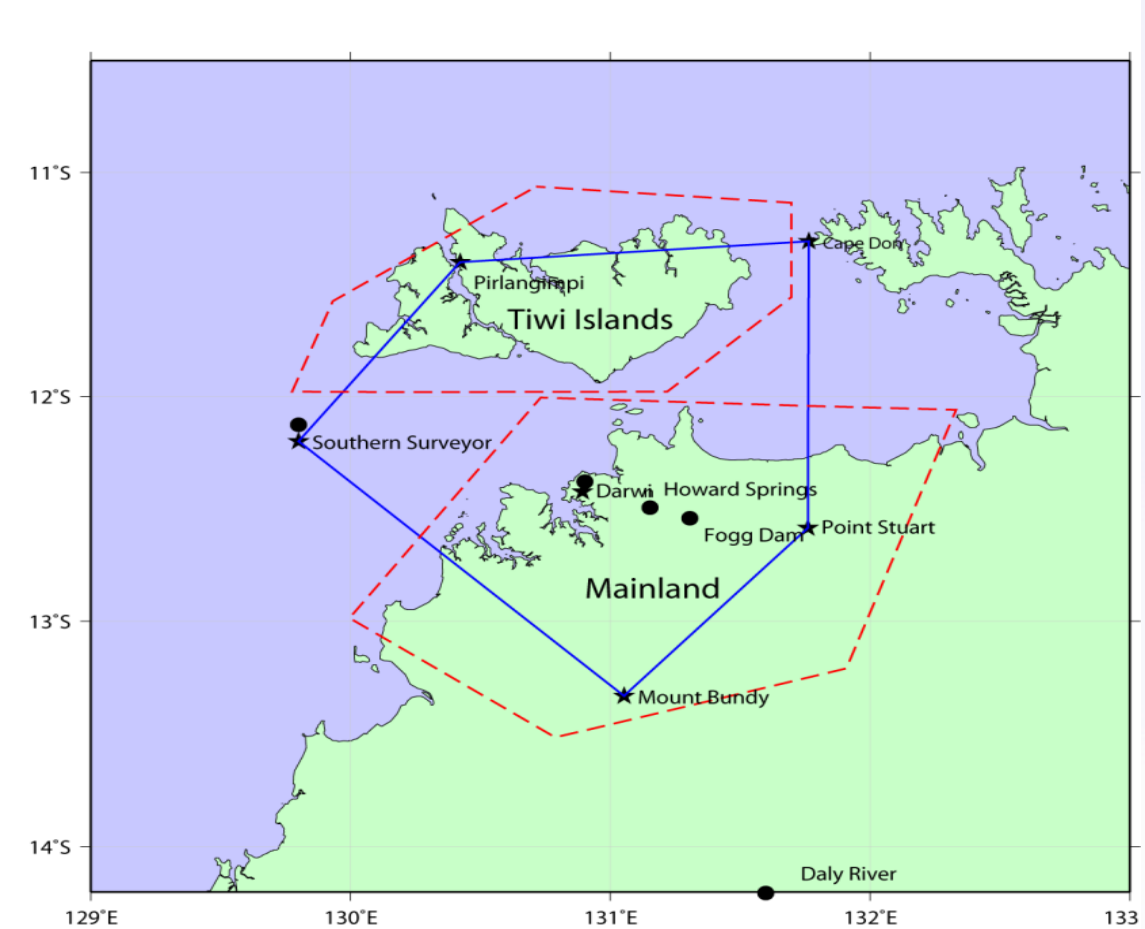
Q1 varies over the four regimes



Diabatic heating profiles are closely associated with large-scale structures, cloud types, and rainfall rates

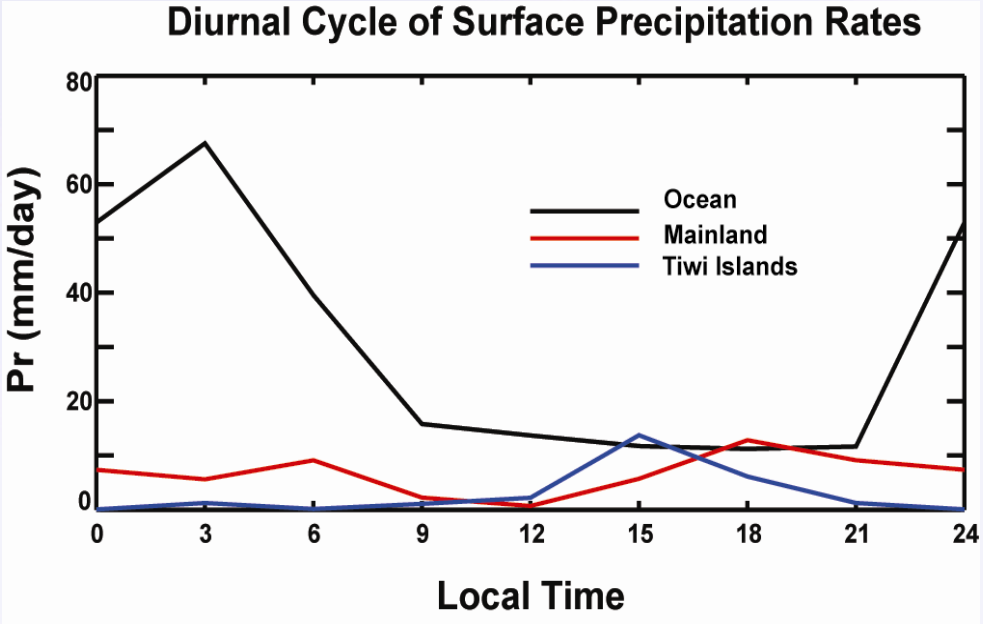
- **Active:**
  - **Peak at 340-540 hPa**
- **Suppressed:**
  - **Heating located at low levels**
- **Break:**
  - **Moderate heating above 765 hPa and weak cooling below**

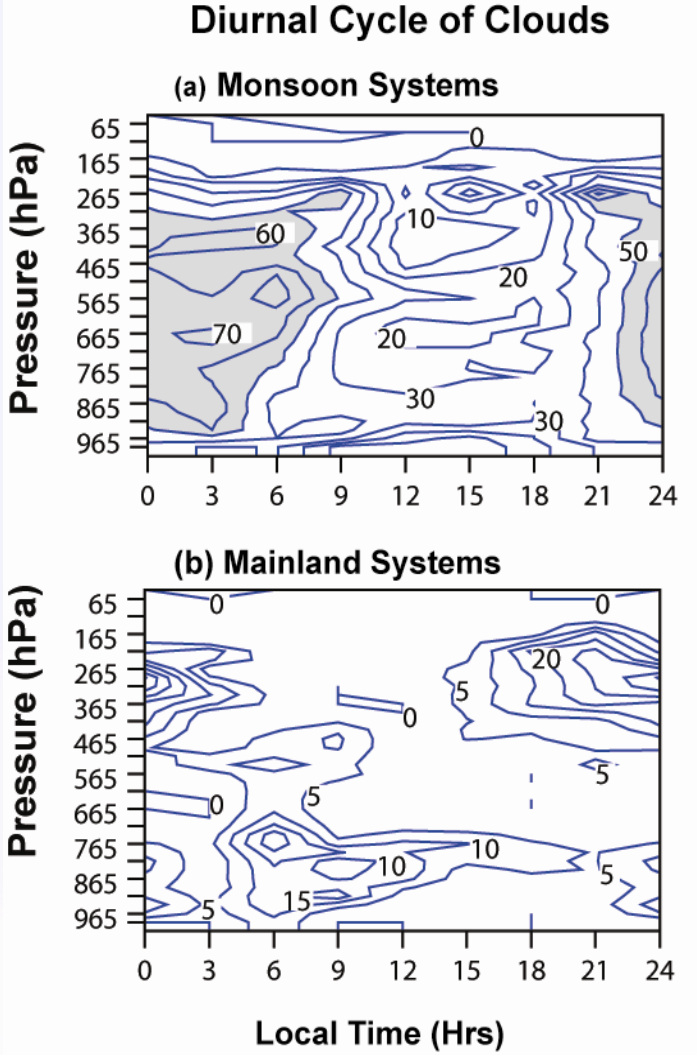
The Diurnal Cycle of Monsoonal, Coastal, and Island-initiated Convection



- **Monsoon Systems (1/22 – 1/26)**
- **Mainland and Island Systems (2/6-2/12)**

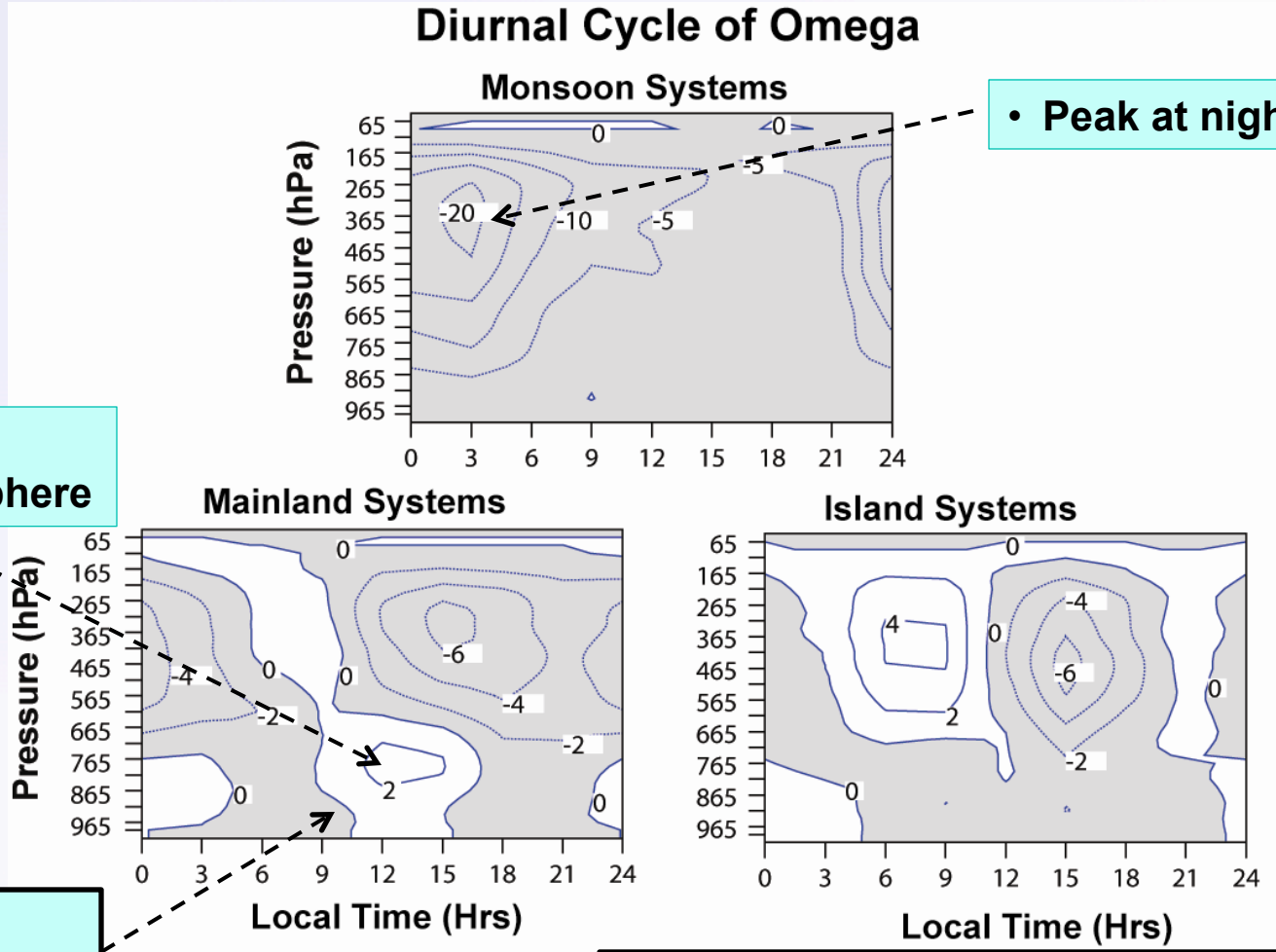
Diurnal Cycle of Precip and Clouds





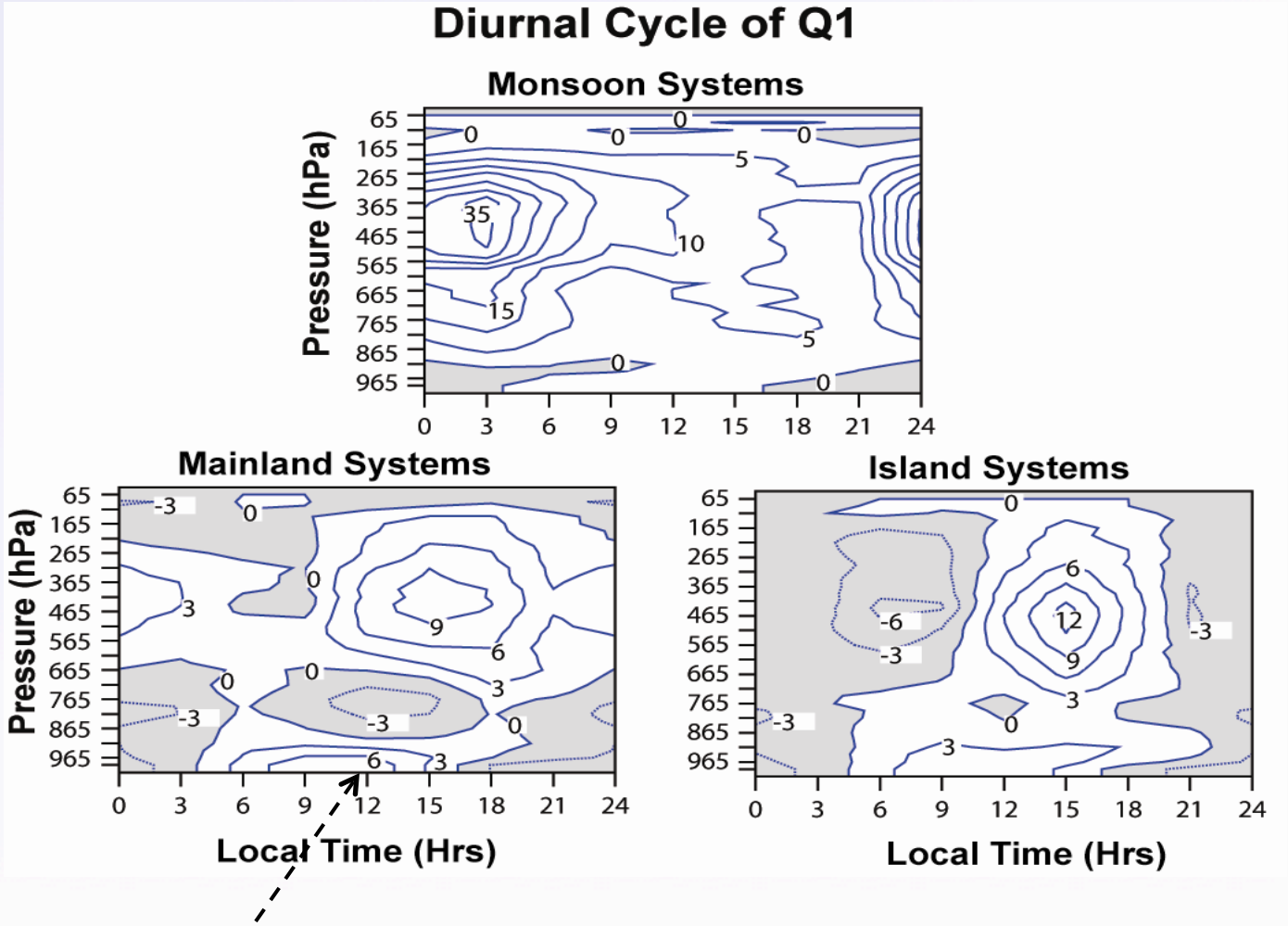
- **Monsoon Systems: peak at 0300 LST**
- **Island Systems: peak at 1500 LST**
- **Mainland Systems: one peak at 0600 LST and the other one 1800 LST**

Diurnal Cycle of Vertical Velocity



- Peak at night
- Subsidence at middle troposphere
- Weak upward motion at low levels at the initial stage
- Deeper ascending layer and stronger subsidence layer in the middle troposphere when convection starts

Diurnal Cycle of Q1



- Heating at low levels due to shallow convection

- Heating during the day and cooling at night

Summary

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- ***TWP-ICE : a typical northern Australian summer monsoon flow influenced by a major MJO event***

- ***The large-scale structures and diabatic heating profiles have significant variations between different synoptic regimes***
  - ***Cloud types and surface rainfall rates***
  - ***Similar to those diagnosed from other tropical field campaigns***

- ***The mid-level subsidence and horizontal dry advection ~> the dry middle troposphere during the suppressed period***

- ***Monsoon, mainland, and island systems exhibit significant differences in these structures through their diurnal evolutions.***

Xie et al., 2009: TRMM Latent Heating Special Issue, J. Climate, DOI: 10.1175/2009JCL3071.1