Dissecting Diabatic Heating From TWP-ICE

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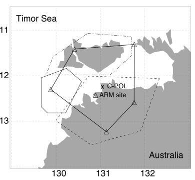
1. Introduction

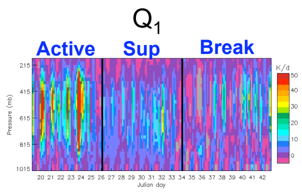
Observations made by the sounding array, C-POL, and ARM Darwin facility during TWP-ICE are used to determine the latent, radiative, and sensible heating profiles associated with Australian monsoon convection.



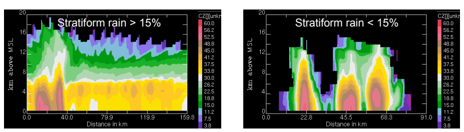
The apparent heat source, Q_1, is derived from the sounding array (including subdomains), while the latent heating (LH) is estimated from C-POL and the radiative heating (RH) is calculated using MMCR and MPL observations. The vertical eddy transport of sensible heat (SH) is a residual based on:

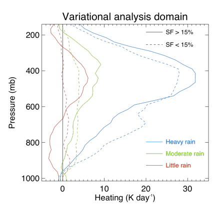
$$Q_1 = LH + RH + SH$$

In addition, three distinct regimes occurred during TWP-ICE, i.e., the active (westerlies, large MCSs), suppressed (westerlies, fast moving sheared convection), and break (easterlies, strong land convection) periods.



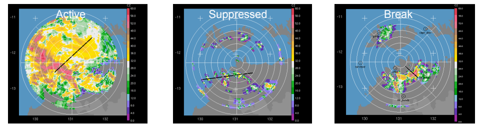
2. Q_1 By Rain and Stratiform %

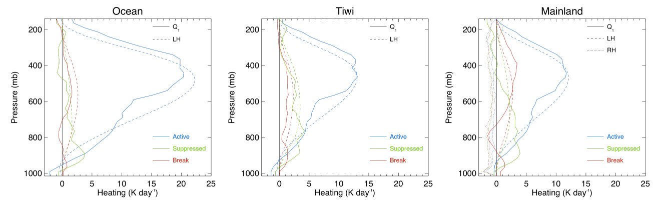




- Rain contributions >50, 5-50, and <5% strongly vary Q_1.
- Higher stratiform rain fractions cause Q_1 to have more heating above 600 mb and less below.

3. Land/Ocean and Monsoon Regimes



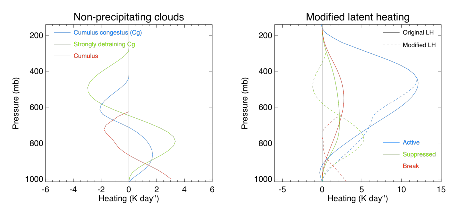


Active: Stratiform rain fractions ~30%, strong upper level heating, highest heating values over ocean because of large MCSs

Suppressed: Stratiform rain fractions ~10%, max low-level heating except for upper level RH signal, largest heating over Tiwi Islands

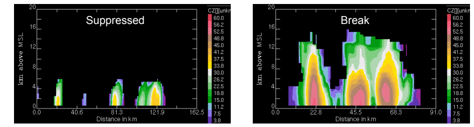
Break: Stratiform rain fractions still low (~13%), strongest Q_1 over the mainland where break convection dominates, low-level cumulus signal

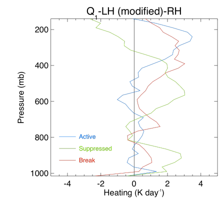
4. Cumulus Cloud Modification of LH



- Non-precipitating cumulus clouds do not add LH but can modify the LH profile at low and mid levels.
- Based on MMCR cloud populations, cloud LH profiles were assumed for each monsoon regime and added to C-POL LH over the mainland.

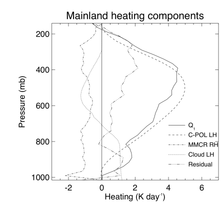
5. Mainland Residual/SH





- Q1-LH (modified)-RH ideally equates to the vertical eddy transport of sensible heat; note the lower maximum aloft during the suppressed period.

6. Q_1 Dissected and Conclusions



- Latent heating accounts for a bulk of Q_1, especially at low levels.
- The radiative and sensible heating components are roughly equivalent but of the opposite sign.

- Q_1 and C-POL latent heating profiles are strongly dependent on rain amount, stratiform rain fraction, and storm type (all of which vary in time and space during TWP-ICE).
- Radiative heating and non-precipitating cumulus clouds further modify the total heating profile.
- Gross estimates of the vertical eddy flux convergence of sensible heat were determined by a residual, although the residual could be unrealistic due to uncertainties in the other heating components.

Future work: Analyze longer C-POL/MMCR records and comparisons with cloud resolving models.