Dissecting Diabatic Heating From TWP-ICE

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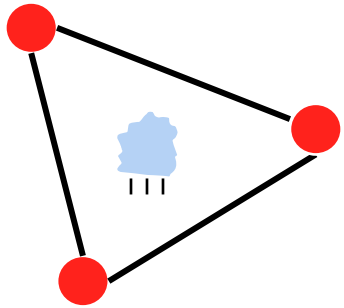
The apparent heat source, Q_1

1. Sounding-based budget (environment)

$$Q_1 = \frac{\partial \bar{s}}{\partial t} + \overline{\nabla \cdot sV} + \frac{\partial \bar{s}\bar{\omega}}{\partial p}$$



2. Ground radar, gauge, aircraft, satellite, photography (phenomenon)

$$Q_1 = \bar{Q}_R + L(c - e) - \frac{\partial \overline{s'\omega'}}{\partial p}$$

Radiative heating (RH)

Latent heating (LH)

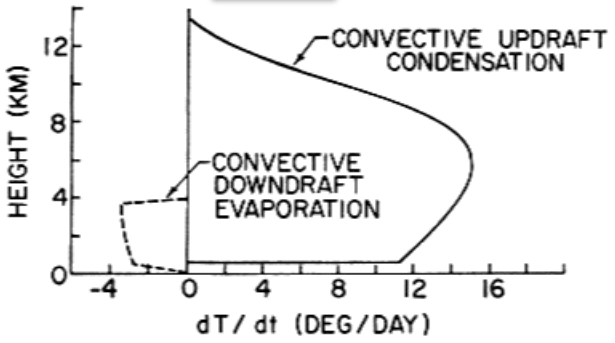
Vertical eddy transport of sensible heat (SH)

Component profiles of Q_1 in idealized MCS

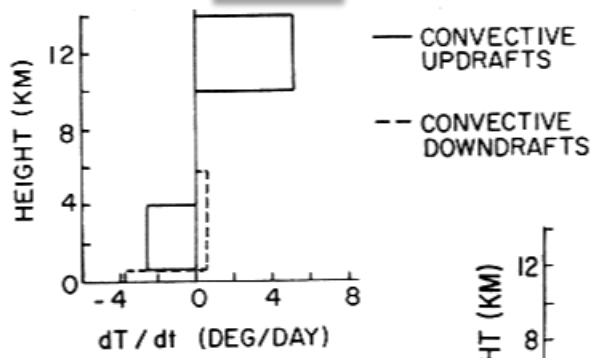
Convective

Stratiform

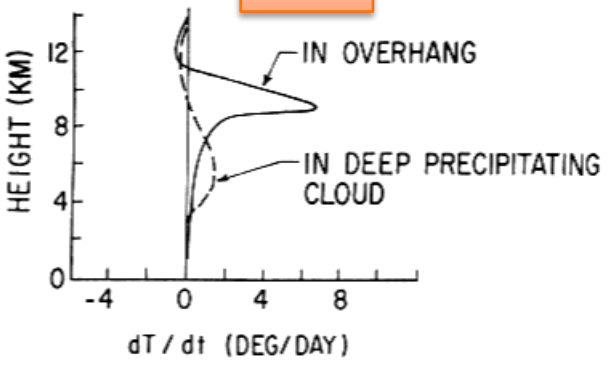
LH

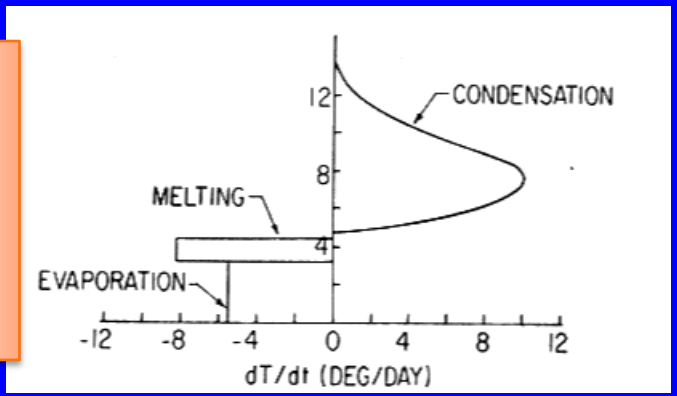


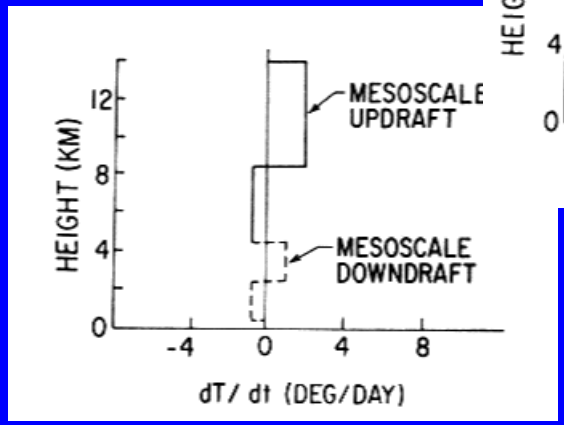
SH



RH

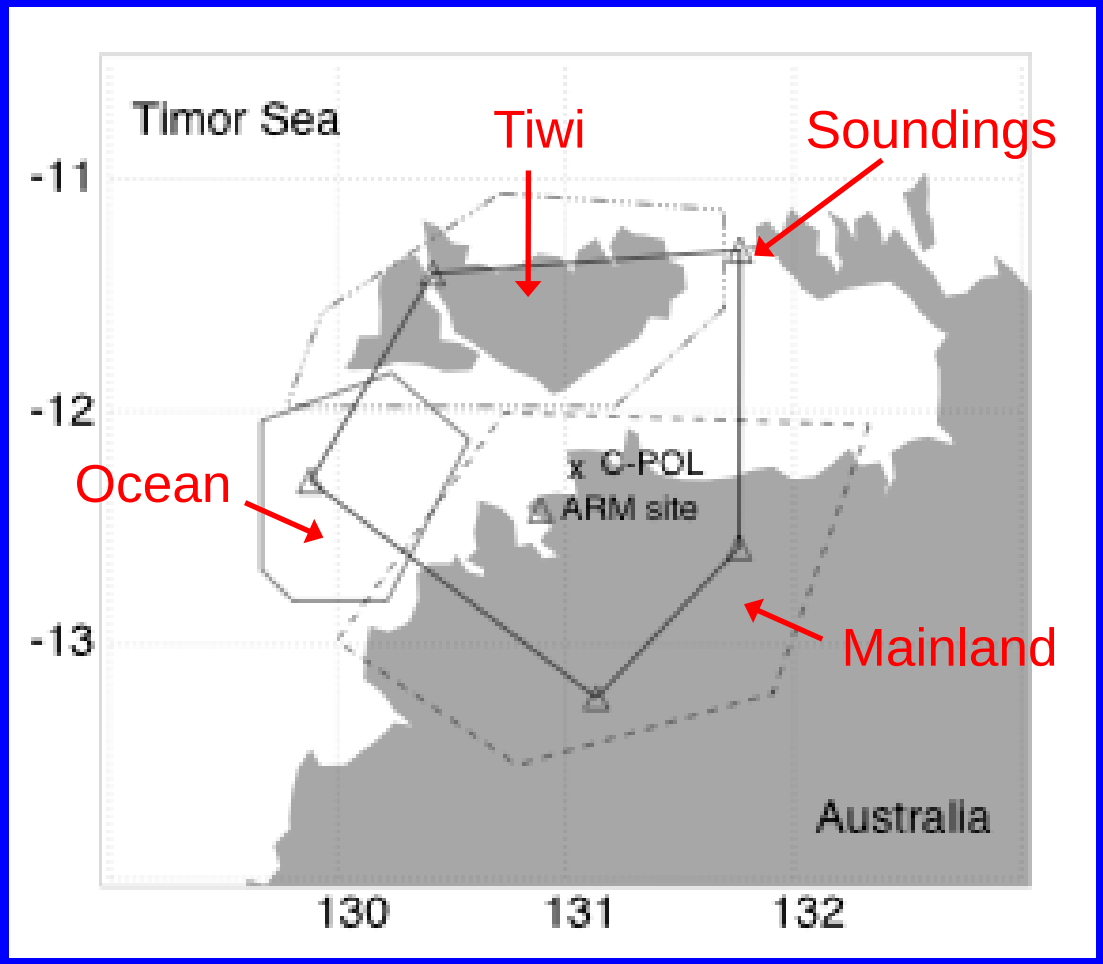






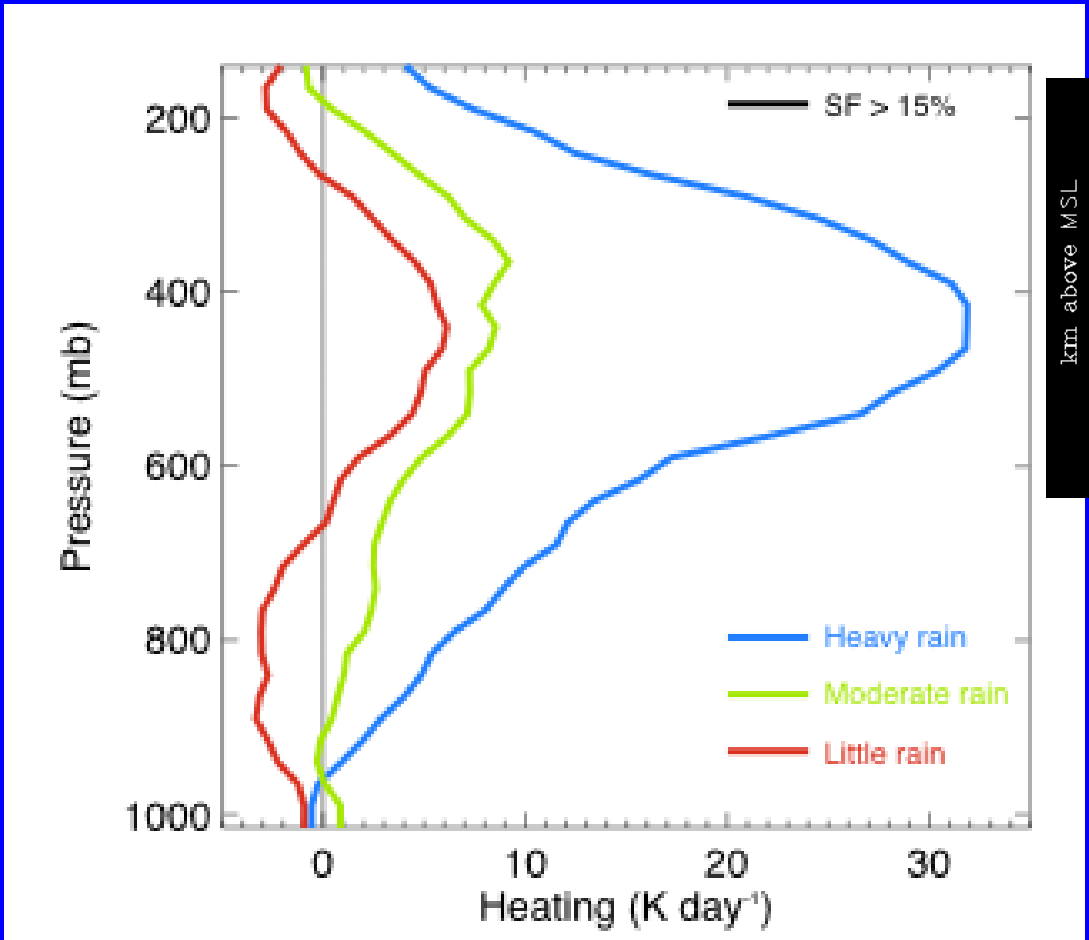
Houze (1982)

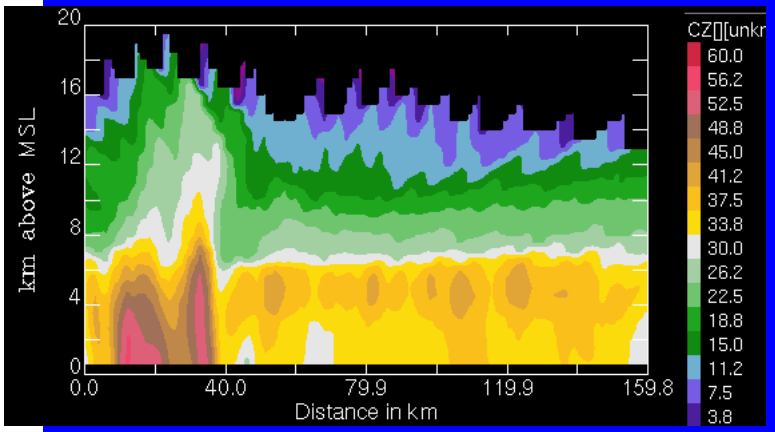
TWP-ICE variational analysis domains



19 January – 12 February 2006, 3 hourly

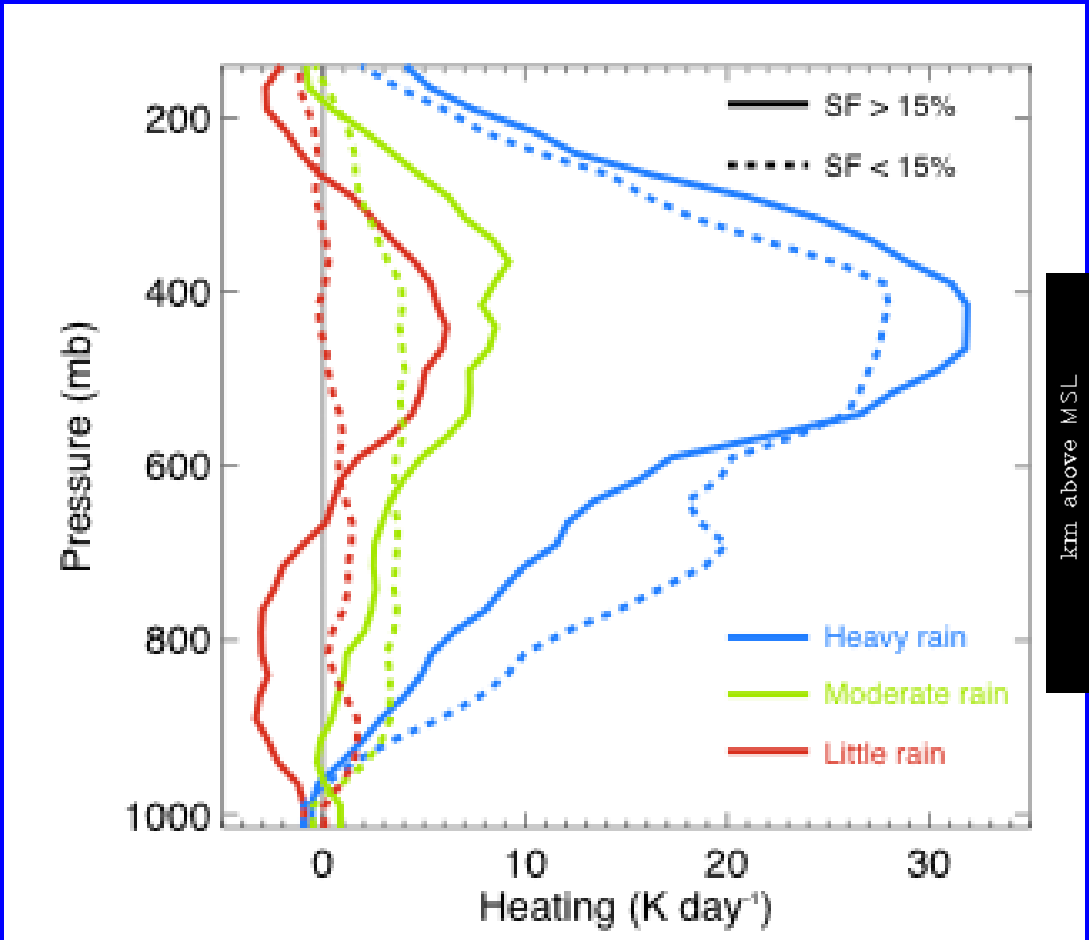
Q_1 dependence on rain amount + type

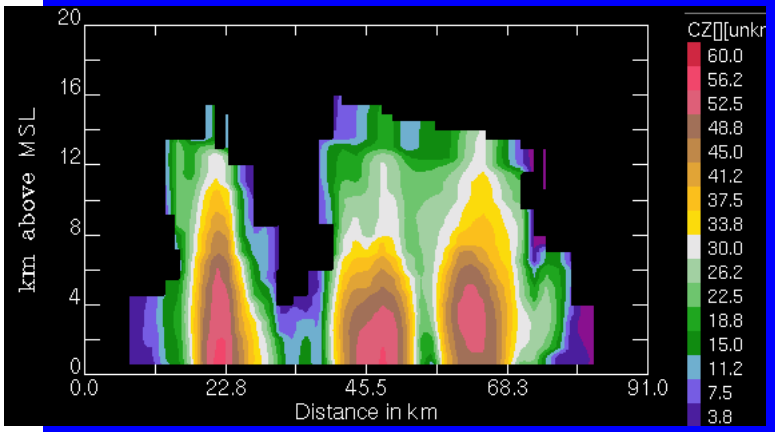




Q1 is sensitive to rain amounts and high stratiform rain fractions

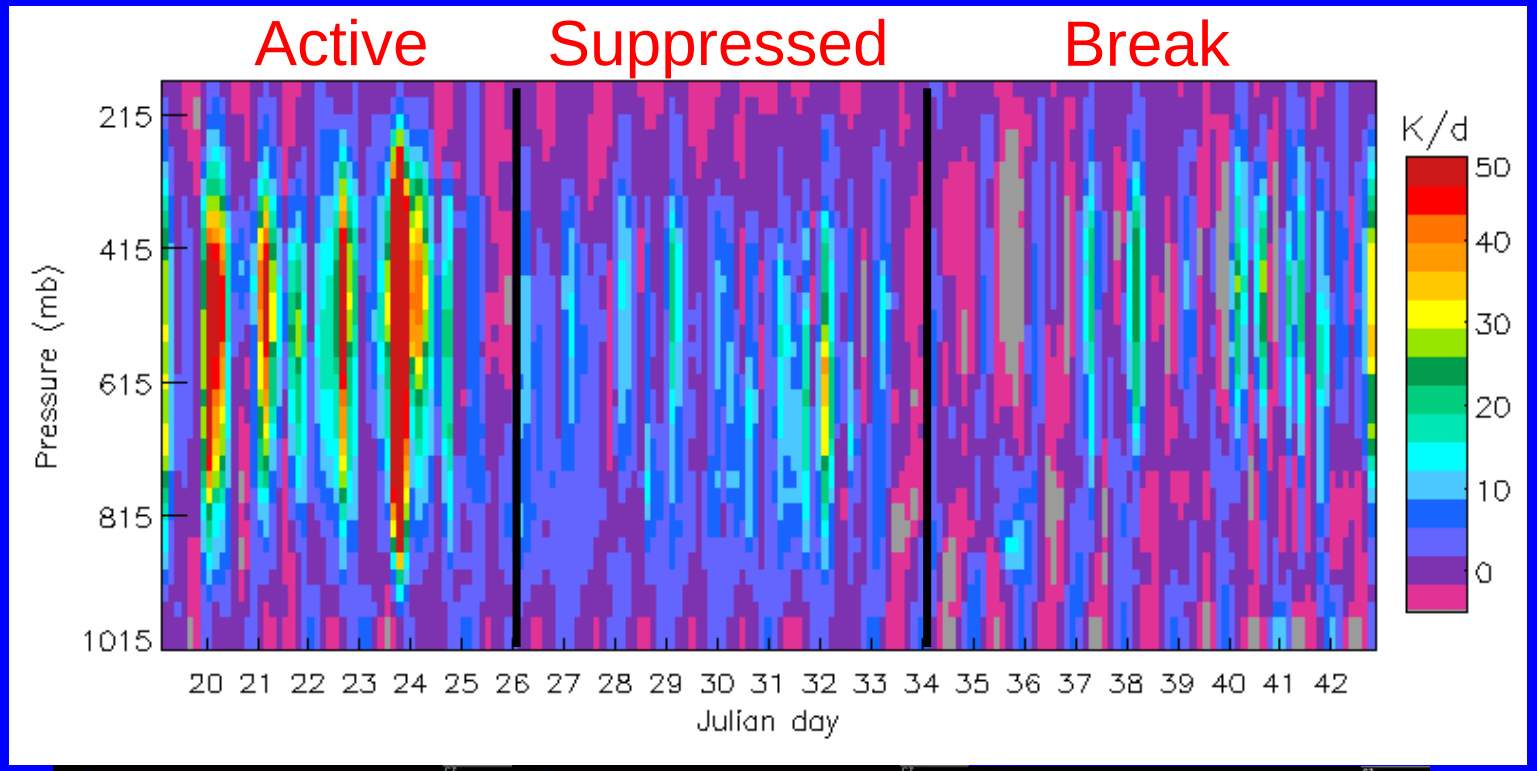
Q_1 dependence on rain amount + type



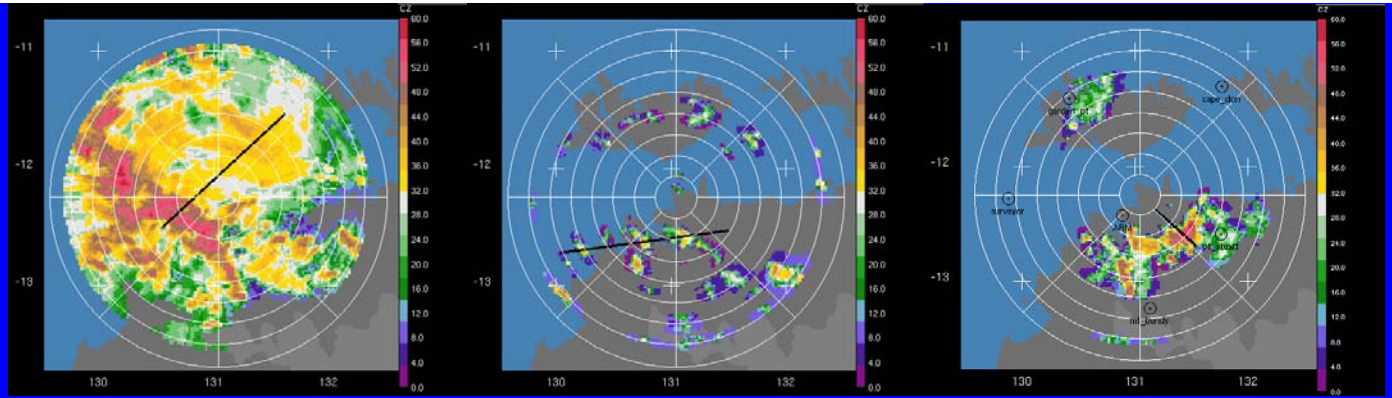


Lower stratiform rain fractions => more heating at low levels

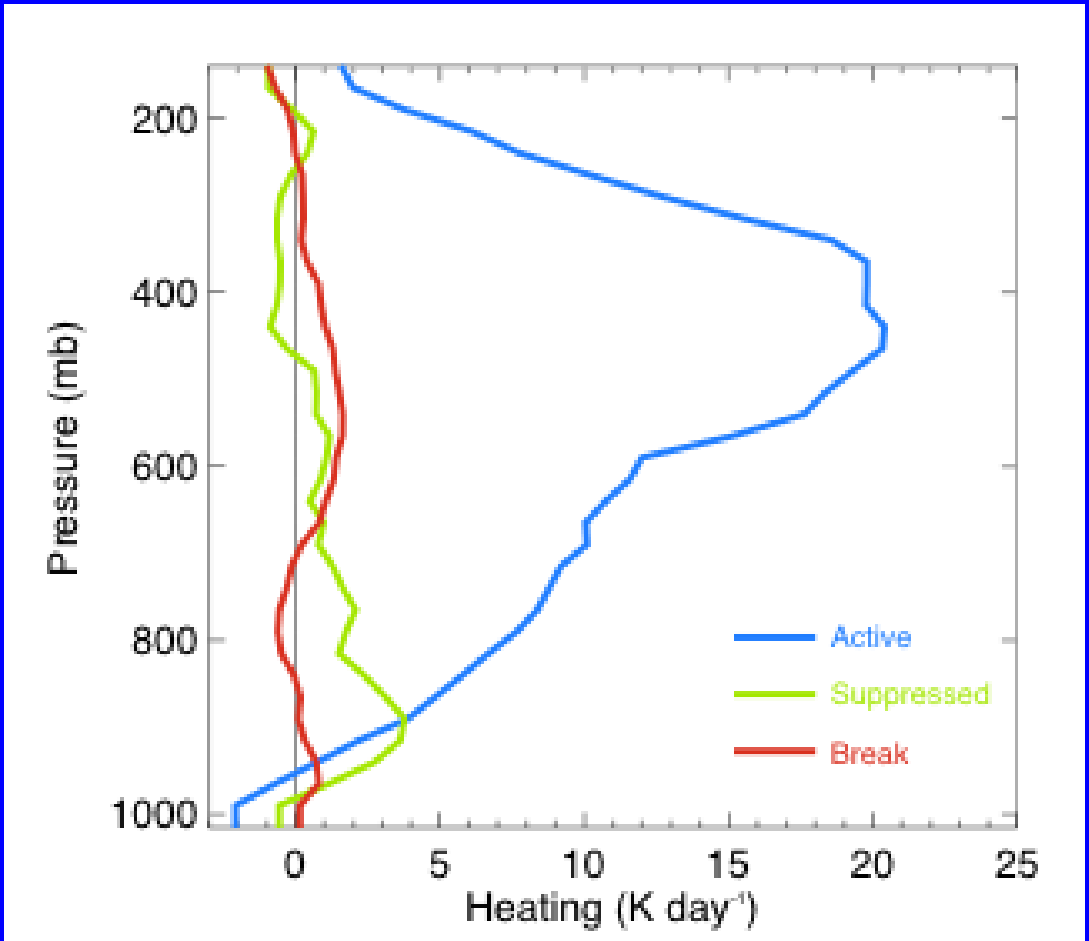
Q_1 monsoon regimes



C-POL

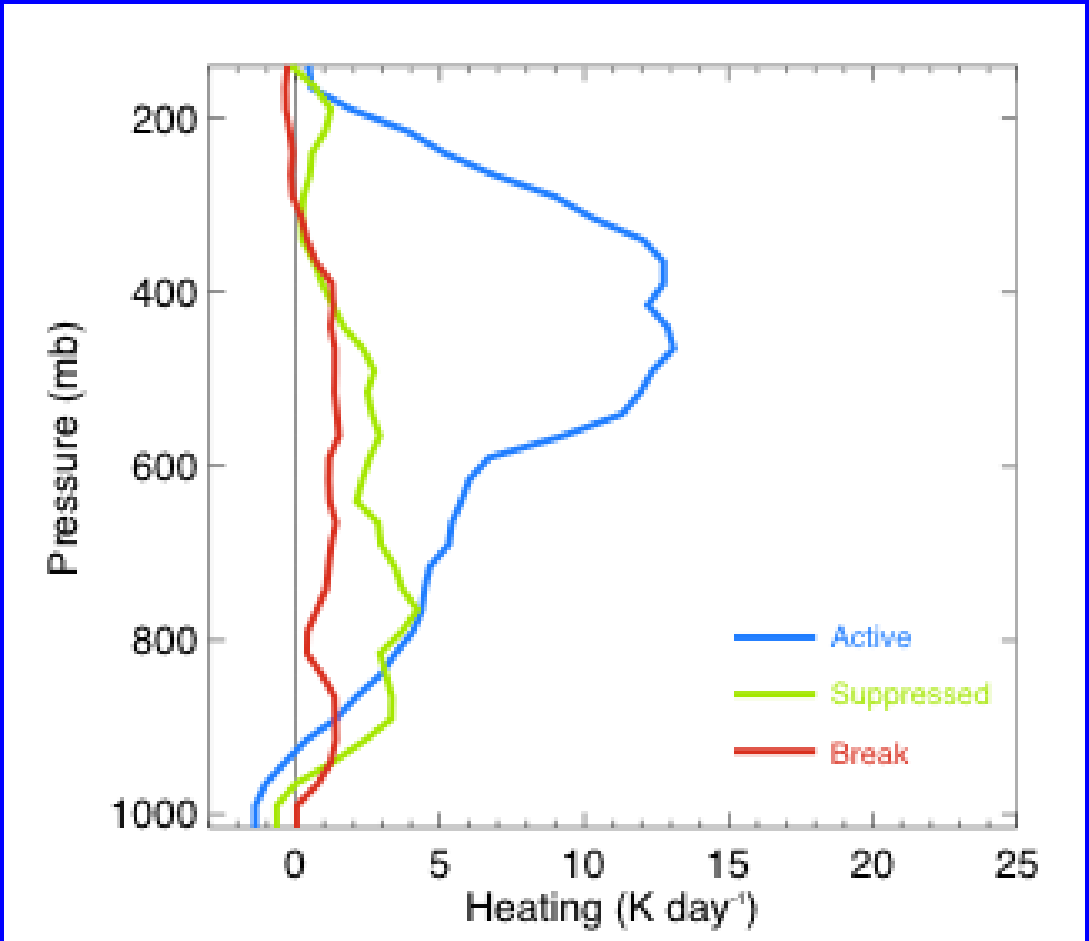


Ocean Q_1 by monsoon regime



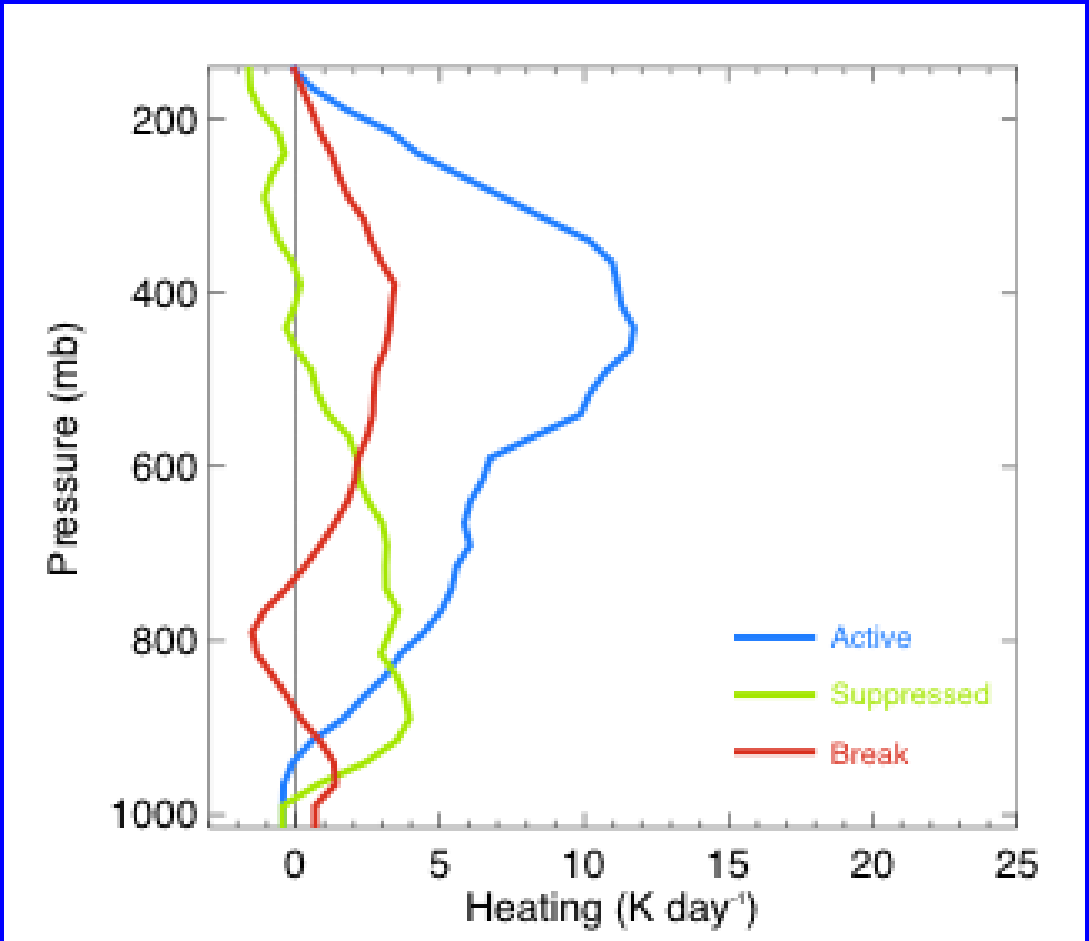
Active period strongest over the ocean (large MCSs)

Tiwi Q_1 by monsoon regime



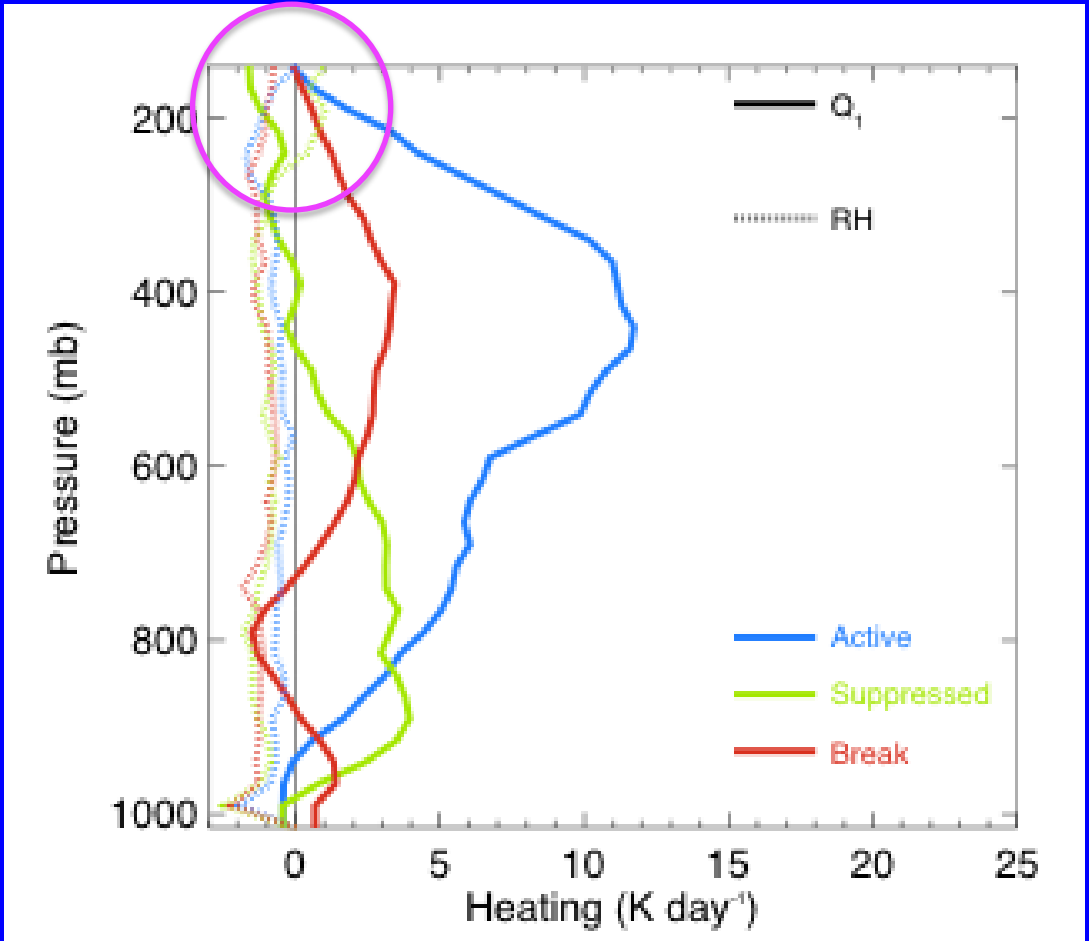
Tiwi Islands most heating aloft during suppressed period (Hector)

Mainland Q_1 by monsoon regime



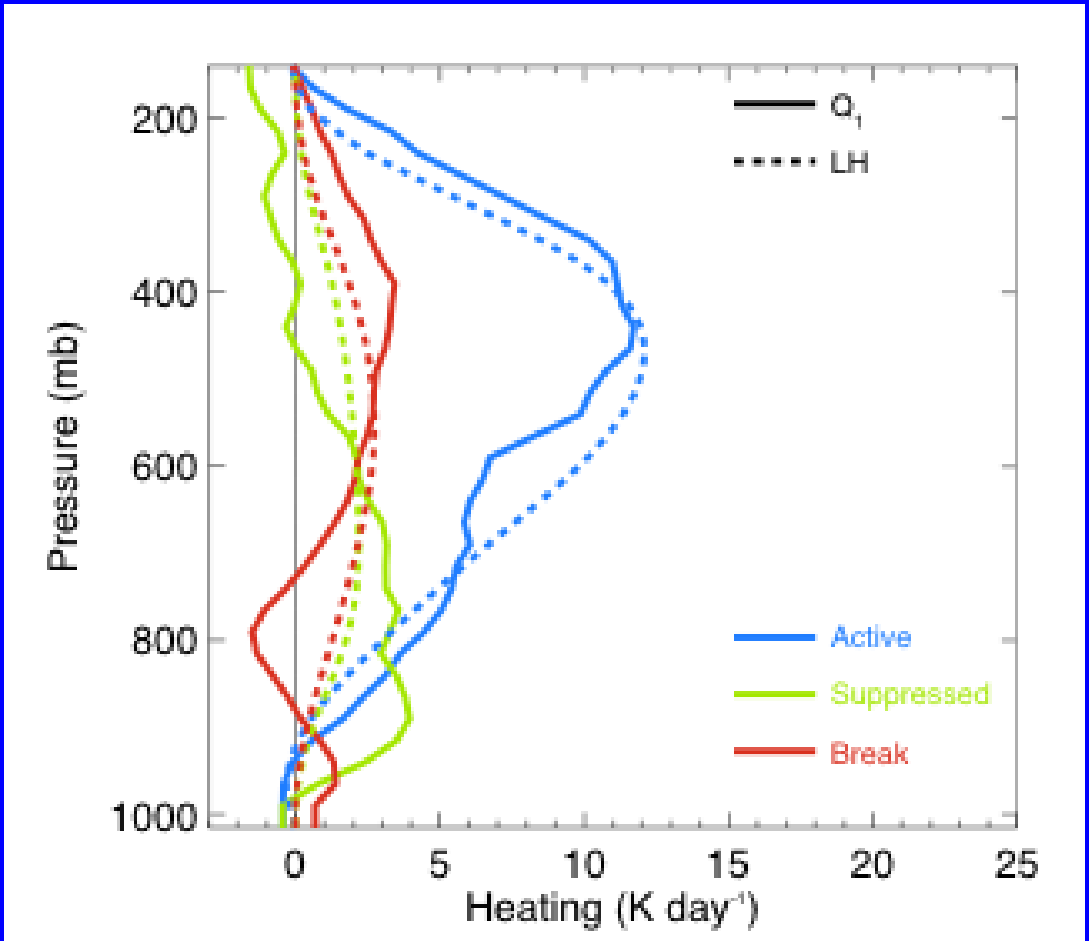
Break period strongest over mainland (land convection dominant)

Mainland Q_1 and radiative heating



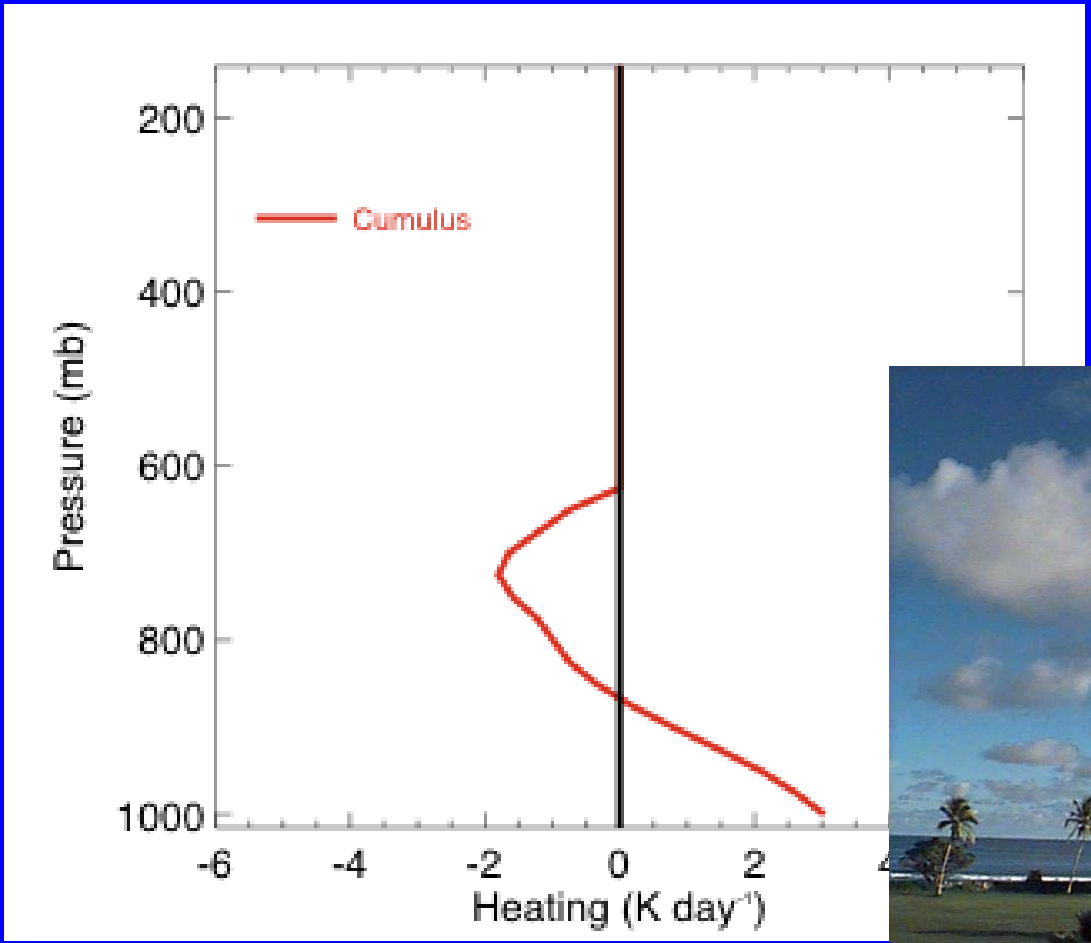
MMCR/MPL RH (clear+cloudy) also sensitive to monsoon regimes

Mainland Q_1 and latent heating



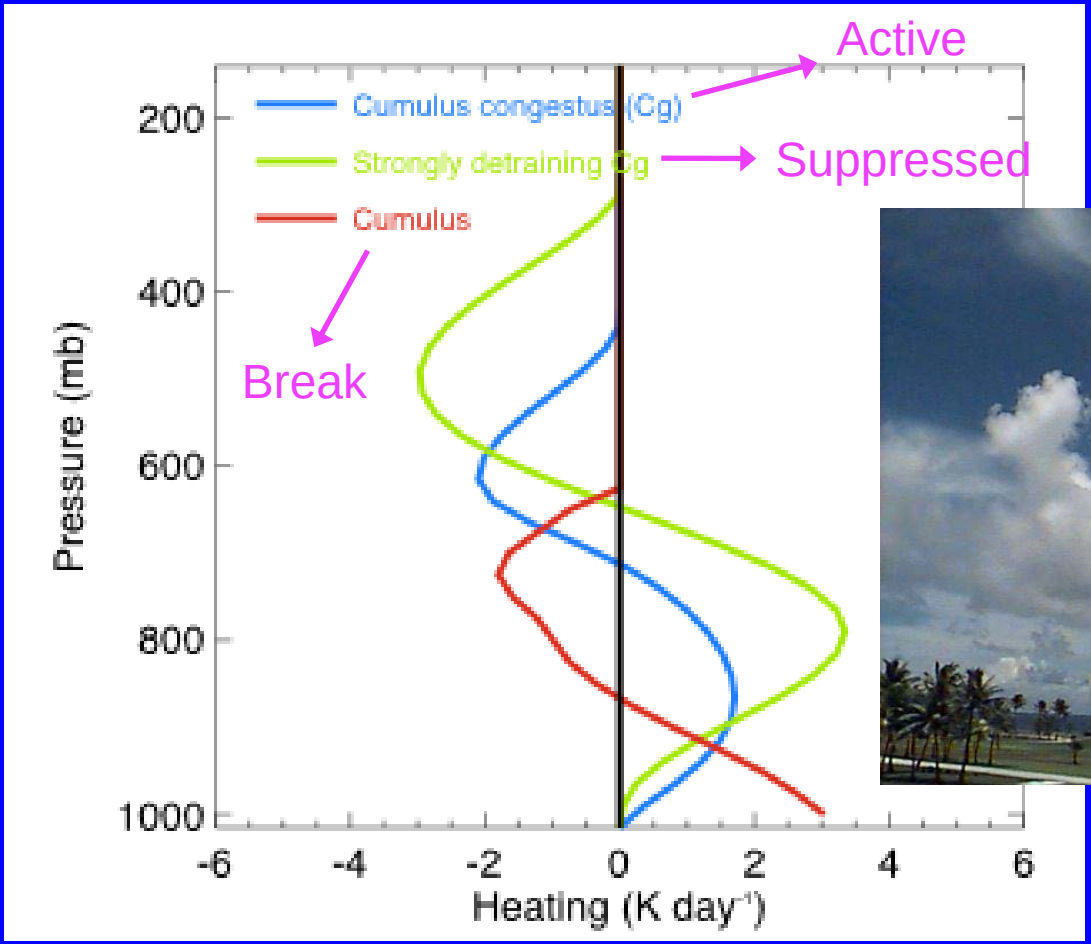
C-POL LH important to Q_1, but not always well matched

Cumulus cloud latent heating



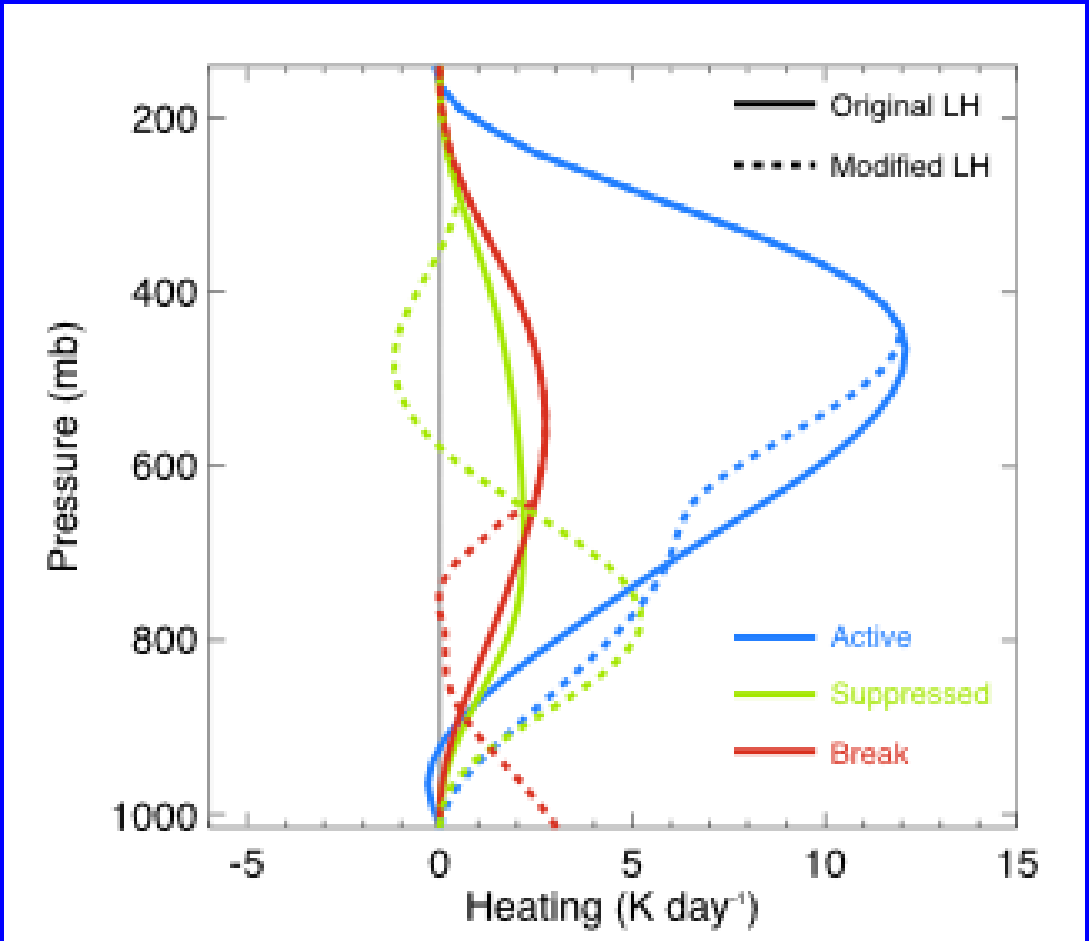
Non-precipitating cu don’t add LH, but can modify profile

Cumulus cloud latent heating



Cumulus congestus can also redistribute LH, esp. when sheared

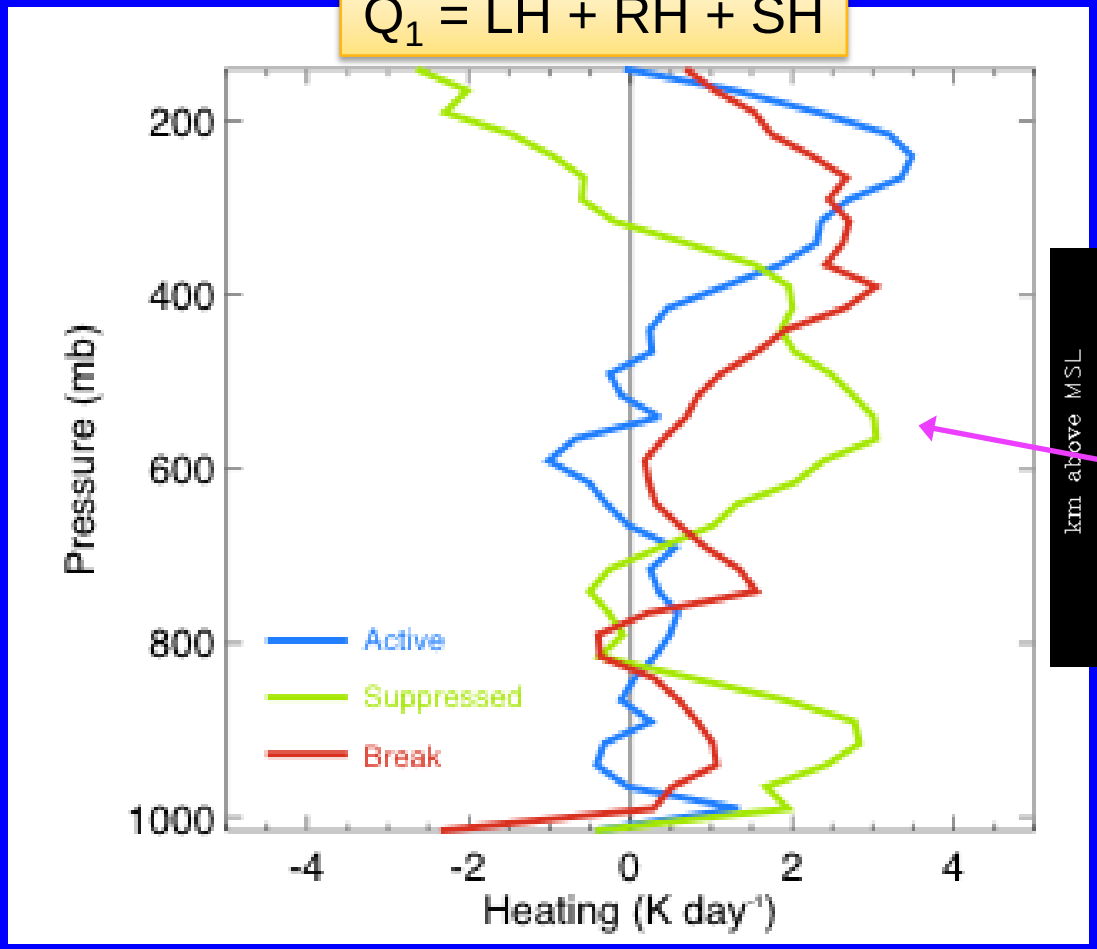
Modified latent heating

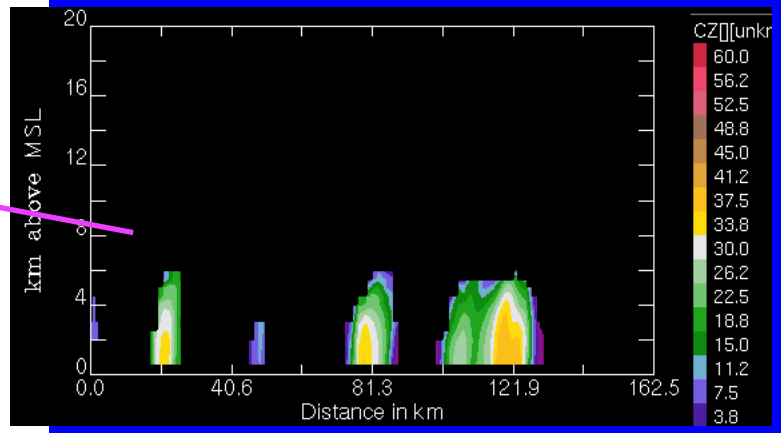


Cloud LH strongly modifies C-POL profile at low and mid levels

Residual/sensible heating

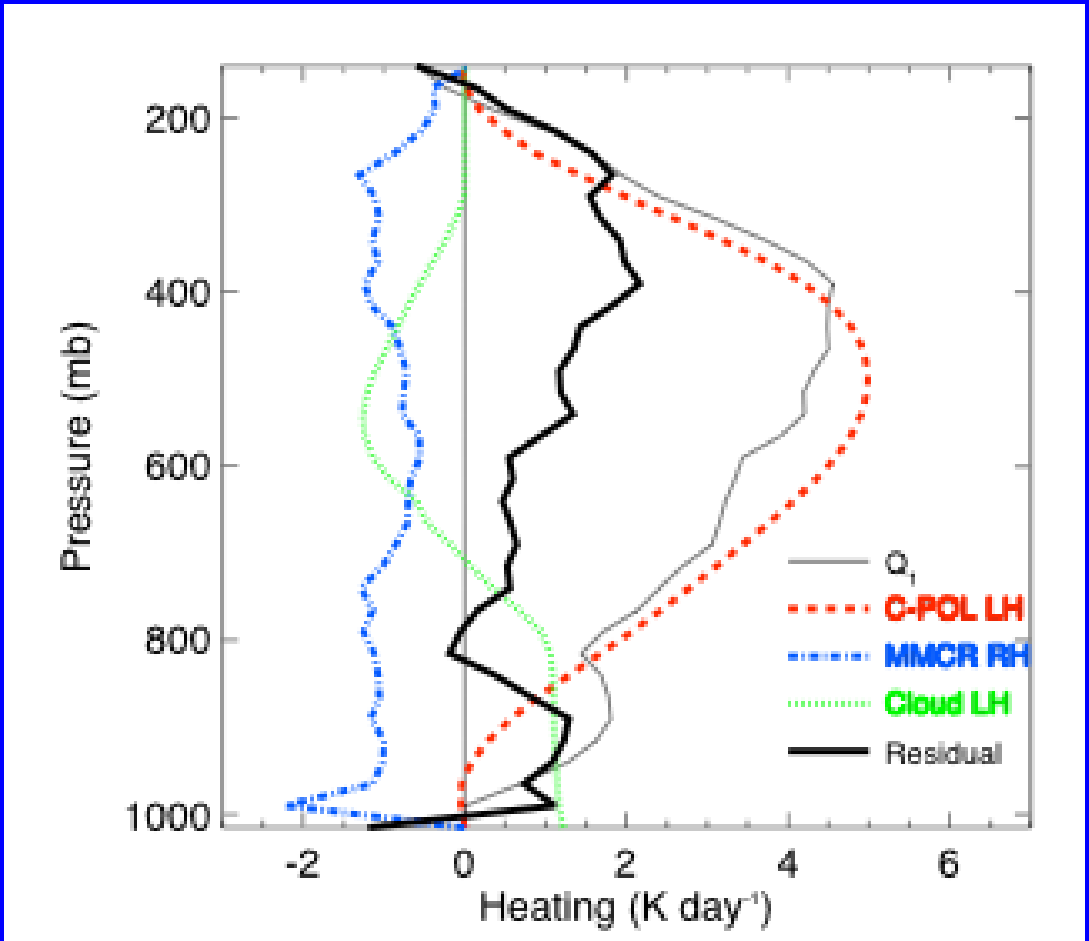
Q_1 = LH + RH + SH





Vertical eddy transport of SH warms mid/upper troposphere

Q_1 dissected



LH dominates mid levels, RH and SH ~balance at upper levels