Thermodynamical interpretations of generation and decay of stable layers over the Indochina Peninsula in the dry season

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1. Introduction

- ◇ The climatological seasonal variation of inversion layers is characterized by the increase of its central height from the early dry season to the pre-monsoonal season (Nodzu et al., submitted to J. Climate).
- ◇ Over the Indochina Peninsula in the dry season, the time scale of stable (inversion) layer variations is about a month.
- ◇ We examined the thermodynamical process of these variations, and found some types of mechanisms about the generation and disappearance of stable layers.

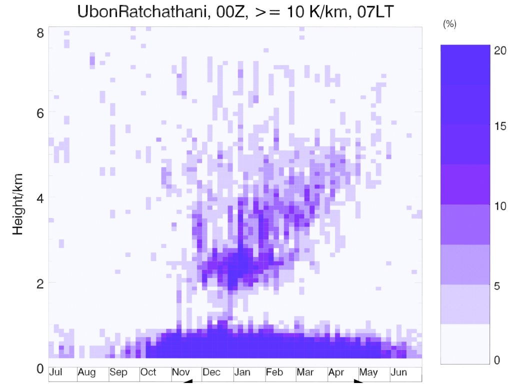


Figure 1: A time-height cross-section of the stable layer frequency (%) obtained from the morning data at Ubon Ratchathani (15° 15' N, 104° 52' E).

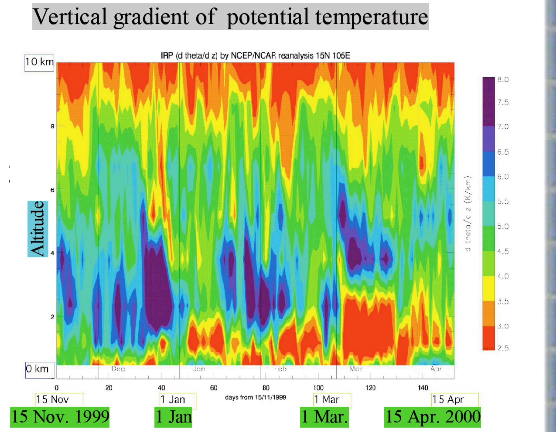


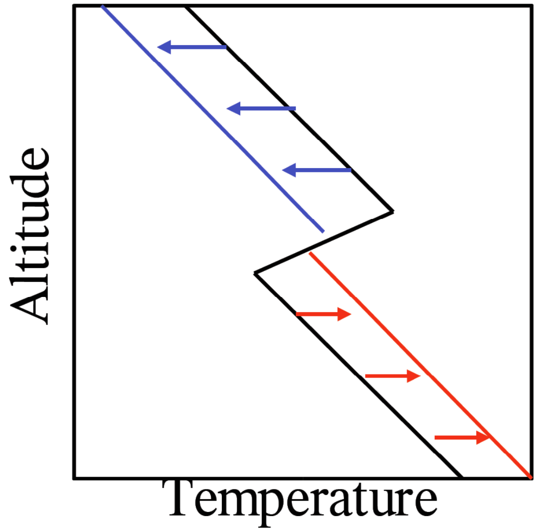
Figure 2: A time-height cross-section of the vertical gradient of potential temperature obtained from the NCEP/NCAR reanalysis-1 data near Ubon Ratchathani (15° N, 105° E).

2. Data and Analysis

Generation and disappearance of stable layers

↓

Heating and cooling above and over stable layers



- Thermal and moisture badget analysis
  - NCEP/NCAR DOE 2 reanalysis data
  - Indochina Peninsula (inland part)

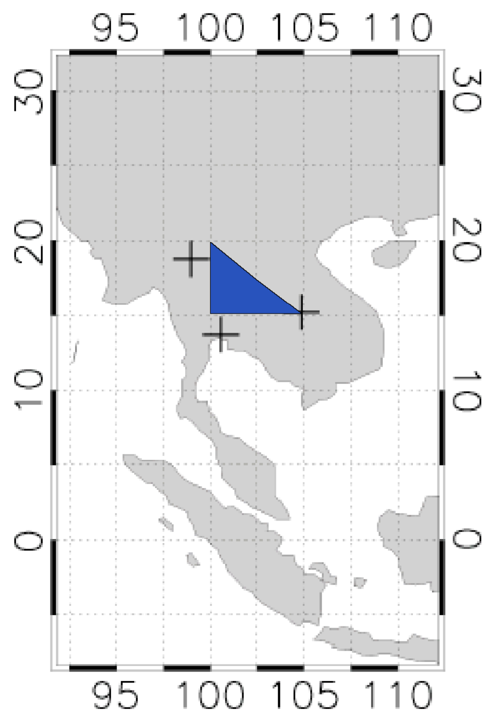


Fig. 3: Our analysis region. (+ marks show the operational rawinsonde observation stations)

3. Result-1

3.1 Stable layer in dry season

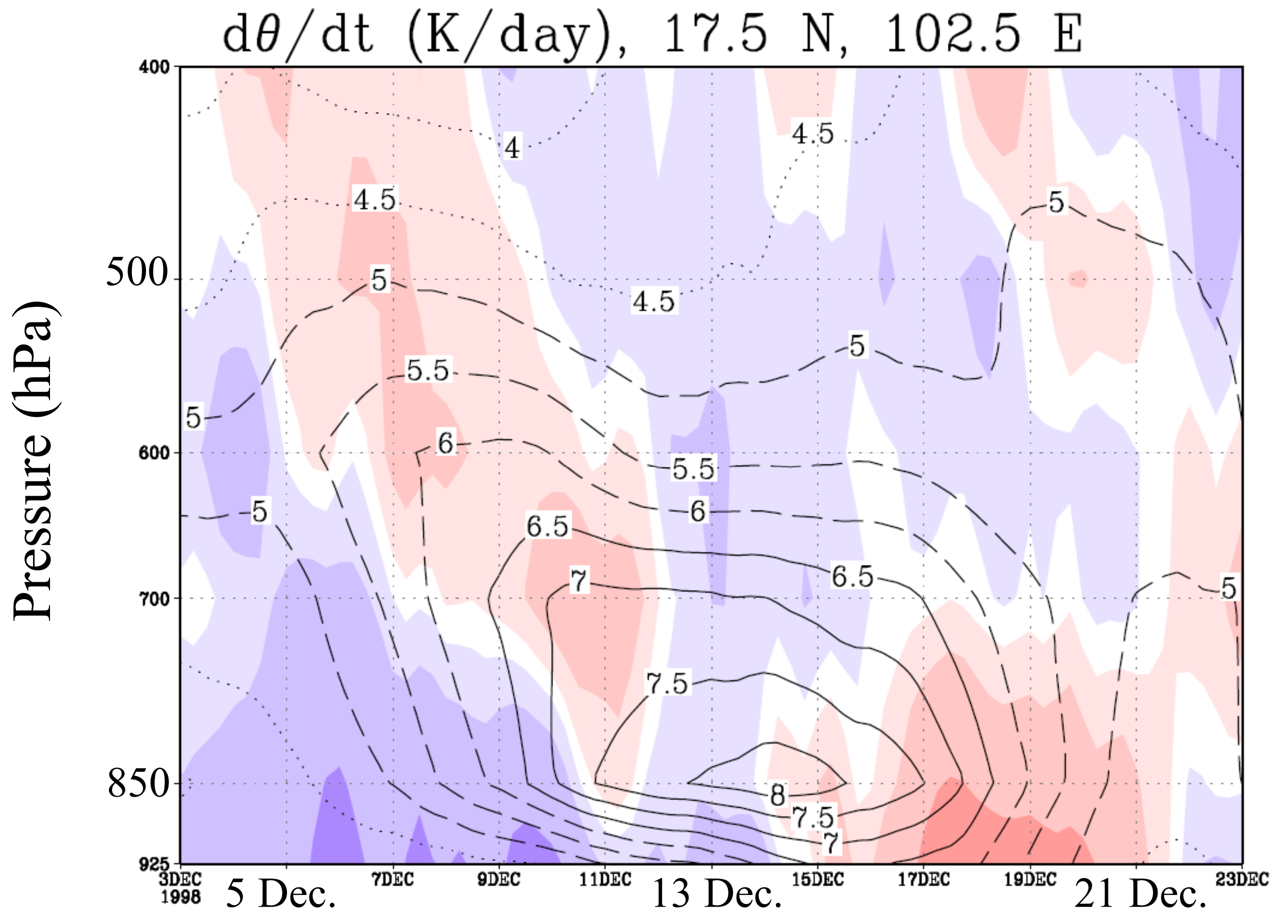
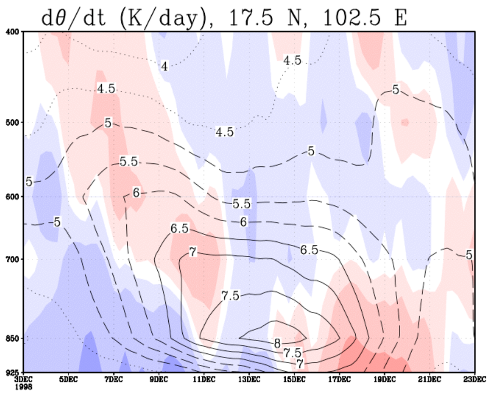
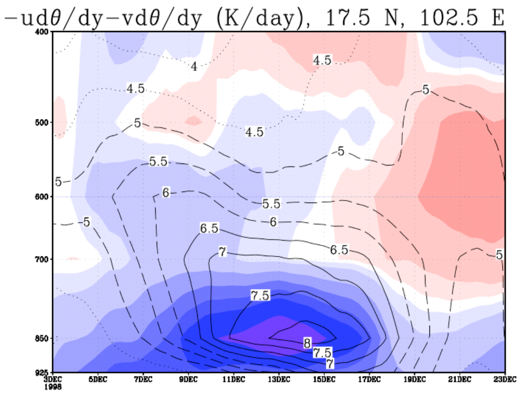
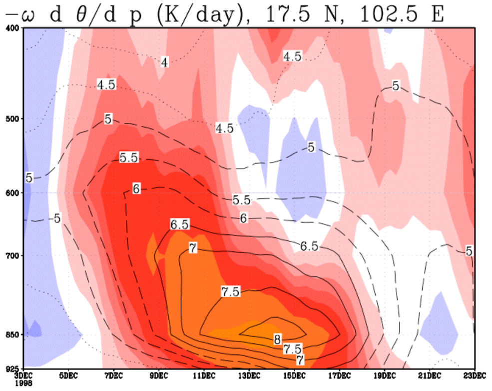


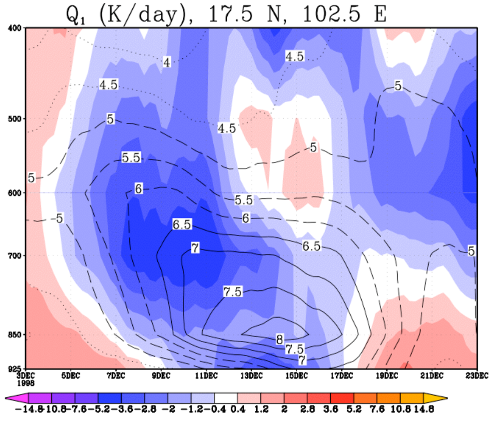
Figure 4: A time-height cross-section of the changing rate of potential temperature in the analysis region from 3 Dec. 1998 to 23 Dec. 1998.

3.2 Heating and cooling around stable layer

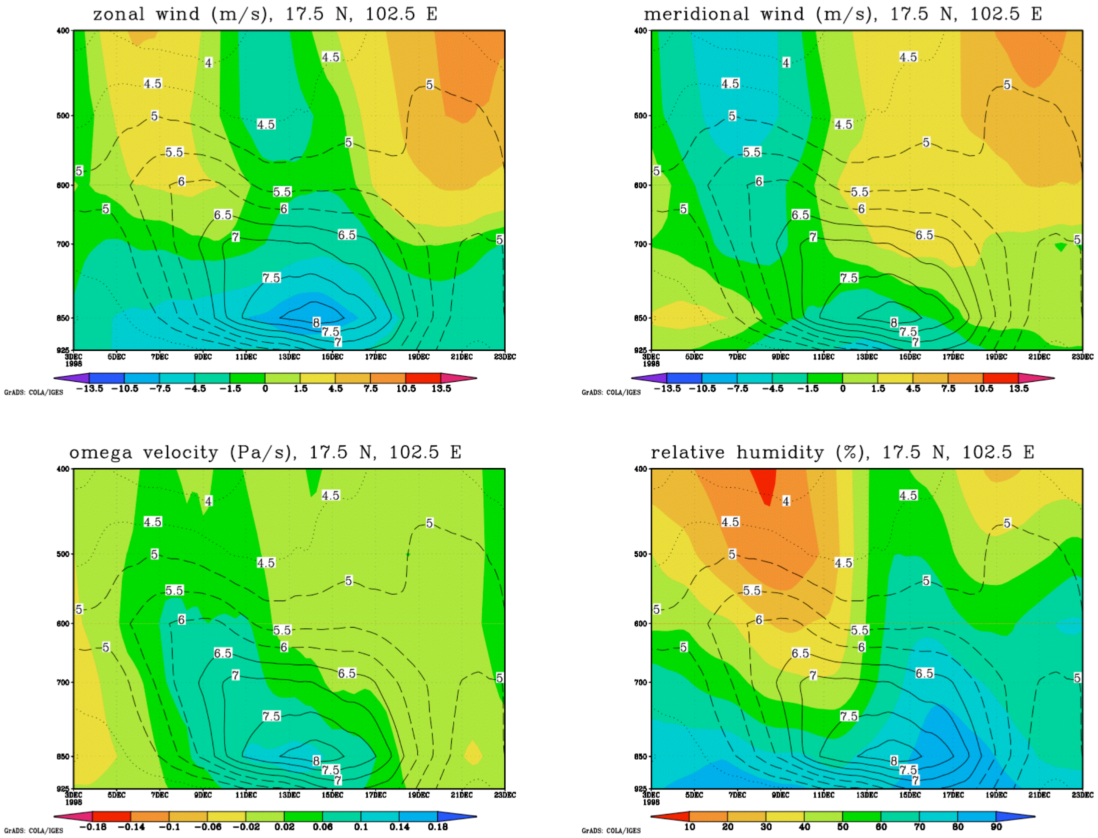




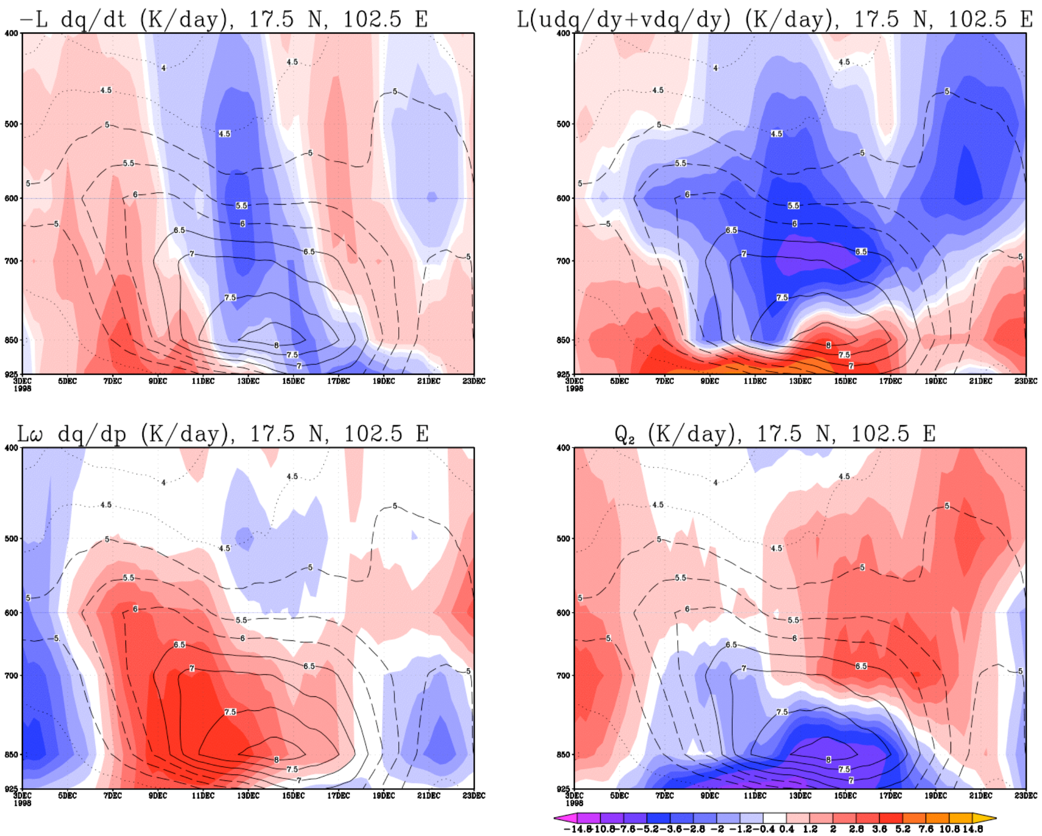




3.3 Wind and moisture distribution around stable layer



3.3' Moisture budget around stable layer



3.4 Summary on dry season case

- A stable layer appeared between the upper heating and the lower cooling.
- The upper heating was caused mainly by the vertical advection accompanied by the downward motion.
- The lower cooling was caused mainly by the horizontal advection accompanied by the north-easterly wind.

3.4 Summary on dry season case (continued)

- A stable layer disappeared between the upper cooling and the lower heating.
- The upper cooling was caused mainly by Q_1.
- The lower heating was caused mainly by the vertical advection accompanied by the downward motion region which came from the upper layer.

4. Result-2

4.1 Stable layer in pre-monsoon season

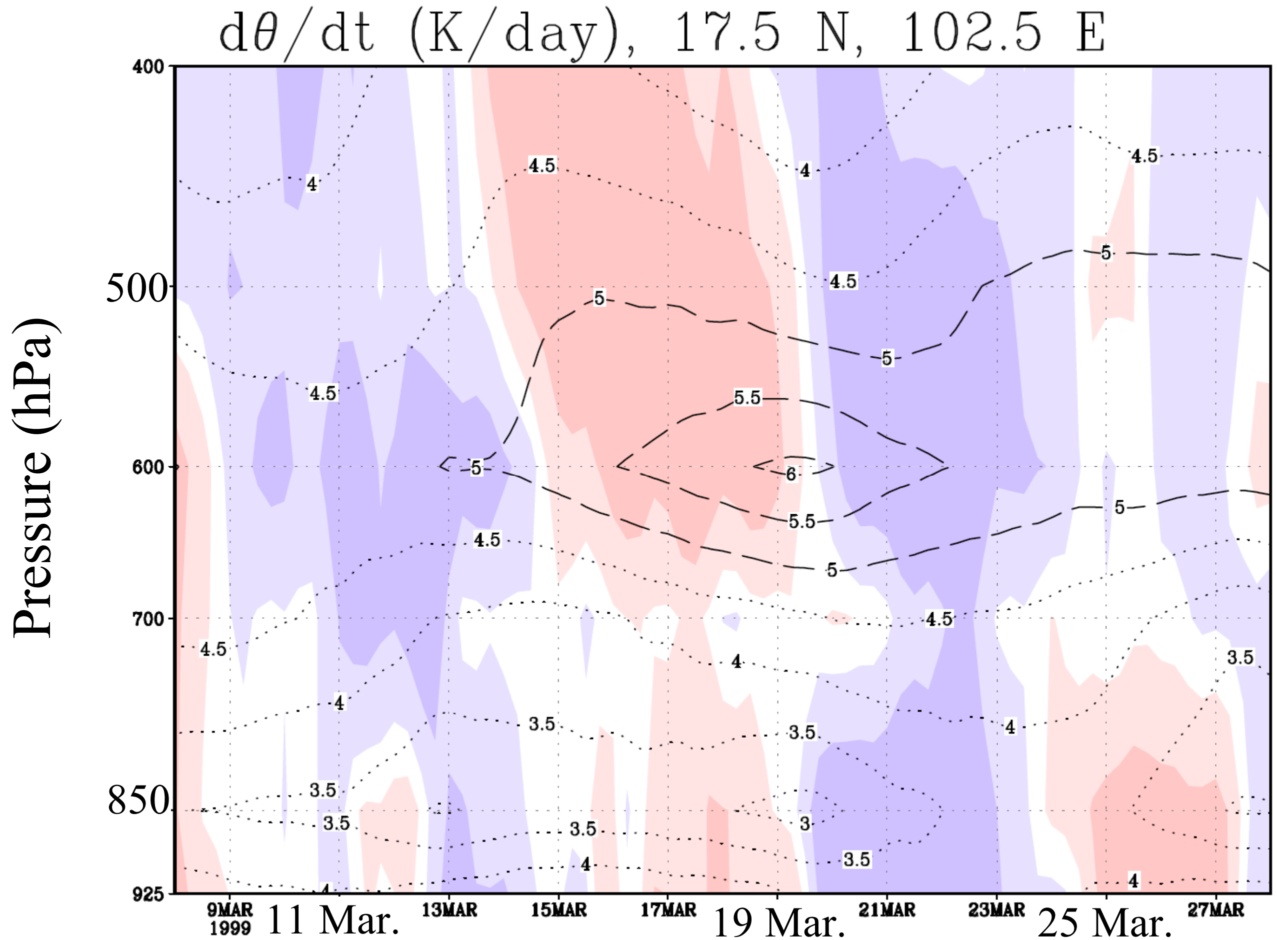
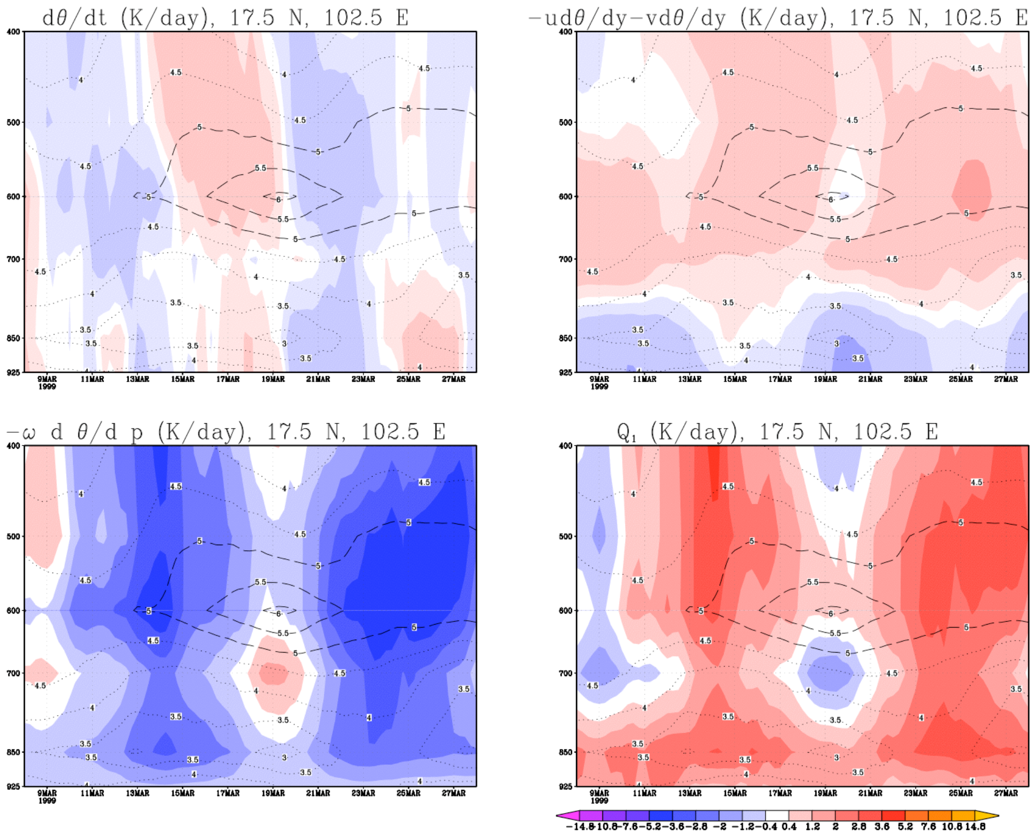
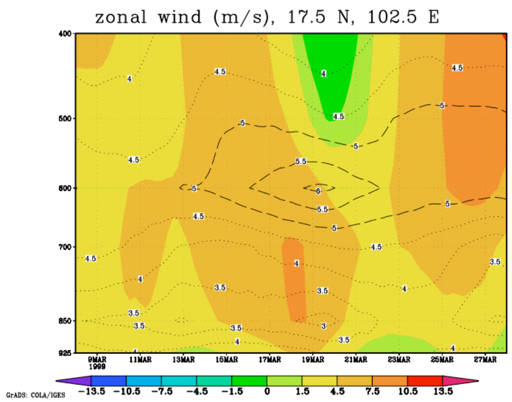


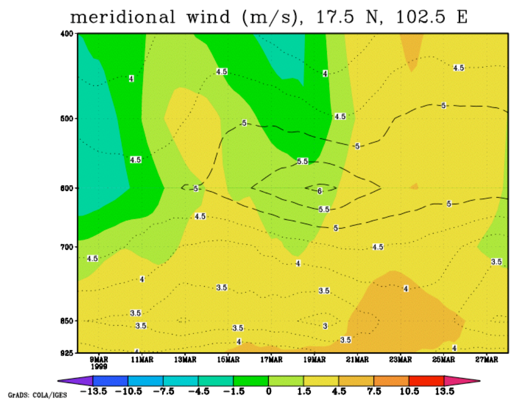
Figure 7: A time-height cross-section of the changing rate of potential temperature in the analysis region from 3 Dec. 1998 to 23 Dec. 1998.

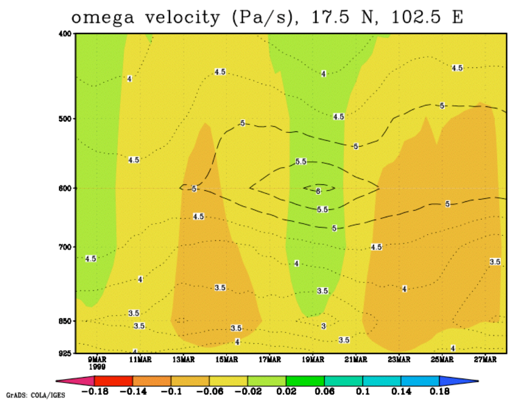
4.2 Heating and cooling around stable layer

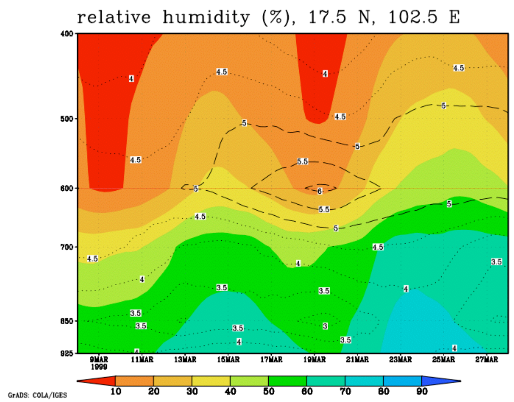


4.3 Wind and moisture distribution around stable layer

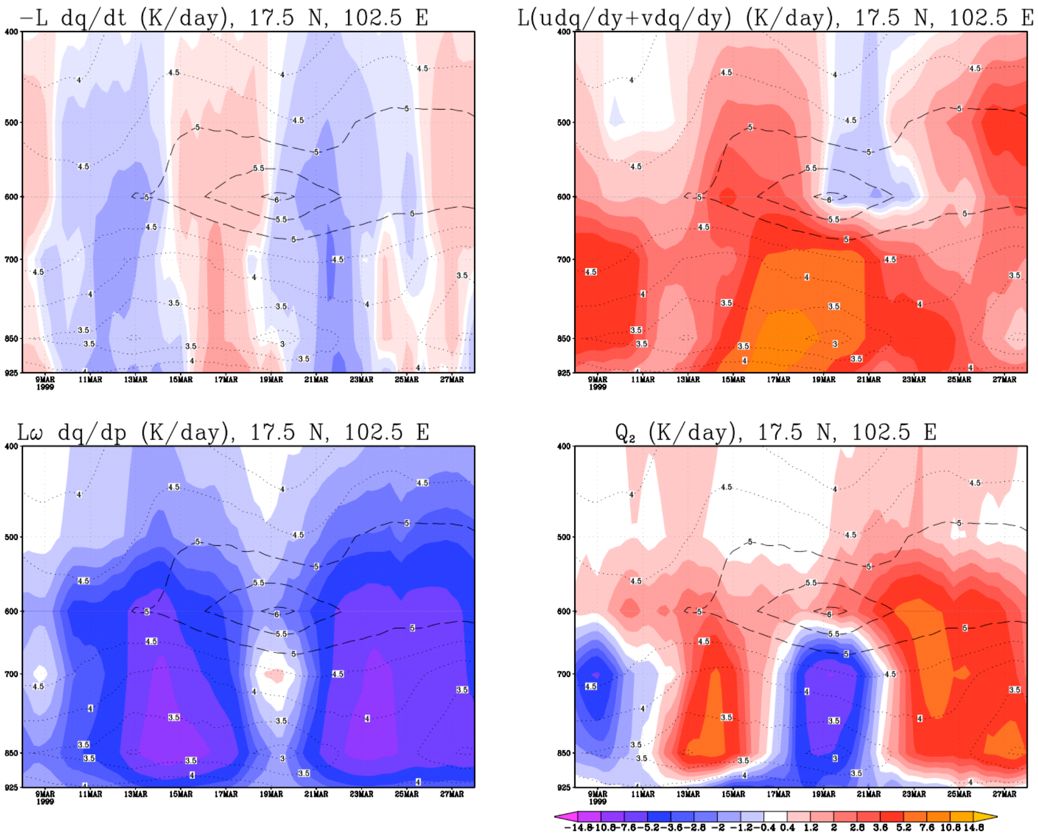








4.3' Moisture budget around stable layer



4.4 Summary on premonsoon case

- A stable layer appeared below the upper heating and disappeared below the upper cooling.
- The upper heating was caused mainly by the Q_1.
- The upper cooling was accompanied by the decrease of Q1 at first and caused mainly by the vertical advection of upward motion.

5. Other cases
(10 cases in the dry season in 1998—99)

+ Generation
  - Lower horizontal cold advection (6 cases: mailny in the early dry season)
  - Upper horizontal warm advection (2 cases)
  - Positive Q_1 in the upper layer (2 cases)
+ Disappearance
  - Lower vertical warm advection (3 cases: mailny in the early dry season)
  - Positive Q_1 in the lower layer (3 cases: probably 2 cases are due to the latent heating: mailny in the pre-monsoon season)
  - Difficult to classify (4 cases)

6. Summary

- We found that the generation and disappearance of stable layers are caused by the only one mechanism.
- There is a little difference in mechanisms between the early dry season and the pre-monsoon season.