

# On the Vortex- Dipole Triggered Heavy Precipitation during the Mei-yu season of Taiwan

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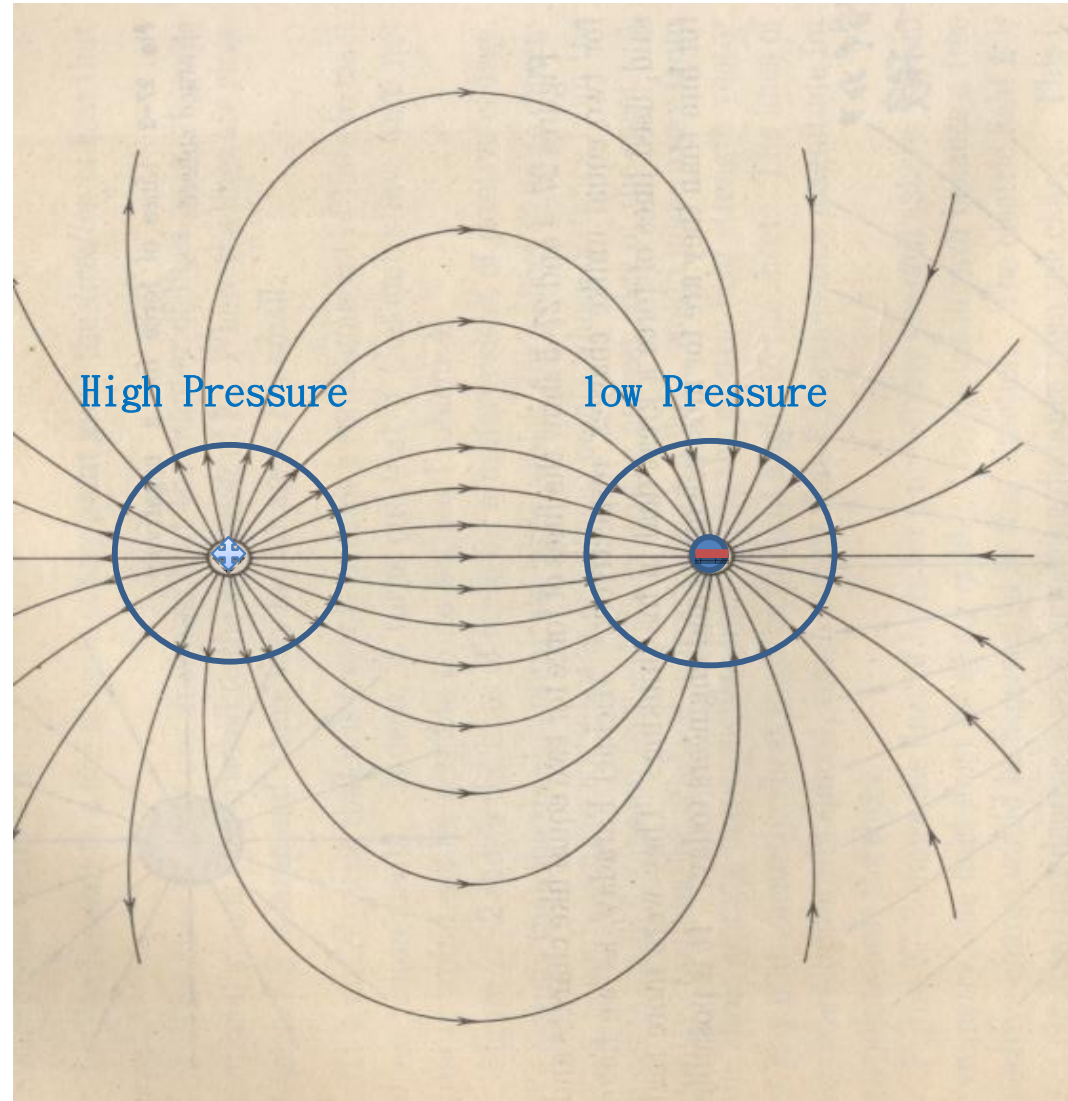
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# Major Content

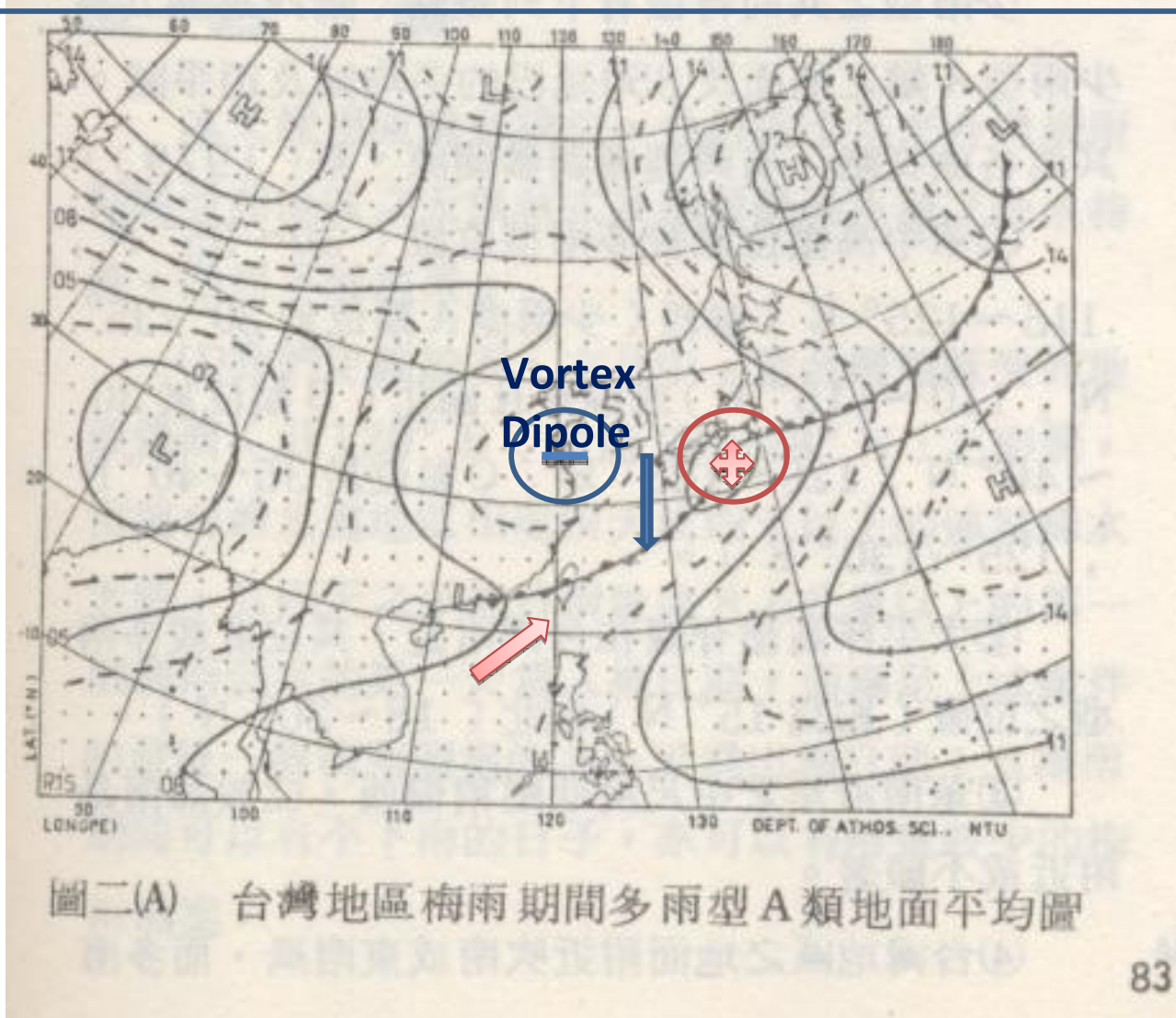
1. What is Dipole ?
2. Electric Dipole.
3. Vortex- Dipole (And Related Weather System).
4. Vortex- Dipole and north wind.
5. The trigger mechanism of heavy precipitation during the Mei-yu season of Taiwan.

# Electric Dipole



**Is any weather system like the electric dipole system ?**

**Rainy Pattern of surface mean during Mei-Yu Season associated with the  
vorticity dipole and north wind**



**Cold High Pressure**  
**Warm Low Pressure**  
**Southwest Flow**  
**North Flow**

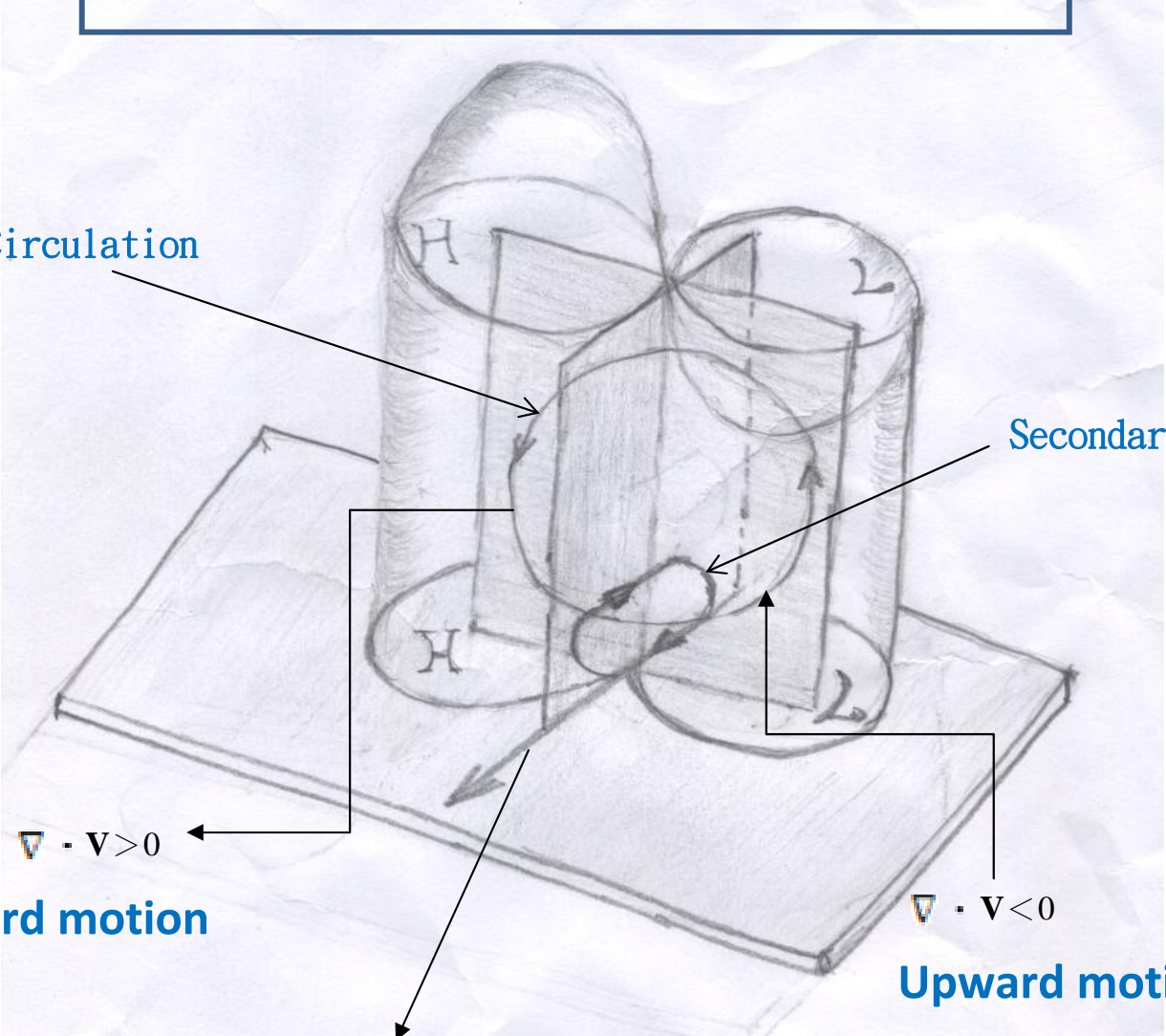
## The concept

- The ageostrophic wind is largely responsible for the occurrence of subsynoptic changes in weather. Among the ageostrophic components latitude effect, the confluence and diffluence effect are considered reasons of northerly jet.
- The thermal wind and secondary circulation within the same area is toward the north therefore the jet decreases with height, i.e., it forms a wedge with down slope southward.

# Conceptual Model

Thermal Direct Circulation

Secondary Circulation



$$\nabla \cdot \mathbf{V} > 0$$

Downward motion

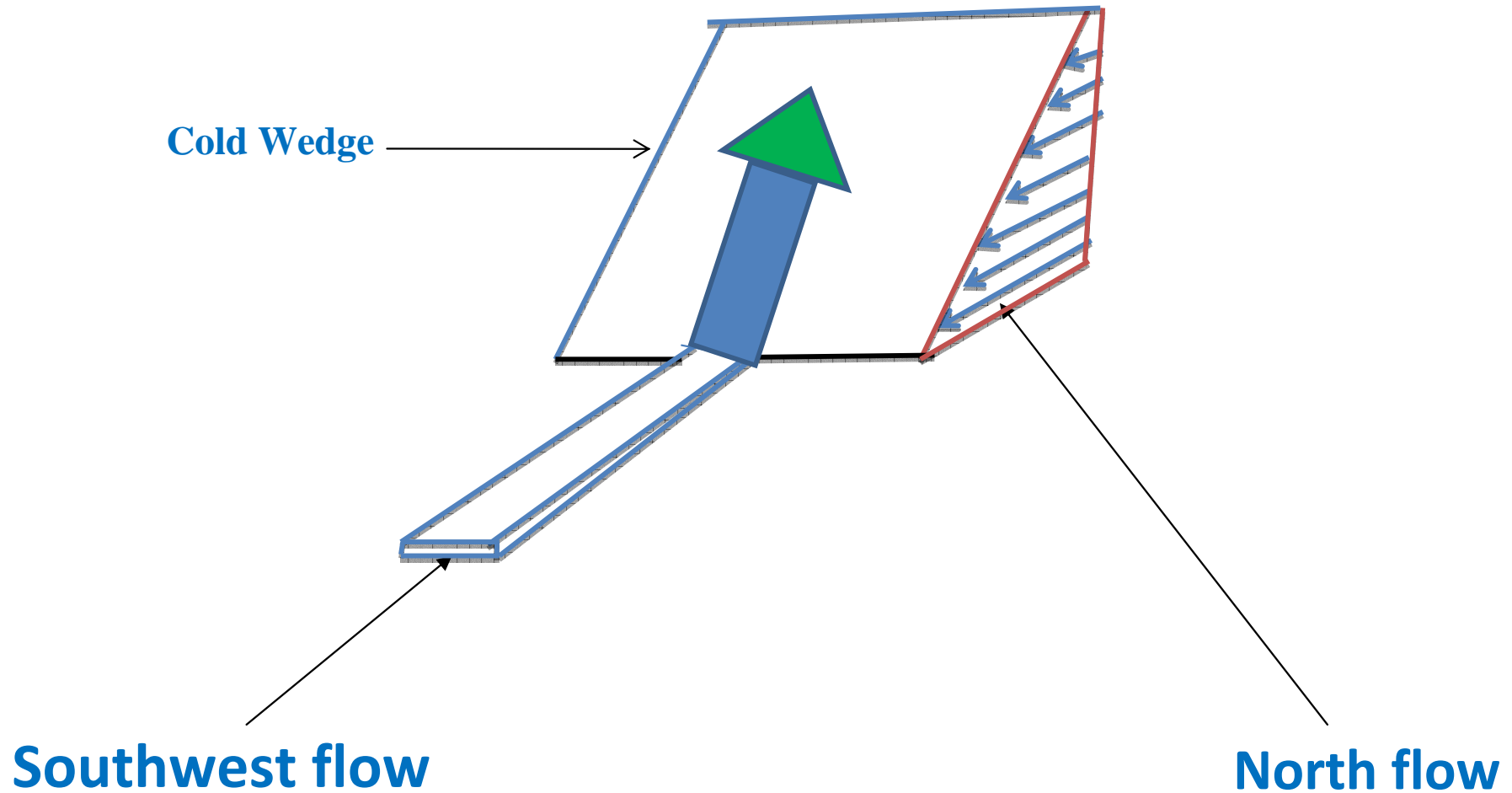
$$\nabla \cdot \mathbf{V} < 0$$

Upward motion

$$\frac{d\mathbf{V}}{dt} = -f \mathbf{K} \times \mathbf{v}_{ag}$$

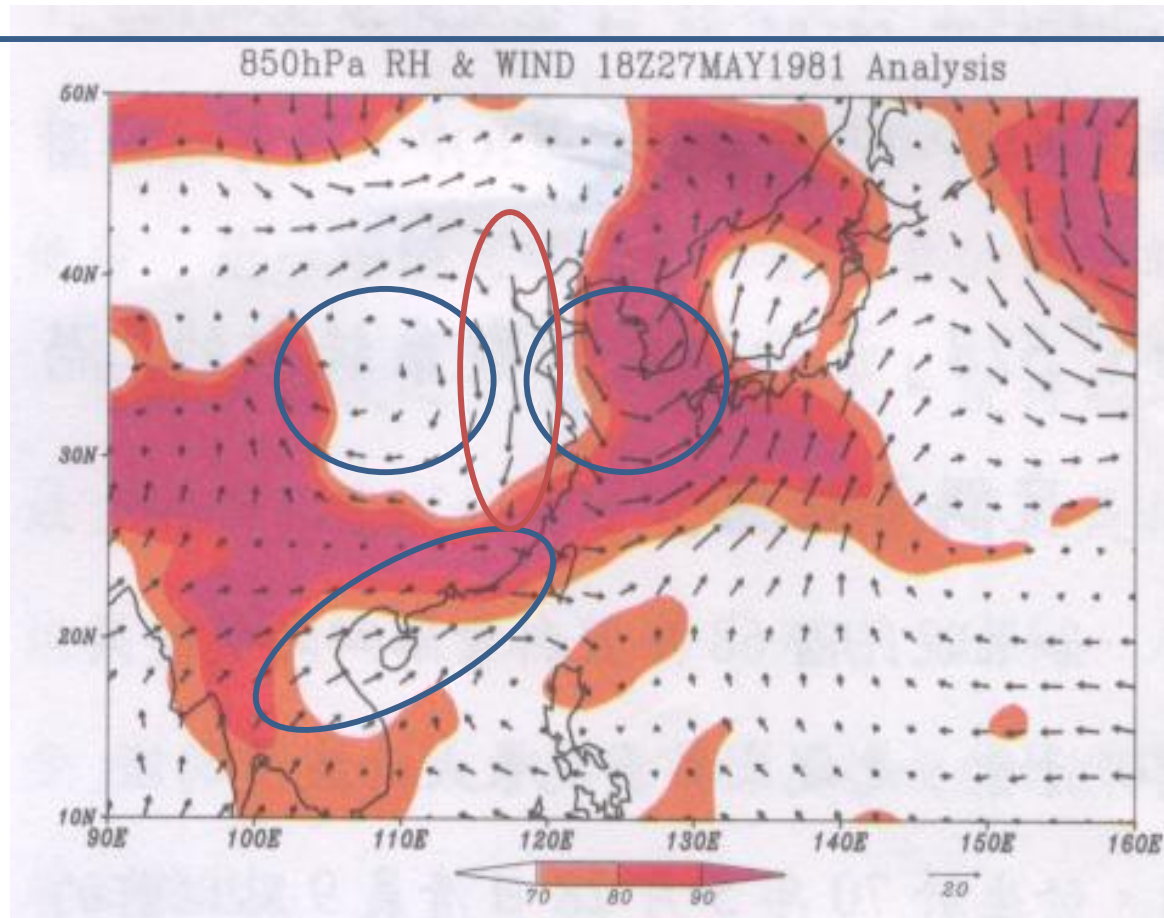
**Ageostrophic wind** accelerate the low level wind between the dipole and cause northerly jet

# Conceptual Model



When the north flow encounter with the moist southwest flow then the moist air could be shoved upward motion and create heavy rainfall.

# Vortex Dipole And Northly Flow



**Heavy rainfall case**

**(And then 1987 TAMEX)**

The vortex dipole of 850 hpa wind field and relative humidity at **0200 LST 28 May 1981** (from Liu, Hsiao, and Chang 2009).

# THE SATELLITE IMAGERY AT 0700 LST MAY 28 1981

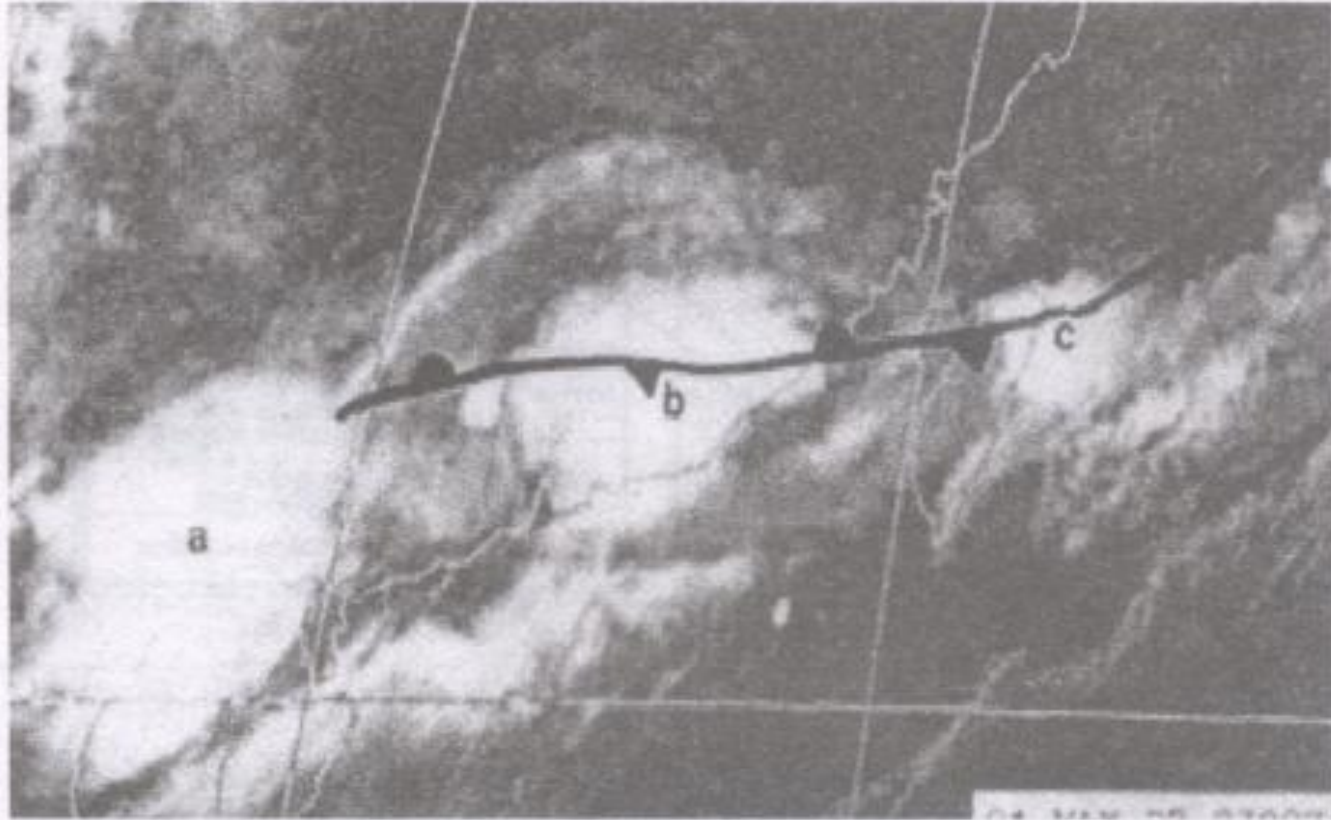
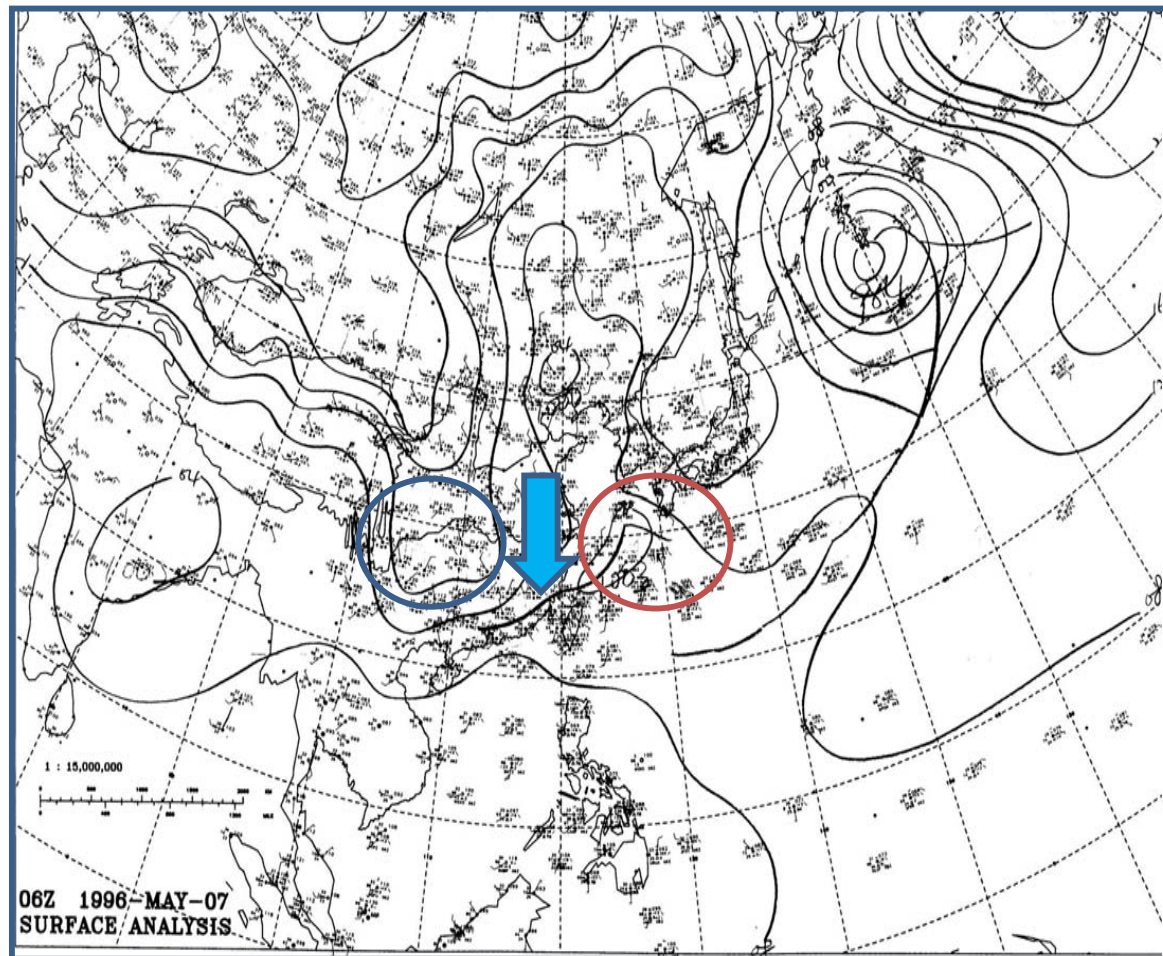


圖 3 1981 年 5 月 28 日上午 7 時之 GMS 地球  
同步衛星紅外線雲圖 (紀與陳, 1984)

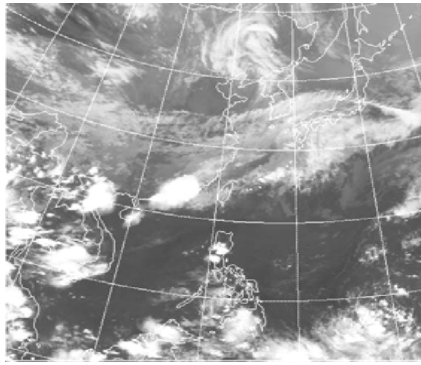
**Convective cloud systems generated along the front, but not located at low center.**

# Surface map at 06UTC 07 may 1996.

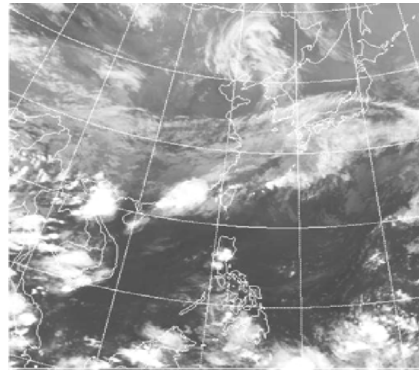
A weak front passed through Taiwan also caused local area heavy rainfall



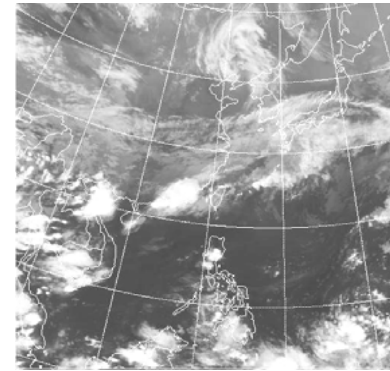
The satellite imagery from 11UTC 07 May to 16UTC 07 May 1996.



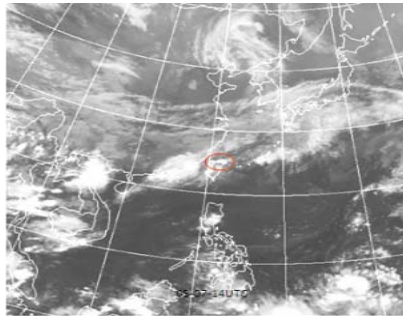
(a) 11UTC 07 May



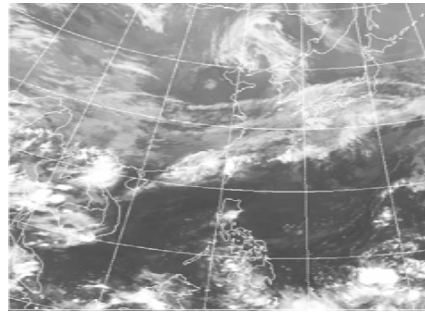
(b) 12UTC 07 May



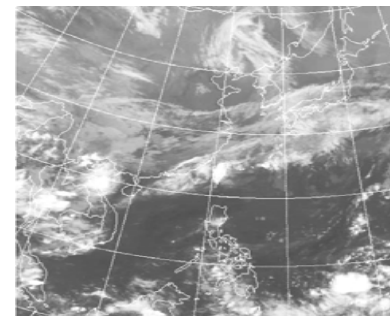
(c) 13UTC 07 May



(d) 14UTC 07 May



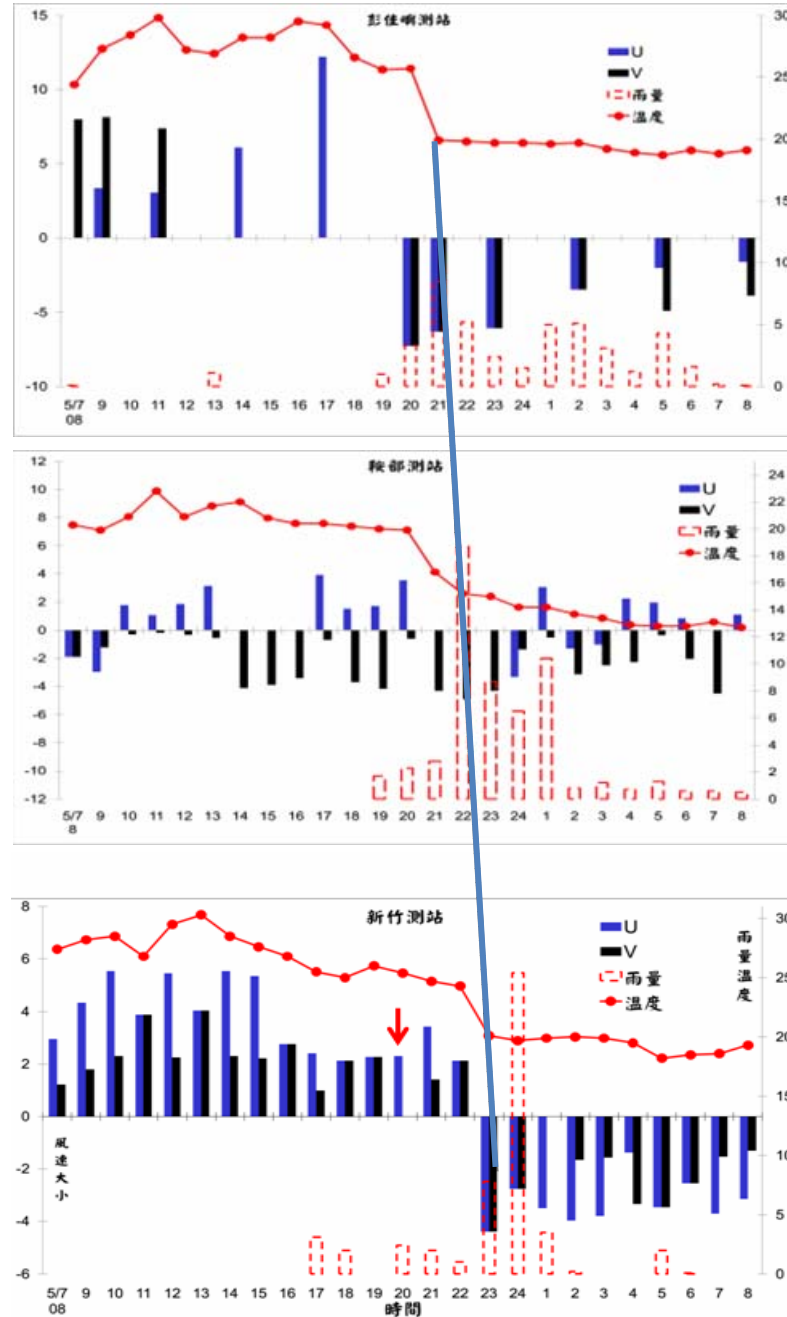
(e) 15UTC 07 May



(f) 16UTC 07 May

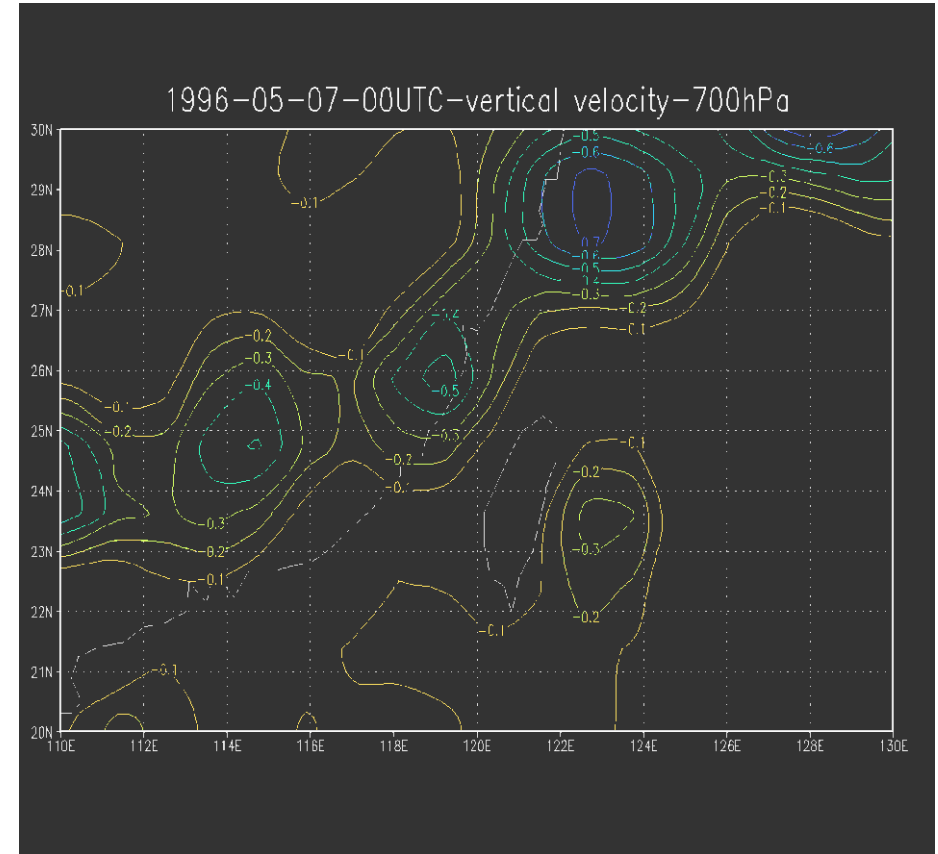
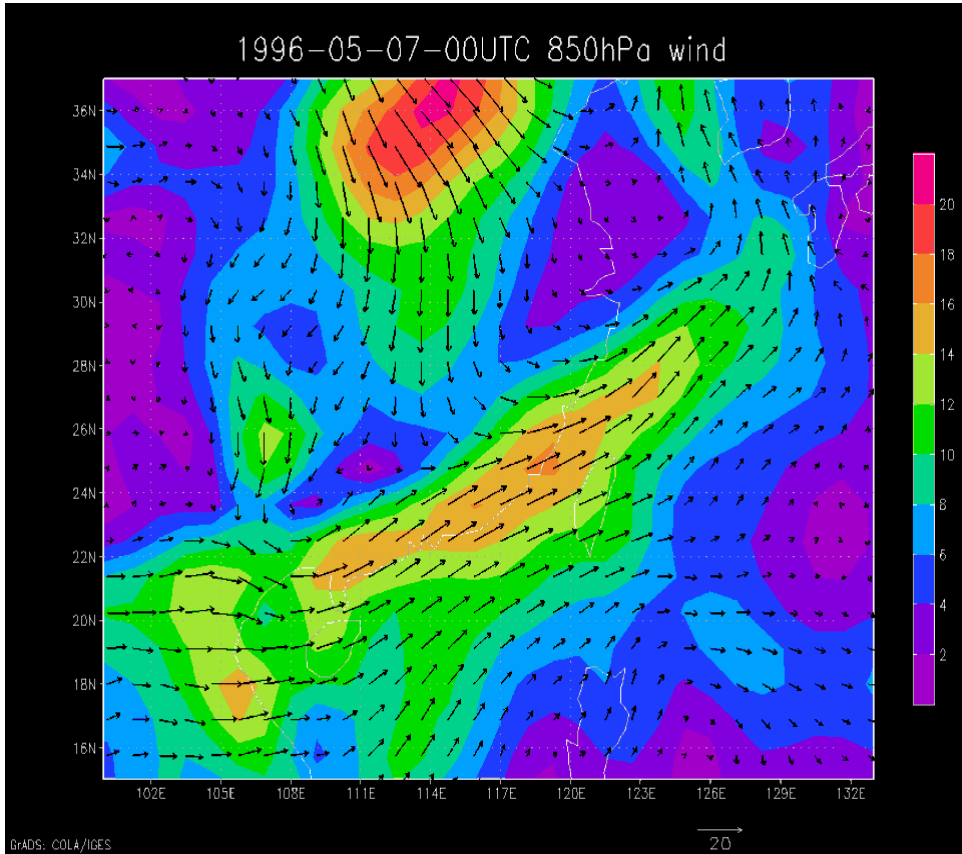
**Convective cloud systems generated along the cloud front associated with north wind, and the convective cloud moved eastward.**

# Weather element variation in May 7-8 1996



The local rainfall amount near 50mm in a few hours

00 UTC May 07 1996

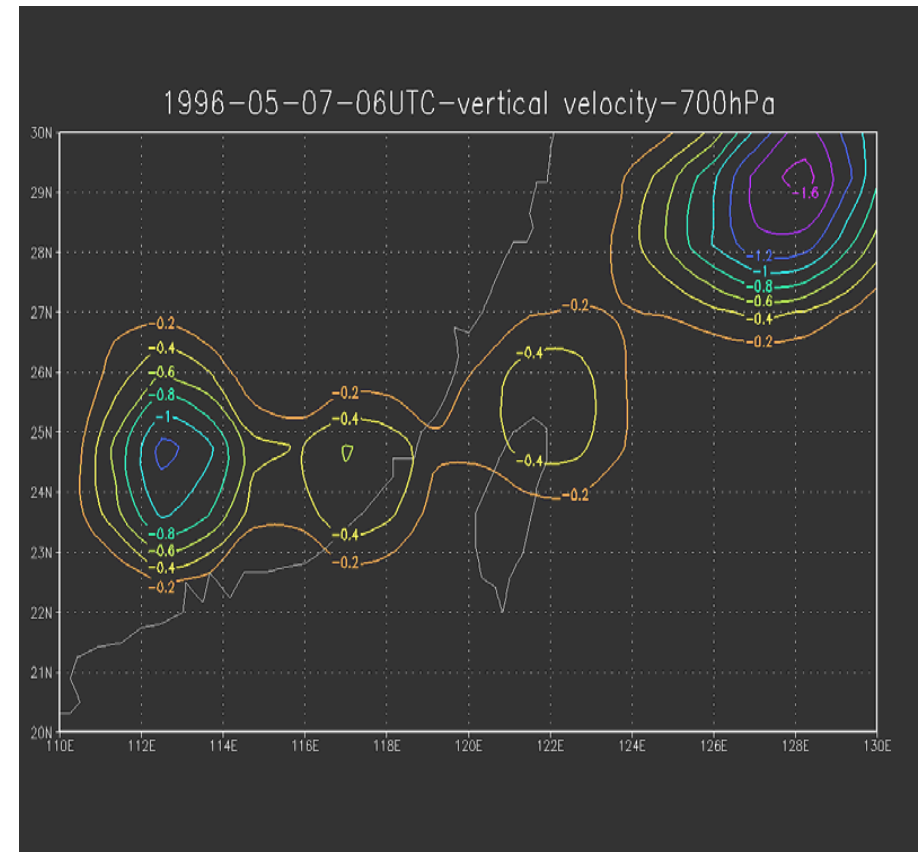
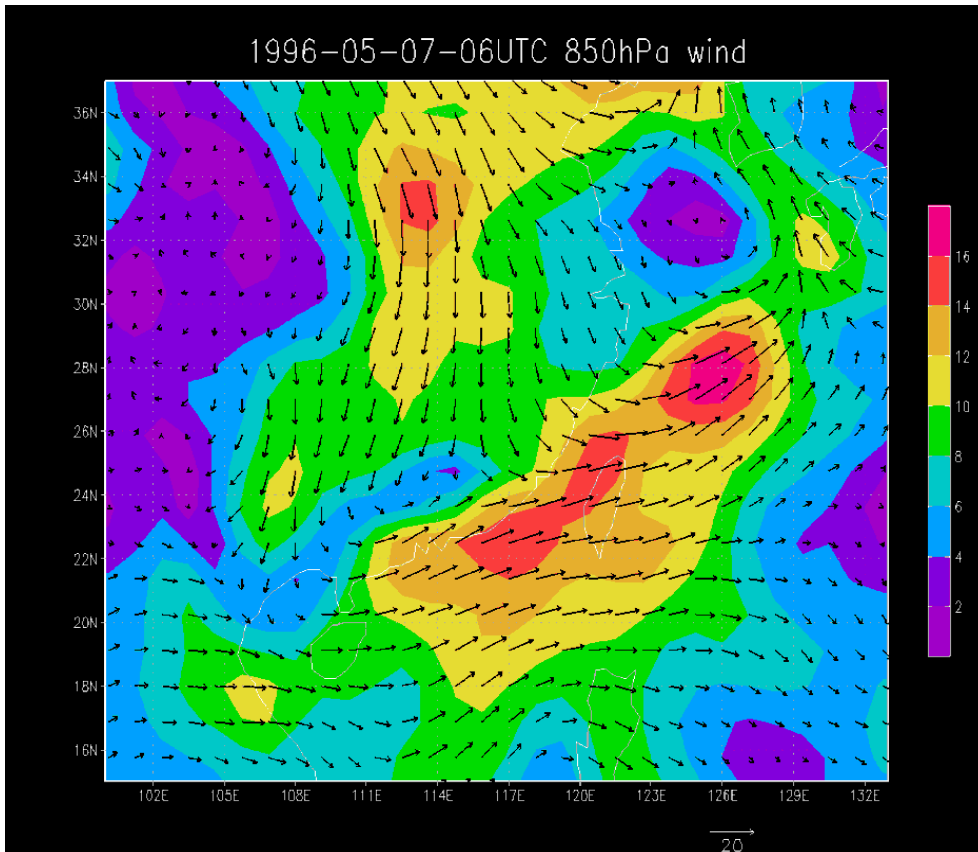


(1) Wind field of 850 hpa

(2) Vertical motion of 700hpa

**The north flow moved from the north part of Mainland China**

06 UTC May 07 1996

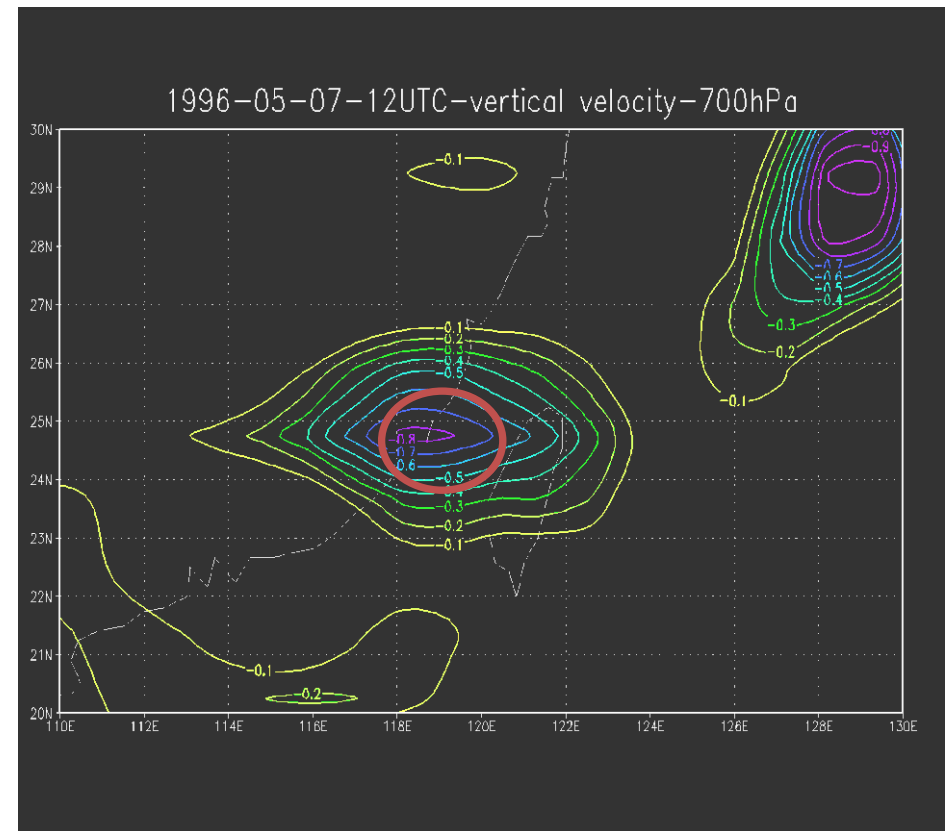
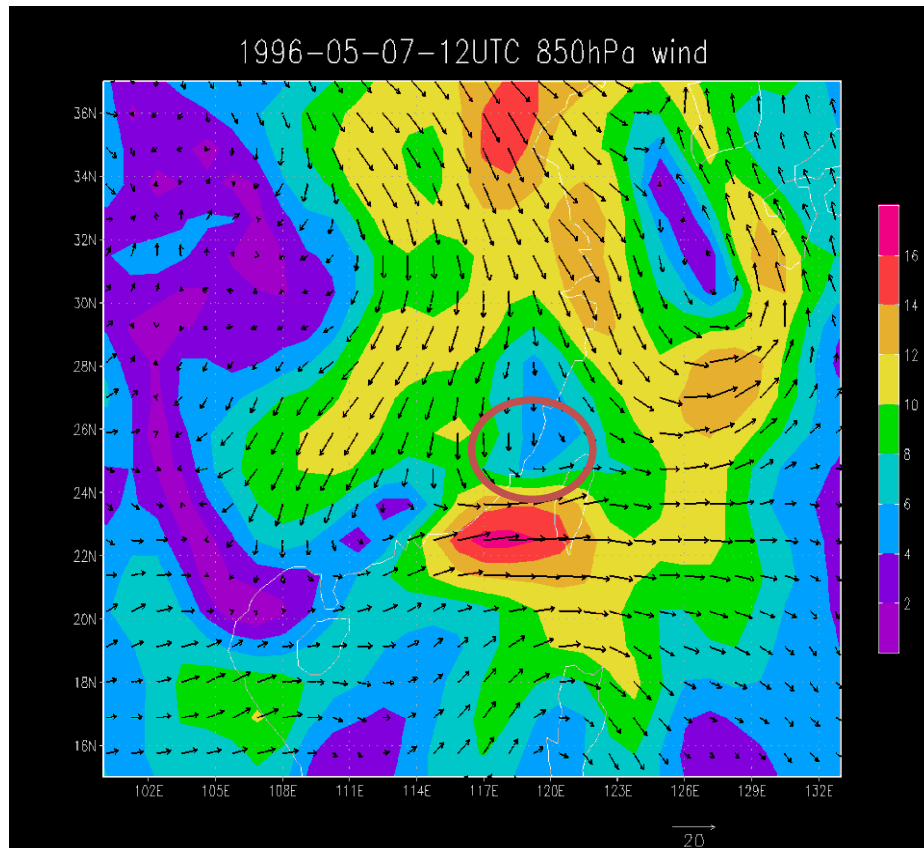


(1) Wind field of 850 hpa  
700hpa

(2) Vertical motion of  
700hpa

**The north flow moved eastward**

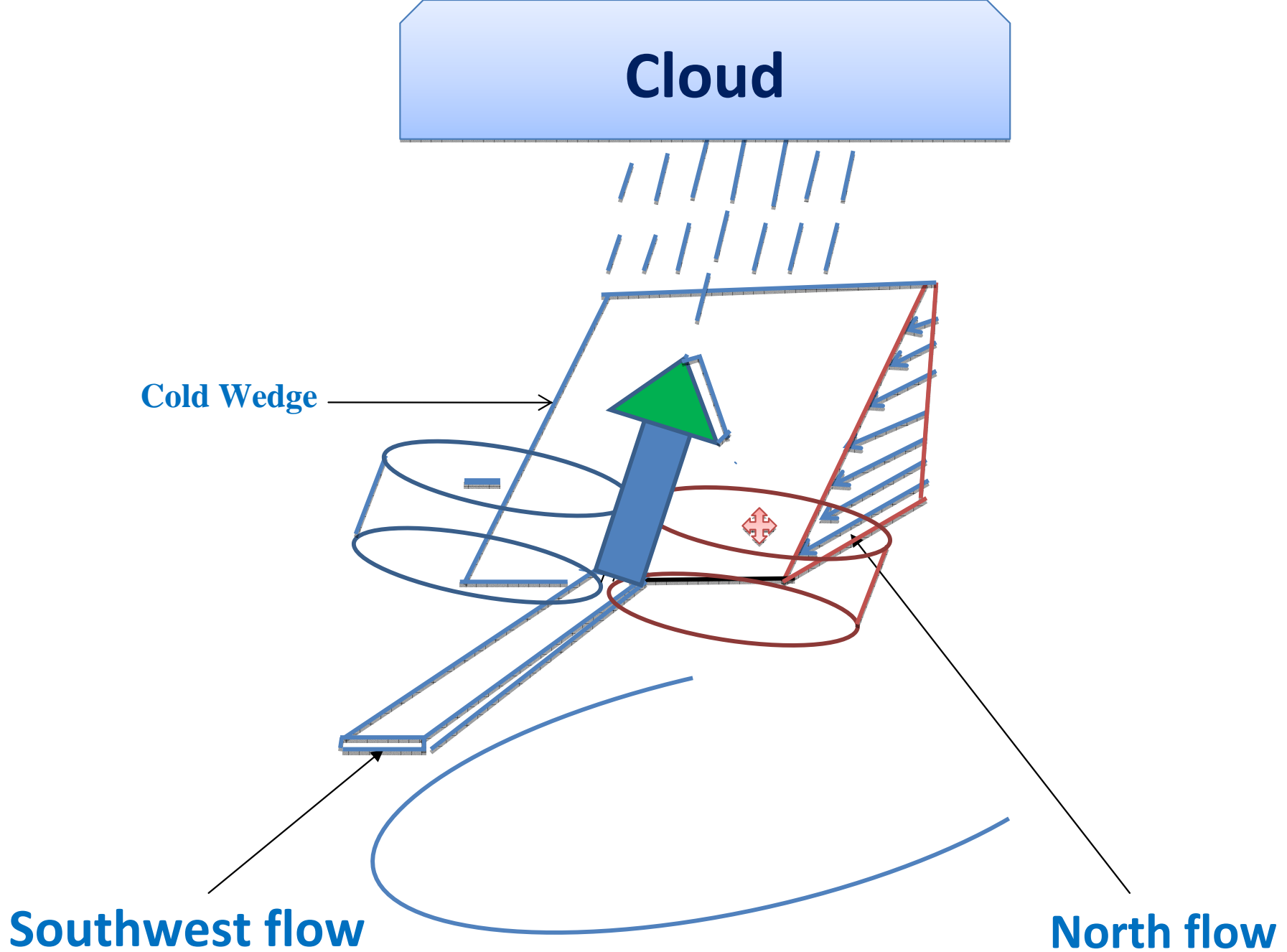
# 12 UTC May 07 1996



(1) Wind field of 850 hpa

(2) Vertical motion of 700hpa

As the north flow near Taiwan area cause the southwest flow very strong vertical motion



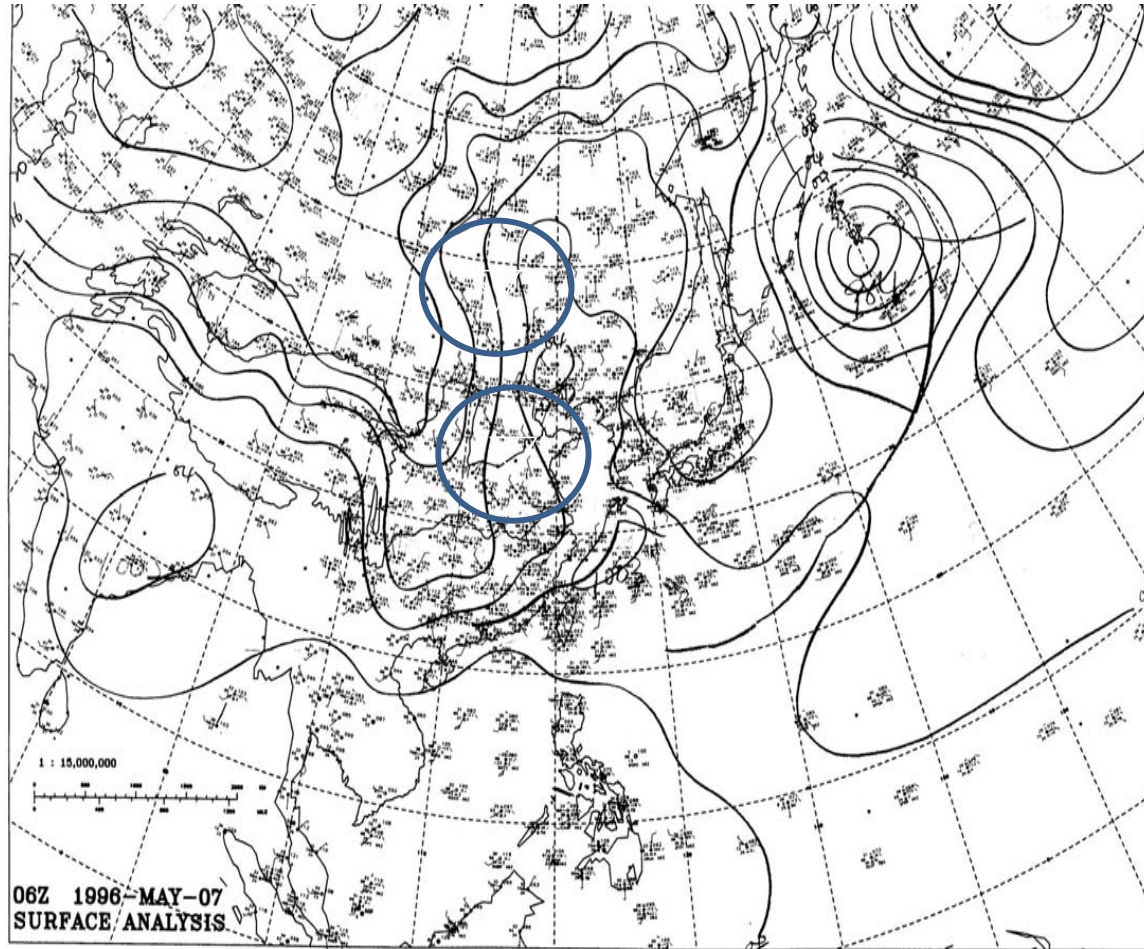
When the north flow encounter with the moist southwest flow then the moist air could be shoved upward motion and create heavy rainfall.

# Conclusion

1. Vortex dipole is one of the feature that could advantage to the development of the local system.
2. The characteristic of north wind between the Vortex dipole may be one of the reasons that create heavy precipitation.
3. Because the North wind between the Vortex dipole encounter with the Southwest flow, and then force the moist flow climb up the slop of north wind.
4. And trigger the heavy rainfall.

**Thank You for Your**

**Attention ! ! !**



$$d\mathbf{V}/dt = -\nabla\Phi - \mathbf{k} \times \mathbf{V}f = -f \mathbf{K} \times \mathbf{V}_{ag}$$

