天 氣 學 二

(Synoptic Meteorology II)

上課時間: 10:20～12:10 Wednesday, B105

授課教師: 游政谷

email: yuku@ntu.edu.tw

Chapter 1 Extratropical Cyclones

1.3 Cyclogenesis based on Petterssen equation

Development of the surface cyclone should not be viewed as a passive response to “upper-level forcing”, as discussed in 1.2.

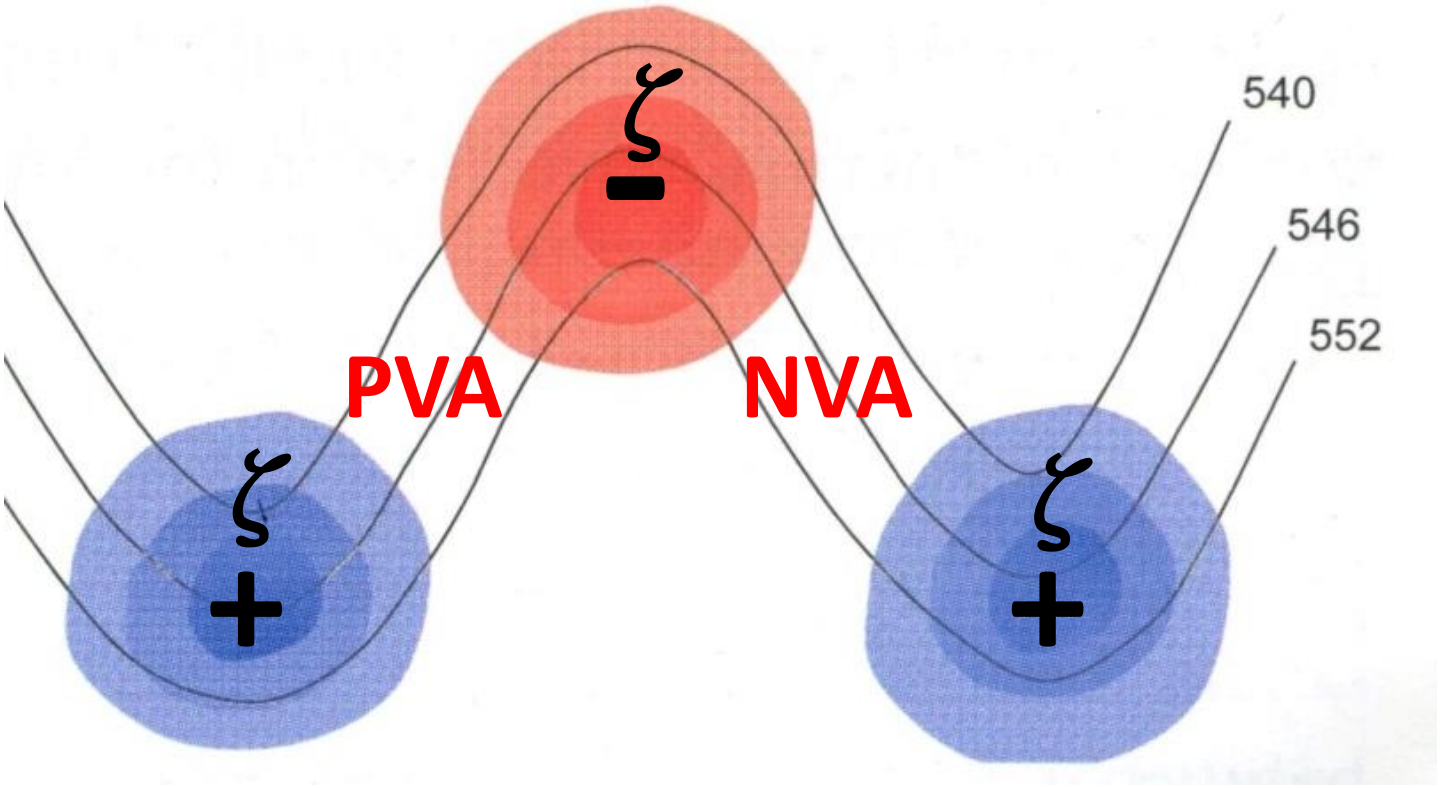
Theoretical and observational studies have shown an active linkage between lower- and upper-level processes during cyclogenesis.

Question: Is there any dynamical principle of describing lower-to-upper-level relationship you had learned previously?

Petterssen equation is a classic tool on this problem.

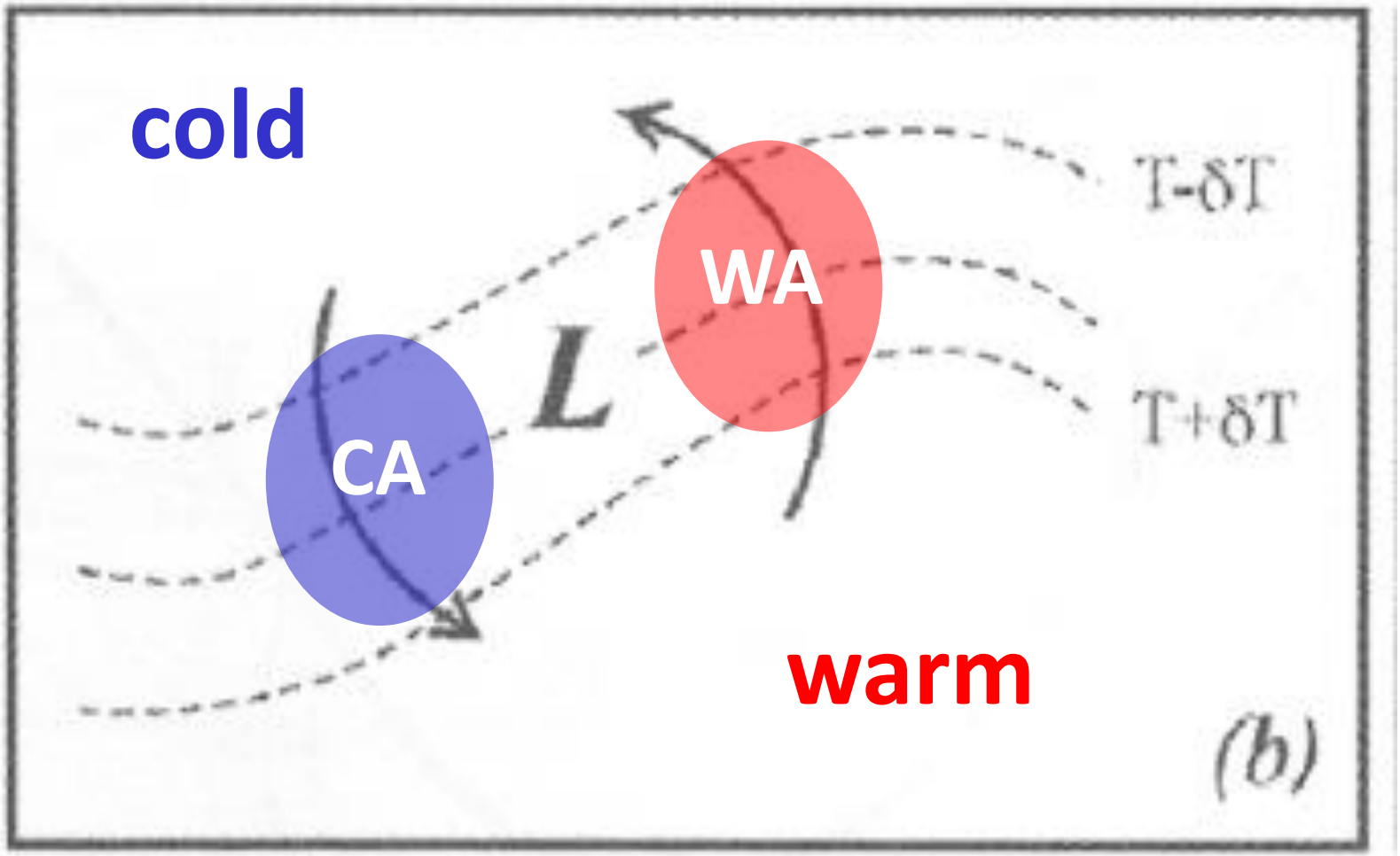
Petterssen equation will be derived in the class.

Schematic illustrating PVA (positive vorticity advection) and NVA (Negative vorticity advection) associated with upper-level trough/ridge

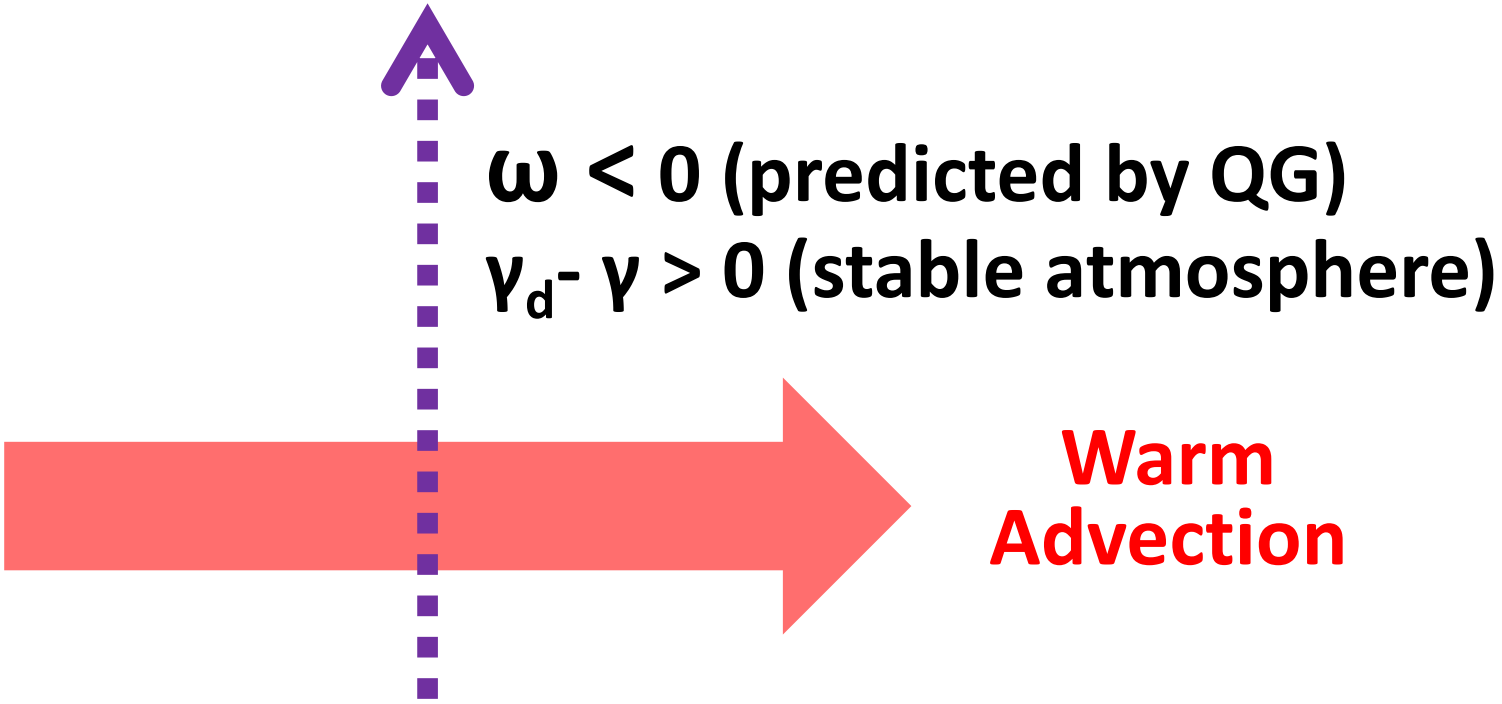


An initial surface disturbance (low pressure) embedded with ambient temperature gradient

(Note that relatively little thermal advection near the center)



Schematic illustrating the stability term (S) can serve to put a brake on the cyclogenesis process



Average distribution of cyclones over the East China Sea

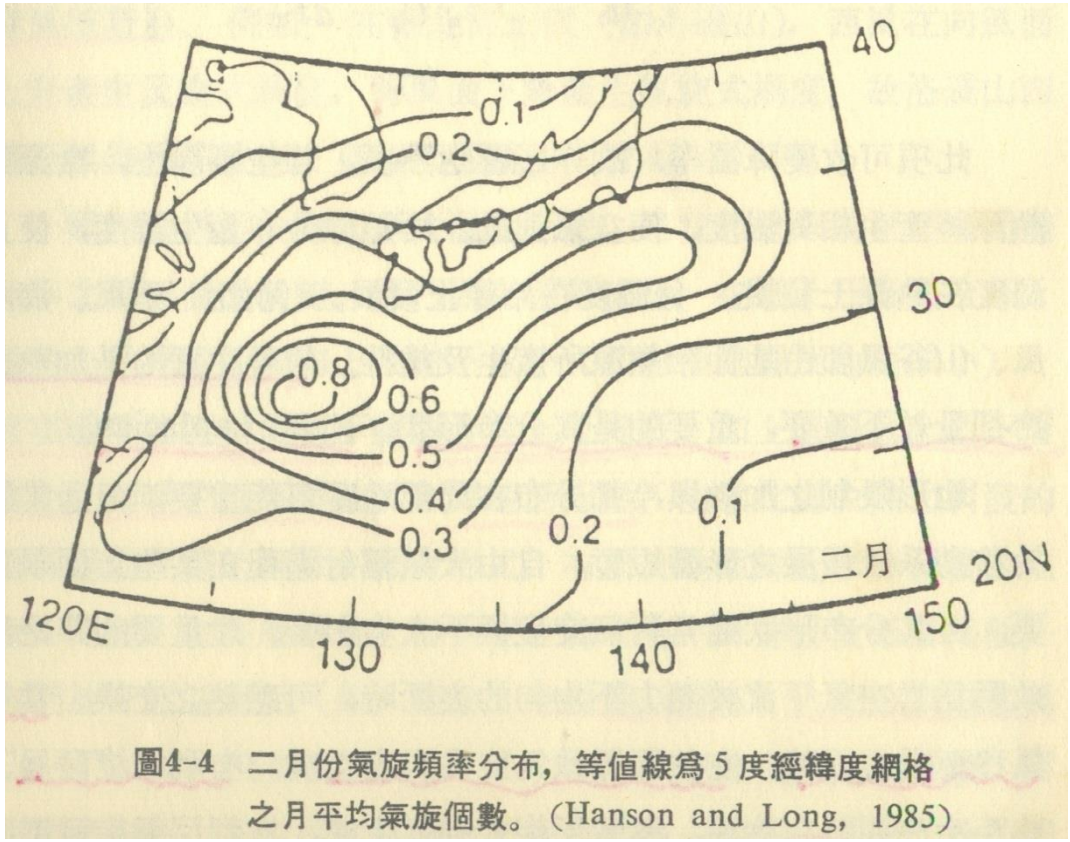
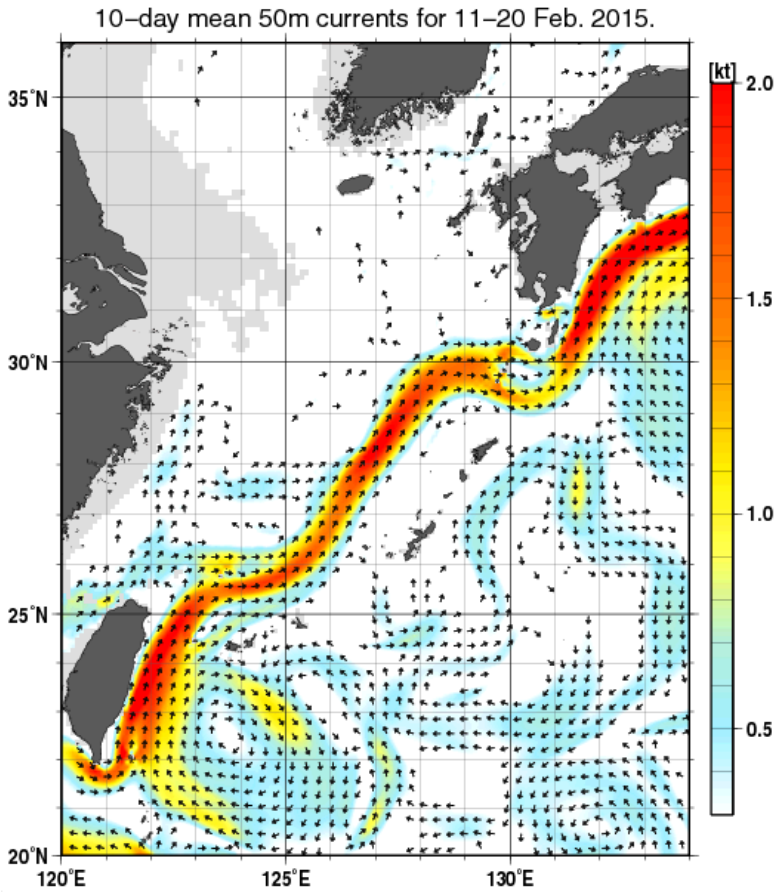


圖4-4 二月份氣旋頻率分布，等值線爲 5 度經緯度網格之月平均氣旋個數。(Hanson and Long, 1985)

(Adopted from Chen 1989)

Path of Kuroshio during Feb. 2015 (from JMA)



台灣低壓(Taiwan Low)為發生在台灣及鄰近區域之中間尺度(1000~2000公里)低壓，時間尺度約為1天。

旋生頻率分布之主軸與黑潮相當一致

其生成發展與海洋邊界可感熱傳送(減低氣團低層穩定度)及凝結潛熱釋放有關，當低壓與高層槽脊系統耦合時，有機會發展成強烈溫帶氣旋(陳 1987)

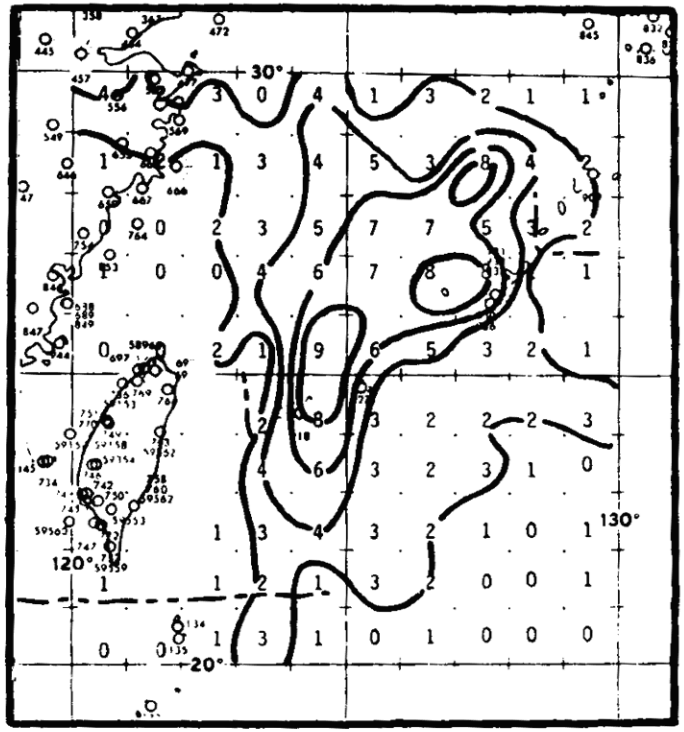
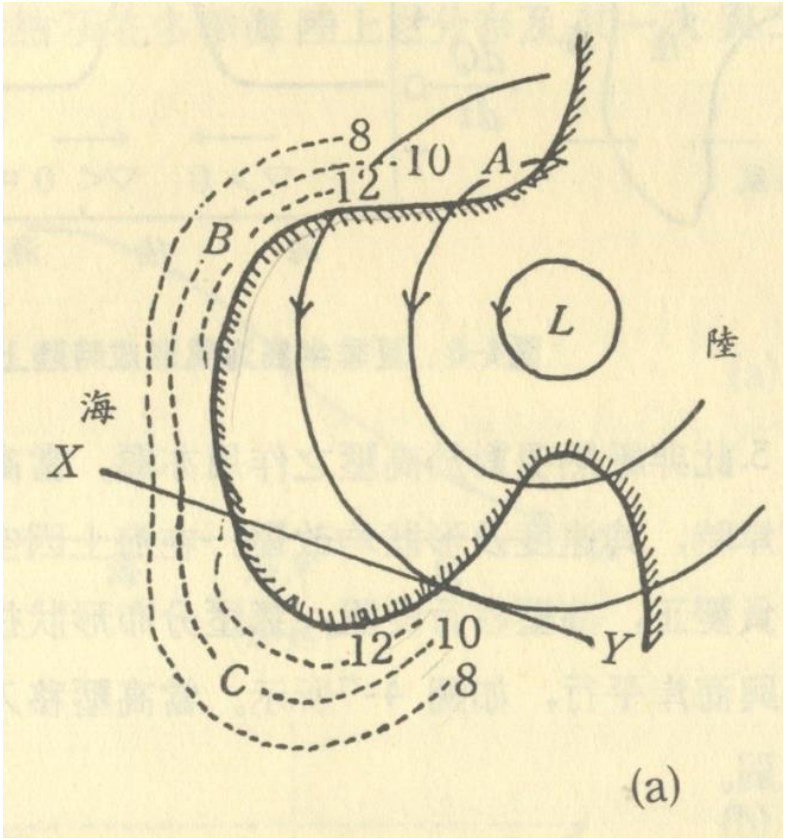


圖4-19 1962～1976年12月～3月臺灣低壓形成分布 (Yu, 1980)

Differential heating over land and ocean (like peninsula) can result in the development of cyclones over land (illustrations from Chen 1987)



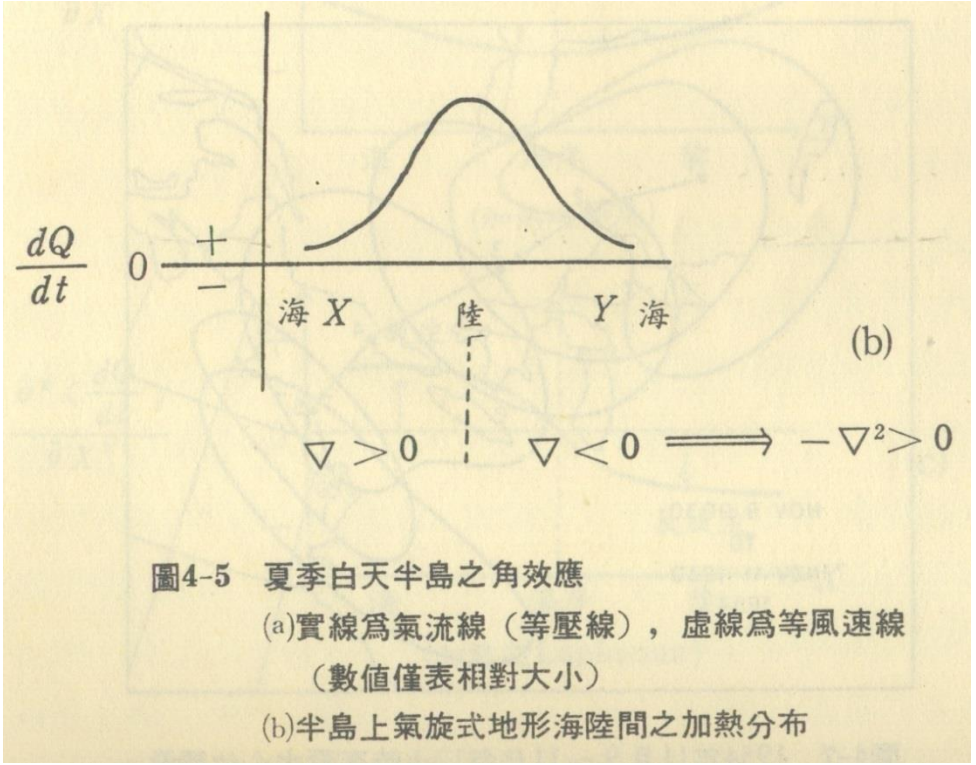


圖4-5 夏季白天半島之角效應
(a)實線爲氣流線（等壓線），虛線爲等風速線
（數值僅表相對大小）
(b)半島上氣旋式地形海陸間之加熱分布

Petterssen classified the cyclogenesis into two types:

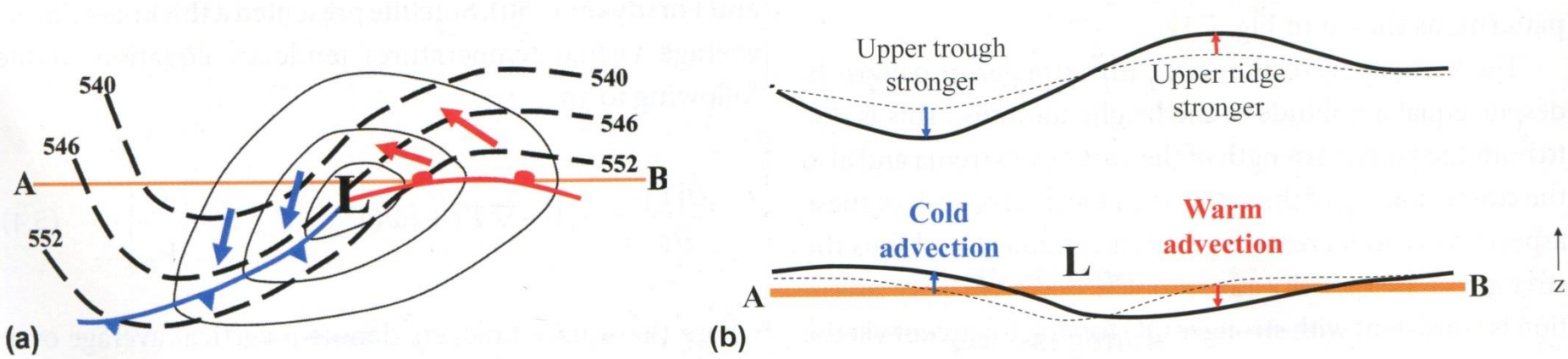
Type A: Cyclogenesis is not associated with 500-mb trough, with dominance of thermal forcings (**A_T + S + H**)

Type B: Cyclogenesis is dominated by the 500-mb trough forcing (i.e., dynamic forcing)

To better monitor the cyclogenesis, each term of Petterssen equation should be carefully evaluated.

Q: Which one occurs more often?

Schematic illustrating a positive feedback between the lower-tropospheric thermal advection, the upper wave, and the surface cyclone



Schematic depiction of feedback between lower-tropospheric thermal advection and upper wave: (a) plan view of 1000–500-mb thickness (dashed black contours), sea level isobars (gray solid lines), fronts, and selected geostrophic wind vectors [red (blue) indicating warm (cold) thickness advection]. Orange line A–B indicates location of cross section shown in (b); (b) vertical cross section showing before and after positions of the 1000- and 500-mb height surfaces (dashed before, solid after), along with relative locations of warm and cold advection maxima (labeled).

Positive feedback: A developing cyclone → favor warm (cold) advection → stronger upper ridge/trough → stronger vorticity advection → further intensify cyclone