天 氣 學 二

(Synoptic Meteorology II)

上課時間: 10:20～12:10 Wednesday, B105

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Chapter 1 Extratropical Cyclones

1.4 Explosive Cyclogenesis (Bomb)

In terms of both prediction and societal impacts, rapidly intensifying cyclones present important challenges.

Definition: A central sea level pressure decrease greater than

1 Bergeron (b) = 24 mb[sinΦ/sin(60^o)] 24 h^{-1}

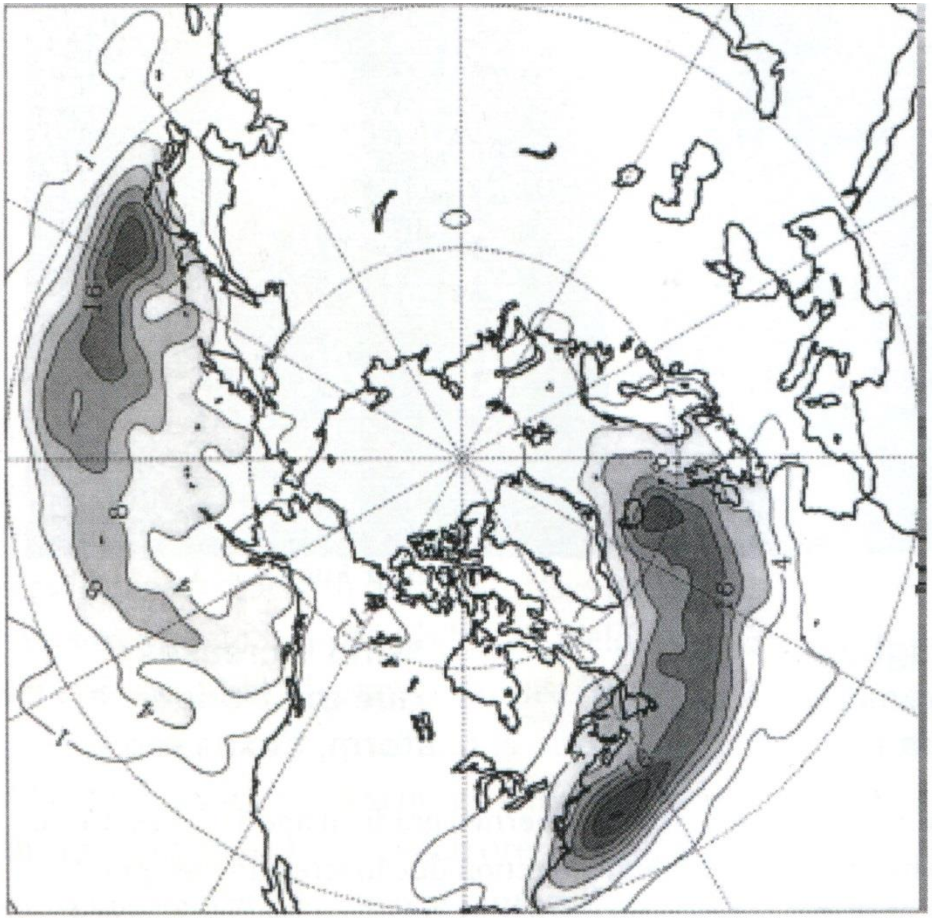
Φ : latitude

(Sanders and Gyakum 1980, MWR)

Ex: Φ=90^o, 1b = 28 mb 24 h^{-1}; Φ=25^o, 1b = 12 mb 24 h^{-1}

Q: Why does latitude factor in this criterion (i.e., lower latitude requires smaller growth rate in pressure) ?

Genesis of explosive cyclones from 1979 to 1999



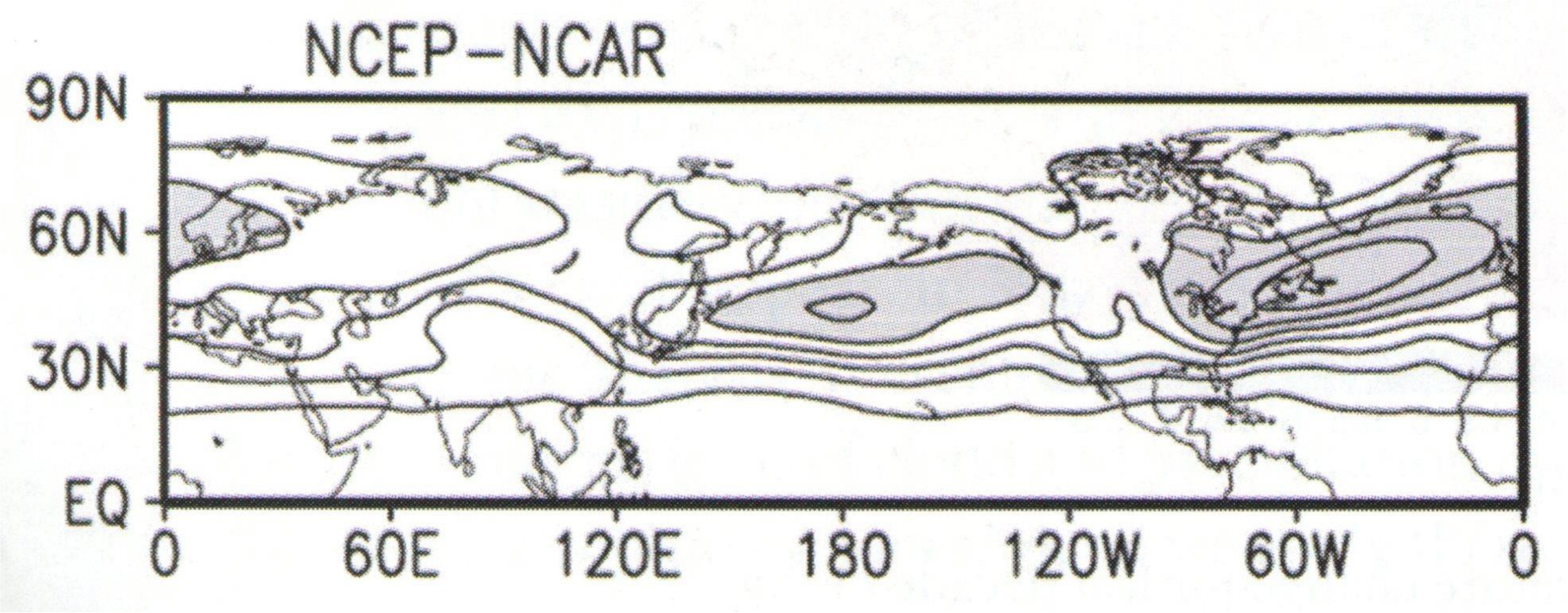
Northern Hemisphere explosive cyclone density [contour interval is 4×10^{-5} explosive cyclones ($^{\circ}\mathrm{lat}^{-2}$), with 1×10^{-5}contour added, and shaded greater than 8×10^{-5}] based on NCAR–NCEP reanalysis data from 1979 to 1999 (from Lim and Simmonds 2002, their Fig. 11).

- The bomb is primarily a maritime event
- Genesis coincided with the western oceanic boundary currents (what are the implications?)

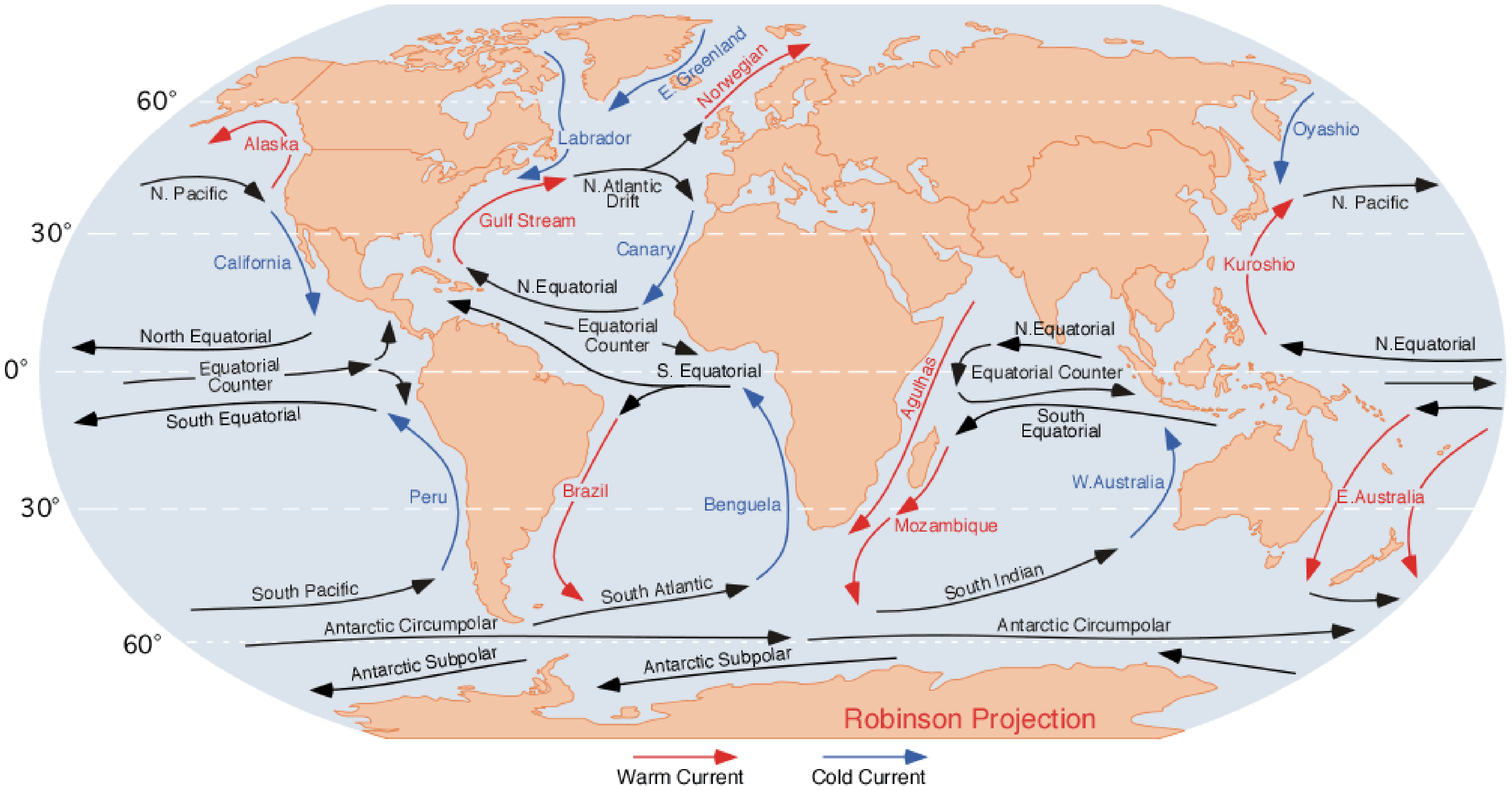
Q: How about the strength of the braking term in the maritime location?

The lack of rapid cyclogenesis over land is likely due to reduced latent-heat contribution, greater static stability, and stronger friction

Northern Hemisphere storm track defined using the standard deviation of filtered 500-mb geopotential height from NCEP-NCAR reanalysis during 1982-94 (Chang 2009)



A close relationship of Gulf Stream and Kuroshio with Bomb



1.5 Anticyclones

- Anticyclones are generally less likely to produce high-impact weather than cyclones (why?)

It can be understood via views from the vorticity equation and gradient wind balances

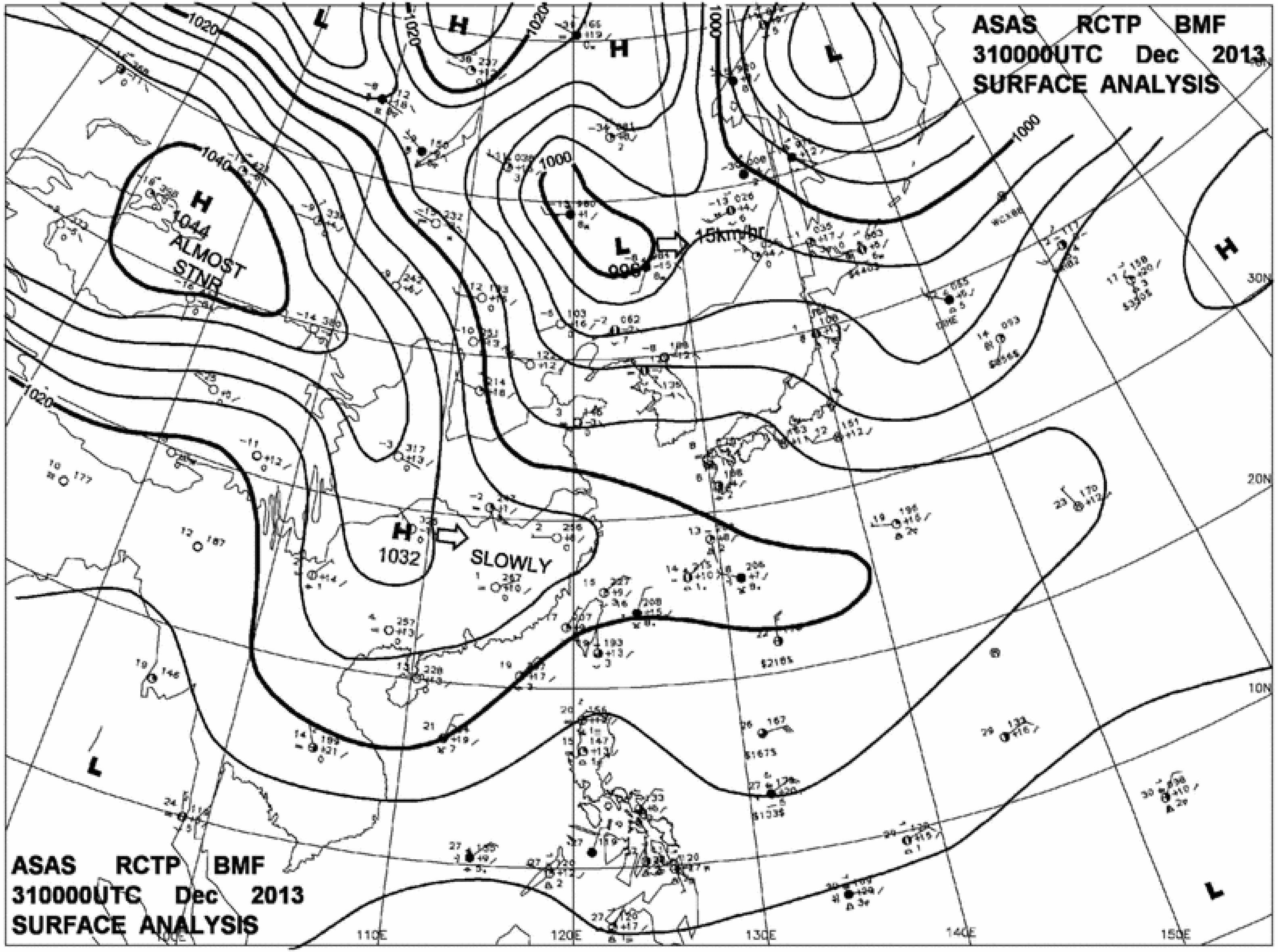
General characteristics: relatively weak systems, flat center, downward motions, less cloud, gentle wind, and inversion layer etc.

- Application of Petterssen Eq. to the development of anticyclones, in a way similar to that of cyclogenesis

NVA at 500 mb and **A_T** are also a factor

S is usually a negative effect because of dry and downward motions

H is frequently important for the development of anticyclones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SURFACE ANALYSIS
H
1044
ALMOST
STNR
1040
1020
1000
L
996
15km/hr
H
1032
SLOWLY
30N
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120E
130E
140E
150E
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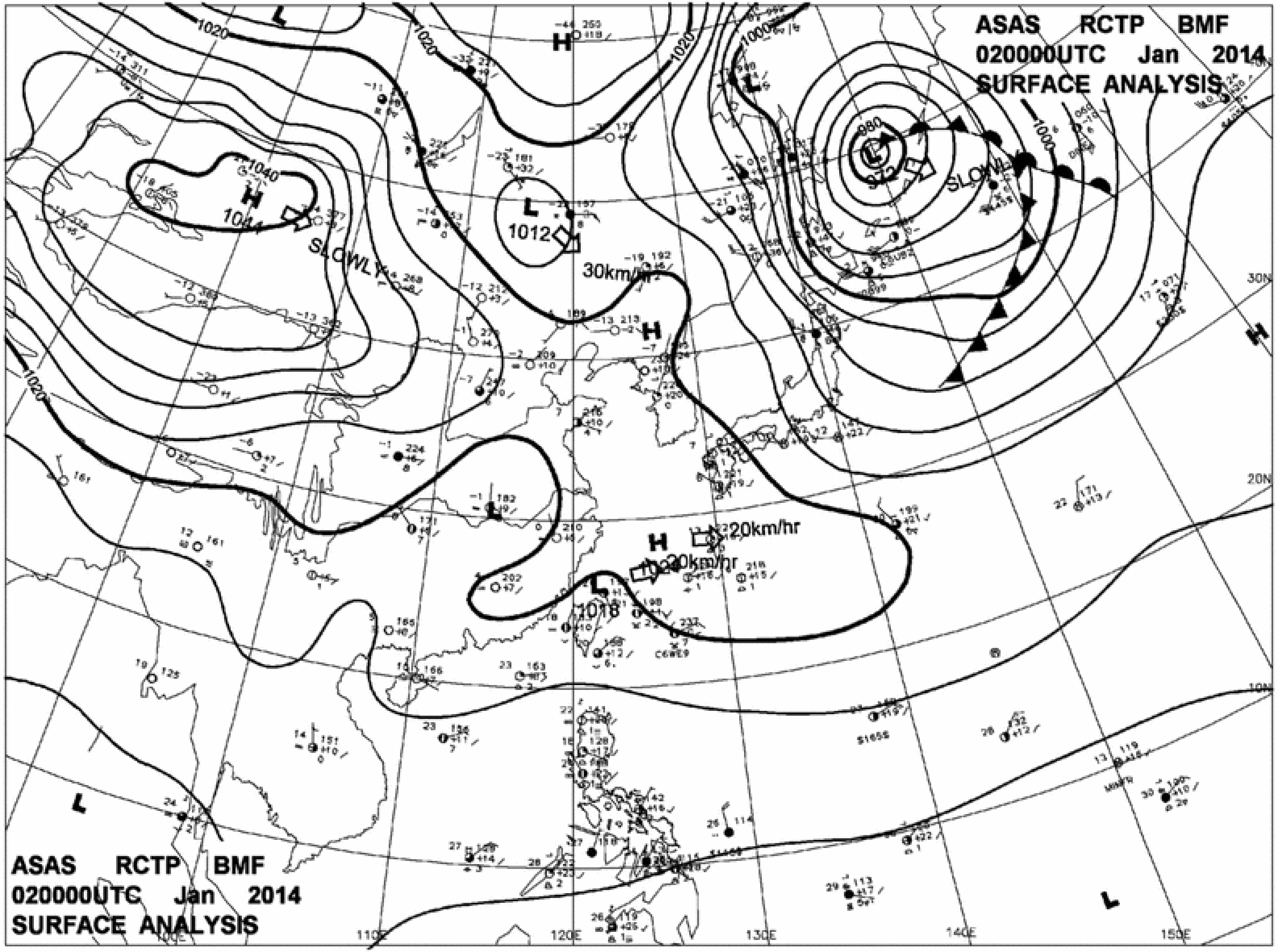
SURFACE ANALYSIS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SURFACE ANALYSIS
H
L
1040
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1012
1018
1024
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980
972
SLOWLY
30km/hr
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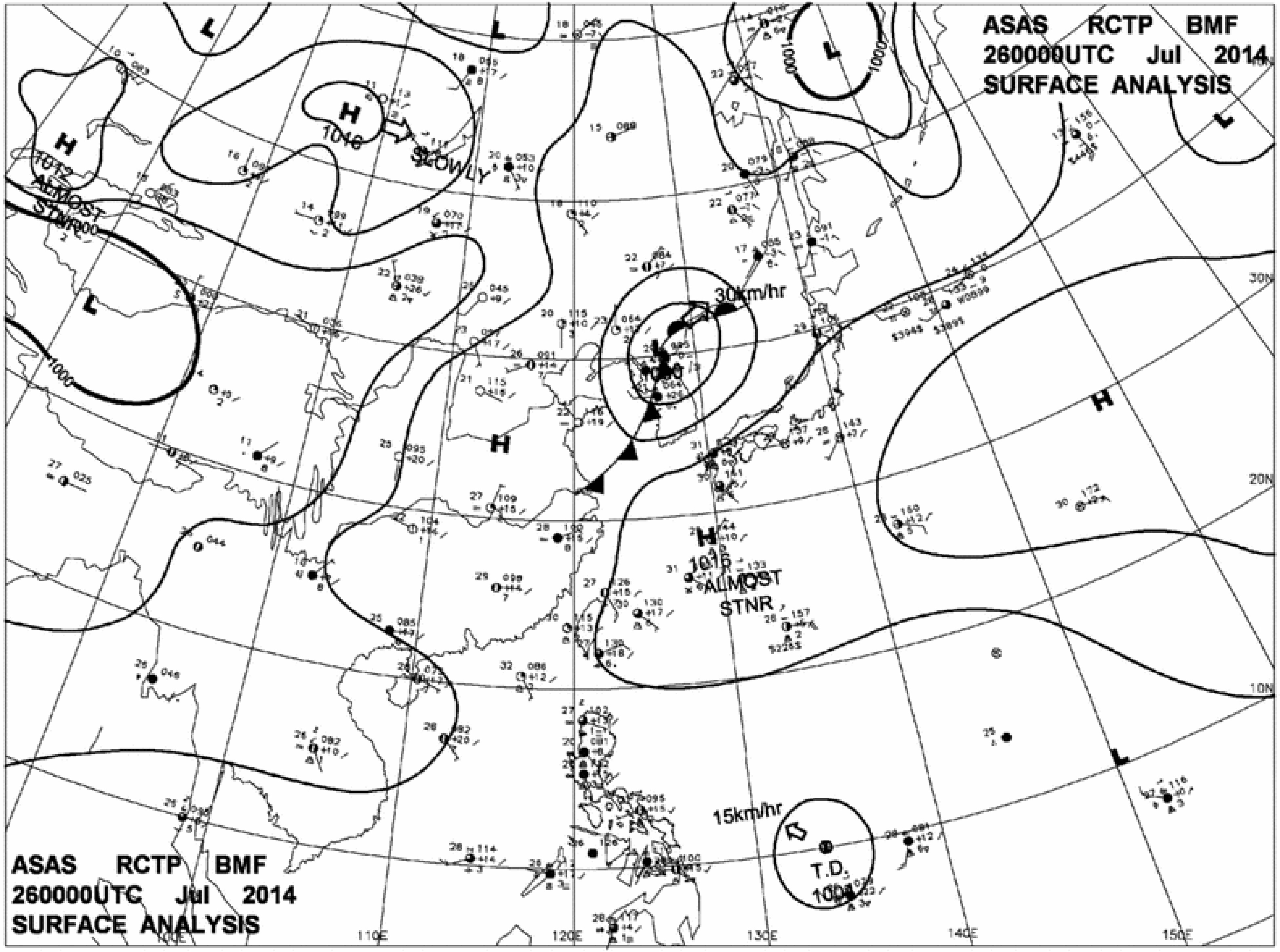
SURFACE ANALYSIS


ASAS RCTP BMF
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SURFACE ANALYSIS
H
1016
SLOWLY
H
1012
ALMOST
STNR
1000
L
L
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L
L
1000
1000
1000
30km/hr
H
H
H
1016
ALMOST
STNR
15km/hr
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L
ASAS RCTP BMF
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SURFACE ANALYSIS
30N
20N
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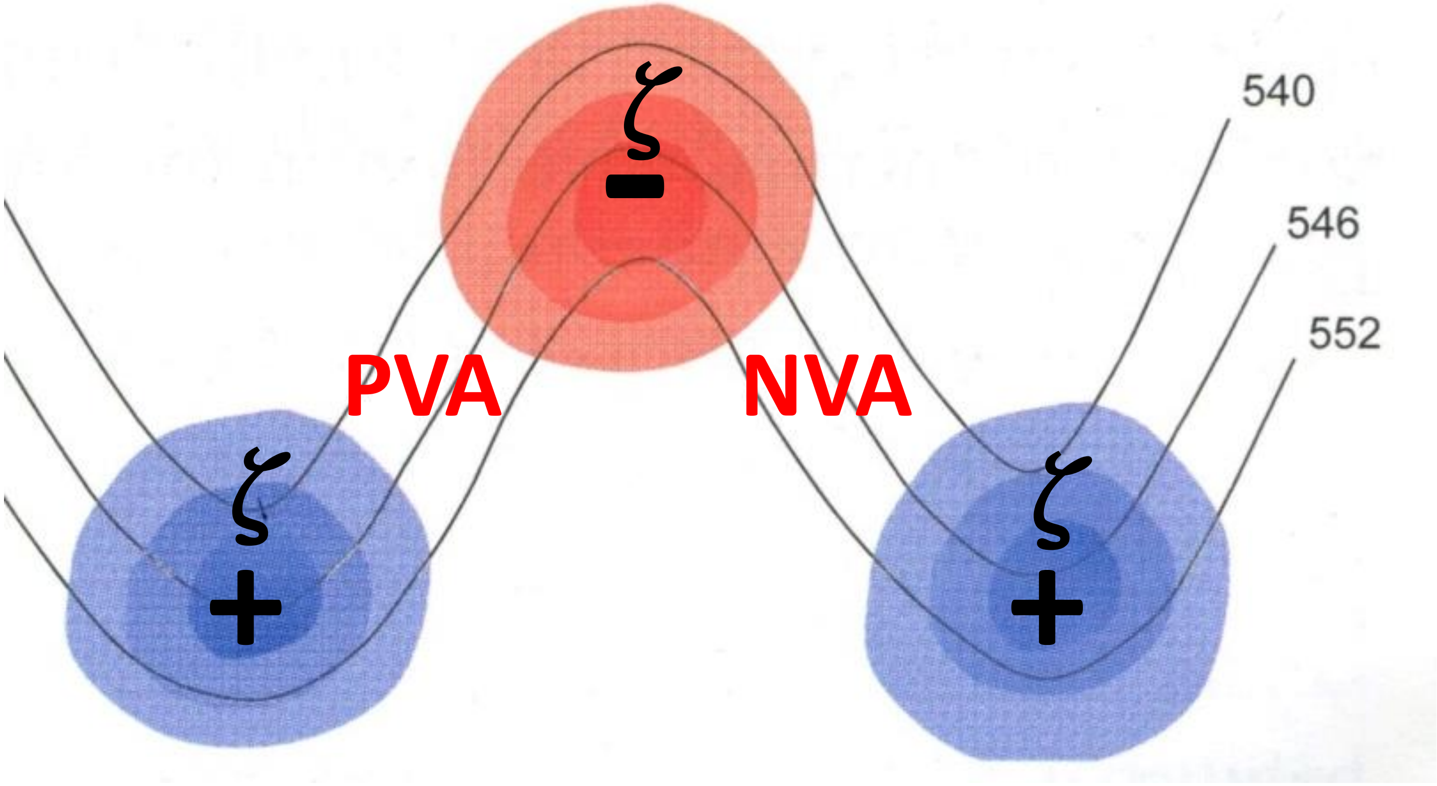
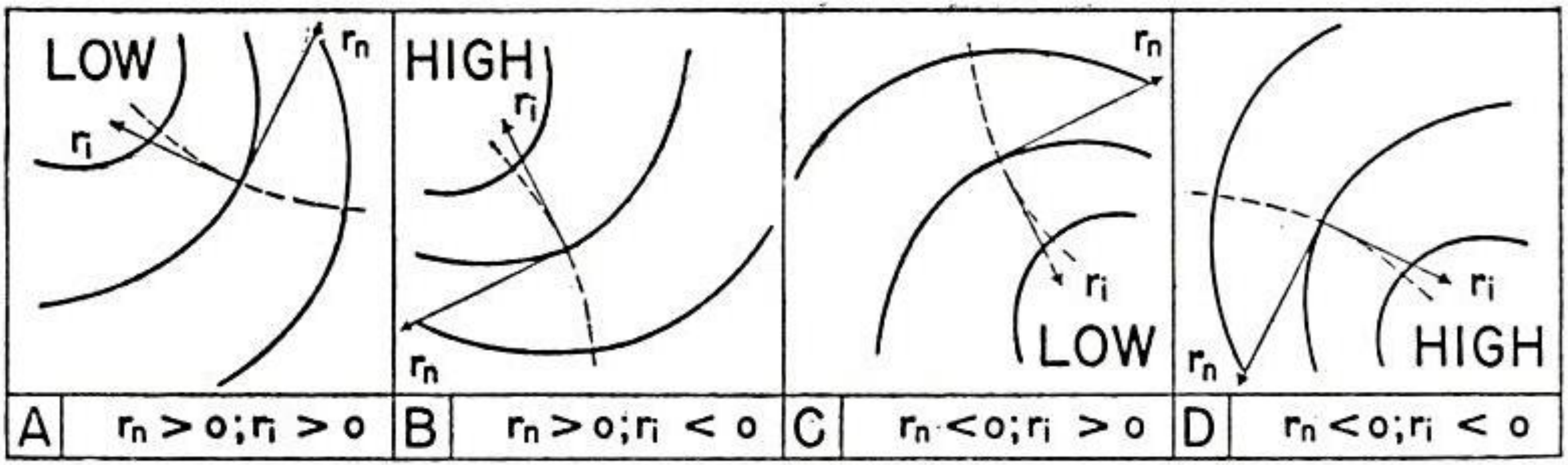
100E
110E
120E
130E
140E
150E

NVA (Negative vorticity advection) downstream of the ridge usually favors the development of anticyclones



Schematic illustrating the radii of tangential (r_i) and orthogonal (r_n) curvature



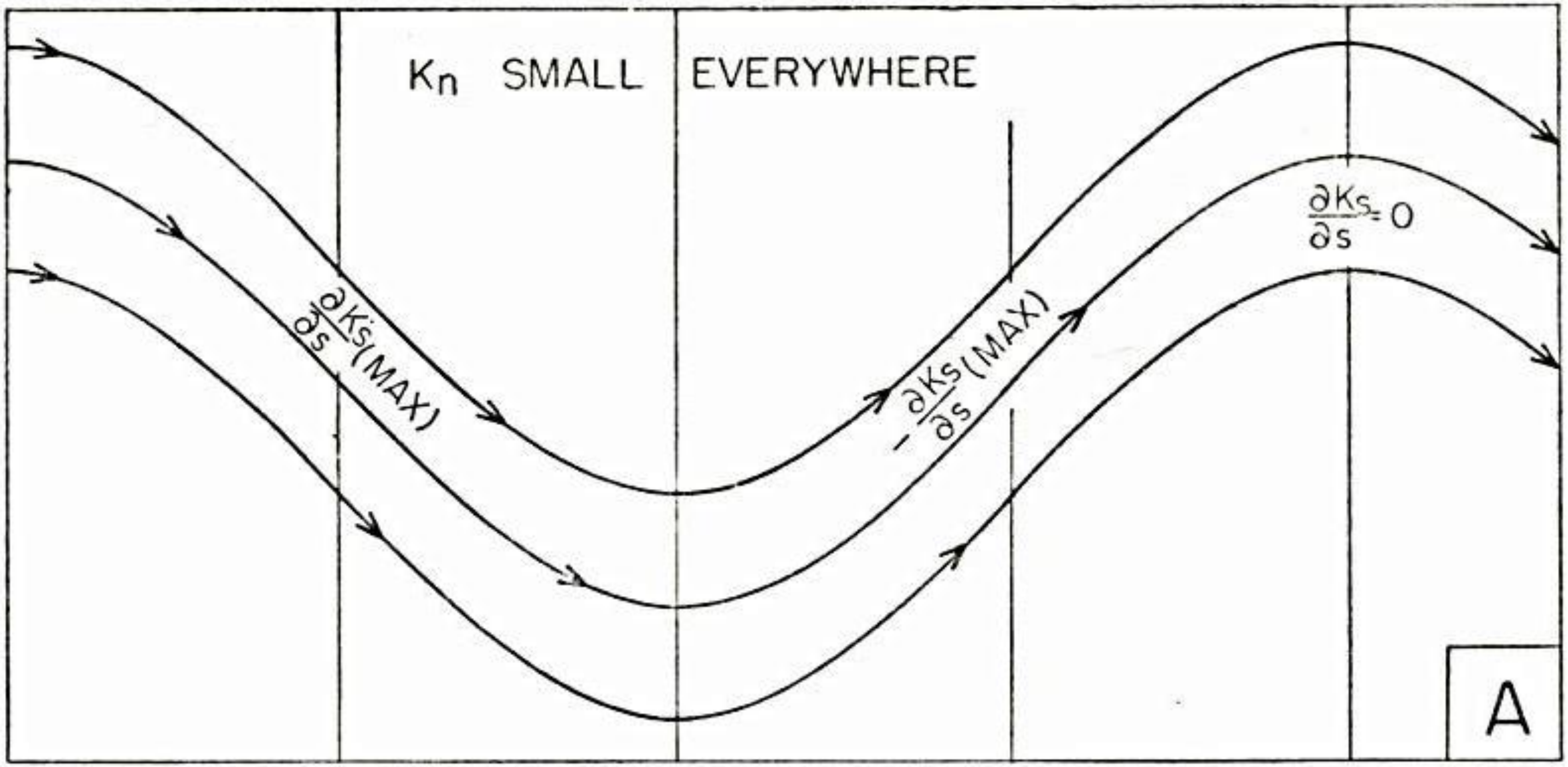
A $r_n > o; r_i > o$

B $r_n > o; r_i < o$

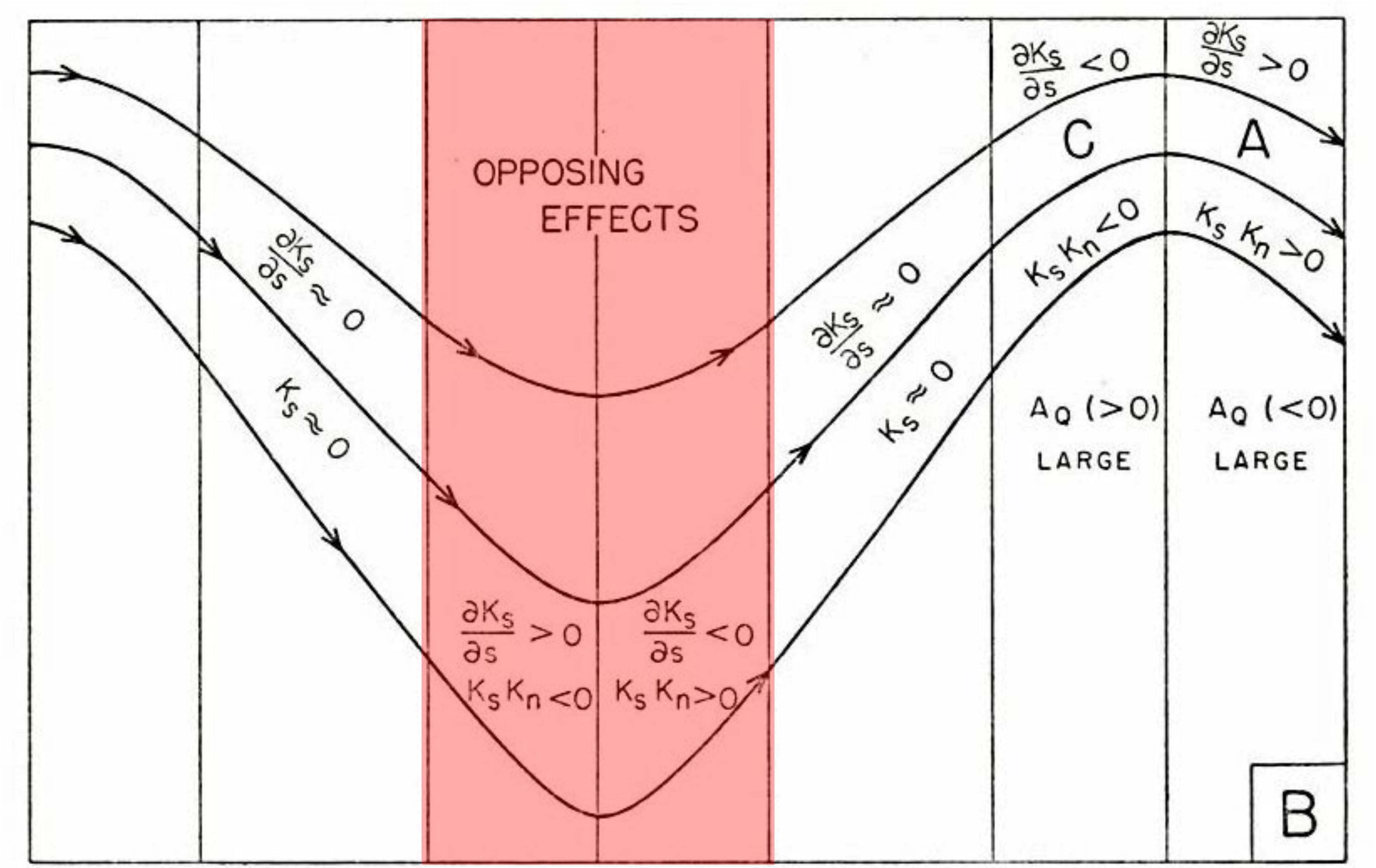
C $r_n < o; r_i > o$

D $r_n < o; r_i < o$

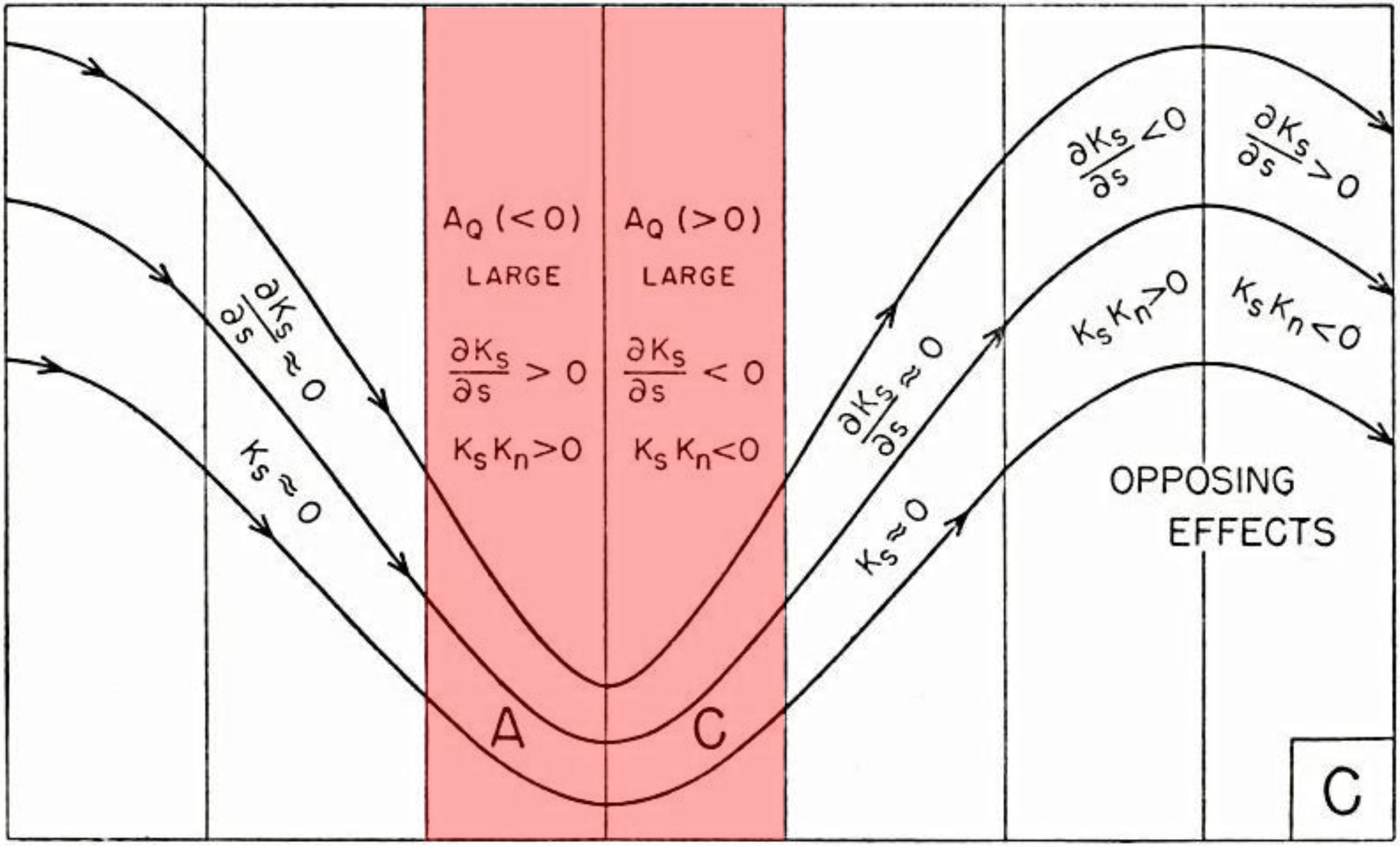
Trough without confluent or diffluent pattern



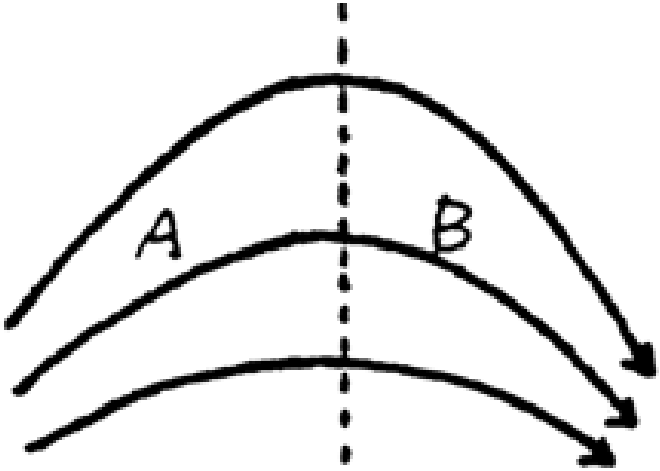
Trough with diffluent entrance and confluent exit
(槽前合流, 正渦度平流較小)

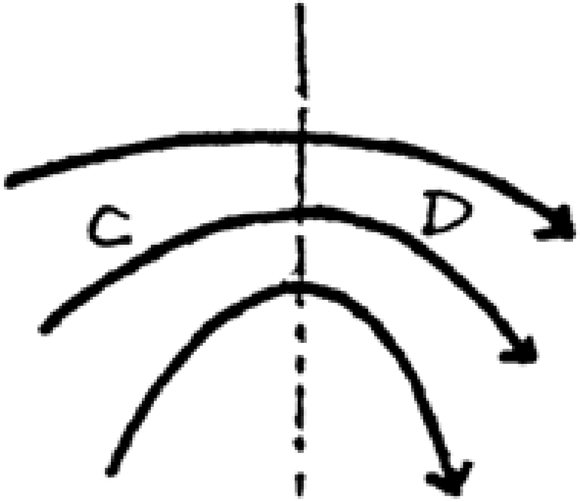


Trough with confluent entrance and diffluent exit
(槽前分流, 正渦度平流較大)

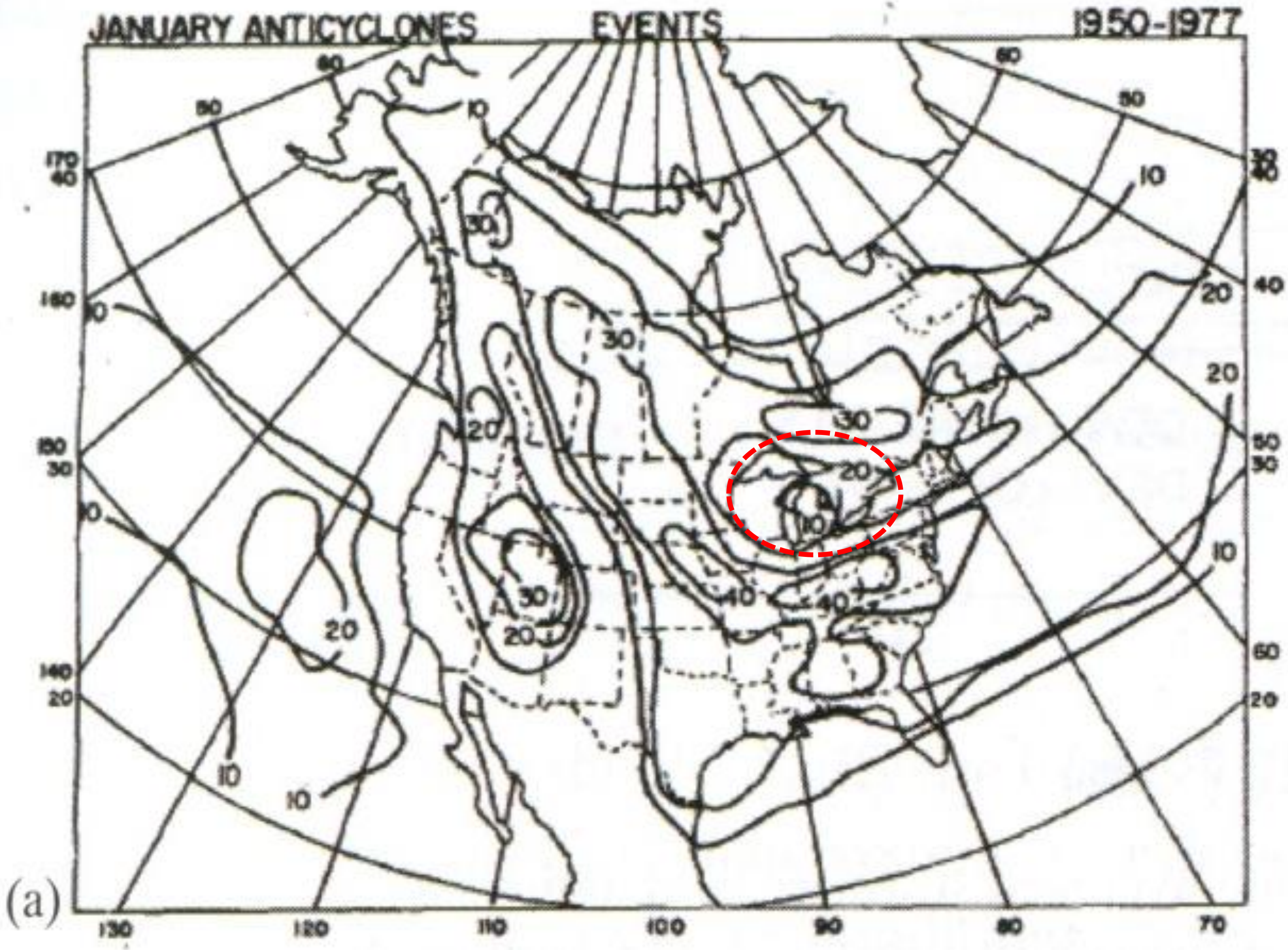


Think about the two ridge patterns below and which pattern (area) favors stronger NVA?

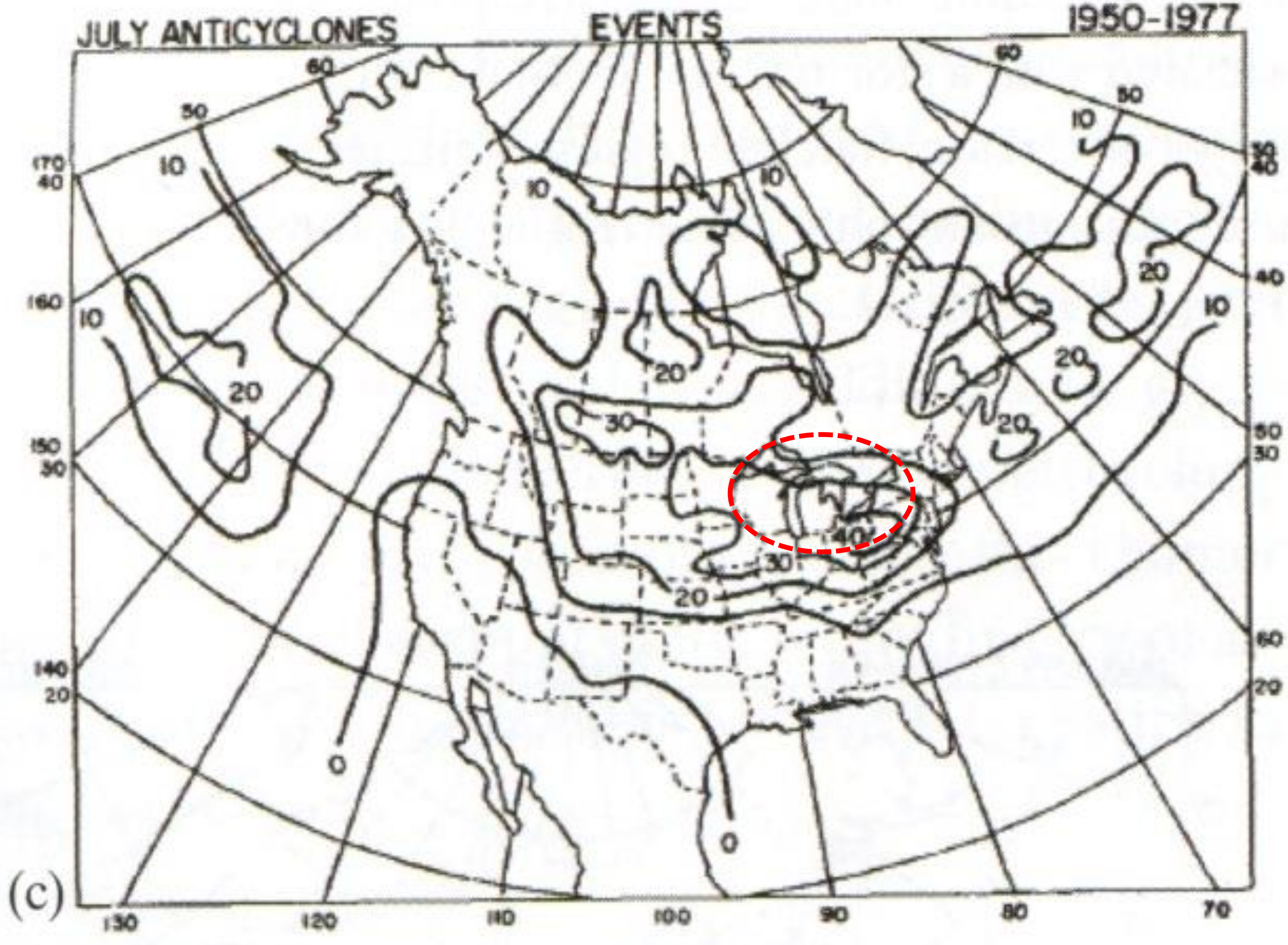




Relative minimum in anticyclone frequency over the Great Lakes (dashed circle) during winter (role of H term)



Relative maximum in anticyclone frequency over the Great Lakes (dashed circle) during summer (role of H term)



阻塞高壓 (Blocking High) (Adopted from Prof. Lee's materials)

中緯度中高對流層一般均吹西風，噴流於對流層頂下形成，天氣系統(氣旋、反氣旋)受此西風帶之影響，一般向東移動；低緯則不同。當西風強時，系統往東移動迅速，不易南移(北方之冷空氣將不易南侵)。一般常以緯流指標 (Zonal Index ，ZI)來表示緯流(西風)的強弱，$ZI = (\Phi_{35^\circ N} - \Phi_{55^\circ N})_{500mb}$，一般ZI＞0，ZI大時，緯流強，ZI小時，緯流弱。正常狀況下，ZI均不致太小，系統亦往東移，如圖5-15所示為地面鋒面十天的位置合成圖。

(註：緯流指沿緯度圈之氣流或東西向。經流指沿經度圈之氣流或南北向)。

在特殊狀況下，會形成封閉高壓，形狀為Ω型，稱為〝阻塞高壓〞。此時ZI變得很小，東西向風速很小，此阻塞高壓近似滯留，其伴隨之系統(如割離低壓等)，亦會近似滯留。其影響所及的上下游地區，系統之移動亦成遲滯，而此時其他系統之移動亦將避開此區，而於其南或北通過，但速度不致太快。如圖5-16為阻塞形成後，鋒面之10天位置合成圖。阻塞高壓形成後，一般可維持7～10天左右。

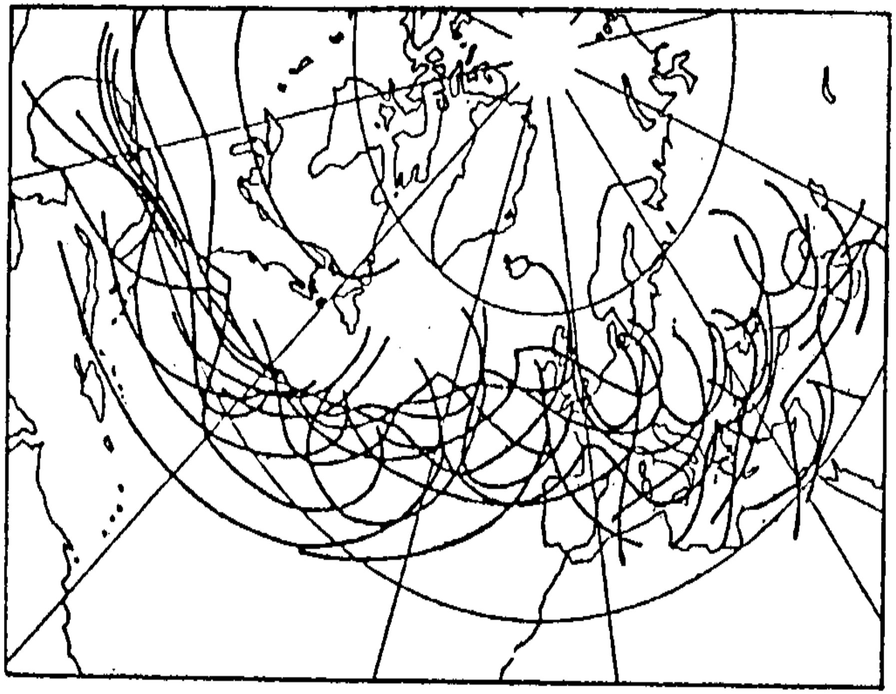


圖5-15

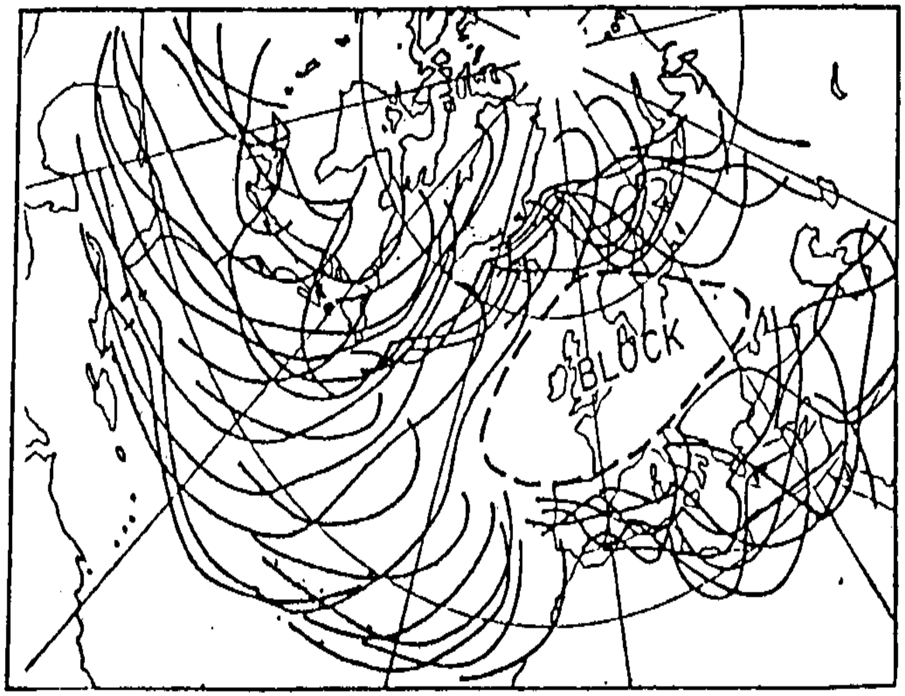
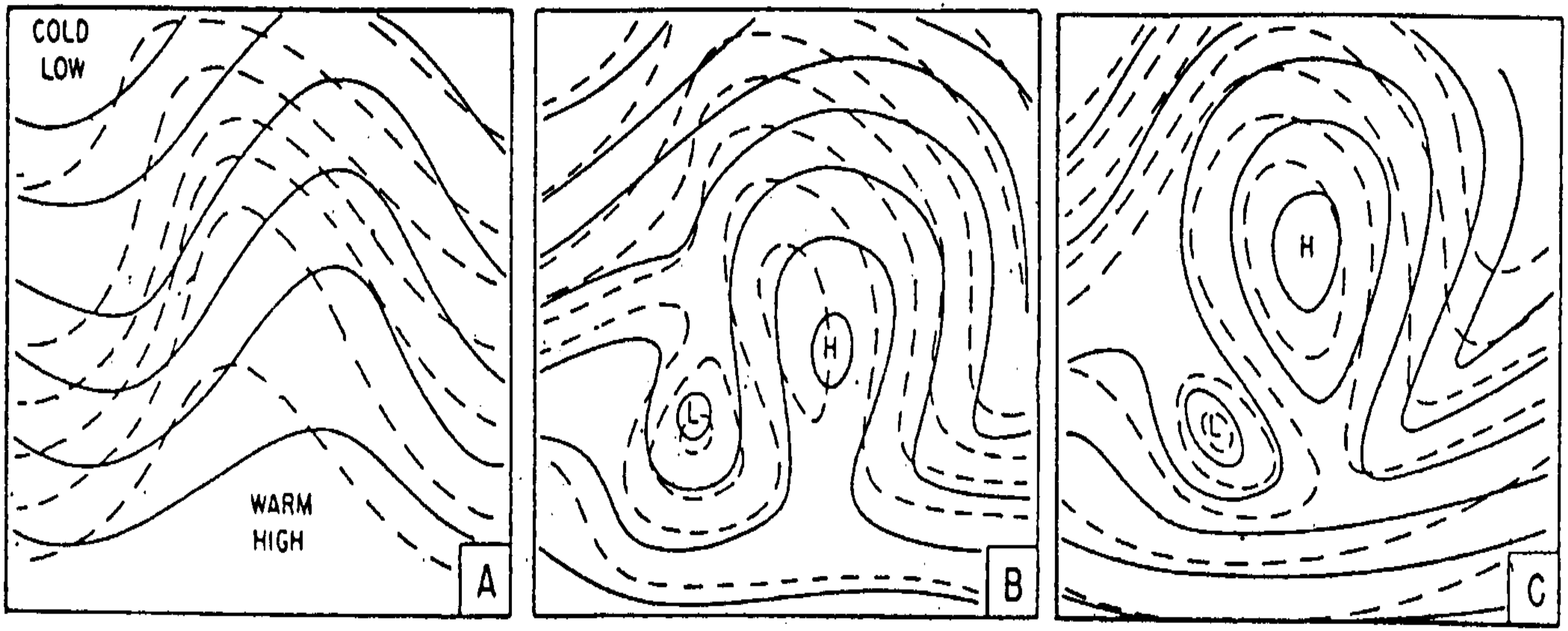


圖5-16

阻塞高壓之特徵與形成過程

阻塞高壓之基本特徵為 (1)滯留高壓，其出現時間至少六天以上，(2)具暖對流層與冷平流層。阻塞高壓發生的季節以春季最多，夏季最少，故阻塞高壓之形成似與波動或中緯度斜壓系統之活躍性有密切相關。其次，阻塞高壓發生的位置以歐洲西岸和北美西岸為最多，分別稱為大西洋和太平洋阻塞，且在大西洋發生者較太平洋為多，因此推測阻塞高壓之形成與海陸分佈亦有密切關聯。此外，若考慮不同之定義時，歐亞大陸和北美大陸亦可出現阻塞高壓脊，而其成因似與廣大的山脈地形（如烏拉山或青藏高原）有關（數值模擬中如除去地形，阻塞即消失） 。

圖5-17



阻塞高壓形成時必伴隨有極強的暖平流，如圖5-17所示（註：500～1000hPa暖平流亦有可能造成地面低壓，但因高層為冷平流，故地面仍為高壓），圖中實線代表500hPa 等高線，虛線則代表500hPa等溫線。在地面天氣圖上可看到一系列的氣旋族往東移近阻塞高壓形成的地方(參見Petterssen Fig 12.8.7)，其前方有強烈的暖平流，為阻塞高壓暖空氣之來源(見圖5-18)。