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

1.2 Cyclogenesis from the vorticity and pressure view

There are several different, yet consistent, ways that can interpret the physical mechanisms of cyclogenesis.

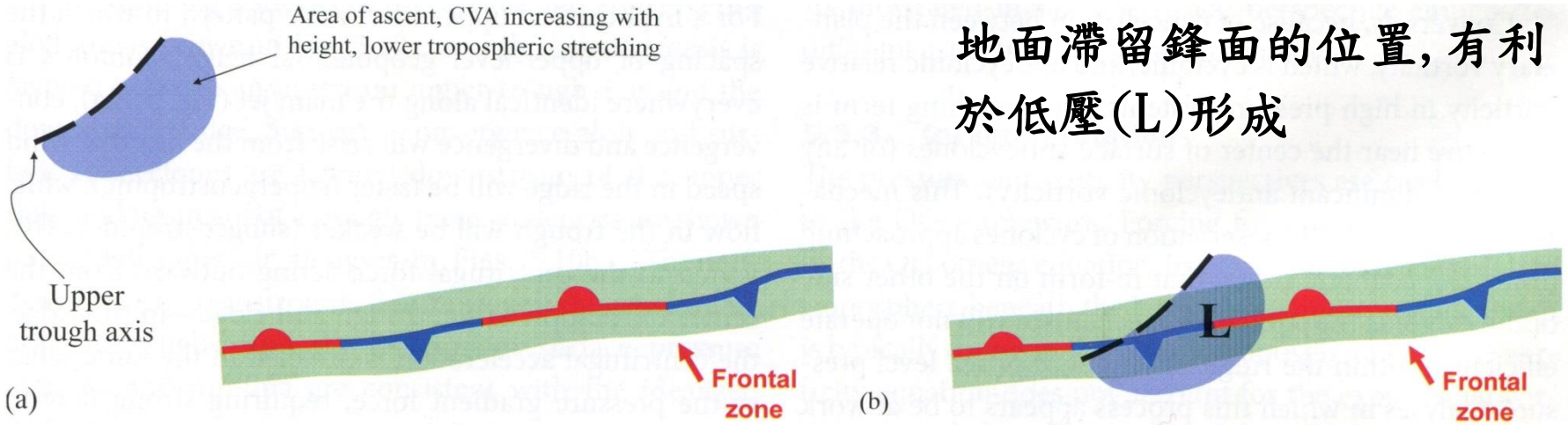
Weather disturbances of many types like extratropical cyclones are usually characterized by “cyclonic vorticity maxima” at the surface. **Vorticity framework** can provide a straightforward means of understanding the process of cyclogenesis.

Vorticity equation will be introduced in the class.

Schematic illustrating a cyclone form as the upper-trough axis approaches the surface stationary frontal zone

初始時間：高層槽尚未到達地面滯留鋒面的位置

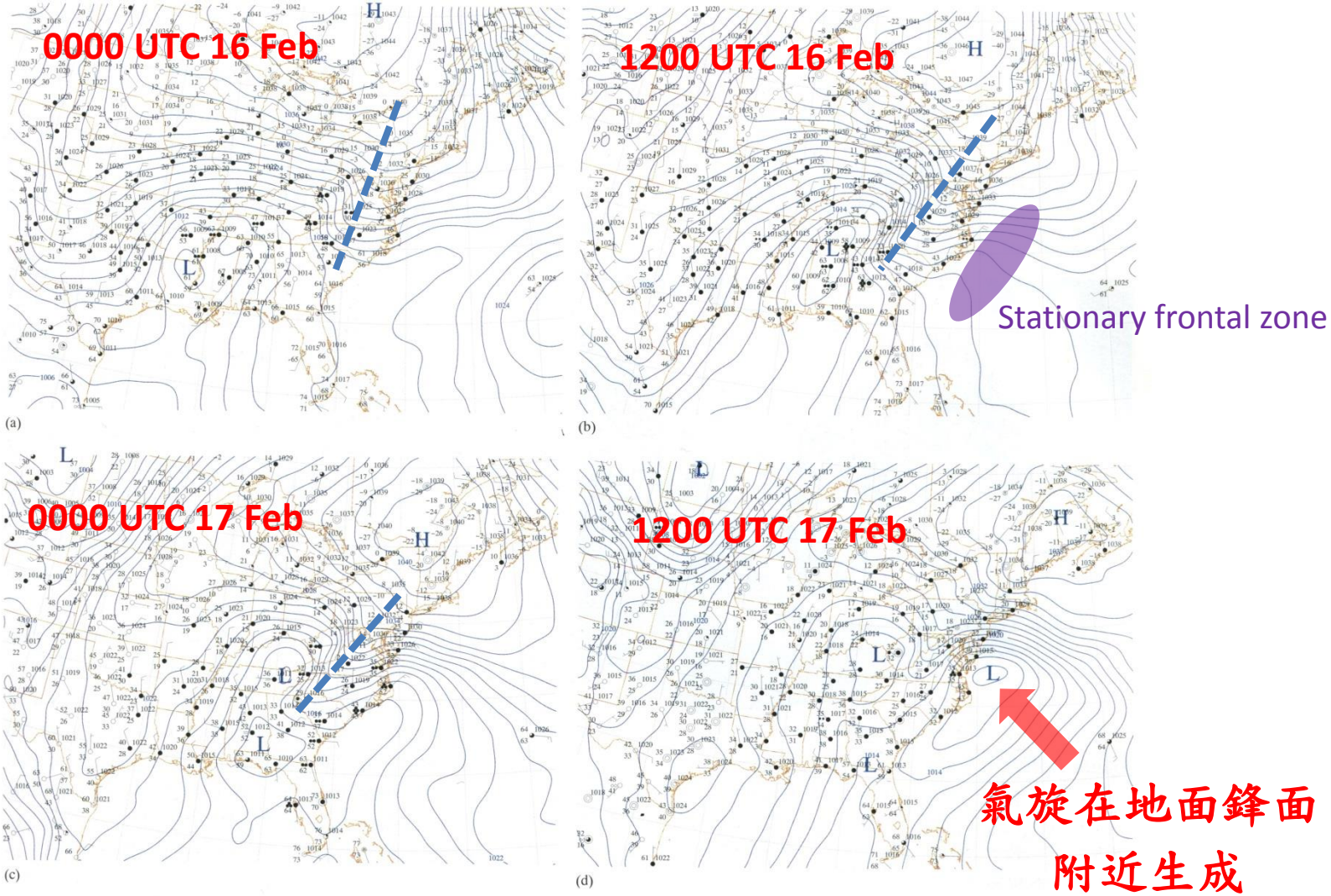
稍後時間：高層槽已到達地面滯留鋒面的位置，有利於低壓(L)形成



Idealized schematic of an upper trough (dashed black line denotes trough axis) and associated area of QG forcing for ascent (blue shading) overtaking a preexisting stationary front, associated with a band of enhanced cyclonic relative vorticity (green shading): (a) initial time and (b) later time with an upper trough overtaking surface front, and formation of surface low pressure center (L).

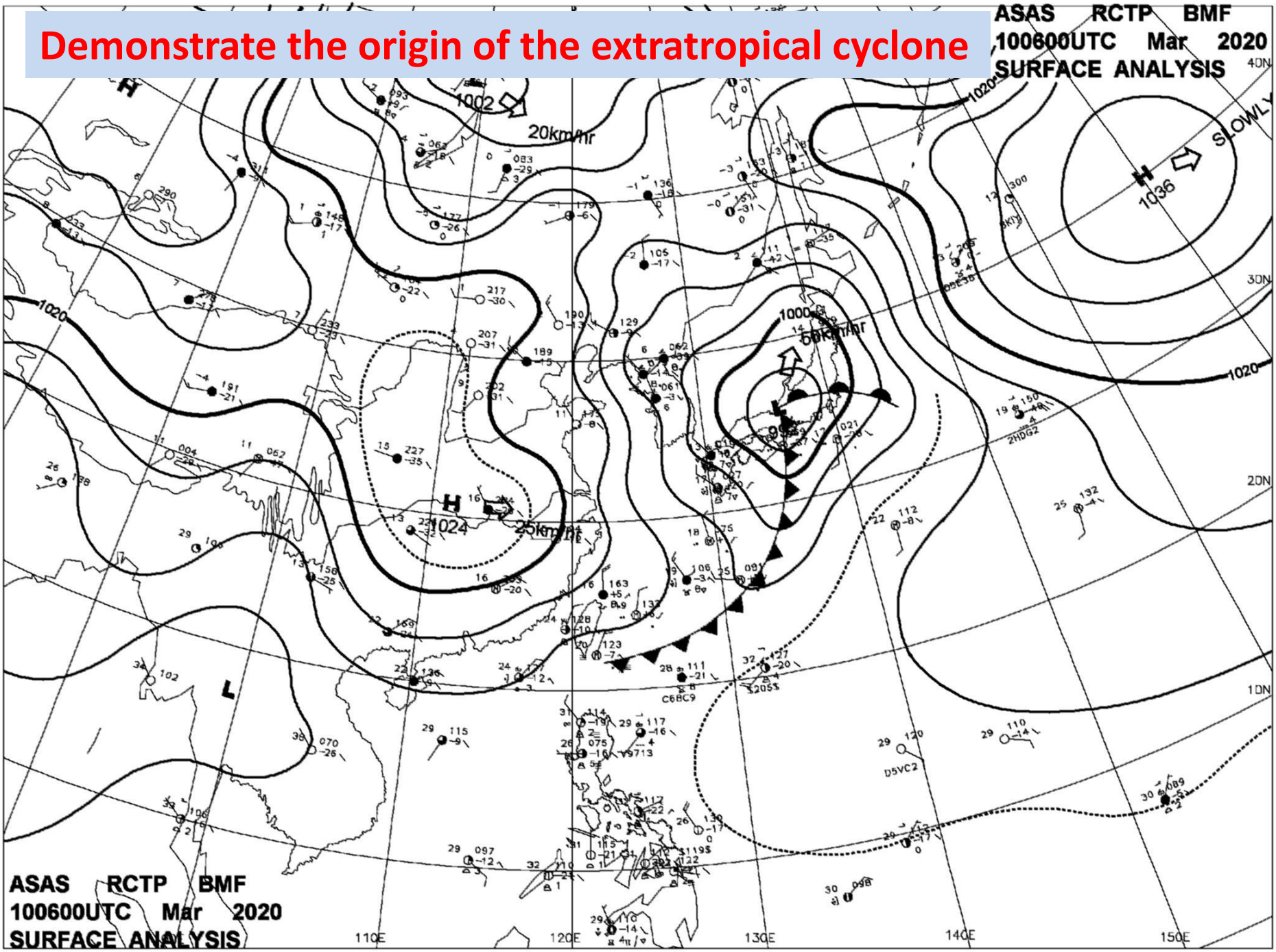
A sequence of surface analyses showing the rapid spinup of a separate cyclone over the region of preexisting vorticity (along the east coast of US)

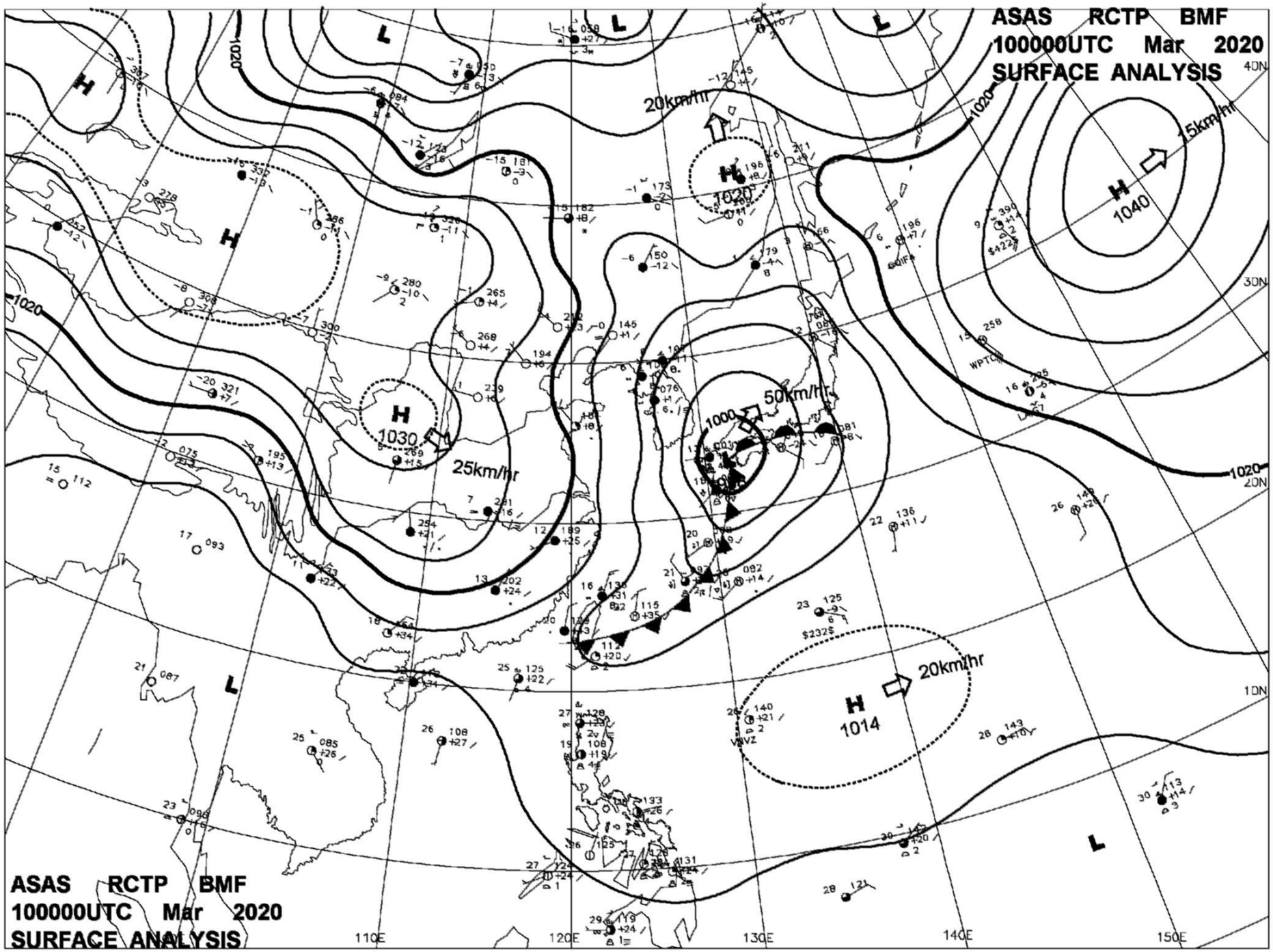
Dashed lines denote ridge induced by cold air damming along the Appalachian Mountains



Surface observations and sea-level pressure analysis (blue contours, interval is 2 hPa) from the North American Mesoscale (NAM) model at (a) 0000 and (b) 1200 UTC 16 Feb and (c) 0000 and (d) 1200 UTC 17 Feb 2003. Dashed lines in (c) correspond to trough axes.

Demonstrate the origin of the extratropical cyclone





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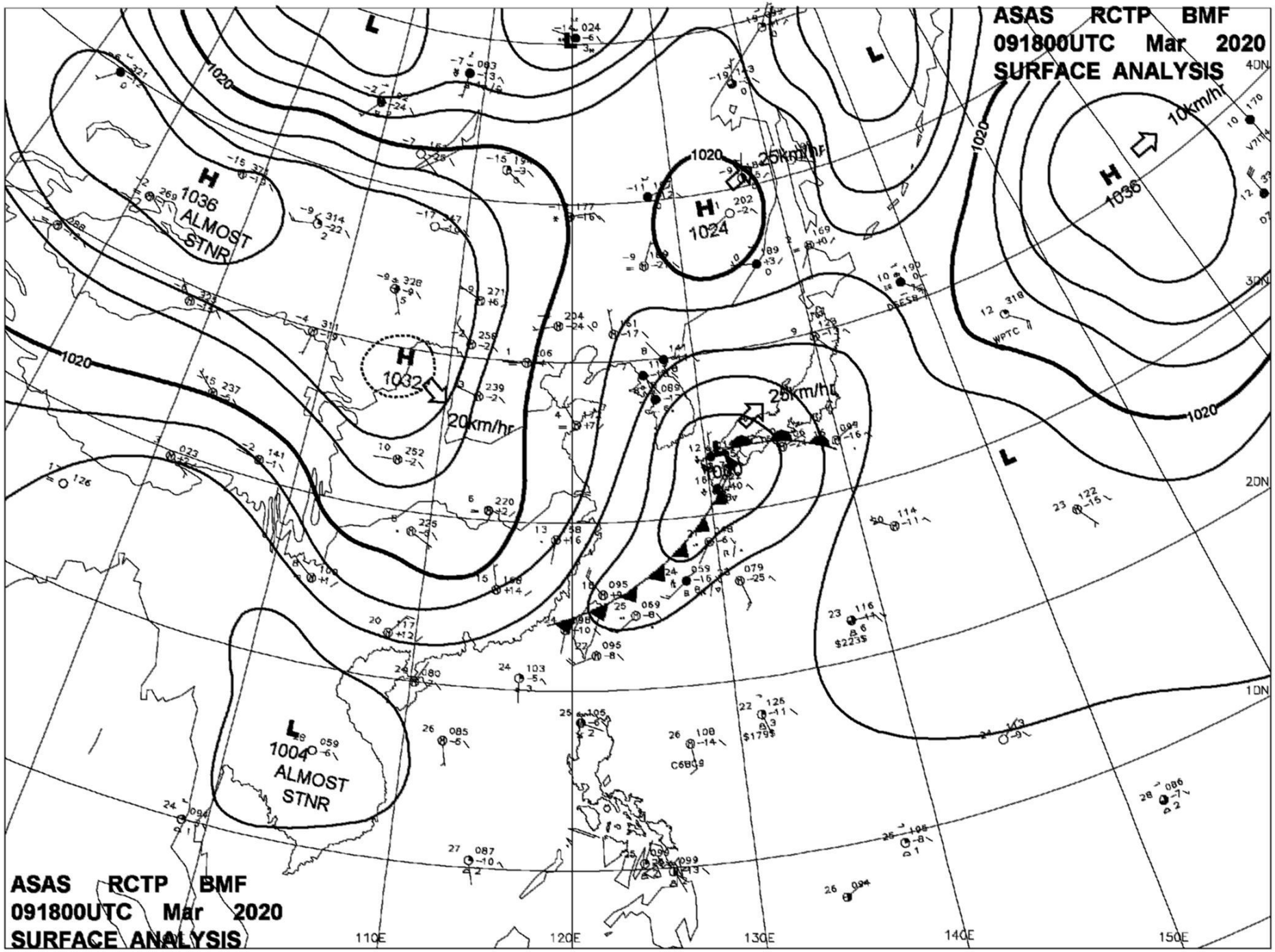
100000UTC Mar 2020
SURFACE ANALYSIS



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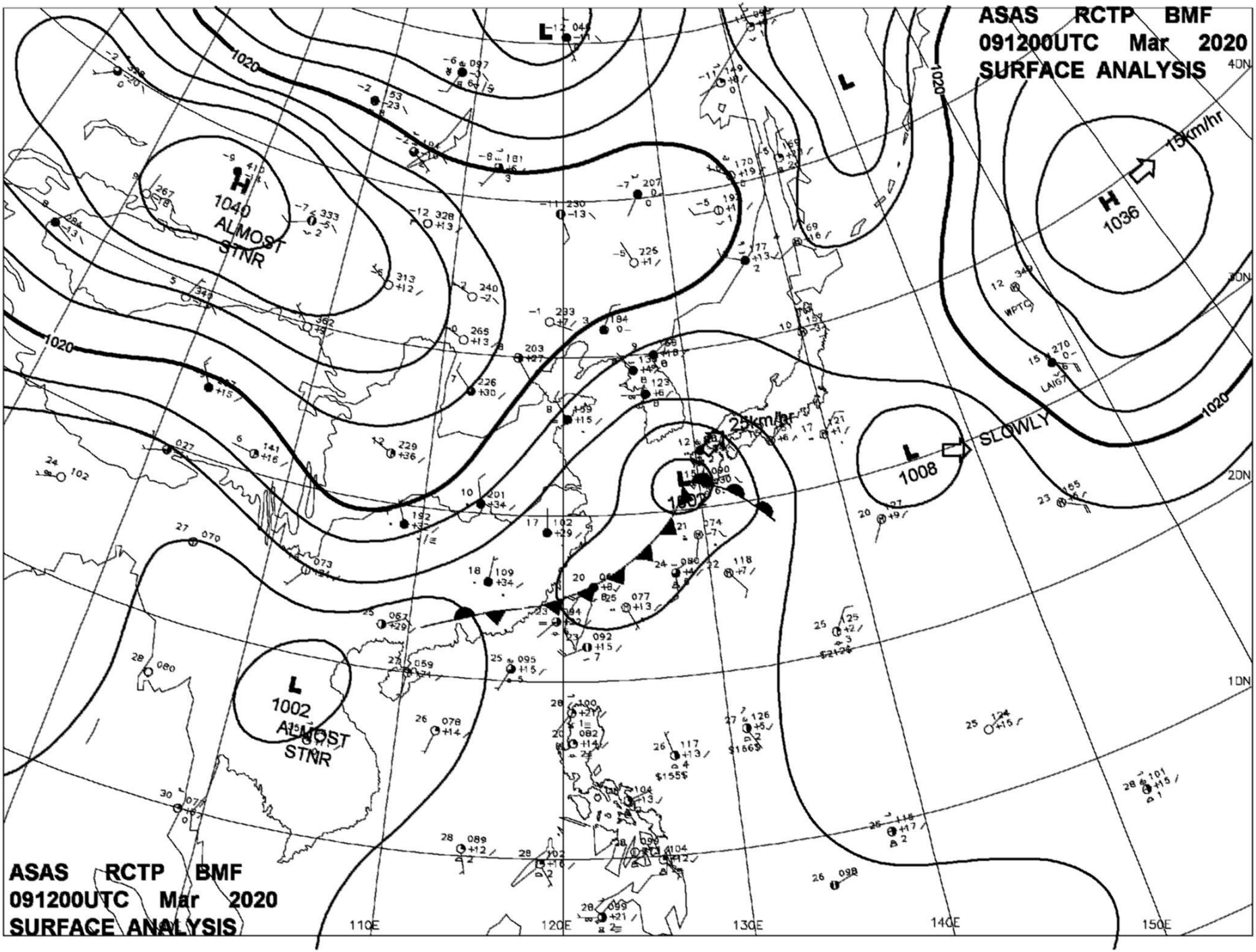

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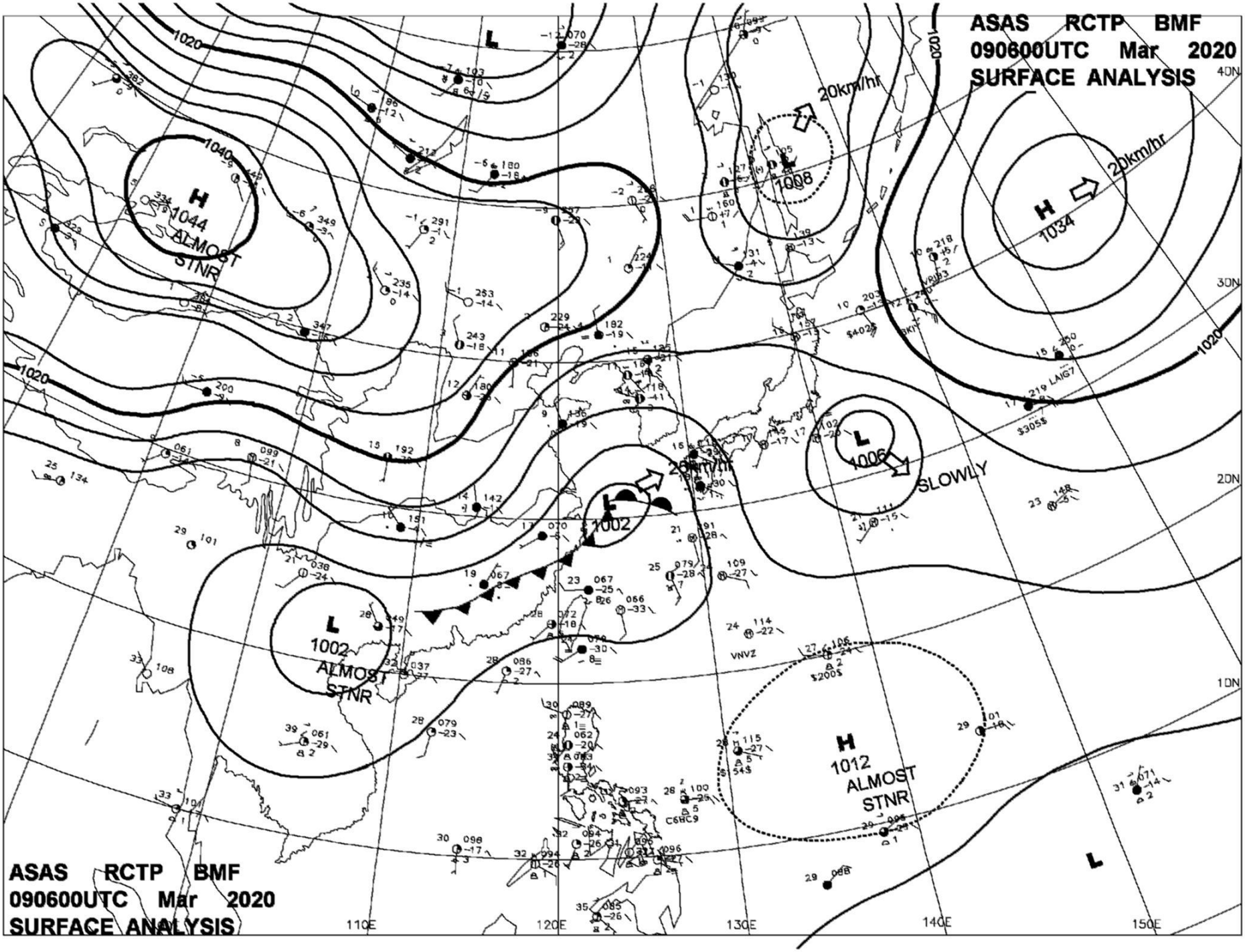
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SURFACE ANALYSIS
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SLOWLY
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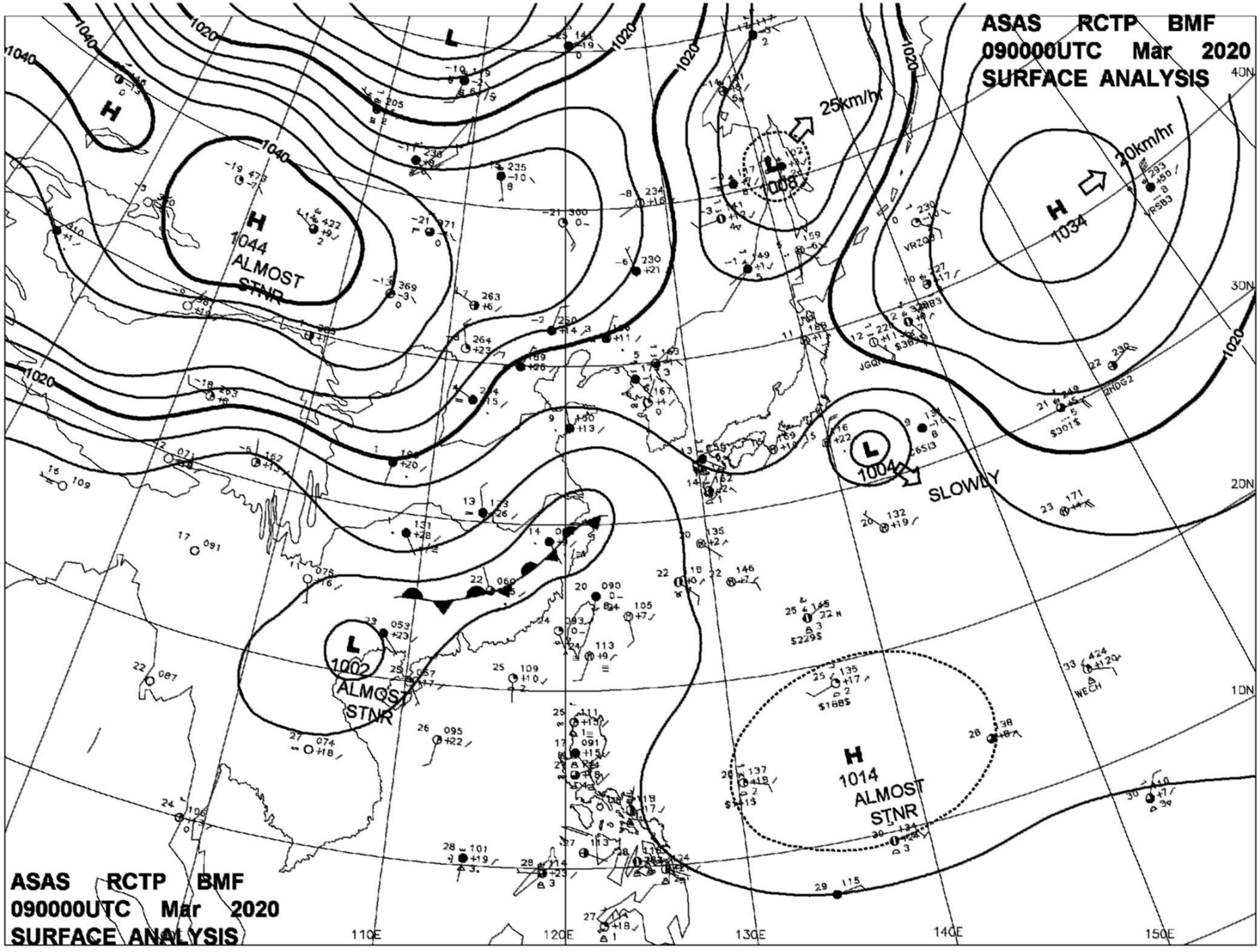
SURFACE ANALYSIS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SURFACE ANALYSIS
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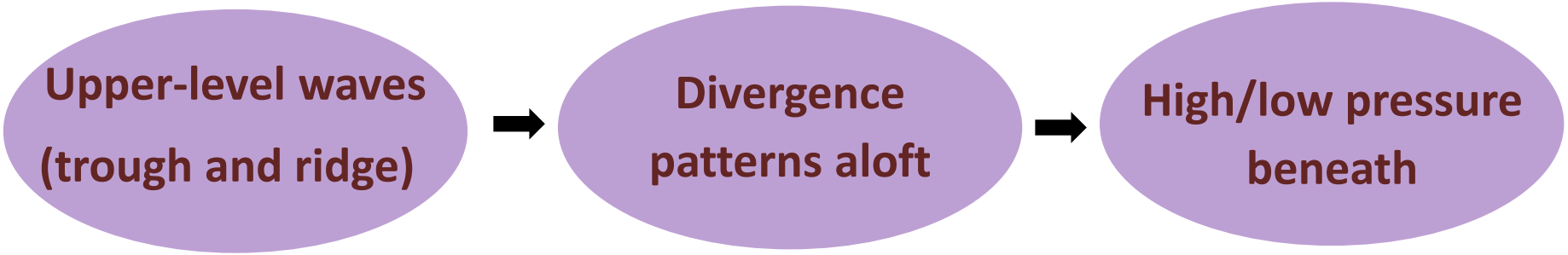
SURFACE ANALYSIS

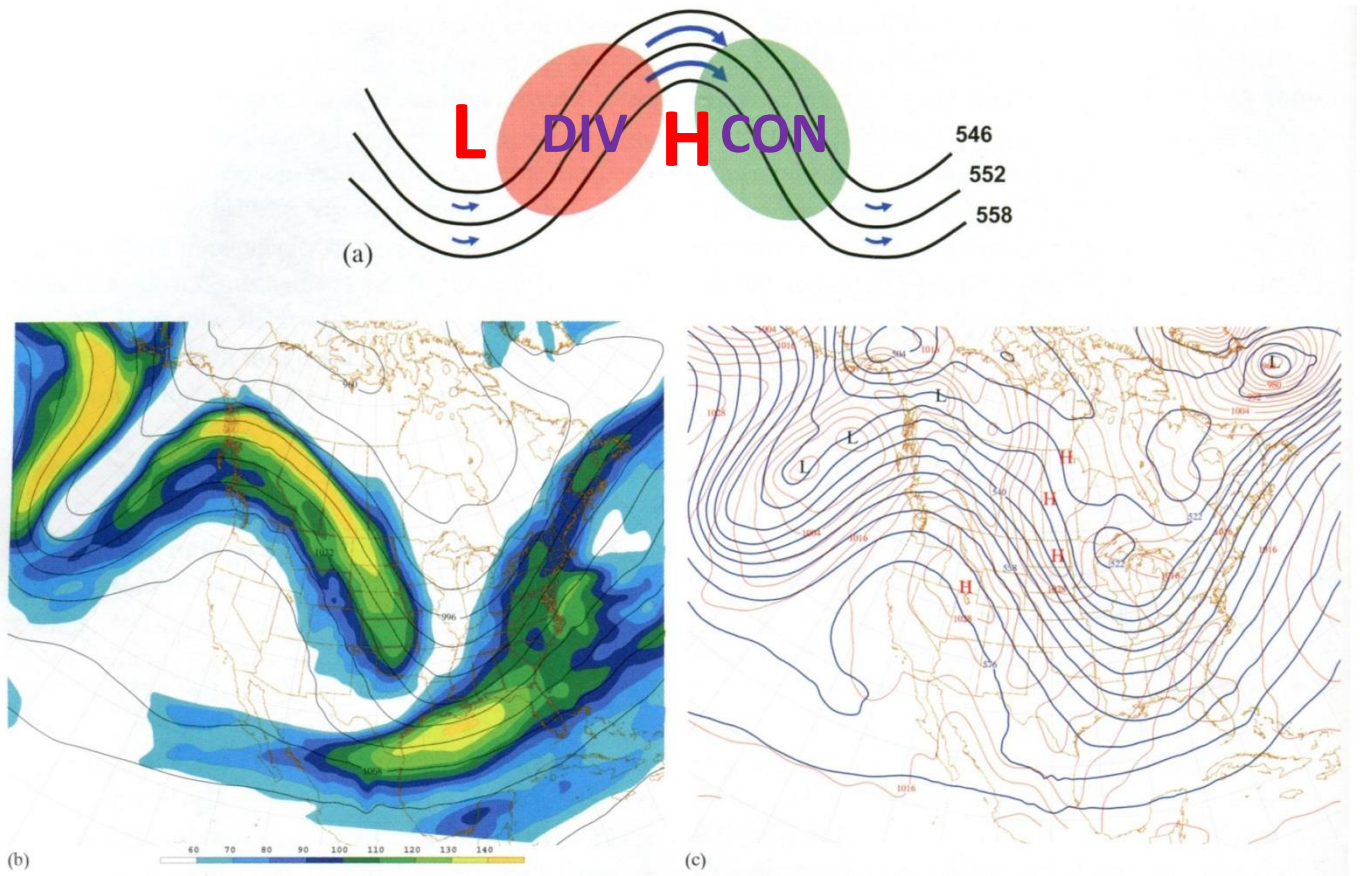
Pressure view: Atmospheric pressure is nearly equal to the weight of the overlying air column. For the surface pressure to fall at the center of a developing cyclone, there must be net mass divergence in the overlying air column.

Because frictional inflow within PBL in the vicinity of lower pressure results in mass convergence, mechanisms associated with divergence aloft should be focused.



Schematic showing divergence patterns associated with a upper-level trough/ridge and a realistic case illustrating a close relationship of surface cyclones and anticyclones with 250-mb wave patterns

250-mb 等高線與等風速線(陰影)

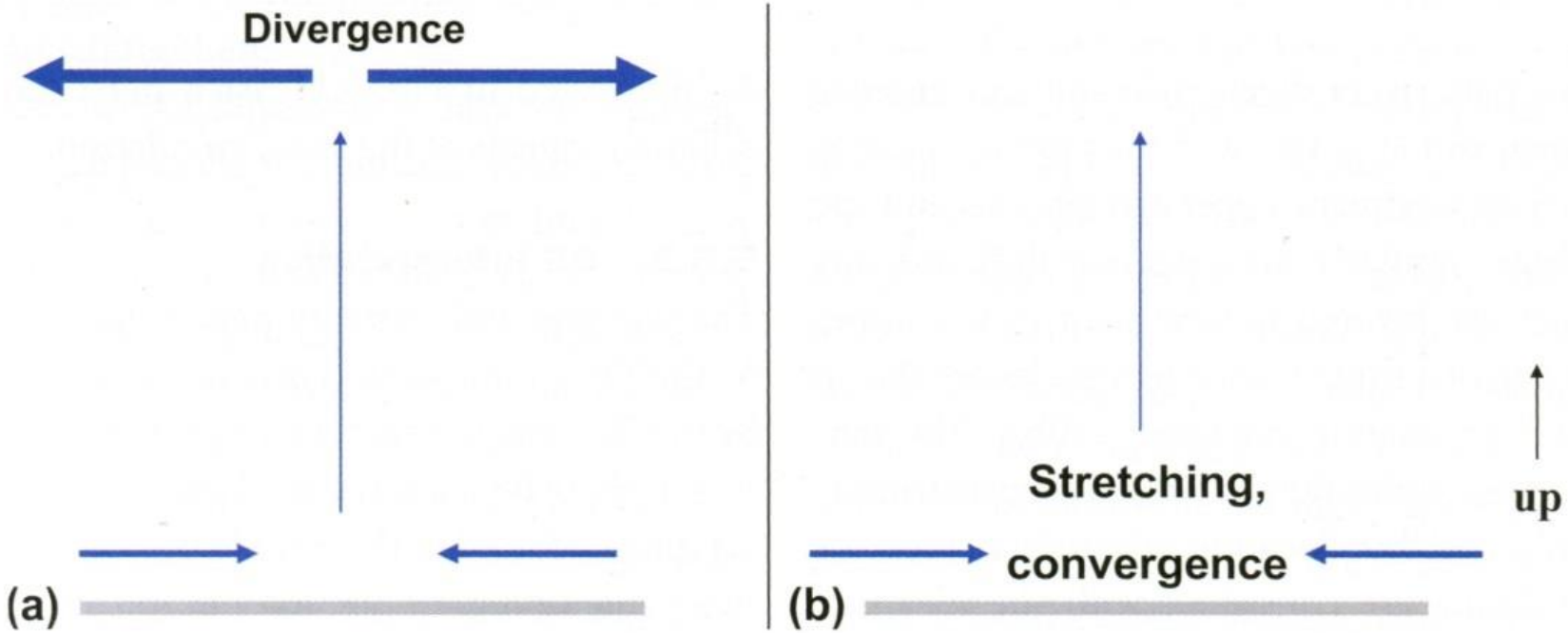


海平面氣壓與250-mb等風速線

(a) Idealized upper-wave pattern with arrows indicating weaker flow in troughs and stronger flow in ridges as expected from gradient wind balance; region of pink (green) shading corresponds to a zone of upper-level divergence (convergence); (b) 250-mb height (contours, interval is 12 dam) and isotachs (kt, shaded as in legend) for 0000 UTC 3 Feb 2009; (c) as in (b) but with sea level pressure replacing 250-mb isotachs. The symbols H and L indicate the location of surface high and low pressure systems, respectively.

Schematic showing the pressure and vorticity view of cyclogenesis and their different emphasis

pressure view **vorticity view**

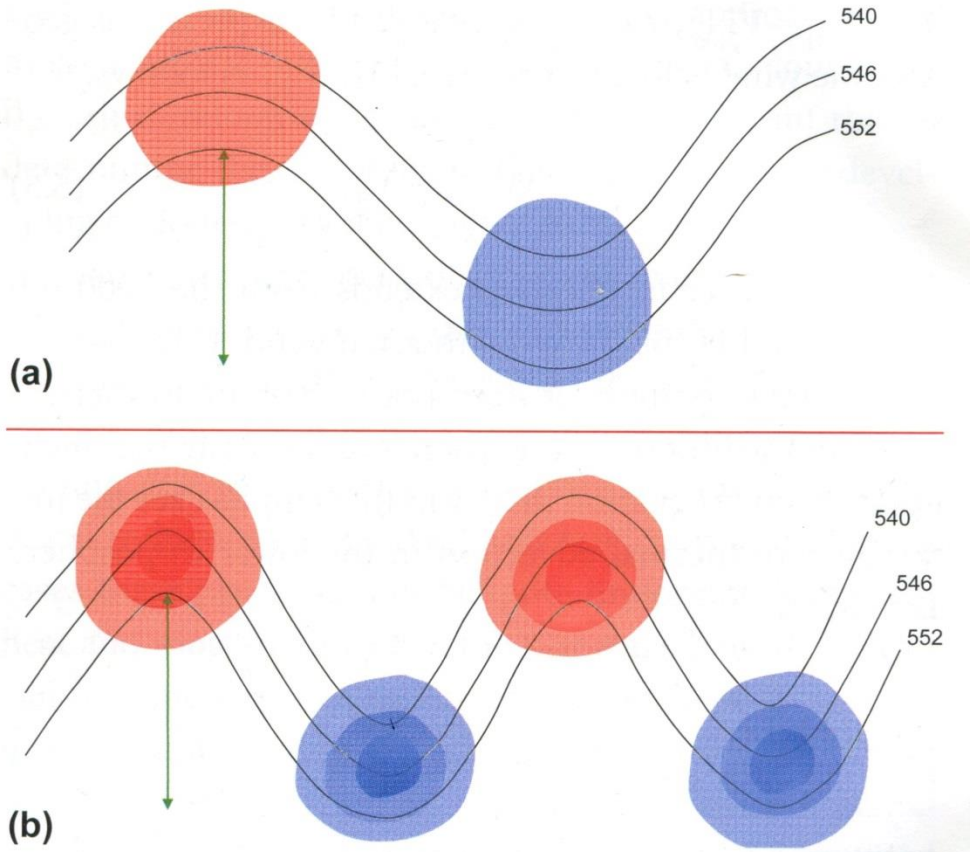


Cross-sectional comparison of pressure and vorticity views of cyclogenesis: (a) divergence aloft exceeds near-surface convergence for a developing surface low pressure system, and (b) vortex stretching and near-surface convergence result in an increase of cyclonic vorticity in the lower troposphere.

Two upper-wave patterns of equal amplitude with different degree of QG forcing [i.e., stronger vorticity advection in (b)]

長波

短波



Idealized upper-wave patterns of equal amplitude (defined as the latitudinal displacement of geopotential height contours). Black solid lines represent geopotential height contours. Shading depicts idealized cyclonic (blue) and anticyclonic (red) relative vorticity centers. (a) Wave pattern one; (b) wave pattern two with shorter wavelength.