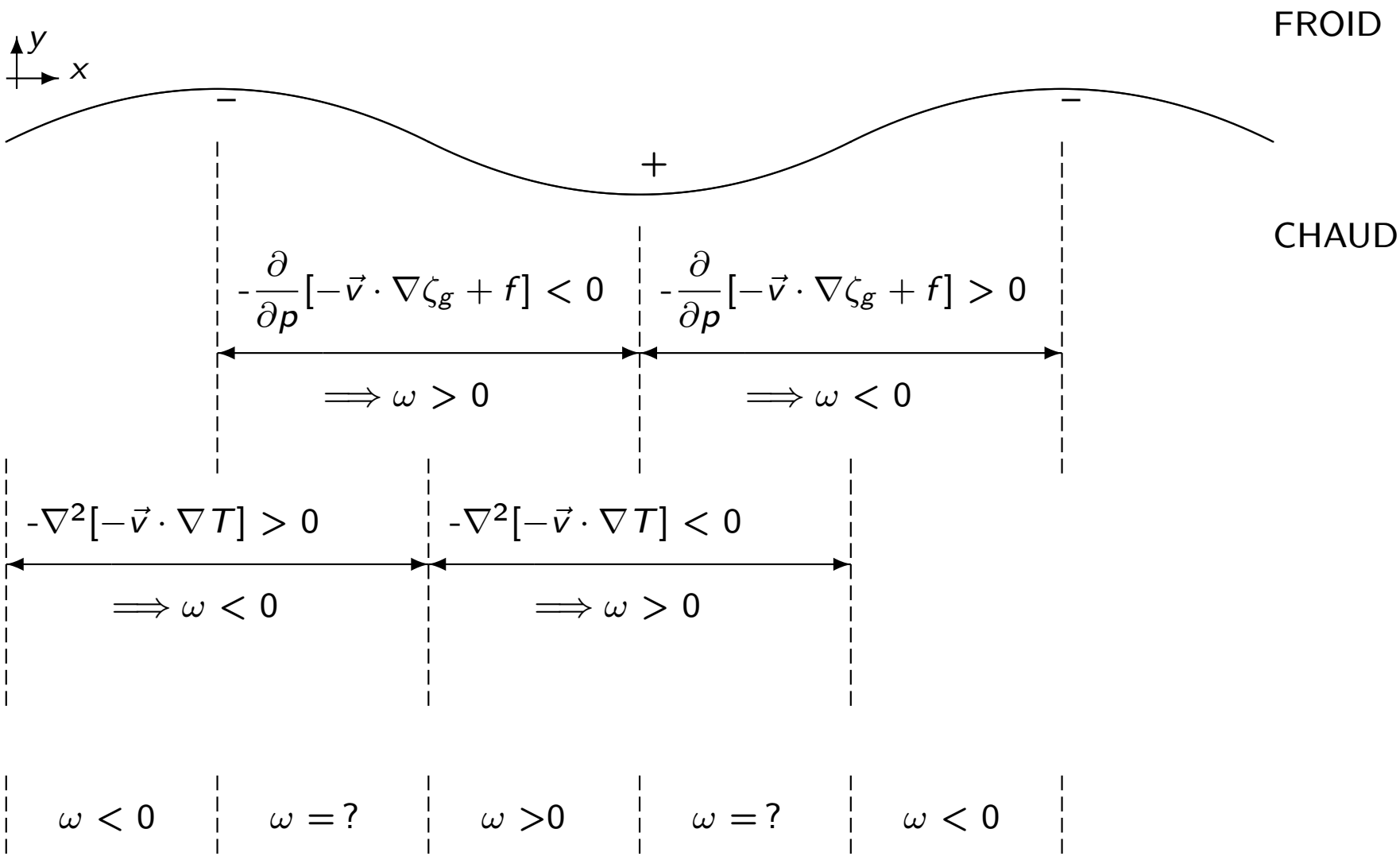
SCA 7043 - Météorologie synoptique

Quasi-Géostrophisme : Vecteur Q

Le Mardi 08 novembre 2016

UQÀM

Quel est le mouvement vertical de l'air à ces deux endroits ?



Vecteur $\overrightarrow{Q}$

En combinant l'équation QG de la quantité de mouvement et l'équation thermodynamique pour un écoulement sur un plan f_0 sans friction et adiabatique. On obtient

$$\left(\sigma\nabla^2 + f_0^2\frac{\partial^2}{\partial p^2}\right)\omega = -2\nabla\cdot Q \tag{1}$$

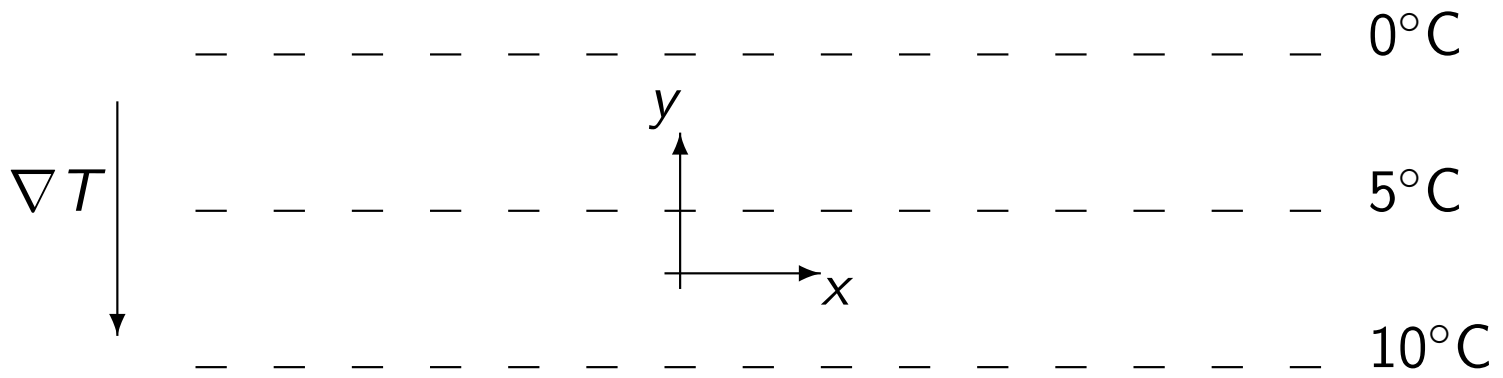
où

$$Q = (Q_1, Q_2) = -\frac{R}{p}\frac{\partial\vec{v}_g}{\partial x}\cdot\nabla T\ \hat{\imath} - \frac{R}{p}\frac{\partial\vec{v}_g}{\partial y}\cdot\nabla T\ \hat{\jmath} \tag{2}$$

$\nabla\cdot Q > 0 \Longrightarrow ()\omega < 0 \Longrightarrow \omega > 0$
$\nabla\cdot Q < 0 \Longrightarrow ()\omega > 0 \Longrightarrow \omega < 0$

Vecteur $\overrightarrow{Q}$

Cette expression est difficile à appliquer. Il est alors avantageux de la dériver en coordonnées naturelles. En supposant que l'axe x est parallèle aux isothermes, on peut dire que $\nabla T = \dfrac{\partial T}{\partial y}\hat{\jmath}$.

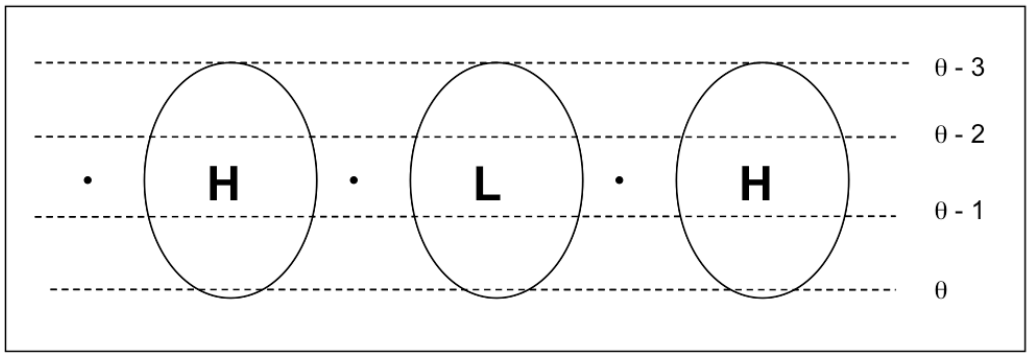


Donc,

$$Q = -\frac{R}{p}\left|\frac{\partial T}{\partial y}\right| \hat{k} \times \frac{\partial \vec{v}_g}{\partial x} \tag{3}$$

Vecteur $\overrightarrow{Q}$: Exemples

Q-Vectors with a pattern of midlatitude cyclones and anticyclones



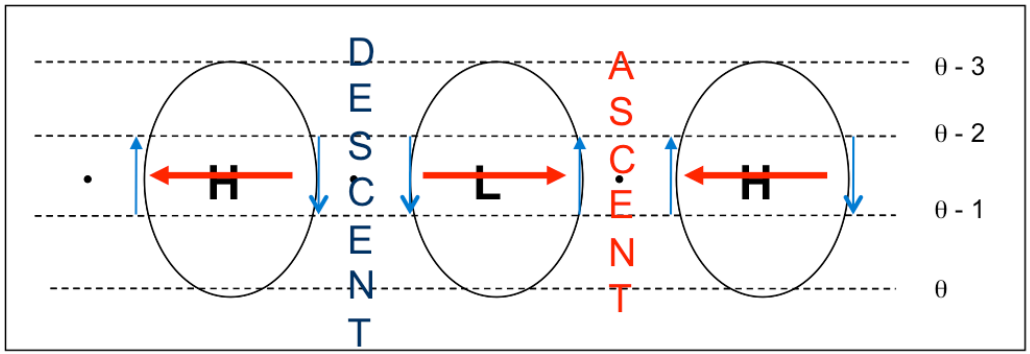
$$Q_1 = -\frac{\partial u_g}{\partial x}\frac{\partial \theta}{\partial x} - \frac{\partial v_g}{\partial x}\frac{\partial \theta}{\partial y}$$

$$Q_2 = -\frac{\partial u_g}{\partial y}\frac{\partial \theta}{\partial x} - \frac{\partial v_g}{\partial y}\frac{\partial \theta}{\partial y}$$

Following Sanders and Hoskins *(1990, Wea. Forecasting)*

Vecteur $\overrightarrow{Q}$: Exemples

Q-Vectors with a pattern of midlatitude cyclones and anticyclones



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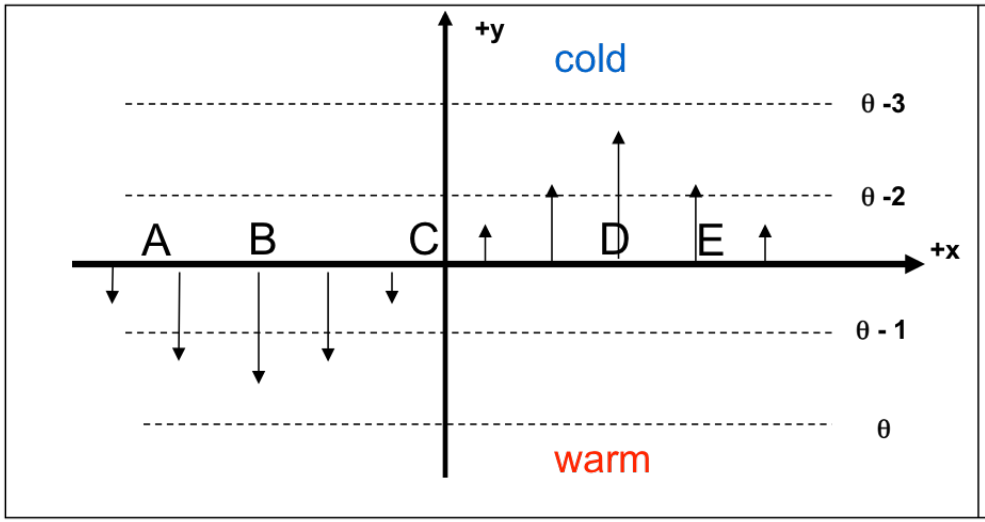
Vecteur $\overrightarrow{Q}$: Exemples (Lackmann, 2011)

↑ = geo wind

Q-Vector Example



$$Q_1 \propto -\frac{\partial u_g}{\partial x}\frac{\partial \theta}{\partial x} - \frac{\partial v_g}{\partial x}\frac{\partial \theta}{\partial y}$$

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Example:

- Let x-axis be parallel to isentropes, cold to north
- Assume meridional geostrophic wind *varies only in x*, as indicated
- Determine Q at each of the points shown

Vecteur $\overrightarrow{Q}$: Exemples (Lackmann, 2011)

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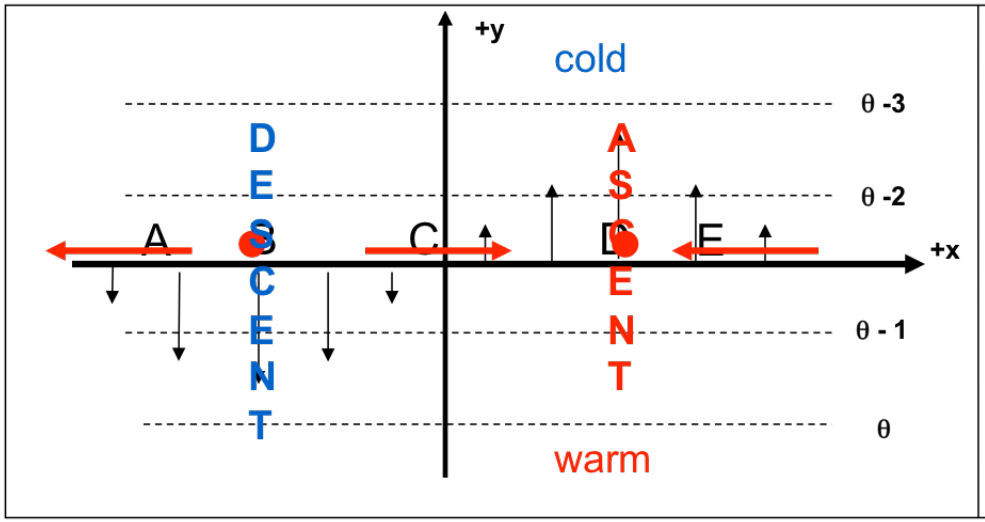
Q-Vector Example



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Example:

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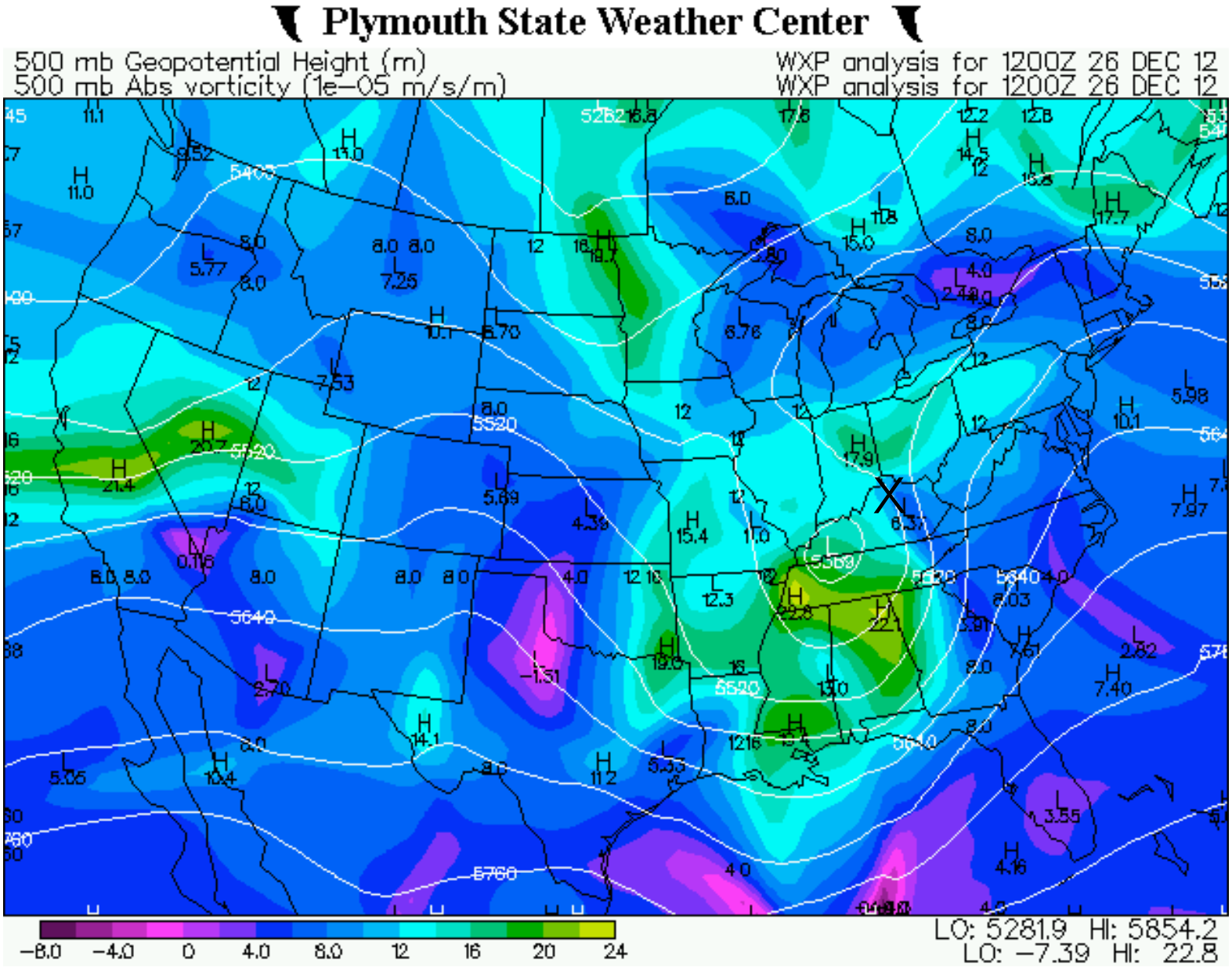
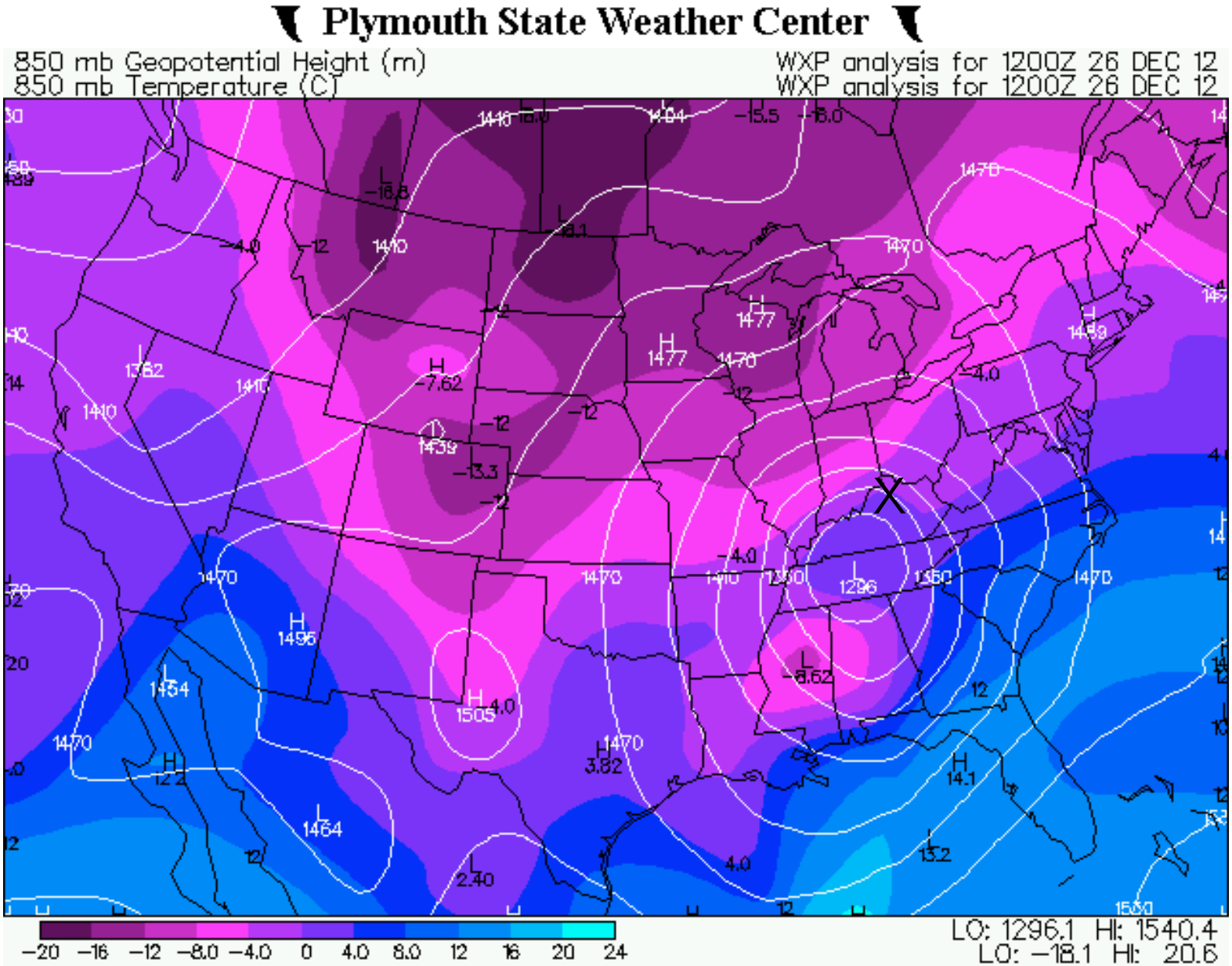
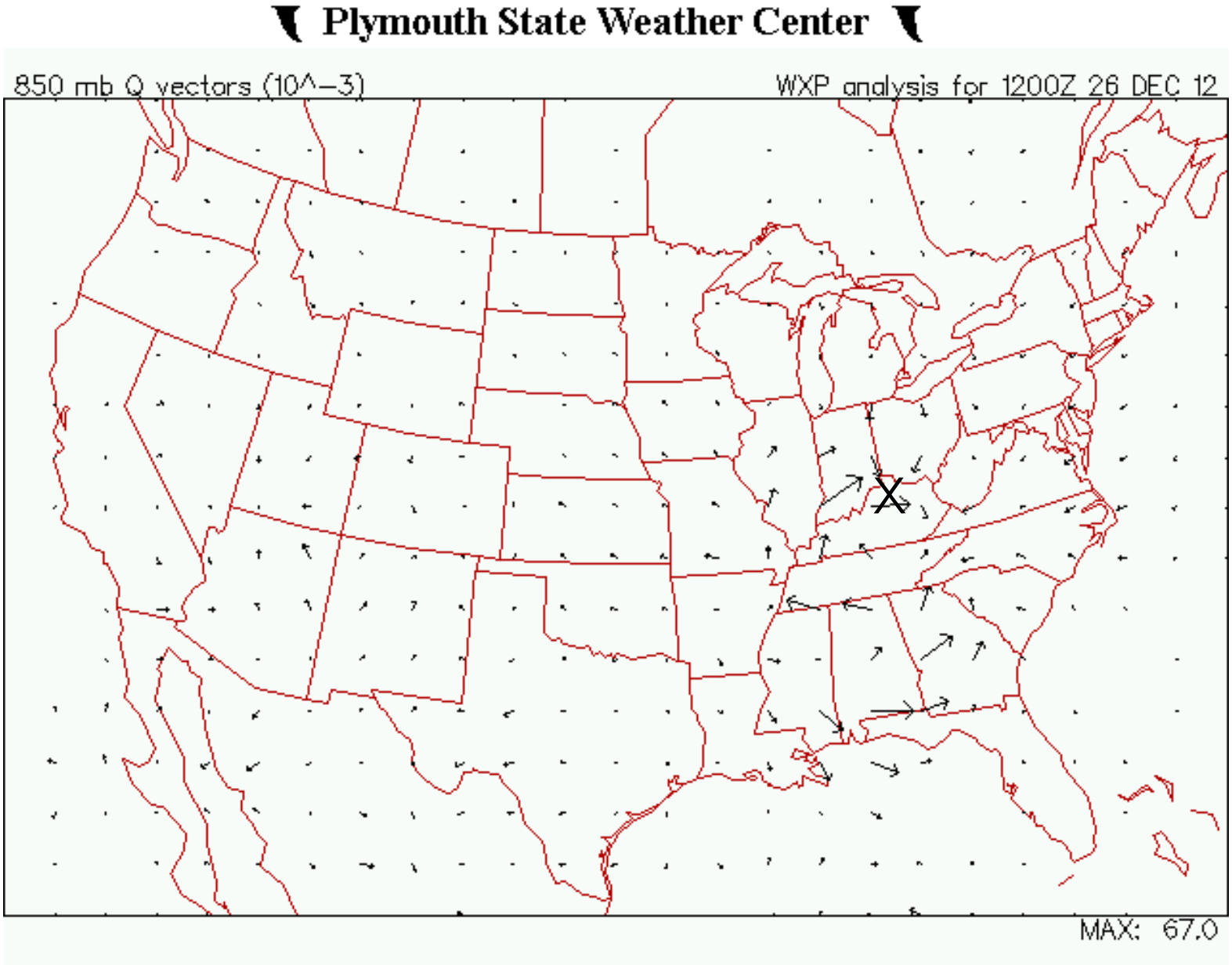
Déterminer le sens du mouvement vertical de l'air au point X

500 hPa : 1200 UTC 26 dec 2012

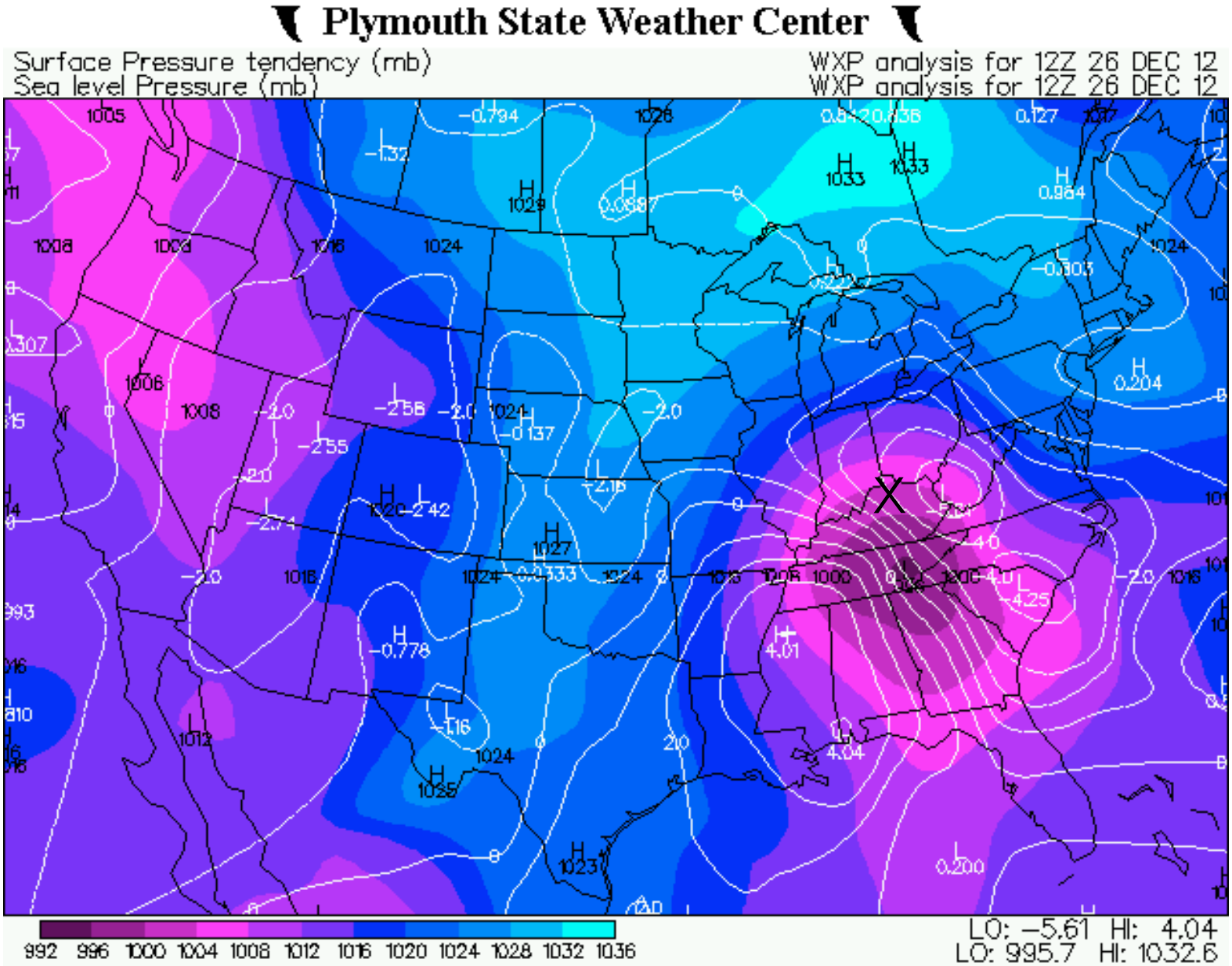



Plymouth State Weather Center
850 mb Geopotential Height (m)
850 mb Temperature (C)
WXP analysis for 1200Z 26 DEC 12
WXP analysis for 1200Z 26 DEC 12
−20 −16 −12 −8.0 −4.0 0 4.0 8.0 12 16 20 24
LO: 1296.1 HI: 1540.4
LO: −18.1 HI: 20.6

Réponse

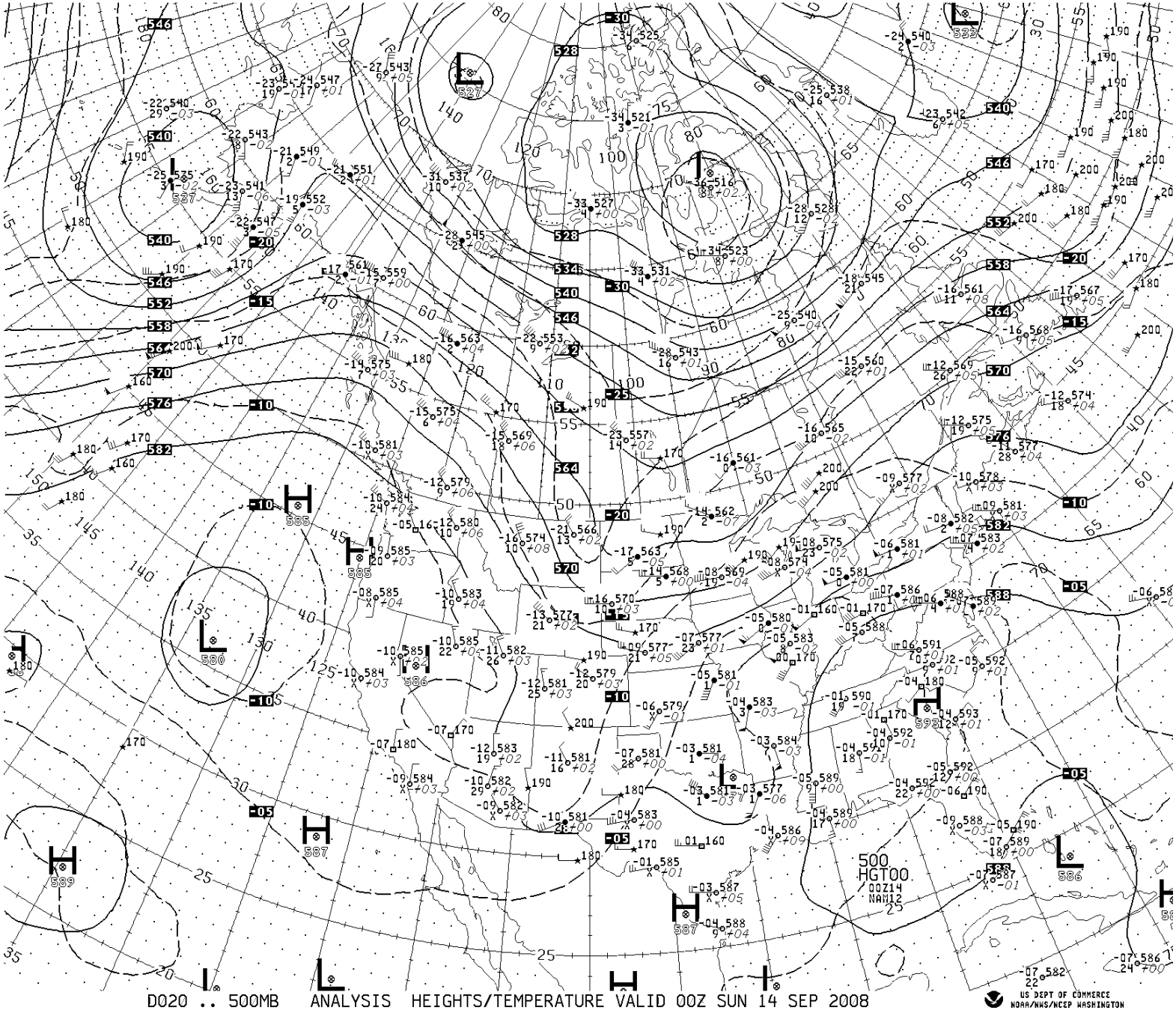

Plymouth State Weather Center
850 mb Q vectors (10^-3)
WXP analysis for 1200Z 26 DEC 12
MAX: 67.0

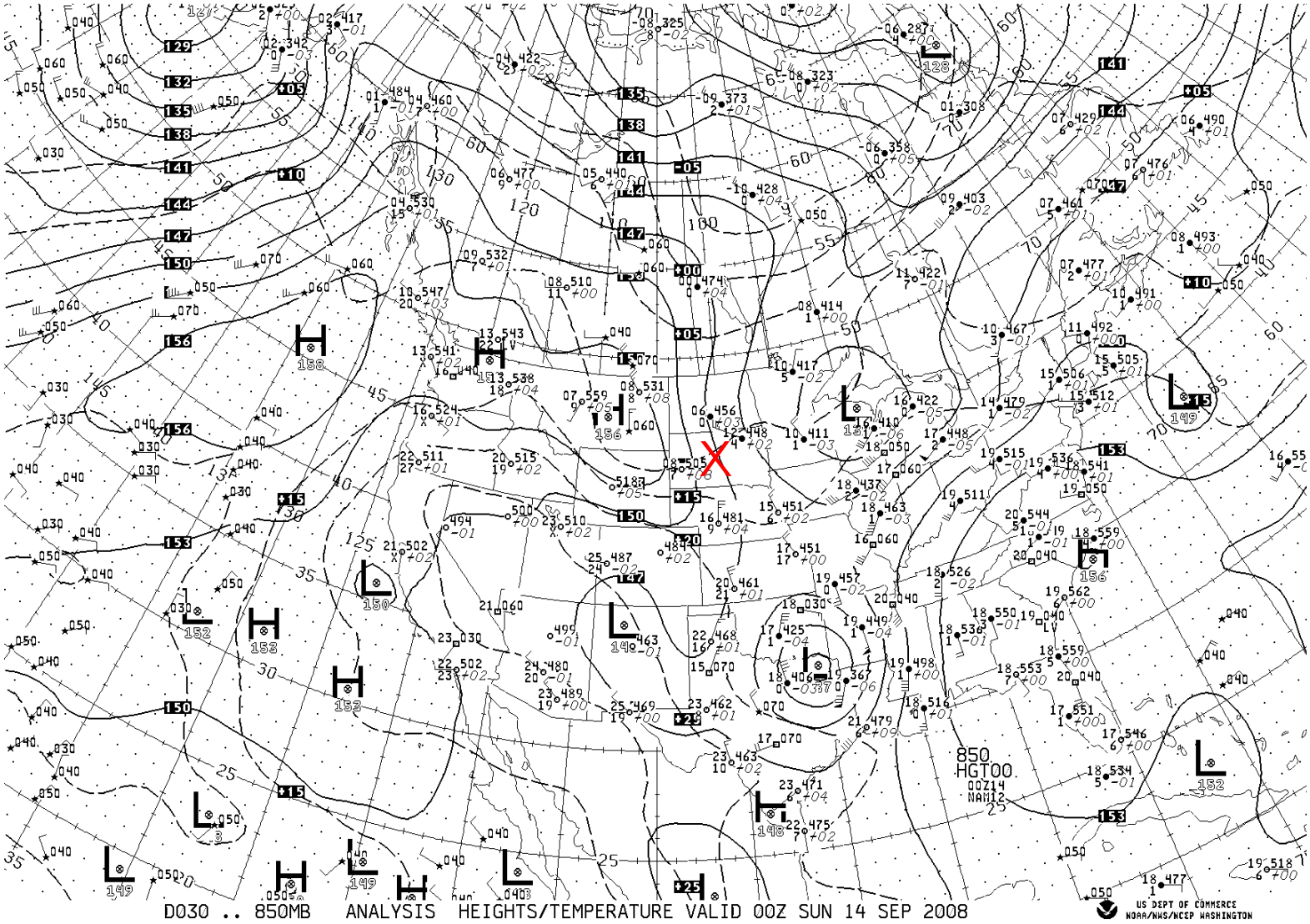
Niveau de la mer : 1200 UTC 26 dec 2012



Exercice

Déterminer le sens du mouvement vertical de l'air au point X :


500
HGT00.
00Z14
NAM12
D020 .. 500MB ANALYSIS HEIGHTS/TEMPERATURE VALID 00Z SUN 14 SEP 2008
US DEPT OF COMMERCE
NOAA/NWS/NCEP WASHINGTON


850
HGT00
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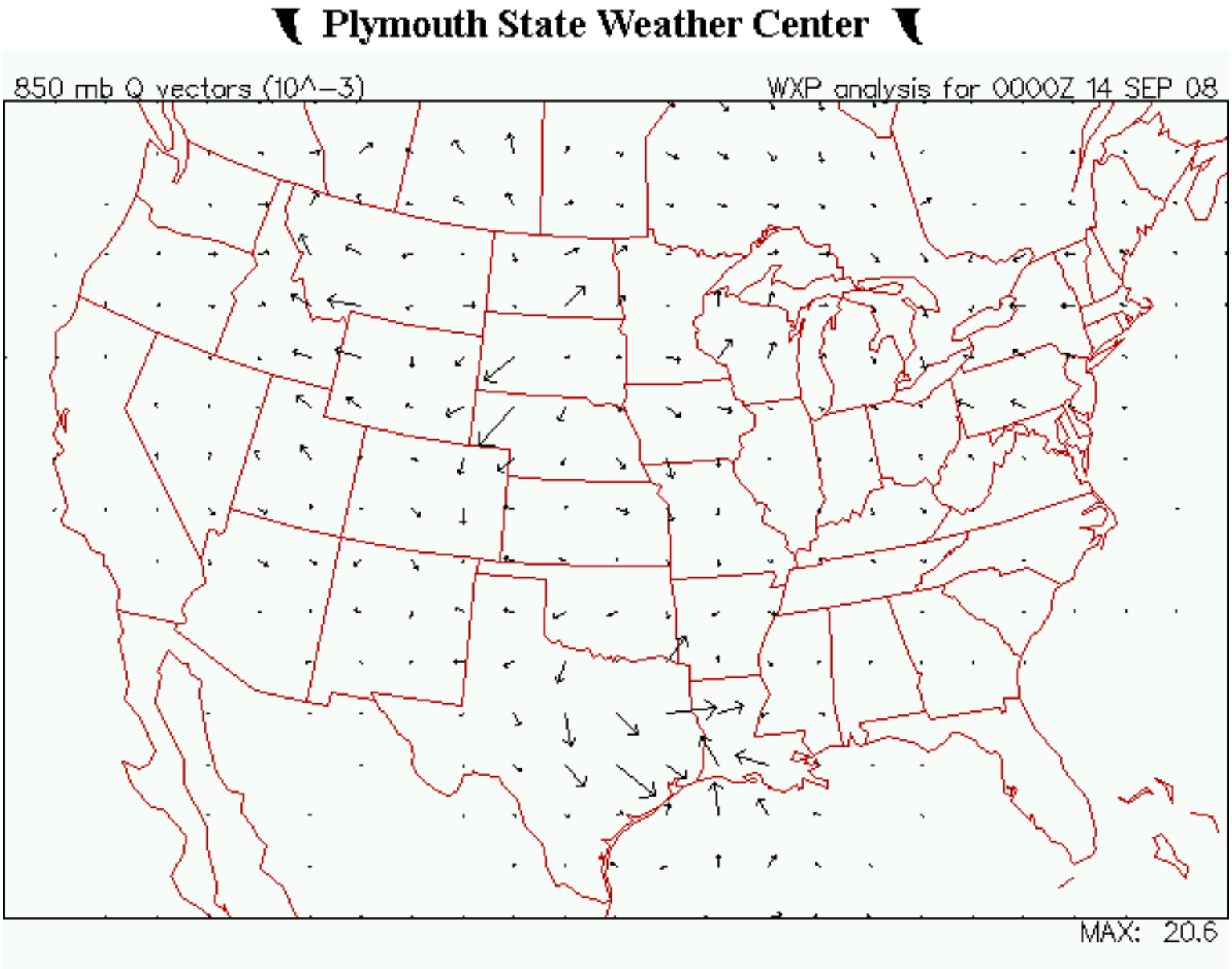
Réponse


Plymouth State Weather Center
850 mb Q vectors (10^-3)
WXP analysis for 0000Z 14 SEP 08
MAX: 20.6