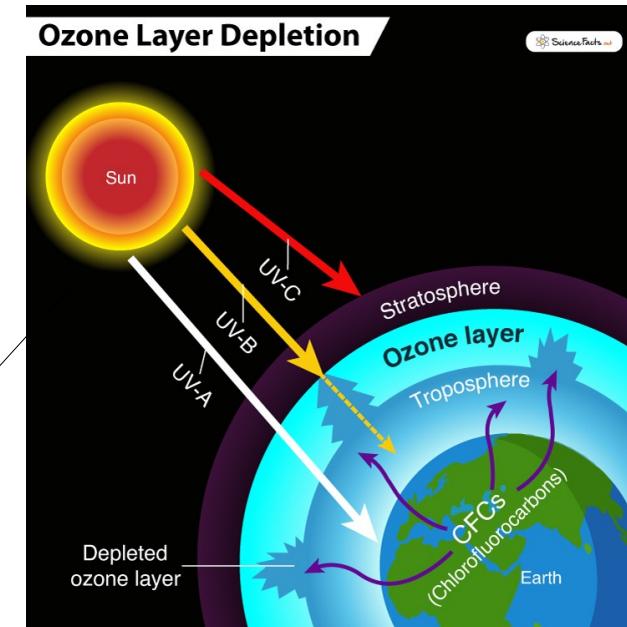
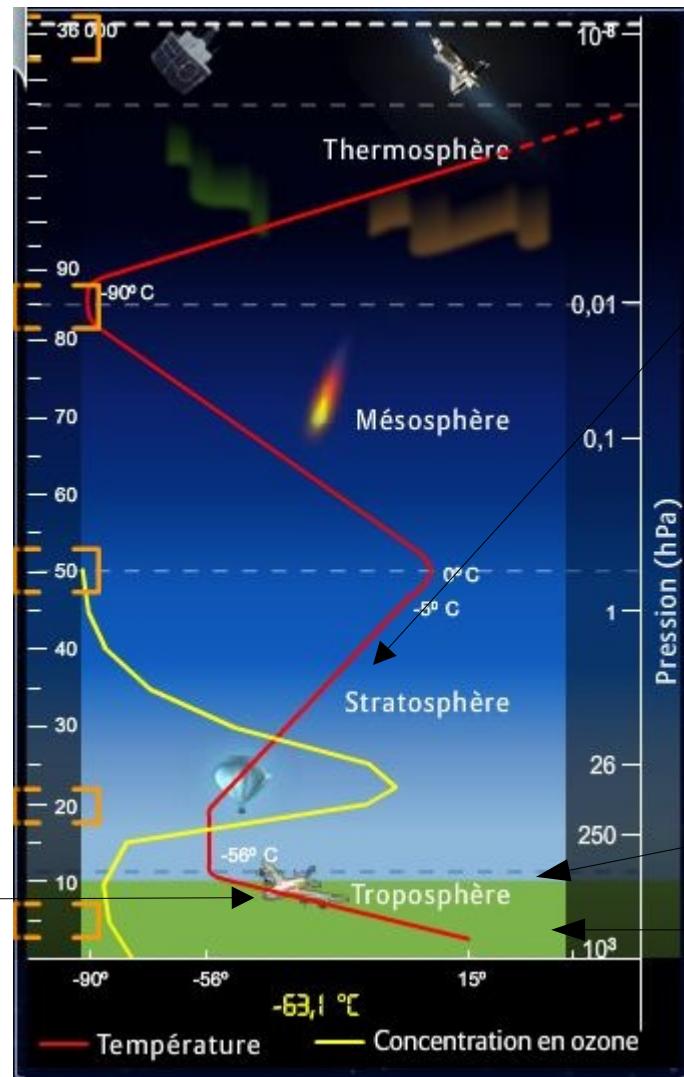


1. Structure verticale de l'atmosphère

Atmosphère standard:

$$p(z) = 1013,25 \left(1 - \frac{0,0065 \cdot z}{288,15}\right)^{5,255}$$

Loi des gaz parfaits :
 $PV=nRT$

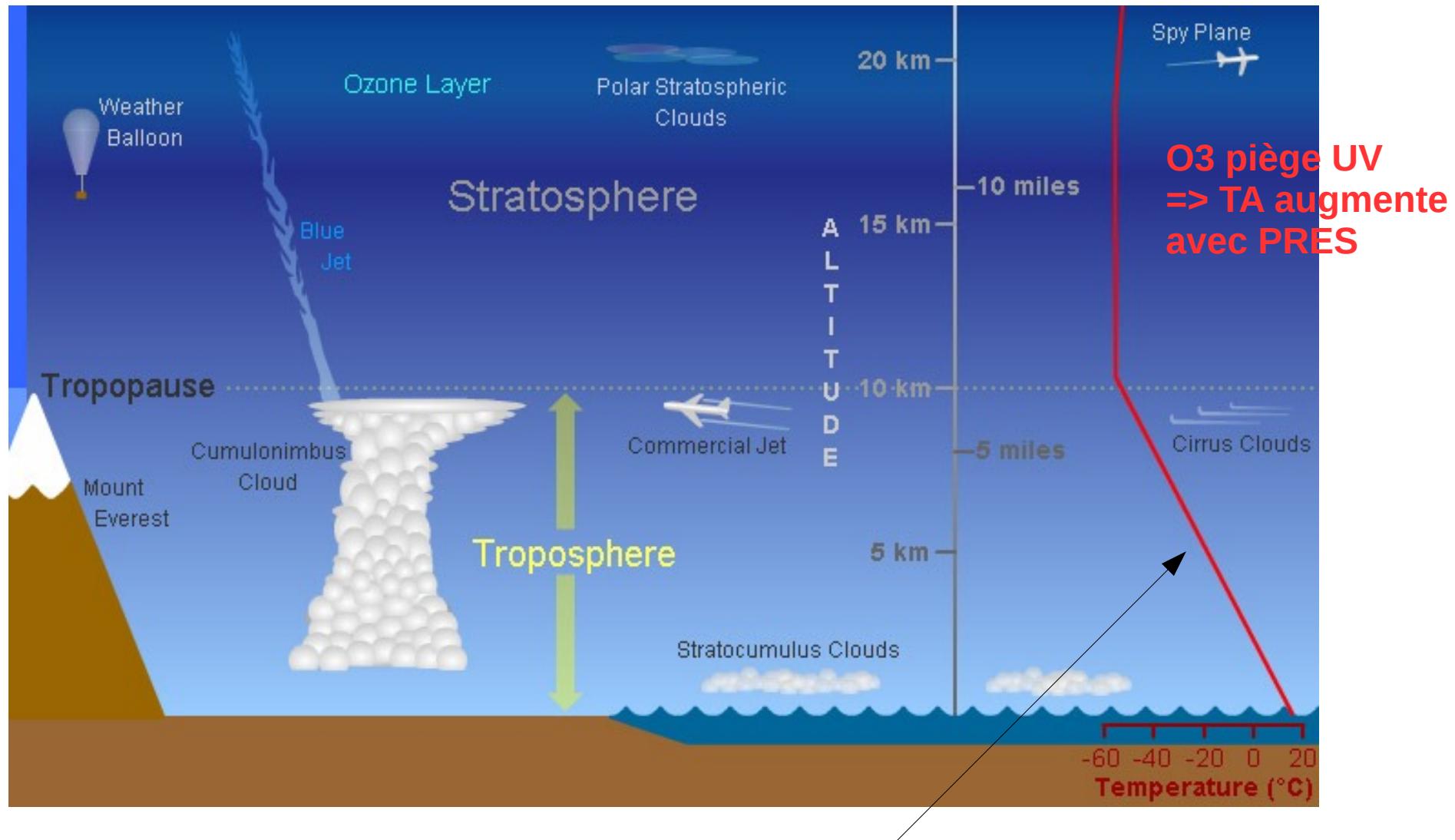


Ozone stratosphérique (bloque les UV)

Tropopause

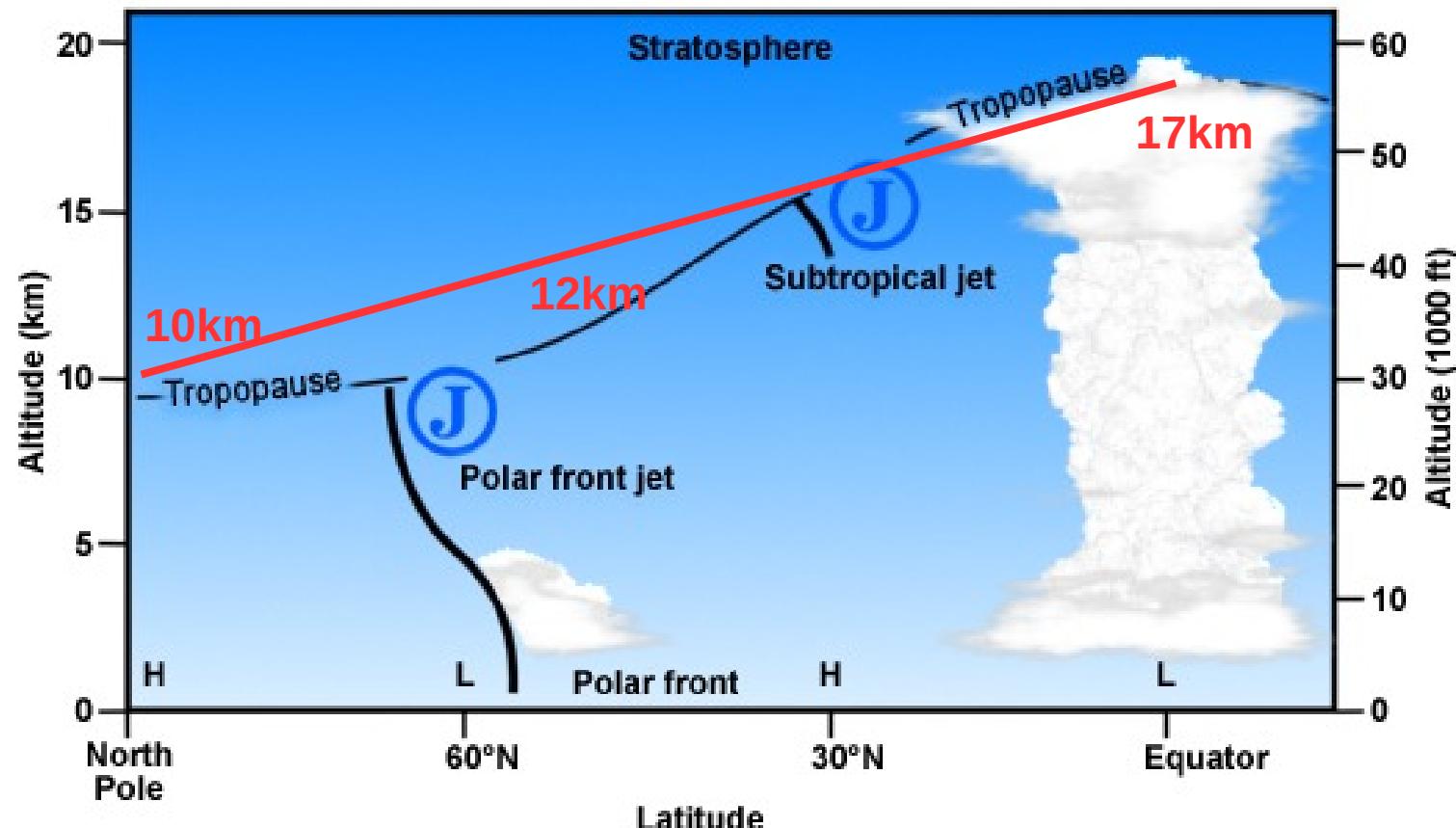
Nuages et météo

1. Structure verticale de l'atmosphère



1. Structure verticale de l'atmosphère

Northern Hemisphere Jet Streams



©The COMET Program

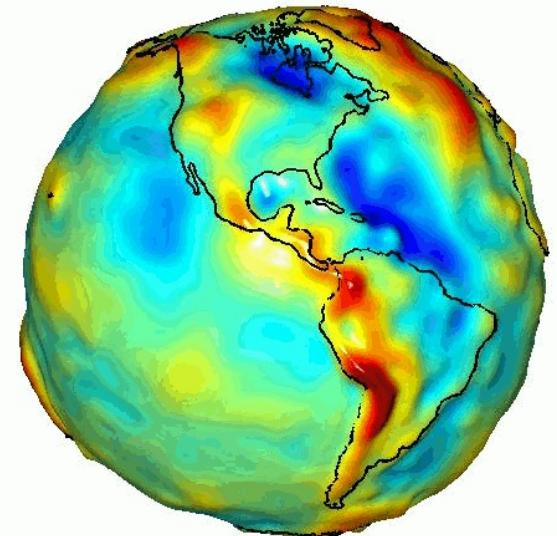
2. Géopotentiel

Géopotentiel et isohypse

La hauteur du géopotentiel désigne l'altitude à laquelle on atteint un potentiel égal de gravité. Elle est donc utilisée pour obtenir les niveaux de pression constante en corrigeant pour la variation locale de la gravité

$$Z_g = (\ln P_{nmm} - \ln P) \left(\frac{R}{g_0} \bar{T} \right) = \text{fct(SP, Tave)} \text{ avec } g \text{ constant}$$

- => **Z500 = géopotentiel à 500hPa ~ 5500 m**
Z700 ~ 3000m
z850 ~ 1500m
- => **Z500 est haut si anticyclonique et/ou dans l'air chaud.**



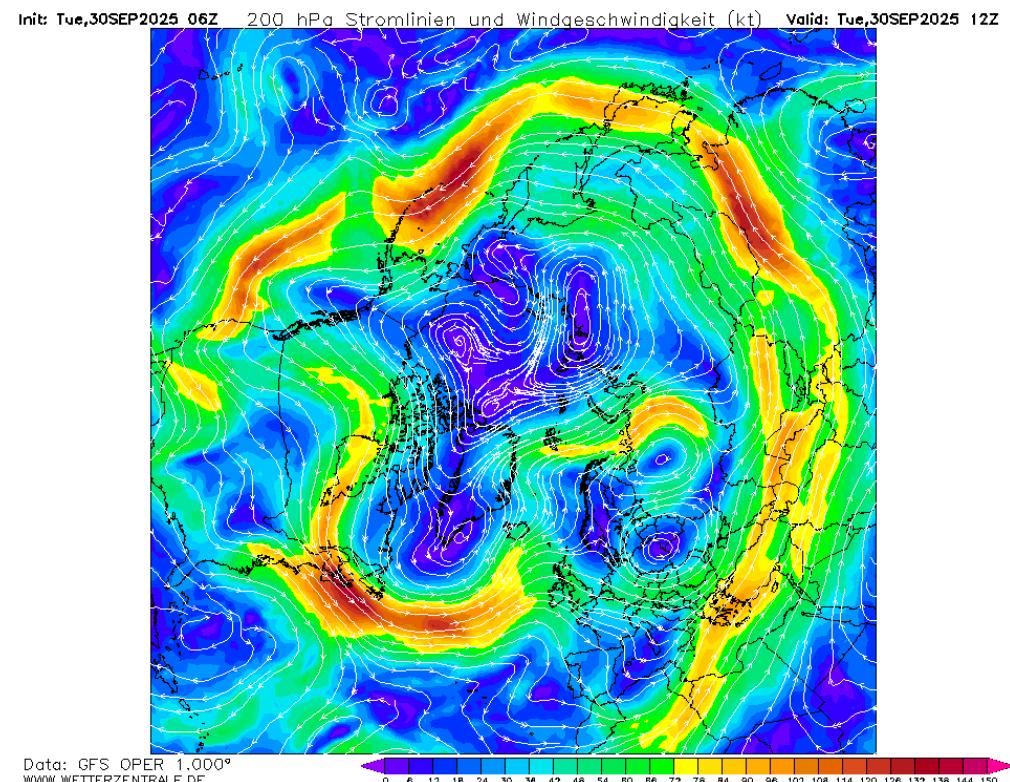
$$1 \text{ gpm} = 9,8/g \text{ mètre géométrique}$$

2. Géopotentiel

Variables de base

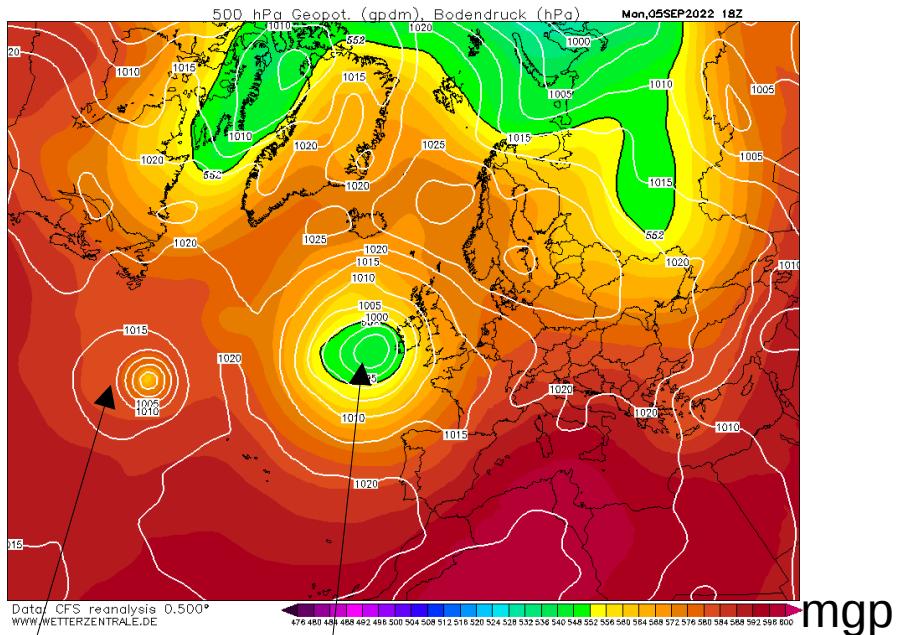
- Z500 = circulation générale
- SLP = pression de surface => circulation en surface
- T850 = T° à 850hPa ou 0850 => masse d'air
- Q700 = Q à 700hPa => précipitation/nuage
- W200 = vent à 200 hPa => Jet Stream

- + topographie
- + saison



2. Géopotentiel

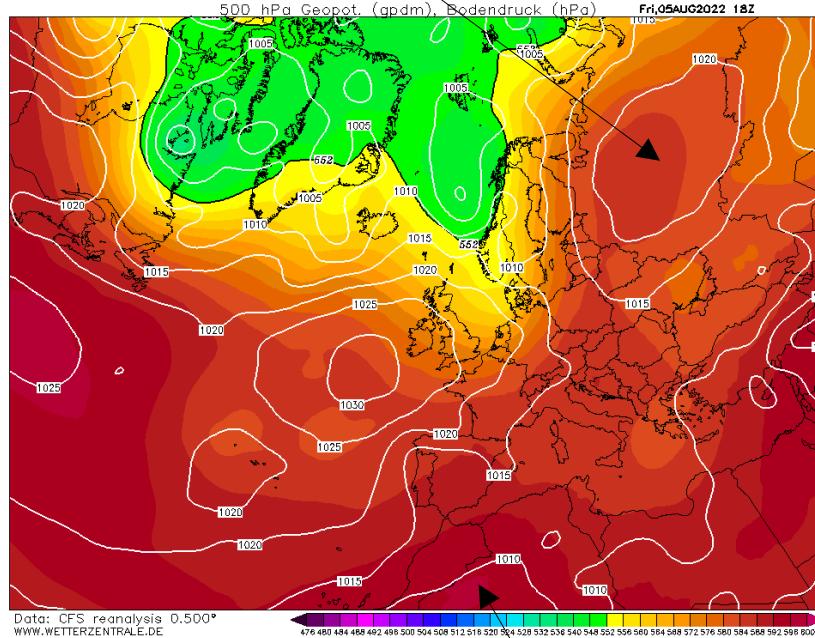
Anticyclone en surface et en altitude



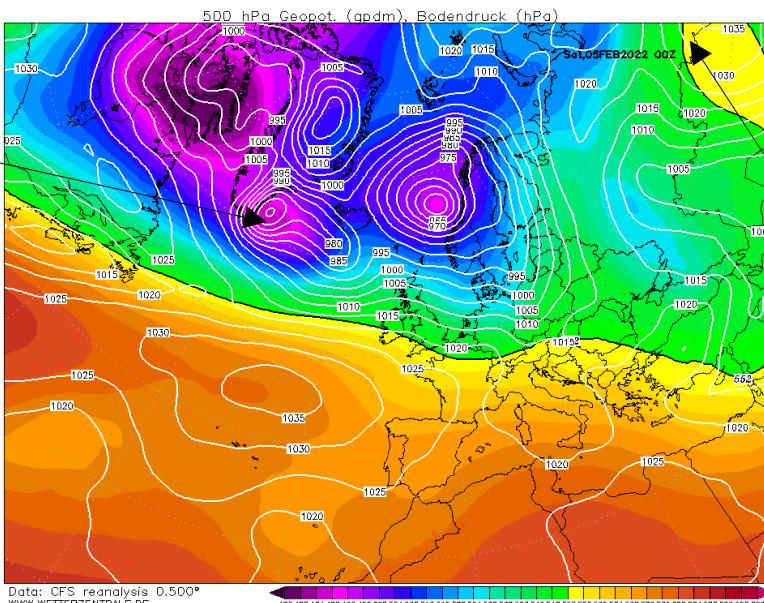
« Danielle »

Dépression en surface et en altitude

contour : pression de surface
couleur : Z500 en gpm

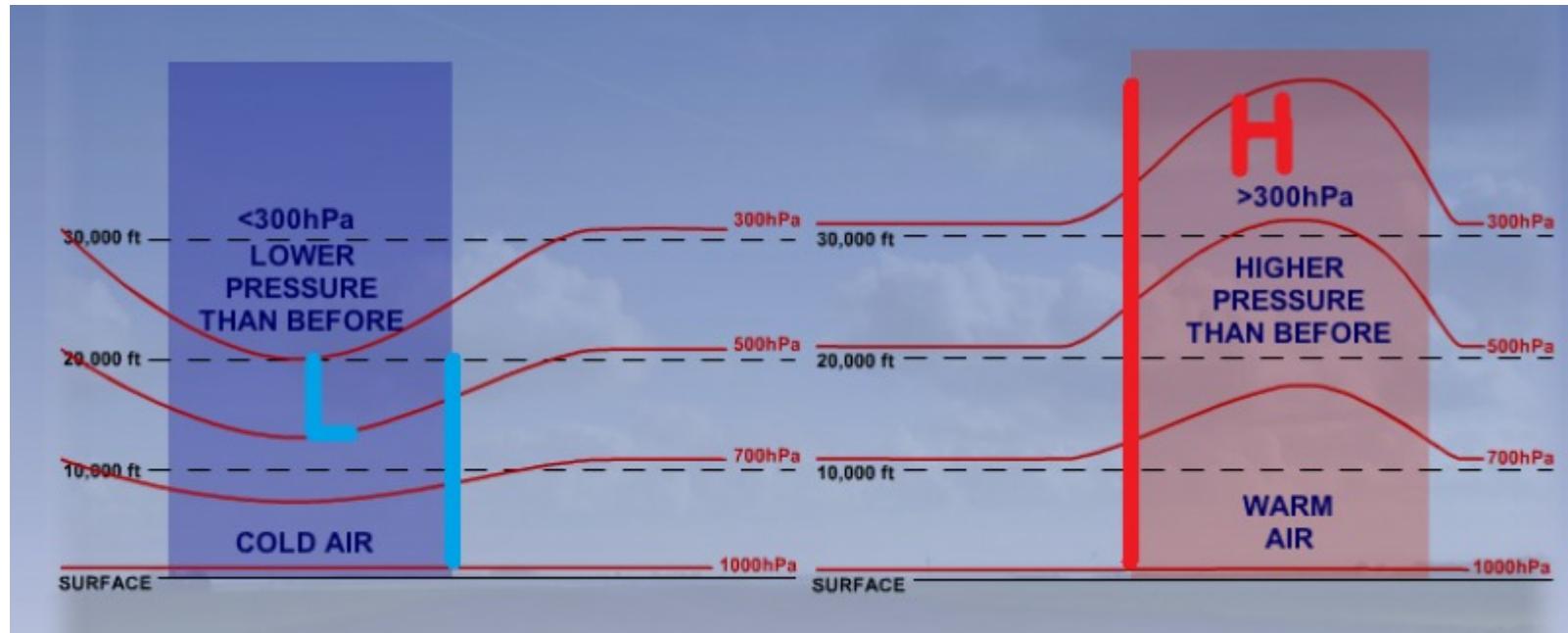


Dépression en surface uniquement (en été)



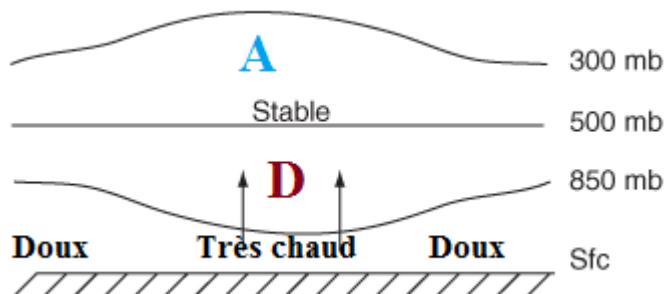
Anticyclone en surface uniquement (en hiver)

2. Géopotentiel

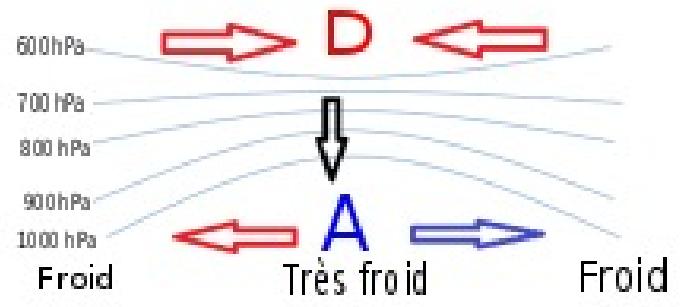


Dépression thermique vs dynamique

Dépression thermique (Sahara)

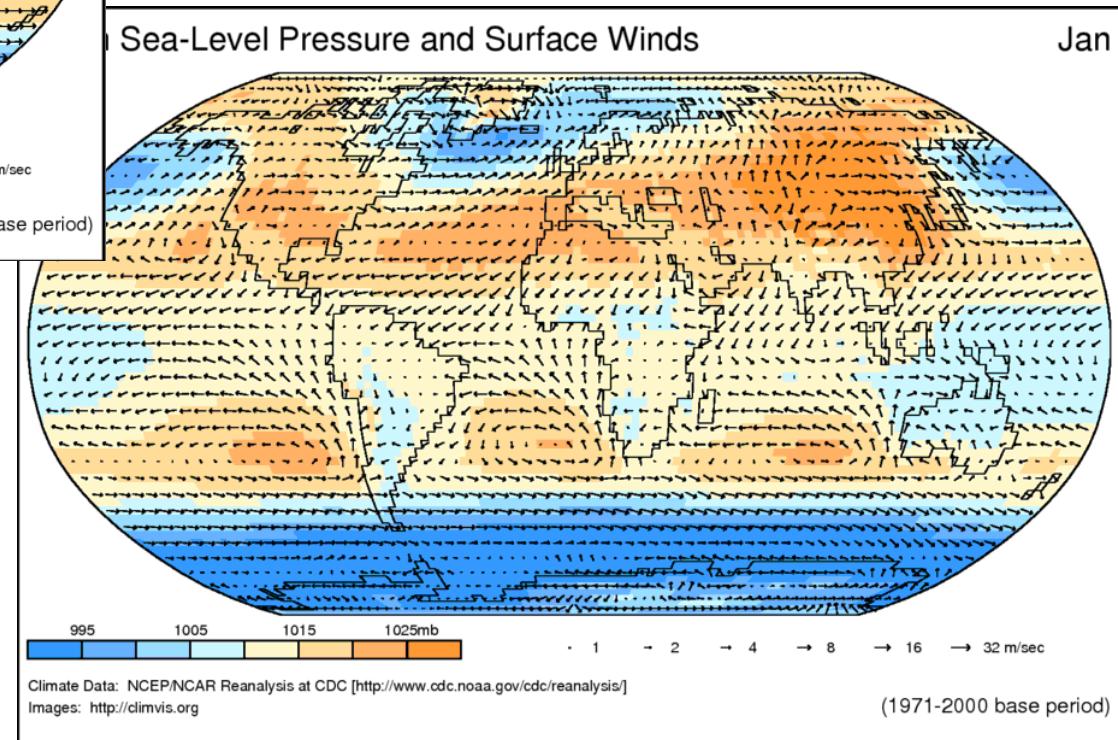
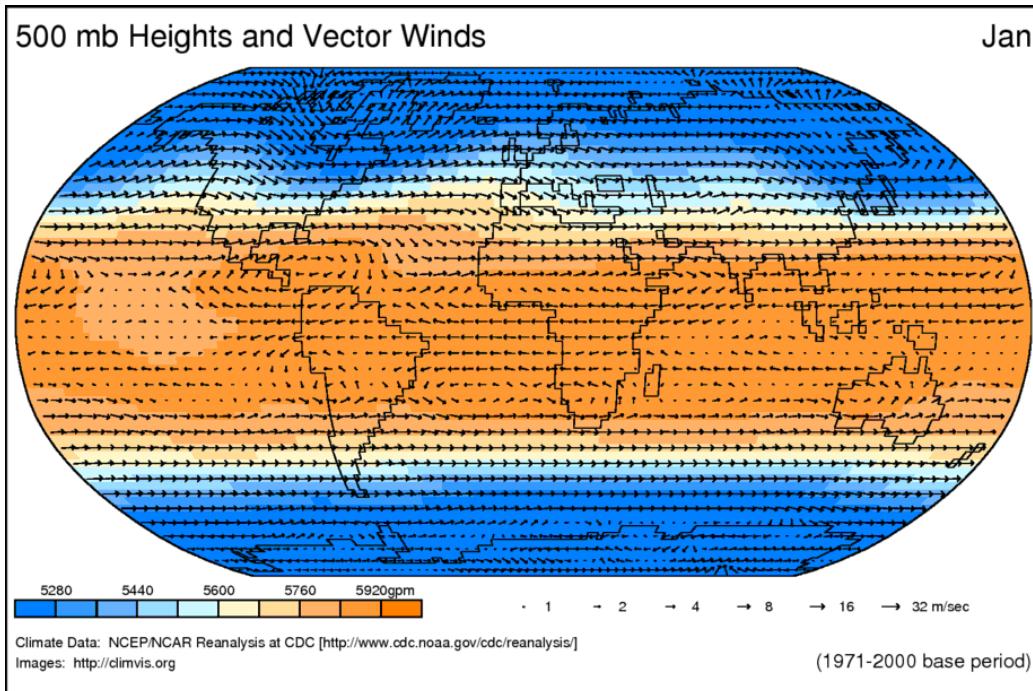


Anticyclone thermique (Sibérie)



2. Géopotentiel

Géopotentiel vs pression de surface



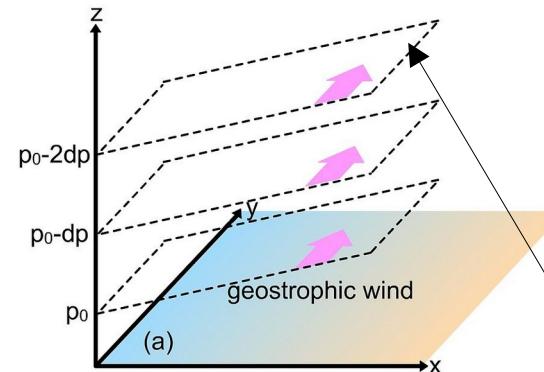
3. Vent Thermique

	Vent géostrophique	Vent thermique
Vitesse	dP/dx	dT/dx
Origine	Dynamique (force de Coriolis)	Thermique
Direction	Dépression à gauche (le long des isohypes)	Air froid à gauche (le long des isothermes)
	Vent dominant	Déviation (la plus part du temps)

$$\mathbf{V}_g = \frac{\hat{\mathbf{k}}}{f} \times \nabla_p \Phi \quad \mathbf{v}_T = \frac{R}{f} \ln \left[\frac{p_0}{p_1} \right] \mathbf{k} \times \nabla_p \bar{T}$$

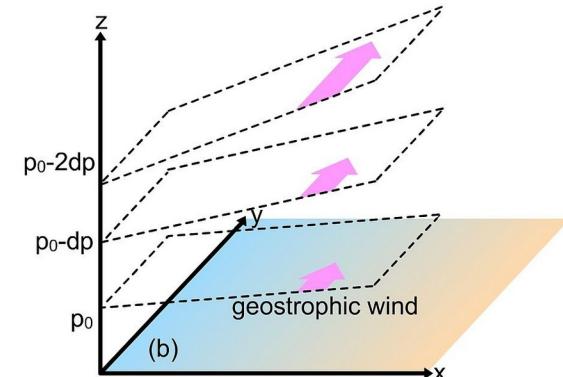
Hémisphère sud : D à droite et air froid à droit !

Isohypses avec la même température



Barotropic Atmosphere

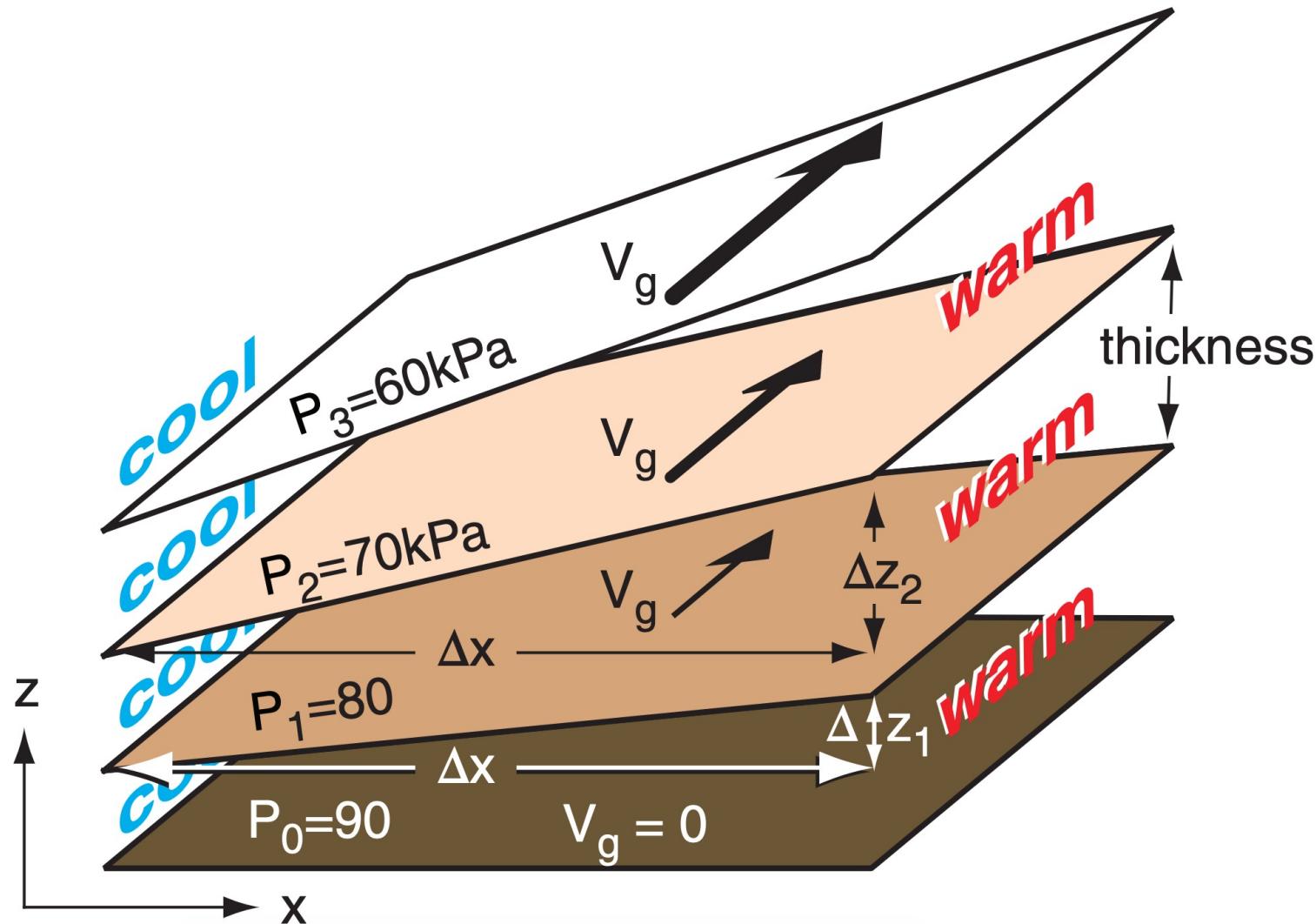
Surface isobaric



Baroclinic Atmosphere

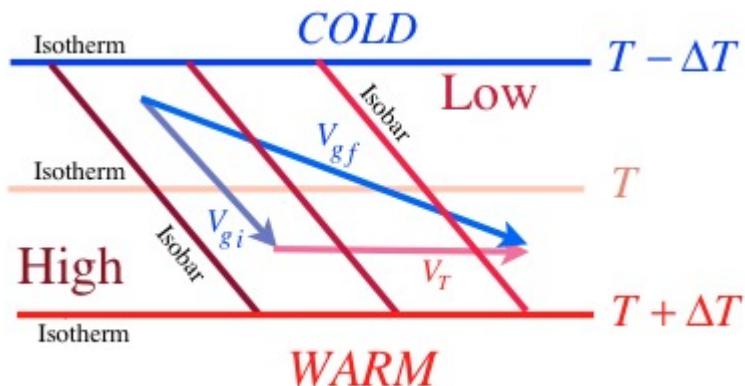
Isohypses avec de l'air froid à gauche

3. Vent Thermique



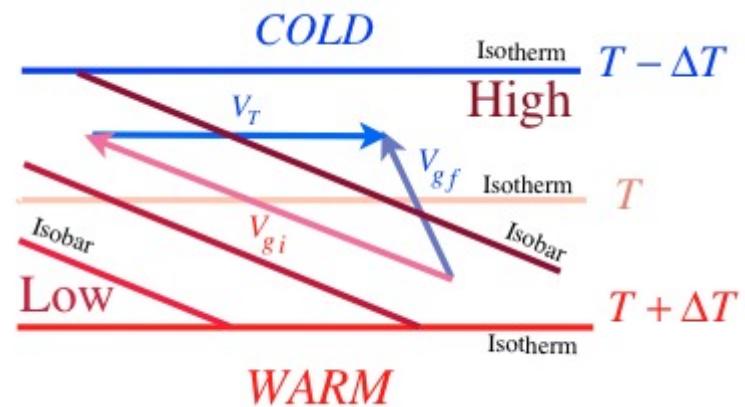
Le gradient de température accélère le vent géostrophique !

3. Vent Thermique



(a) Advection froide

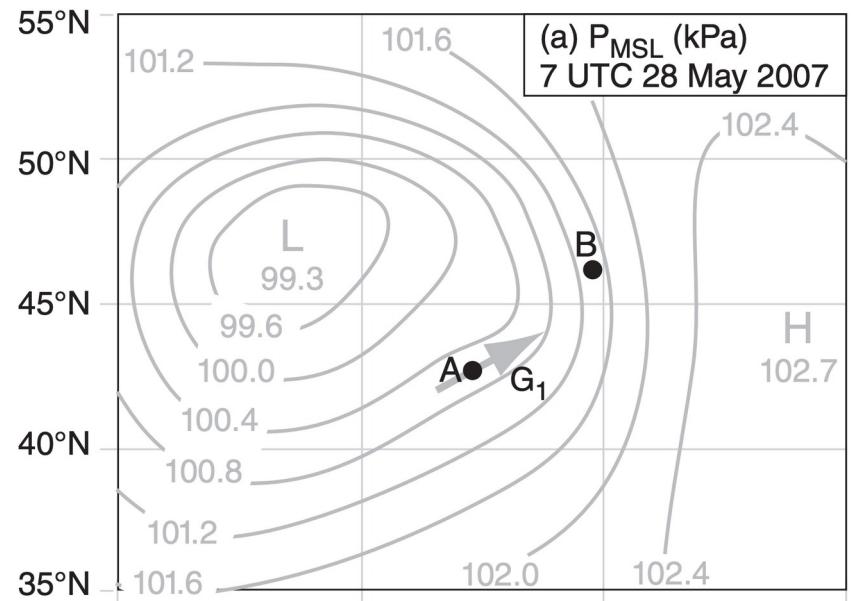
Renforcement de l'advection
avec l'altitude



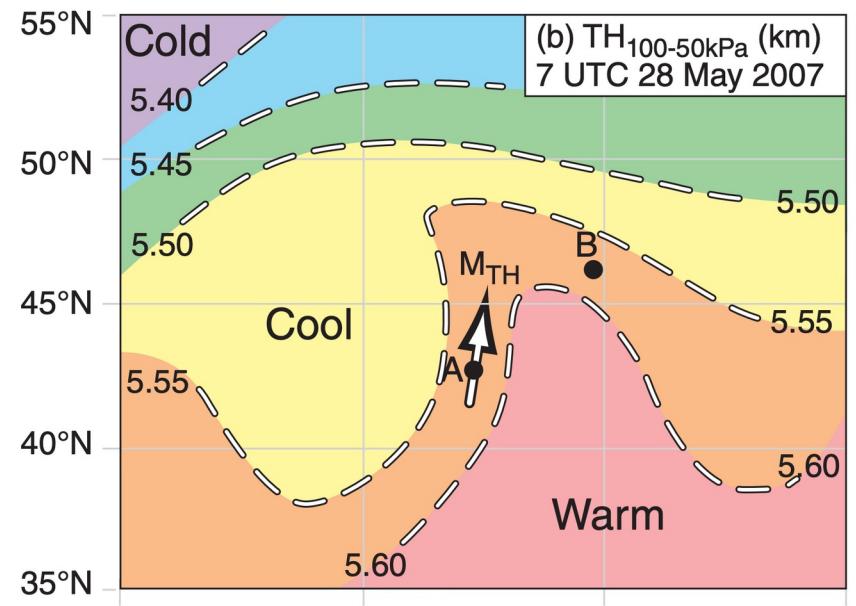
(b) Advection chaude

Atténuation de l'advection
avec l'altitude

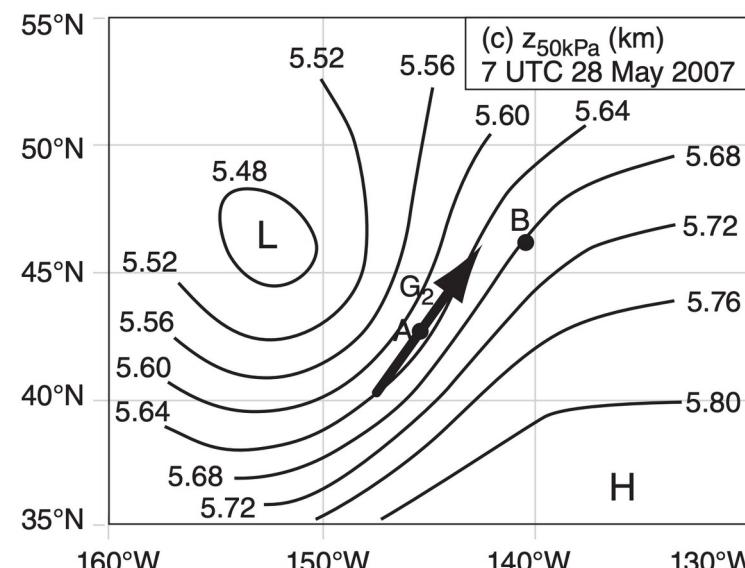
3. Vent Thermique



Vent géostrophique en surface



Vent thermique

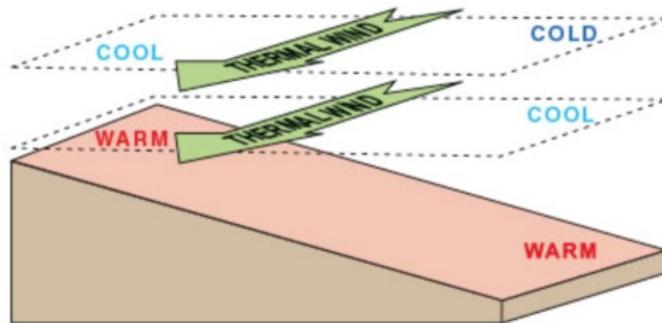


Vent résultant à Z500
(légèrement dévié et
plus fort qu'en surface)

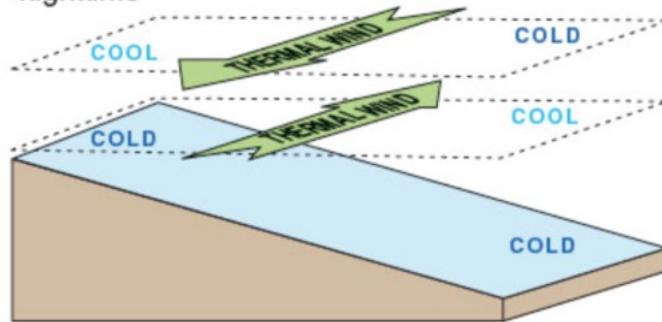
3. Vent Thermique (Low level Jet)

Low-level jet

(a) daytime

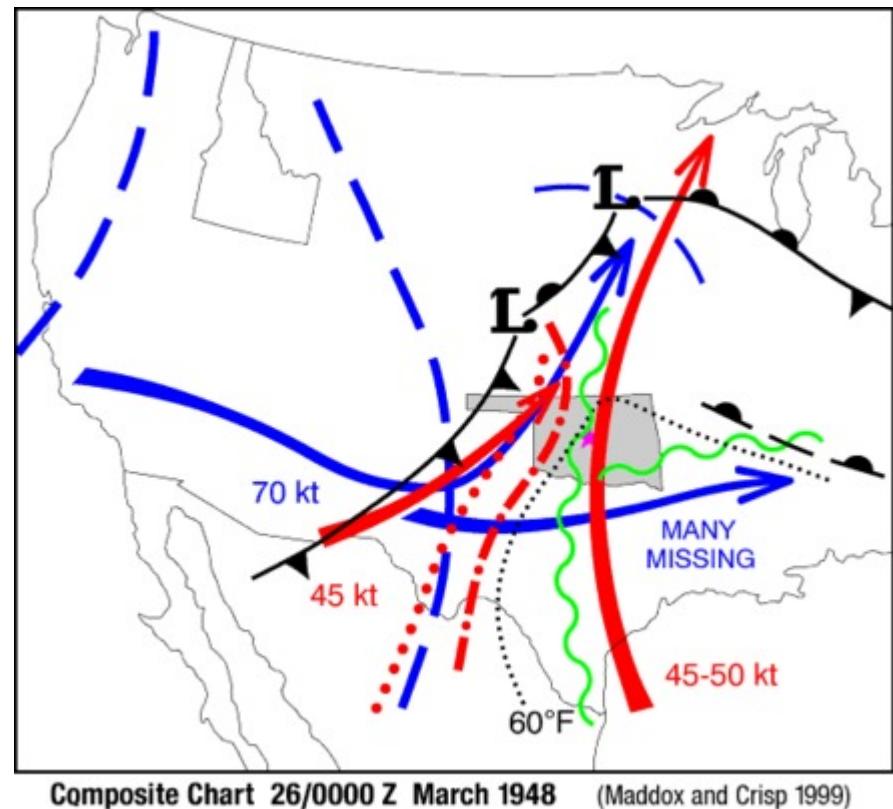


(b) nighttime



Rocky

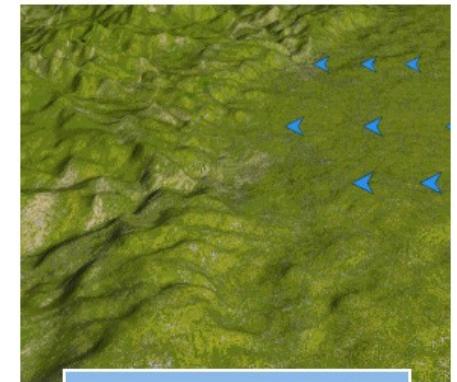
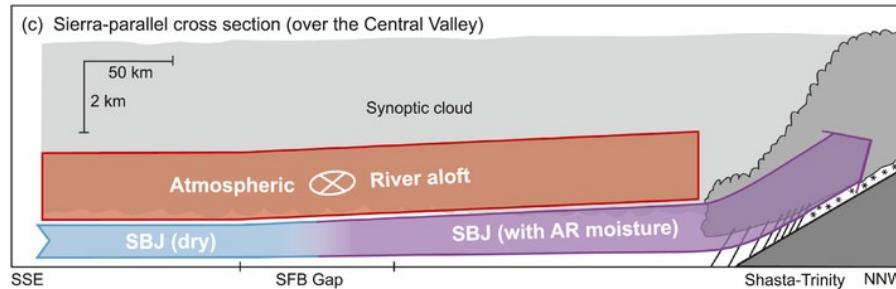
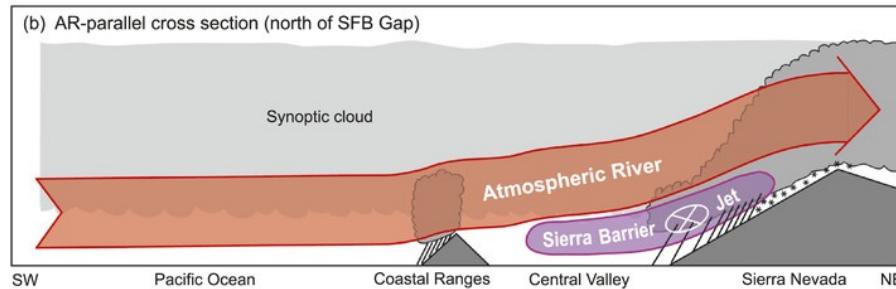
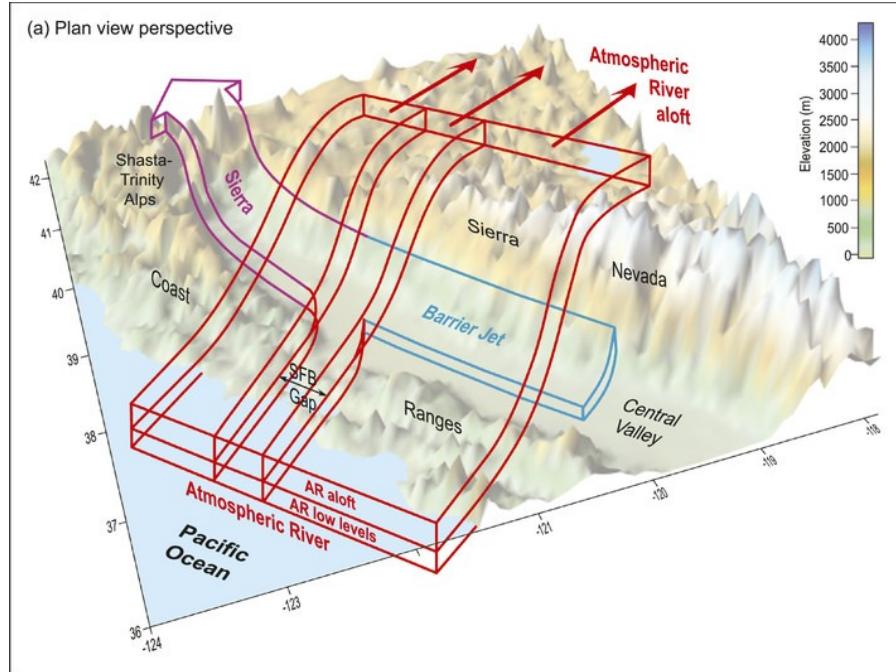
Plaine américaine



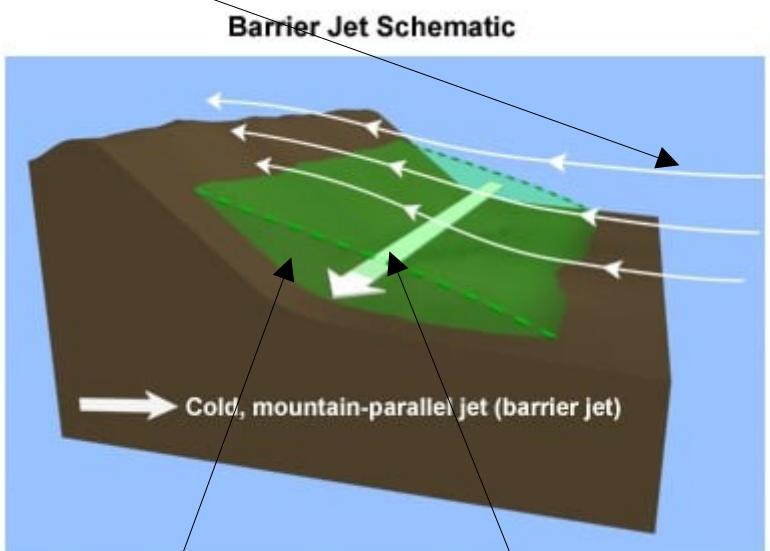
Composite Chart 26/0000 Z March 1948

(Maddox and Crisp 1999)

3. Vent Thermique (Barrier Jet)



Air chaud en altitude

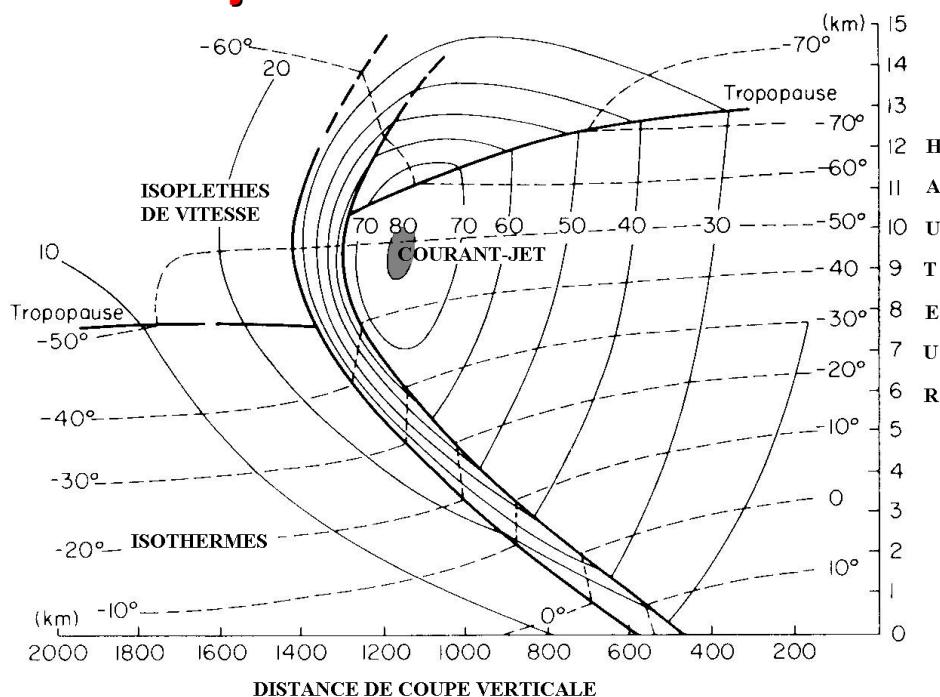


Accumulation d'air froid
dans les basses couches

Vent thermique à la
frontières des masses d'air

3. Vent Thermique (Jet Stream)

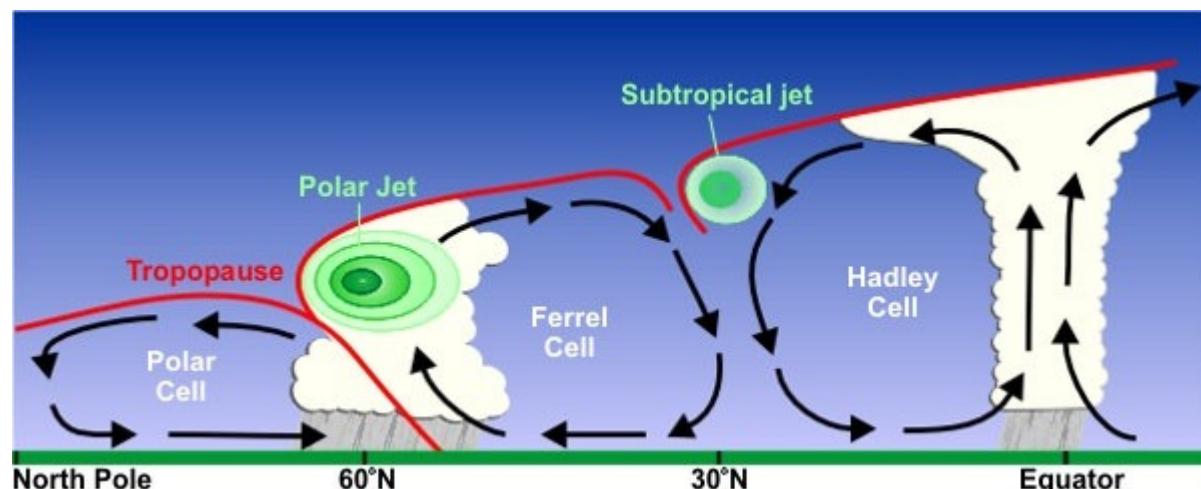
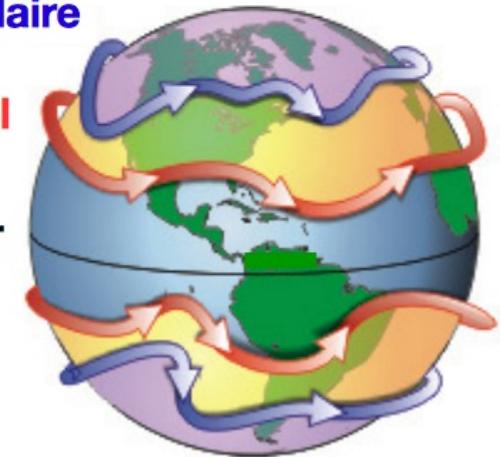
Courant-jet



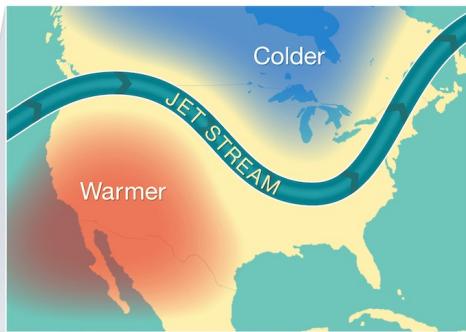
courant pôle

courant sous-tropical

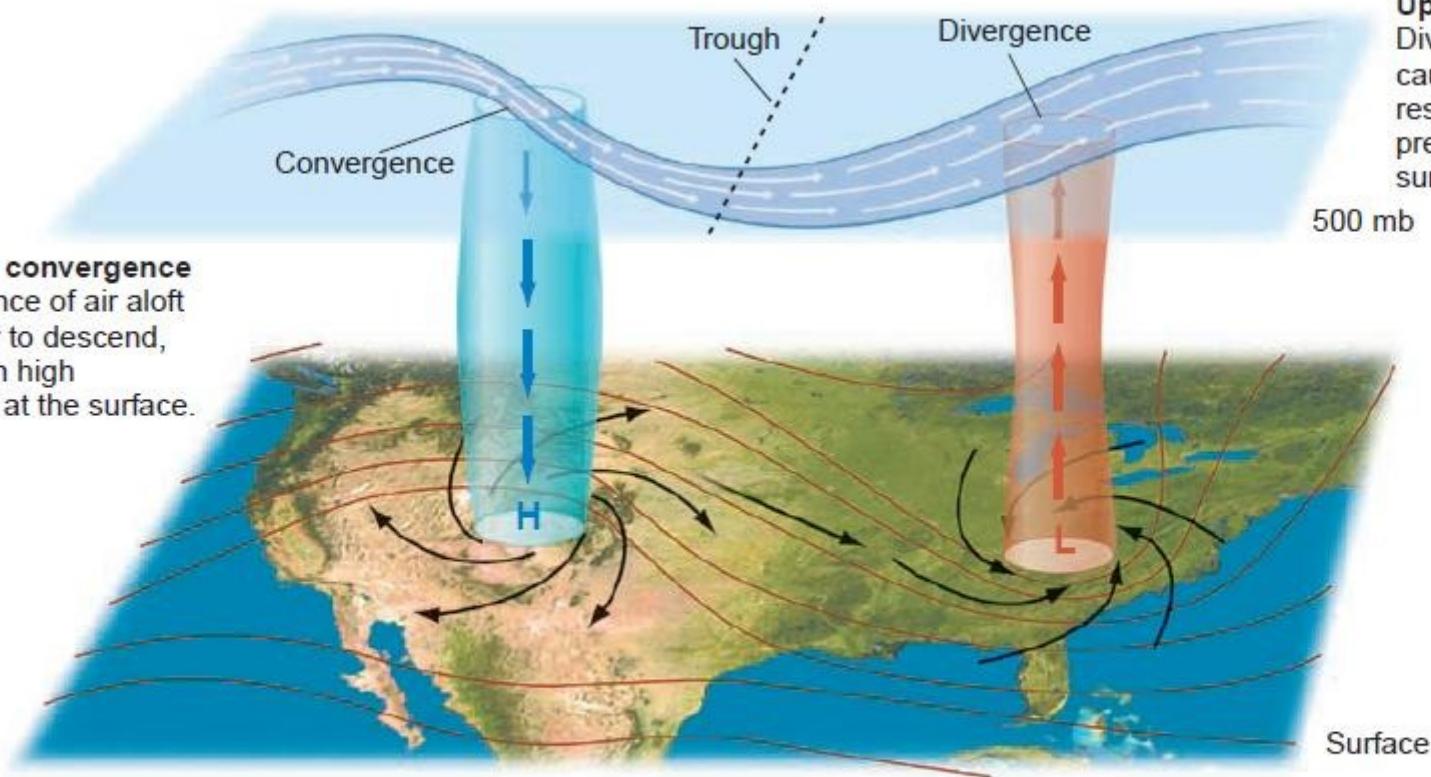
équateur



3. Vent Thermique (Jet Stream)



Upper-air convergence
Convergence of air aloft causes air to descend, resulting in high pressures at the surface.

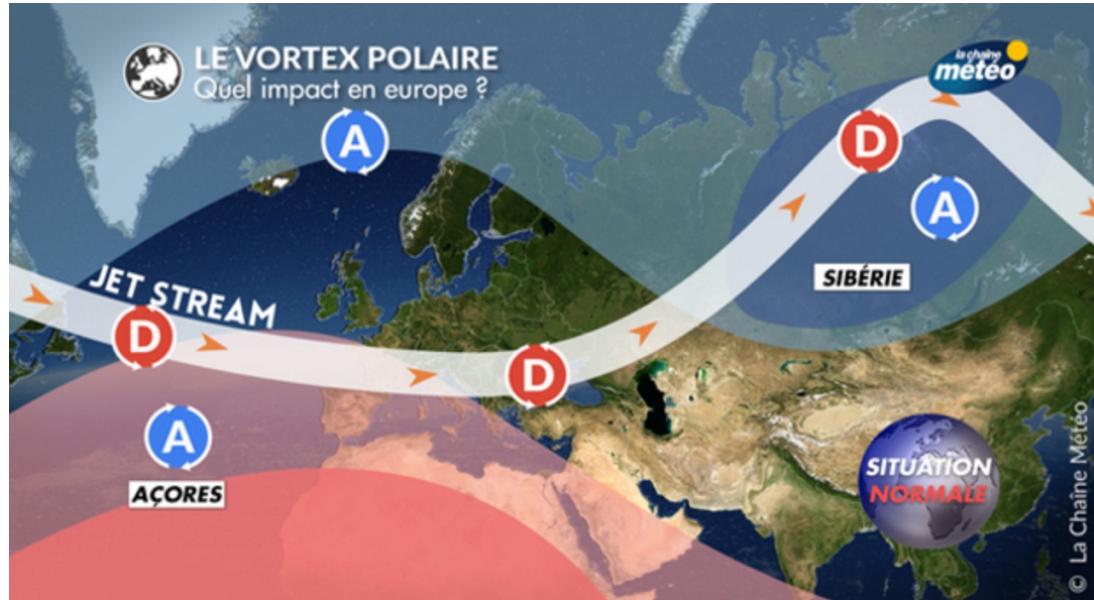


Upper-air divergence
Divergence of air aloft causes air to ascend, resulting in low pressures at the surface.

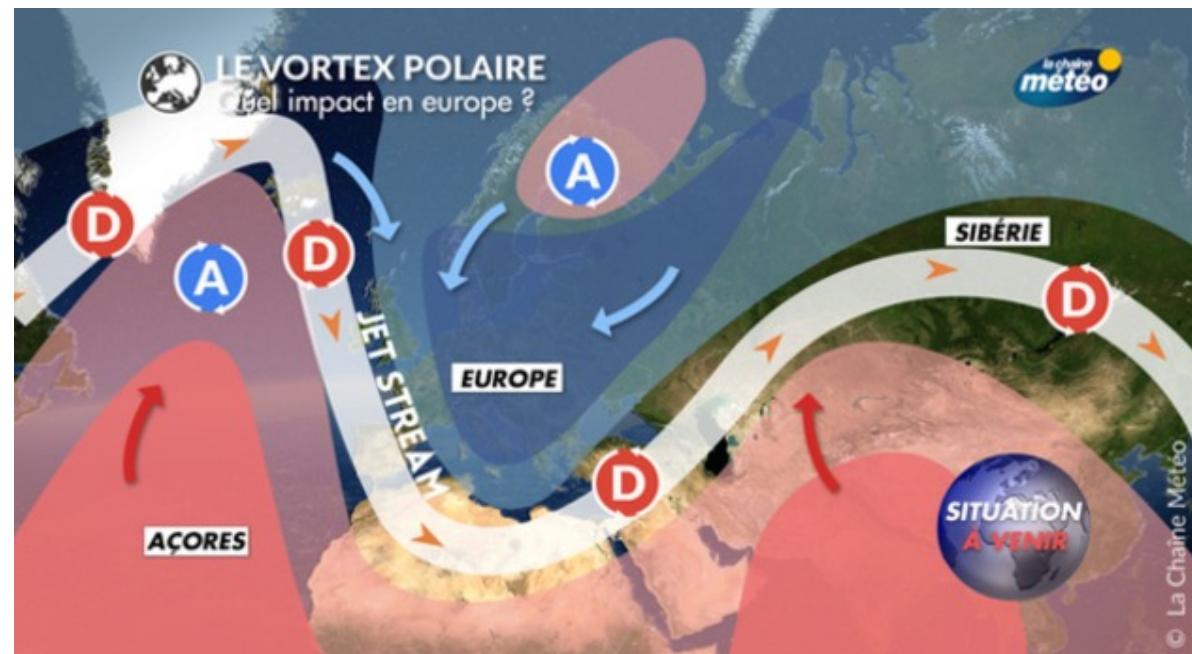
500 mb

Surface

3. Vent Thermique (Jet Stream)

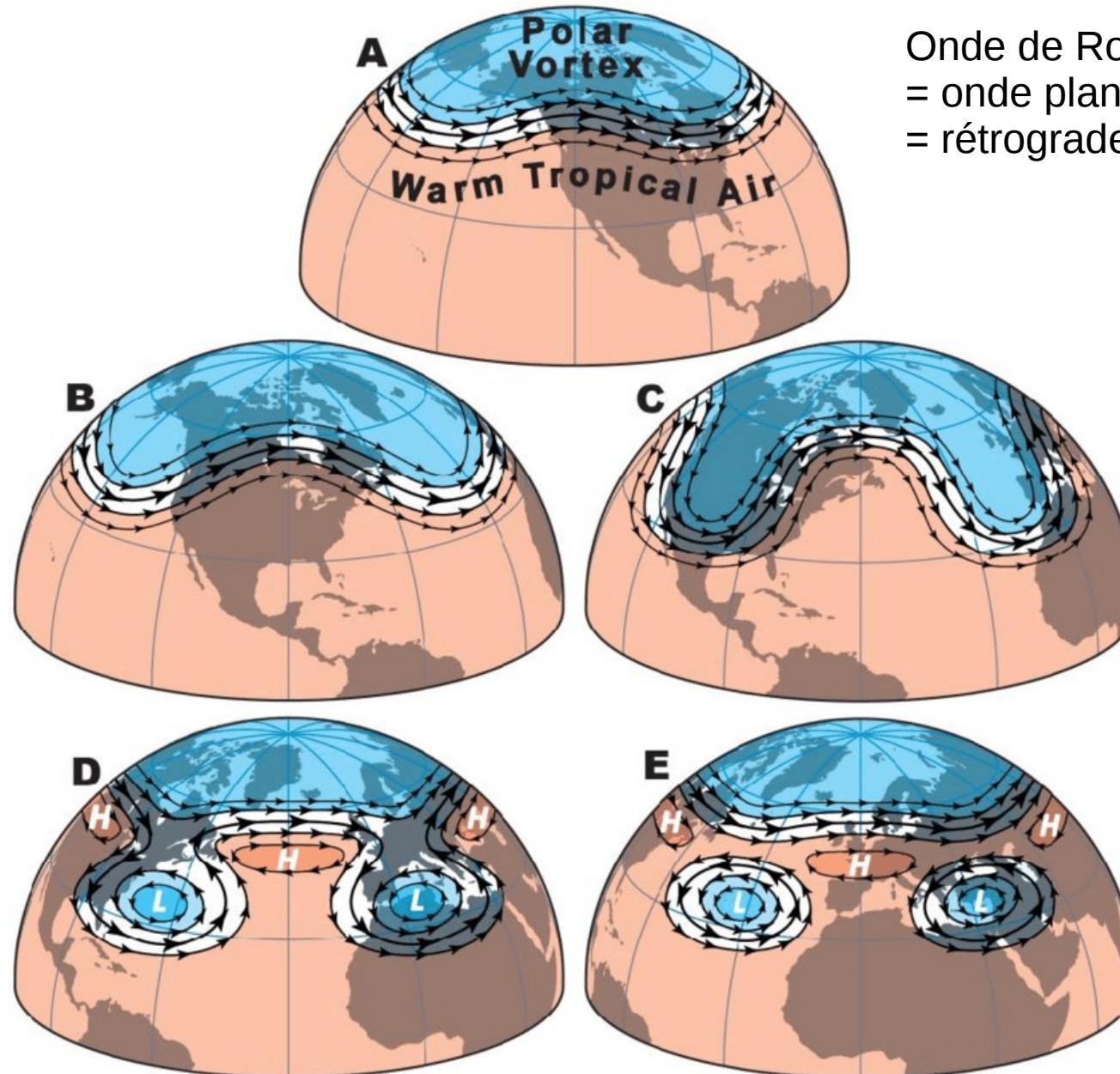


Les oscillations (appelé onde de Rossby) du jet stream permettent à l'air froid de venir chez nous en hiver



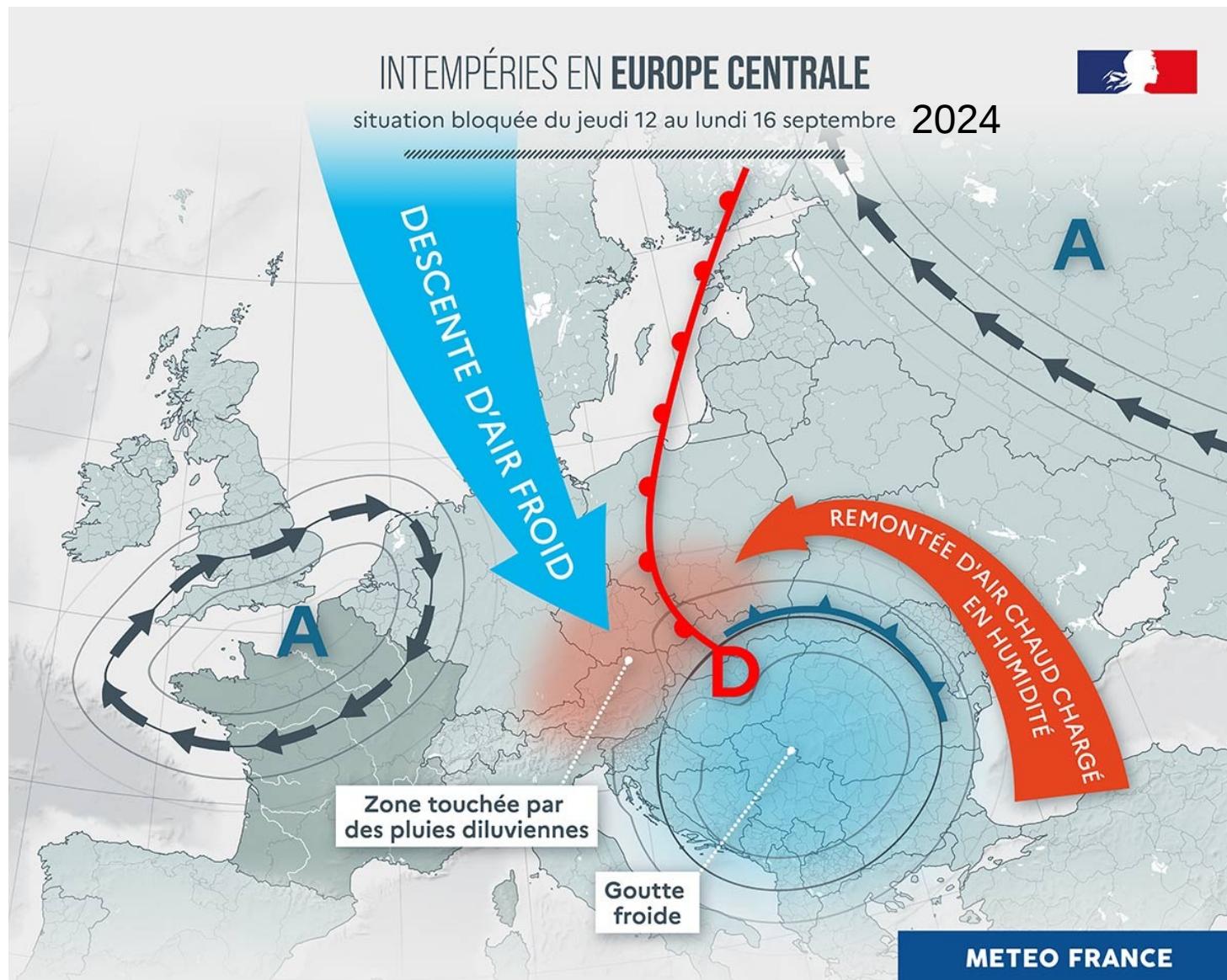
3. Vent Thermique (Onde de Rossby)

Goûte froide
en été
ou vague de
froid en
hiver

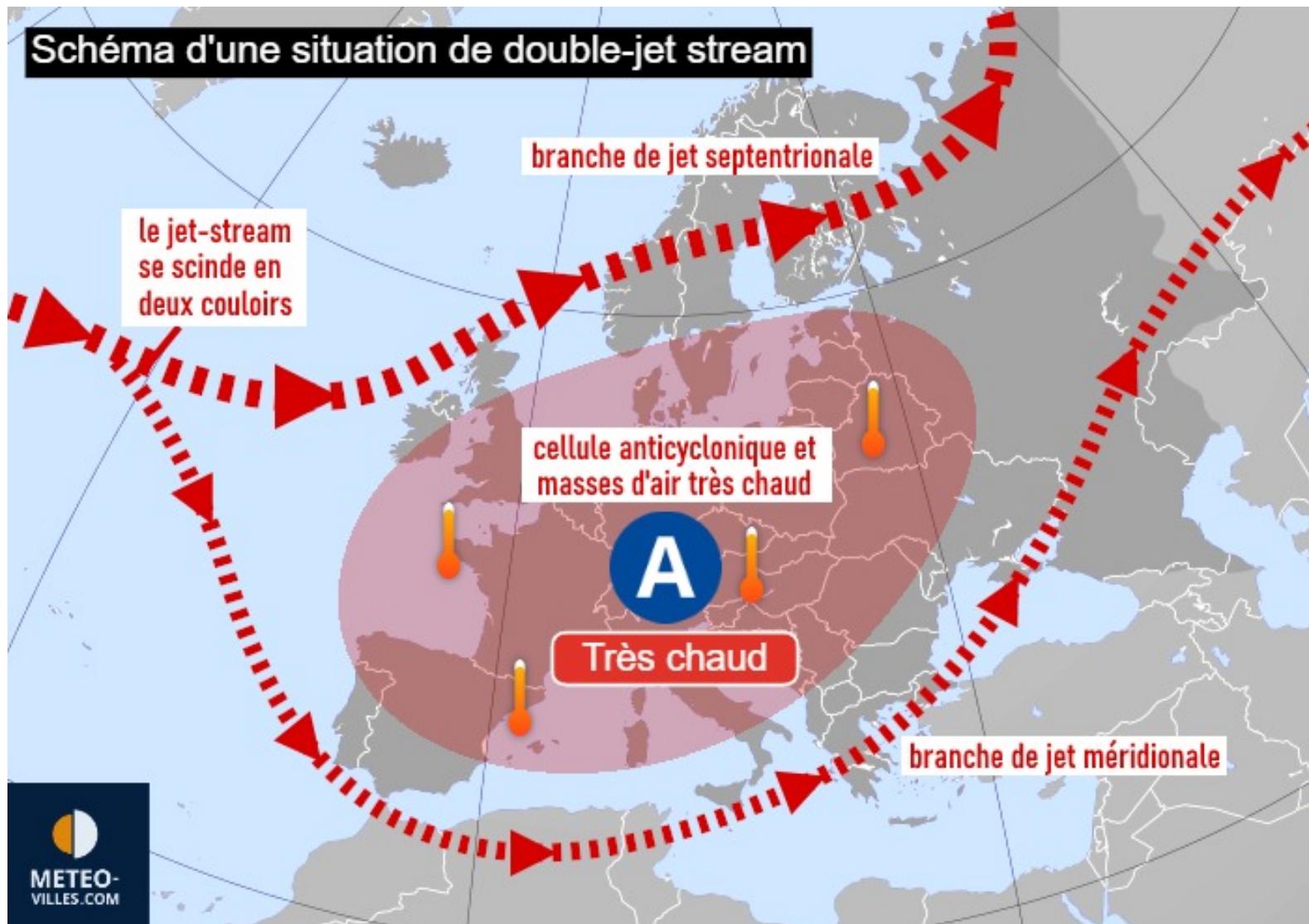


Onde de Rossby
= onde planétaire
= rétrograde

3. Vent Thermique (Onde de Rossby)

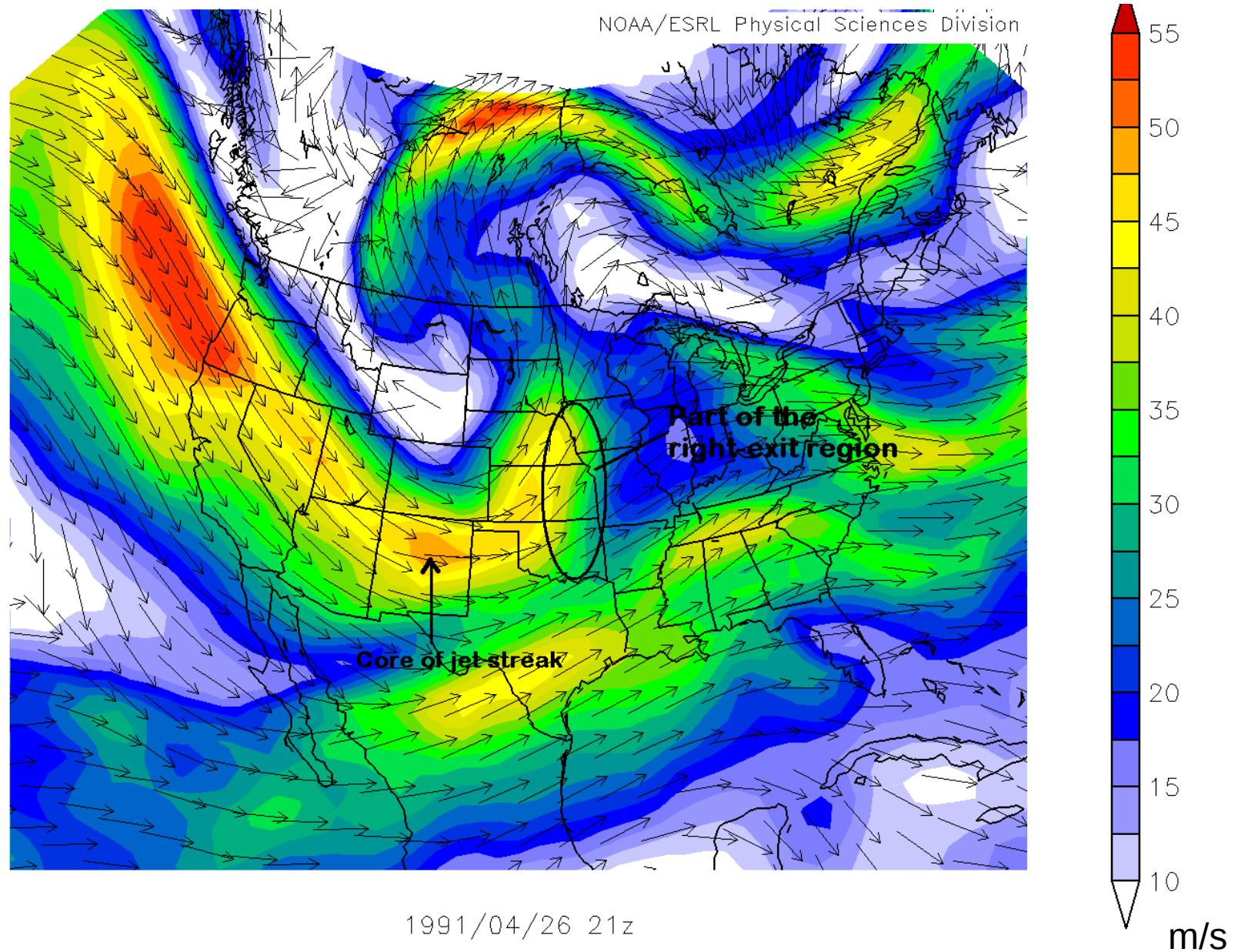


3. Vent Thermique (Jet Stream)



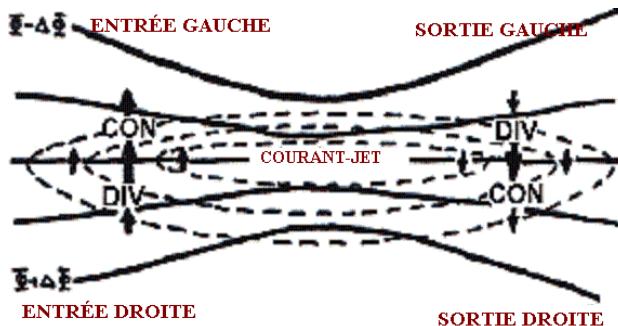
Une double branche du jet stream a emprisonné un anticyclone sur nos régions pendant l' été 2022 !

3. Vent Thermique (Jet Stream)

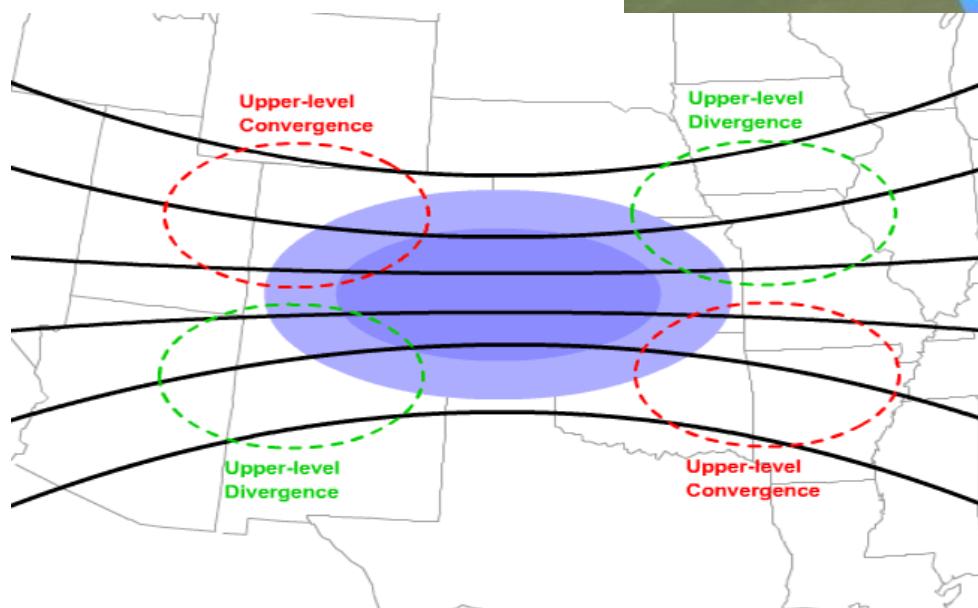
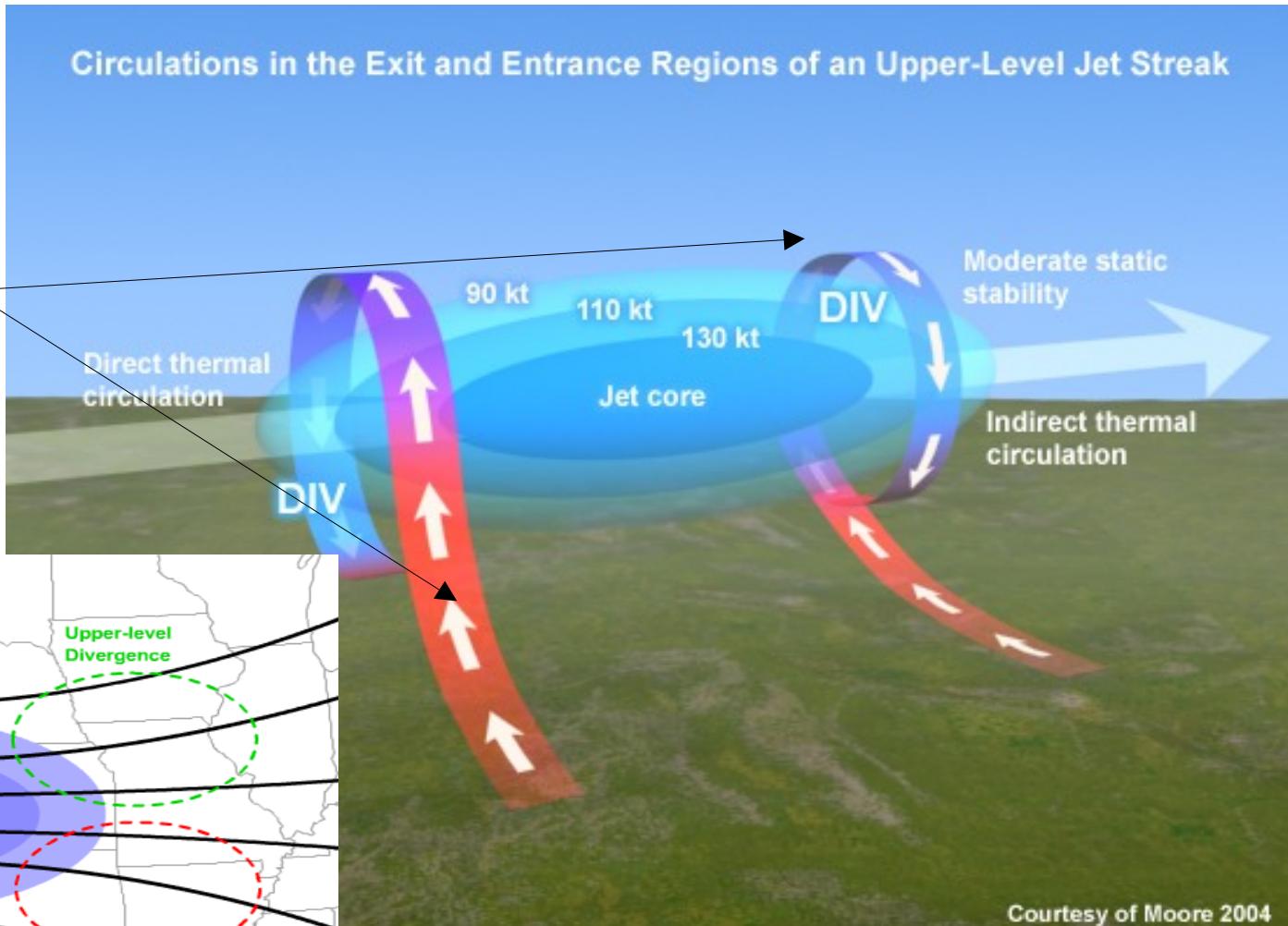


Le jet stream n'est pas continu... => jet-stream core or streak

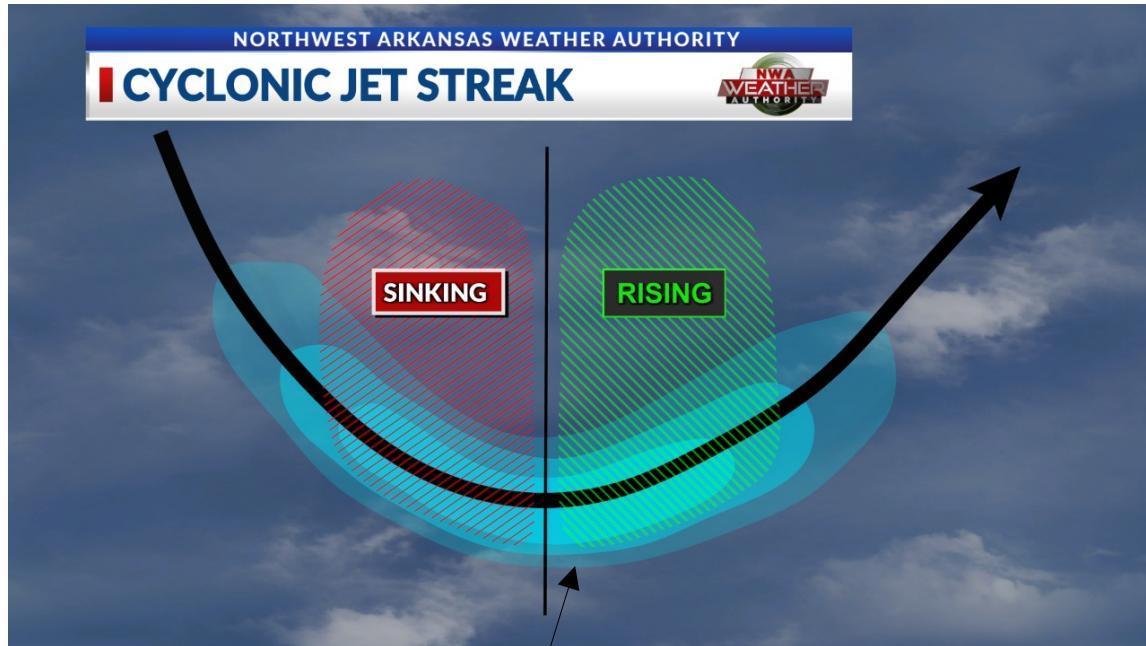
3. Vent Thermique (Jet Stream)



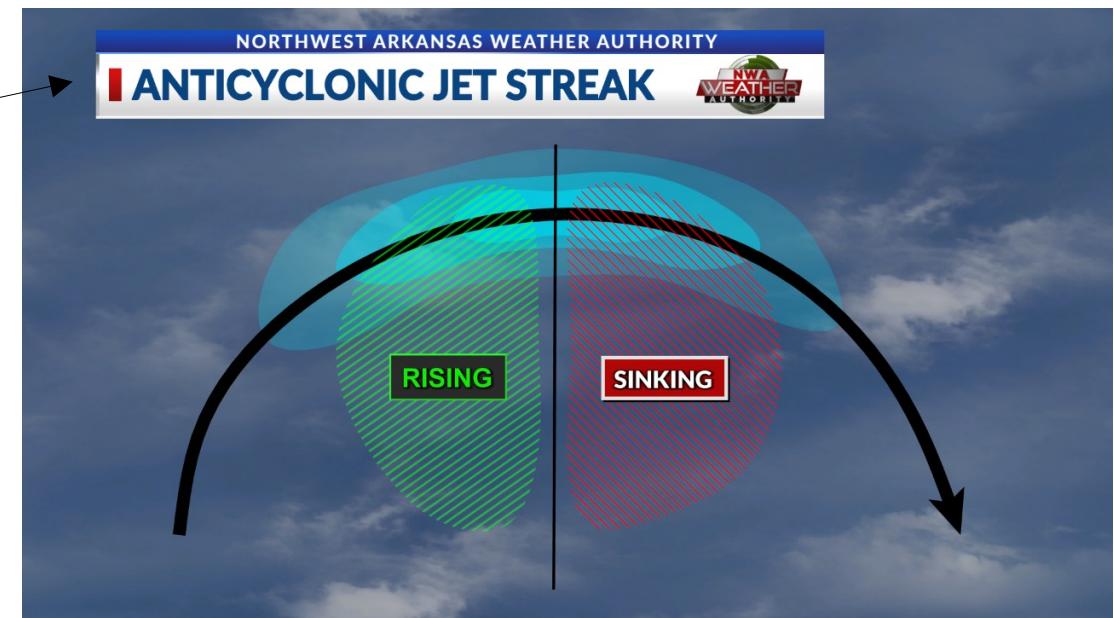
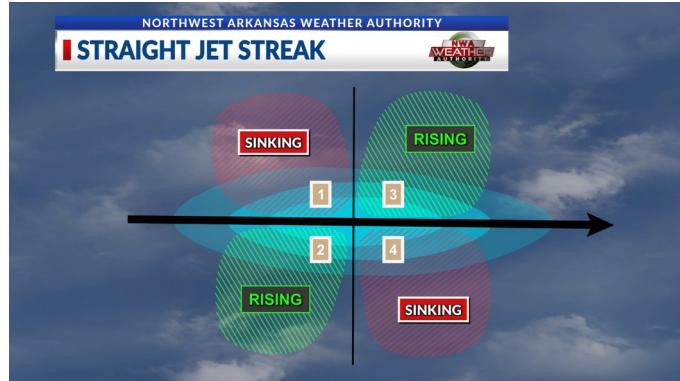
Régions instables
(entrée droite
et sortie gauche)



3. Vent Thermique (Jet Stream)

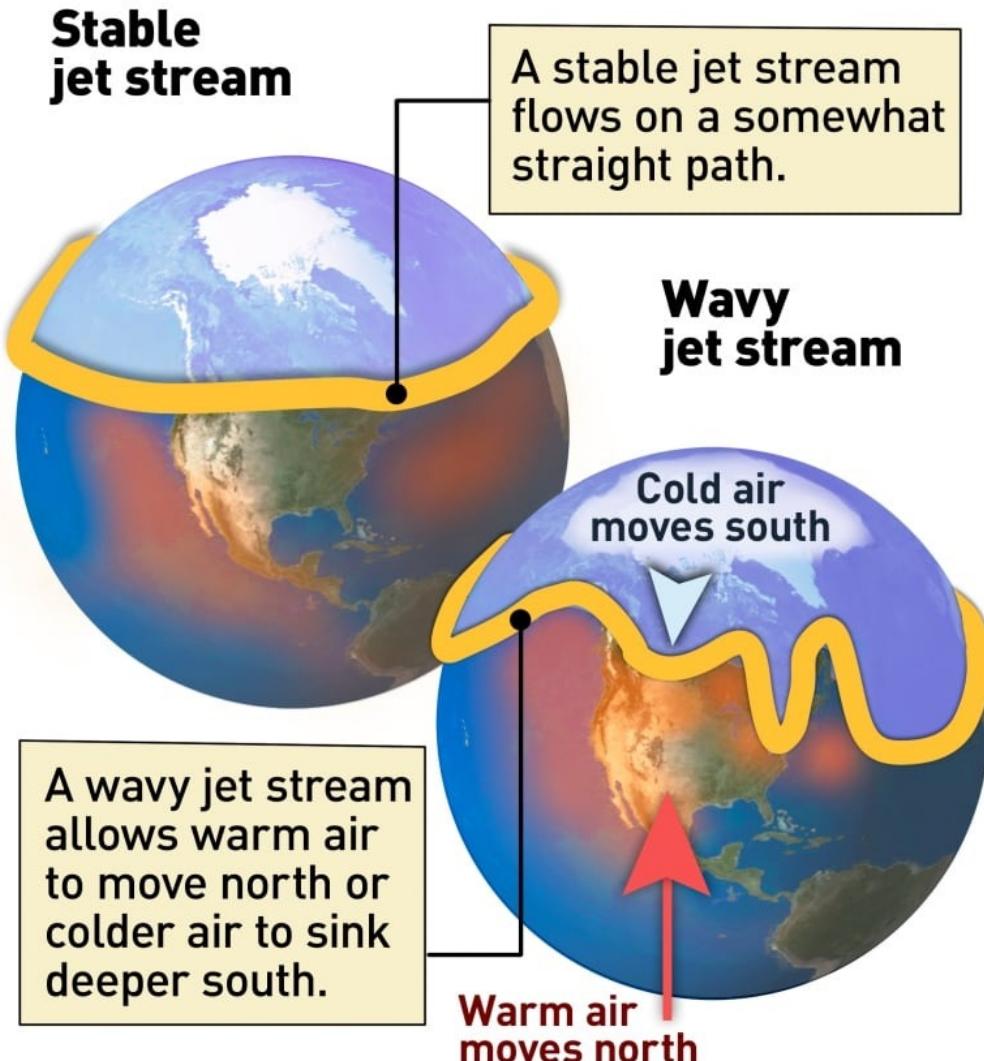


Cas théorique :



3. Vent Thermique (Jet stream)

The Changing Jet Stream



Réchauffement climatique :

=> ralentissement + oscillation du jet

=> jet plus au nord (surtout en été)

