Western Boundary Currents

Start:

$$-fv = -\frac{\partial}{\partial x} p + \frac{\partial \tau^x}{\partial z} - ru + A_h \Delta u$$

vertikal Integrieren & Rotation anwenden:

$$\beta V = \frac{\partial \tau_0^y}{\partial x} - \frac{\partial \tau_0^x}{\partial y} - r\zeta + A_h \Delta \zeta$$

(β plan. approx.
$\zeta = \frac{\partial v}{\partial x} - \frac{\partial u}{\partial y}$ (Vortr.))

3 Fälle:

Sverdrup: $\beta V = \frac{\partial \tau_0^y}{\partial x} - \frac{\partial \tau_0^x}{\partial y}$

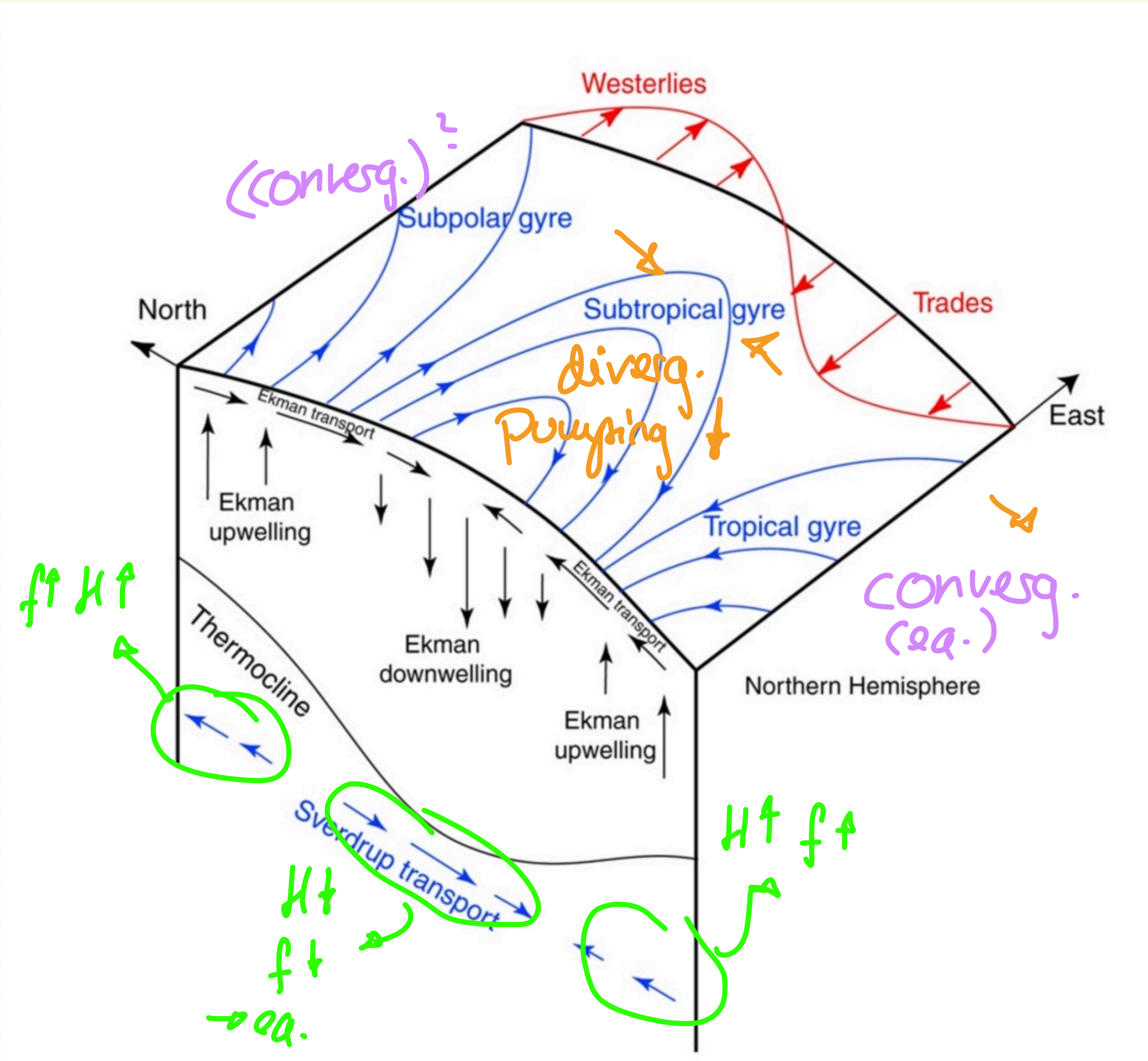
Stommel: $\beta V = \frac{\partial \tau_0^y}{\partial x} - \frac{\partial \tau_0^x}{\partial y} - r\zeta$ + horizontale Reibung

Munk: $\beta V = \frac{\partial \tau_0^y}{\partial x} - \frac{\partial \tau_0^x}{\partial y} + A_h \Delta \zeta$ + horizontale Viskos.

$R \to$ Rayleigh friction

$A_h \to$ lateral turb. viscosity

} Reibung, um westl. Randströme zu erklären


Westerlies
Trades
North
East
Subpolar gyre
Subtropical gyre
Tropical gyre
Ekman transport
Ekman transport
Ekman upwelling
Ekman downwelling
Ekman upwelling
Thermocline
Sverdrup transport
Northern Hemisphere
(converg.)?
diverg.
Pumping
converg.
(eq.)
f↑ H↑
H↓ f↓
→eq.
H↑ f↑

[NHK]

Also: 1) Sverdrup: Nettotransport zum Äquator (nach Süden)

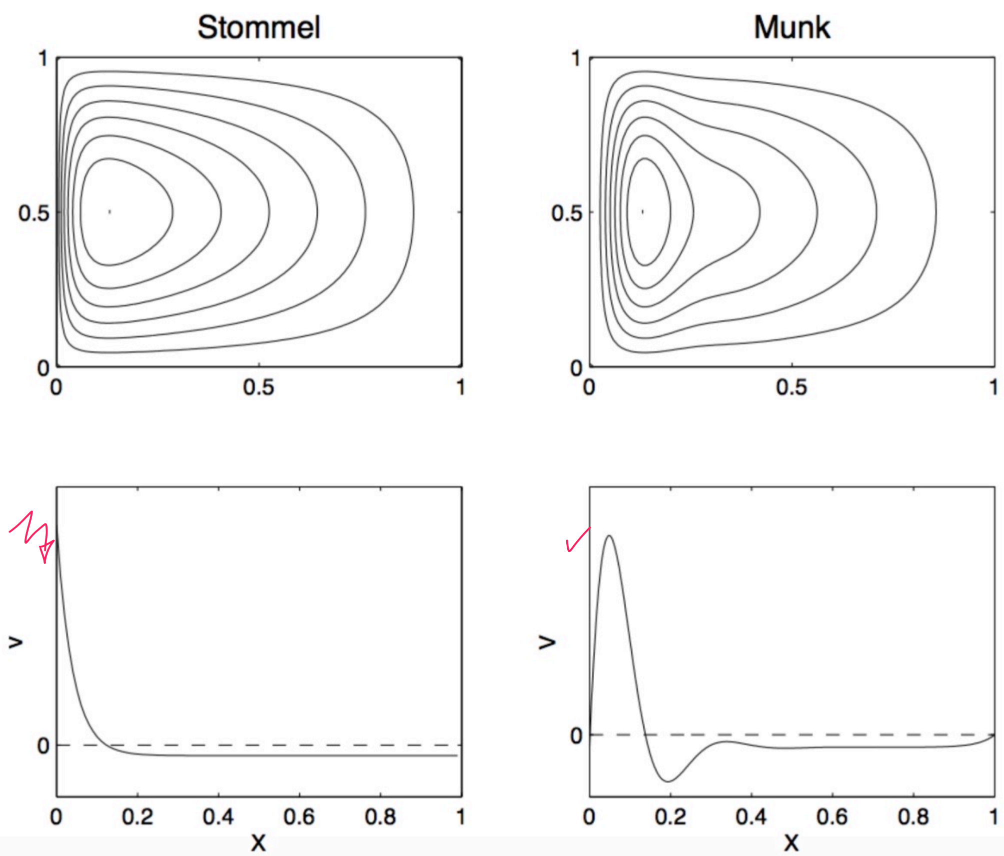
2) Ausgleich nötig $\rightsquigarrow$ starker Randstrom nach Norden

Three cases:

1. Sverdrup: $\beta V = \partial_x \tau_0^y - \partial_y \tau_0^x$ with $w_E^{top} = \frac{\beta}{f} V_G$
2. Stommel: $\beta V = \partial_x \tau_0^y - \partial_y \tau_0^x - r\zeta$
3. Munk: $\beta V = \partial_x \tau_0^y - \partial_y \tau_0^x + A_h \Delta \zeta$

with $A_h = 0 \rightarrow$ Stommel's equation (left)

and $R = 0 \rightarrow$ Munk's equation (right)



$$\beta \frac{\partial \psi}{\partial x} = \boxed{\beta V \approx -R \frac{\partial v}{\partial x}}$$

Δf friction

balance in wbc

weil Sverdrup $V<0$
↳ nach Süden

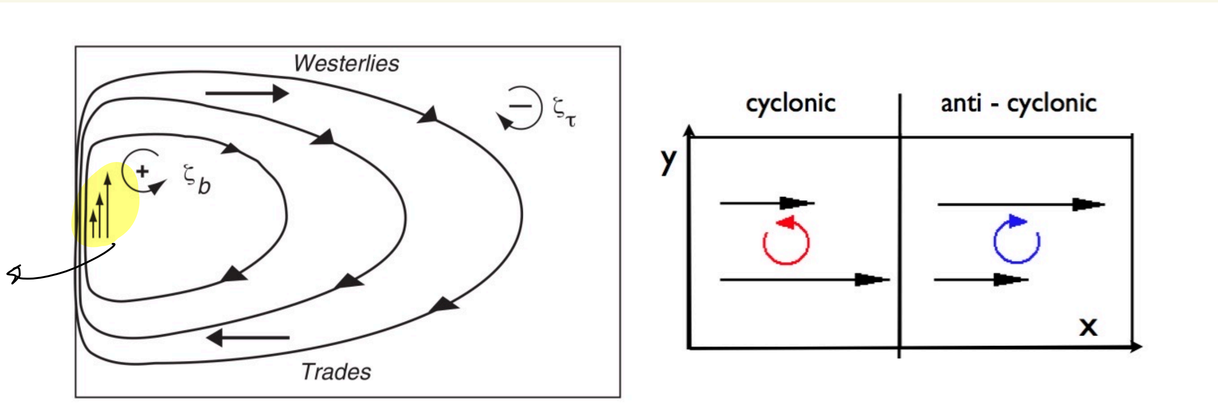
Western bound. curr: $V>0$

$\rightarrow \beta V > 0$

Nördlicher Transport

Nördlich
innen: Sv südlich

Reibung



wind → anti-cycl. spin → negative vorticity [→ conservation]

positive vorticity from western boundary current