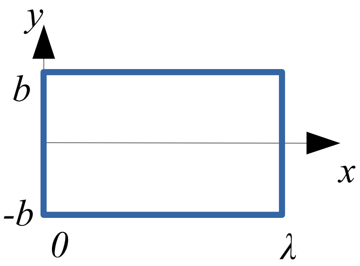
1.4. Vjetrovno strujanje u oceanima: Munkov model

Stacionarno strujanje u oceanima izazvano sustavom stalnih vjetova

Zajedničko sa Sverdrupom:

- $\rho \neq const.$: ∃ d, $(\vec{\nabla}_H p)_{z=-d} = 0$ (d ~ 1000 m)
- realistična razdioba vjetra nad oceanom



Zajedničko sa Stommelom:

- pravokutni ocean

Novo:

- lateralno trenje uz bočne granice → jedn. gibanja, r.u.

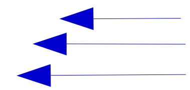
- jednadžbe gibanja i kontinuiteta za transport mase
- rubni uvjeti u z = 0 i z = -d
- jednadžba za strujnu funkciju:

$$K\left(\frac{\partial^4 \Psi}{\partial x^4} + 2\frac{\partial^4 \Psi}{\partial x^2 \partial y^2} + \frac{\partial^4 \Psi}{\partial y^4}\right) - \beta\frac{\partial \Psi}{\partial x} + \left(\frac{\partial \tau_y}{\partial x} - \frac{\partial \tau_x}{\partial y}\right) = 0$$

DINAMIKA: rotor lateralnog trenja | planetarna vrtložnost | rotor vjetra

1.4. Vjetrovno strujanje u oceanima: Munkov model

Vjetrovno forsiranje: $\vec{\tau} \equiv \tau_x \vec{i}\ , \tau_x = \tau_x(y)$



Rubni uvjeti na bočnim granicama: $\vec{M} \cdot \vec{n} = 0\ ,\ \ \vec{M} \cdot \vec{t} = 0$ (! lateralno trenje)

...

...

Rješenje za strujnu funkciju: $\Psi(x, y) = \frac{\lambda}{\beta}\ X(x)\ \frac{d\,\tau_x}{dy}$

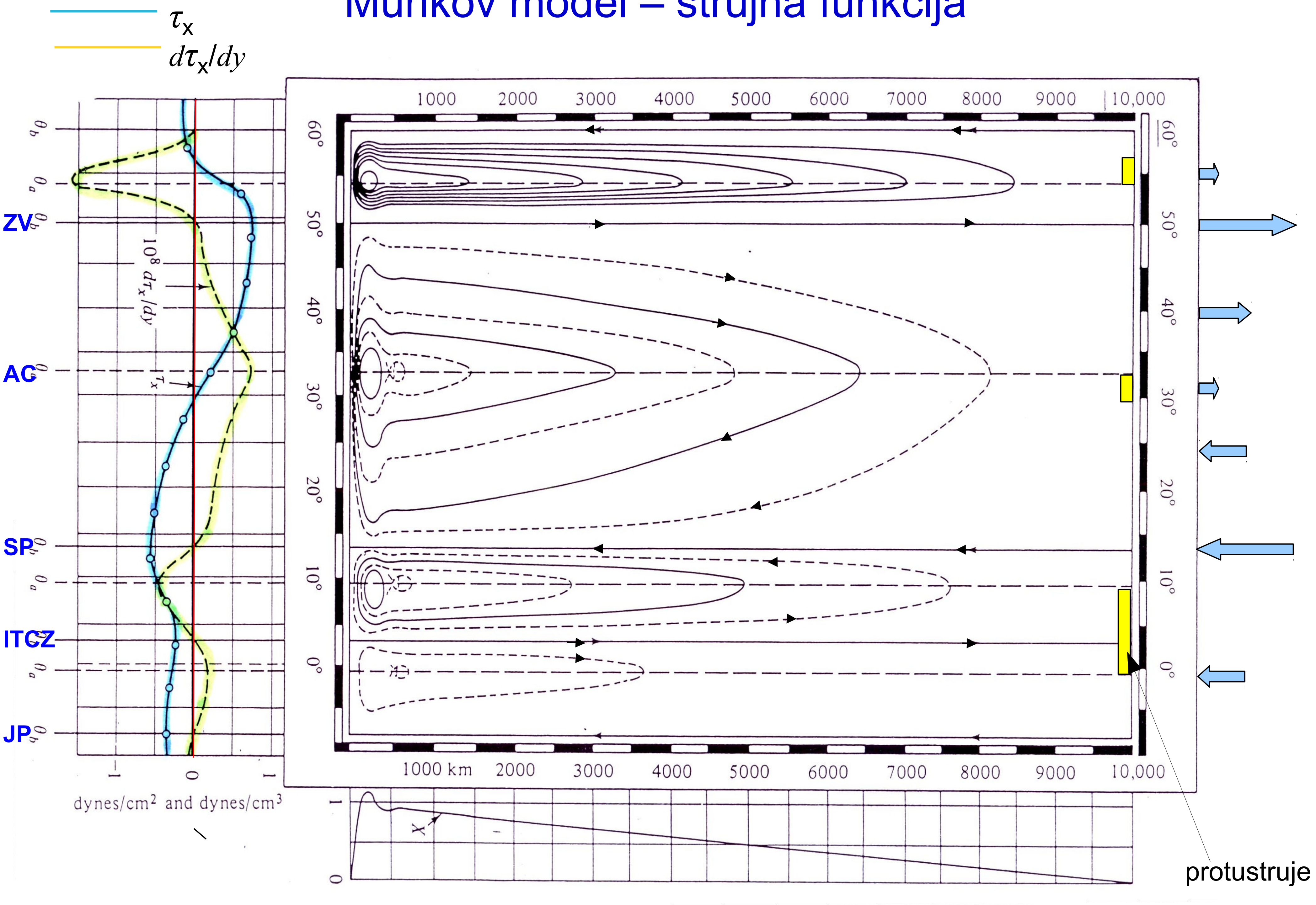
$$M_x = -\frac{\partial \Psi}{\partial y} = -\frac{\lambda}{\beta}\ X(x)\ \frac{d^2 \tau_x}{dy^2}\ , \qquad M_y = \frac{\partial \Psi}{\partial x} = \frac{\lambda}{\beta}\ X'(x)\ \frac{d\,\tau_x}{dy}$$

Za realističnu razdiobu vjetra:

$\exists\ \varphi_b$ t.d. $d\tau_x/dy = 0 \ \rightarrow\ M_y = 0\ ,\ \ \vec{M} \equiv M_x \vec{i}$ $\quad\varphi_b$: razdjelnice cirkulacijskih ćelija

$\exists\ \varphi_a$ t.d. $d^2\tau_x/dy^2 = 0 \ \rightarrow\ M_x = 0\ ,\ \ \vec{M} \equiv M_y \vec{j}$ $\quad\varphi_a$: središta cirkulacijskih ćelija

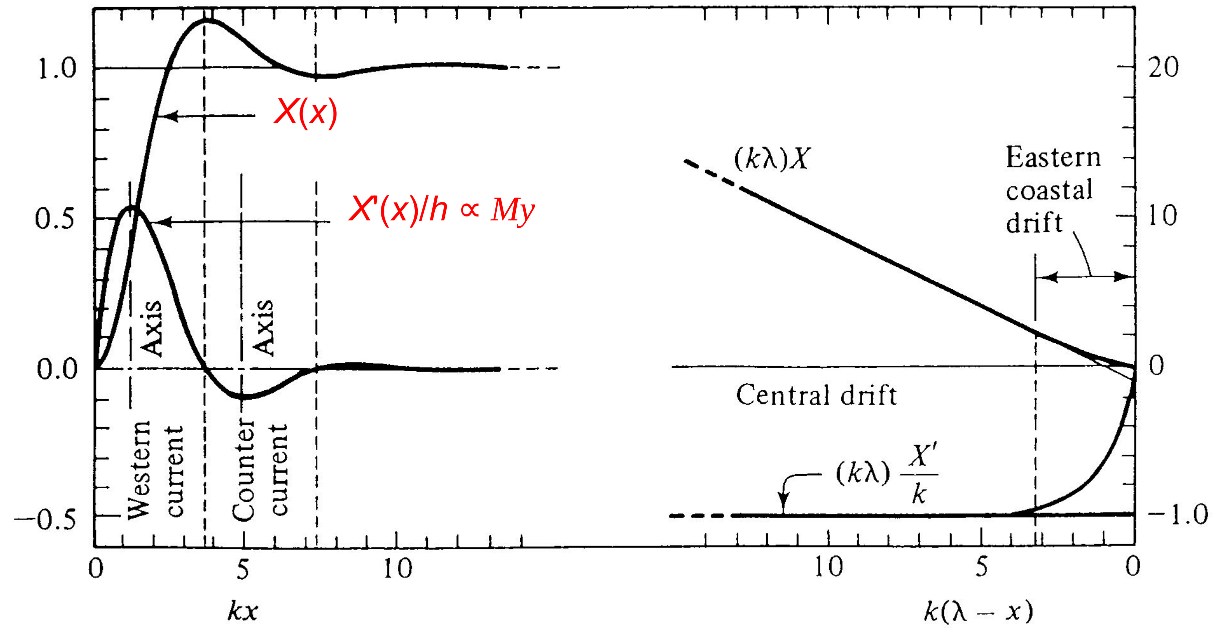
Munkov model – strujna funkcija



Munkov model – zonalna promjenjivost

$$\Psi(x,y) = \frac{\lambda}{\beta}\, X(x) \left(\frac{d\tau_x}{dy}\right)$$

zonalna meridionalna promjenjivost



$$X_n(x) = \underbrace{-Ae^{-kx/2}\cos\left(\frac{\sqrt{3}}{2}kx + \frac{\sqrt{3}}{2k\lambda} - \frac{\pi}{6}\right)}_{W} + \underbrace{1 - \frac{1}{k\lambda}(kx}_{C}\underbrace{- e^{-k(\lambda-x)} - 1)}_{E} \equiv X(x)$$

$$X'(x) = \underbrace{k[Ae^{-kx/2}\sin\left(\frac{\sqrt{3}}{2}kx + \frac{\sqrt{3}}{2k\lambda}\right)}_{W} \underbrace{- \frac{1}{k\lambda}(1}_{C} \underbrace{- e^{-k(\lambda-x)})]}_{E}$$

C: $X'(x \simeq \lambda/2) = -\frac{1}{\lambda}$

$$M_y = \lambda\beta^{-1}X'\,\frac{d\tau_x}{dy}$$

$$M_y = -\frac{1}{\beta}\frac{d\tau_x}{dy}$$

Sverdrup

Munkov model: Dinamika

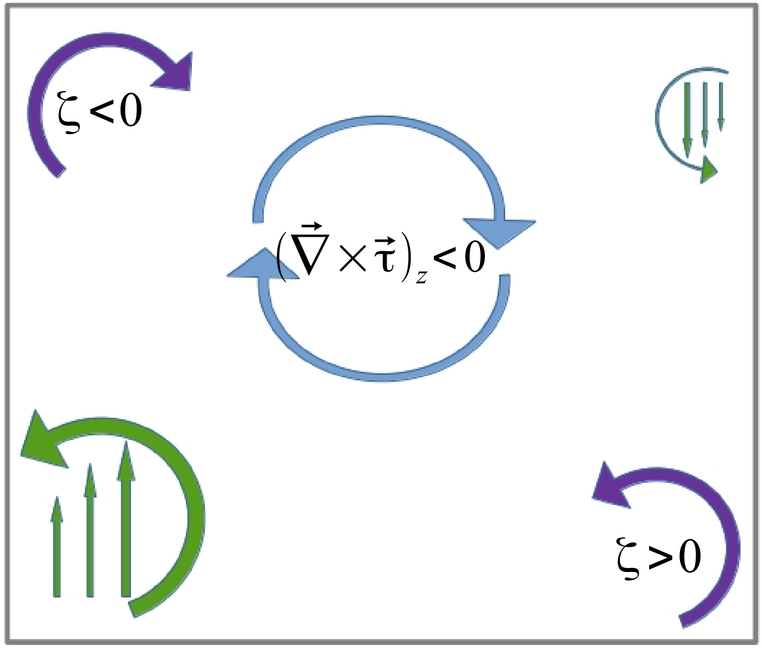
$$K\left(\frac{\partial^4\Psi}{\partial x^4}+2\frac{\partial^4\Psi}{\partial x^2\partial y^2}+\frac{\partial^4\Psi}{\partial y^4}\right)-\beta\frac{\partial\Psi}{\partial x}+\left(\frac{\partial\tau_y}{\partial x}-\frac{\partial\tau_x}{\partial y}\right)=0$$

DINAMIKA: rotor lateralnog trenja, planetarna vrt., rotor vjetra

$$\boxed{1} + \boxed{2} + \boxed{3} = 0$$

C, E: $\boxed{2} \approx -\boxed{3}\ ,\ \boxed{1} \ll$

W: $\boxed{1} = -(\boxed{2}+\boxed{3})$



$$\frac{\zeta+f}{H}=const.$$