Prvo predavanje
(11. ožujka 2022.)

Dinamika obalnog mora

Prisilna i slobodna gibanja uzrokovana vjetrom

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   1. Uvod
   2. Sverdrupov model
   3. Stommelov model
   4. Munkov model
2. Vjetrovno strujanje u okrajnjim morima
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   3. Model ruske škole
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3. Seši u okrajnjim bazenima
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   4. Prigušenje seša u pravokutnom bazenu
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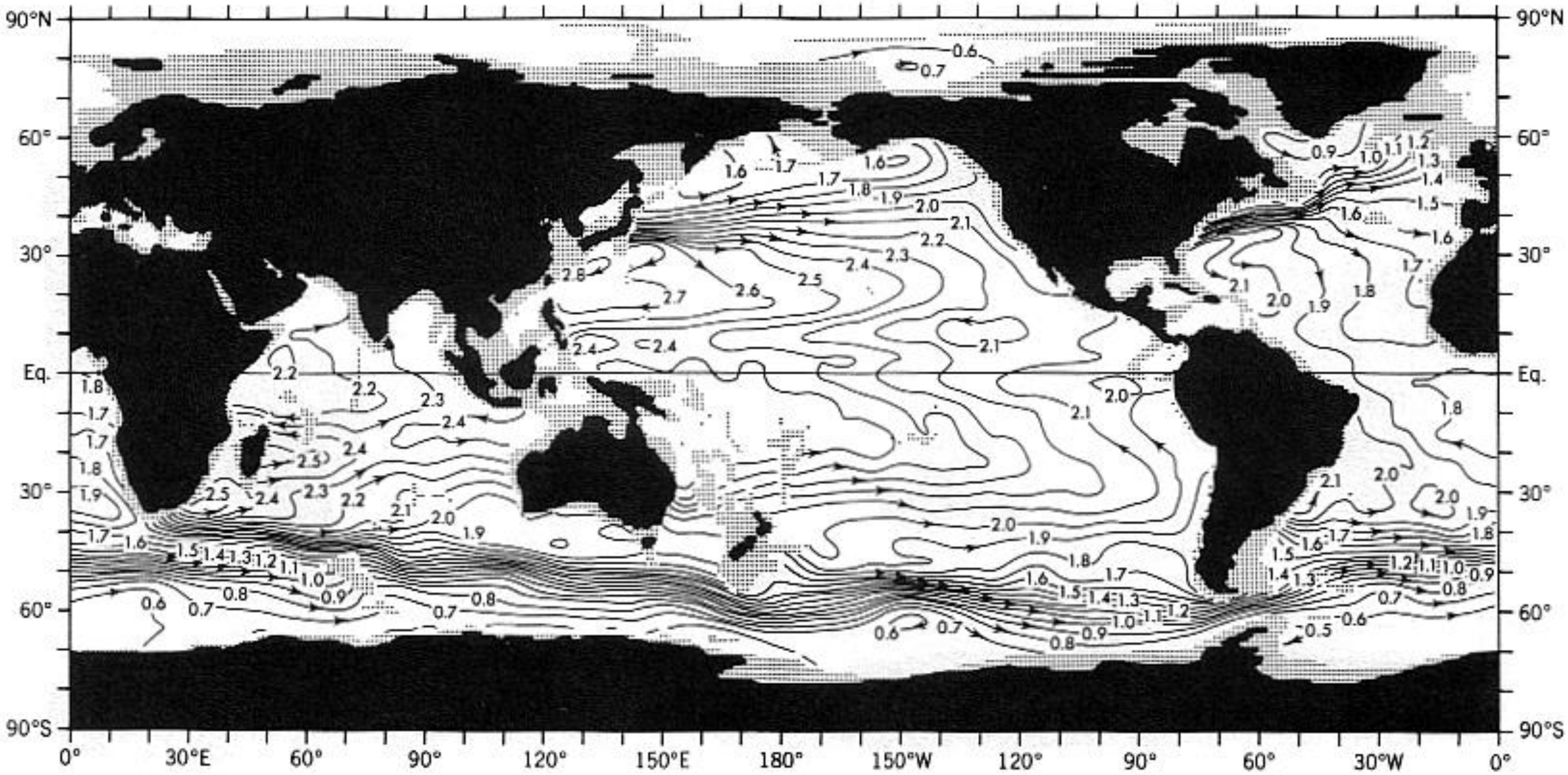
   3. Valovi u kružnom bazenu

1. Vjetrovno strujanje u oceanima
1.1. Uvod

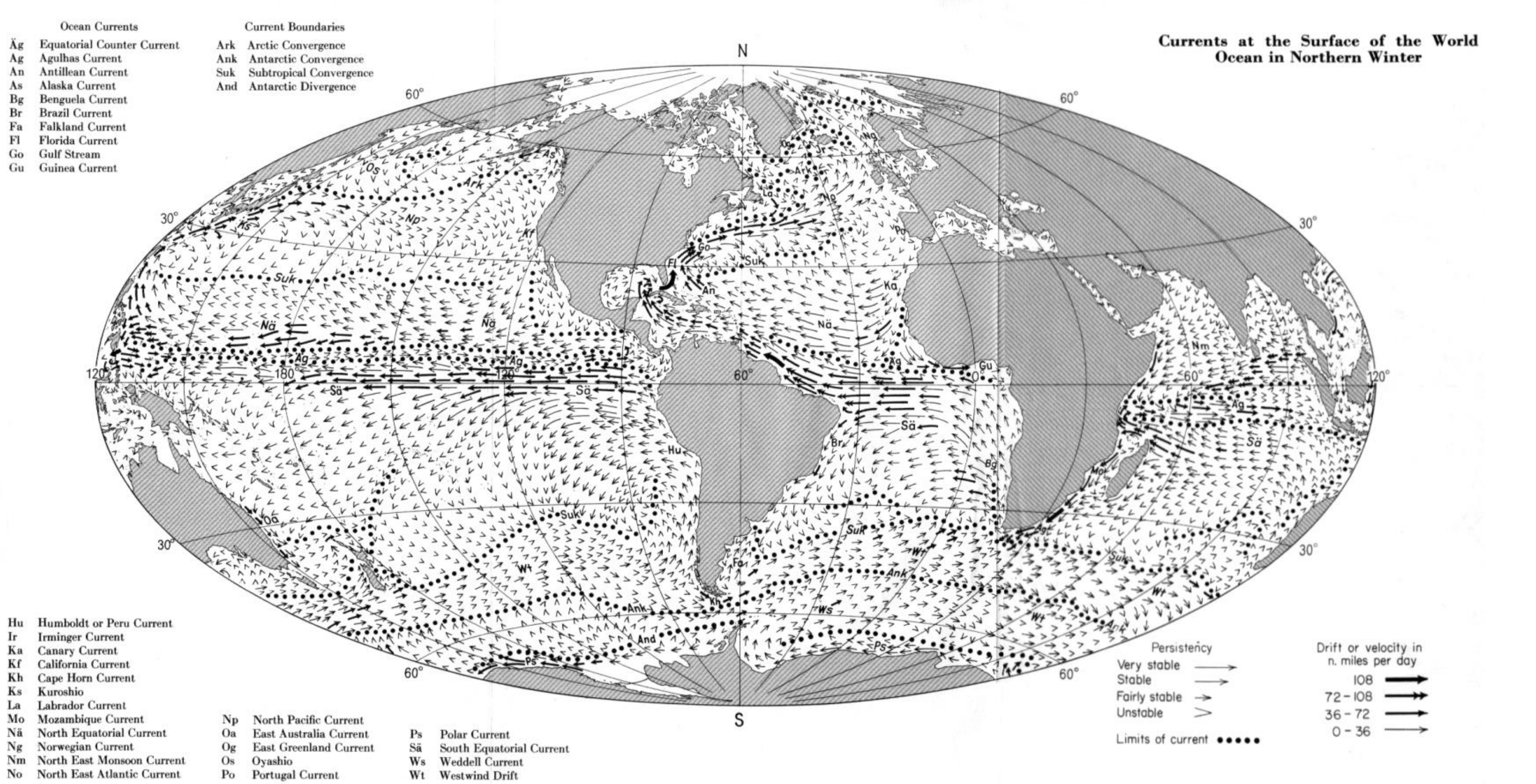
Površina oceana – klasična metoda dinamičkog računa



Levitus, 1982.

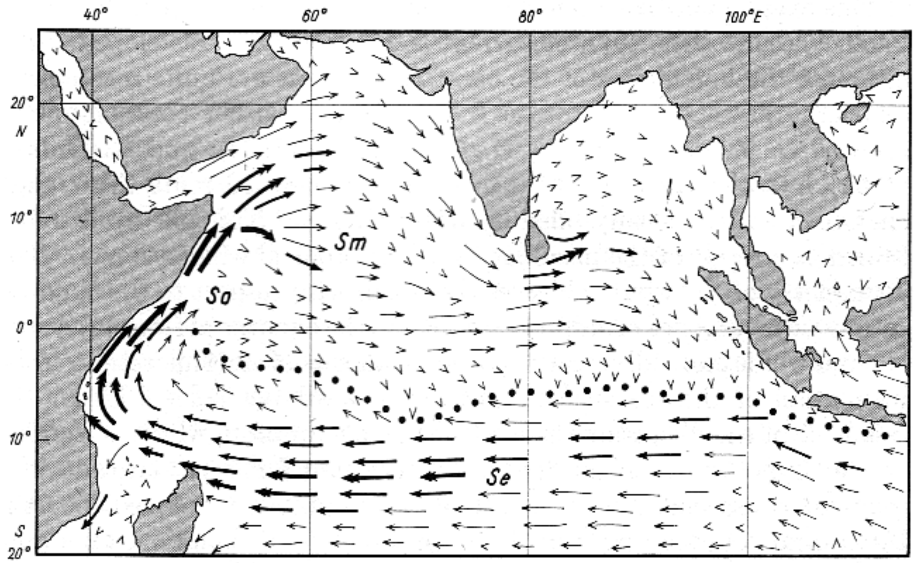
Površina oceana – podaci o zanošenju broda

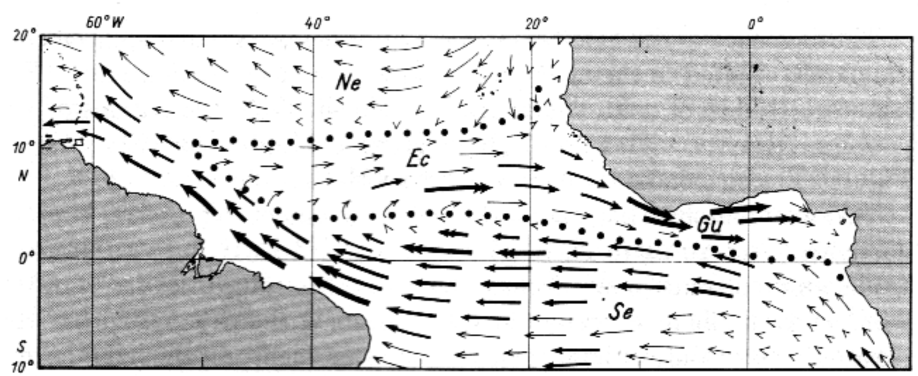
Zima



Dietrich, 1963.

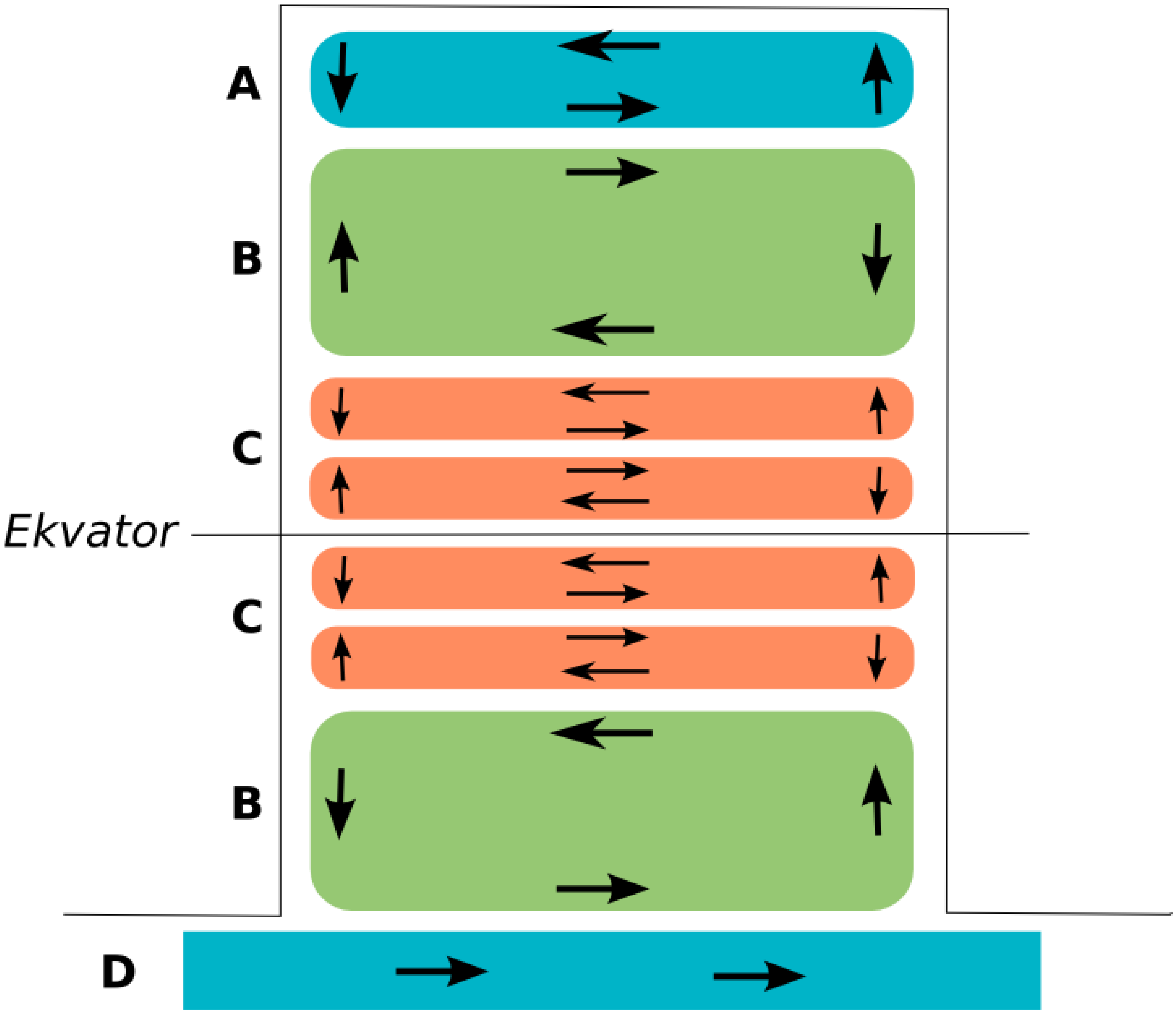
Ljeto



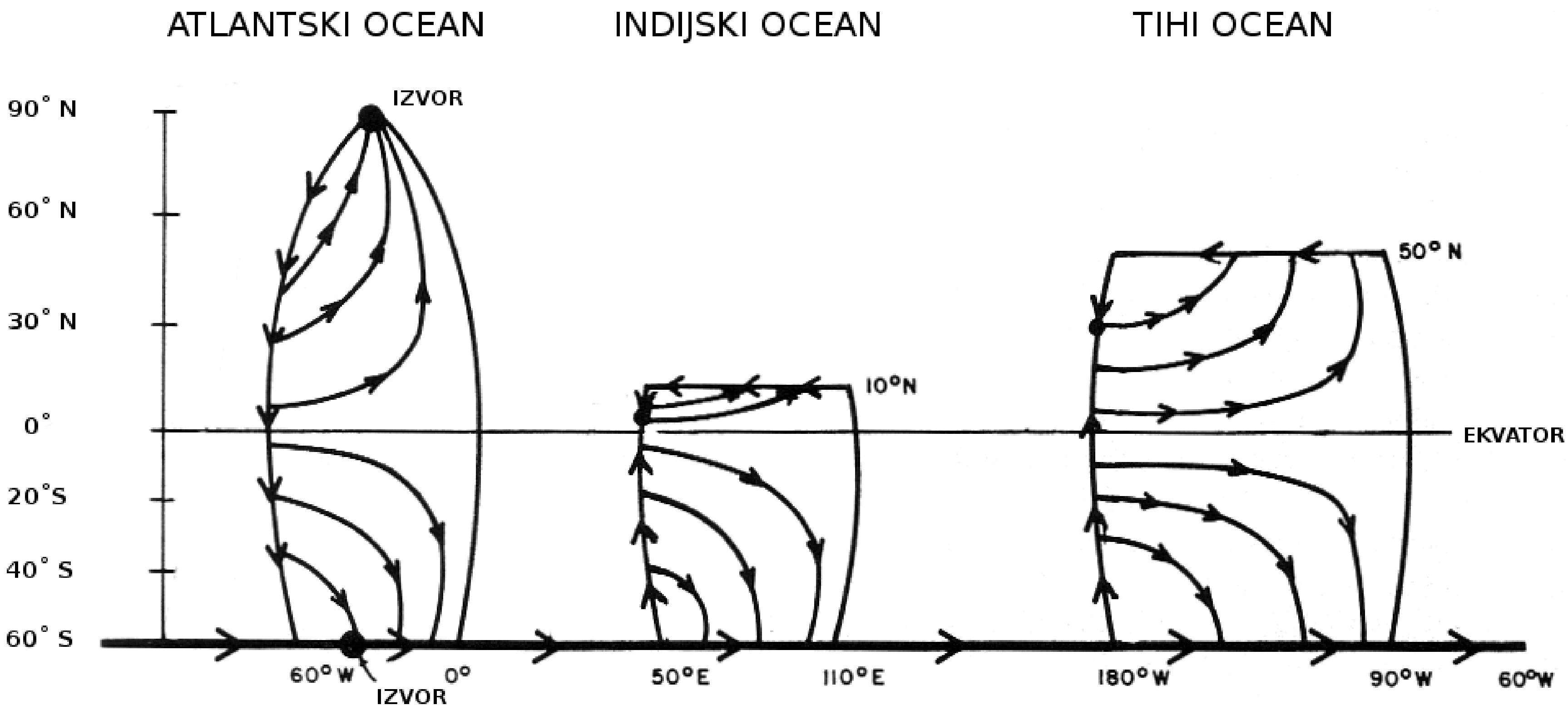


Dietrich, 1963.

Površina oceana – shema



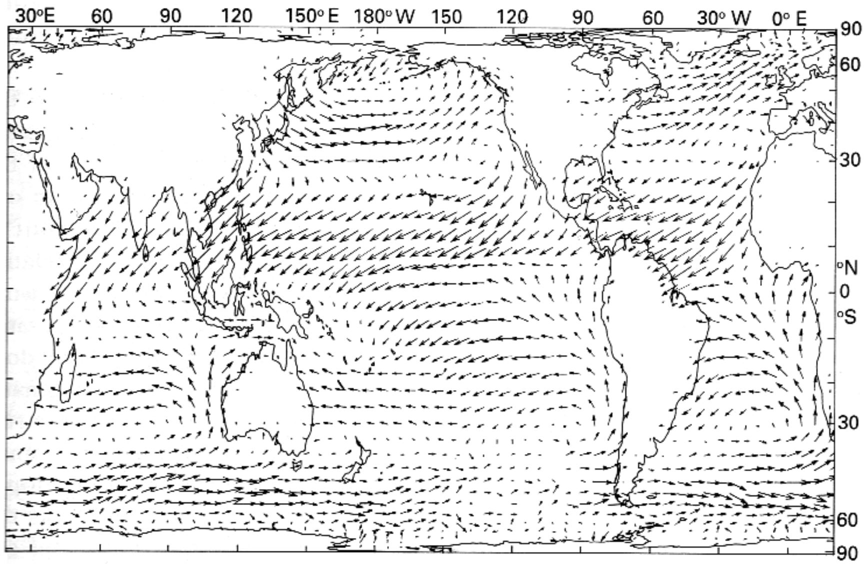
Dno oceana



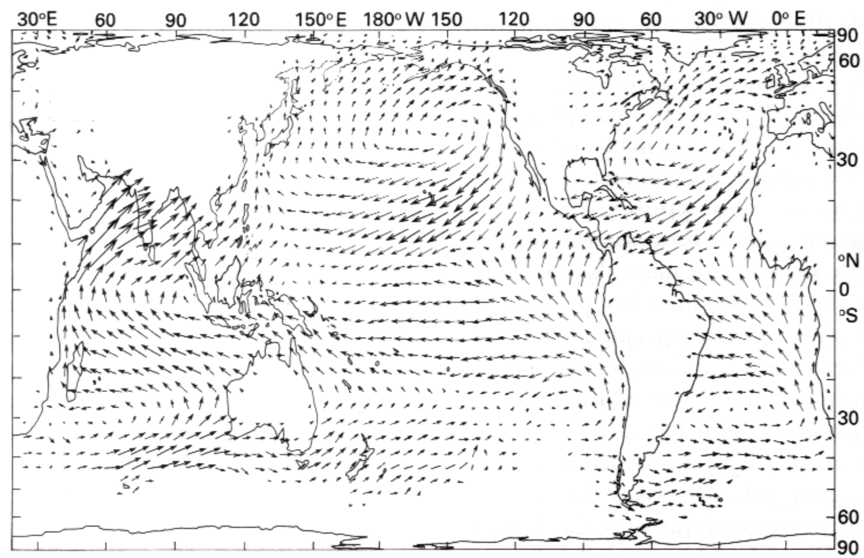
Veronis, 1975.

Dinamika – vjetar

Vjetar nad oceanima



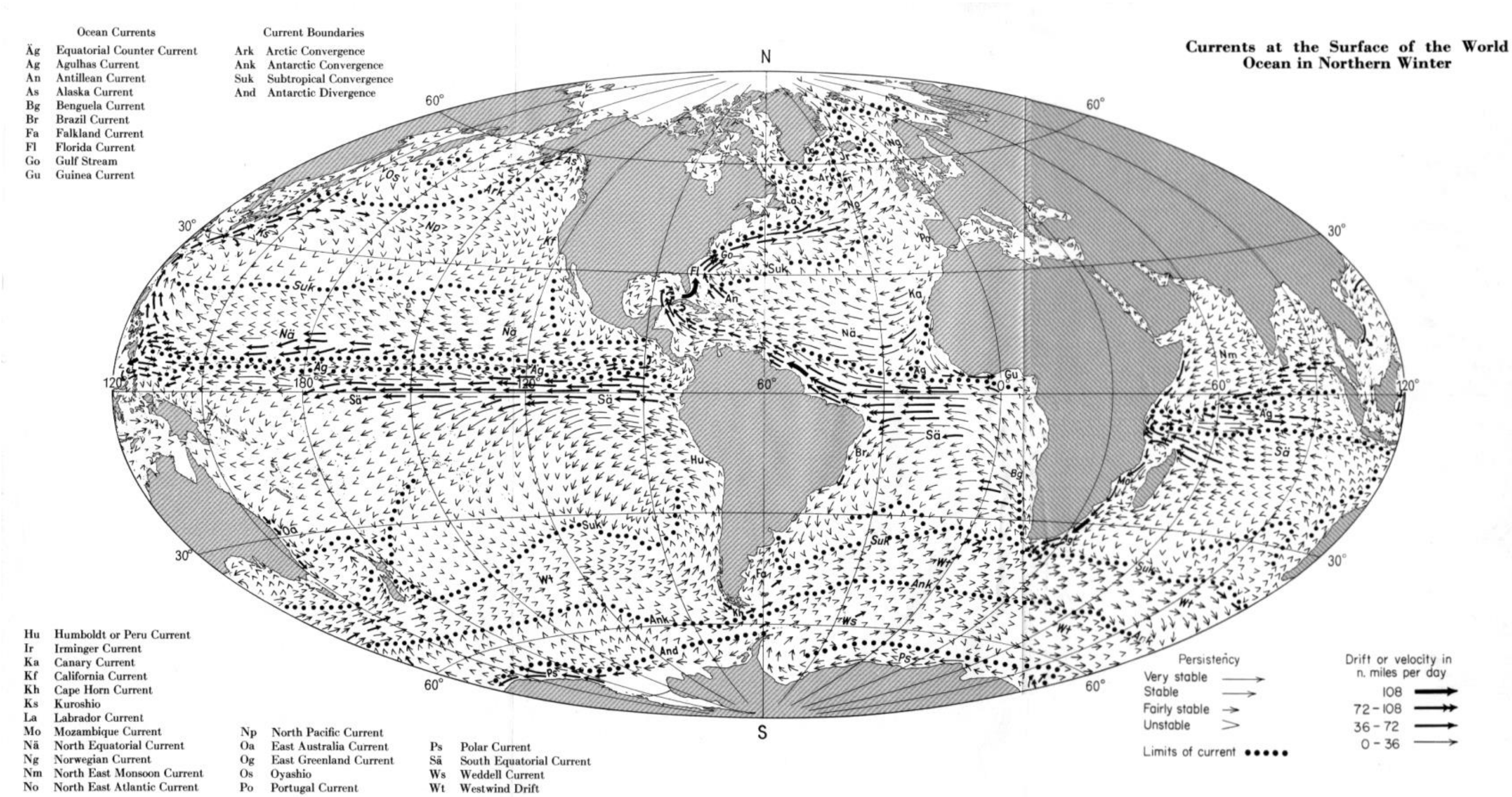
siječanj



srpanj

Tomczak & Godfrey, 1994.

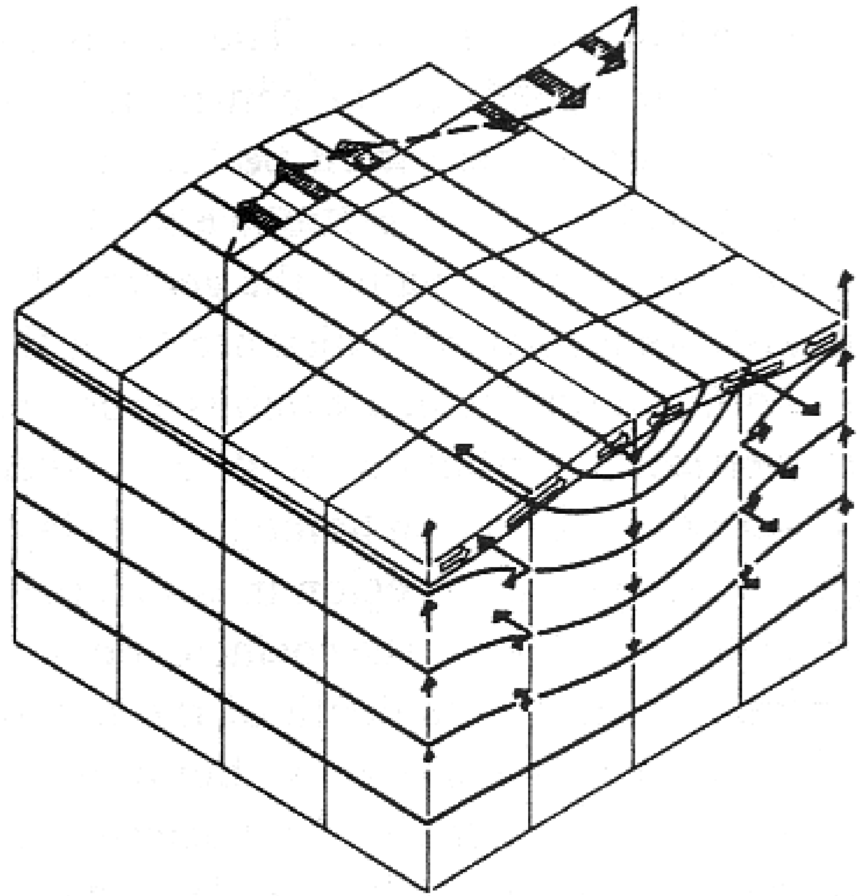
Površinske struje u oceanima



Dietrich, 1963.

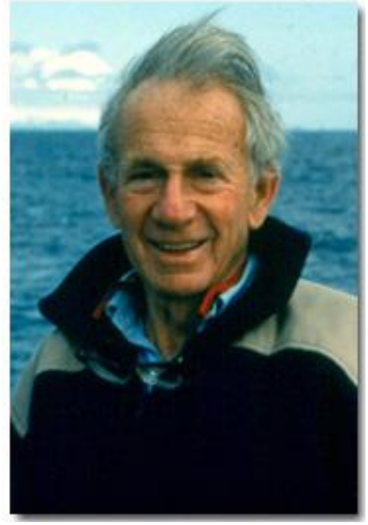
Izvorni Ekmanov model

V. W. Ekman, 1905.



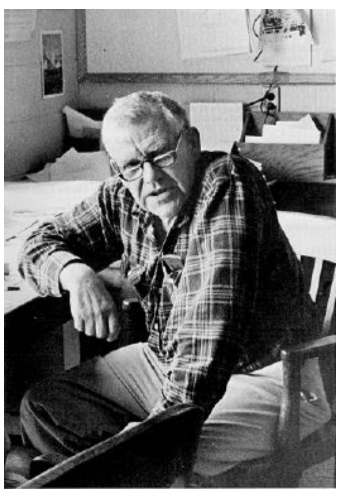
Stommel, 1957.

Kasniji analitički modeli

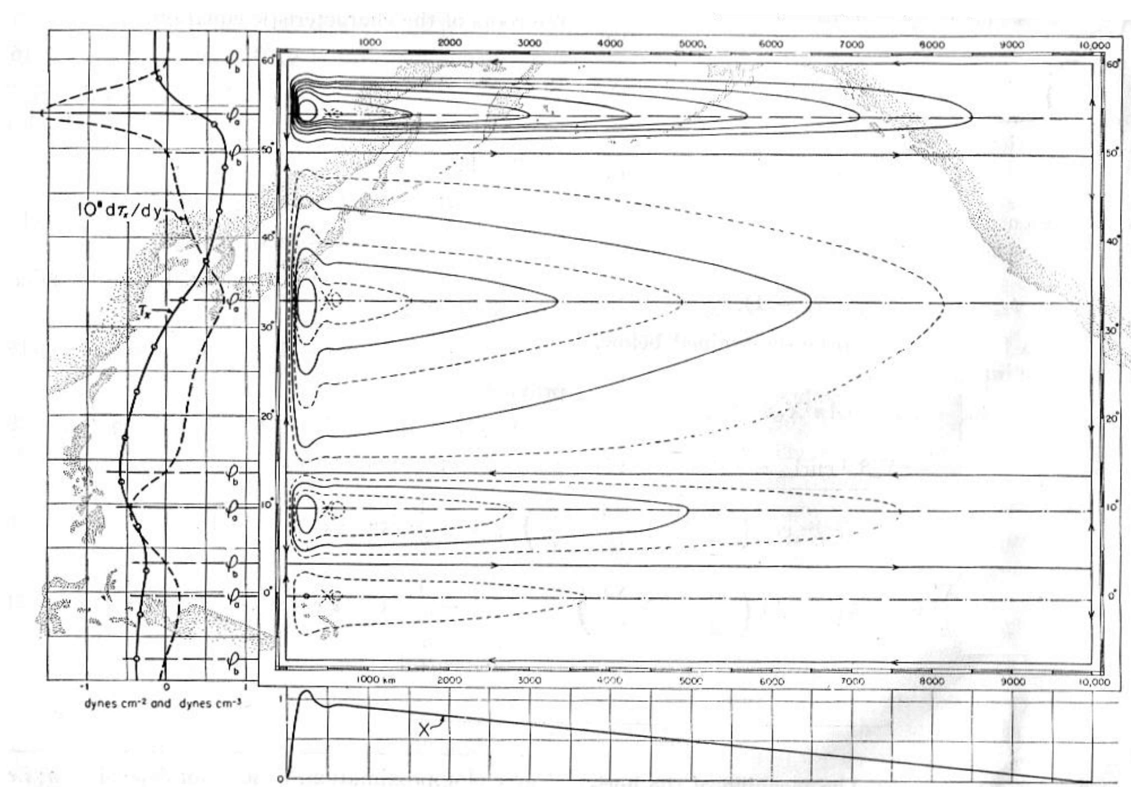


W.H. Munk, 1950.

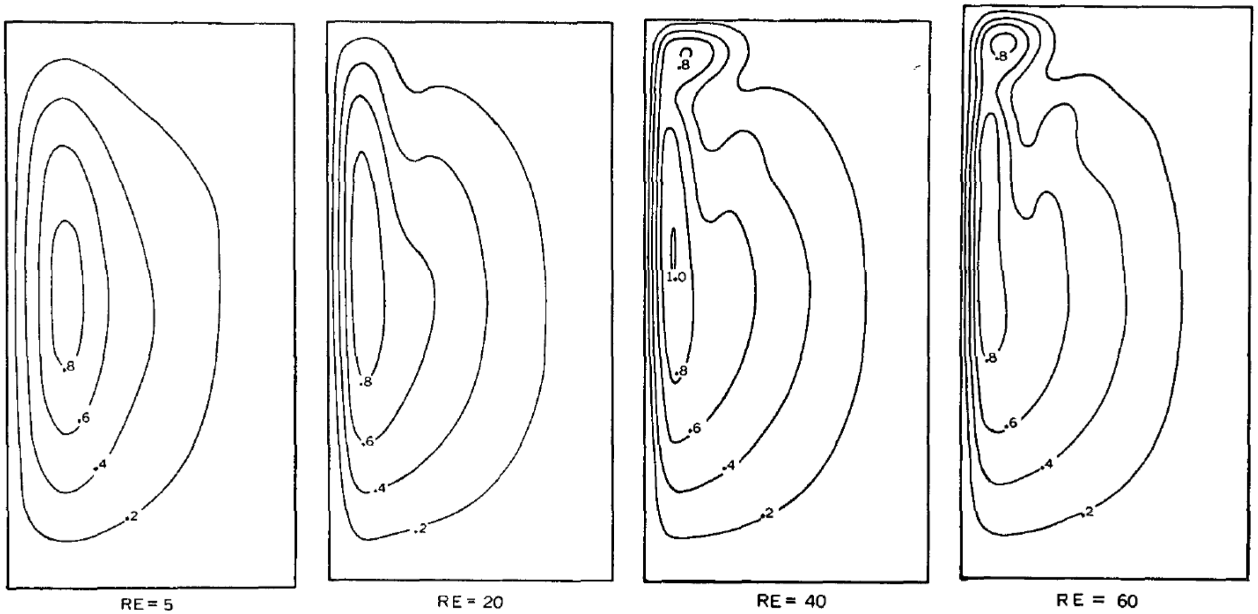
H. U. Sverdrup, 1947.



H. Stommel, 1948.



Počeci numeričkog modeliranja



K. Bryan, 1963.

1.2. Sverdrupov model (H. U. Sverdrup, 1947)

Početne jednadžbe

$$\frac{\partial p}{\partial x} = \rho f v + \frac{\partial}{\partial z}\left(A\frac{\partial u}{\partial z}\right)$$

$$\frac{\partial p}{\partial y} = -\rho f u + \frac{\partial}{\partial z}\left(A\frac{\partial v}{\partial z}\right)$$

$$\frac{\partial p}{\partial z} = -\rho g$$

$$\frac{\partial\left(\rho u\right)}{\partial x} + \frac{\partial\left(\rho v\right)}{\partial y} + \frac{\partial\left(\rho w\right)}{\partial z} = 0$$

Odnos barotropnog i baroklinog doprinosa gradijentu tlaka (posebno na dubini *d*)

$$d_z p = -g\rho dz \quad \Big/ \int_{-h}^{\zeta} \quad \Longrightarrow \quad p = p_a + g\int_{-h}^{\zeta} \rho dz, h = konst.$$

$$\frac{\partial p_a}{\partial x} = \frac{\partial p_a}{\partial y} = 0 \quad \Longrightarrow \quad \frac{\partial p}{\partial x} = g\frac{\partial}{\partial x}\int_{-h}^{\zeta} \rho dz = g\int_{-h}^{\zeta} \frac{\partial \rho}{\partial x} dz + g\rho_{\zeta}\frac{\partial \zeta}{\partial x}$$

$$\frac{\partial p}{\partial y} = g\frac{\partial}{\partial y}\int_{-h}^{\zeta} \rho dz = g\int_{-h}^{\zeta} \frac{\partial \rho}{\partial y} dz + g\rho_{\zeta}\frac{\partial \zeta}{\partial y}$$

Jednadžbe gibanja i kontinuiteta nakon integracije duž vertikale

$$\frac{\partial}{\partial x}\int_{-d}^{\zeta} p dz - p_a \frac{\partial \zeta}{\partial x} - p_{-d}\frac{\partial d}{\partial x} = f M_y + \tau_x$$

$$\frac{\partial}{\partial y}\int_{-d}^{\zeta} p dz - p_a \frac{\partial \zeta}{\partial y} - p_{-d}\frac{\partial d}{\partial y} = -f M_x + \tau_y$$

$$\frac{\partial M_x}{\partial x} + \frac{\partial M_y}{\partial y} = 0$$

Poprečnim deriviranjem dobiva se Sverdrupova jednadžba:

$$\frac{df}{dy}M_y + \left(\frac{\partial \tau_x}{\partial y} - \frac{\partial \tau_y}{\partial x}\right) = 0$$

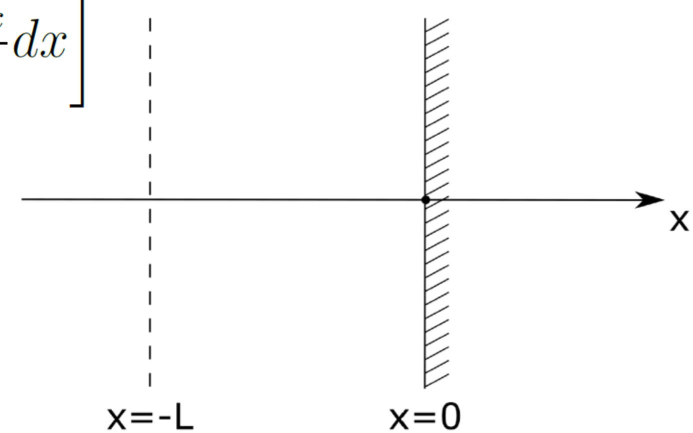
Iz Sverdrupove jednadžbe neposredno slijedi:

$$M_y = -\frac{\partial \tau_x / \partial y}{\beta} = -\frac{\partial \tau_x}{\partial y}\frac{R}{2\omega\cos\varphi}$$

Jednadžba kontinuiteta i prethodno rješenje daju:

$$\frac{\partial M_x}{\partial x} = -\frac{\partial M_y}{\partial y} = \frac{\partial^2 \tau_x}{\partial y^2}\frac{R}{2\omega\cos\varphi} + \frac{\partial \tau_x}{\partial y}\frac{\sin\varphi}{2\omega\cos^2\varphi}$$

$$M_x\Big|_{-L}^{0} = \frac{1}{2\omega\cos\varphi}\left[R\int_{-L}^{0}\frac{\partial^2\tau_x}{\partial y^2}dx + \tan\varphi\int_{-L}^{0}\frac{\partial\tau_x}{\partial y}dx\right]$$



$$\boxed{M_x(x=-L) = -\frac{L}{2\omega\cos\varphi}\left[R\left\langle\frac{\partial^2\tau_x}{\partial y^2}\right\rangle + \tan\varphi\left\langle\frac{\partial\tau_x}{\partial y}\right\rangle\right]}$$

Dvije komponente transporta mase (tone po sekundi kroz vertikalnu plohu 1 x 1000 m; R. O. Reid, 1948)