Arus 1

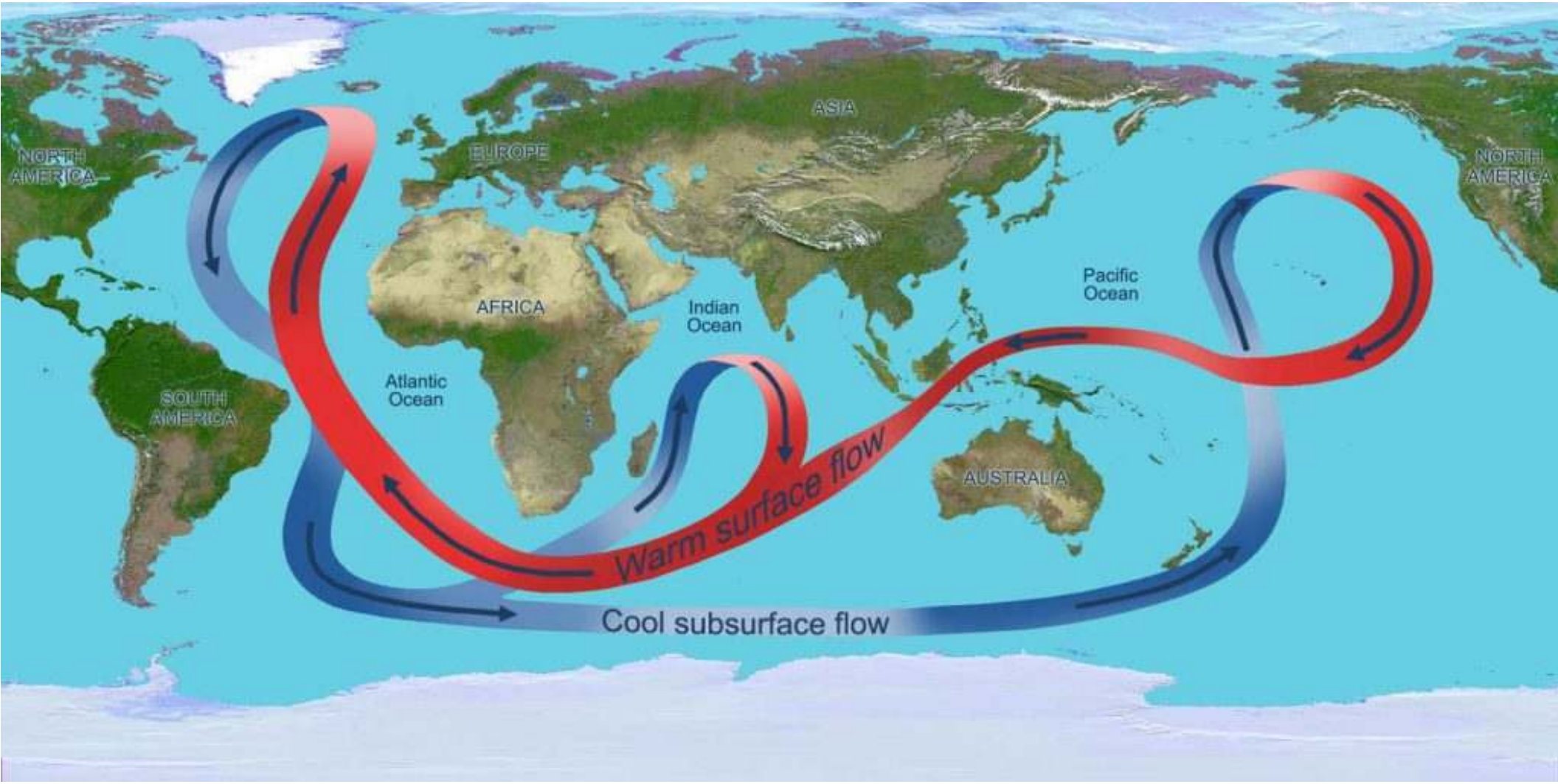
(*Current or Ocean Circulation*)

ARUS → Massa air yang bergerak dari suatu tempat ke tempat yang lain di dalam laut

Apa penyebabnya?

- **Angin (*Wind-driven Circulation*): di permukaan (*surface circulation*)**
- **Perbedaan tekanan horizontal:**
  - **Arus densitas (*Density Current*):**
  - **Arus geostropik** (terjadi akibat pengaruh gradien tekanan mendatar dan gaya Coriolis).
  - **Sirkulasi perairan dalam (*Deep Sea Circulation*)**
  - **Sirkulasi termohalin** (*Thermohaline Circulation)*

densitas=fungsi (suhu, salinitas, tekanan);



Currents that move up and down in the water column, also called vertical currents, are created by differences in the density of water masses, where heavier waters sink and lighter waters rise. This type of ocean circulation is called thermohaline circulation (therme=heat, halos=salt) because the vertical movement is caused by differences in **temperature** and salinity (the amount of salt in water). Adding heat decreases the density of water, while adding salt increases the density of water. Thermohaline circulation occurs because winds move warm surface waters from the equator towards the poles, where the water cools and increases in density. Some of this water gets so cold that it freezes, leaving its salt behind in the remaining water, further increasing the density of this water. This cold, salty water near the poles (primarily in the North Atlantic and near Antarctica) sinks and spreads along the bottom and eventually rises back towards the surface of the ocean. It takes about 1000 years for water to circulate around what is called the global conveyor belt that moves water three dimensionally throughout the world's ocean basins.

https://ugc.berkeley.edu/background-content/ocean-circulation/

PERSAMAAN GERAK ARUS

- HUKUM NEWTON 2:

$$\vec{F} = m\vec{a}$$

$\vec{F}$ = Gaya yang bekerja

m = massa

$\vec{a}$ = percepatan

Jika gaya $\vec{F}$ bekerja pada massa m, maka massa tersebut akan mengalami percepatan $\vec{a}$

Gaya-gaya yang bekerja

Semua Arus Laut dibangkitkan oleh keseimbangan 4 kelompok gaya:

- Perbedaan tekanan (Pressure gradient)
- Gaya Coriolis (gaya akibat bumi berputar pd porosnya shg membelokkan arus udara/air laut)
- Gesekan Angin (Wind stress)
- Gesekan Molekuler (Molecular Friction)

Gaya yang membangkitkan arus: Gaya Primer

- Gravitasi → gradien tek horizontal → gerak
- Gesekan angin (wind stress) → transfer momentum (energi) ke paras laut
- Buoyancy (gaya dorong ke atas atau ke bawah) thd parcel air → akibat perbedaan densitas dgn sekitar. Massa air dingin → densitas naik → tenggelam
- Tekanan atmosfir → gradien tek horizontal → gerak
- Seismic (pergeseran dasar samudera)

Gaya Sekunder: Gaya yang bekerja bila ada pergerakan

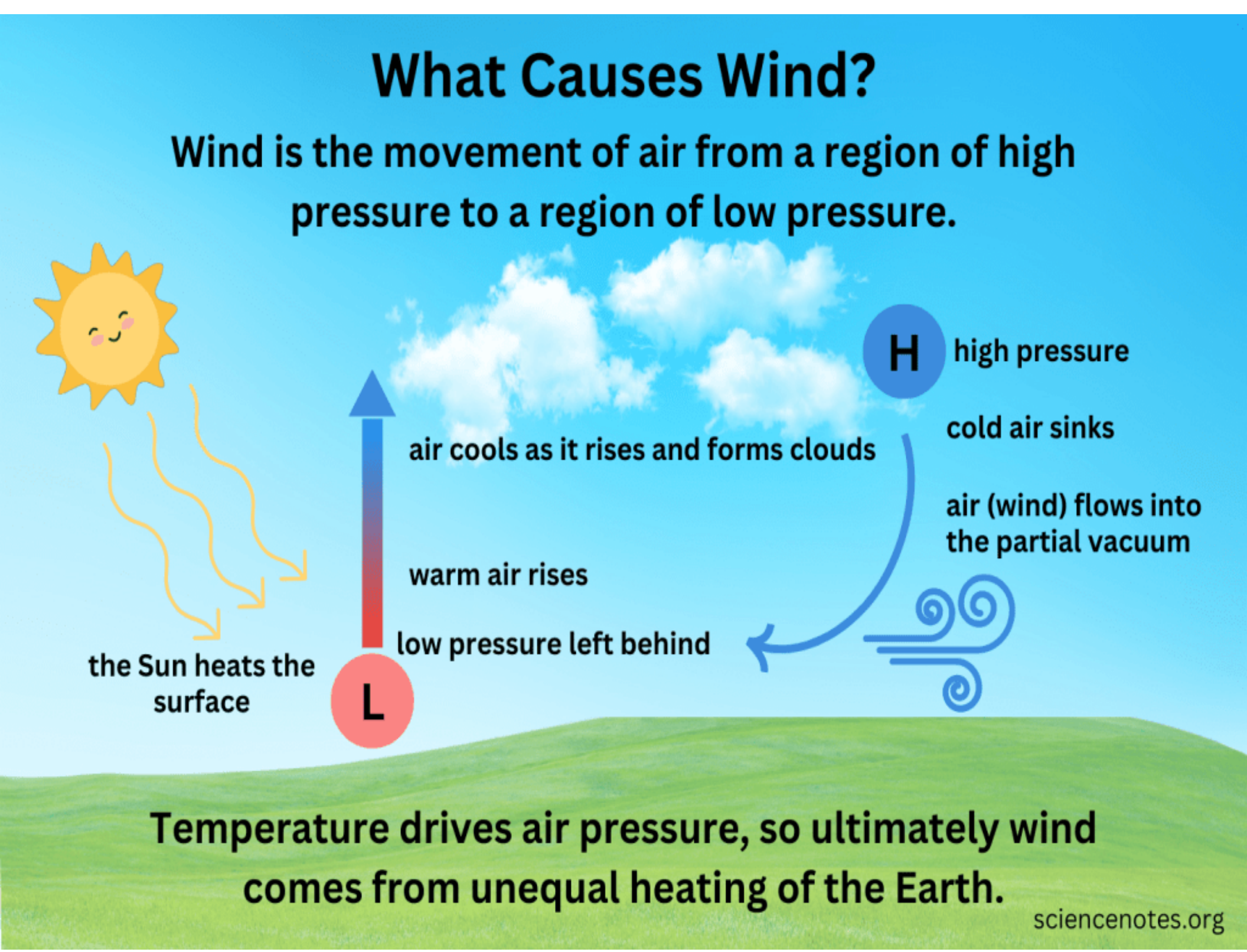
- Gaya Coriolis: gaya yg seolah-olah bekerja pada benda yg bergerak (pseudo- forces) bila gerak itu diamati relatif thd koordinat sistem yg berputar.
- Friction (friksi): bekerja mula2 pada boundary (tepi atau batas) lalu penetrasi ke dalam utk meredam gerak

Angin

- Angin adalah aliran udara dalam jumlah yang besar diakibatkan oleh rotasi bumi dan juga karena adanya perbedaantekanan udara di sekitarnya. Angin bergerak dari tempat bertekanan udara tinggi ke bertekanan udara rendah.
- Apabila dipanaskan, udara memuai. Udara yang telah memuai menjadi lebih ringan sehingga naik. Apabila hal ini terjadi, tekanan udara turun kerena udaranya berkurang. Udara dingin di sekitarnya mengalir ke tempat yang bertekanan rendah tadi. Udara menyusut menjadi lebih berat dan turun ke tanah. Di atas tanah udara menjadi panas lagi dan naik kembali. Aliran naiknya udara panas dan turunnya udara dingin ini disebut konveksi.

What Causes Wind?

Wind is the movement of air from a region of high pressure to a region of low pressure.



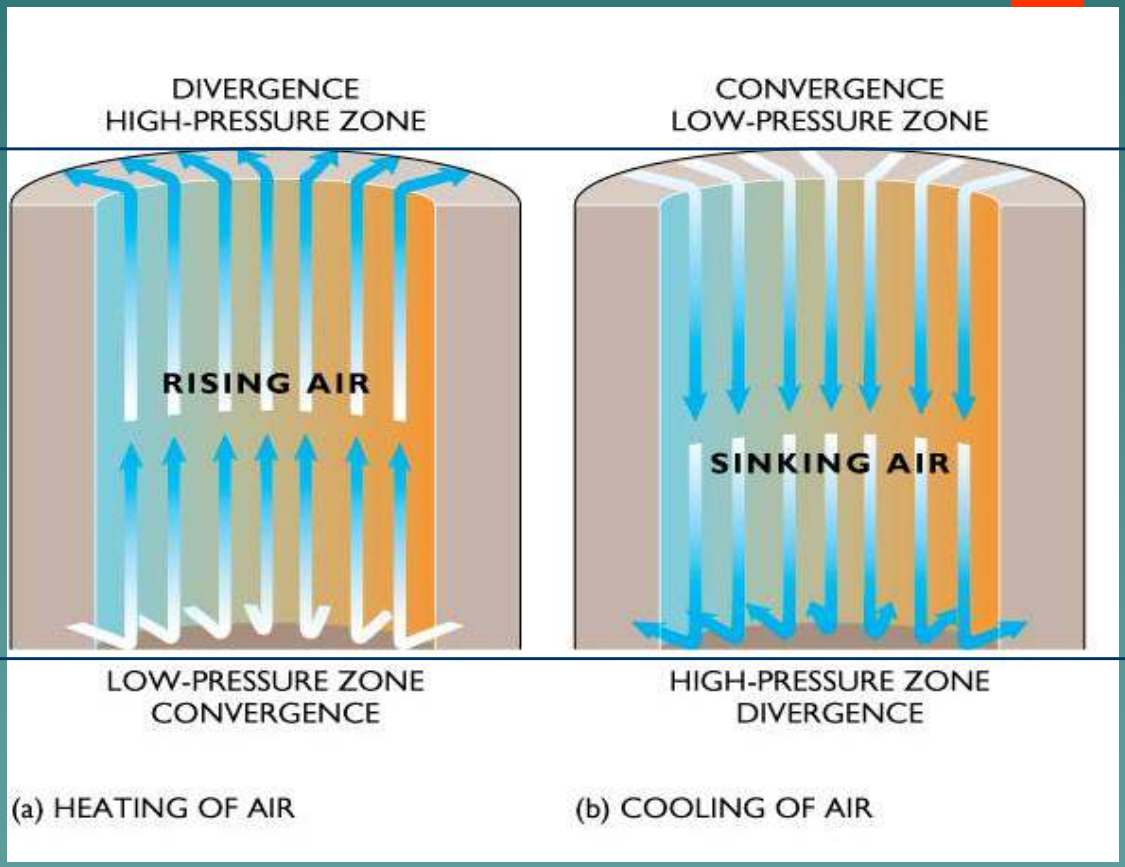
Temperature drives air pressure, so ultimately wind comes from unequal heating of the Earth.

sciencenotes.org

Gesekan Angin (Wind stress)

Apa yang menggerakkan atmosfir?

Pemanasan oleh matahari → **Tekanan udara**



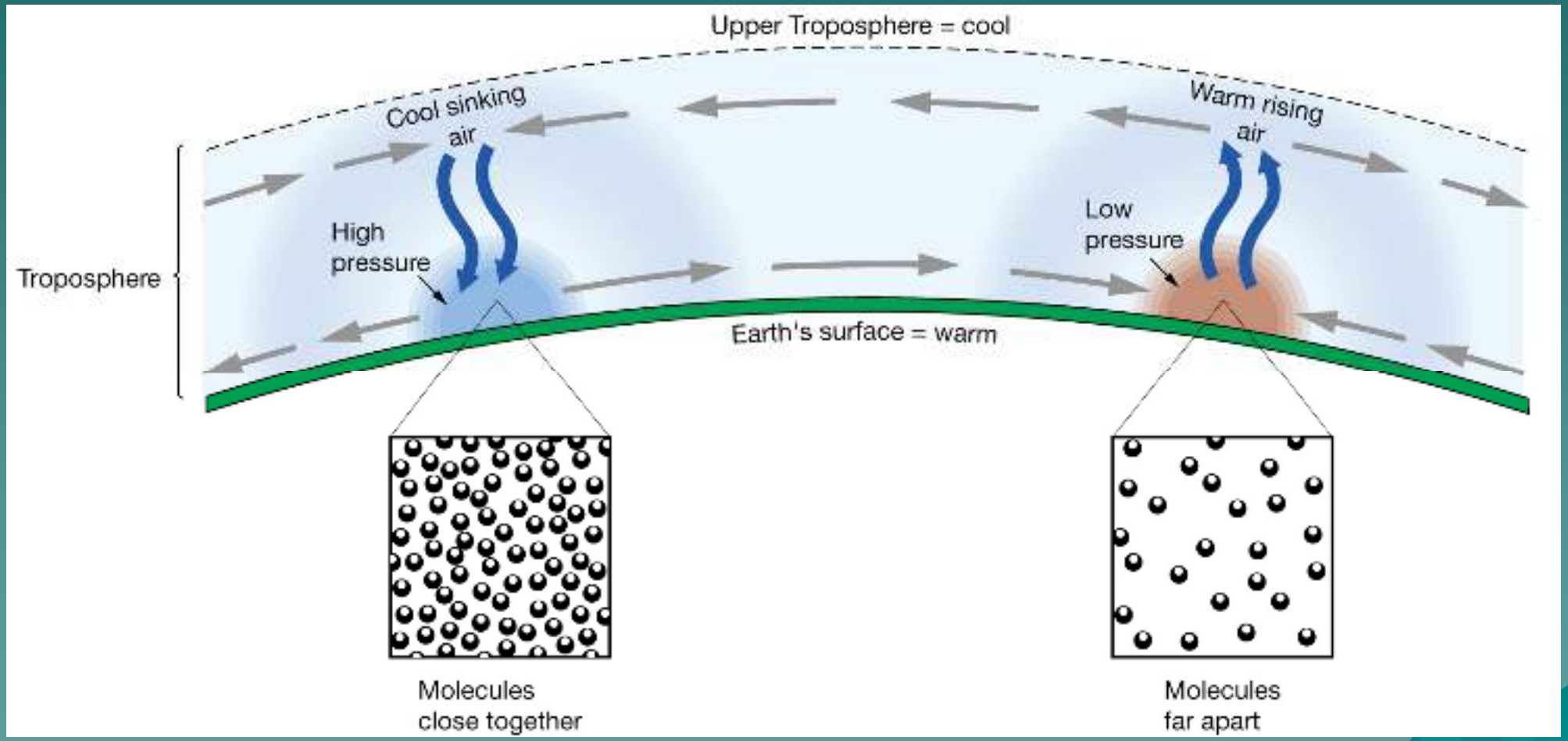
troposphere

surface

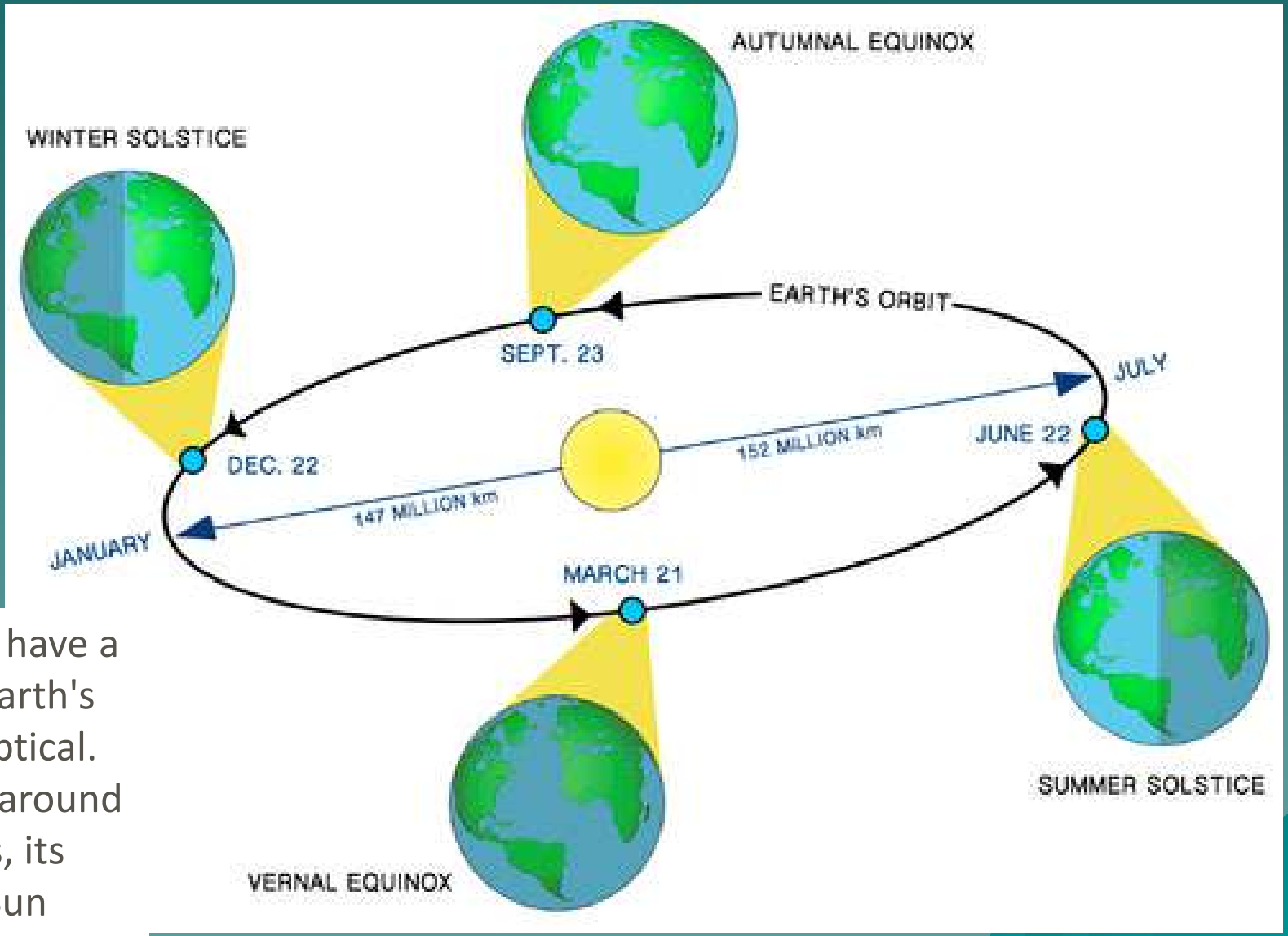
Equator/Tropik

Lintang tinggi

Sirkulasi Atmosfir



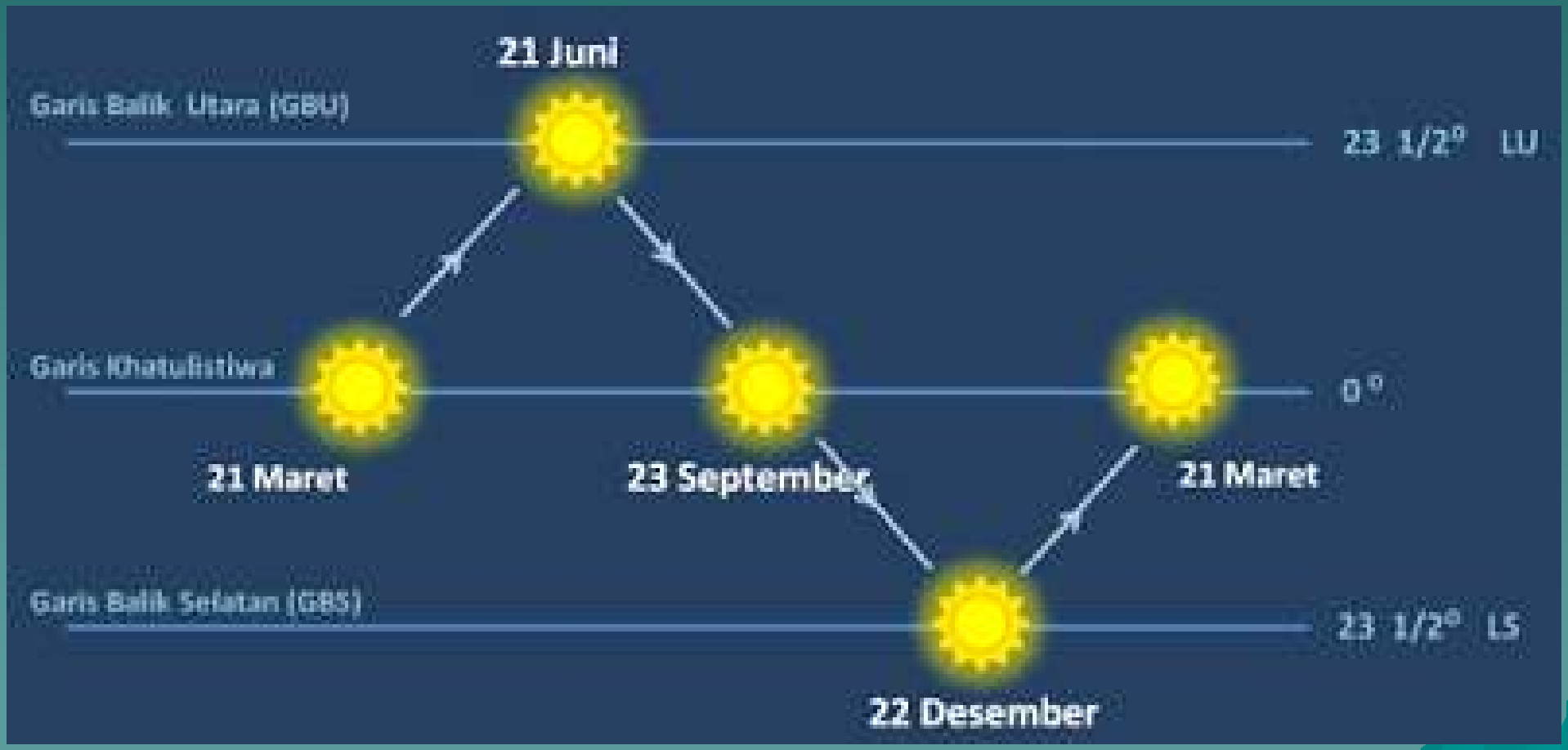
Revolusi Bumi



Initially believed to have a circular orbit, the Earth's orbit is actually elliptical. As the Earth orbits around the Sun in 365 days, its distance from the Sun varies between 147 and 152 million kilometers.

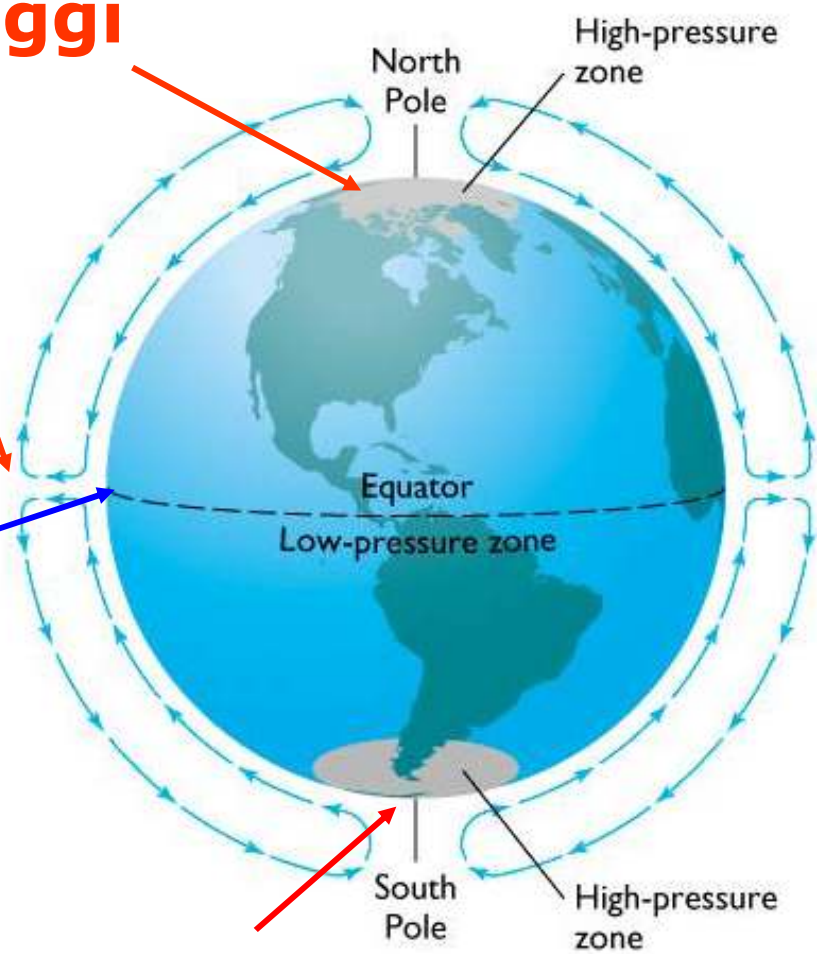
https://www.ck12.org/c/physics/newtons-universal-law-of-gravity/rwa/earths-orbit/

Gerak Semu Matahari



Pandangan vertikal tek udara (konveksi global)

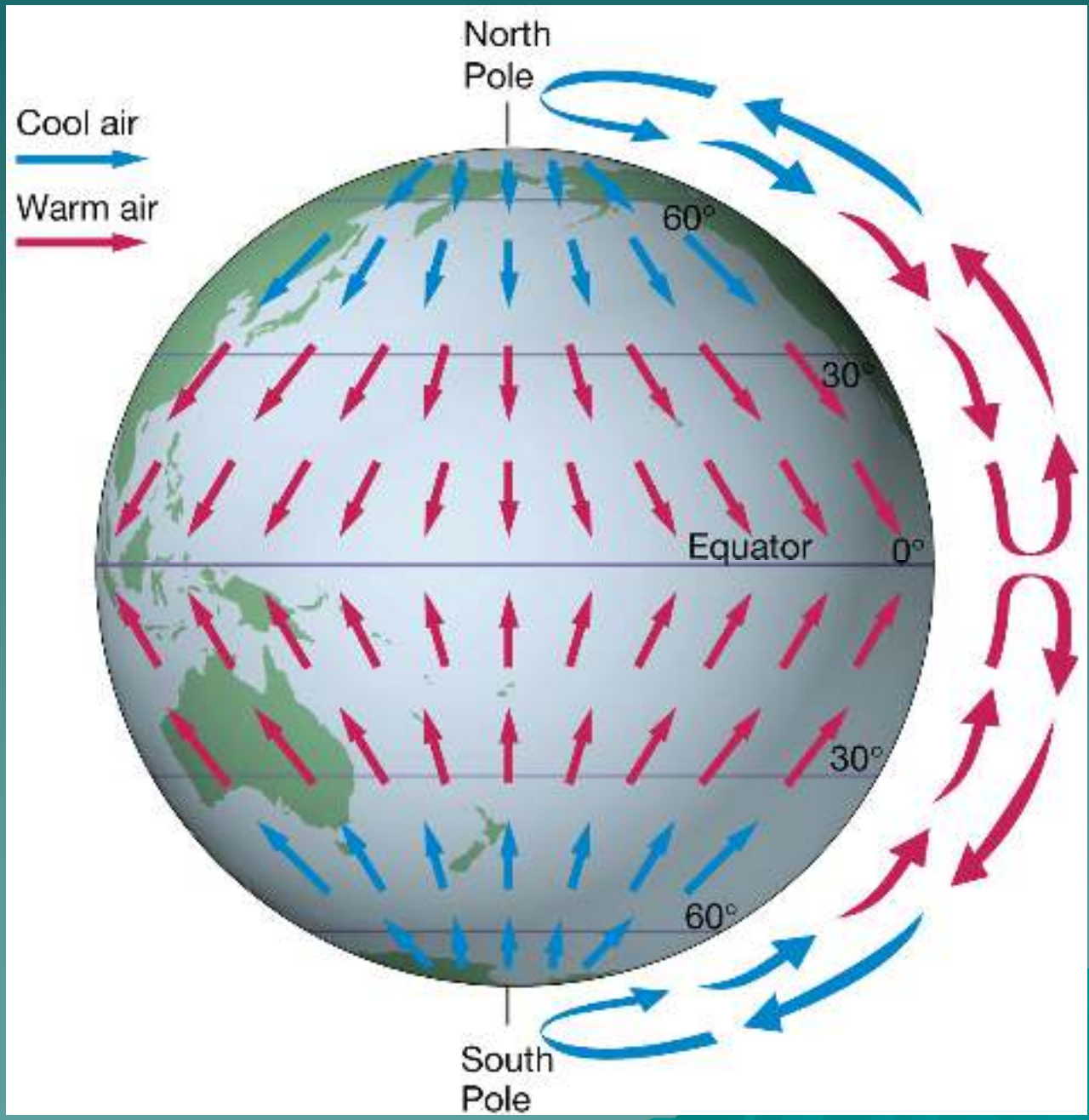
Tek Tinggi



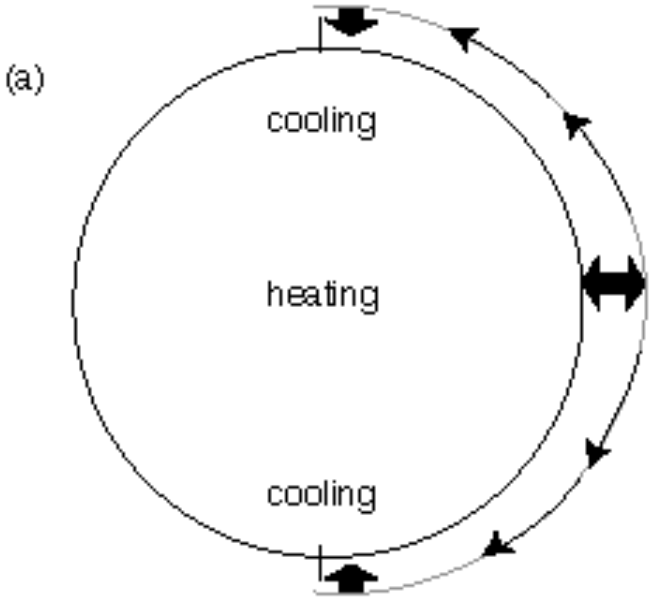
Tek Rendah

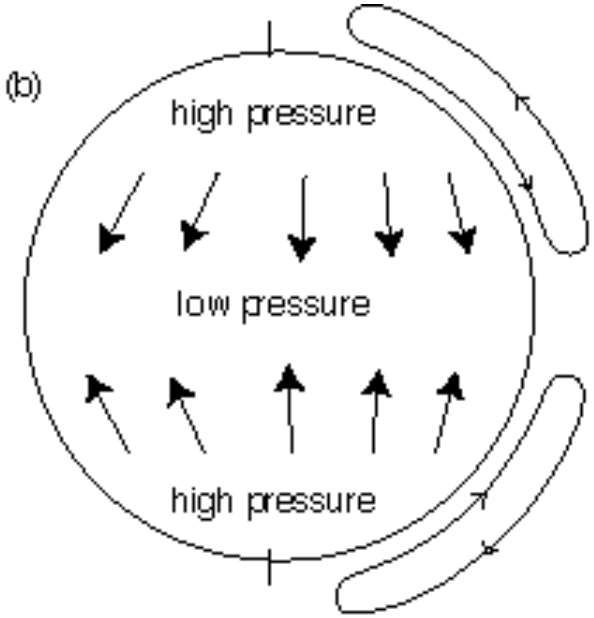
Tekanan Tinggi

Sirkulasi Atmosfir pada bumi tidak berotasi

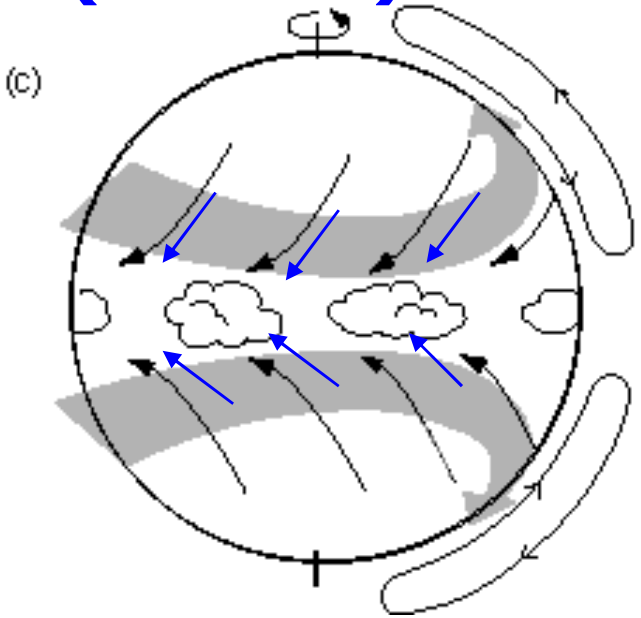


Urutan skematis dari perkembangan sirkulasi atmosfir , dimulai dari kondisi diam

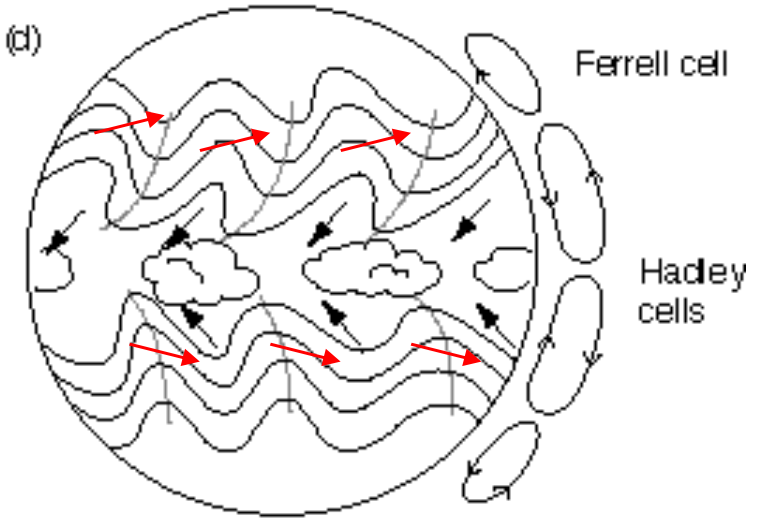




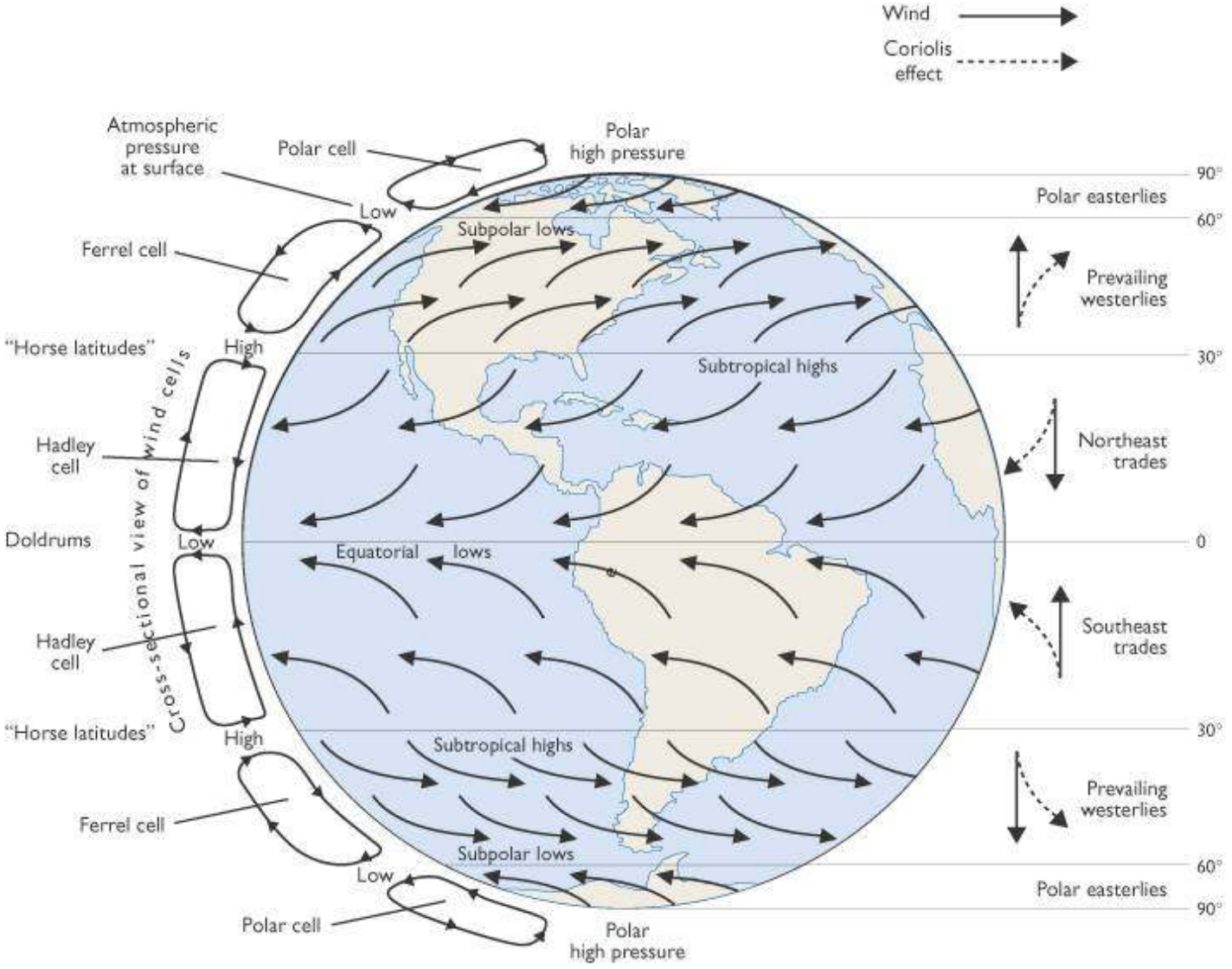
Passat (Trades)



Westerlies

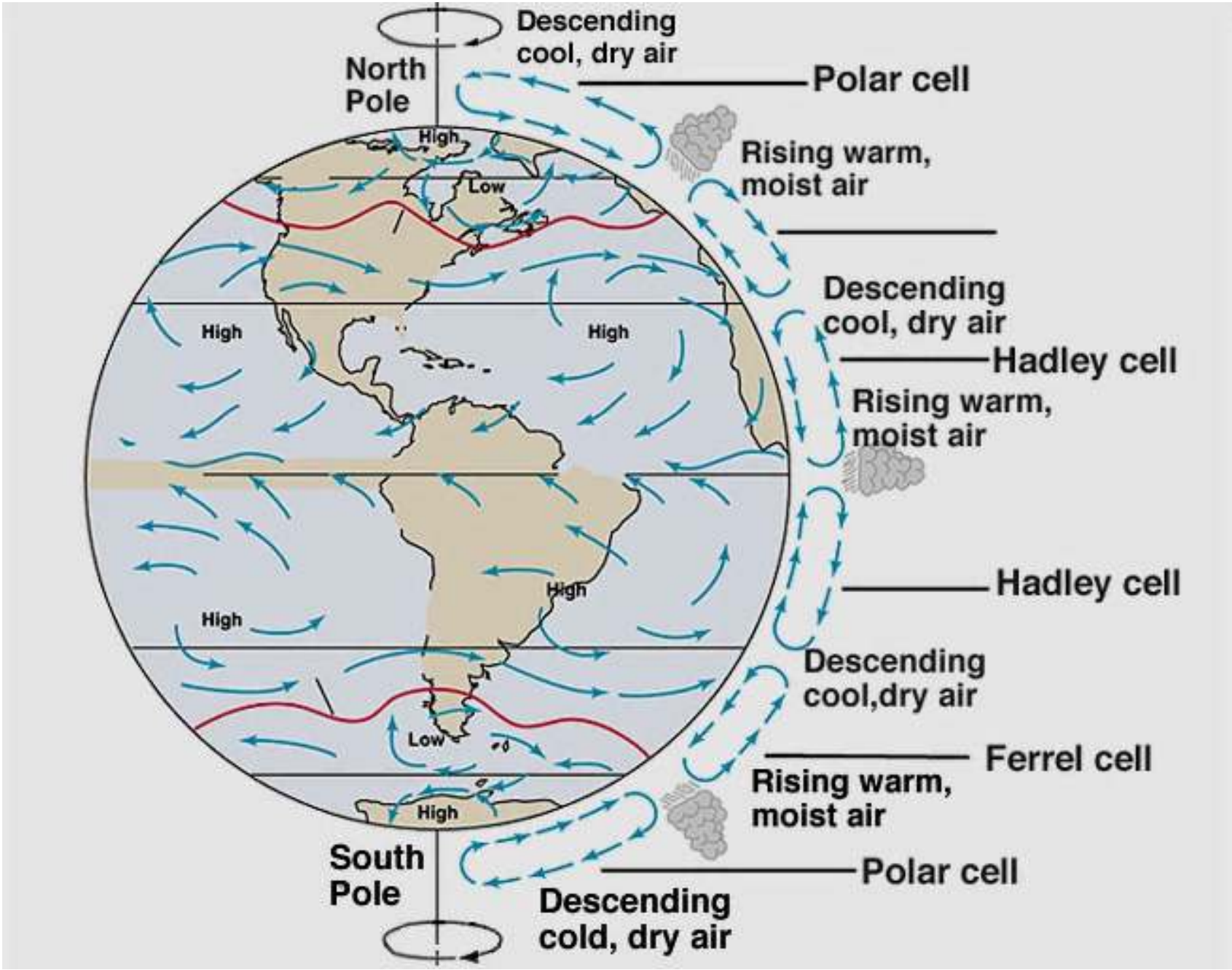


Pemanasan yang berbeda pada permukaan bumi dan pengaruh defleksi Gaya Coriolis mengakibatkan terbentuk sistem angin zonal (timur barat): diatur dalam sel tiga sirkulasi



(a) GLOBAL WIND PATTERN

Diagram Sikulasi Atmosfir



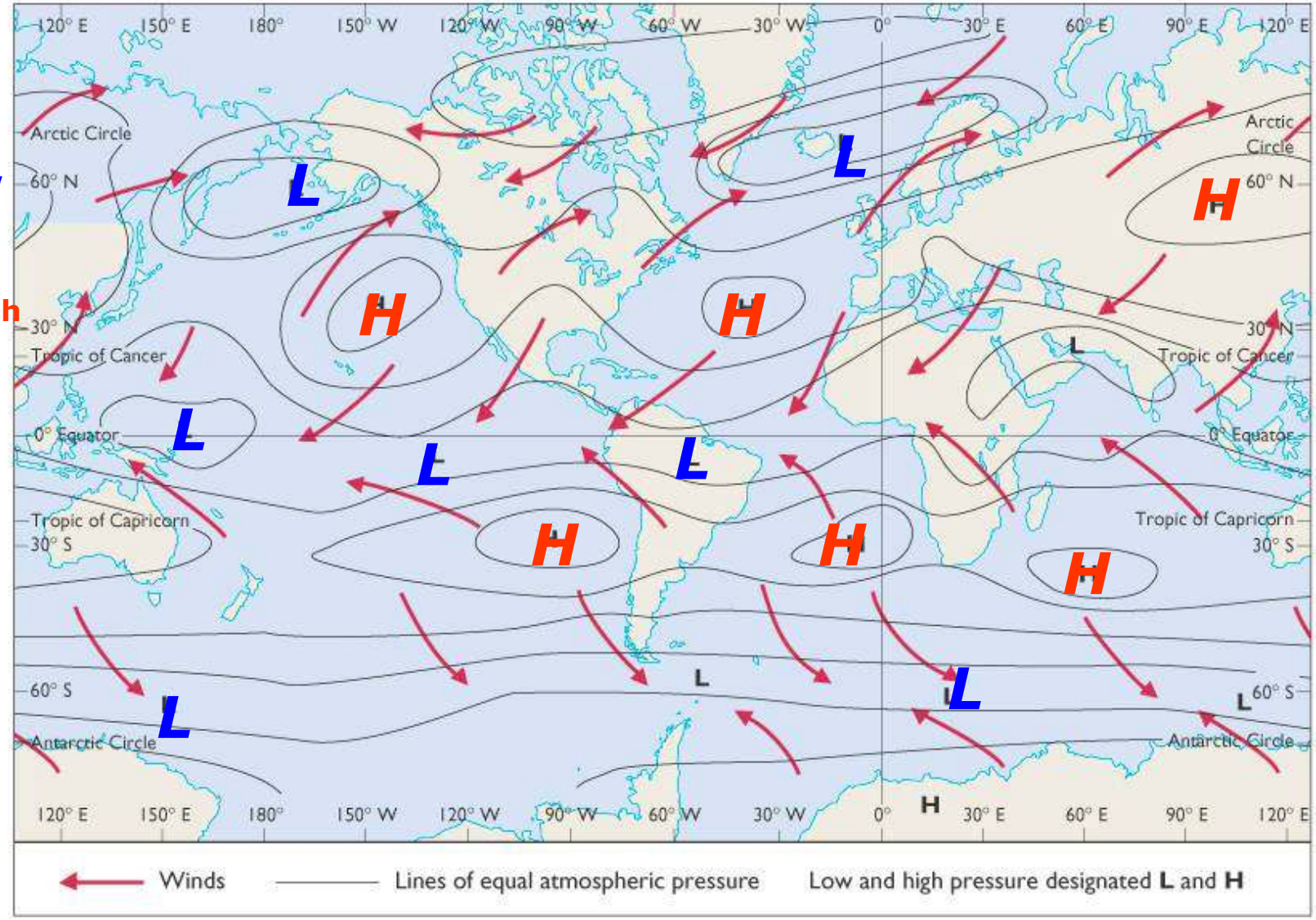
Plot angin yang terjadi pada peta tek udara dunia yang menunjukkan bahwa angin bertiup dari zona tek tinggi ke zona tek rendah dengan membentuk sudut terhadap arah gradien tekanan regional

Polar High

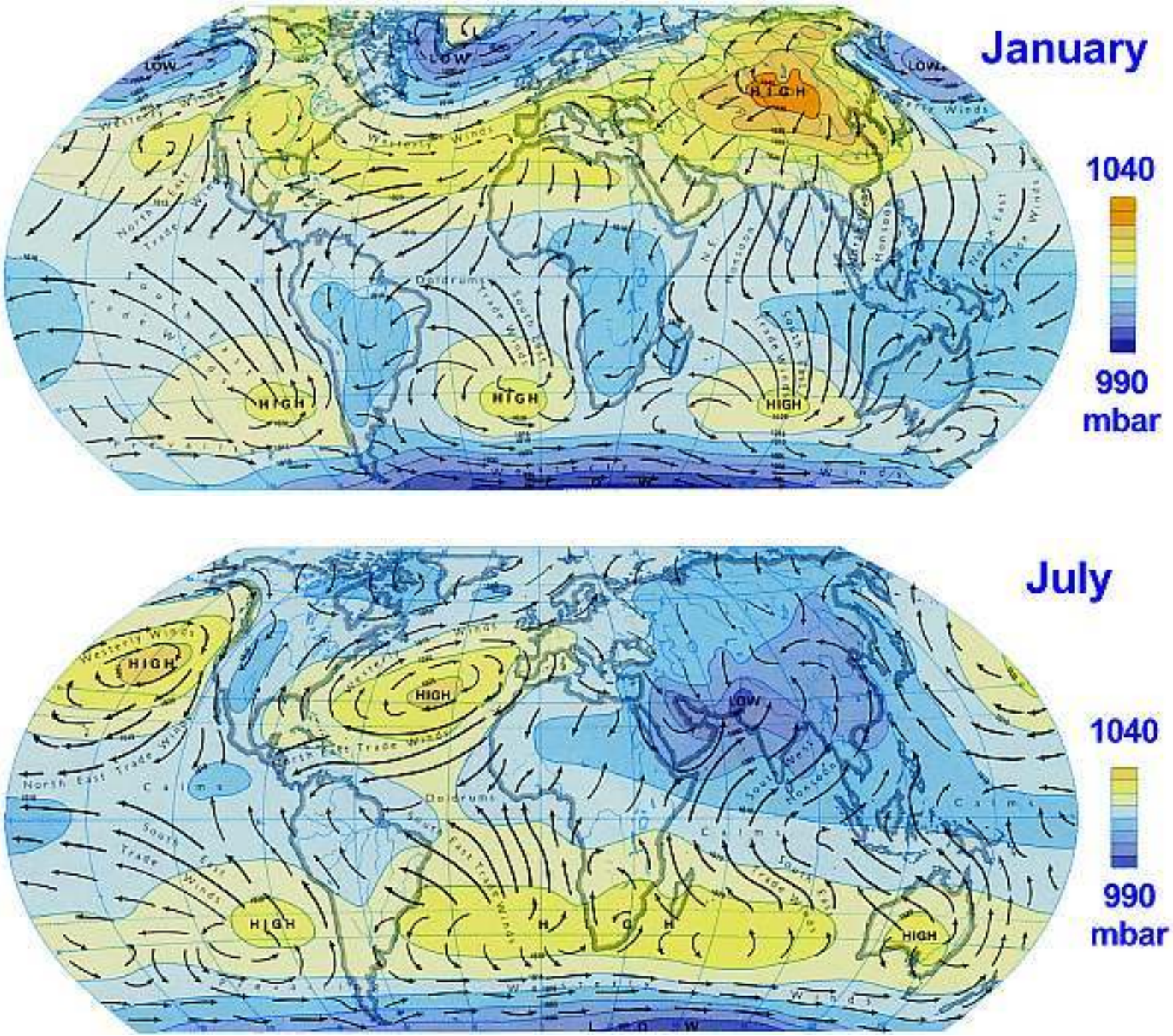
Subpolar Low

Subtropical High

Eq. Low

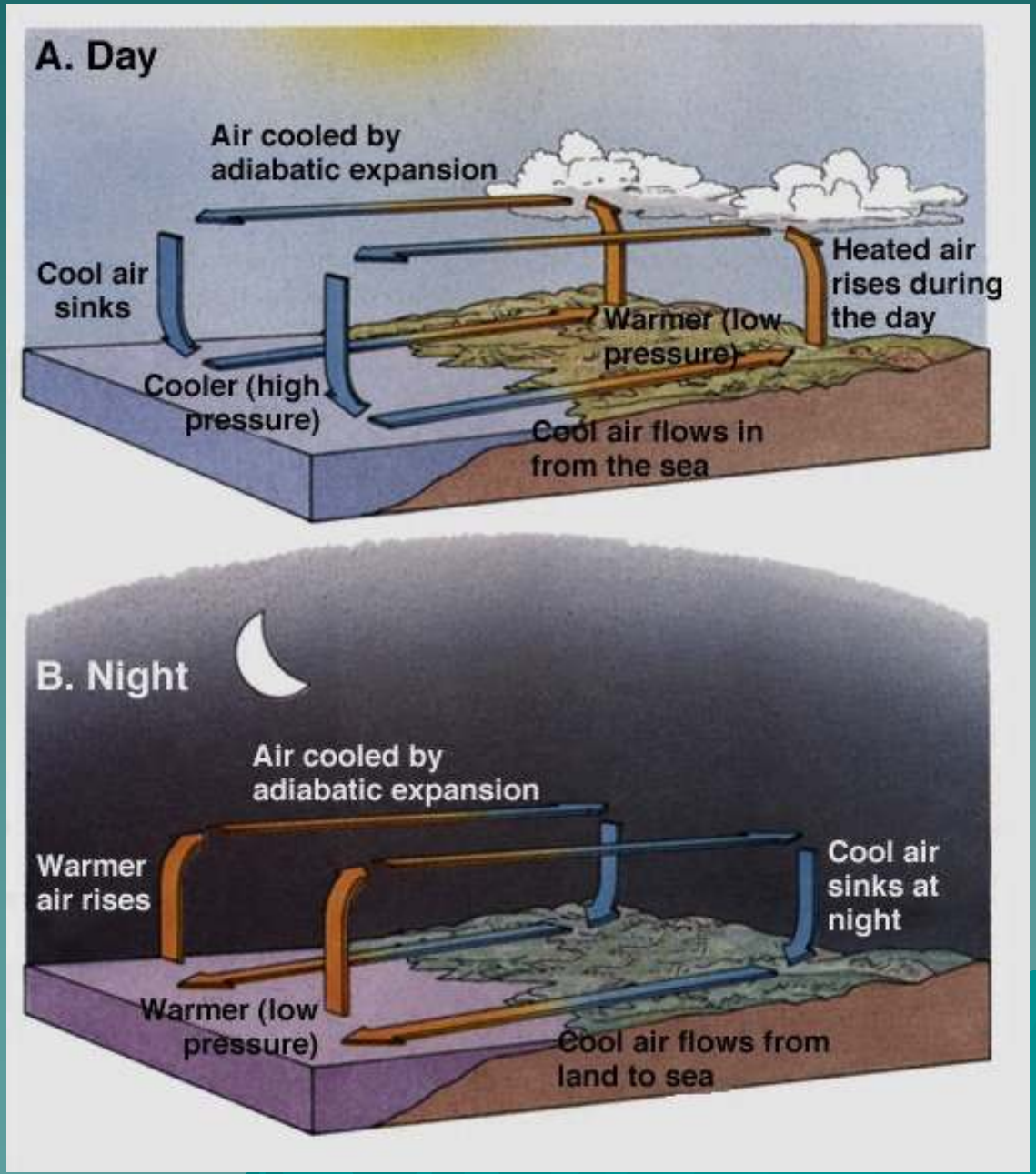


Plot Pusat Tek Udara Tinggi dan Rendah serta Angin

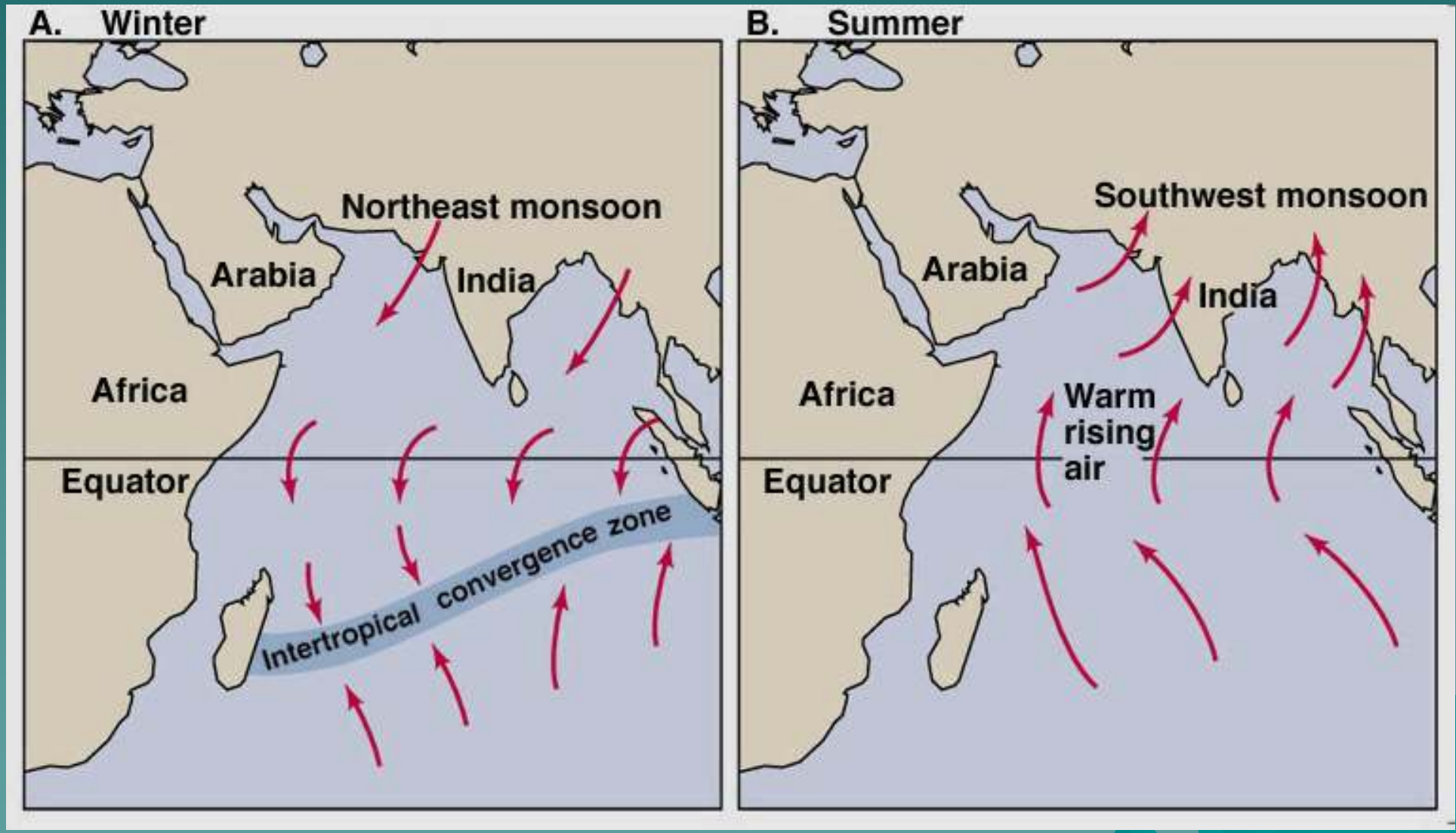


Efek Rotasi bumi tidak selalu Penting

Angin Darat/Laut (Land-Sea Breeze)

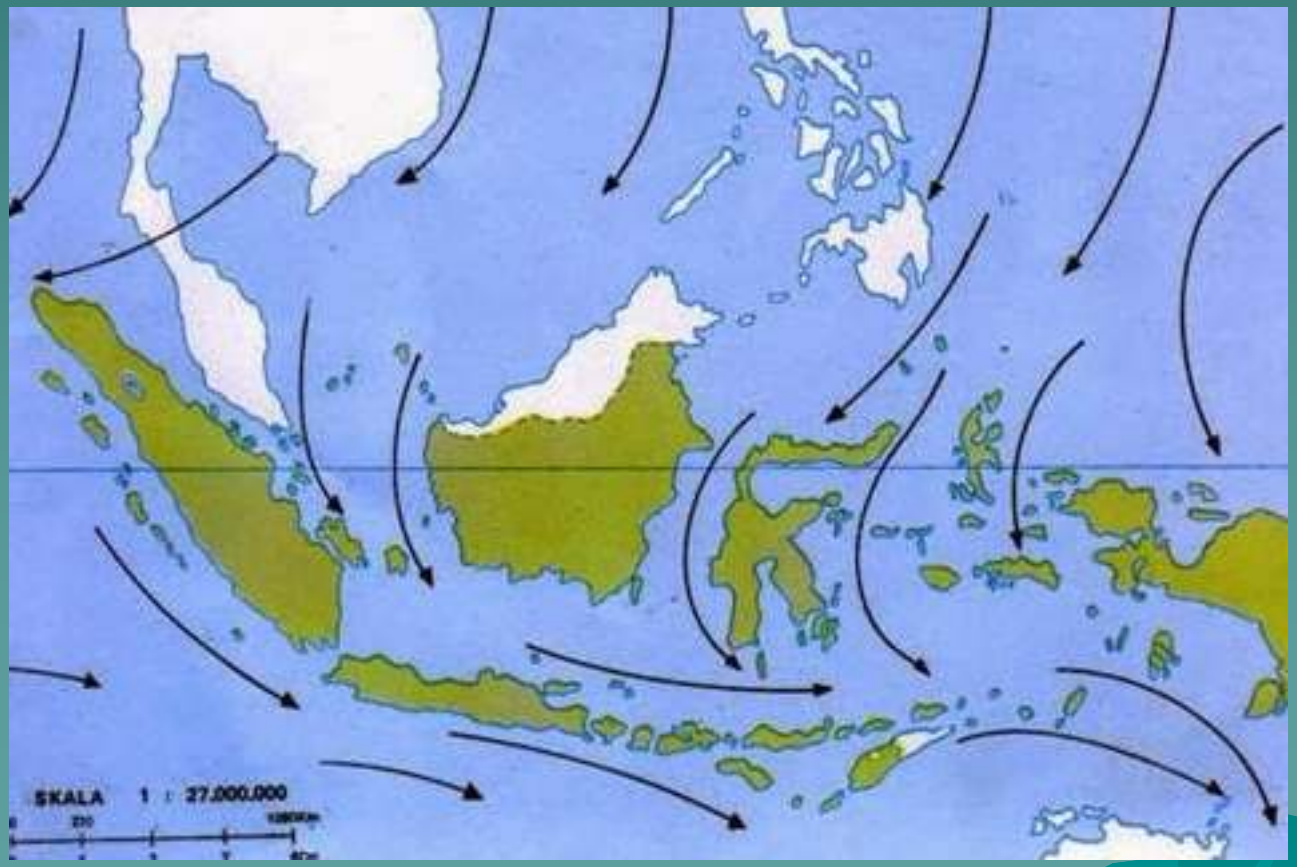


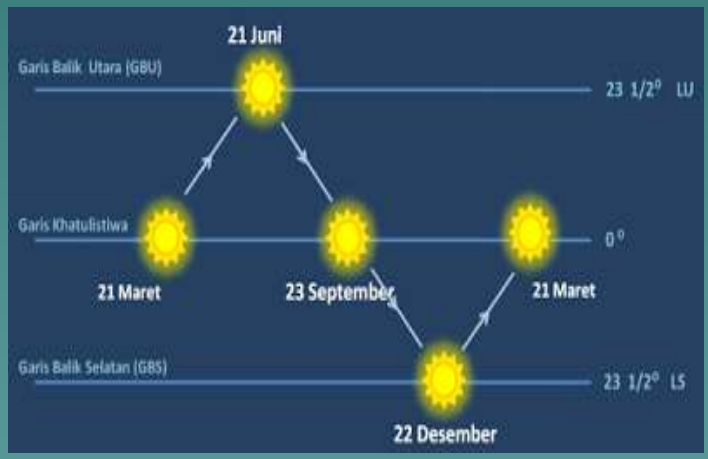
Muson (Monsoons): Angin Darat/Laut skala benua (continental scale land-sea breeze)



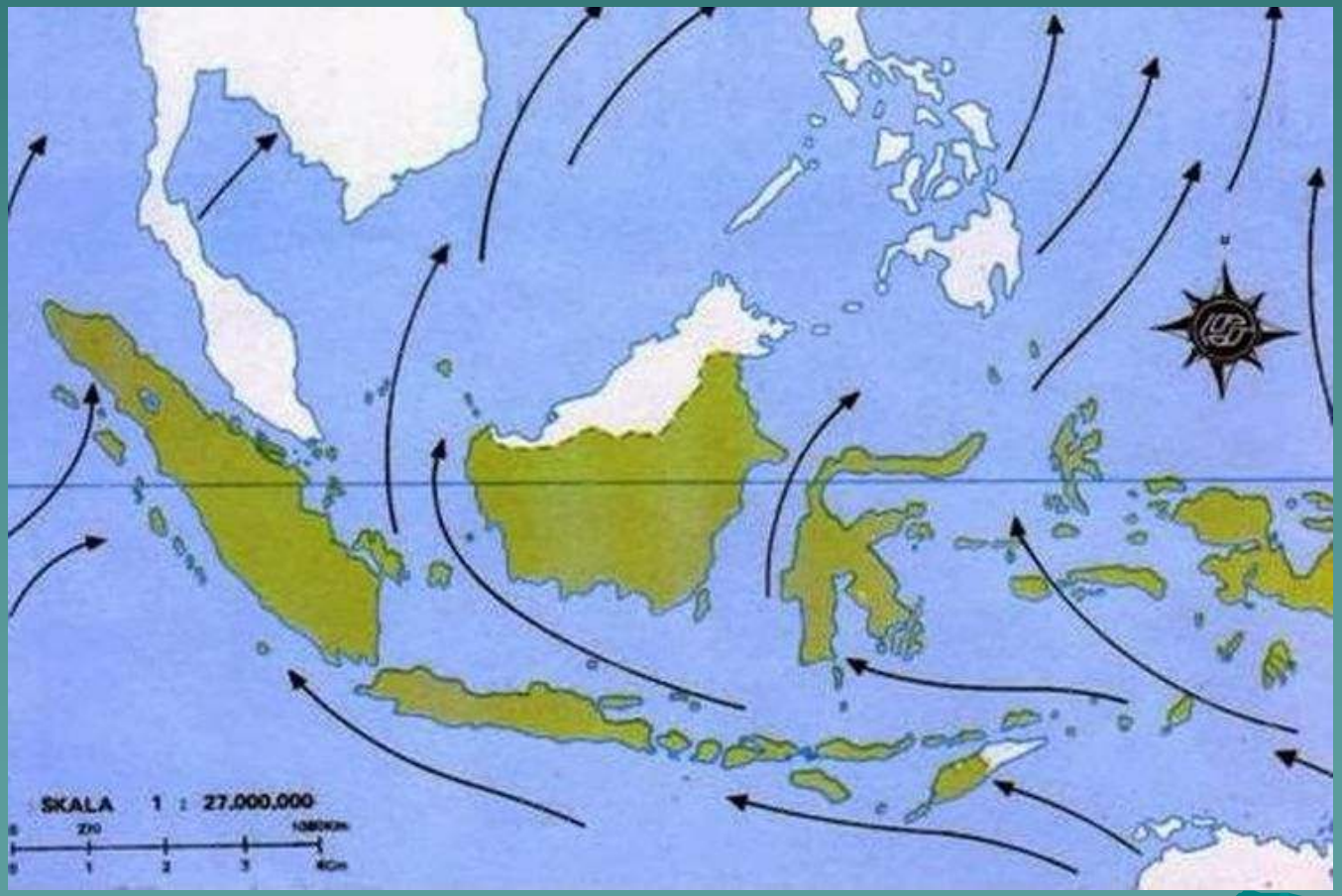
Angin Monsoon di Indonesia

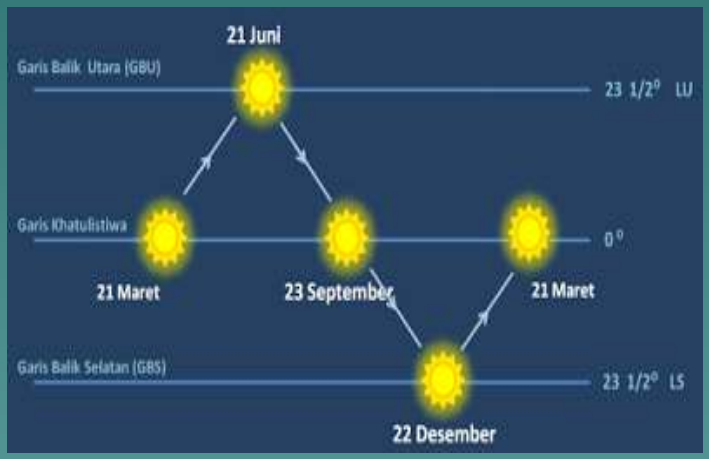
- Pengertian angin **muson barat** adalah angin yang berhembus dari arah Asia. Angin tersebut kemudian bergerak menuju Australia, melalui Samudra Hindia. Angin muson barat ini terjadi dalam periode Oktober – April. Maka pada periode ini, Indonesia akan mengalami musim penghujan.





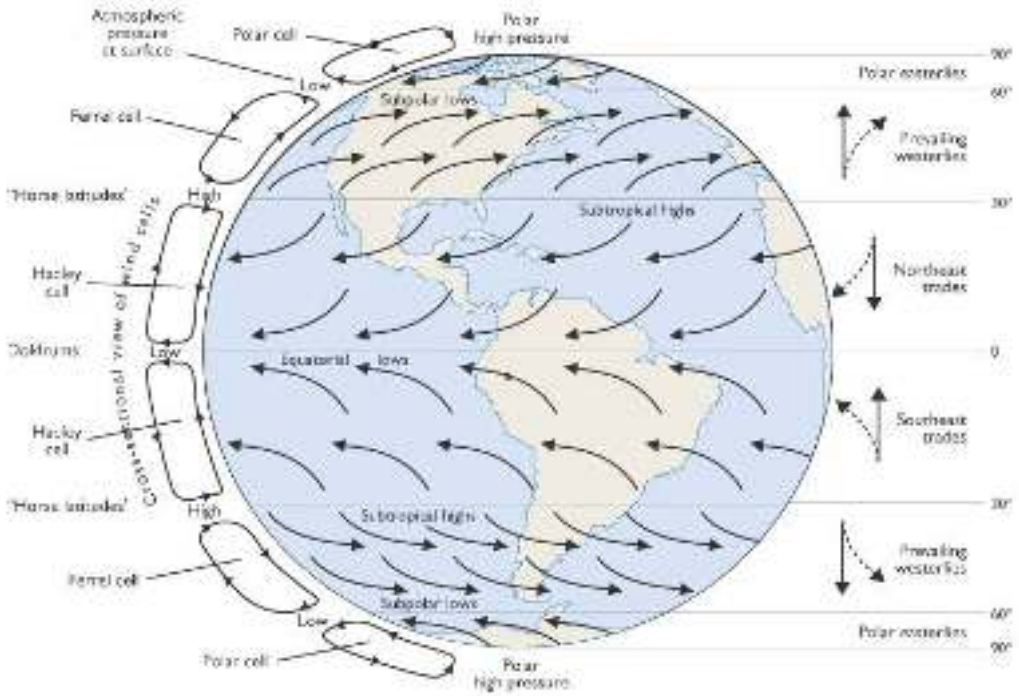
- Angin **muson timur** adalah angin yang berhembus dari Australia. Angin ini menuju arah Asia melalui Indonesia. Angin muson timur ini terjadi pada periode April – Oktober. Maka pada periode ini, Indonesia akan mengalami musim kemarau.





Bagaimana Angin menggerakkan Arus Laut

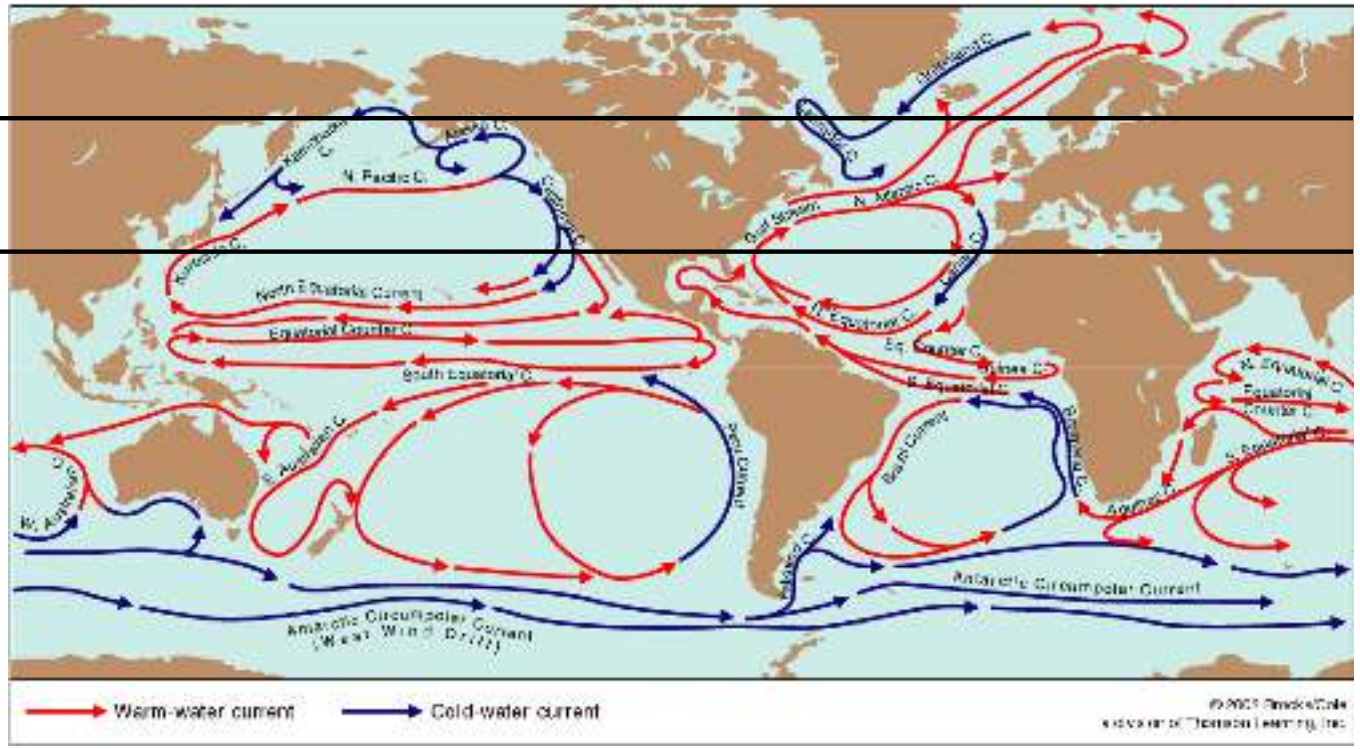
Bagaimana Angin menggerakkan Arus Laut



Atmosfir

60

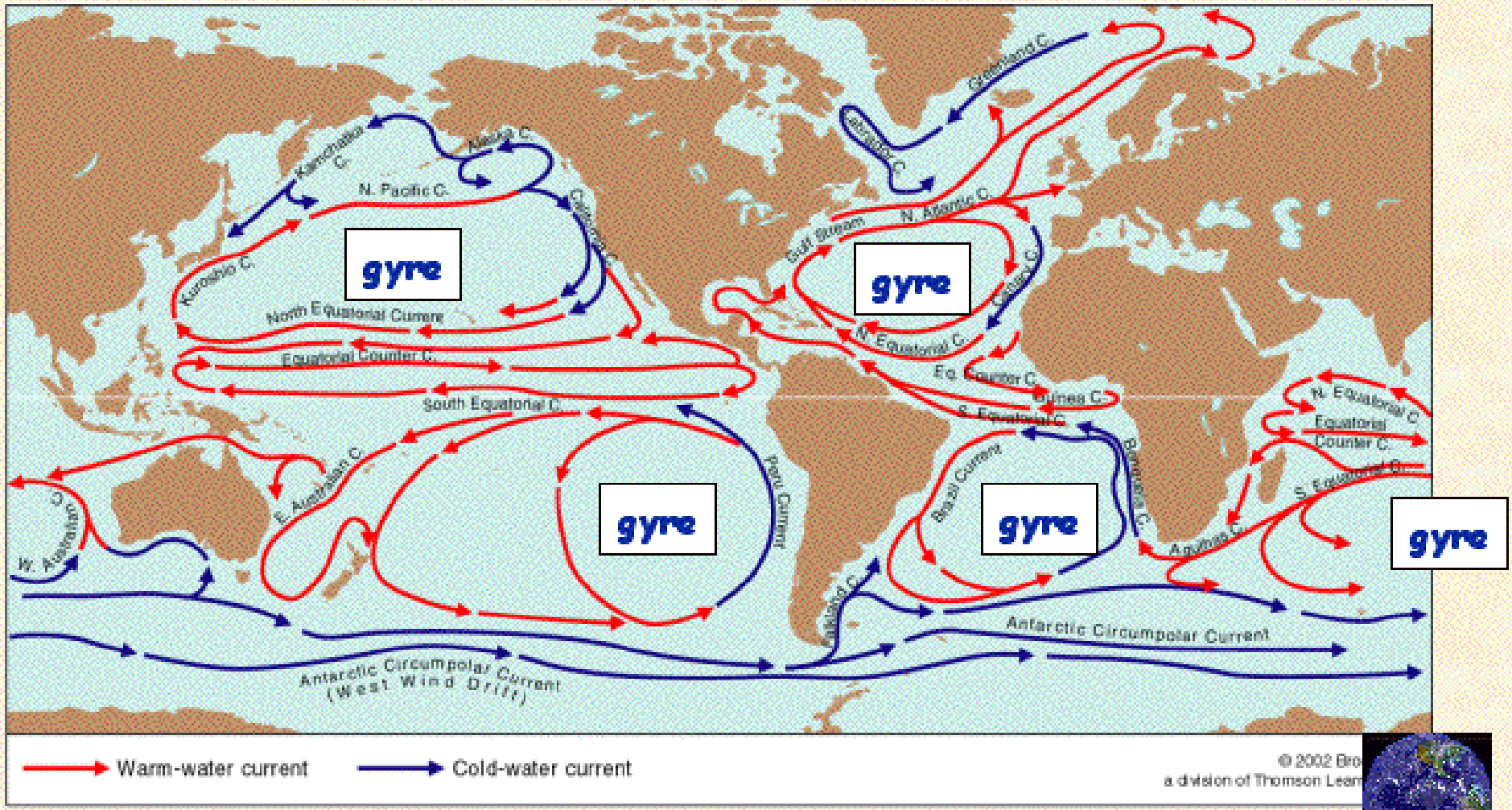
30



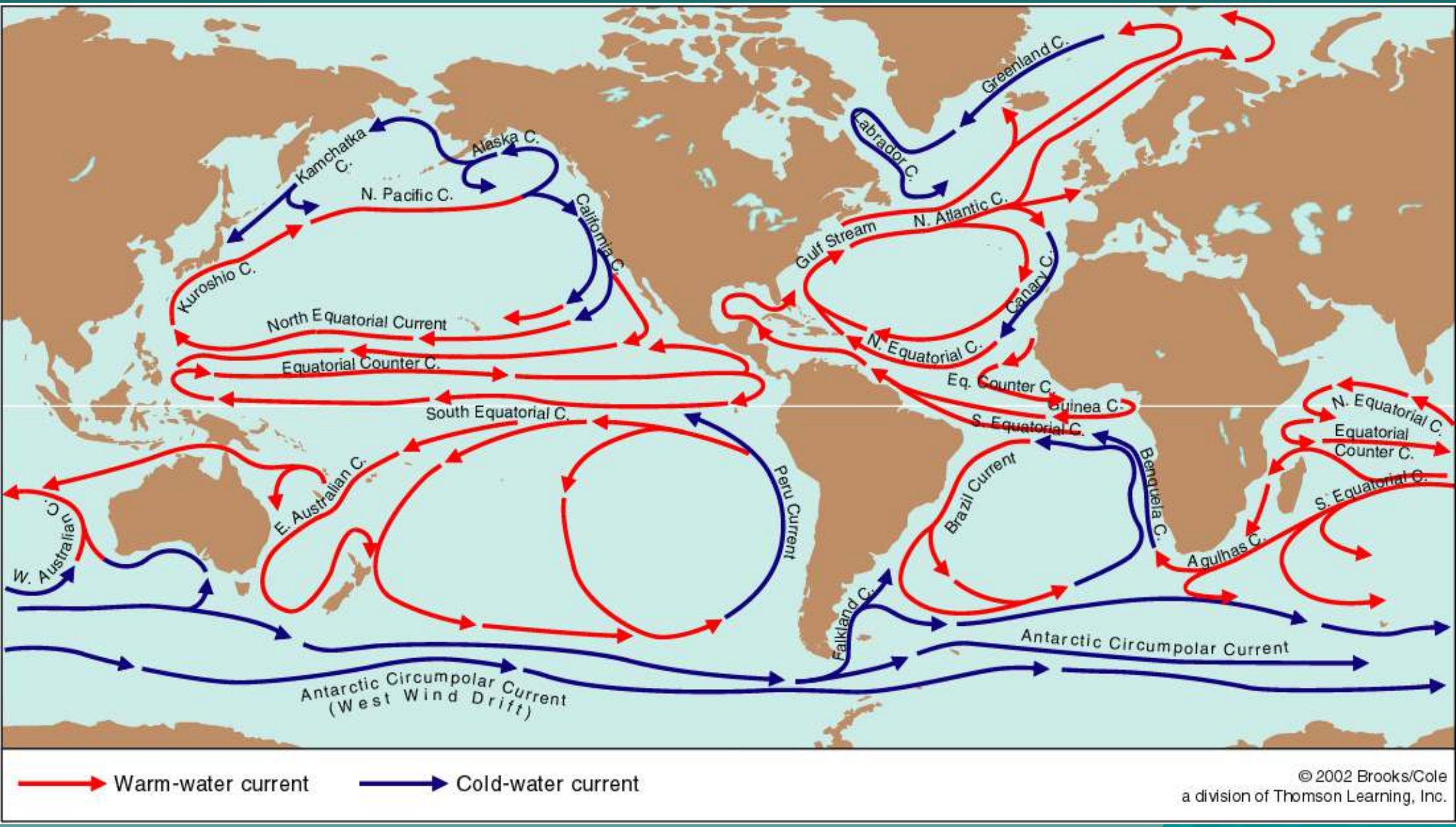
Laut

Surface Ocean Circulation and Currents:

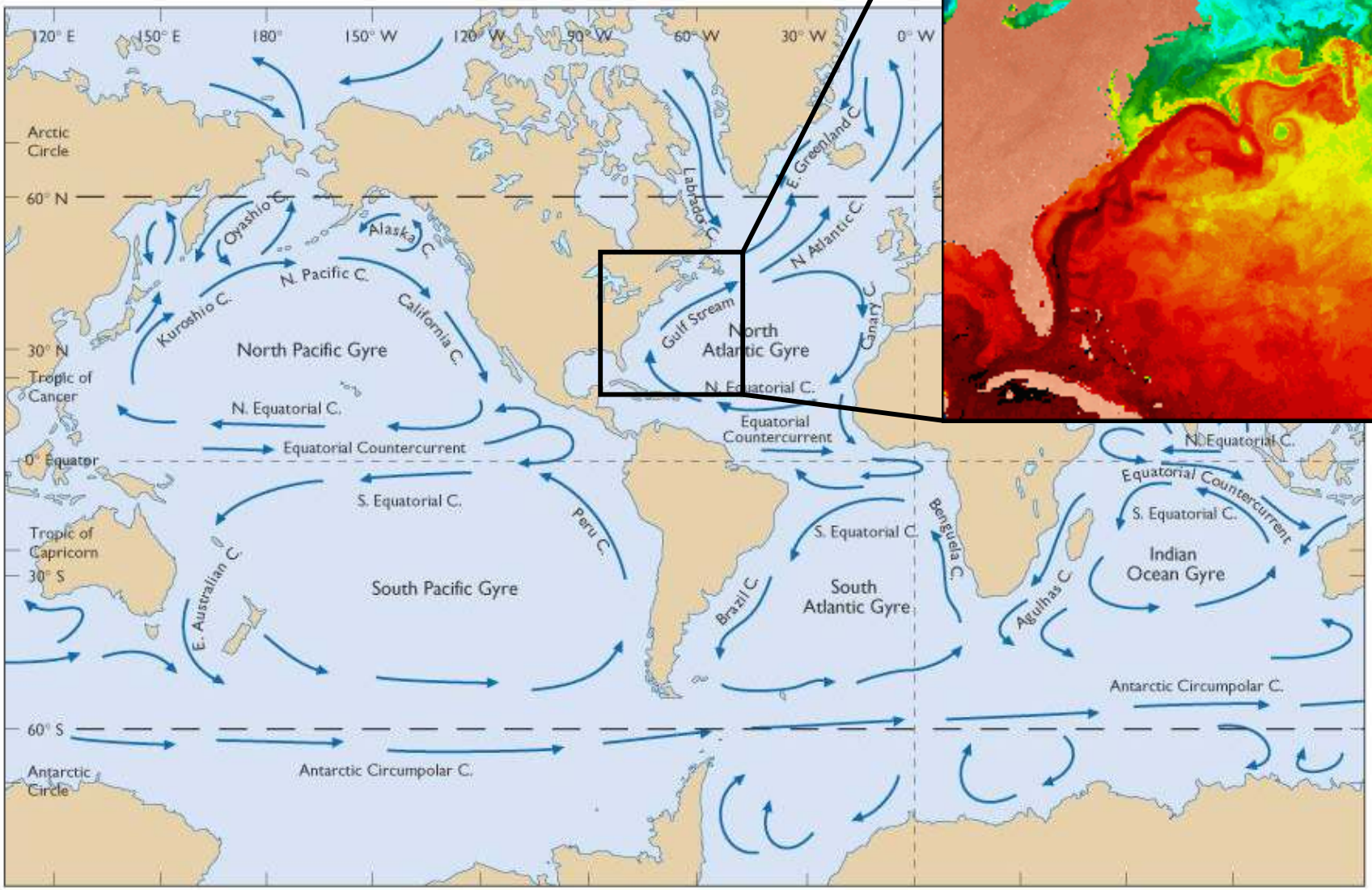
- circular current systems in major ocean basins: gyres
- boundary currents parallel to ocean margins, western, eastern



Sistem Sirkulasi Utama (Major) Lautan



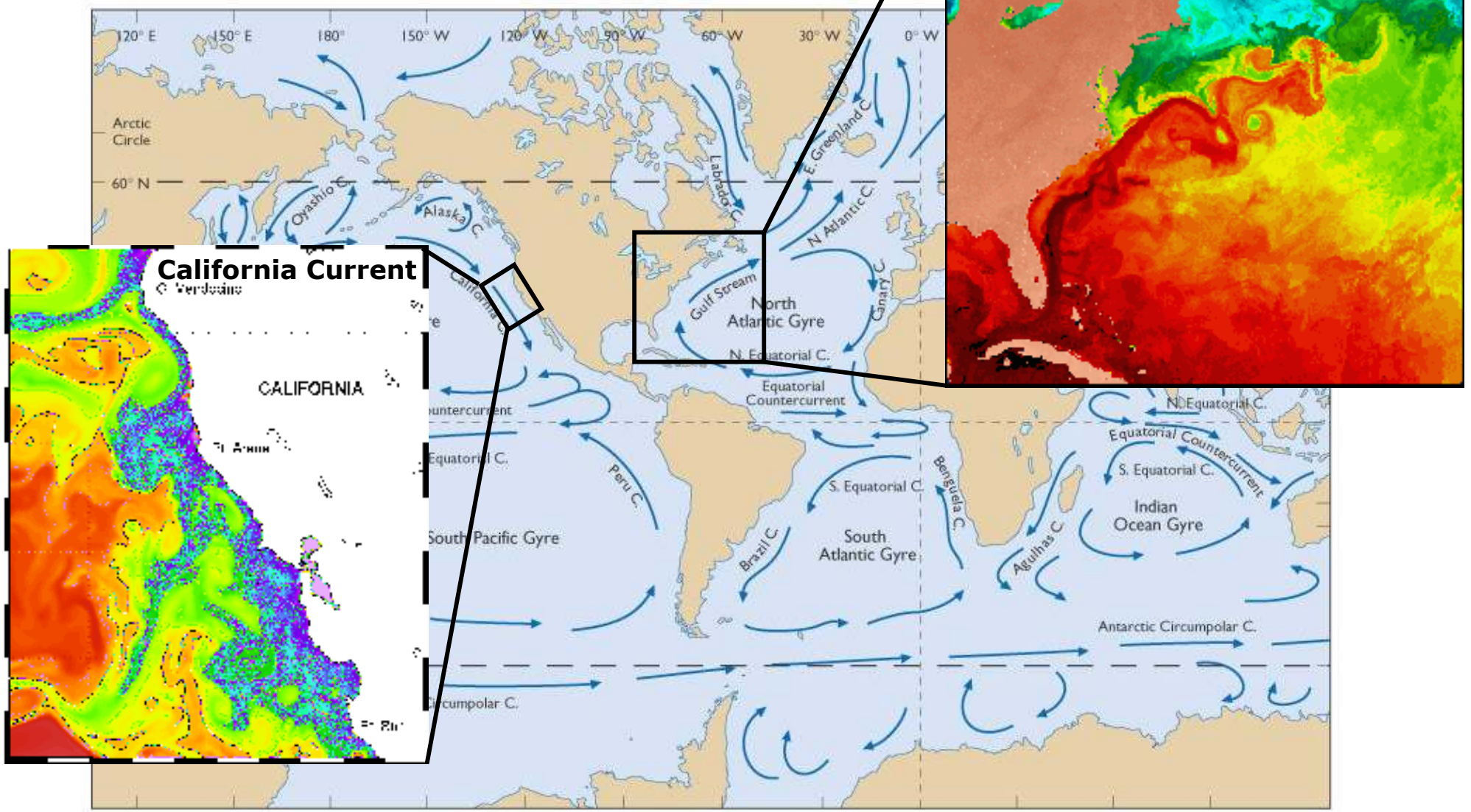
Sirkulasi Rata-rata (Mean Circulation) di Lautan



(b) GLOBAL SURFACE-WATER CURRENT PATTERN

Gulf Stream

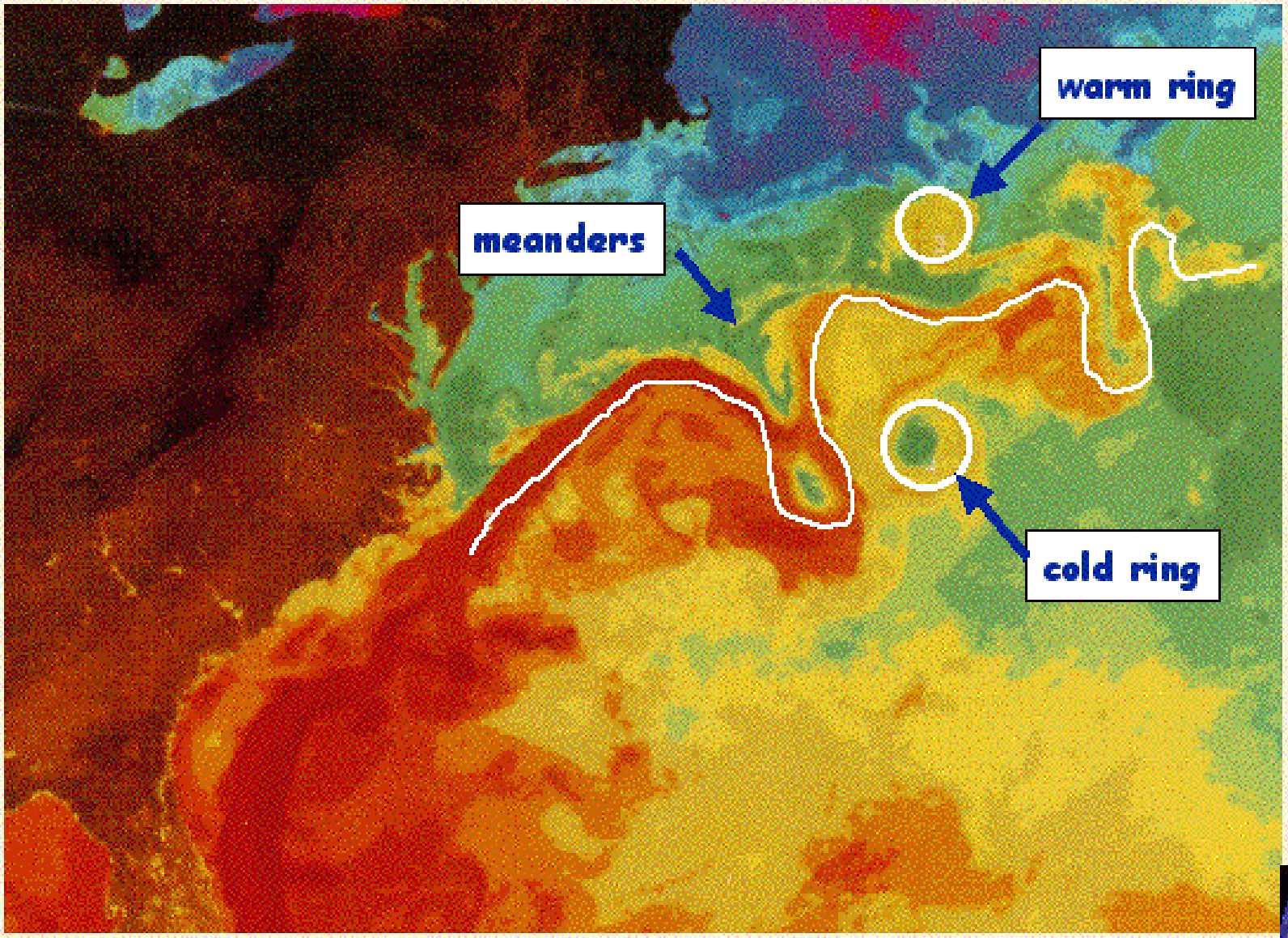
Sirkulasi Rata-rata (Mean Circulation) di Lautan



(b) GLOBAL SURFACE-WATER CURRENT PATTERN

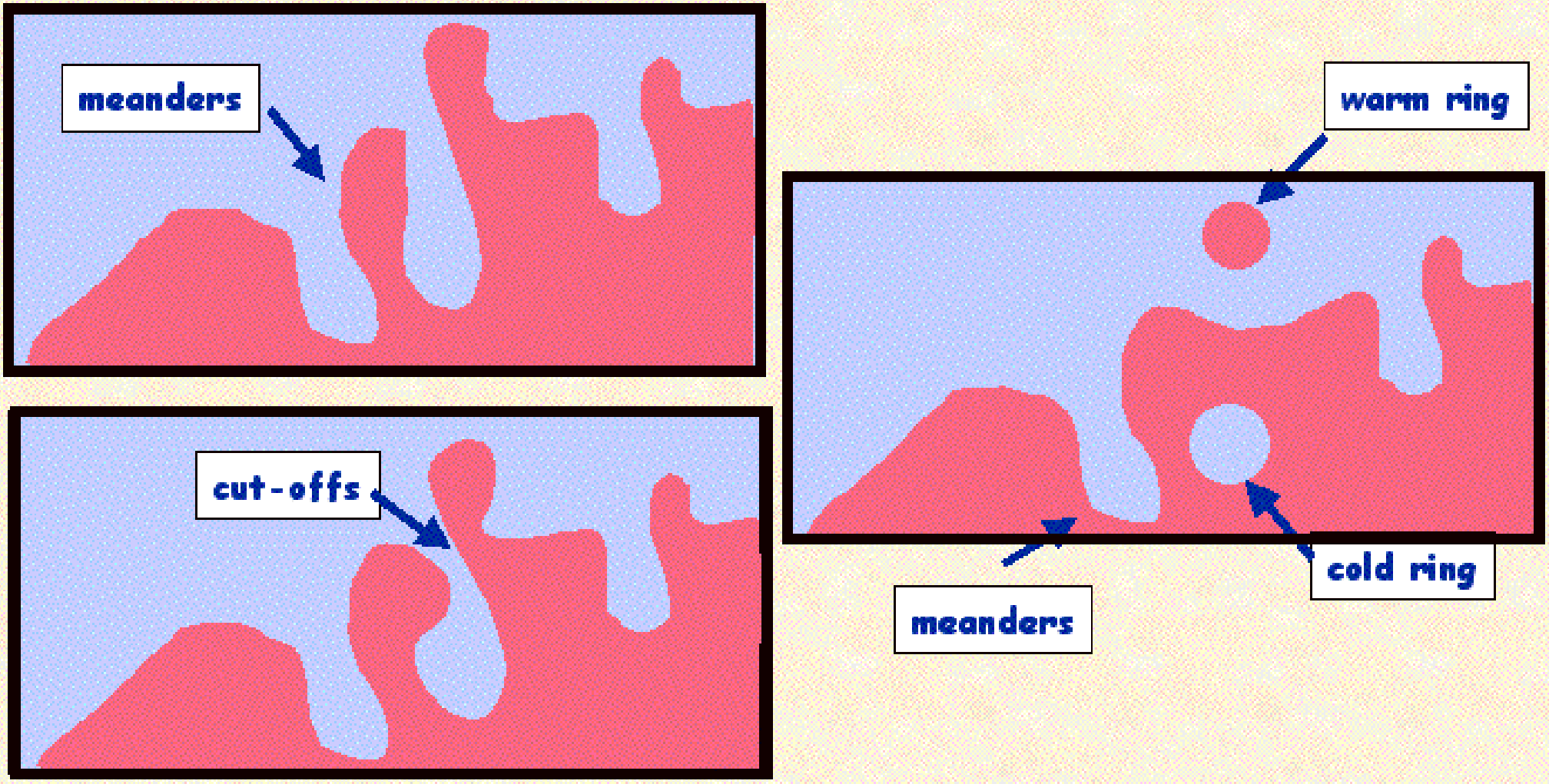
Meanders and Rings:

- A common phenomenon in the Gulf Stream



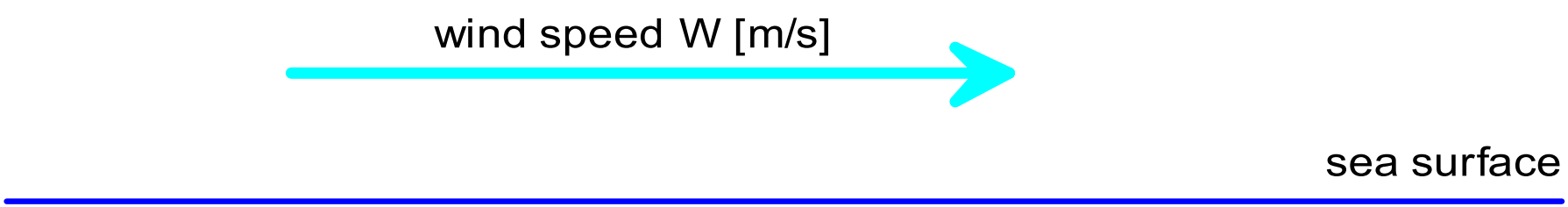
Meanders and Rings:

- A common phenomenon in the Gulf Stream



Bagaimana energi angin di transfer ke lautan?

Teori Ekman ...



wind generates a sea surface wind stress τ

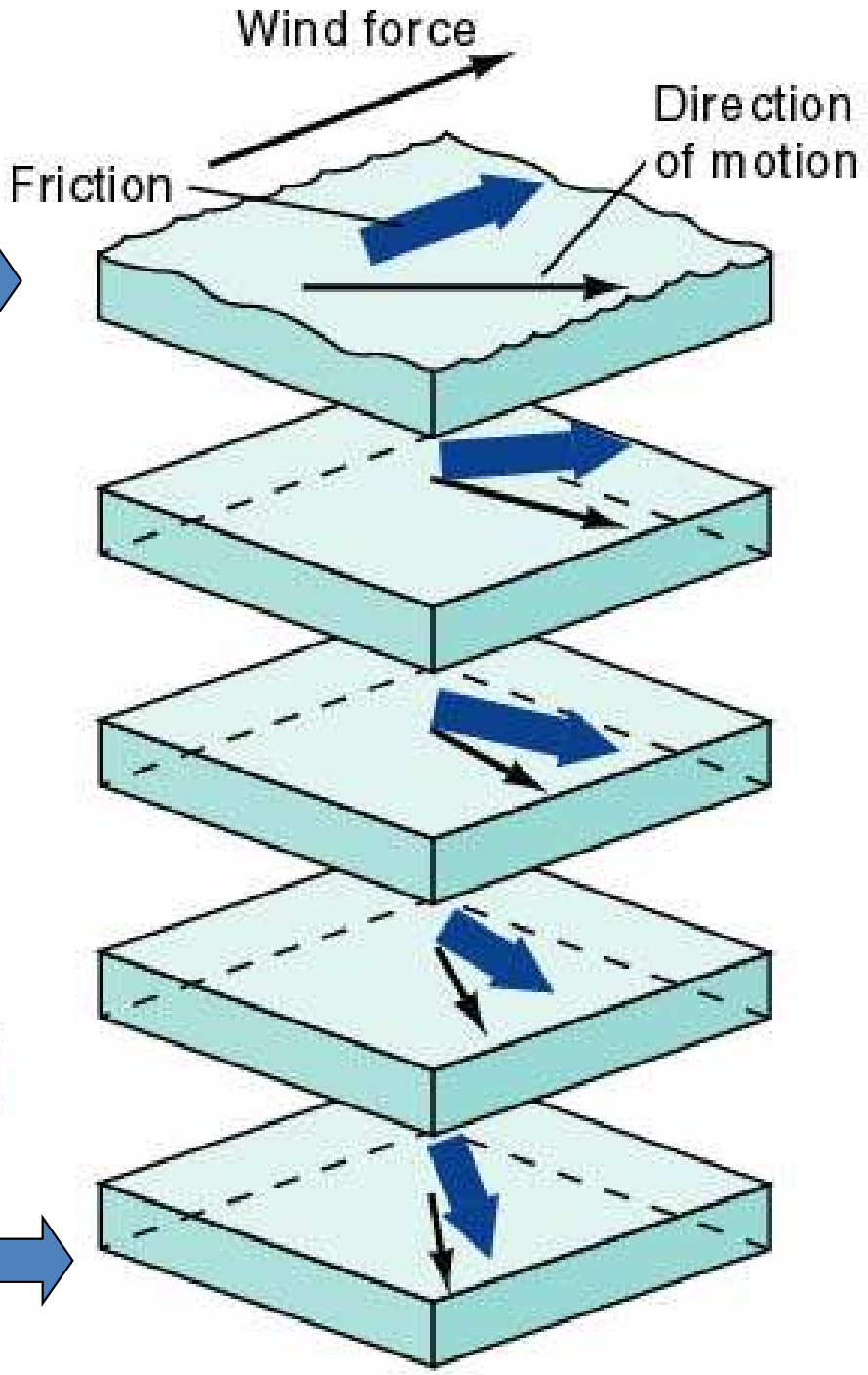
$$|\tau| = \rho_a C_w W^2$$

C_w: koefisien seretan (drag) angin

ρ_a: densitas udara

Bagaimana Kekuatan Angin menggeraknan Lautan

permukaan

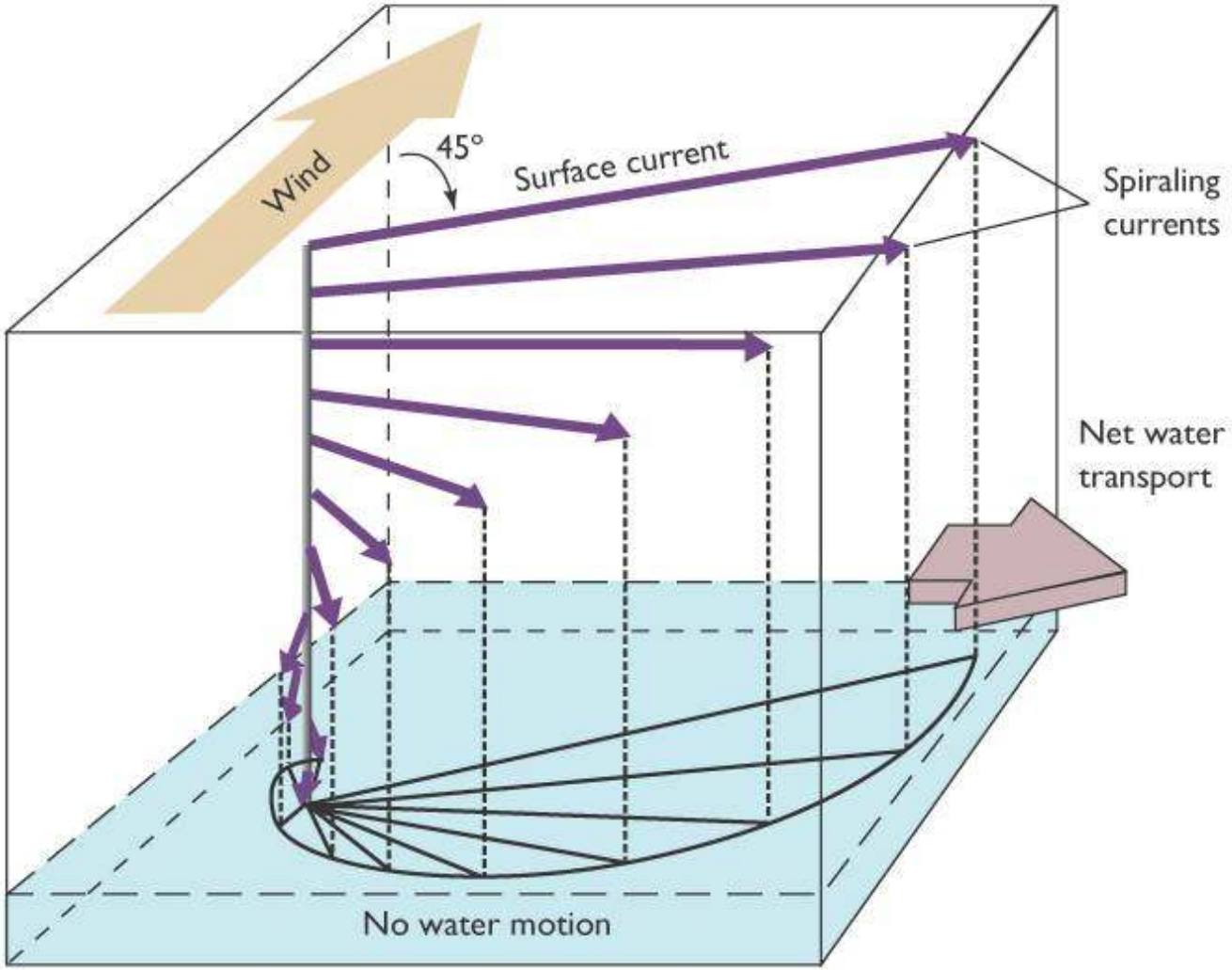


Keseimbangan antara gesekan angin dan rotasi bumi (gaya Coriolis)

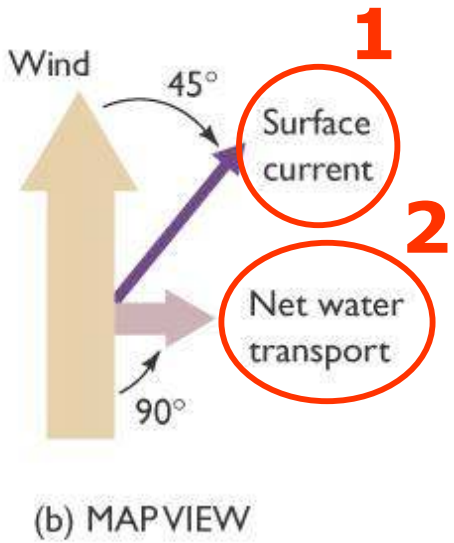
Ked 100 meter

b

Ekman transport.



(a) EKMAN SPIRAL IN THE NORTHERN HEMISPHERE

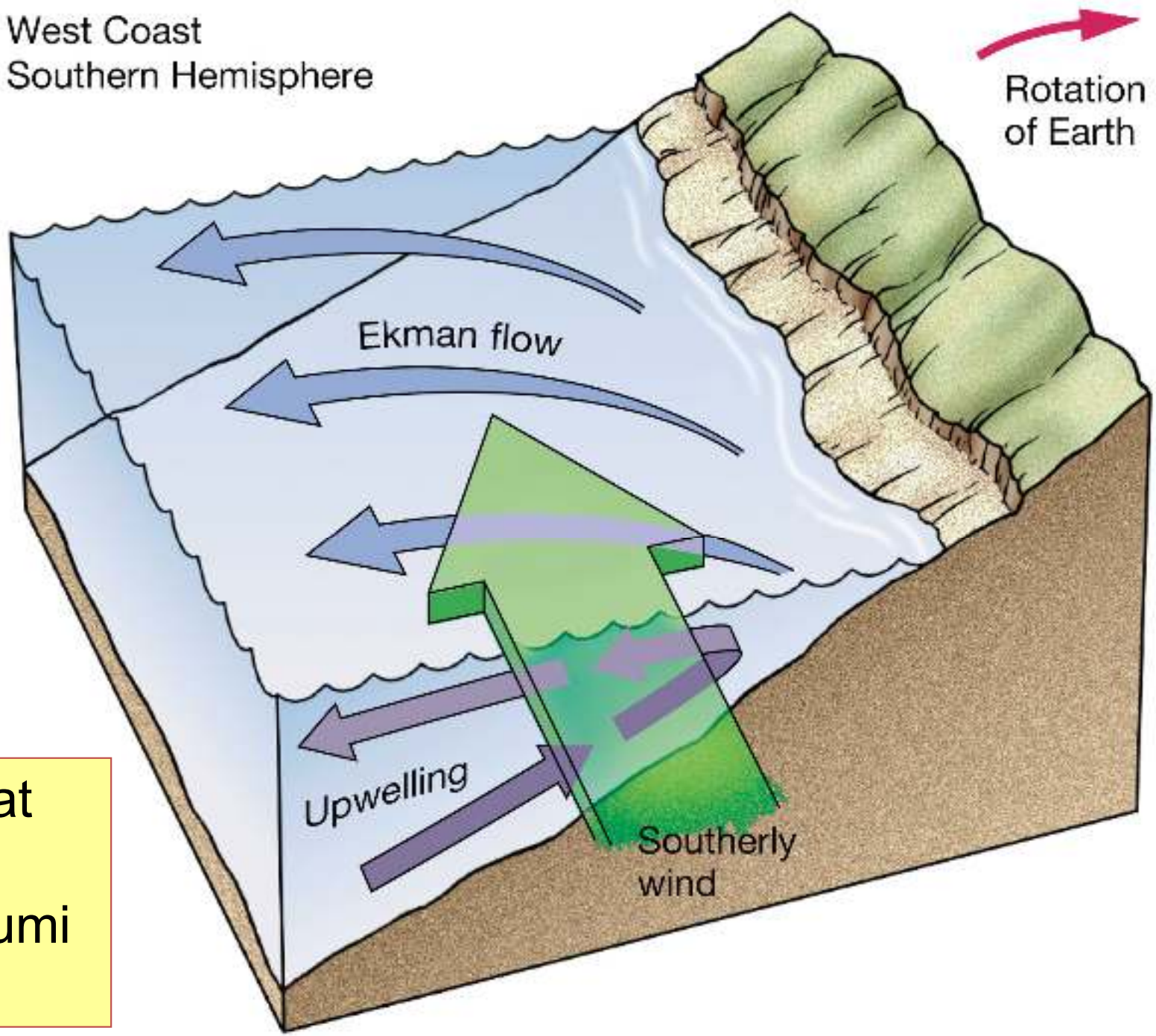


(b) MAP VIEW

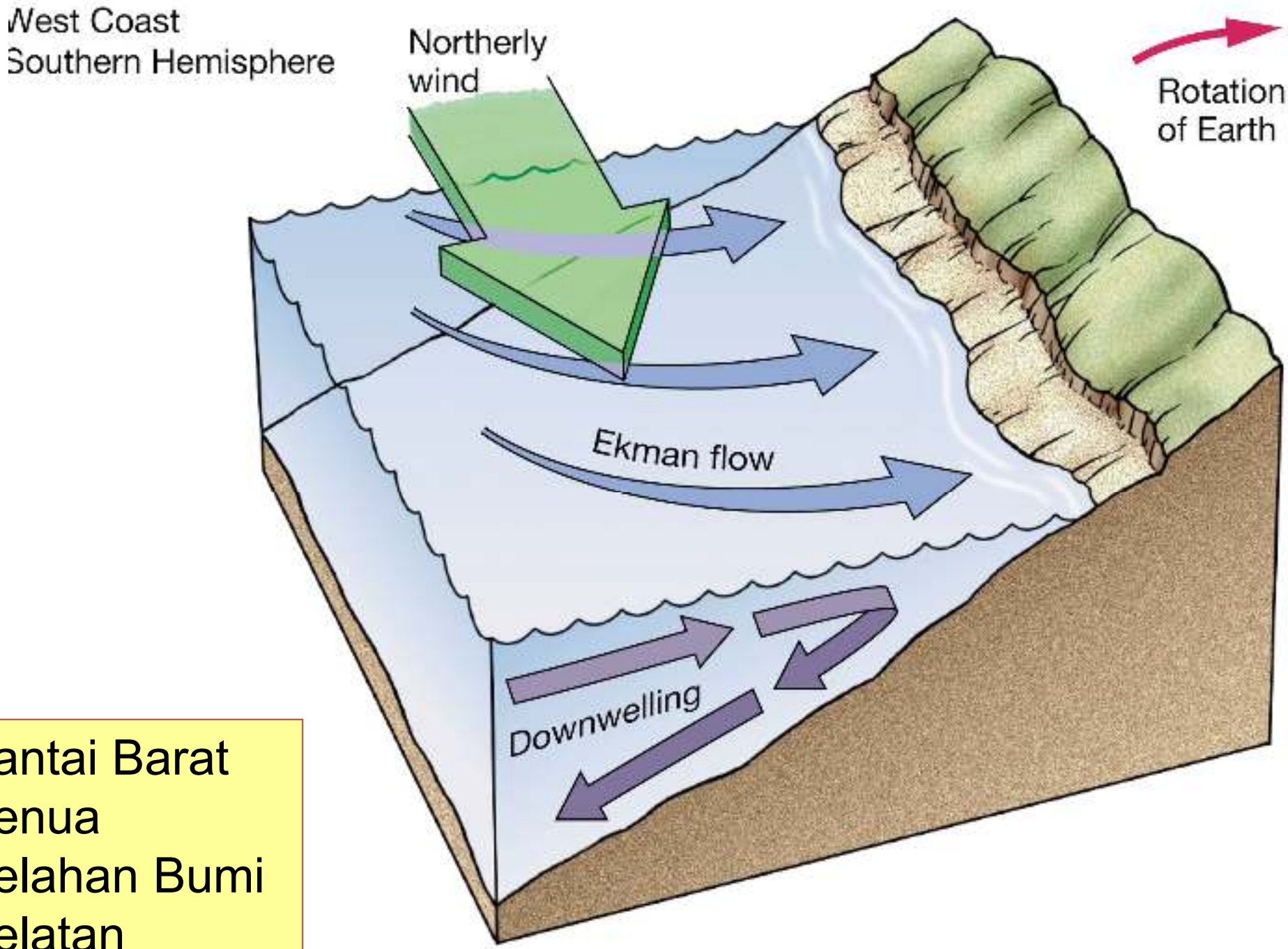
Teori Ekman ...dan adveksi vertikal di lautan

UPWELLING dan DOWNWELLING di perairan pesisir (coastal)

PEMOMPAAN EKMAN DI LAUTAN TERBUKA (OPEN OCEAN EKMAN PUMPING)

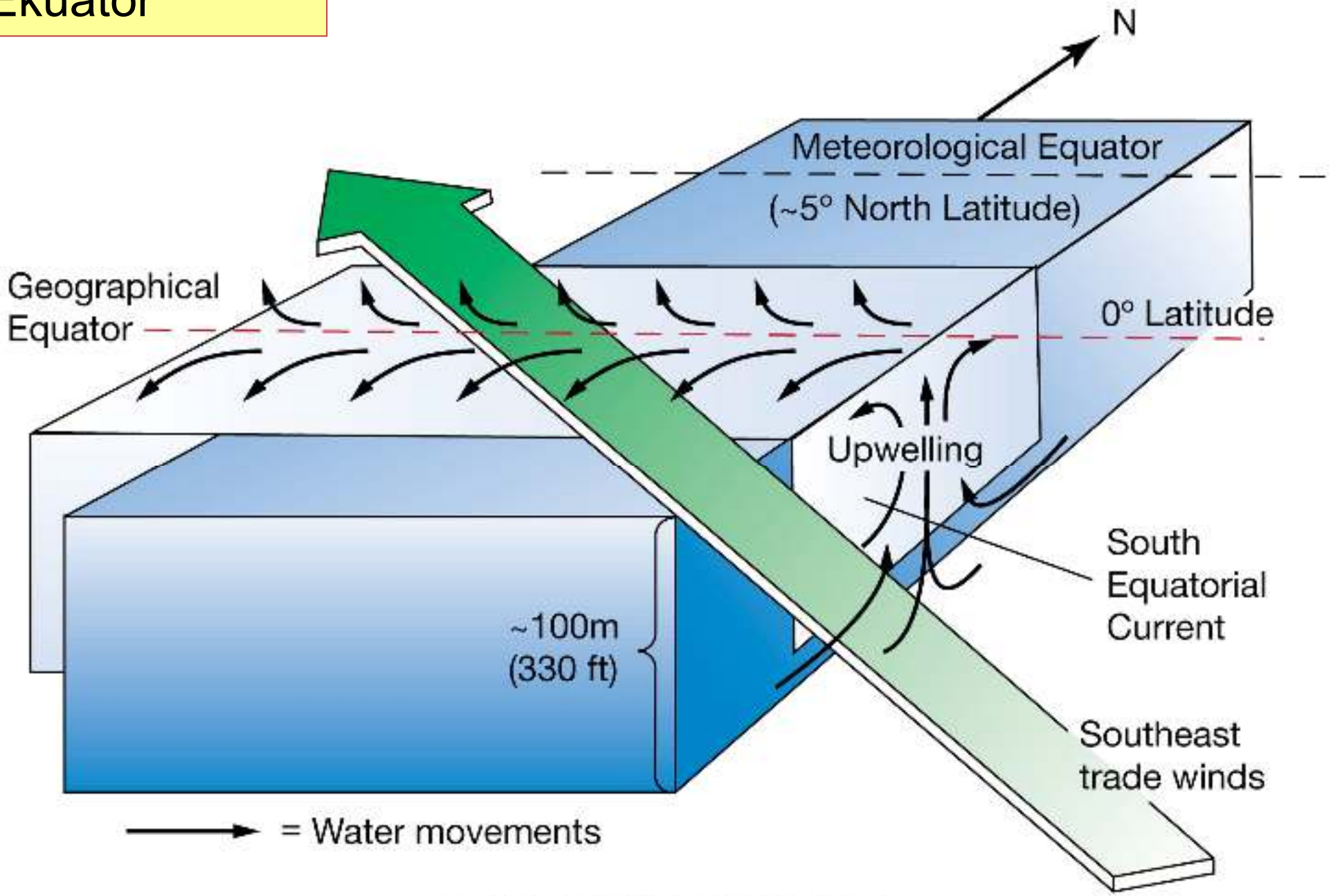


Pantai Barat
Benua
Belahan Bumi
Selatan

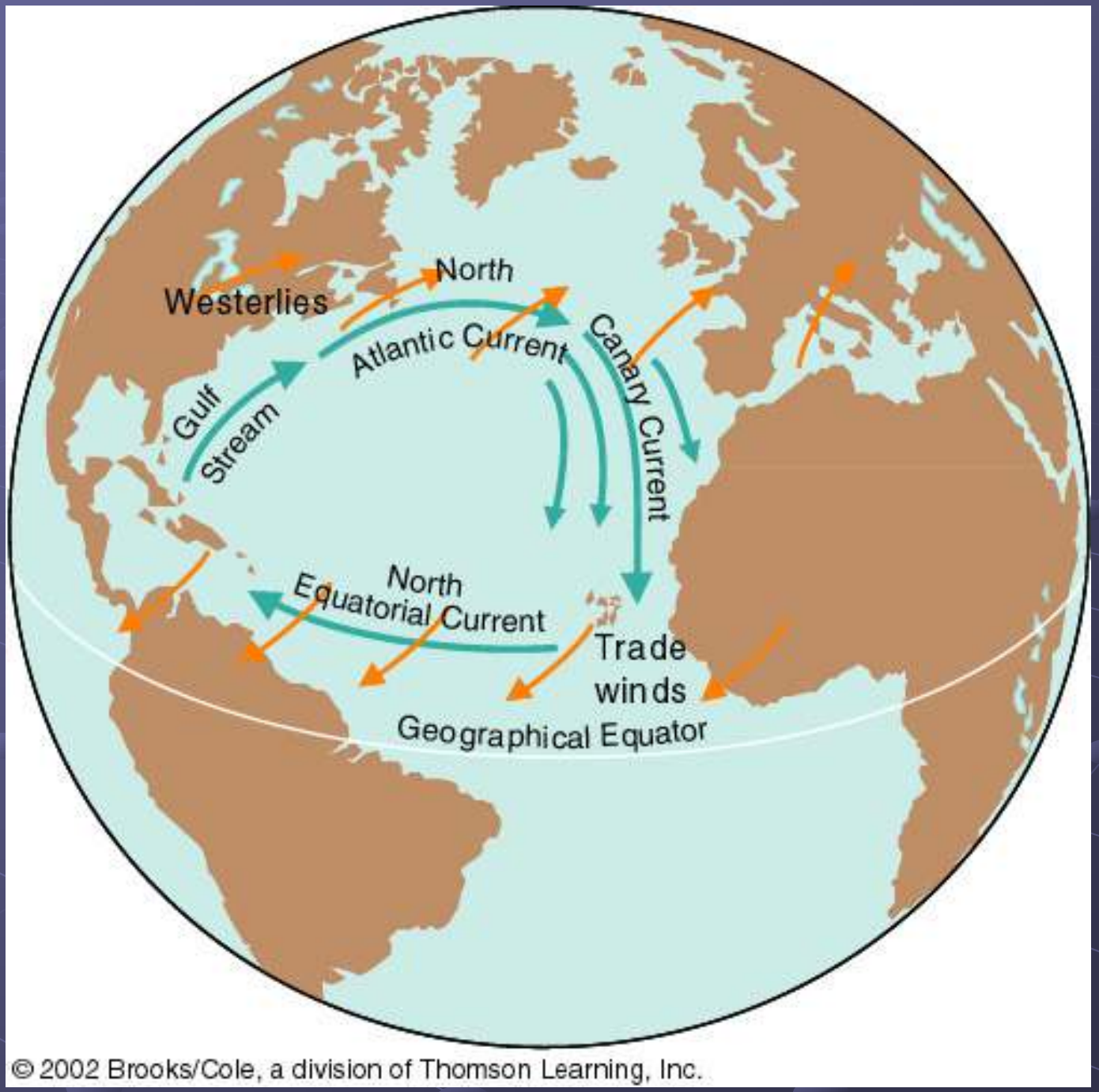


Pantai Barat
Benua
Belahan Bumi
Selatan

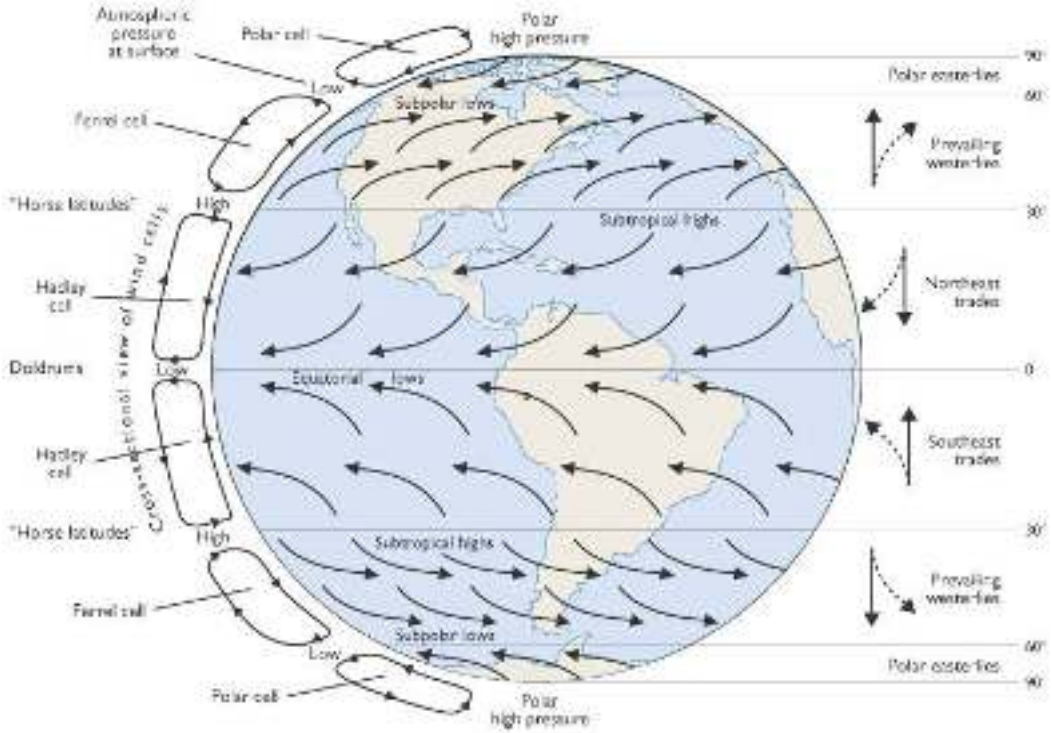
Laut Terbuka Ekuator



Effek dari Arus Ekman



Atmosphere



60

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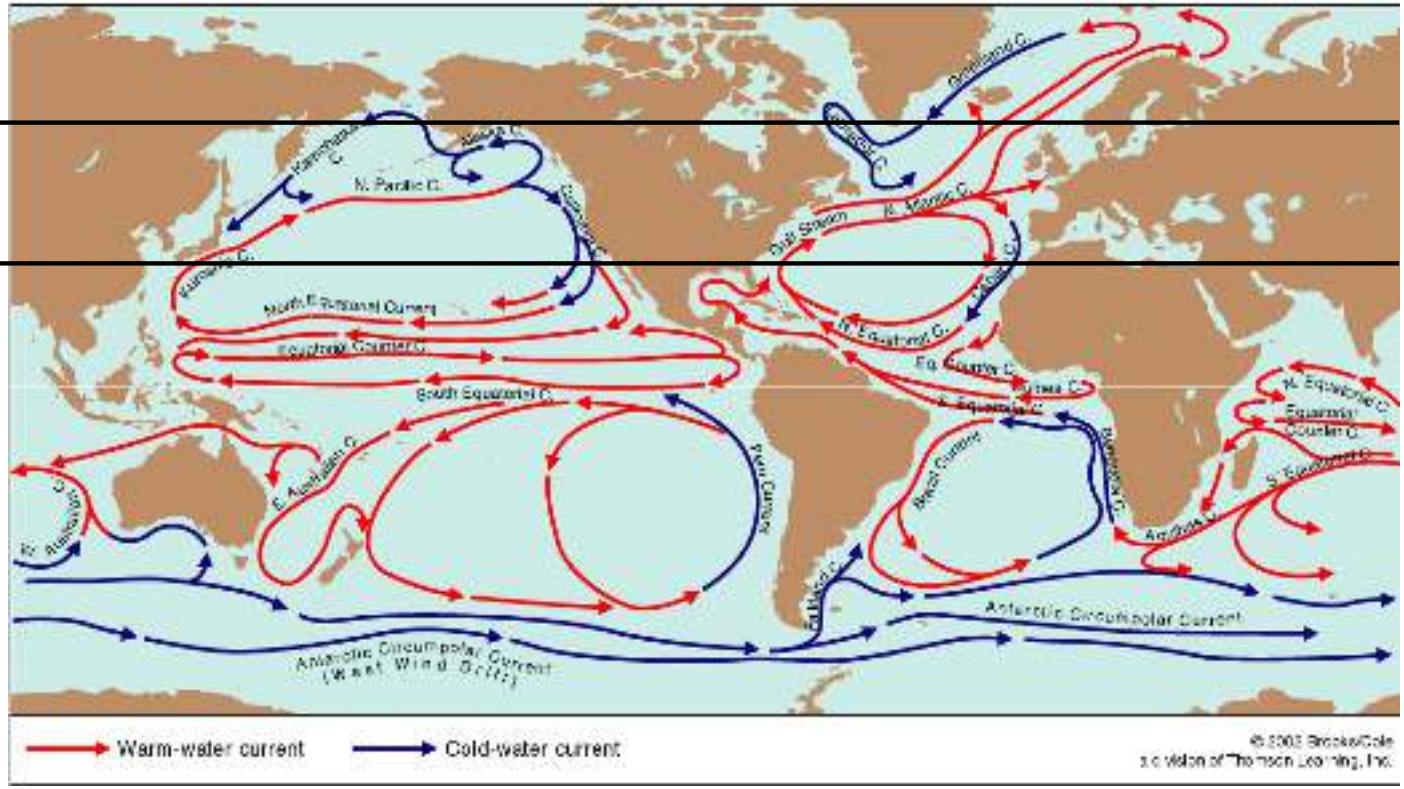
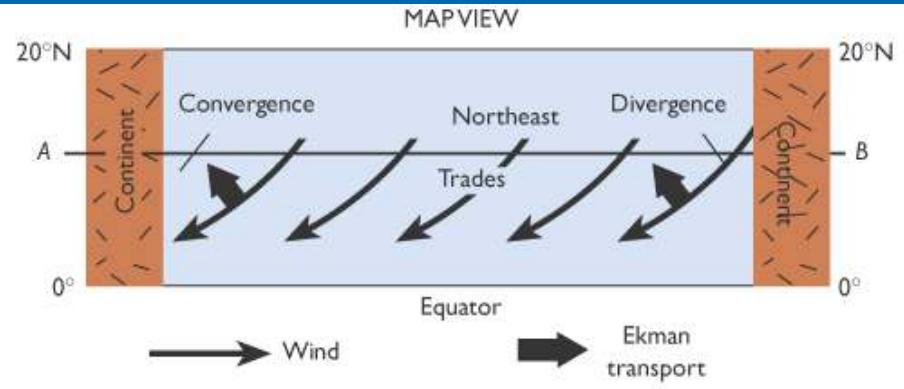
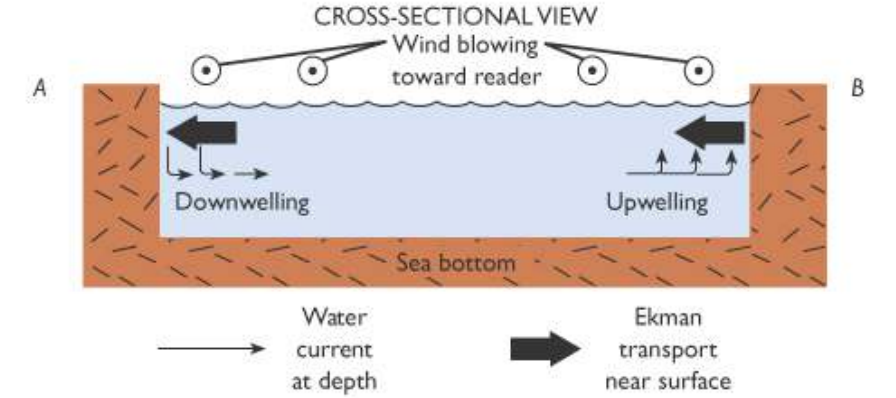
Ocean



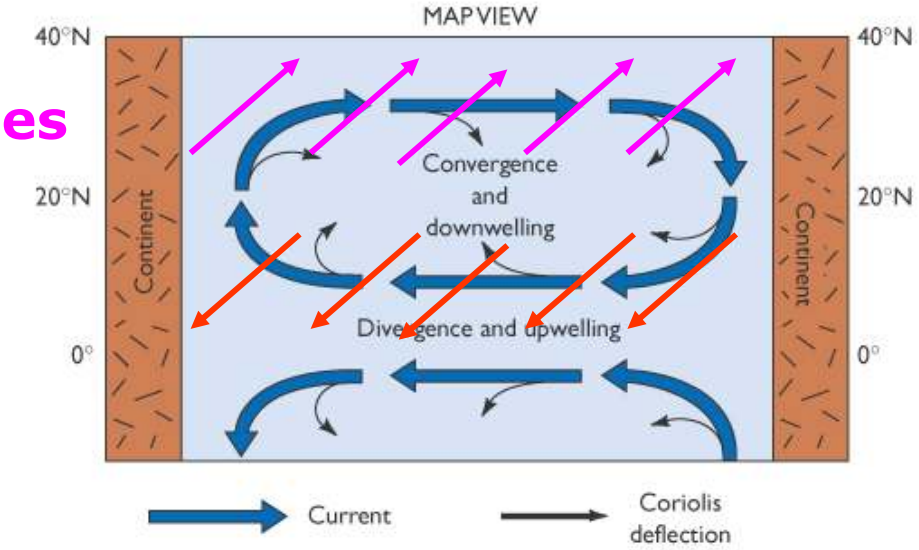
Effek dari Trasfor Ekman





(a) COASTAL DIVERGENCE AND CONVERGENCE

Upwelling dan
Downwelling
di continental margin



(b) OCEAN DIVERGENCE AND CONVERGENCE

Westerlies

Passat (Trades)

Upwelling dan
Downwelling
pada gyres

Terima Kasih