tekanan atmosfer
dan sirkulasi atmosfer global

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Referensi

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Tekanan udara (tekanan atmosfer)

- Adalah berat atmosfer per satuan luas
- Batasan lain mengatakan bahwa tekanan atmosfer suatu ketinggian tertentu adalah gaya per satuan luas yang diusahakan oleh udara pada ketinggian tersebut

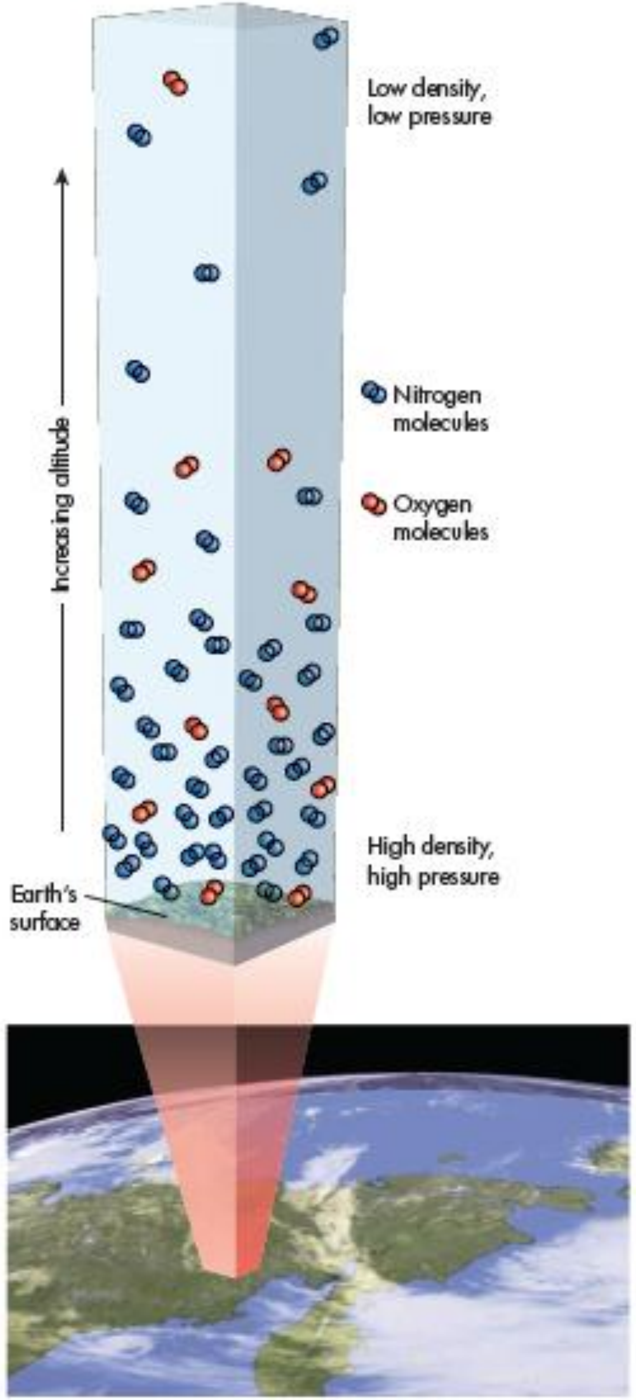
Udara mempunyai sifat yang meluas dan juga dapat ditekan. Oleh karena itu ***tekanan udara yang terbesar*** *adalah pada* ***permukaan tanah****, dan* ***semakin ke atas*** *tekanannya semakin* ***berkurang*** *atau tekanan udara berkurang terhadap ketinggian*

ATMOSFER tersusun oleh berbagai macam gas yang secara kolektif disebut sebagai **udara.** Seperti materi yang lainnya, udara dipengaruhi oleh gravitasi sehingga memiliki bobot tertentu

Bobot dari udara memberi tekanan pada permukaan bumi, yang diukur sebagai ***TEKANAN UDARA***

(sering disebut juga tekanan atmosfer atau tekanan barometrik)

Air pressure: the force that air molecules exert on a surface due to their weight (Arbogast, 2011)



At low altitudes air molecules are held close to Earth by gravity and thus are **more dense**,

Resulting in high atmospheric pressure

In contast, the density of air molecules is **low at high altitudes** and air pressure is thus **relatively low** (arbogast, 2011)

Tekanan udara

- Tekanan atmosfer sangat berkaitan dengan temperatur udara dan kerapatan (densitas) udara
- Di dekat permukaan bumi udara menimbulkan tekanan sebesar 10^5 newton tiap m^2 atau sama dengan 1 bar
- Karena perubahan tekanan udara sehari-harinya kecil maka satuan yang digunakan harus sesuai sehingga setiap kejadian yang berhubungan dengan tekanan udara dapat dilaporkan
- Satuan yang digunakan adalah milibar (mb)

1 bar = 1000 mb, 1 bar = 100.000 newton/m^2, 1 mb = 100 newton/m^2

Tekanan udara

- Tekanan udara akan berkurang terhadap ketinggian, oleh karena itu tekanan terbesar ada pada permukaan bumi.
- Dengan kata lain tekanan udara adalah berat udara pada satuan luas tertentu pada suatu permukaan bumi.
- Adapun volume udara dihitung dari permukaan bumi sampai atmosfer paling atas

Tekanan udara

- Massa udara semakin tipis sehingga semakin ke atas tekanannya semakin rendah.
- Oleh karena itu dengan semakin bertambahnya ketinggian tekanan udaranya akan semakin rendah.
- Secara **teoritik** setiap **naik 10 m** ke ketinggian maka tekanan udaranya **turun 1 mb**.

Tekanan udara

- Dengan asumsi rata-rata tekanan udara pada 0 mdpal adalah 1010 mb, maka tekanan udara pada suatu tempat dapat dihitung dengan rumus:
- Tekanan udara suatu tempat = 1010 mb – penurunan tekanan udara
- Penurunan tekanan udara = $\frac{ketinggian\ tempat}{10}$ x 1 mb

Tekanan udara

- Selain perubahan tekanan udara yang terjadi terhadap ketinggian tempat, tekanan udara juga bervariasi **secara horizontal** di permukaan bumi
- Dikenal adanya **high-pressure system** dan **low-pressure system**

Tekanan udara

- **Sistem tekanan tinggi** adalah tubuh sirkulasi udara *(a circulating body of air)* yang memberikan tekanan yang cukup tinggi di permukaan bumi karena udara turun (ke permukaan) di tengah sistem
- Sebaliknya, **sistem tekanan rendah** adalah tubuh peredaran udara dimana tekanan yang relatif sedikit ada di permukaan bumi, karena udara naik (jauh dari permukaan) di inti sistem

Sistem bertekanan rendah

- **low-pressure system** berkaitan dengan siklon.
- Terkait dengan dengan aliran vertikal udara dari udara yang bergerak ke atas
- Arus yang paling kuat terdapat di pusat sistem
- Bagian pusat dari sistem disimbolkan dengan huruf L pada peta cuaca yang berarti tekanan rendah (low)
- Pada belahan bumi utara, aliran udara yang mengelilingi pusat bertekanan rendah arahnya berlawanan dengan jarum jam, sementara pada belahan bumi selatan searah jarum jam

Sistem bertekanan tinggi

- **high-pressure system** berkebalikan dengan sistem tekanan rendah, daerah yang luas dari sistem ini disebut antisiklon.
- Pada sistem ini aliran vertikal berupa pergerakan udara turun yang kemudian menyebar setelah mencapai permukaan
- Karena turunnya udara paling kuat terdapat pada di pusat sistem maka bagian ini ditandai dengan huruf H (high) pada peta cuaca
- arus udara horizontal di sekeliling pusat di belahan bumi utara bergerak searah jarum jam sedangkan di belahan bumi selatan berlawanan arah jarum jam

Arbogast, 2011

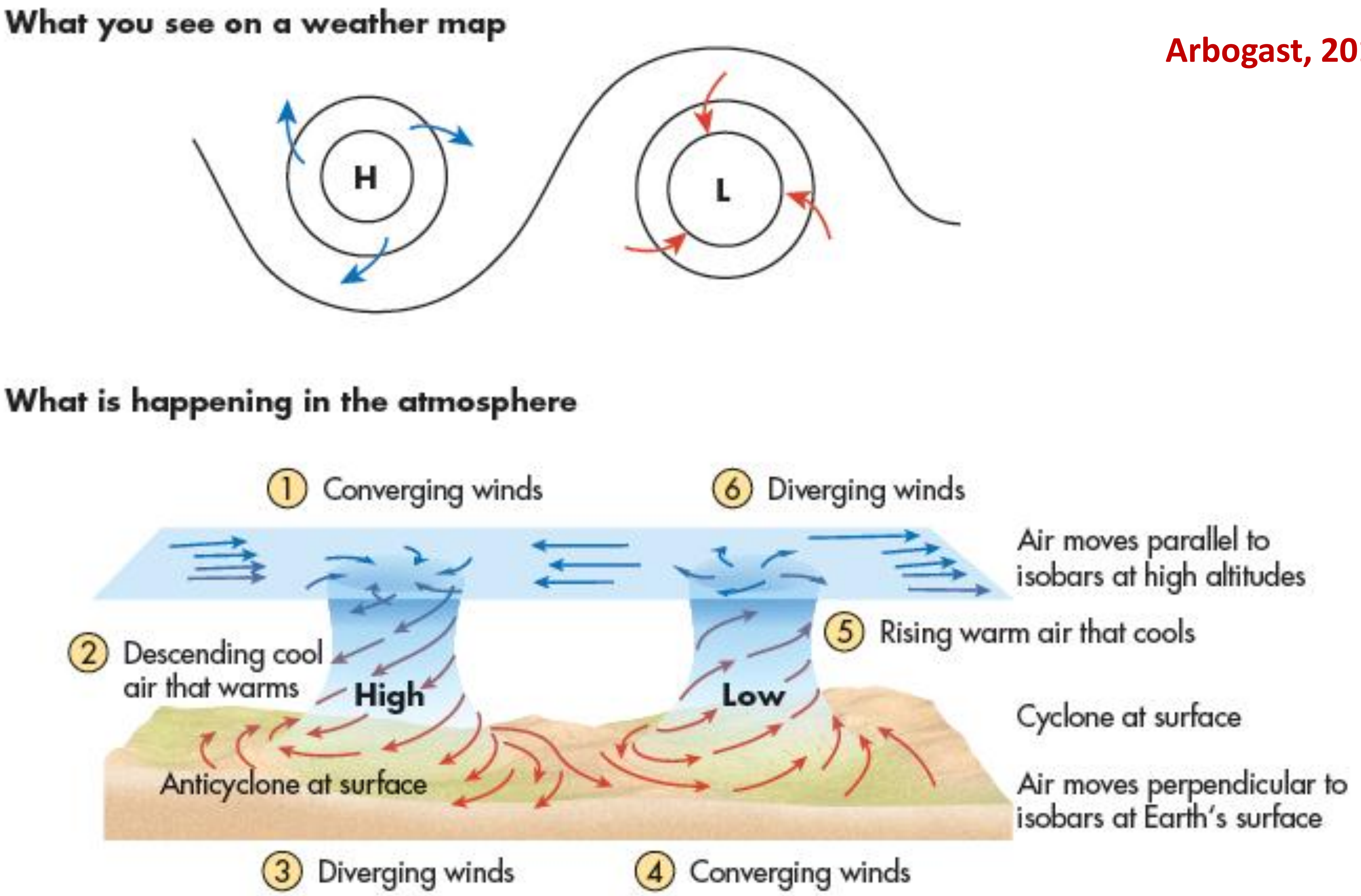
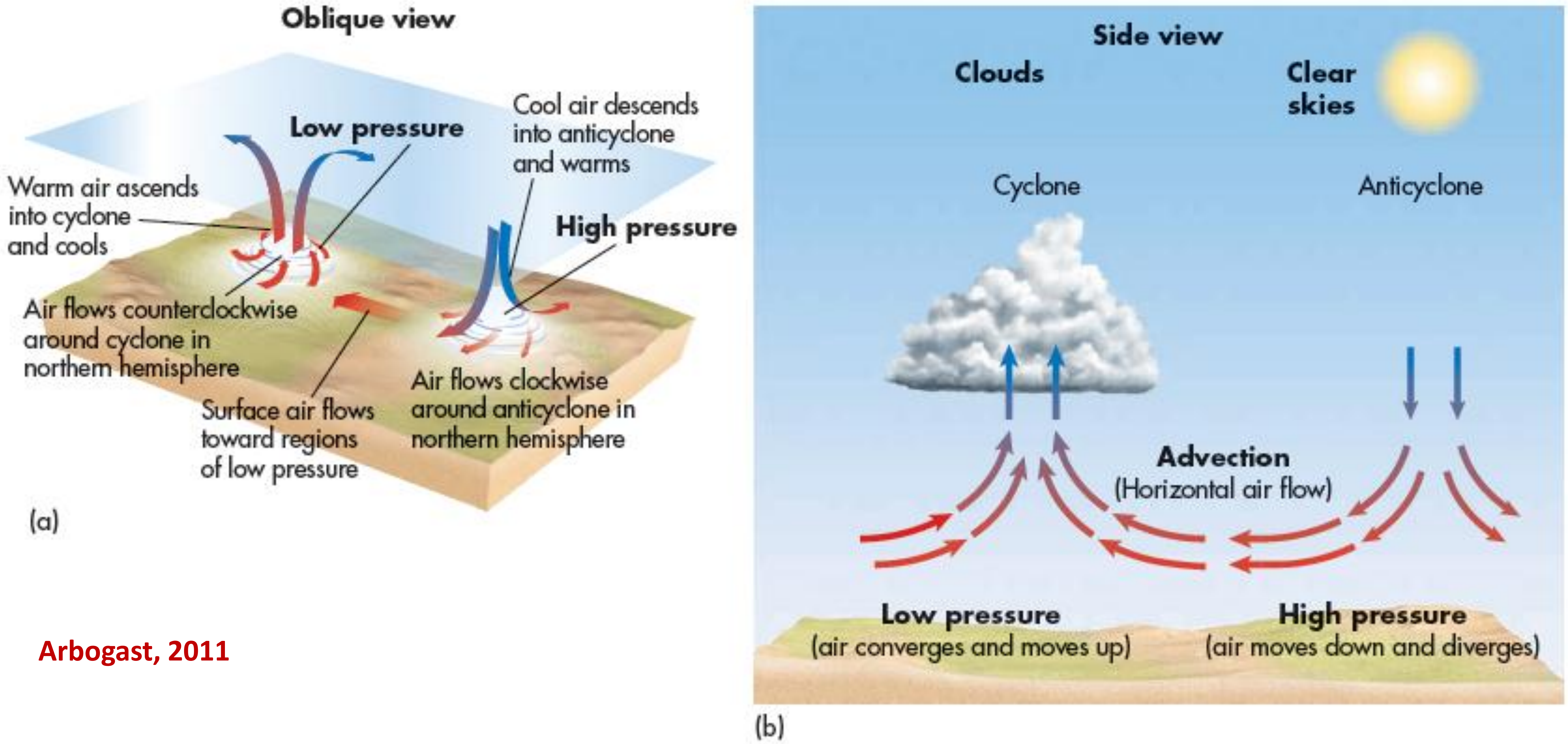


Figure 6.12 A dynamic convection loop. Cyclones and anticyclones are linked together in a convection loop consisting of air masses that spiral due to the Coriolis force. Note how the air masses move vertically within the high- and low-pressure systems and horizontally between them.



Arbogast, 2011

Figure 6.5 Atmospheric pressure systems. Oblique view (a) and side view (b) of typical low- and high-pressure systems. In a low-pressure system, air converging at the surface rises and forms clouds. In a high-pressure system, air descends and diverges at the surface; these systems are usually associated with clear skies.

Arbogast, 2011

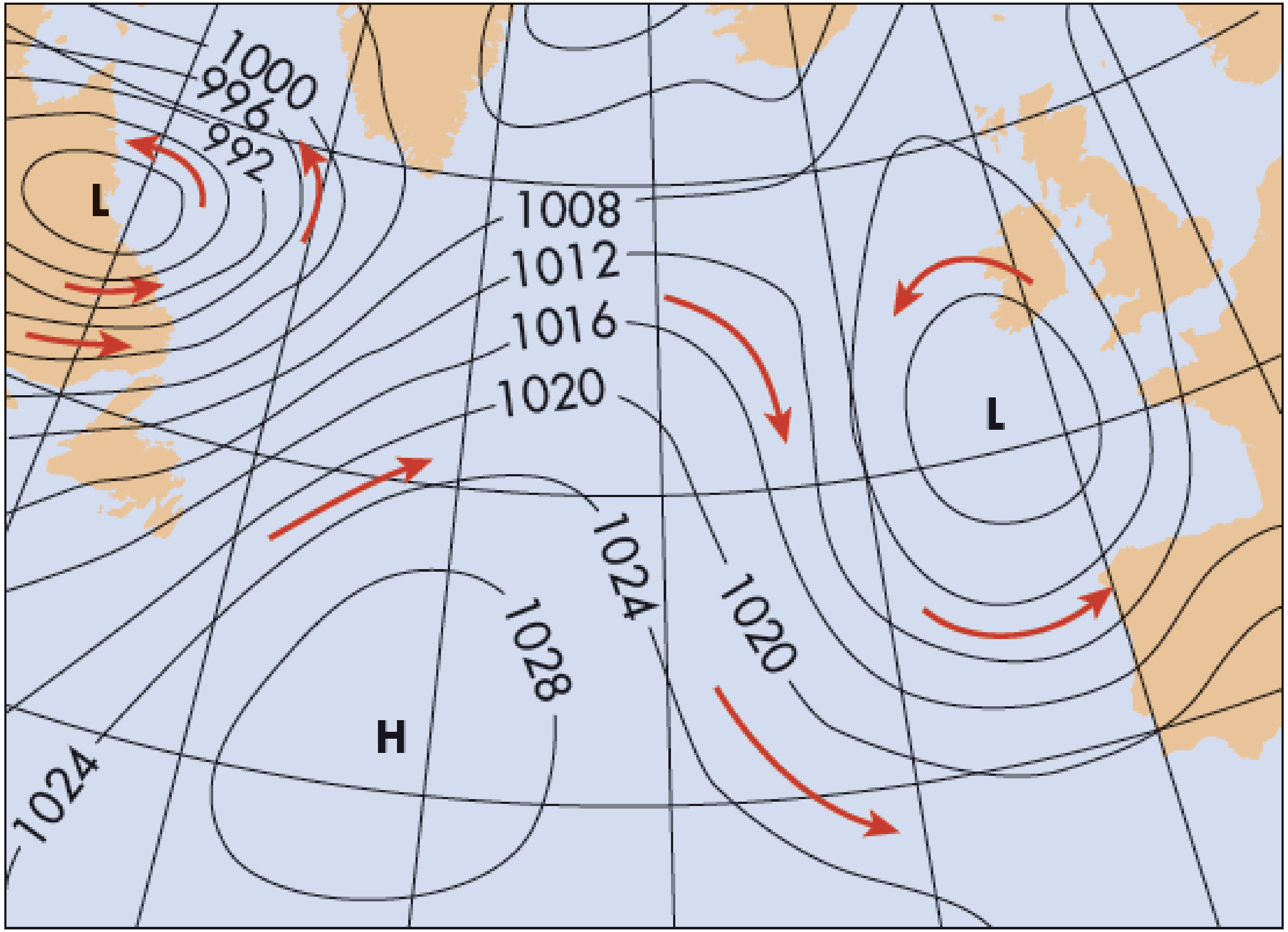


Figure 6.6 Atmospheric pressure map of the North Atlantic. The red arrows represent the direction of the winds. Notice the pressure variability across the ocean and the way air flows.

Arbogast, 2011

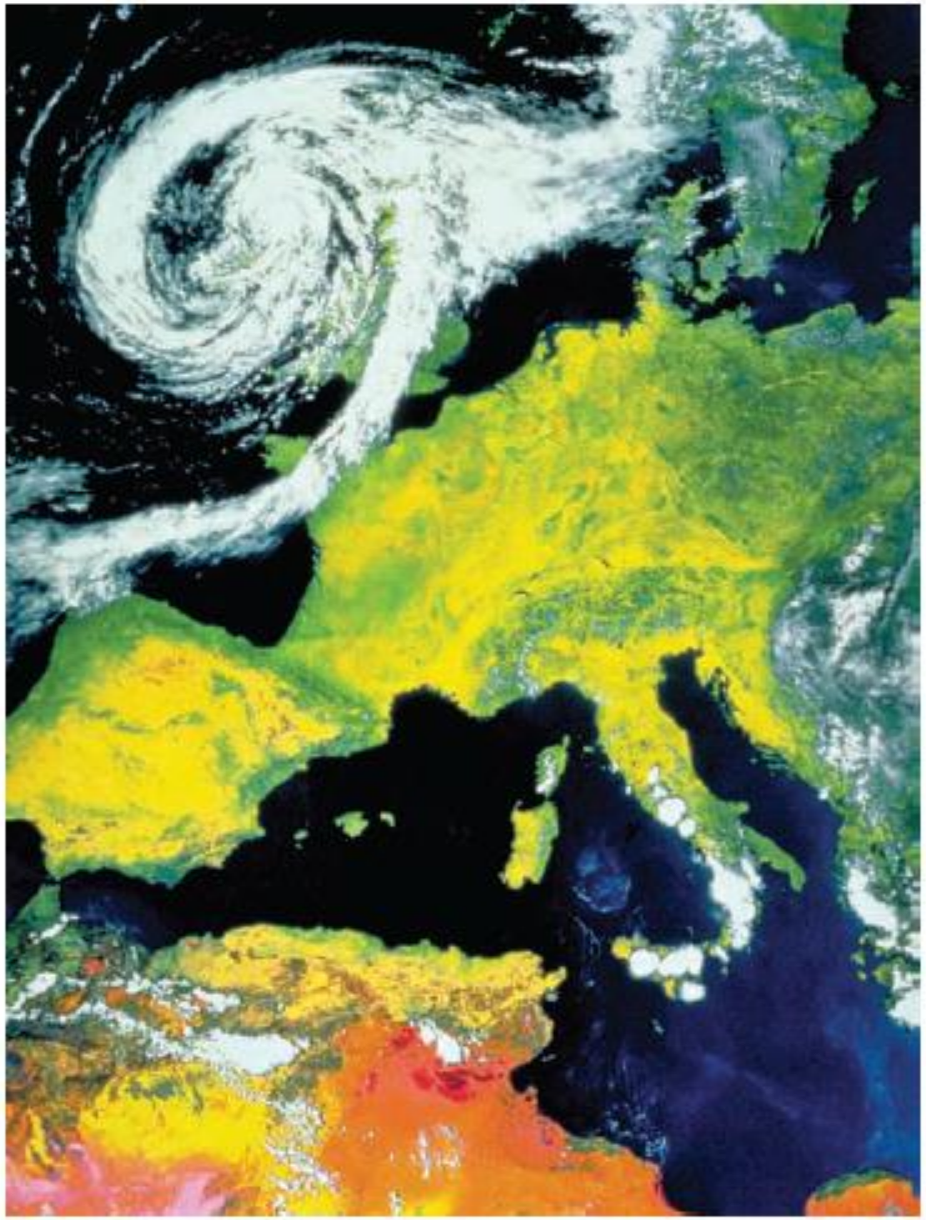


Figure 6.8 Atmospheric pressure systems in Europe. The low is indicated by the clouds that cover Great Britain and Ireland, whereas the high is the clear sky to the east over France, Spain, and Germany.

Arbogast, 2011

KEY CONCEPTS TO REMEMBER ABOUT ATMOSPHERIC PRESSURE SYSTEMS

1. Air pressure refers to the weight of air distributed on the surface of Earth. It generally decreases with increasing altitude.
2. Low-pressure systems are called cyclones and consist of rotating air masses that lift air from the surface. In the Northern Hemisphere, these systems rotate counterclockwise, whereas they rotate clockwise in the Southern Hemisphere.
3. Low-pressure systems are usually associated with clouds and precipitation.
4. High-pressure systems are called anticyclones and consist of rotating air masses that descend toward the surface. In the Northern Hemisphere, these systems rotate clockwise, whereas they rotate counterclockwise in the Southern Hemisphere.
5. High-pressure systems are usually associated with clear skies.
6. On weather maps, isobars indicate areas of equal air pressure.
7. Winds flow from high to low pressure.

Arbogast, 2011

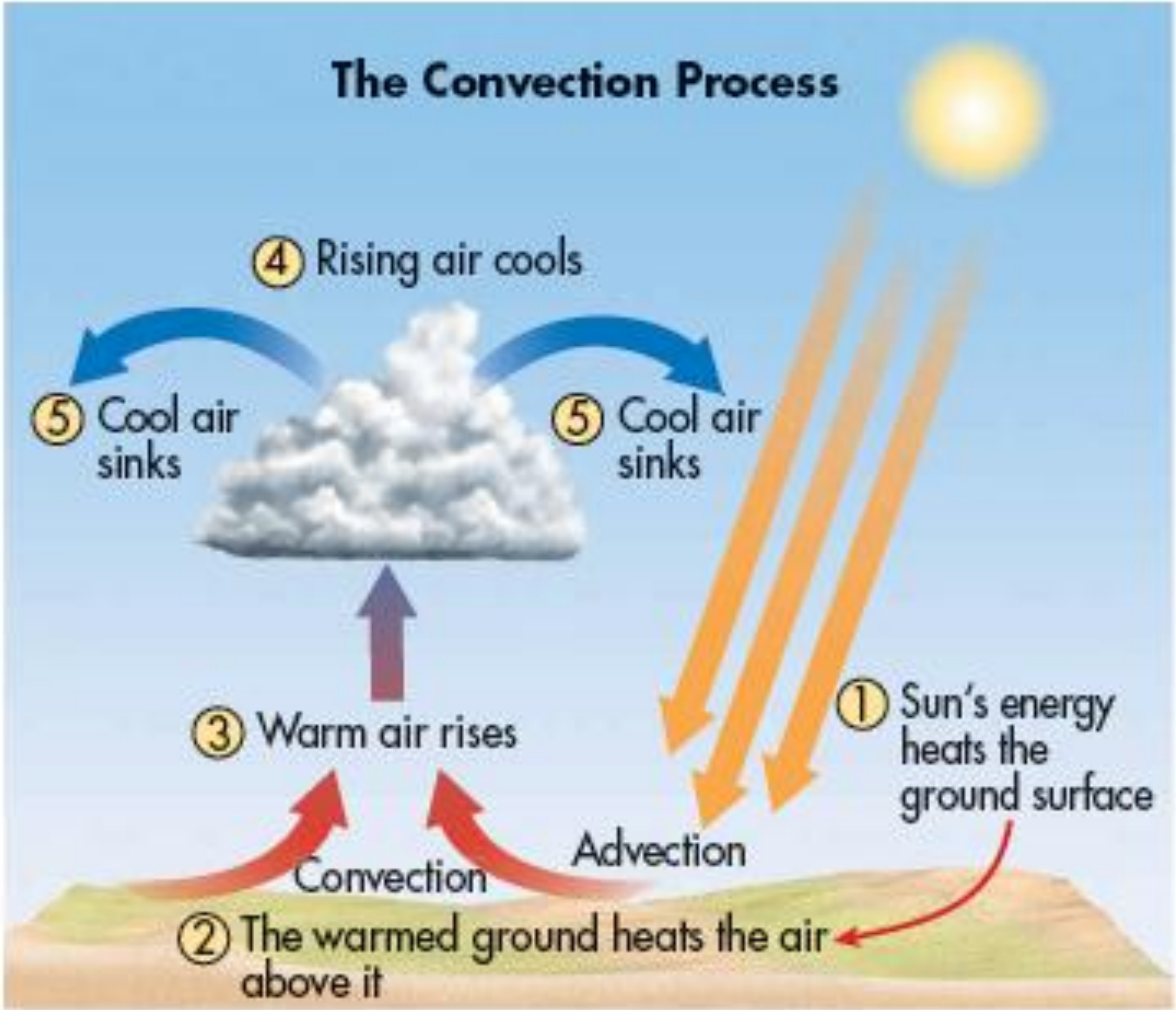


Figure 6.9 Atmospheric convection. Convection occurs when one portion of the Earth's surface is heated relative to another. When this happens, a large "bubble" of air lifts from the surface.

Global Pressure and Atmospheric Circulation

SIRKULASI ATMOSFER

- Atmosfer bumi tidak diam tetapi bergerak secara dinamis
- Gerak atmosfer dapat digolongkan menurut beberapa kriteria
- berdasarkan derajat regularitas dikenal adanya arus laminer dan turbulen
- Beberapa gerak udara disebabkan terutama oleh gaya gradien tekanan, beberapa dipicu oleh gaya apung.
- Gerak udara juga dipicu oleh mekanisme kelabilan oleh sifat thermal (kelabilan vertikal) maupun kelabilan geser
- Berdasarkan skala jarak gerak atmosfer dibedakan menjadi gerak skala planeter, sinoptik, skala meso, dan skala kecil

Oliver, 2005

ATMOSPHERIC CIRCULATION, GLOBAL

Global atmospheric circulation consists of the observed wind systems with their annual and seasonal variations, and is the principal factor in determining the distribution of climatic zones, while variations in the atmospheric and oceanic circulations are responsible for many of the observed longer-term fluctuations in climate. The two major controls on the global wind circulation are inequalities in radiation distribution over the Earth's surface and the Earth's rotation. Global radiation distribution, together with gravity, drives the global atmospheric circulation, whereas the Earth's rotation determines its shape. Basically, the mean surface circulation consists of easterly winds with equatorial components in the tropics and westerly winds with poleward components in middle latitudes, the corresponding meridional flows aloft being reversed. Weak surface easterlies are observed in polar regions, and extensive areas of calms in the equatorial and also the subtropical regions. Strong, westerly winds are found in the upper troposphere poleward of about 25°N and 25°S.

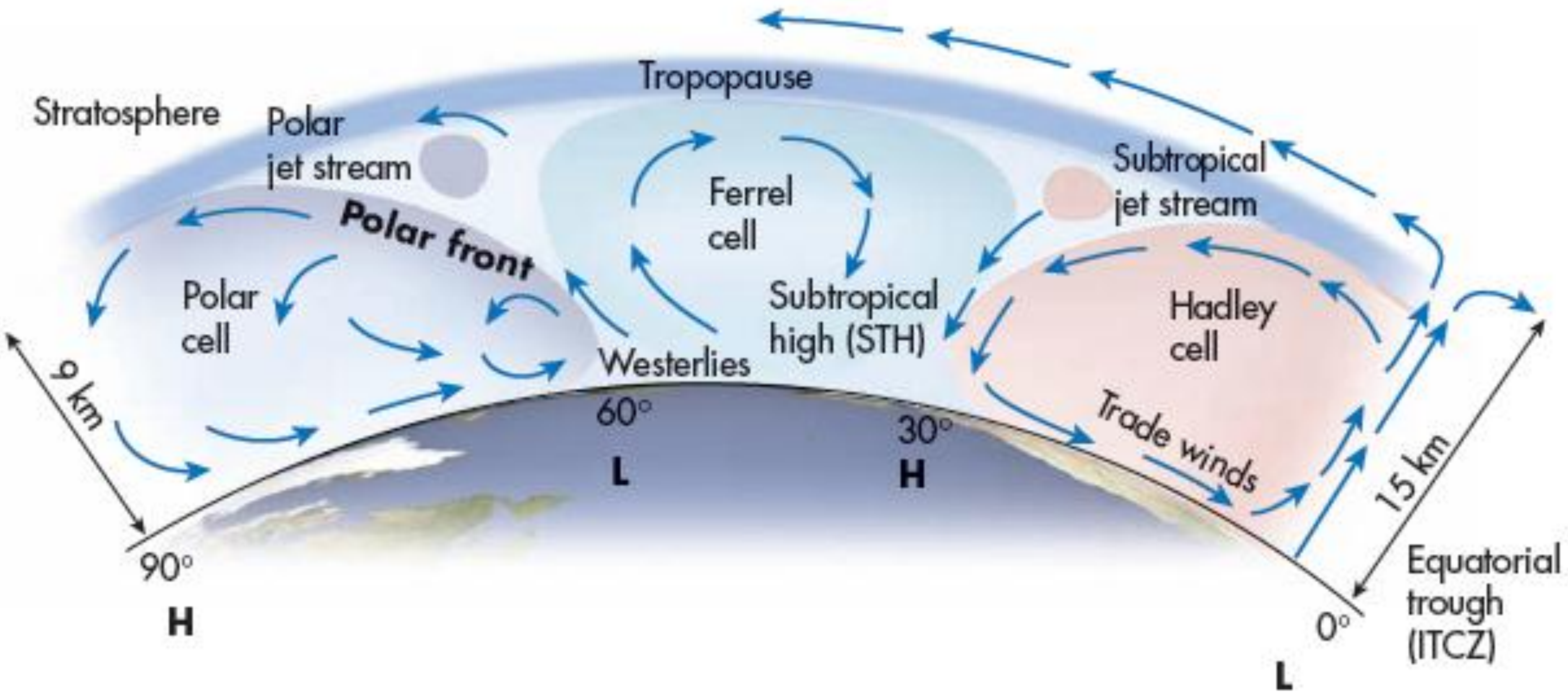
SIRKULASI ATMOSFER

Sirkulasi atmosfer global dipengaruhi oleh

- ❑Distribusi radiasi
- ❑Rotasi bumi
- ❑*Baroclinic instability*

- ❑Sirkulasi atmosfer disebabkan oleh rotasi bumi terhadap sumbu semunya dan oleh pemanasan geografis yang tidak merata pada permukaan bumi bersama atmosfernya
- ❑Sabuk planeter terdiri dari: (a) daerah tenang ekuatorial, (b) sabuk angin sub tropis, (c) sabuk tekanan rendah sub polar, (d) tekanan tinggi polar

Arbogast, 2011



Oliver, 2005

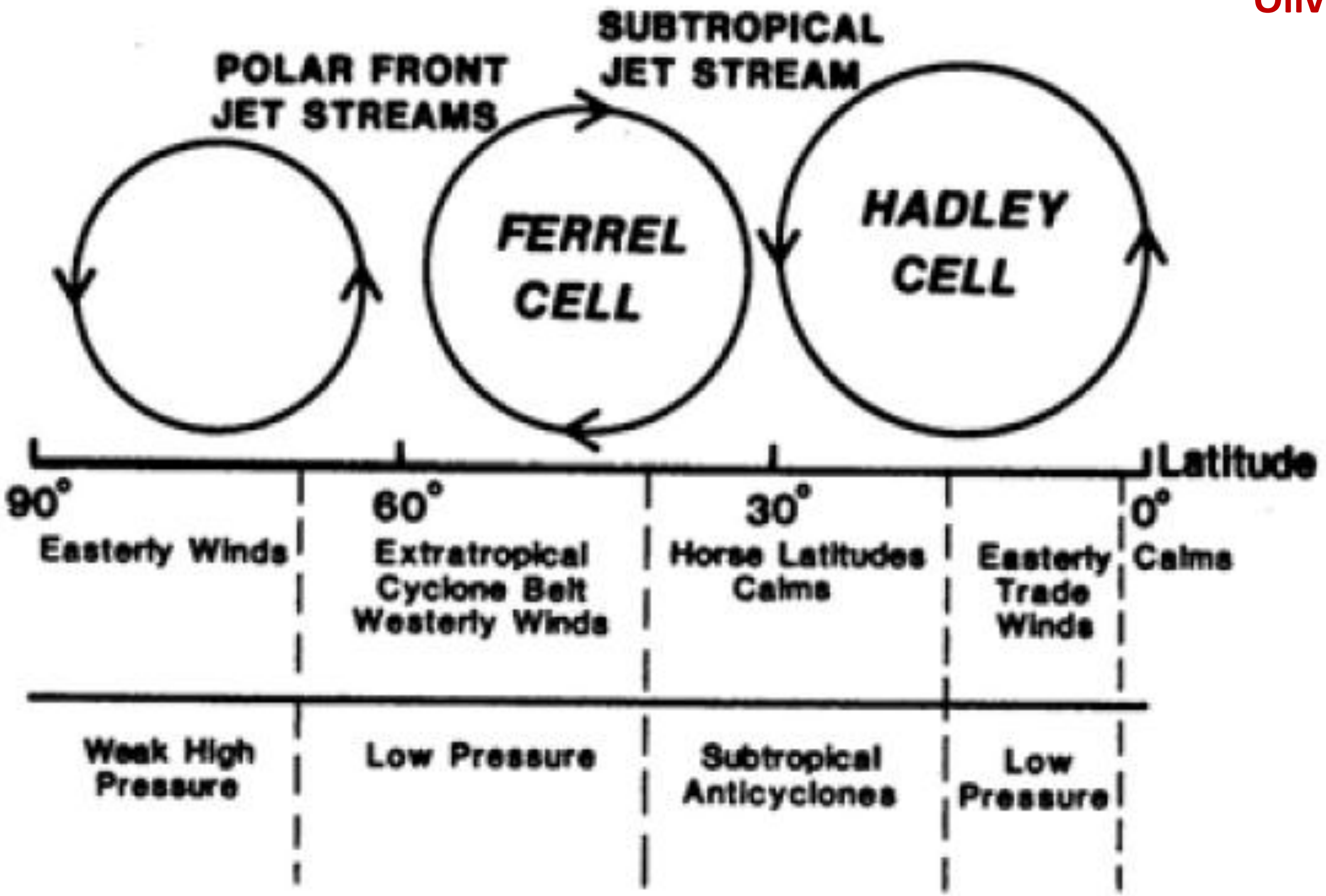


Figure A77 A schematic representation of the mean meridional circulation of the northern hemisphere.

SIRKULASI ATMOSFER

- Model sirkulasi atmosfer yang pertama dikenalkan oleh Hadley pada tahun 1735
- Menurut Maury (1855) sirkulasi atmosfer meridional terdiri dari dua sel yaitu sel antara ekuator dan daerah lintang 30^0 disebut sirkulasi Hadley dan satu sel pada lintang tinggi
- Ferrel telah mengkaji bahwa terdapat tekanan tinggi di sekitar 30^0 dan tekanan rendah di ekuator dan kutub, sirkulasi atmosfer meridional yang diusulkan Ferrel terdiri dari tiga sel sirkulasi yaitu Sel Hadley, Sel Ferrel, dan Sel Polar

HADLEY CELL

Oliver, 2005

In 1735 George Hadley proposed a cellular model to explain the primary circulation of the atmosphere. Based upon pressure differences produced by uneven heating of the earth, Hadley postulated that cold air sinking at the poles would flow equatorward to be replaced by warm air rising at the equator and flowing poleward aloft. This would result in two large Hadley circulation cells in each hemisphere (Figure H1a). This model was shown to be greatly oversimplified and to disregard the Earth's rotation, but it offered a very important first approximation and is reproducible in dishpan experiments. Hadley's model was refined over time and gradually altered to a three-cell model for each hemisphere as in Figure H1b.

Today, the low-latitude circulation between the equatorial low-pressure and the semipermanent high-pressure belts is referred to as the Hadley Cell, although now it is considered more complex than a simple thermal cell.

Oliver, 2005

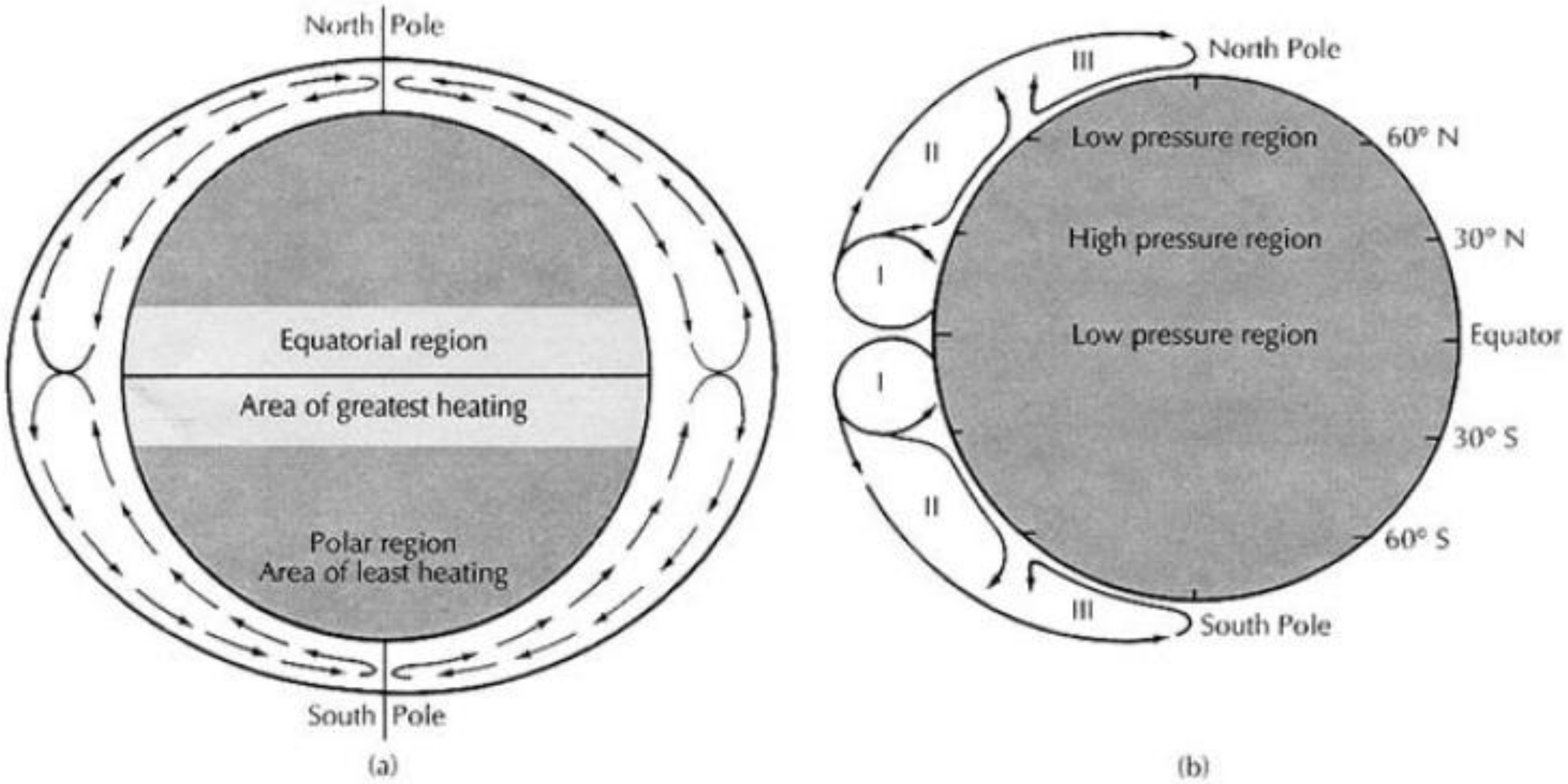
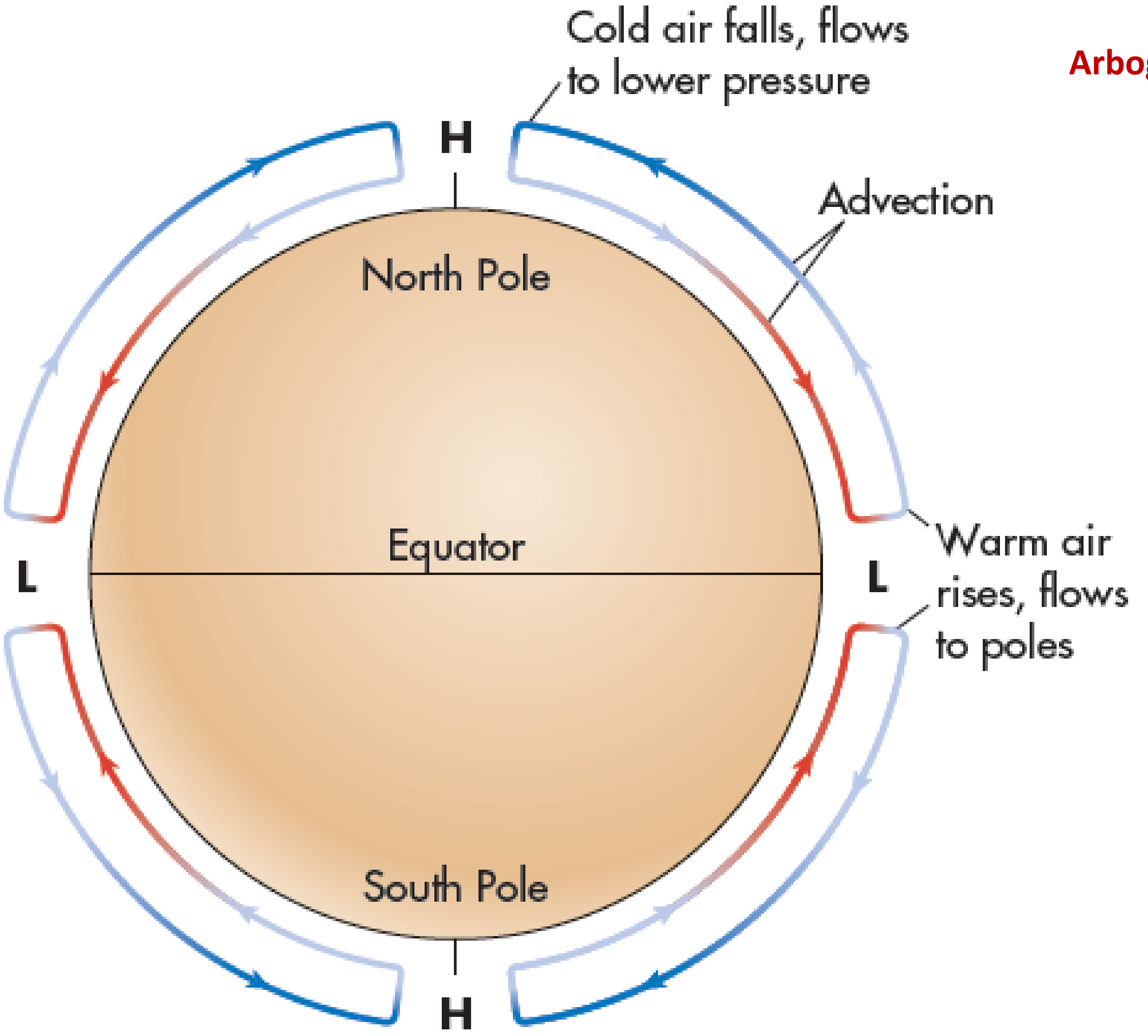


Figure H1 (**a**) A single cell in each hemisphere provides the fundamental air flow based upon temperature differences. (**b**) A three-cell model, for each hemisphere, that results from differential heating and Earth's rotation. The Hadley Cell is labeled 1.



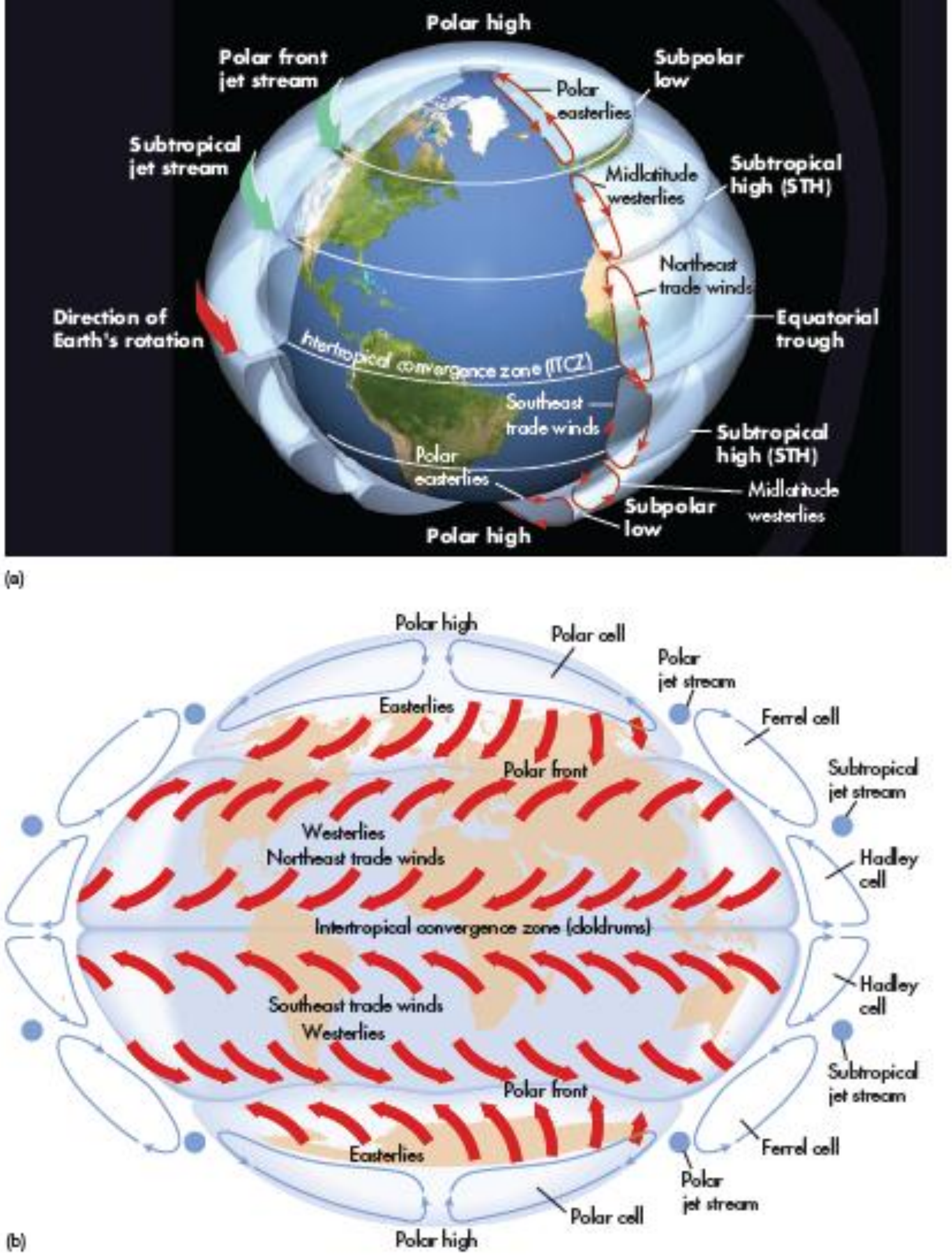
Arbogast, 2011

FERREL CELL

Oliver, 2005

A Ferrel Cell is a circulation pattern named for William Ferrel (1817–1891), an American meteorologist who discovered the effects of the Earth's motion in wind systems. Although George Hadley had recognized the convective nature of the air in 1735, and M. F. Maury, in 1855, had proposed a good model for the atmospheric circulation, both lacked an appreciation of the nature of the westerlies. Ferrel brought a fundamental knowledge of mechanics and mathematics to the subject (Clayton, 1923) and first sketched the diagram of the planetary surface winds that appears in almost every geography textbook (Figure F1). He pointed out that the total movement of air to the east must balance the total movement to the west or else the Earth's rotation would be accelerated or retarded.

Arbogast, 2011



Oliver, 2005

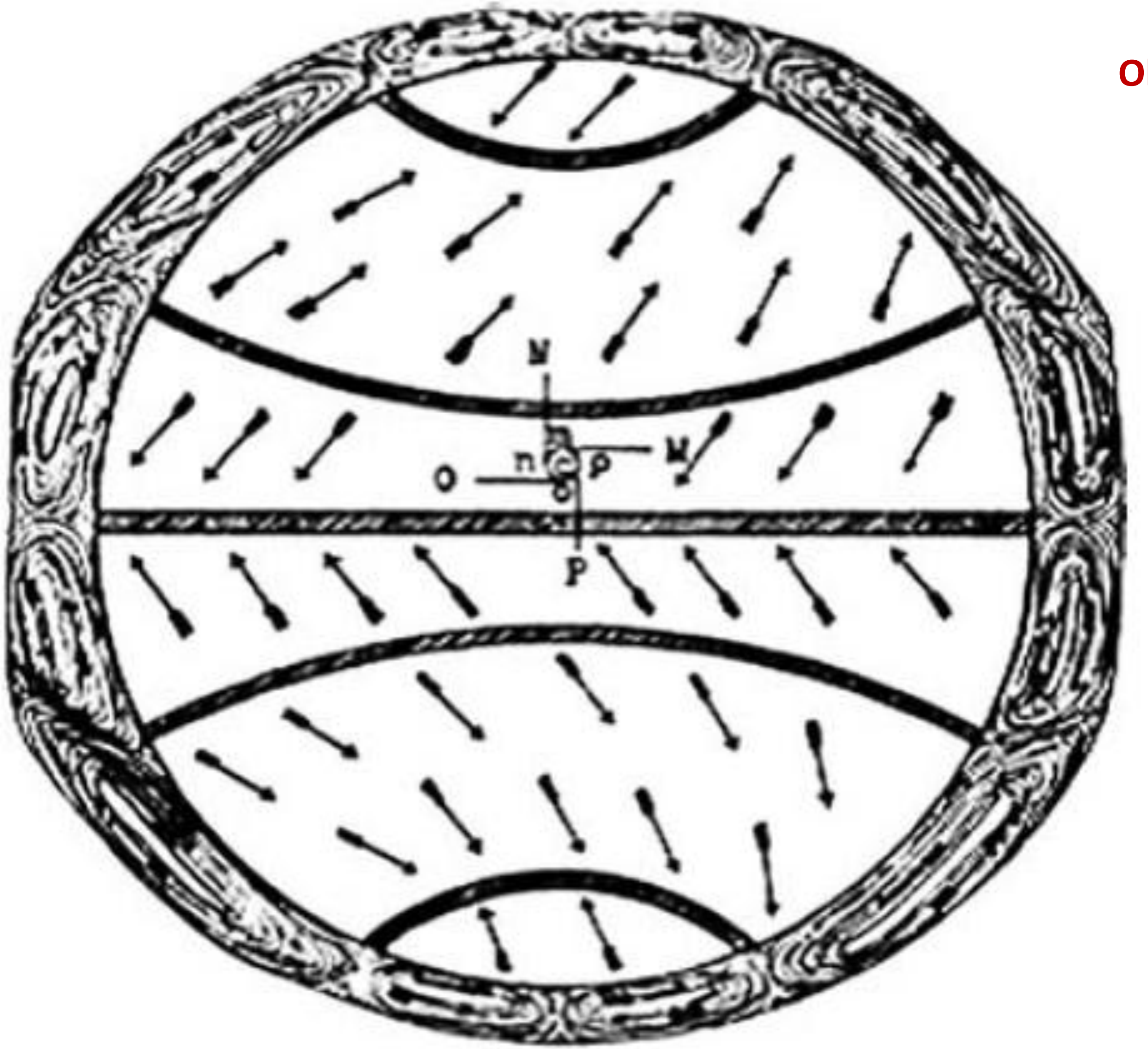


Figure F1 Atmospheric circulation (from Ferrel, 1856).

HORSE LATITUDES

Oliver, 2005

Horse latitudes is a term used to describe north and south Subtropical High atmospheric pressure belts. The term is now used only rarely in modern studies. Marked by dry sinking air, these Subtropical High atmospheric pressure belts are centered around 35°N and 30°S, extending approximately 25° to 40°, respectively, N and S, and shifting seasonally – to the north in the northern summer and to the south in the southern summer. Characterized by light winds and fine, clear weather, where not modified by continental factors, they are sometimes known as the *Calms of Cancer* and *Calms of Capricorn*. In the northern Atlantic the Calms of Cancer include the Sargasso Sea, the lack of wind combining with the gyratory current system to make this an exceptionally difficult region to cross in the days of the sailing ships. According to the *Oxford English Dictionary*, the origin of the name "horse latitudes" is uncertain. However, it has been suggested that sailing ships carrying horses to the West Indies, if becalmed unduly in the Sargasso Sea, occasionally had to jettison their live cargo as fodder ran out.

The two belts merge equatorially into the belts of the Northeast Trade Winds and the Southeast Trade Winds. Poleward they merge into the westerly, zonal wind belts. Over the oceans the horse latitudes correspond approximately to the areas of maximal evaporation. Over land the air is exceptionally dry.