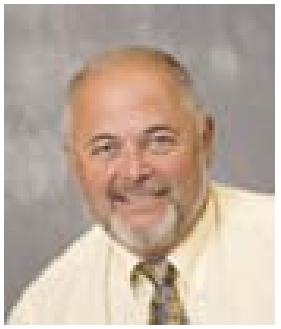
EAPS 10000 Y01
Online Course
Planet Earth

Prof. Lawrence Braile

Welcome to the EAPS 10000 Y01 online course
Planet Earth *(also known as EAPS 100)!*



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PURDUE UNIVERSITY

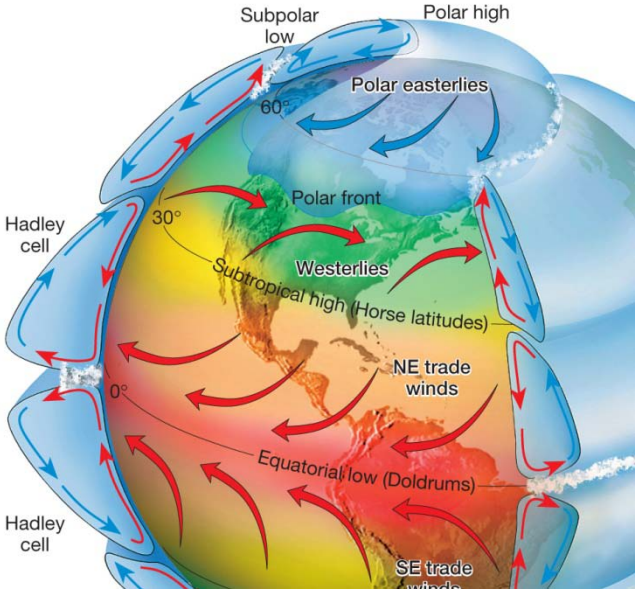
Earth Atmospheric Planetary Sciences

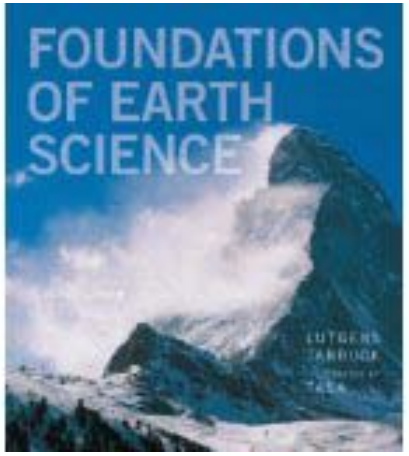
EAPS 10000 Y01 – Planet Earth (online course)
Week 6, Chapters 12 and 13 (see assigned pages below)

Week	Chapter	Assigned Pages	Major Concepts	Important Terms
6	**12 – Moisture, Clouds and Precipitation**	386 – 390, 395 – 402, 414-419	Relative humidity, air stability and instability	Latent heat, adiabatic heating and cooling
6	**13 – The Atmosphere in Motion**	420 – 441	General circulation of the atmosphere	Air pressure, Coriolis effect, high and low pressure areas, Hadley cell

Warm air is less dense and rises

Atmospheric circulation





EAPS 10000 Y01 – Planet Earth (online course) Week 6, Chapter 12 (pages 386-390, 395-402, 414-419) and Chapter 13 (pages 420-441)

When you have finished reading Chapters 12 and 13 (assigned pages) and viewing the weekly PowerPoint file for Chapters 12 and 13, take the quiz (Quiz11; be sure to read the Syllabus for more information on quizzes). You can use your book, notes, etc. during the quiz.

The PPT files (converted to PDF files) are best viewed with the Full Screen view in browsers.

The following slides illustrate some of the important concepts and topics of Chapters 12 and 13:

Thermodynamics (Thermodynamics is a branch of natural science concerned with heat and its relation to energy and work; http://en.wikipedia.org/wiki/Thermodynamics**):**

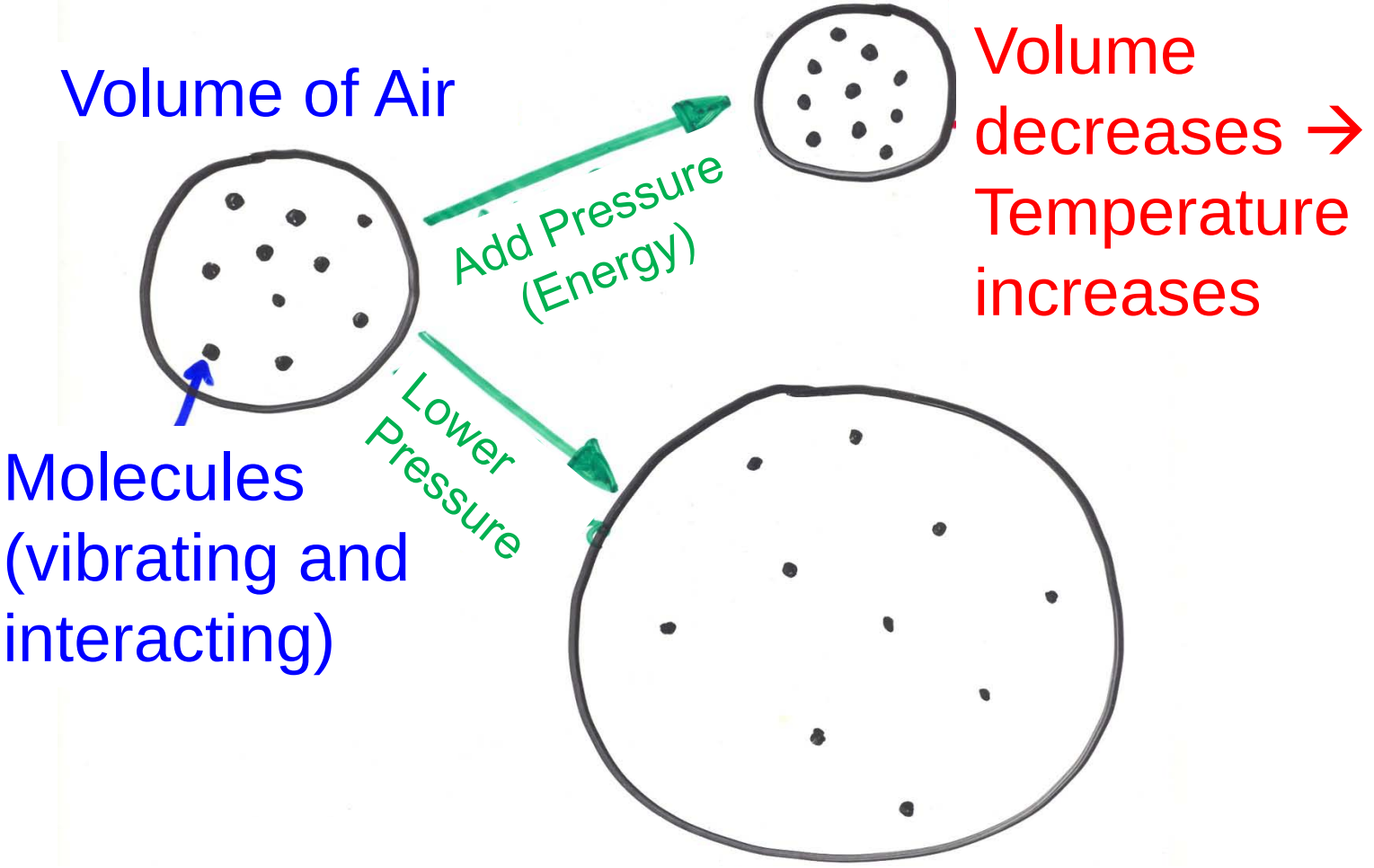
- Equilibrium of pressure and temperature effects in mechanical interactions
- Follows from Conservation of Energy
- Adiabatic Effects (process in which no heat is added or subtracted – **temperature** changes are caused by changes in **pressure**):

  increase pressure → temperature increases

  decrease pressure → temperature decreases

(example: releasing air from a tire)

Example of Thermodynamic Effect – **Adiabatic Heating and Cooling (**An **adiabatic process** is a process occurring without exchange of heat of a system with its environment; http://en.wikipedia.org/wiki/Adiabatic_process**)**



Volume increases → Temperature decreases

Global Circulation on a Non-rotating Earth

Circulation (convection) pattern expected from heating near the equator and cooling near the poles.

Note that, because warm air rises near the equator, the surface winds would be expected to be from pole to equator.

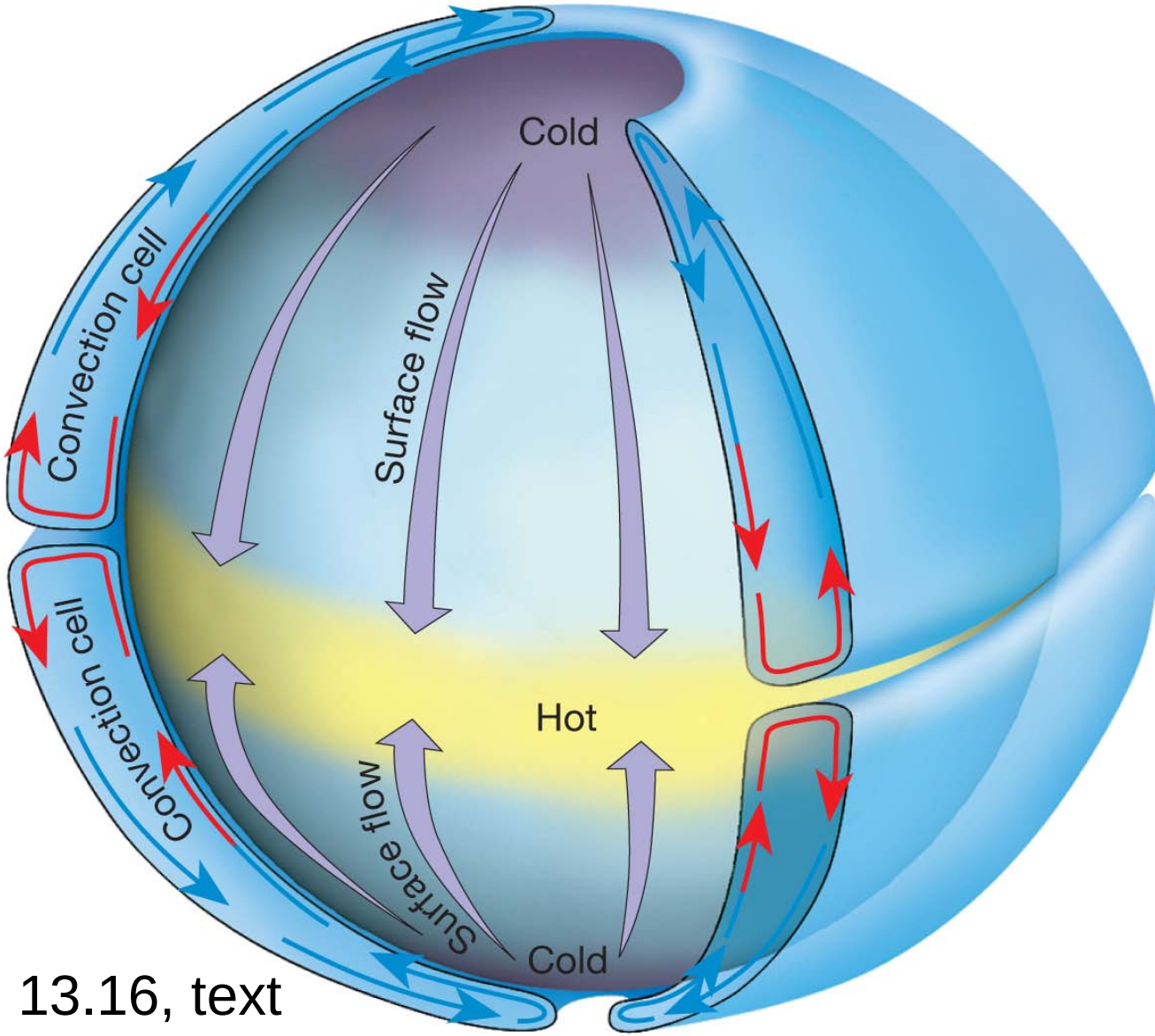


Figure 13.16, text

Idealized Global Circulation

Global circulation breaks into cells due to Coriolis effect and fact that it is too far from equator to pole (10,000 km) for air to retain temperature deviation. Note that the resulting **surface** winds (large red arrows) are the “Trade Winds” (prevailing winds).

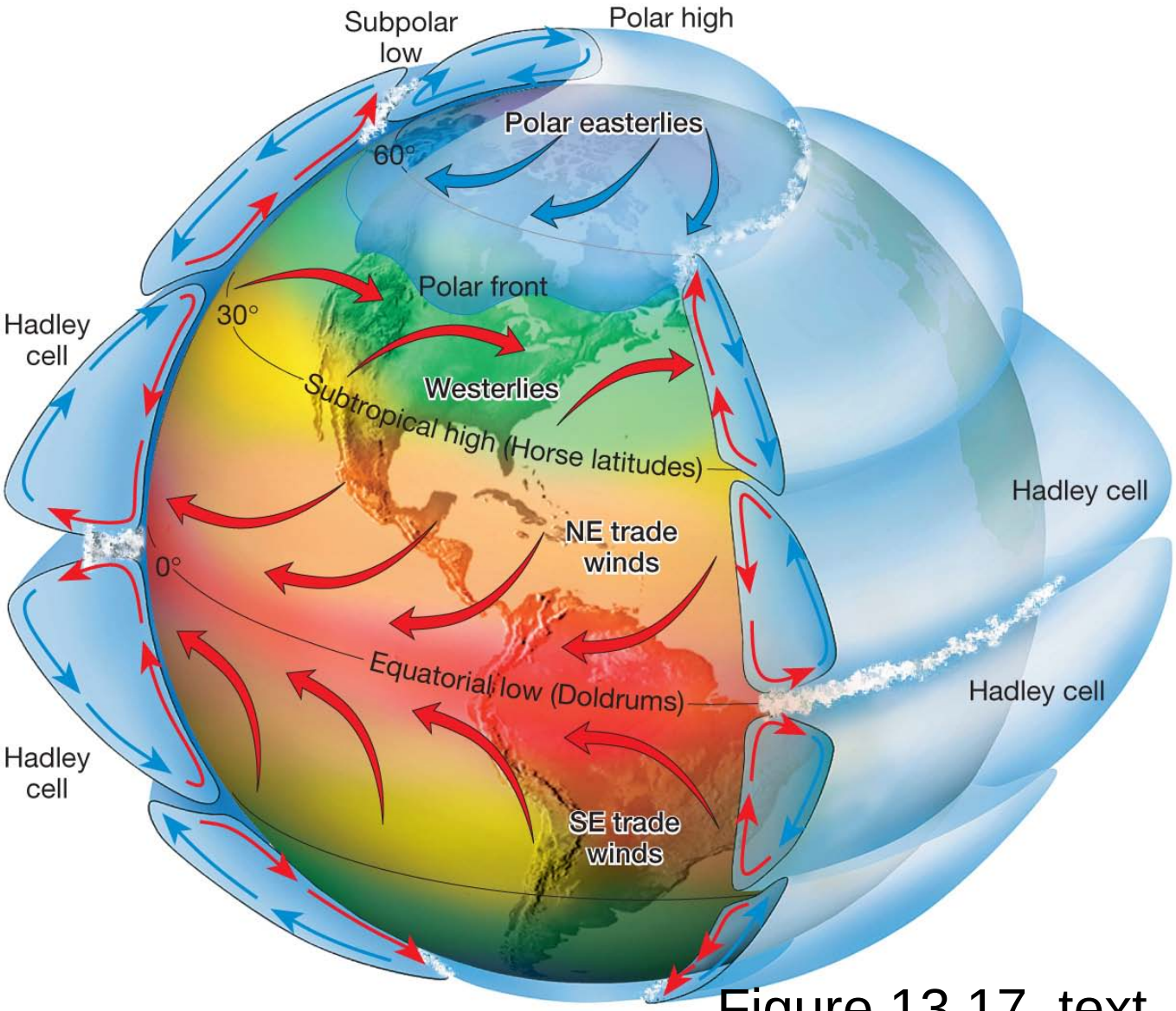


Figure 13.17, text

Idealized Global Circulation (close-up)

Global circulation breaks into cells due to Coriolis effect and fact that it is too far from equator to pole (10,000 km) for air to retain temperature deviation. Note that the resulting **surface** winds are the "Trade Winds" (prevailing winds). Note "Westerlies" in mid-latitude, N hemisphere – most of U.S.

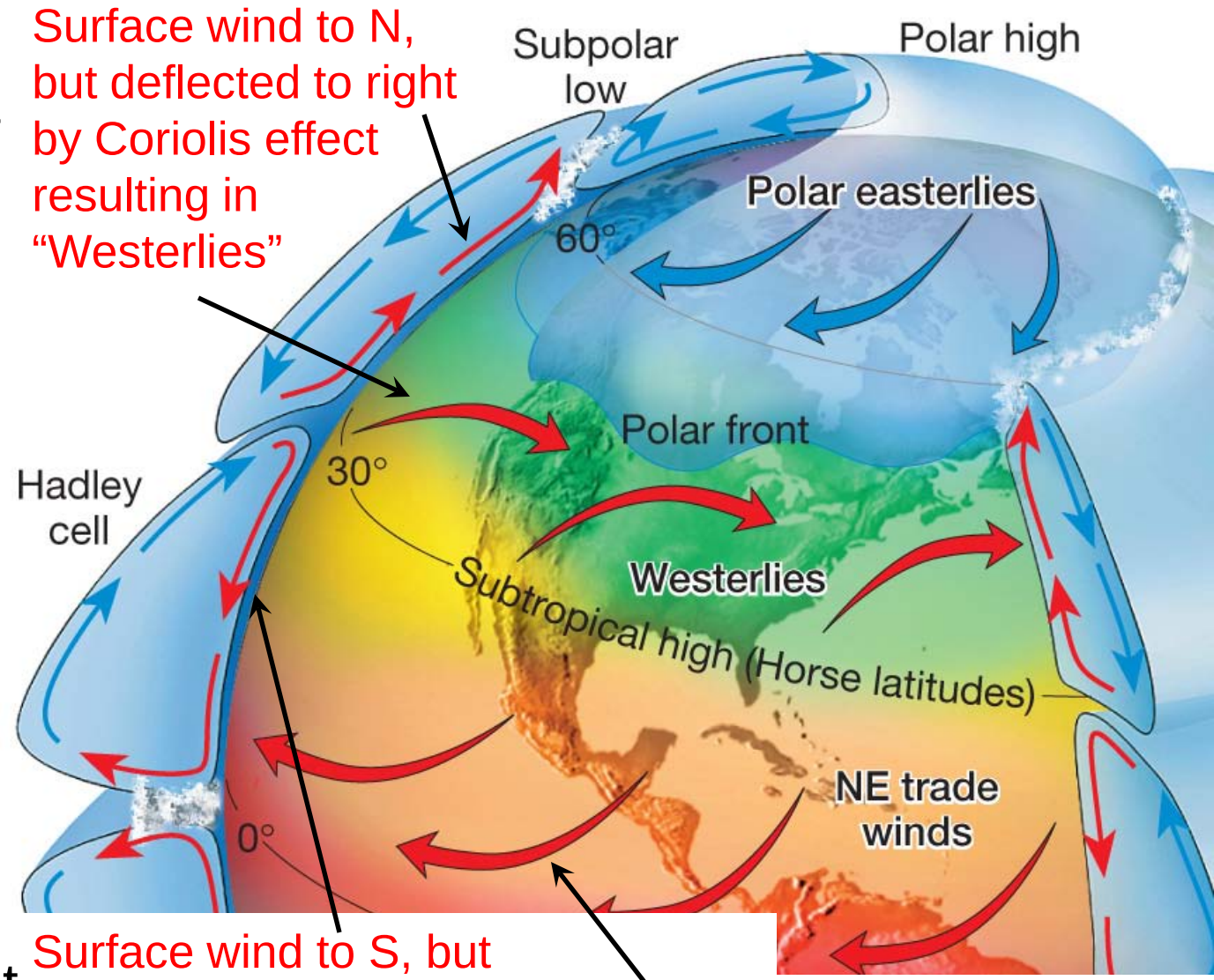
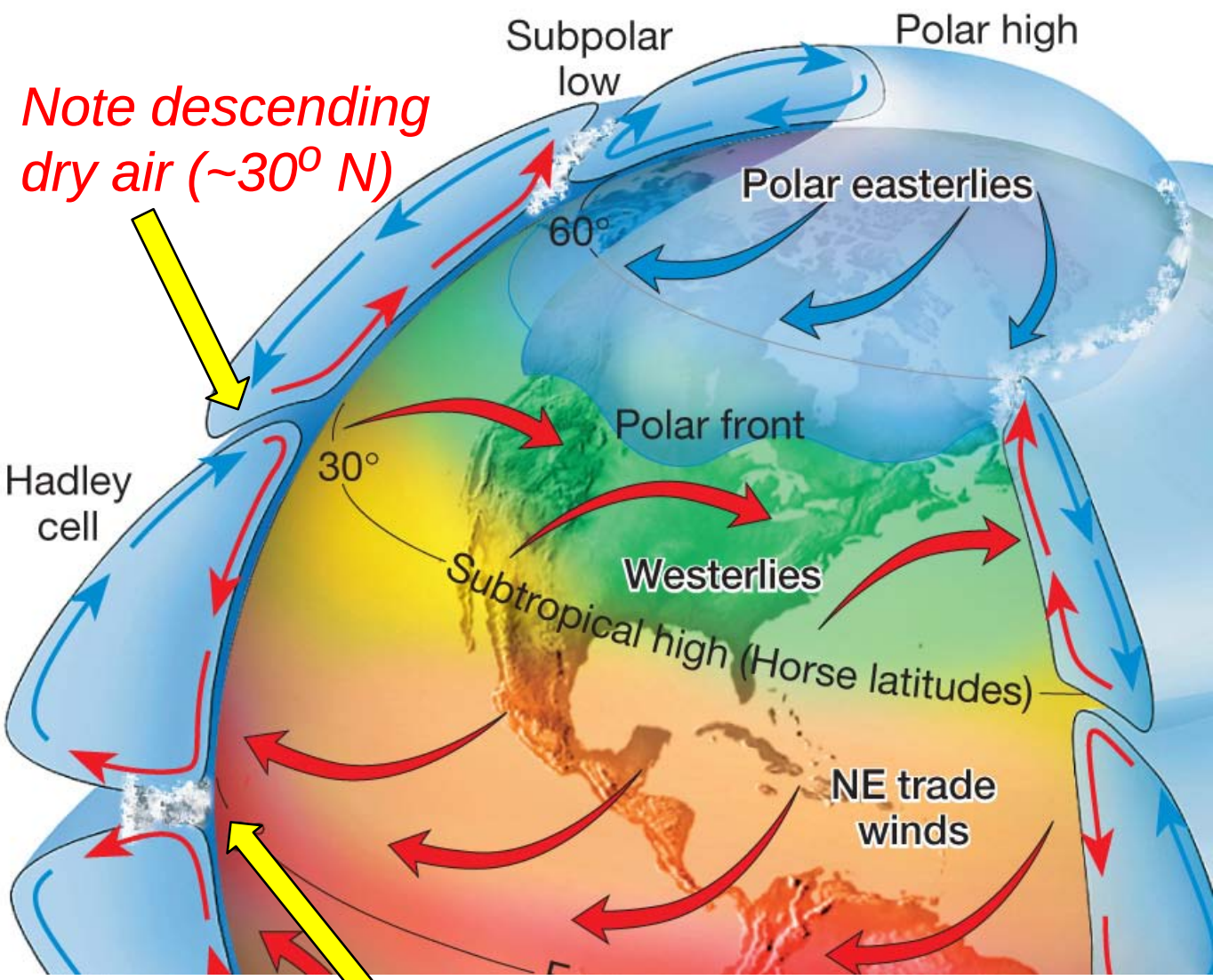


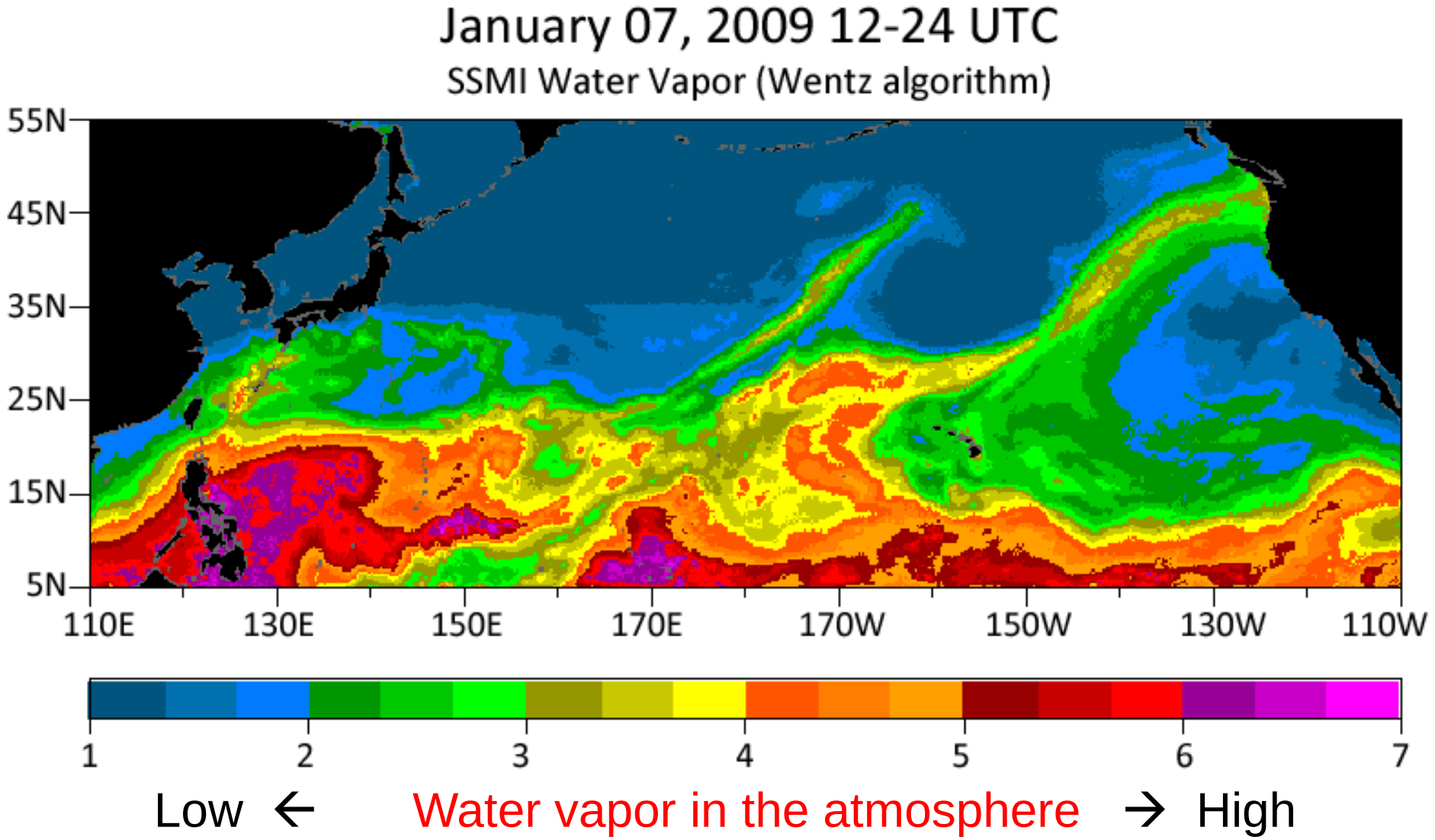
Figure 13.15, text

Idealized Global Circulation (close-up)

Global circulation breaks into cells due to Coriolis effect and fact that it is too far from equator to pole (10,000 km) for air to retain temperature deviation. The resulting **surface** winds are the "Trade Winds" (prevailing winds).



Note rising moist air in tropical area (Figure 13.15, text)



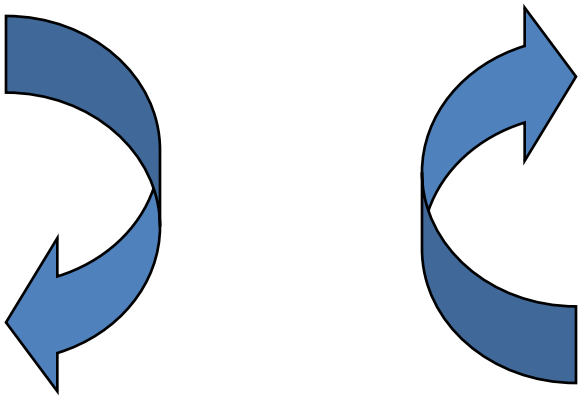
Note “atmospheric river” of moisture headed for California, and the large amount of moisture in the tropical area (rising air in low northern latitudes). http://www.esrl.noaa.gov/psd/atmrivers/events/

The Coriolis Effect:

Results from Earth's rotation on its axis

Causes deflection to the right in the northern hemisphere (view to the right along the direction of motion – toward the head of the arrow/vector)

Both of these Arrows are "to the right"



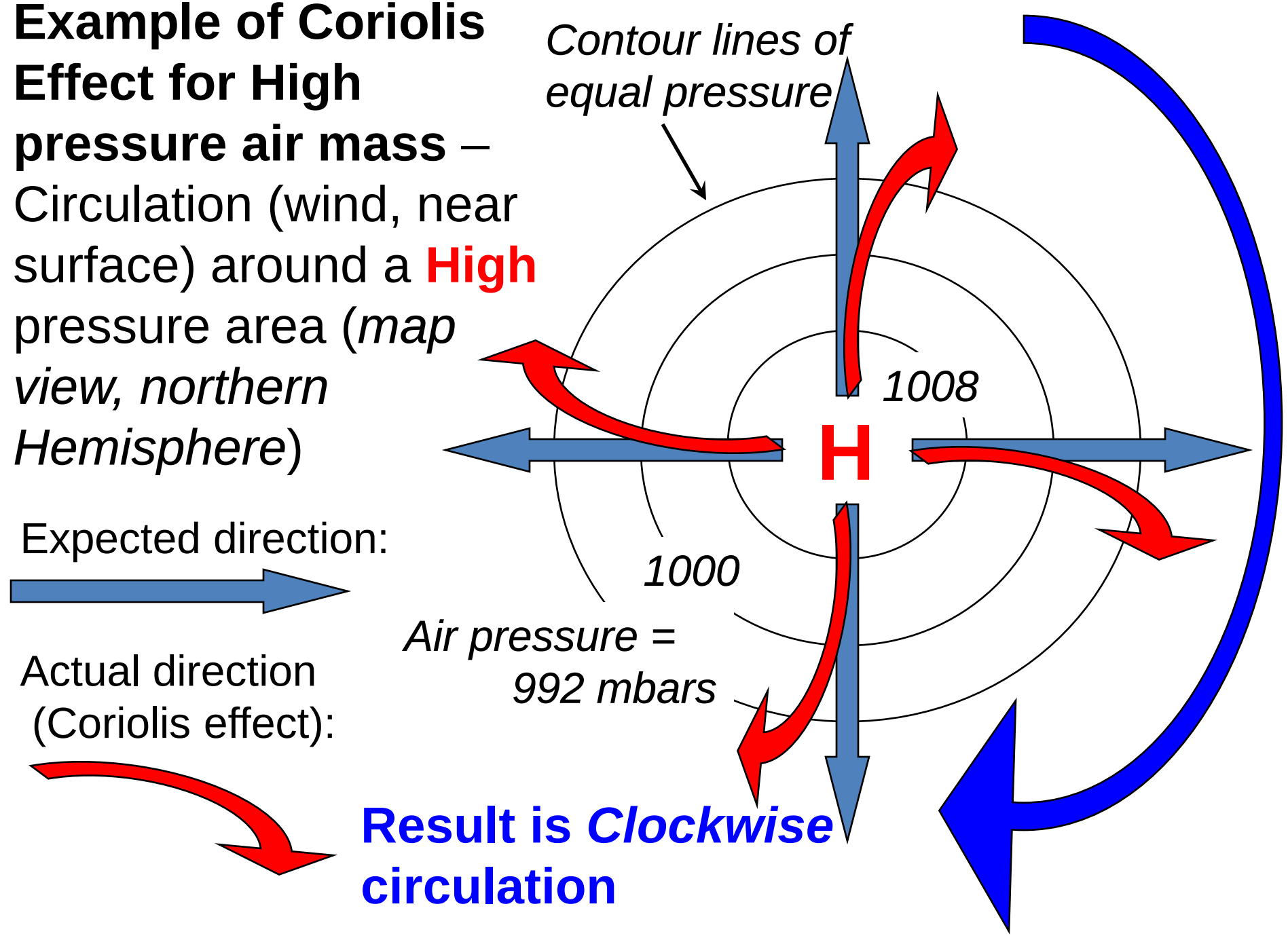
More explanation of the Coriolis effect…

Two demos…Foucault pendulum (watch the YouTube video: http://www.youtube.com/watch?v=U0FcQ3BY2qs) and merry-go-round (see next slide)

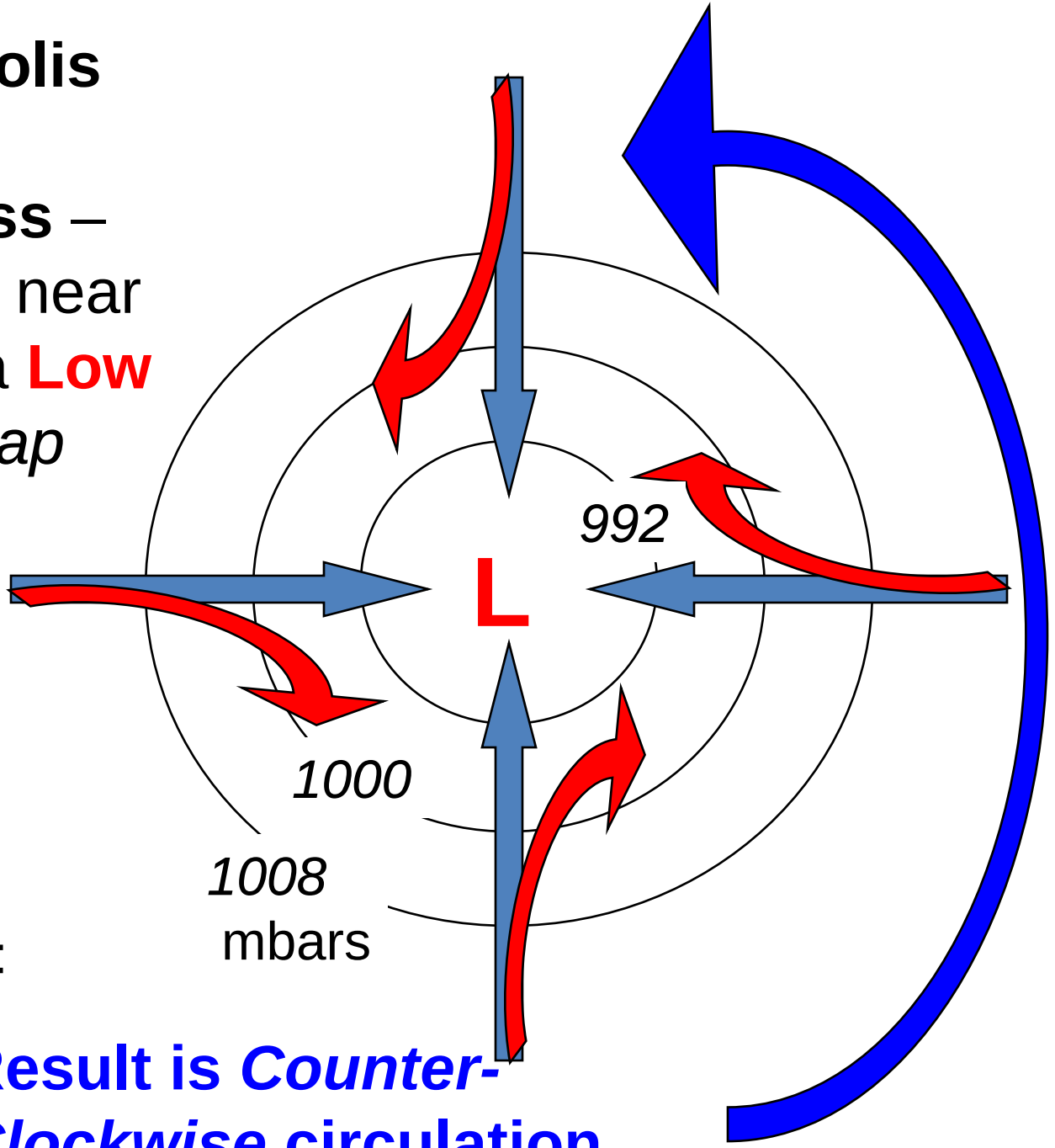
To better understand the Coriolis effect, watch the YouTube video (see link below) which shows a rotating playground merry-go-round and passing a ball across the surface. Note that the ball appears to us, and to the person who rolled the ball, to curve to the left. The merry-go-round is rotating clockwise. If it was rotating counter-clockwise, the deflection would be to the right as it is on Earth in the northern hemisphere. The ball is actually going in a straight line, but the surface is rotating so it does not end up where we would expect it to and it appears to curve.

http://www.youtube.com/watch?v=_36MiCUS1ro

Example of Coriolis Effect for High pressure air mass – Circulation (wind, near surface) around a **High** pressure area (*map view, northern Hemisphere*)



Example of Coriolis Effect for Low pressure air mass – Circulation (wind, near surface) around a **Low** pressure area (*map view, northern Hemisphere*)



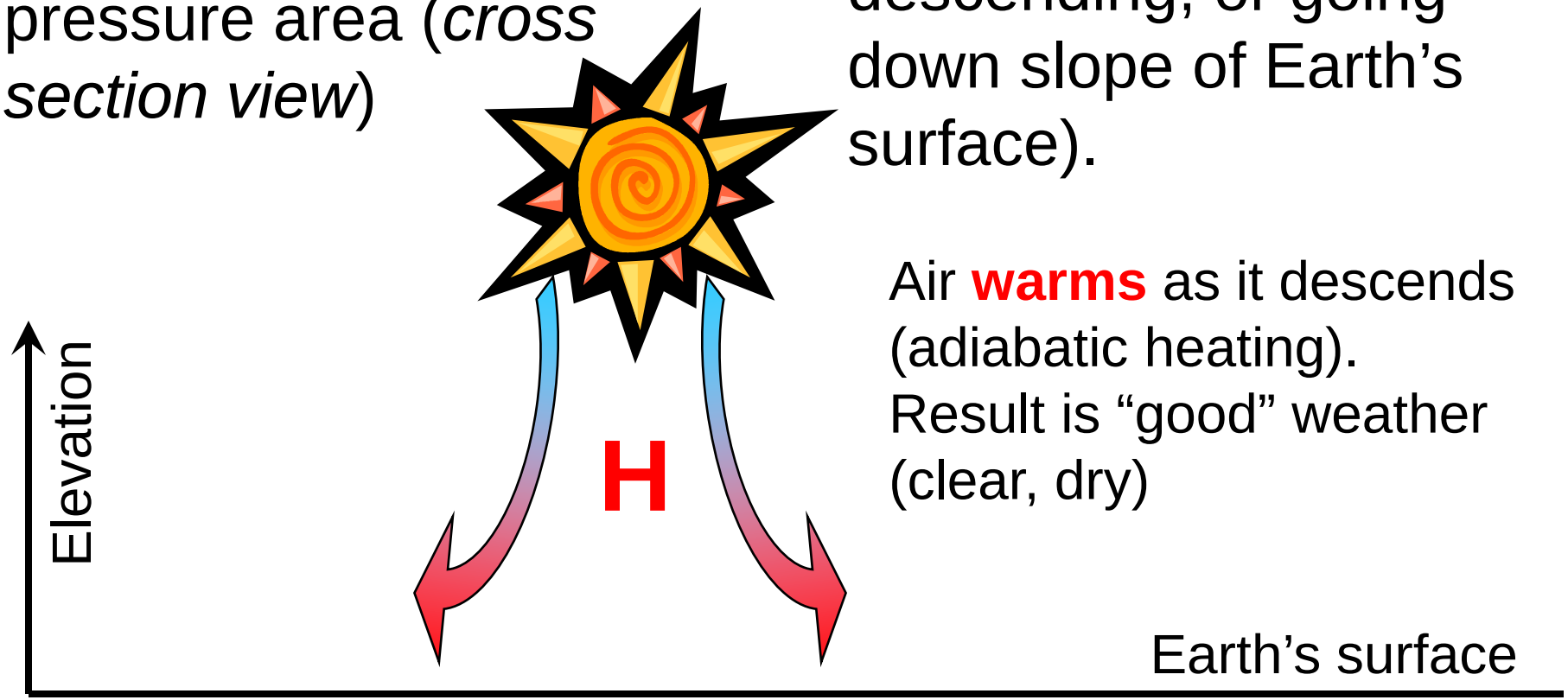
Expected direction:

Actual direction (Coriolis effect, deflection to the right):

Result is *Counter-Clockwise* circulation

Winds are 3-D, so we also need to view in vertical cross section – Circulation (wind, near surface) around a **High** pressure area (*cross section view*)

Cool (from high elev.), ***Dry***, (from high elev.), ***Descending*** (more dense than surrounding air if it is descending, or going down slope of Earth's surface).

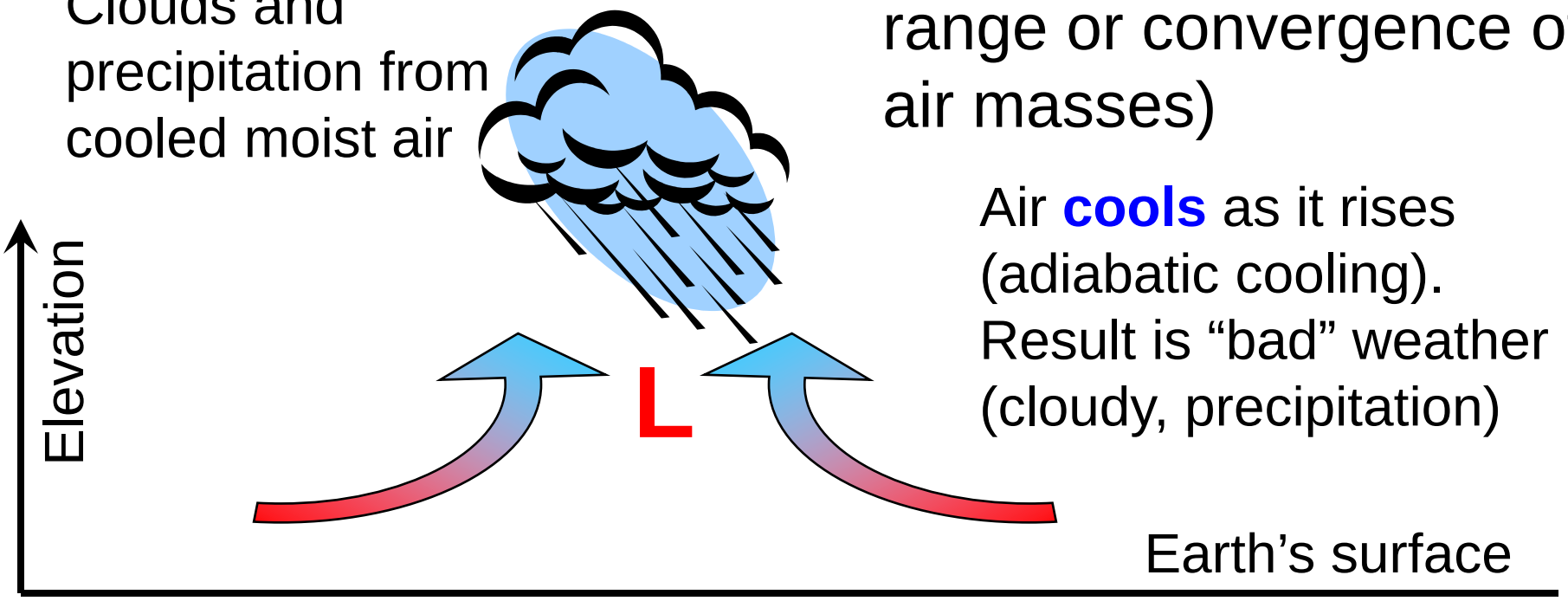


Air **warms** as it descends (adiabatic heating). Result is "good" weather (clear, dry)

Winds are 3-D, so we also need to view in vertical cross section – Circulation (wind, near surface) around a **Low** pressure area (*cross section view*)

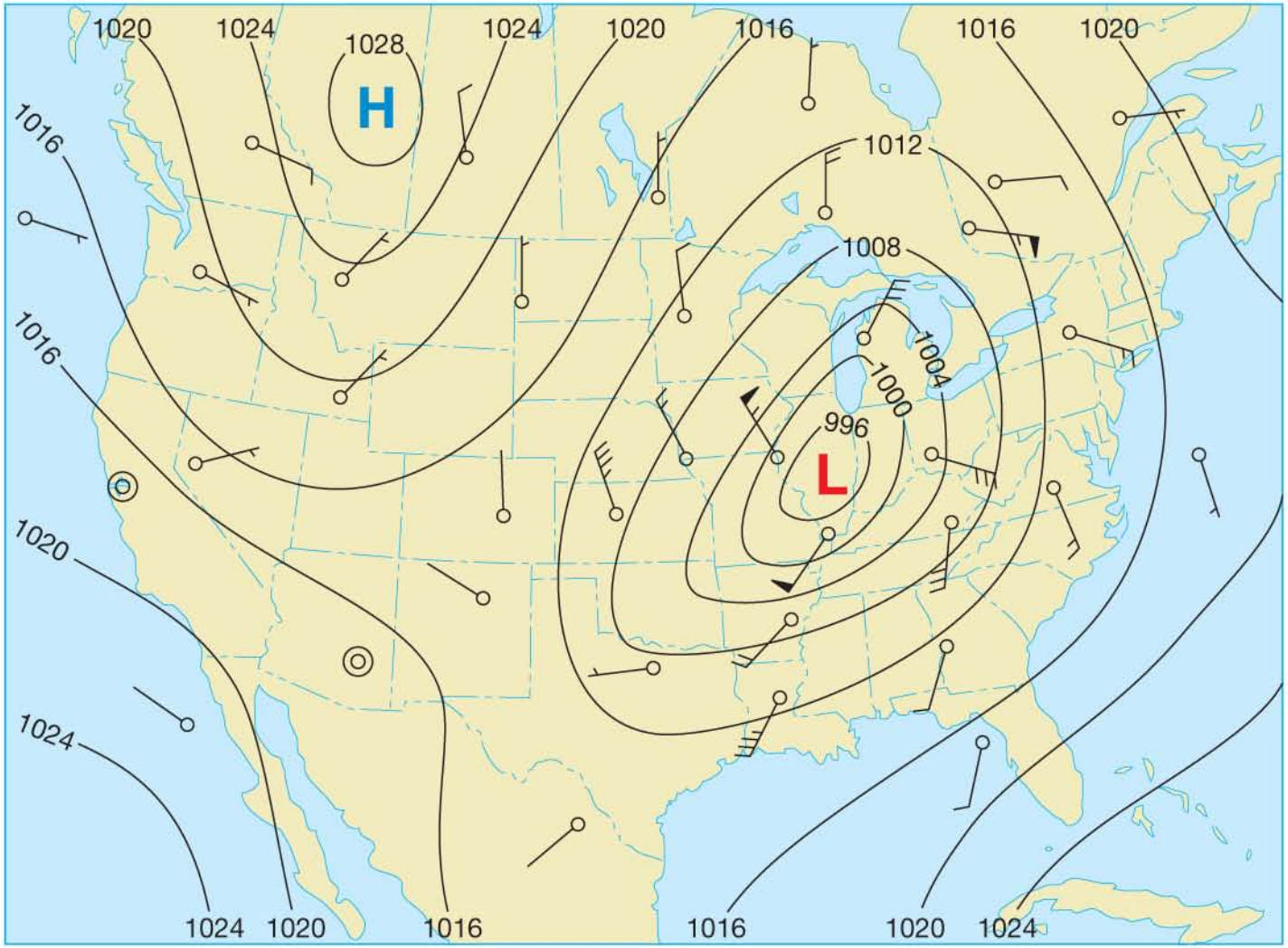
Warm (from low elev.), ***Moist***, (from low elev.), ***Rising*** (must be less dense than surrounding air if it is rising, or forced upwards by mountain range or convergence of air masses)

Clouds and precipitation from cooled moist air



Air **cools** as it rises (adiabatic cooling). Result is "bad" weather (cloudy, precipitation)

Typical atmospheric pressure pattern; note High and Low pressure air masses.



ff	Miles per hour
◎	Calm
	1–2
	3–8
	9–14
	15–20
	21–25
	26–31
	32–37
	38–43
	44–49
	50–54
	55–60
	61–66
	67–71
	72–77
	78–83
	84–89
	119–123

Figure 13.7, text

Circulation (wind, near surface) around **High** and **Low** pressure areas (map view, northern Hemisphere)

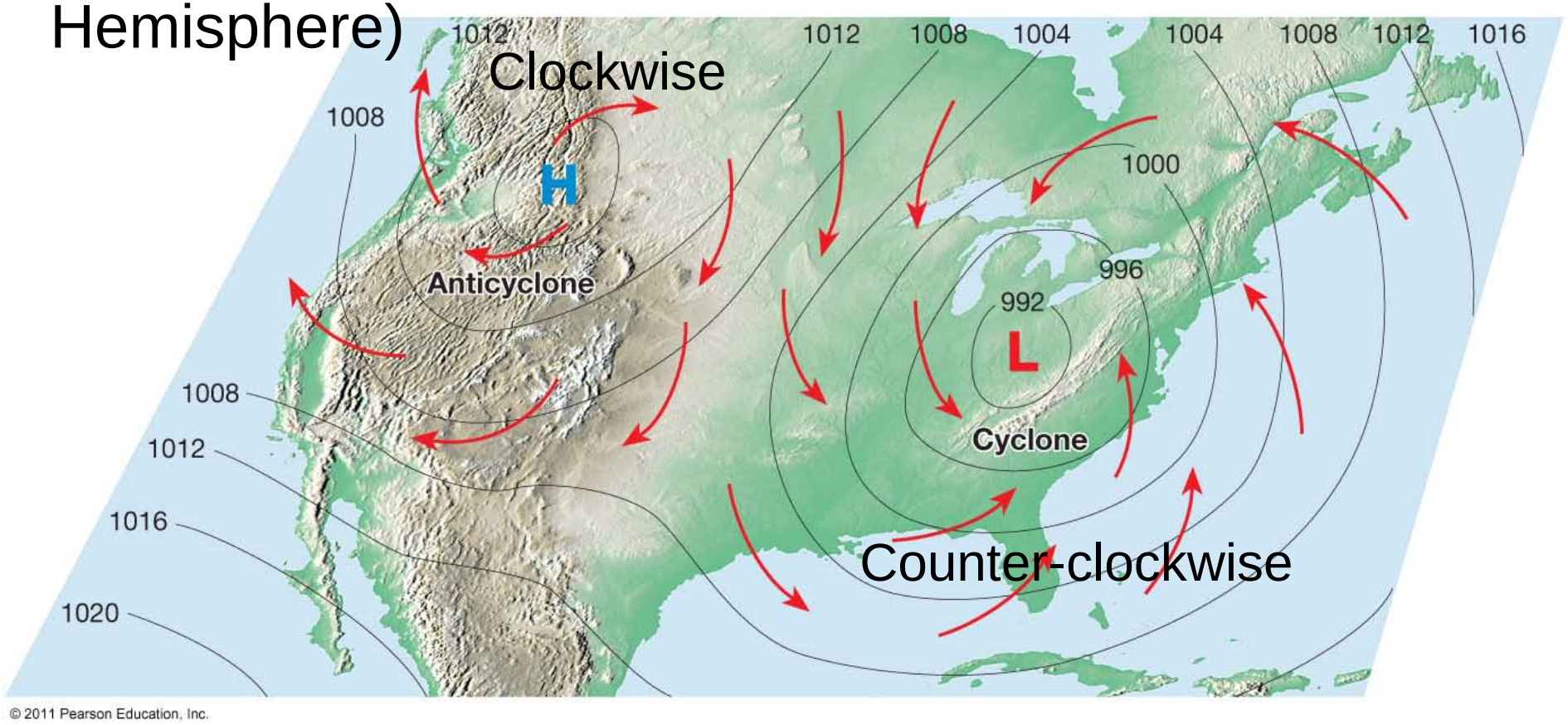


Figure 13.12, text

Circulation around Low pressure area often results in formation of a **cold front**. Collision of dry, cold air with warm, moist air results in precipitation and, possibly, thunderstorms and tornadoes.

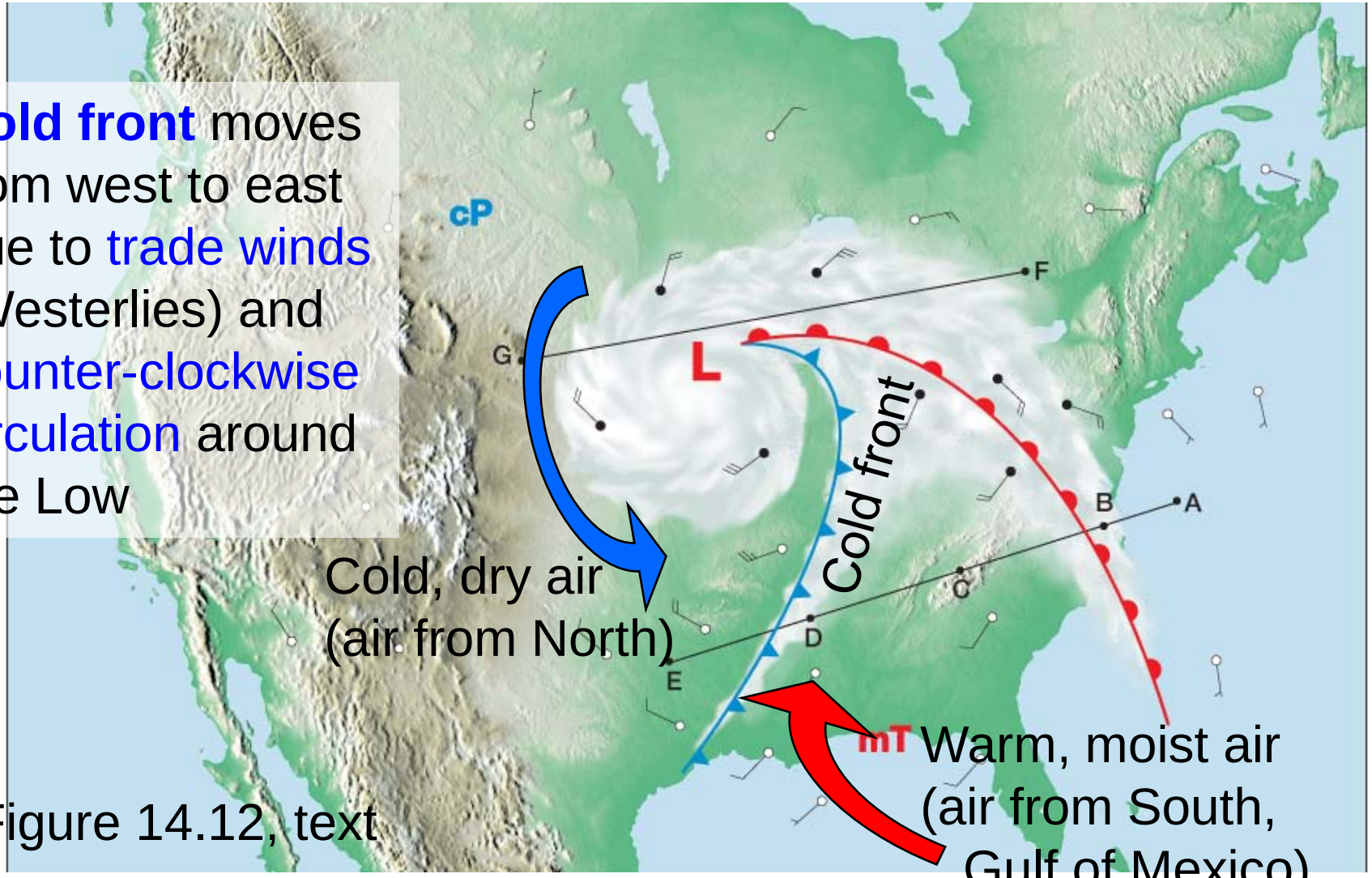


Figure 14.12, text

Clouds associated with a Low pressure area and cold front

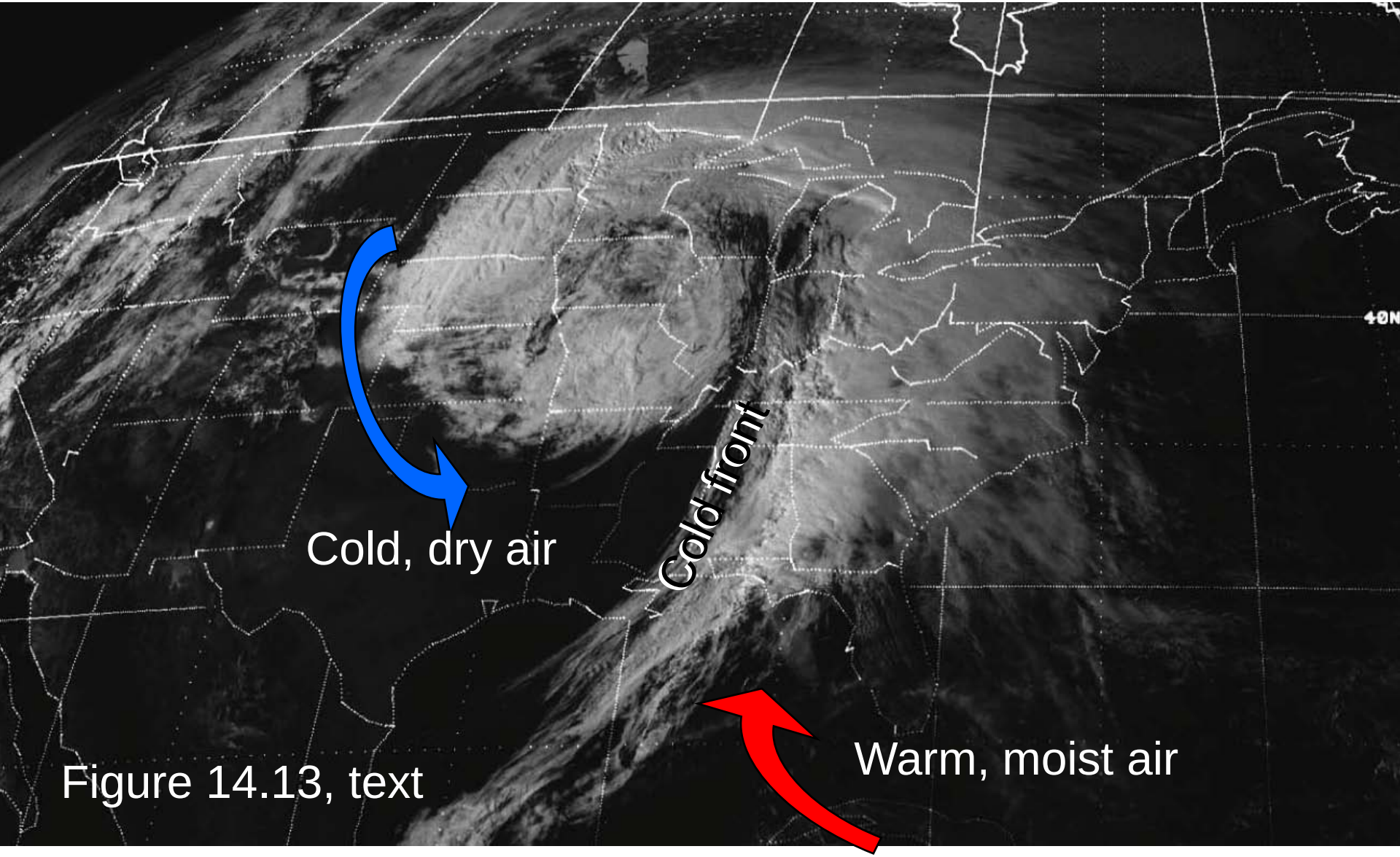
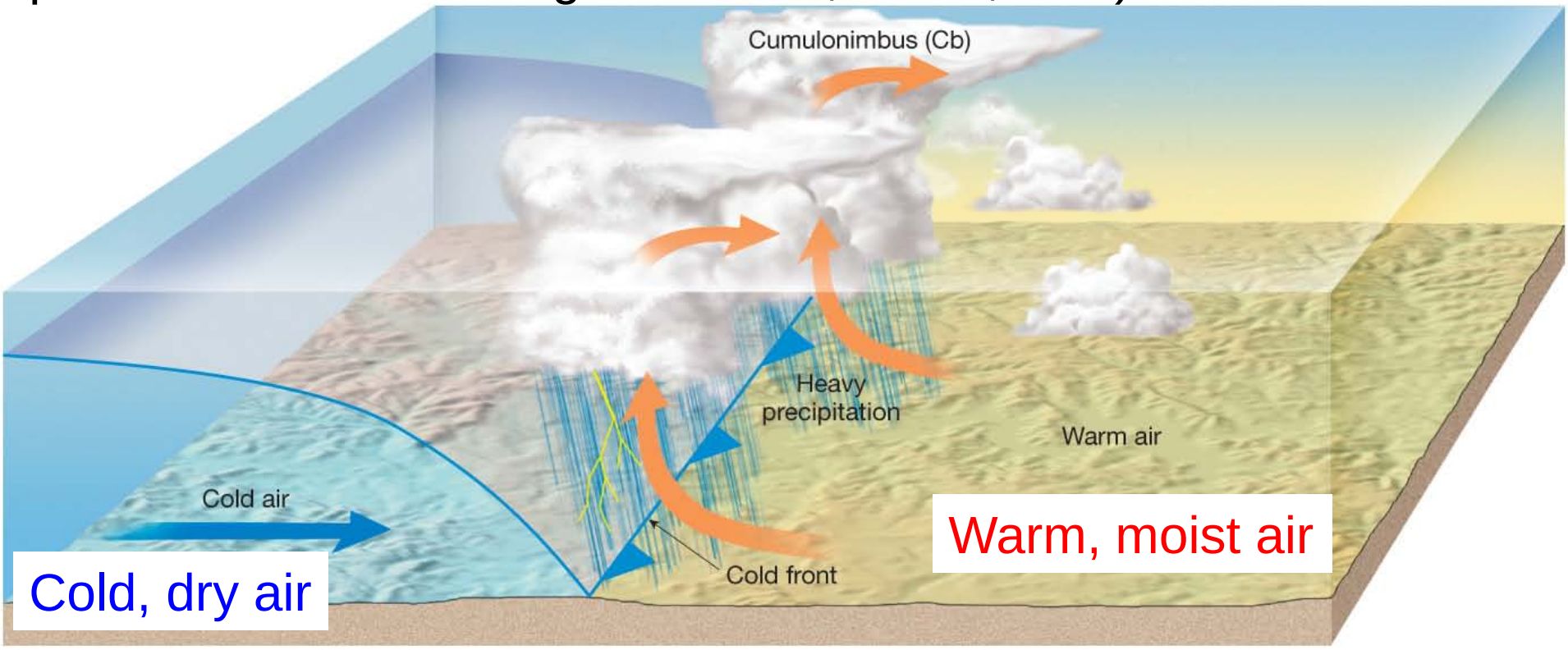


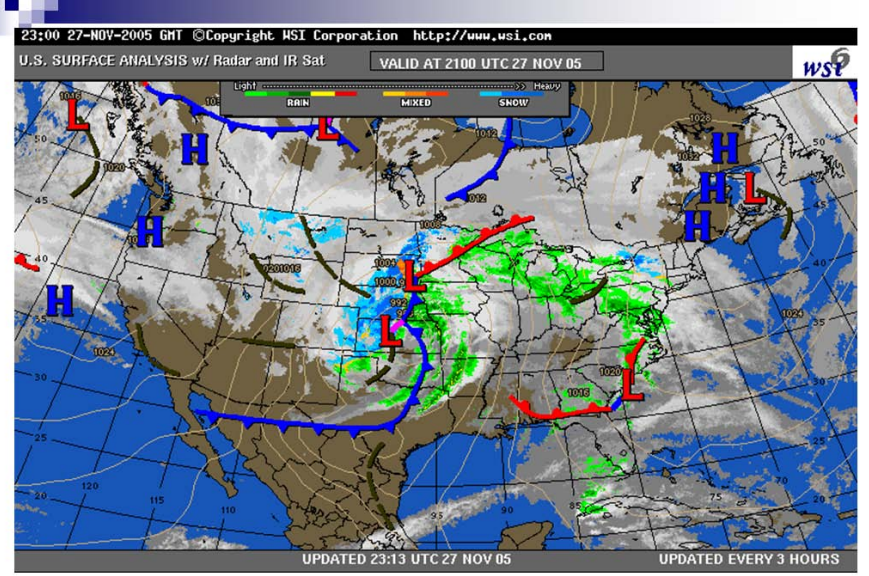
Figure 14.13, text

Cold air is more dense so it stays near the Earth's surface and cause the adjacent warm moist air to rise along the front. (Perspective view of front along profile E to D as shown on previous slide – see Figures 14.11, 14.12, text.)



Note that the cold air moving eastward is relatively dense and therefore stays near the ground and causes the lower density warm, moist air to rise, causing clouds and rain and possibly thunderstorms and tornadoes.

View the following 5 slides 2-3 times to see the movement of a weather system or air mass across part of the Midwest. The figures are from satellite images, radar data and surface air pressure measurements (air pressure displayed by thin white contour lines). Nearly all of the area covered by the continental U.S. is in a mid-latitude region in which the trade winds are “Westerlies” – due to South to North direction surface winds from the global circulation pattern (see slides above) and the rightward deflection caused by the Coriolis effect. The counterclockwise circulation about the low pressure area also contributes to the easterly movement of the frontal region and rainfall.

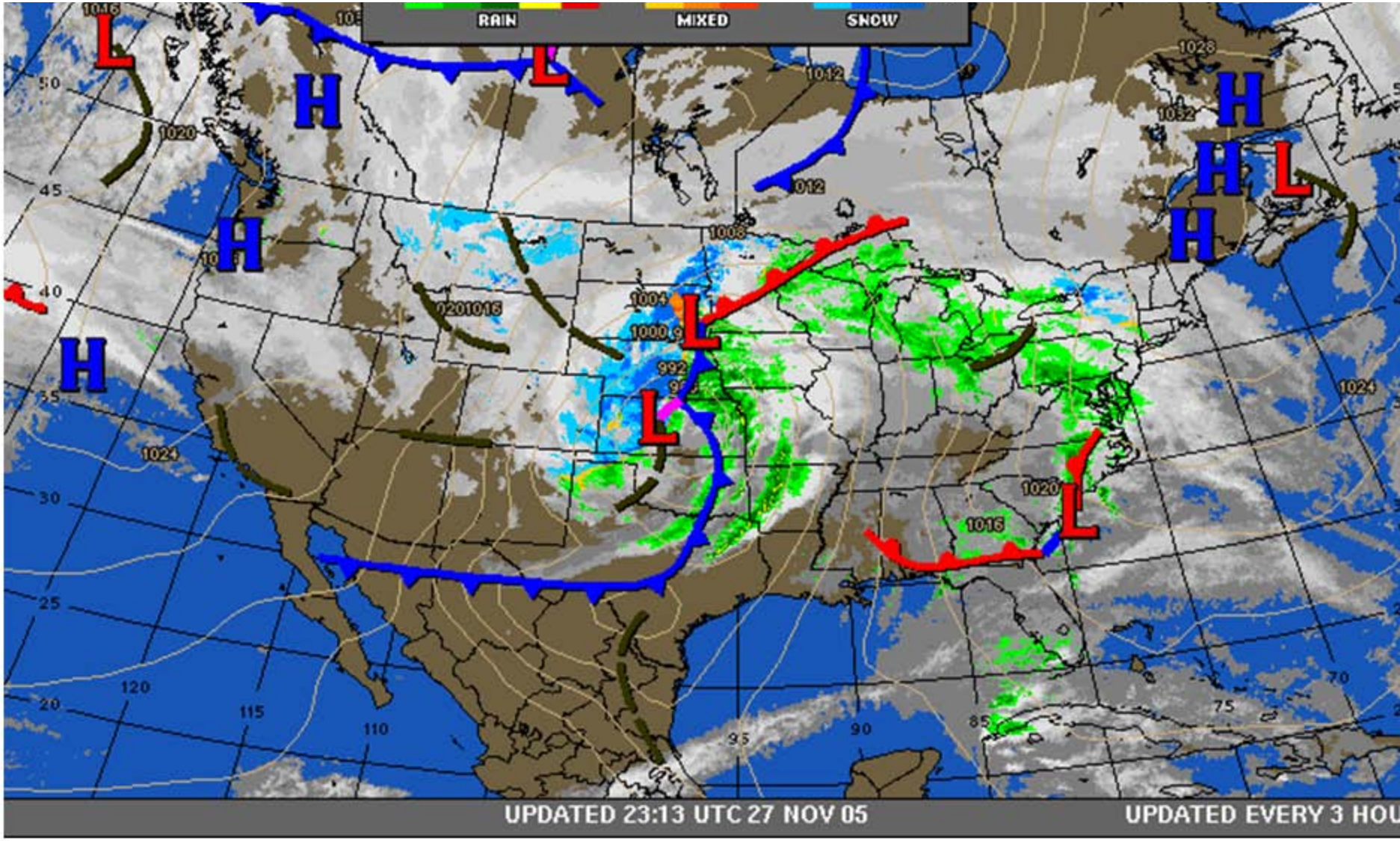


Radar/Surface Loop 1930 11/27 – 1615 11/28 GMT

The images show conditions from 23:00 GMT on Nov. 27, 2005 to 16:15 GMT on Nov. 28, 2005. Images from www.intellicast.com.

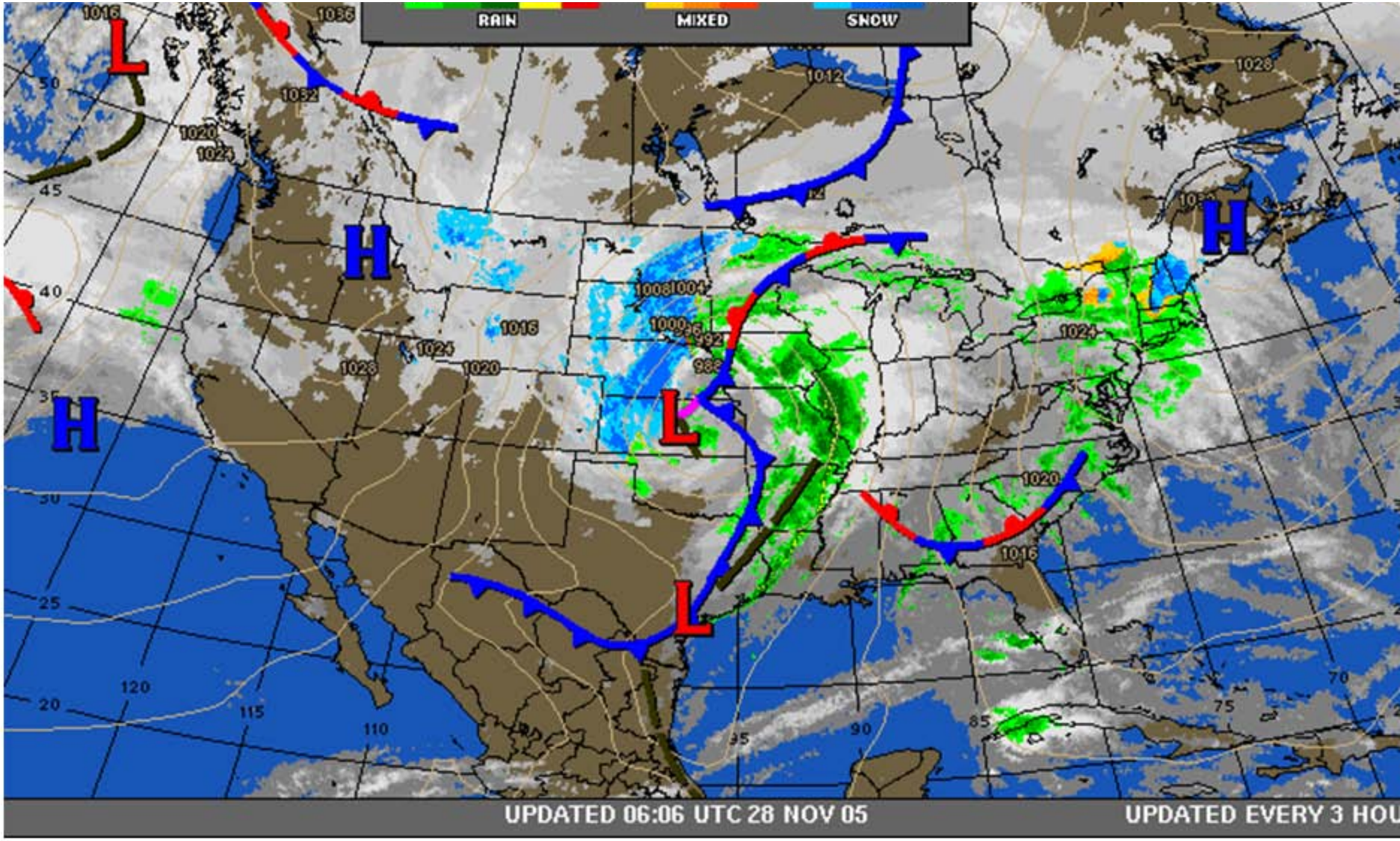
Nov. 27, 2005, 23:00 GMT – Low pressure area and front moving W to E across Midwest (radar and surface images – white/gray = clouds, green/yellow = rain, blue = snow)

- **Nov. 27, 2005, 23:00 GMT – Low pressure area and front moving W to E across Midwest (radar and surface images – white/gray = clouds, green/yellow = rain, blue = snow)**



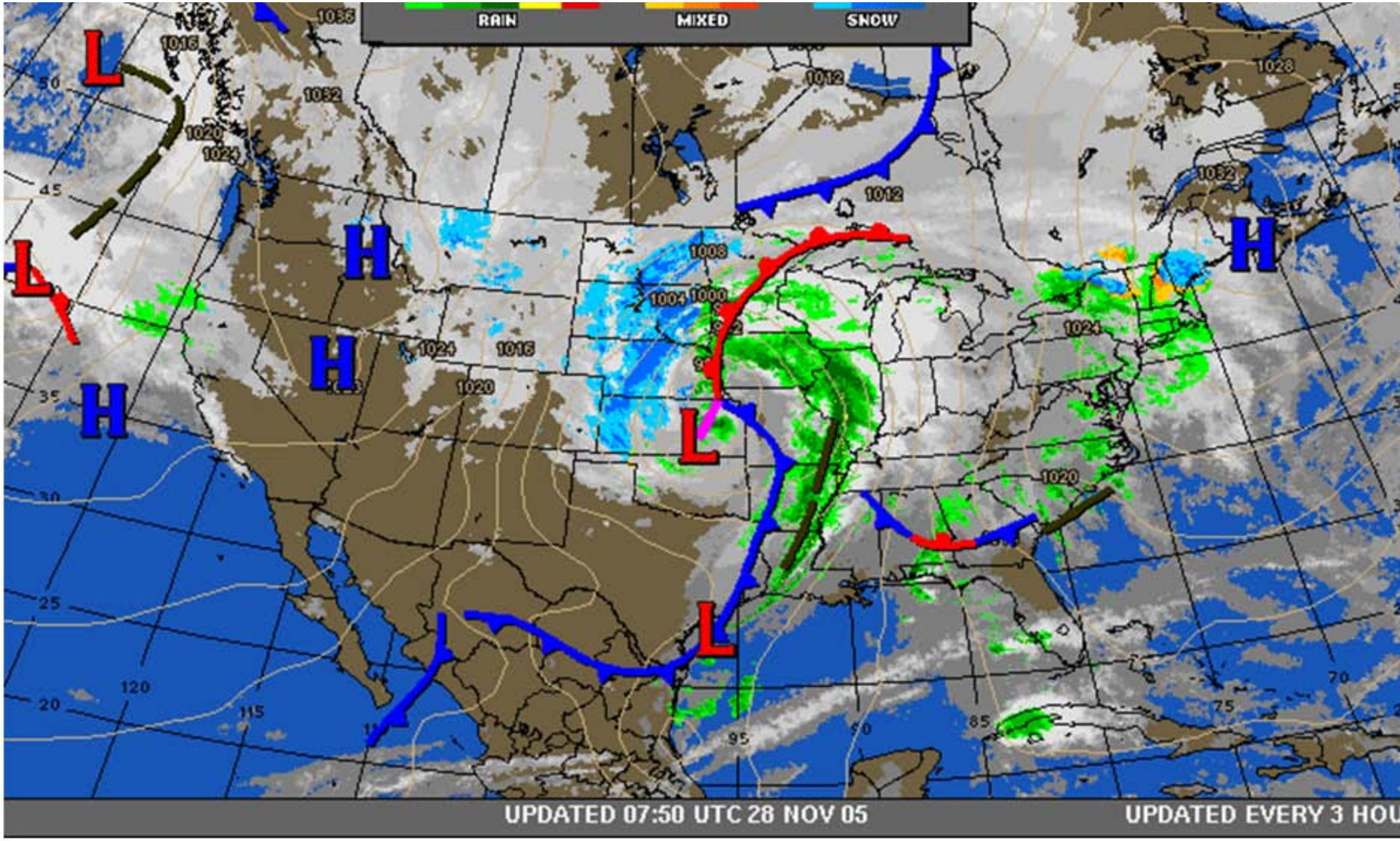
Radar/Surface Loop 1930 11/27 – 1615 11/28 GMT

- **Nov. 28, 2005, 06:00 GMT – Low pressure area and front moving W to E across Midwest (radar and surface images – white/gray = clouds, green/yellow = rain, blue = snow)**



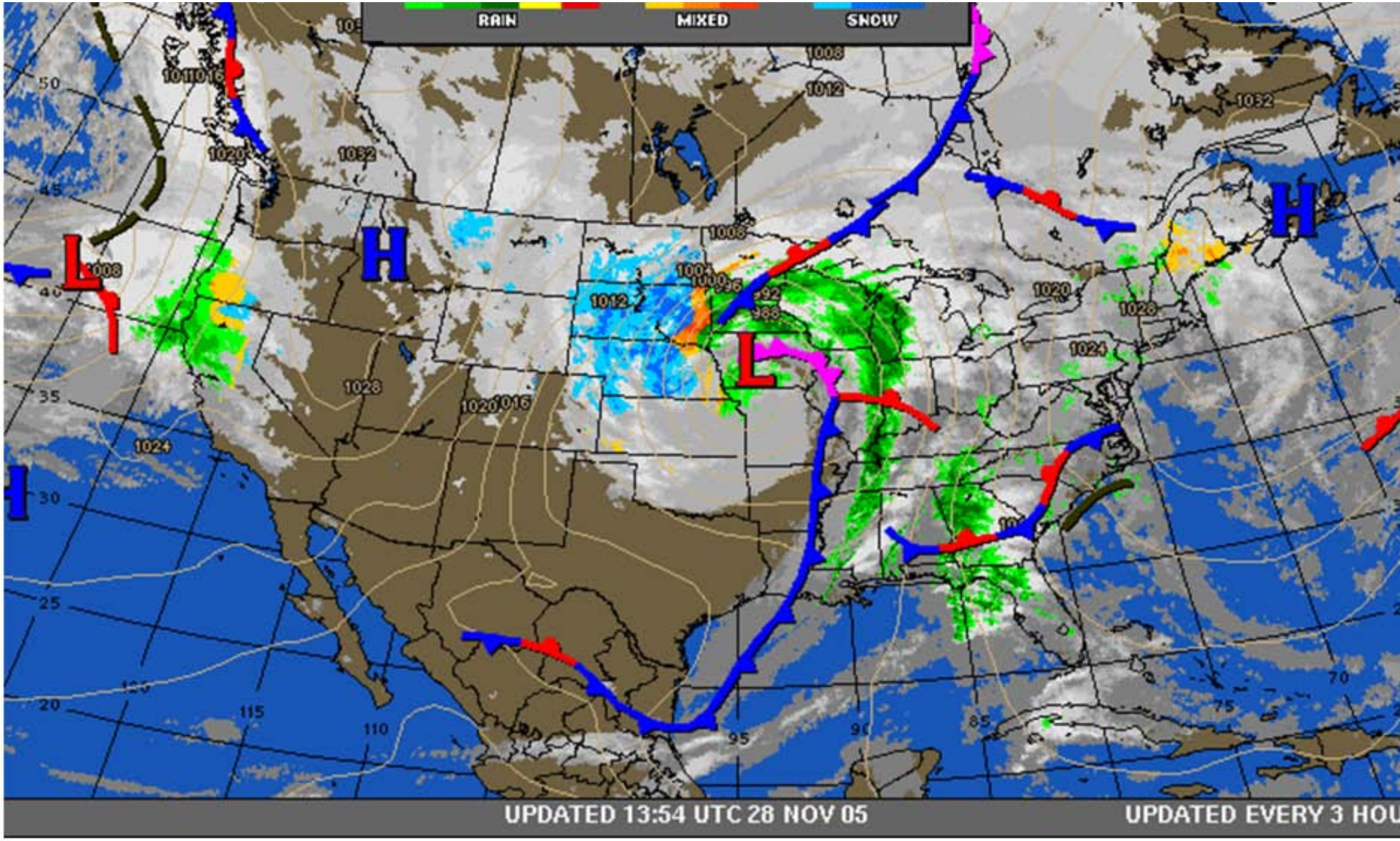
Radar/Surface Loop 1930 11/27 – 1615 11/28 GMT

- **Nov. 28, 2005, 07:45 GMT – Note prominent cold front forming in Missouri and Arkansas, air mass moving to E (trade winds and counterclockwise circulation about the low pressure area**



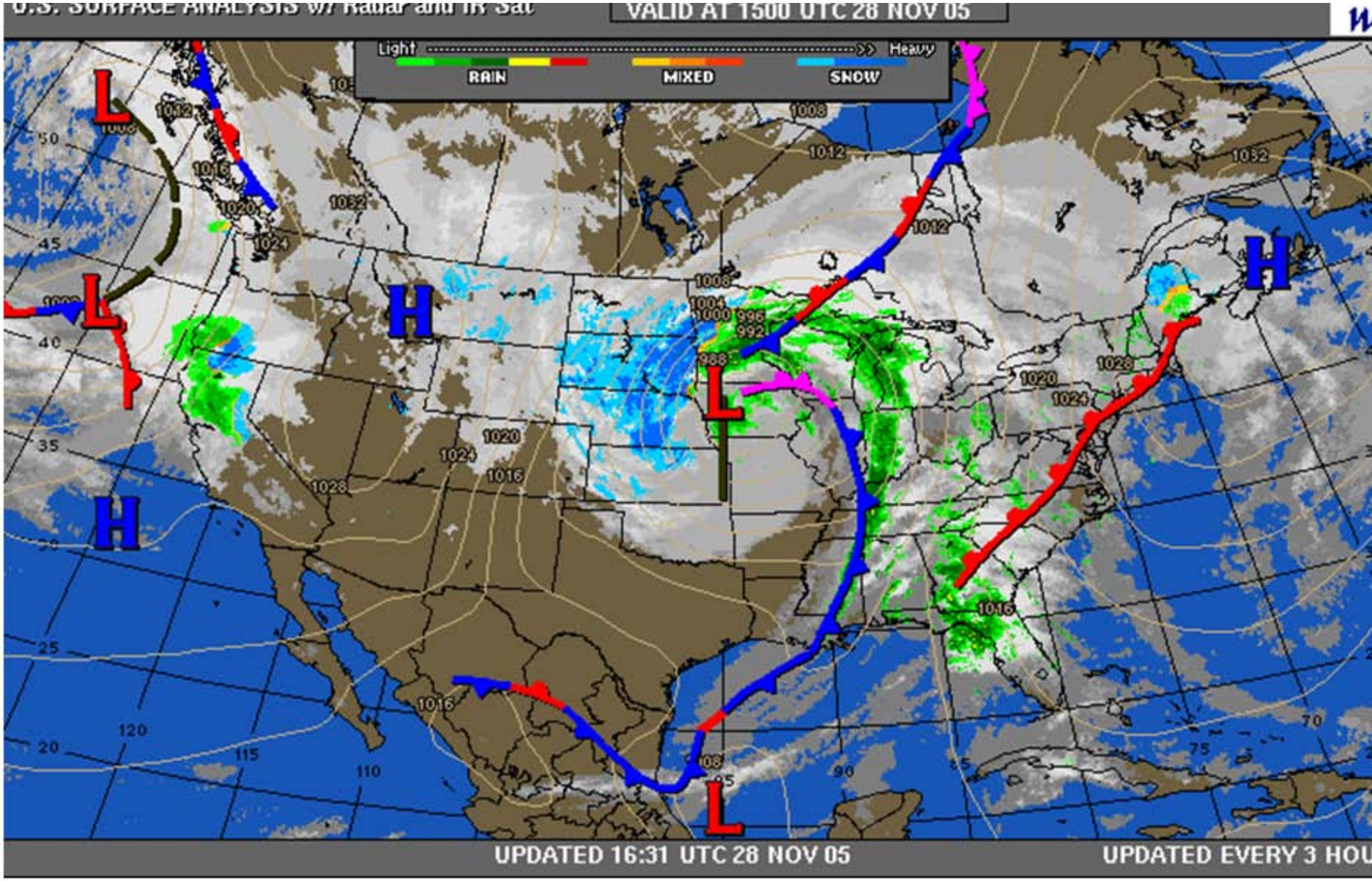
Radar/Surface Loop 1930 11/27 – 1615 11/28 GMT

- **Nov. 28, 2005, 13:45 GMT – Note rainfall associated with the front progressing into Indiana, snow on "back side" of Low (colder as air has circulated to north and to "behind" cold fro**



Radar/Surface Loop 1930 11/27 – 1615 11/28 GMT

- **Nov. 28, 2005, 16:15 GMT – Continued motion to East and counterclockwise circulation around the low pressure area.**



Radar/Surface Loop 1930 11/27 – 1615 11/28 GMT