Global climate zones Ia: building an idealized simple view

Vertical cross-section

Map view

Climate Zones

Wind Belts and Zones

Hadley Cell

Greatest solar heating

Rising warm air

Hadley Cell

H H H H H H — 30°N

L L L L L L L — 0°

H — H — H — H — H — H — 30°S

Subtropical Highs (anticyclones)

Tropics

Intertropical Convergence Zone (ITCZ)

Tropics

Subtropical Highs (anticyclones)

Horse Latitudes

Easterlies (Northeasterlies)   Trade Winds

Doldrums

Easterlies (Southeasterlies)   Trade Winds

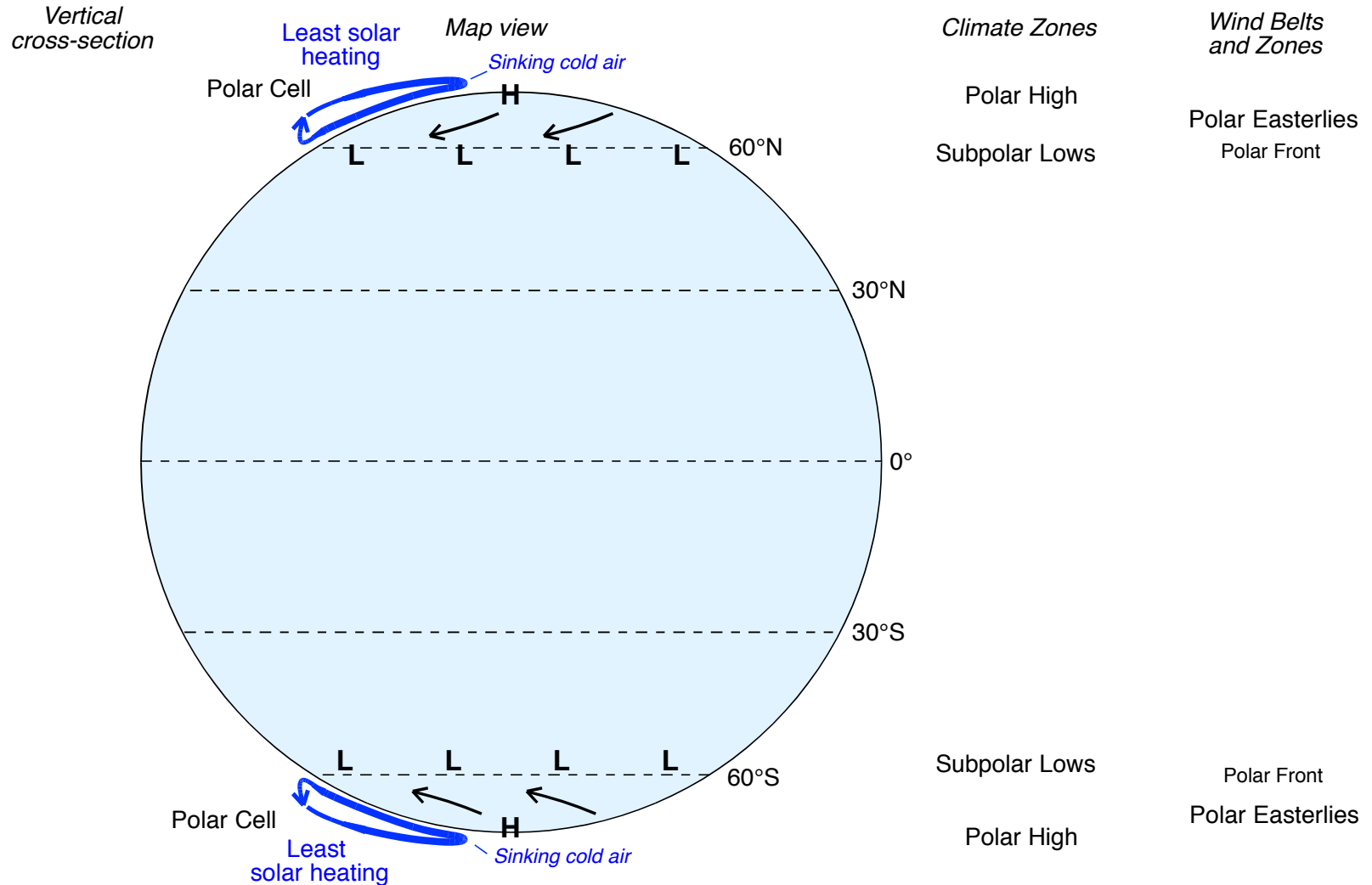Horse Latitudes

This diagram is the first of three building a typical schematic representation of Earth's surface atmospheric pressure, surface winds, and tropospheric circulation. This (Part Ia) and the next (Part Ib) are pedagogical steps to the full representation in Part Ic. Parts II to V then expand on that model.

Earth's surface is heated most near the equator, and so air is heated most there. That warmed air rises, as suggested above, and moves away from the equator high in the troposphere. That air sinks at about 30° N and S, and some of it returns across Earth's surface to the equator to close the Hadley Cells that are shown at left above. In map view,

the winds at Earth's surface turn according to the Coriolis Effect (right in the Northern Hemisphere; left in the Southern Hemisphere), making the Earth-surface winds of both cells easterlies.

Global climate zones Ib: building an idealized simple view

*Vertical
cross-section*

Least solar
heating

Map view

Sinking cold air

Polar Cell

H

L   L   L   L   60°N

30°N

0°

30°S

L   L   L   L   60°S

Polar Cell

H

Least
solar heating

Sinking cold air

Climate Zones

Polar High

Subpolar Lows

Subpolar Lows

Polar High

*Wind Belts
and Zones*

Polar Easterlies

Polar Front
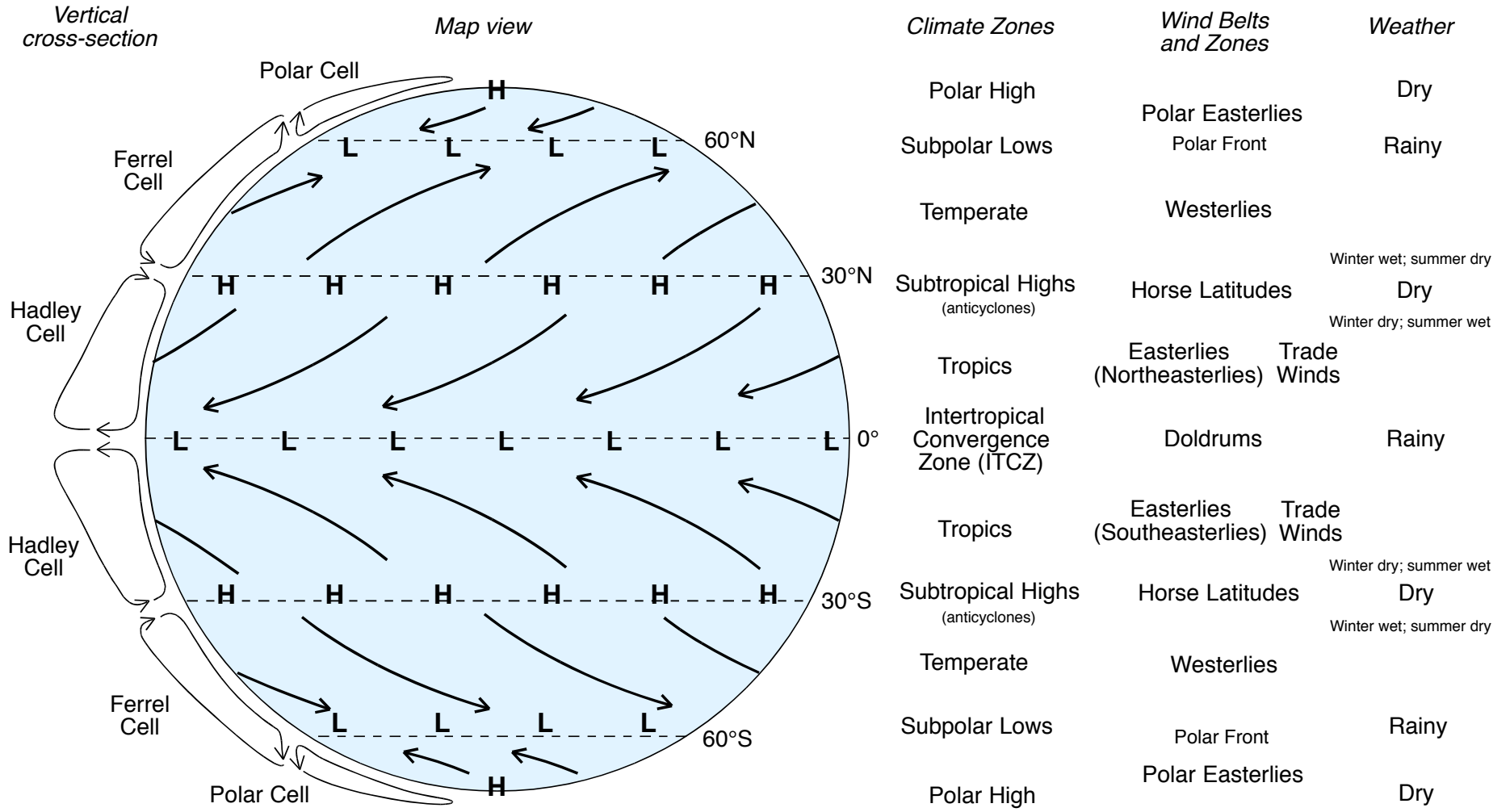
Polar Front

Polar Easterlies

This diagram is the second of three that build a typical schematic representation of Earth's surface atmospheric pressure, surface winds, and tropospheric circulation. This (Part Ib) and the previous (Part Ia) are pedagogical steps to the full representation in Part Ic. Parts II to V then expand on that model.

Earth's surface is heated least at the poles, and so air cools most there. That cold air sinks near the poles, as suggested above, and moves away from the poles across the Earth surface. That air finally warms enough to rise at about 60° N and S, and some of it returns high in the troposphere to sink again at the poles and thus to close the

Polar Cells that are shown at left above. In map view, the winds at Earth's surface turn according to the Coriolis Effect (right in the Northern Hemisphere; left in the Southern Hemisphere), making the Earth-surface winds of both cells easterlies.

Global climate zones Ic: an idealized simple view

Vertical cross-section | *Map view* | *Climate Zones* | *Wind Belts and Zones* | *Weather*

Polar Cell

Ferrel Cell

Hadley Cell

Hadley Cell

Ferrel Cell

Polar Cell

H

L L L L 60°N

H H H H H H 30°N

L L L L L L L 0°

H H H H H H 30°S

L L L L 60°S

H

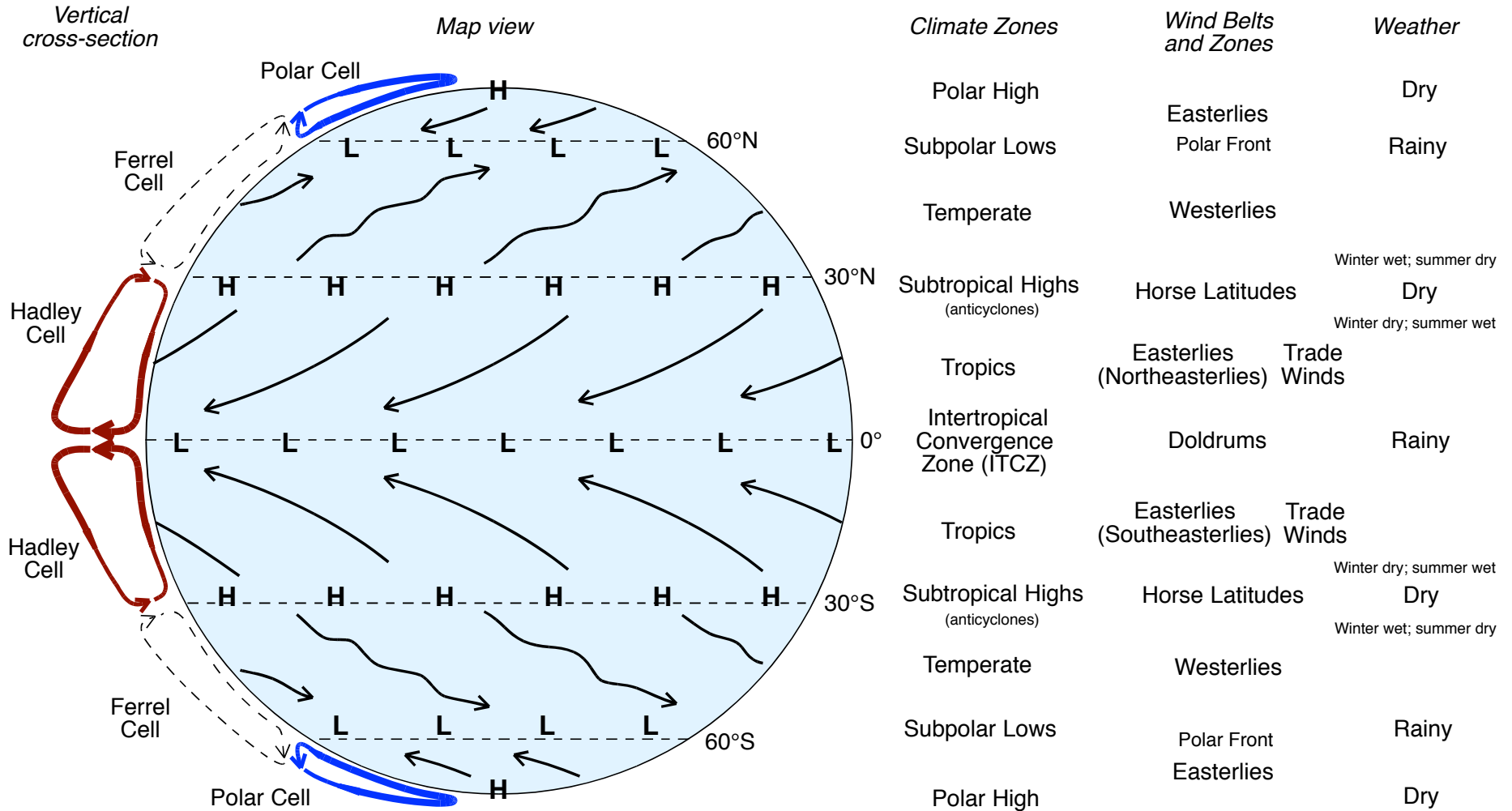| Climate Zones	Wind Belts and Zones	Weather
Polar High	Polar Easterlies	Dry
Subpolar Lows	Polar Front	Rainy
Temperate	Westerlies	
		Winter wet; summer dry
Subtropical Highs (anticyclones)	Horse Latitudes	Dry
		Winter dry; summer wet
Tropics	Easterlies (Northeasterlies) Trade Winds	
Intertropical Convergence Zone (ITCZ)	Doldrums	Rainy
Tropics	Easterlies (Southeasterlies) Trade Winds	
		Winter dry; summer wet
Subtropical Highs (anticyclones)	Horse Latitudes	Dry
		Winter wet; summer dry
Temperate	Westerlies	
Subpolar Lows	Polar Front	Rainy
Polar High	Polar Easterlies	Dry

The diagram above is a typical schematic representation of Earth's surface atmospheric pressure, surface winds, and tropospheric circulation. It mimics diagrams in many introductory climatology and oceanography textbooks. Parts II to V of this series expand on this theme in a little more detail.

Atmospheric circulation is driven by rising of warm air at the equator (at the latitude of maximal solar heating) and by sinking of cold air at the poles (at the latitude of minimal heating). On Earth, the air that has risen from the equator sinks at about 30° N and S, and some of that air returns across Earth's surface to the equator to close the Hadley Cells. The air that has sunk and moved out from

the poles warms and rises at about 60° N and S, and the air that returns aloft to the pole closes the Polar Cells. In between, the Ferrel Cells mirror the vertical flow at 30° and 60° N and S, with each cell like a ball bearing rolled by the other two cells. Earth-surface movement of air in these three kinds of cells gives the surface winds belts shown here.

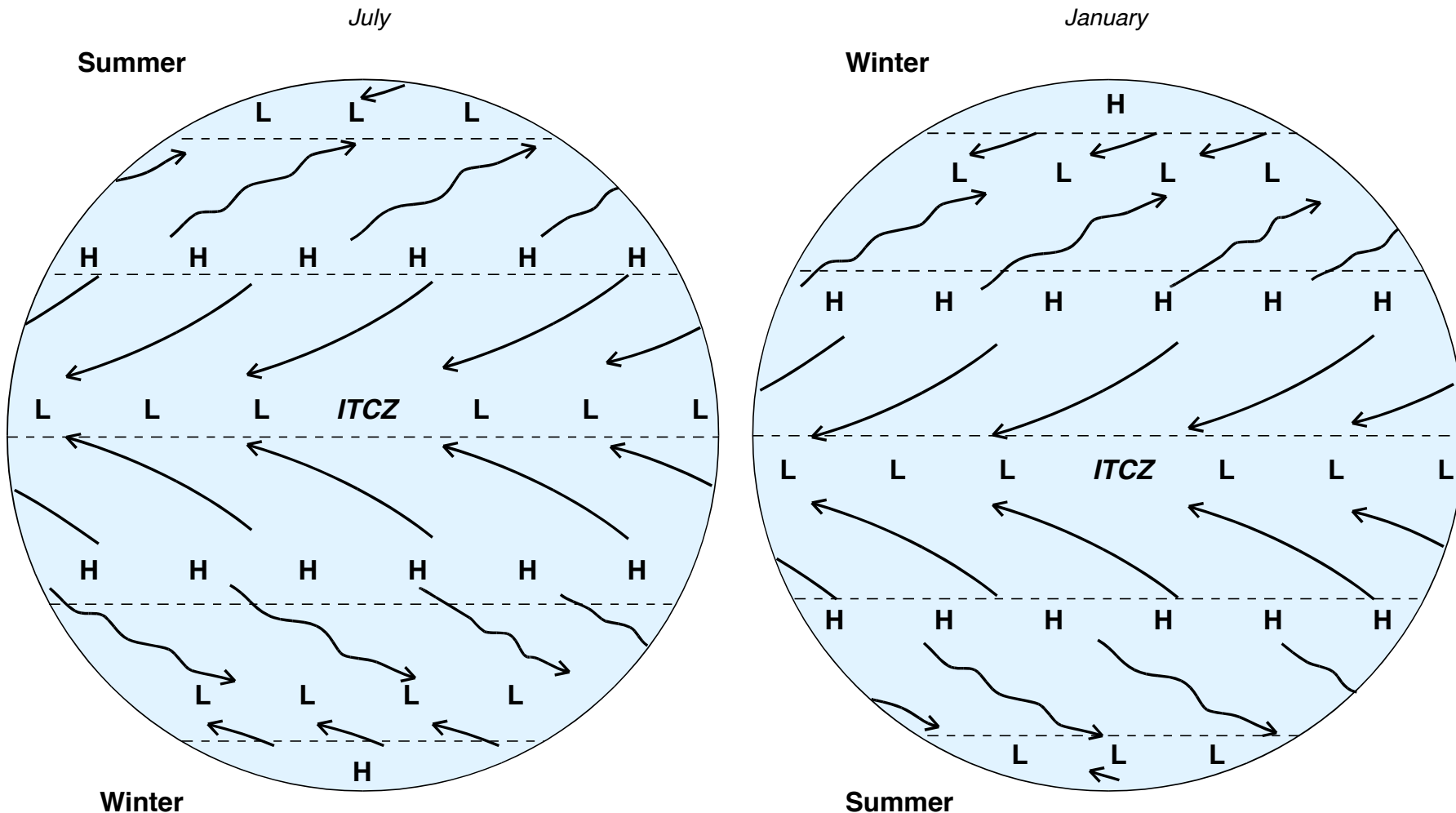# Global climate zones II: an idealized simple view, with weather

Vertical cross-section　　　*Map view*　　　*Climate Zones*　　　*Wind Belts and Zones*　　　*Weather*

Polar Cell

Ferrel Cell

Hadley Cell

Hadley Cell

Ferrel Cell

Polar Cell

H	60°N	
L L L L		

30°N

0°

30°S

60°S

Climate Zones	Wind Belts and Zones	Weather
Polar High	Easterlies	Dry
Subpolar Lows	Polar Front	Rainy
Temperate	Westerlies	
		Winter wet; summer dry
Subtropical Highs (anticyclones)	Horse Latitudes	Dry
		Winter dry; summer wet
Tropics	Easterlies (Northeasterlies) Trade Winds	
Intertropical Convergence Zone (ITCZ)	Doldrums	Rainy
Tropics	Easterlies (Southeasterlies) Trade Winds	
		Winter dry; summer wet
Subtropical Highs (anticyclones)	Horse Latitudes	Dry
		Winter wet; summer dry
Temperate	Westerlies	
Subpolar Lows	Polar Front	Rainy
	Easterlies	
Polar High		Dry

Part I of this series showed a schematic pattern of atmospheric circulation on Earth. This page changes that presentation by suggesting some variability of the westerly winds. That variability is shown here as variation through space, but it is also a variability through time: it is the weather of the westerlies belt.

Earth's easterlies are relatively constant because they are driven by the constant heating (and low pressure) at the equator, and by the constant cold (and high pressure) at the poles. The westerly winds, as the Earth-surface expression of the more secondary or ancillary Ferrel Cells,

are more variable. The westerlies' changes in flow, as transient highs and lows move through the middle latitudes, give the variable weather that characterizes the middle latitudes.

Global climate zones III: an idealized simple view, with seasons and weather

July

Summer

January
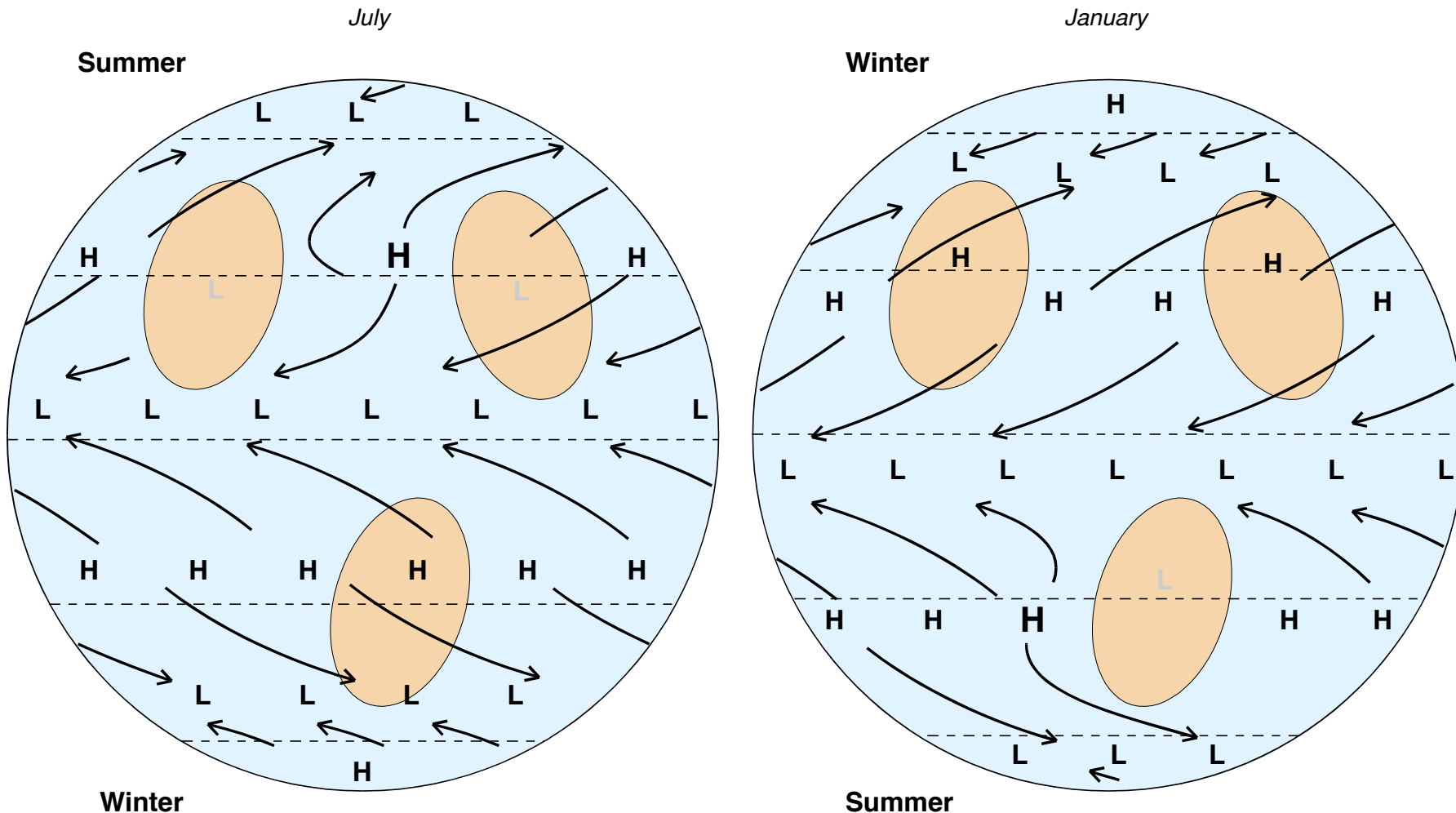
Winter

Winter

Summer

Parts I and II of this series showed a schematic pattern of atmospheric circulation on Earth. This page enlarges on that pattern by showing how the latitude of pressure zones and wind belts changes with the seasons. The left panel shows the northward shift in northern-hemisphere summer, and the

right one shows the southward shift in southern-hemisphere summer. One can think of this in two ways. In the first, the zone of maximum solar heating moves into the summer hemisphere, and so the equatorial low-pressure belt and Inter-Tropical Convergence Zone (ITCZ) move into that hemisphere.

In the second, the polar region of the winter hemisphere becomes colder and its cold area becomes larger, effectively pushing the cells and ITCZ toward the summer hemisphere.

Global climate zones IV: an idealized simple view, with seasons and continents

July

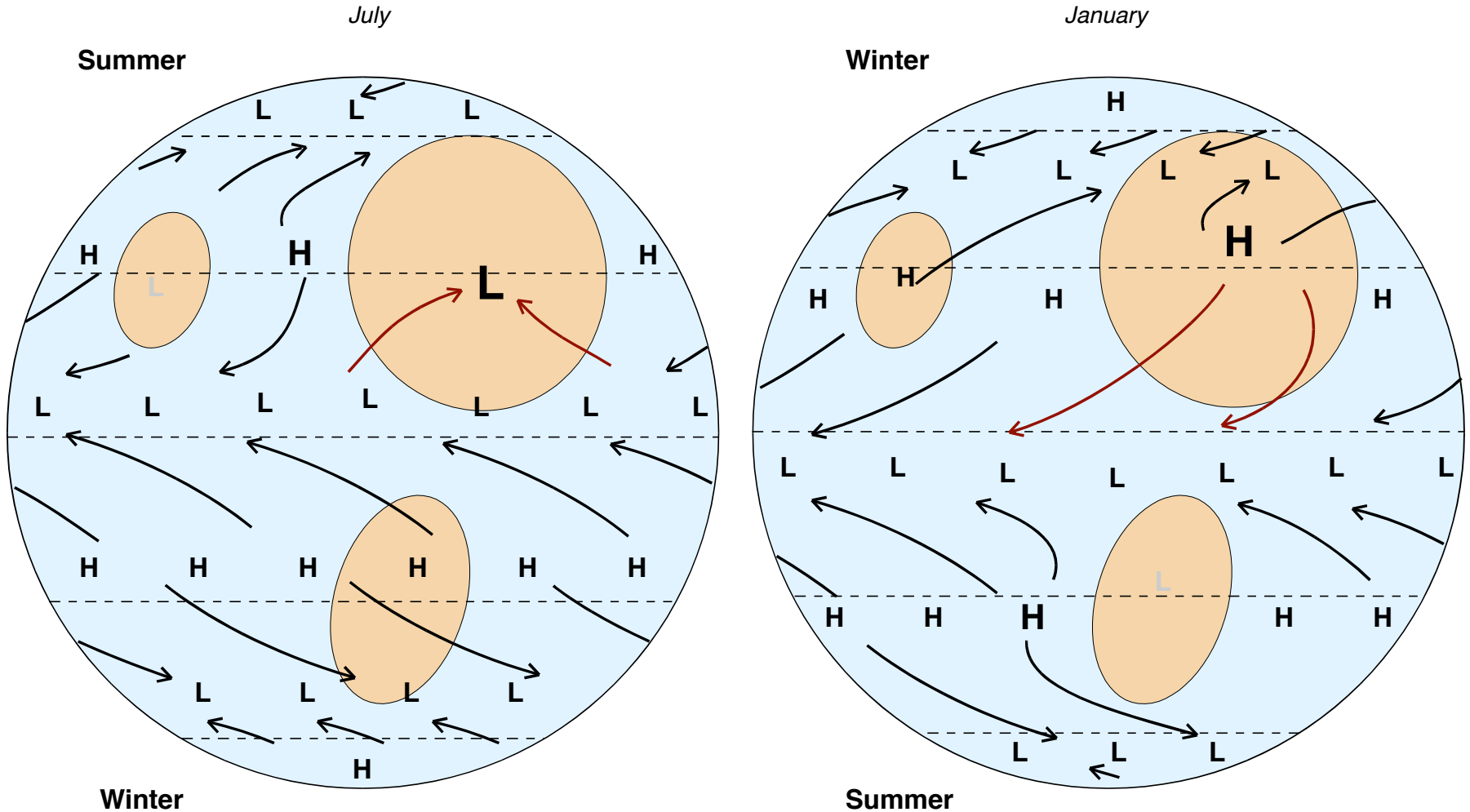**Summer**

January

Winter

Winter

Summer

Part III of this series showed a schematic pattern of atmospheric circulation on Earth. That simplified Earth had a uniform surface, presumably of a global ocean of water. Earth of course has continents of land, which are suggested here with tan ovoids. Continents are significant because, compared to the oceans, they lack water and its heat capacity. Continents thus undergo seasonal temperature changes far more extreme than those of oceans. As a result, warmed air rises from continents in summer to give lows that disrupt the zone of high pressure in the Horse Latitudes, so that the subtropical highs are instead focused over the oceans. On the other hand, chilled air sinks over the continents in winter to give pronounced areas of high pressure. Thus, to a climatologist, "continent" might be defined as "a land mass sufficiently large to develop seasonal anomalies of atmospheric pressure".

Part V of this series considers what happens when a very large continent develops summer lows and winter highs.

Global climate zones V: an idealized simple view, with seasons and a huge continent

July

Summer

Winter

January

Winter

Summer

Part IV of this series showed a schematic pattern of atmospheric circulation on an Earth-like planet with moderate-size continents. The point of that page was that, relative to zonal atmospheric pressure, continents develop lower pressure in summer as they warm, and higher pressure in winter as they cool. Those changes lead to comparatively minor changes in wind directions from season to season.

This page consider what happens when an exceptionally large continent lies at mid-latitude. The continental pattern discussed in Part IV is intensified, most notably in summer when a large low-pressure system develops in the region typically characterized by subtropical highs. The result is a reversal of the usual zonal winds shown in Parts I to III. This reversal of pressure relationships and winds is a **monsoonal system**, and the air drawn into the low rises to give the rain associated with monsoonal systems. In winter, the opposite happens: an exceptionally strong high develops to give strong winds and cold dry weather.