

Global Winds and Ocean Currents

AOSC 200

Tim Canty

Class Web Site: <http://www.atmos.umd.edu/~tcanty/aosc200>

Topics for today:

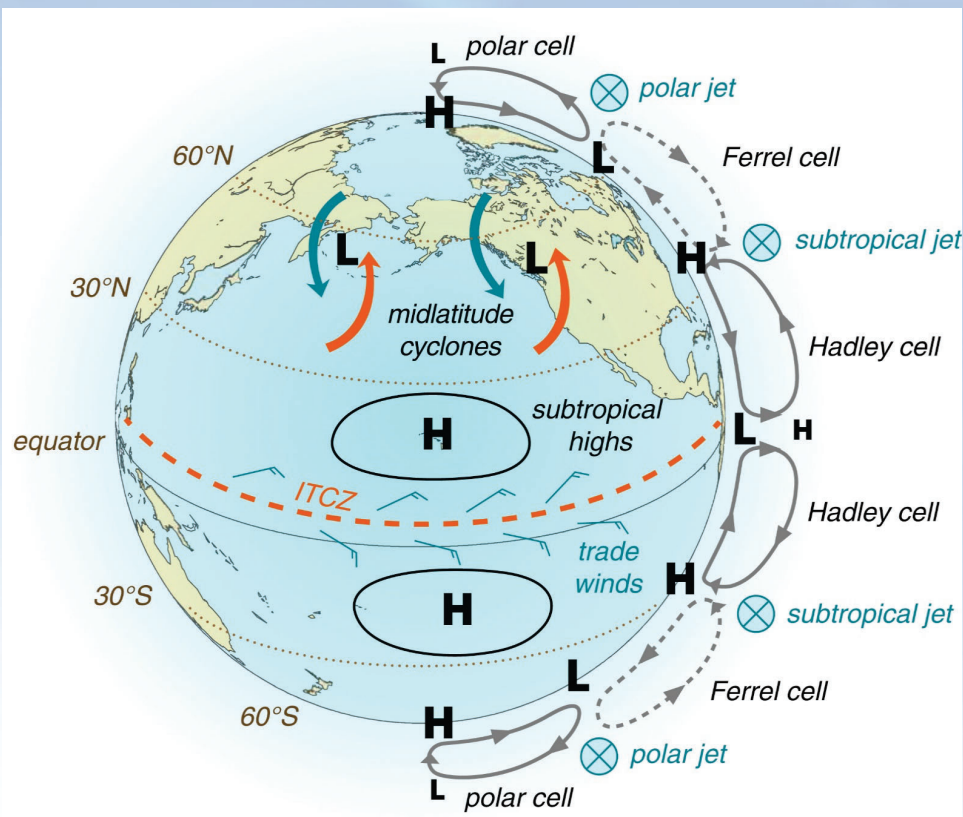
Ocean transport
Ocean cycles
Air Masses

Lecture 19
Oct 31 2019

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Conceptual Model

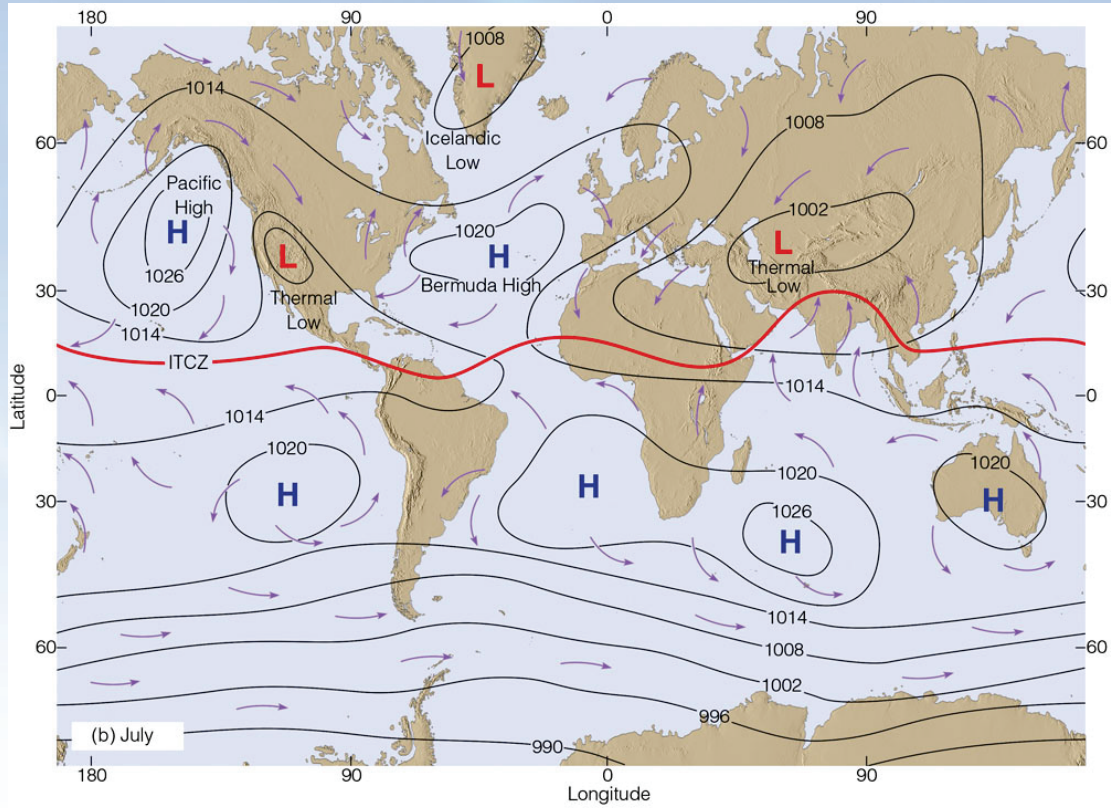


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Fig 9.11 Weather: A Concise Introduction

2

Sea-level pressure in Summer



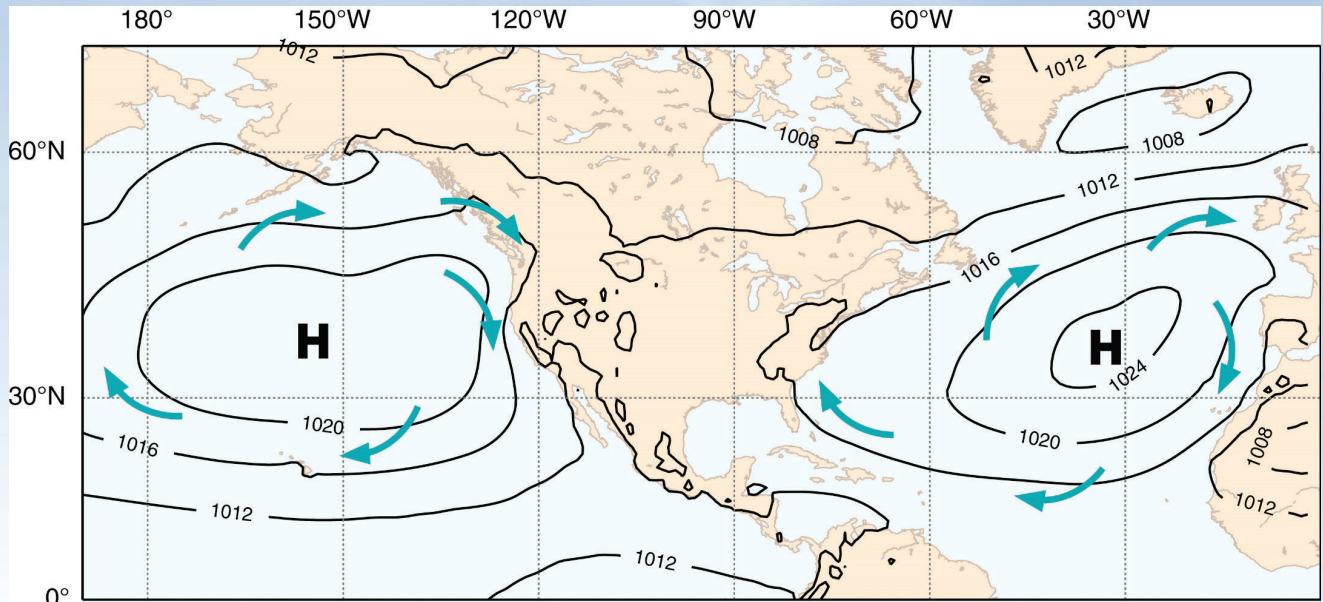
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N.H. summer: thermal lows over land, high pressure over ocean

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Subtropical Highs and Friction

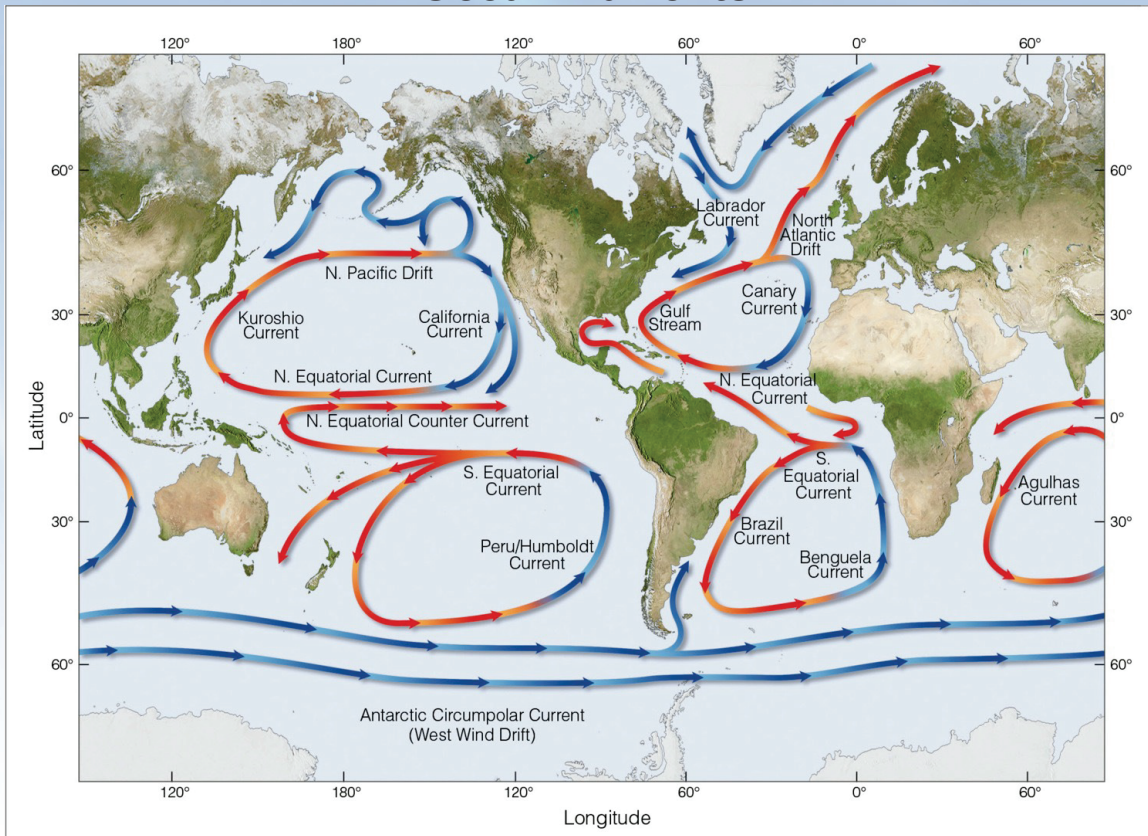


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Fig 9.13 *Weather: A Concise Introduction*

Ocean Currents



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Fig 8-6 *Meteorology: Understanding the Atmosphere*

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Ocean Currents



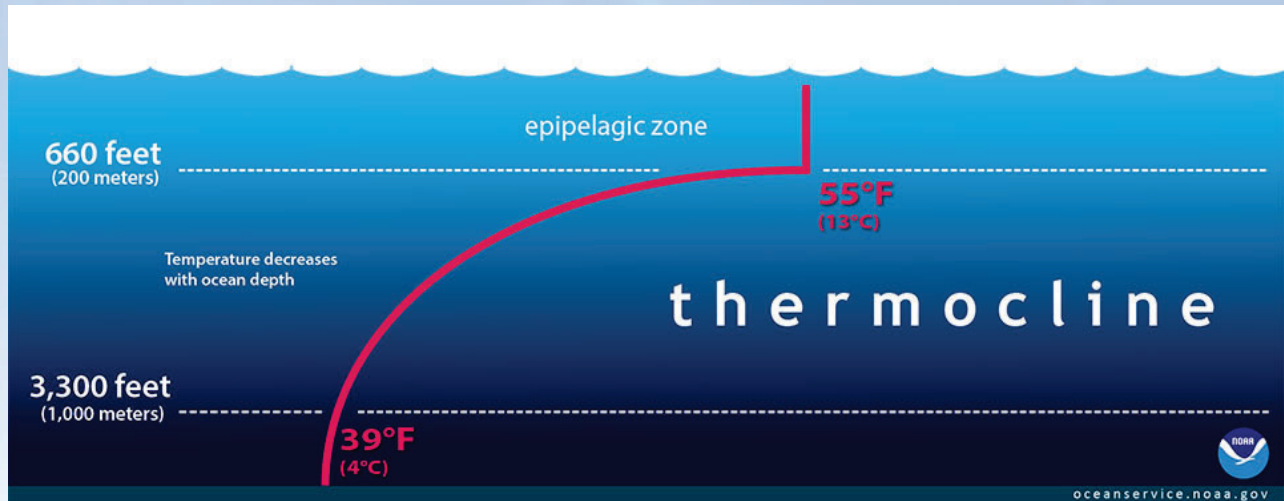
North Atlantic Gyre driven by trade winds and Westerlies

Fig 8-8 *Meteorology: Understanding the Atmosphere*

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Ocean temperatures



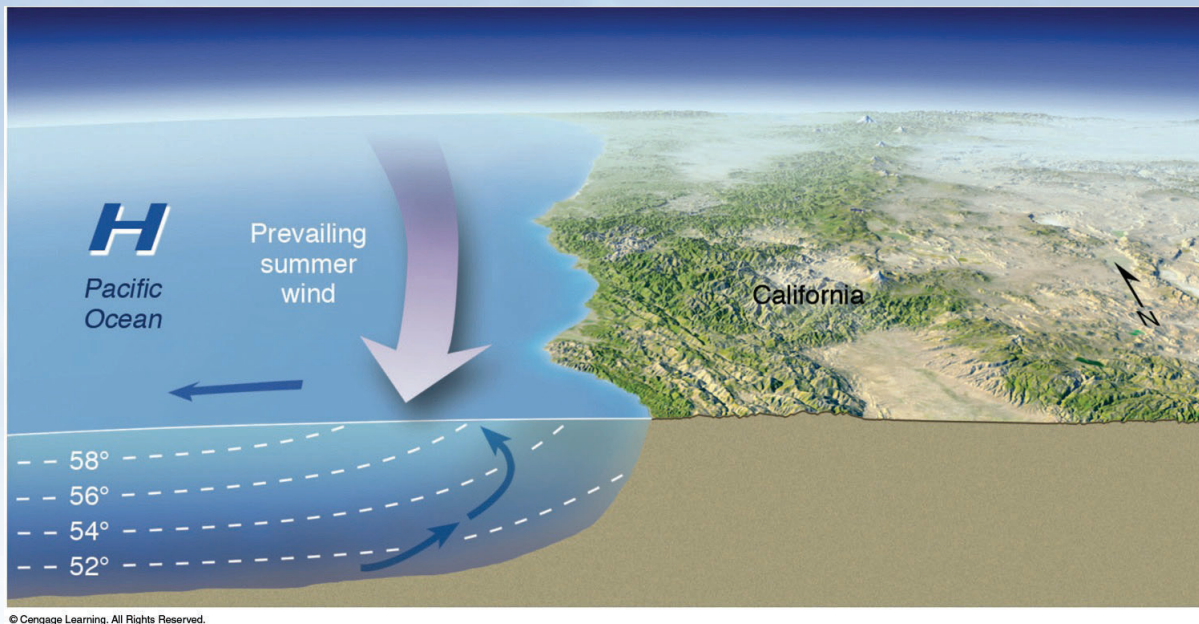
<https://oceanservice.noaa.gov/facts/thermocline.html>

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Ekman Transport



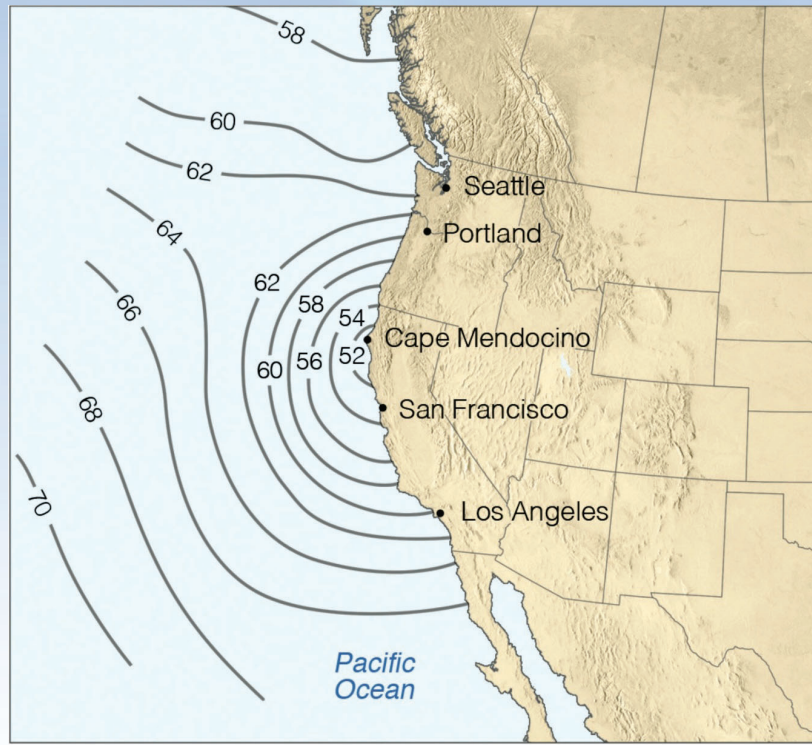
**Ocean water is pushed by wind but is also affected by Coriolis forces
Causes cold water from the lower ocean to rise up – upwelling**

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Fig 7.39: *Essentials of Meteorology* 8

Ekman Transport

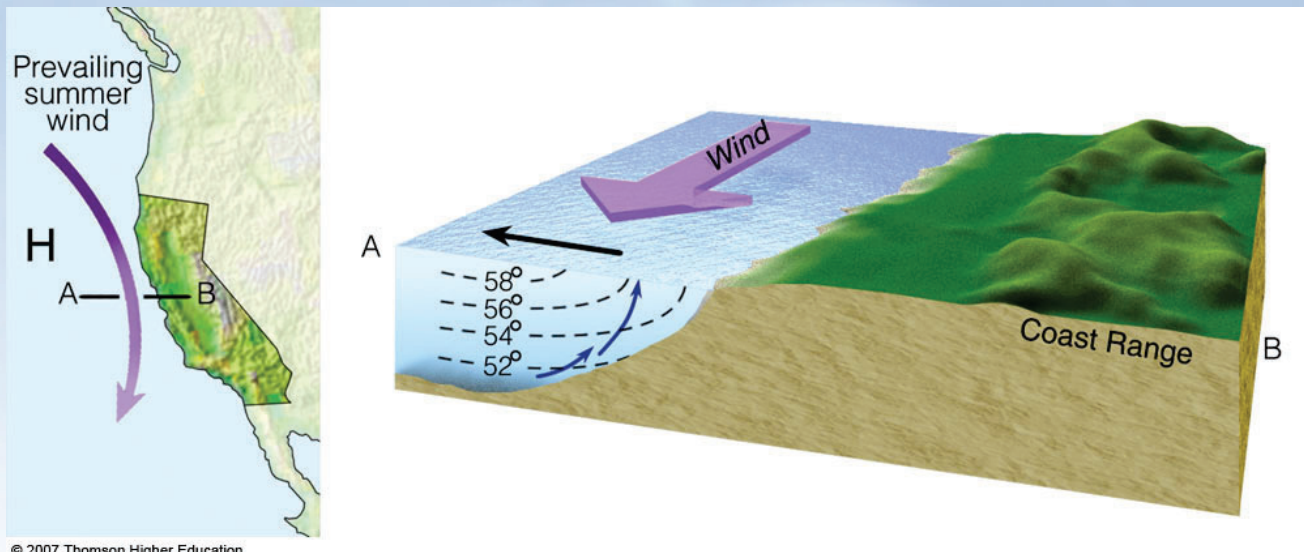


Coastal waters off of California are cold because of the upwelling of deeper water

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Fig 7.38: *Essentials of Meteorology* 9

Ekman Spiral and Ekman Transport

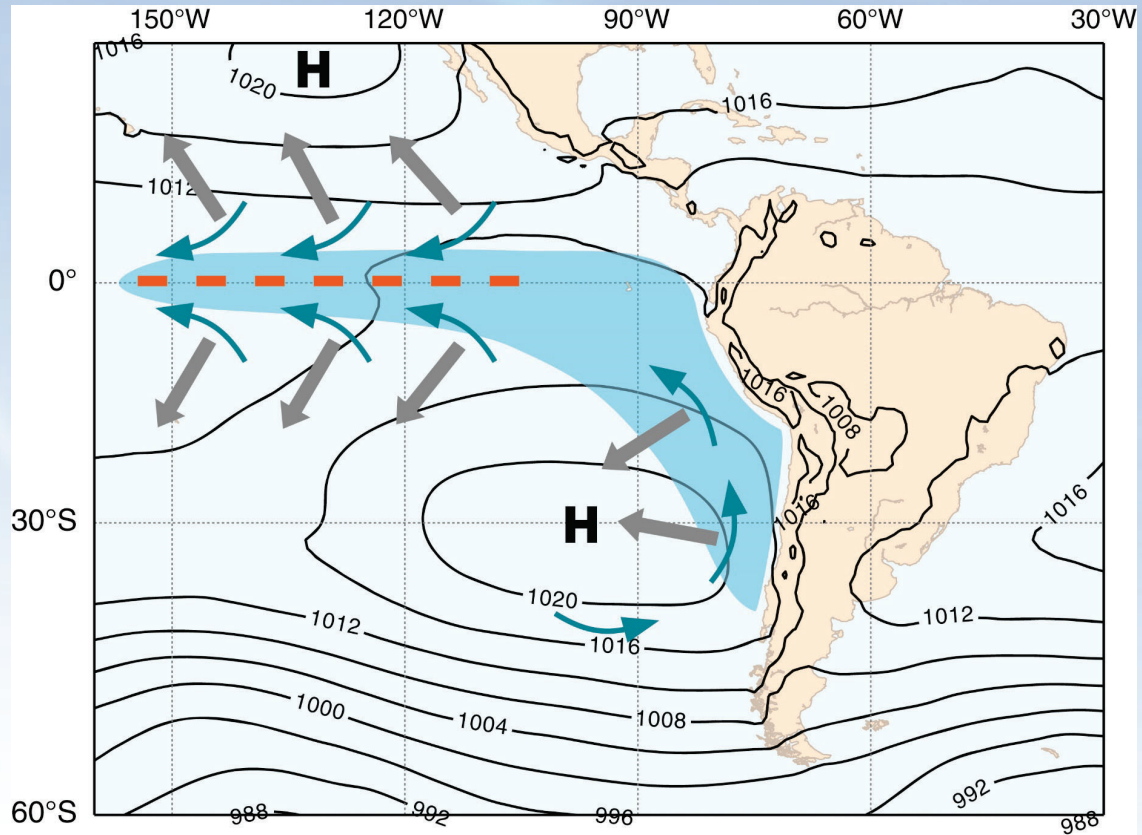


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**Water off the coast of Southern California is cold and teeming with life
Great for fishing!!!!**

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“Cold Tongue”

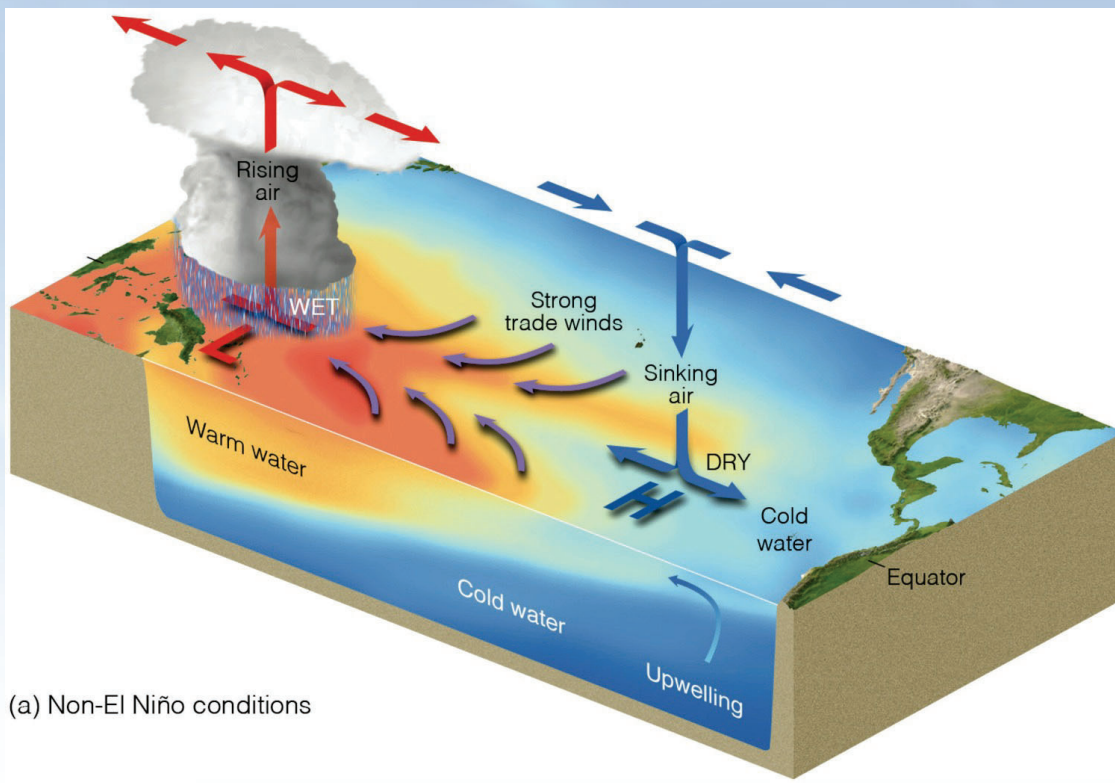


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Fig 9.18 Weather: A Concise Introduction

Normal Conditions



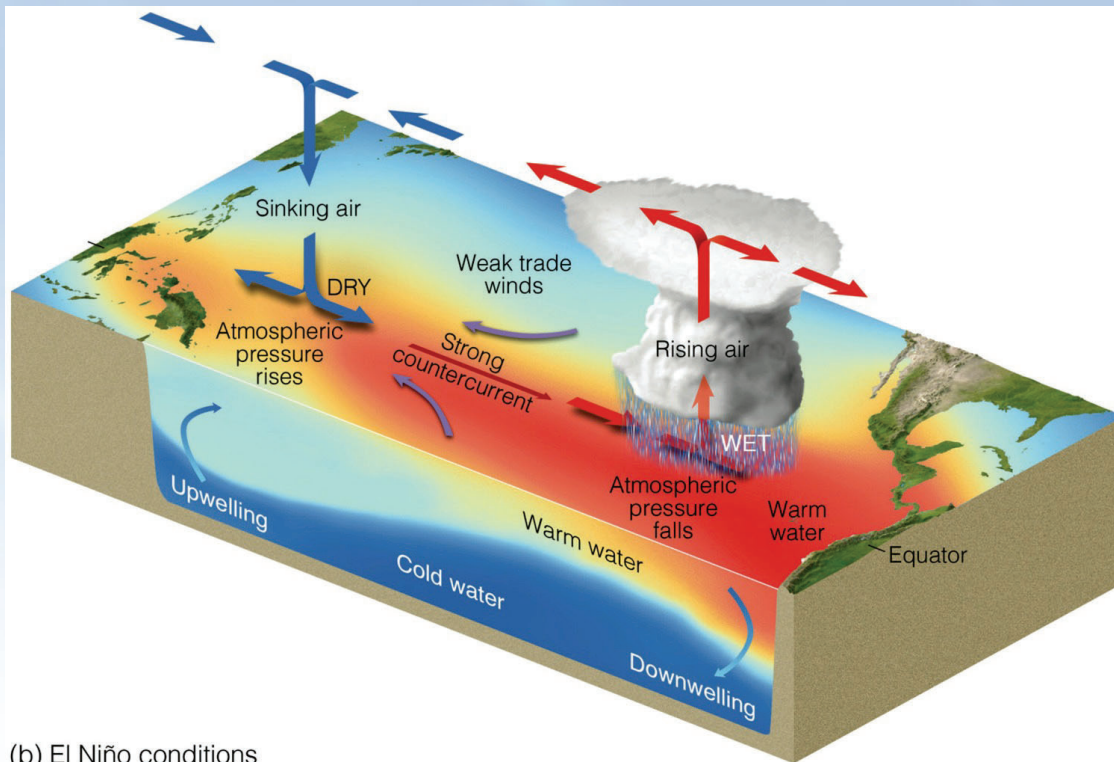
(a) Non-El Niño conditions

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El Niño: warm water sloshes to the east



(b) El Niño conditions

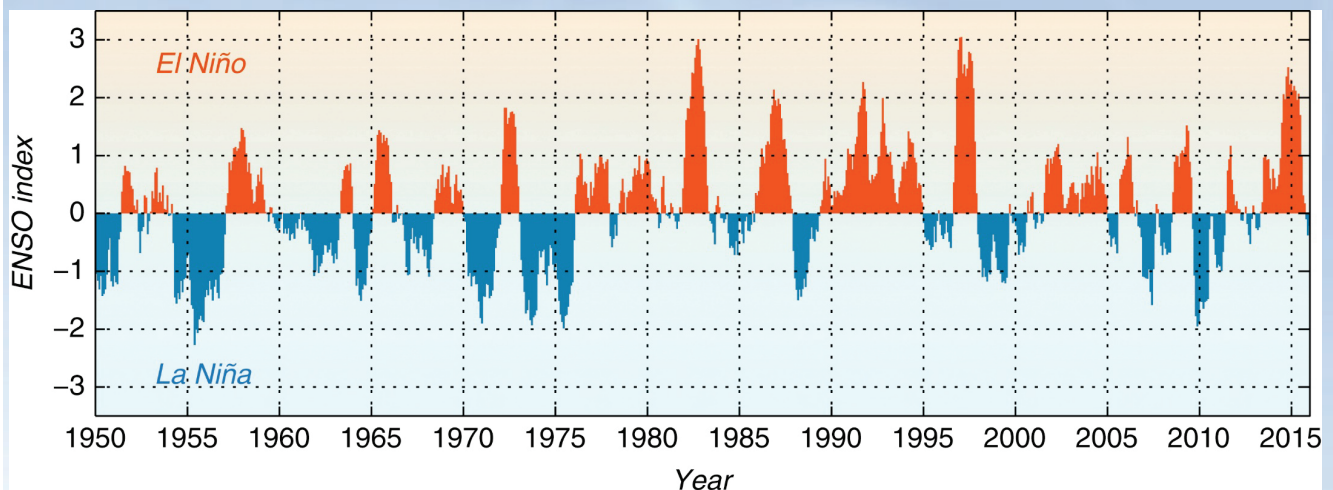
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During an El Niño, easterly trade winds weaken and warm water is transported from western Pacific to eastern Pacific

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El Niño



**Generally: above 1 = El Niño
below -1 = La Niña**

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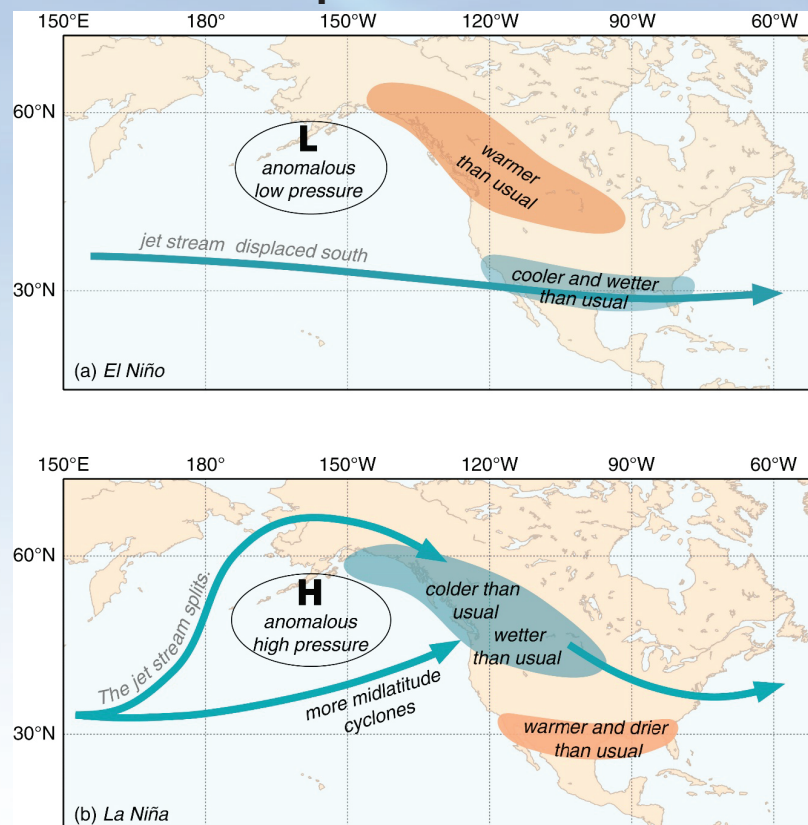
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How does El Niño affect global weather?

- **Western Pacific: less rainfall as warm water moves east.**
- **Shift in rain patterns moves subtropical jet stream from its normal path.**
- **Change in path of sub-tropical jet affects weather of the mid-latitudes as well as the tropics.**
- **The commodities markets use the NOAA El Niño forecasts to influence buying and selling.**

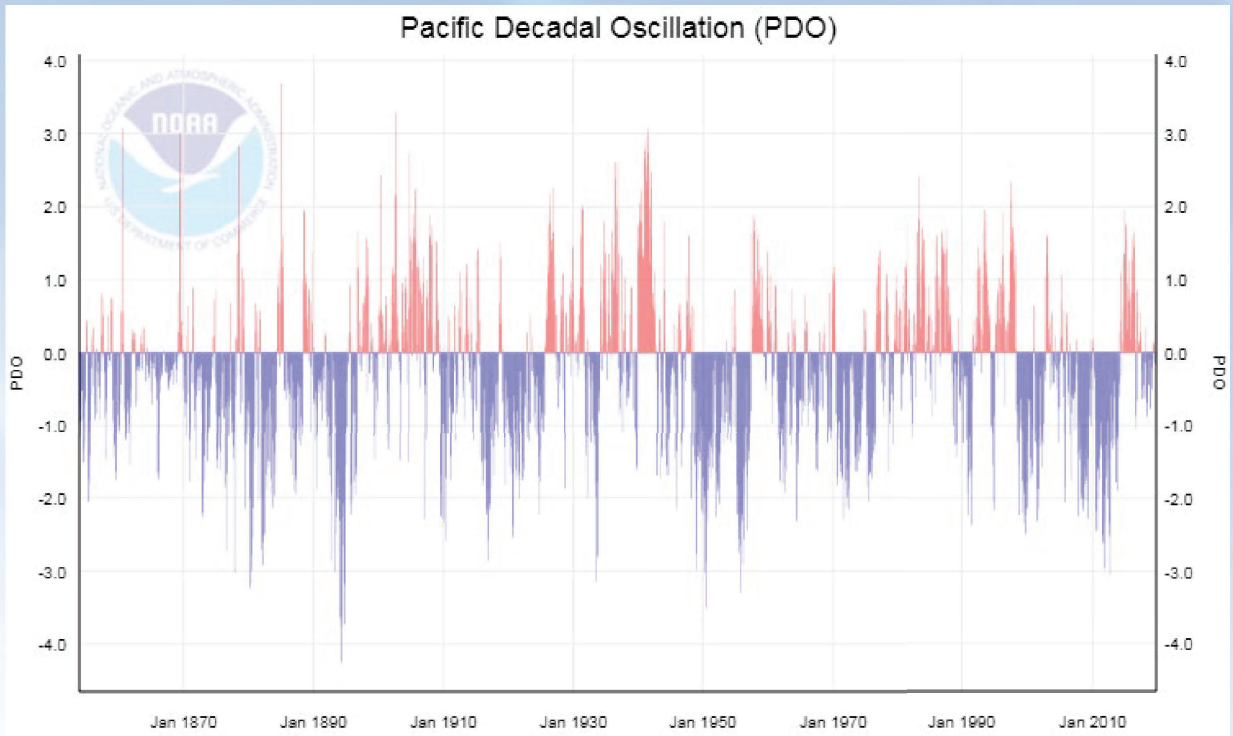
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Impact on U.S.



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Pacific Decadal Oscillation



Similar to El Niño but over much longer time scales

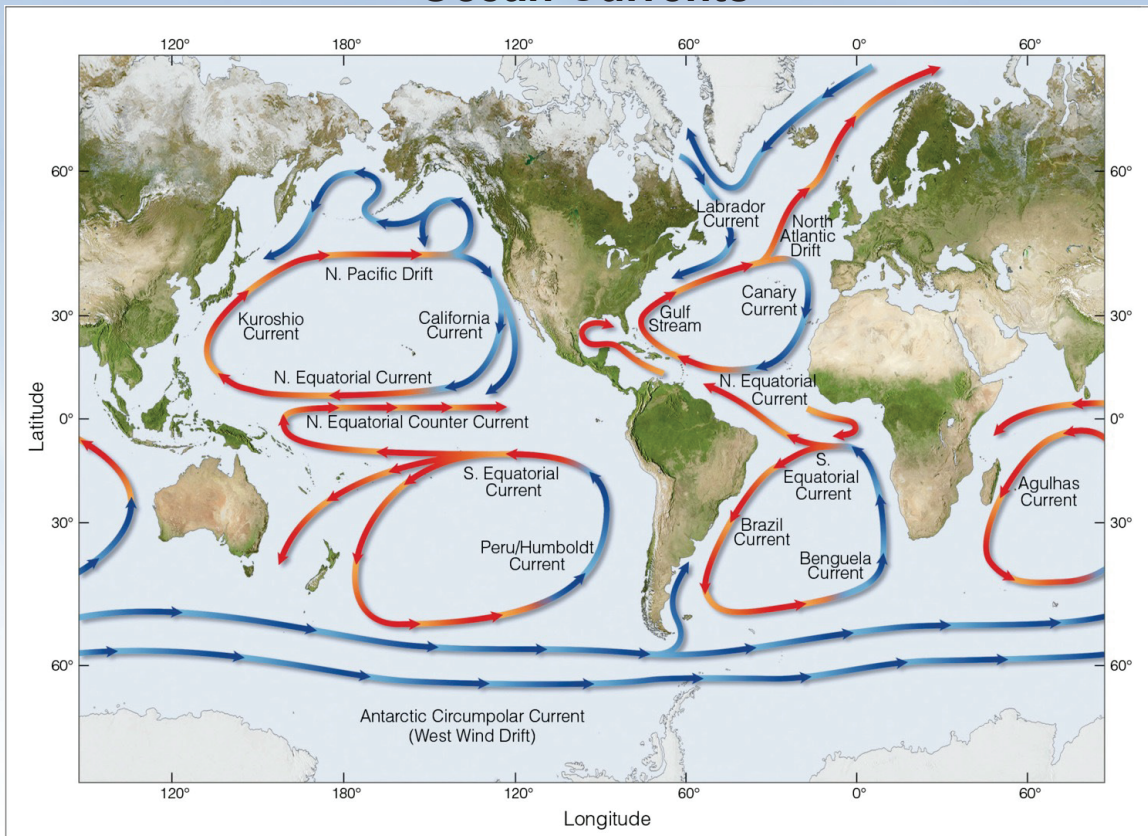
<https://www.ncdc.noaa.gov/teleconnections/pdo/>

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Ocean Currents



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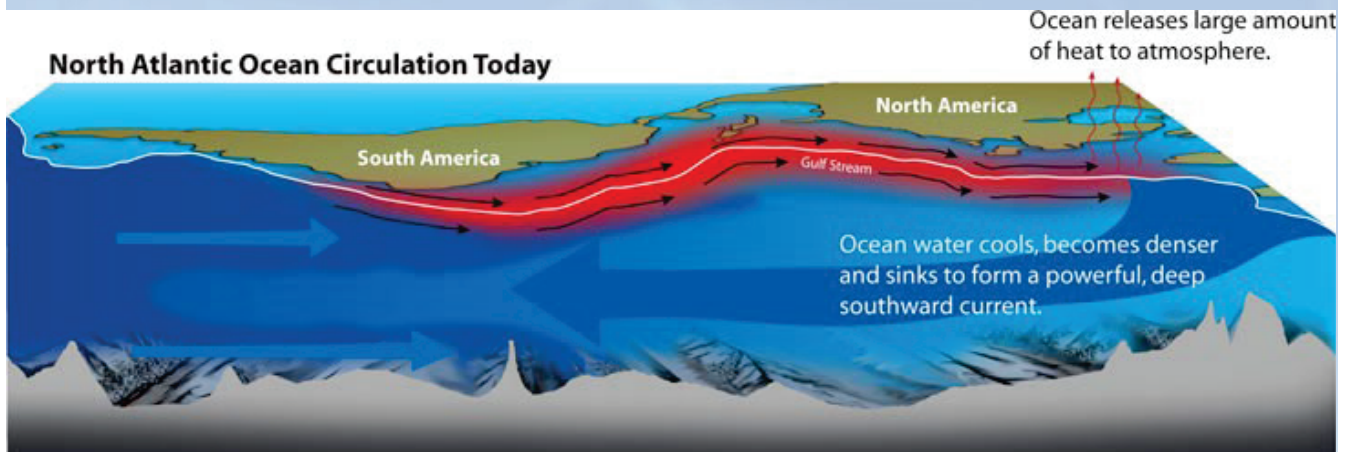
Fig 8-6 Meteorology: Understanding the Atmosphere

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Atlantic Meridional Overturning Circulation



Cold, dense ocean water sinks and heads south, creating a strong, deep water current that heads to the Antarctic

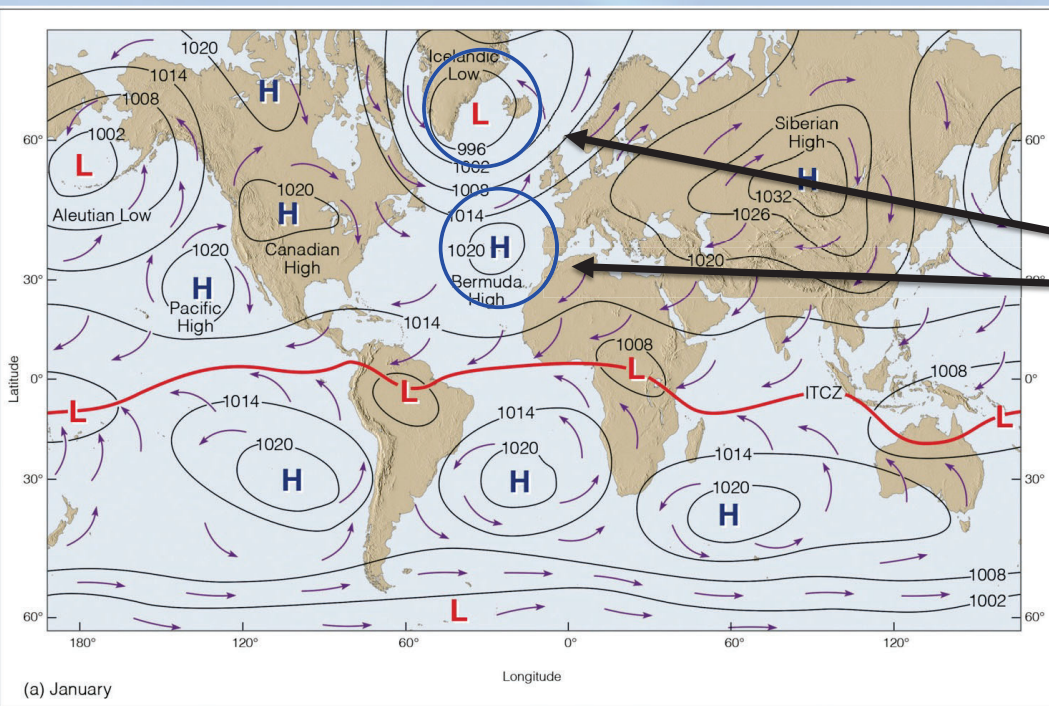
<http://www.whoi.edu/oceanus/feature/the-once-and-future-circulation-of-the-ocean>

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North Atlantic Oscillation



Relative changes in pressure systems

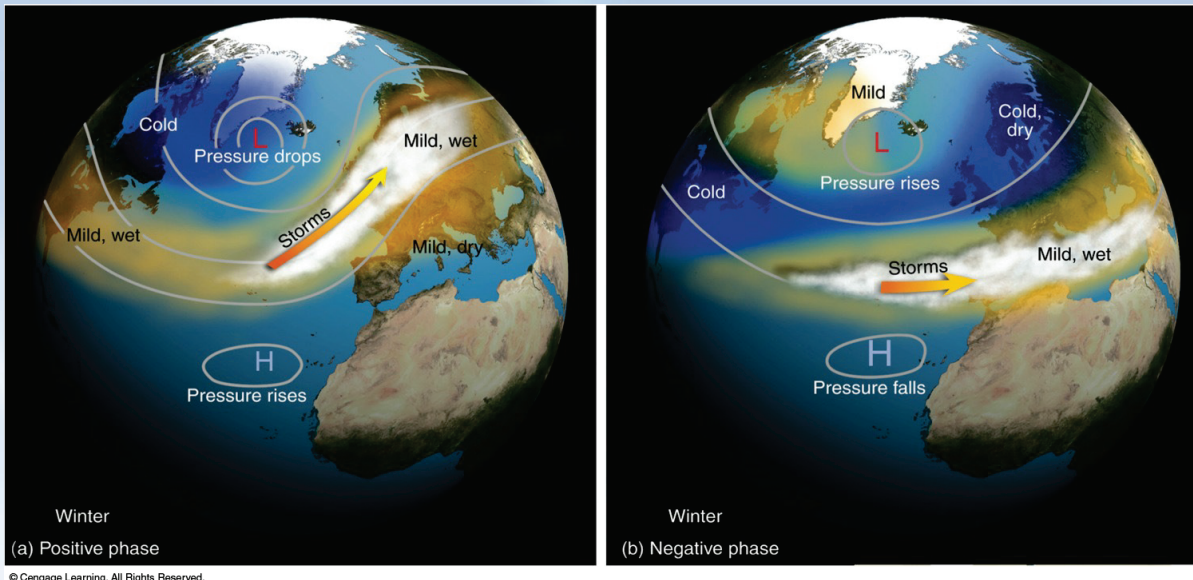
Positive NAO: Both the Bermuda High and Icelandic Low strengthen
Negative NAO: Both the Bermuda High and Icelandic Low weaken

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Fig 7.28: *Essentials of Meteorology*, 20

North Atlantic Oscillation



Positive Phase

Negative Phase

Shift in atmospheric pressure between polar low near N. Pole and subtropical high over Atlantic

Air Masses

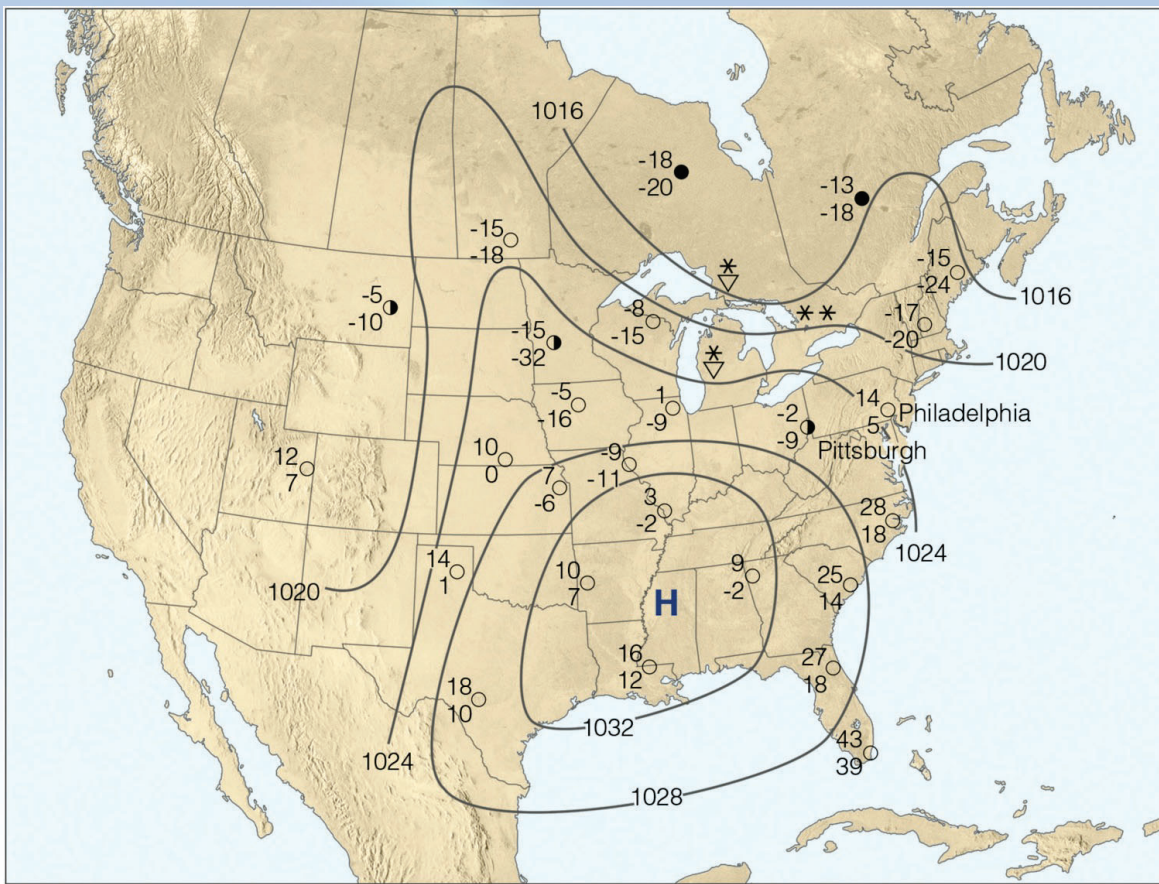
What is an air mass?

Large body of air whose temperature and humidity are the same in any horizontal direction

Can cover huge areas (hundreds of thousands sq mi)

Influenced by the surface over which they form (source region)

Longer the air stays over source region the more it takes on characteristics of that region



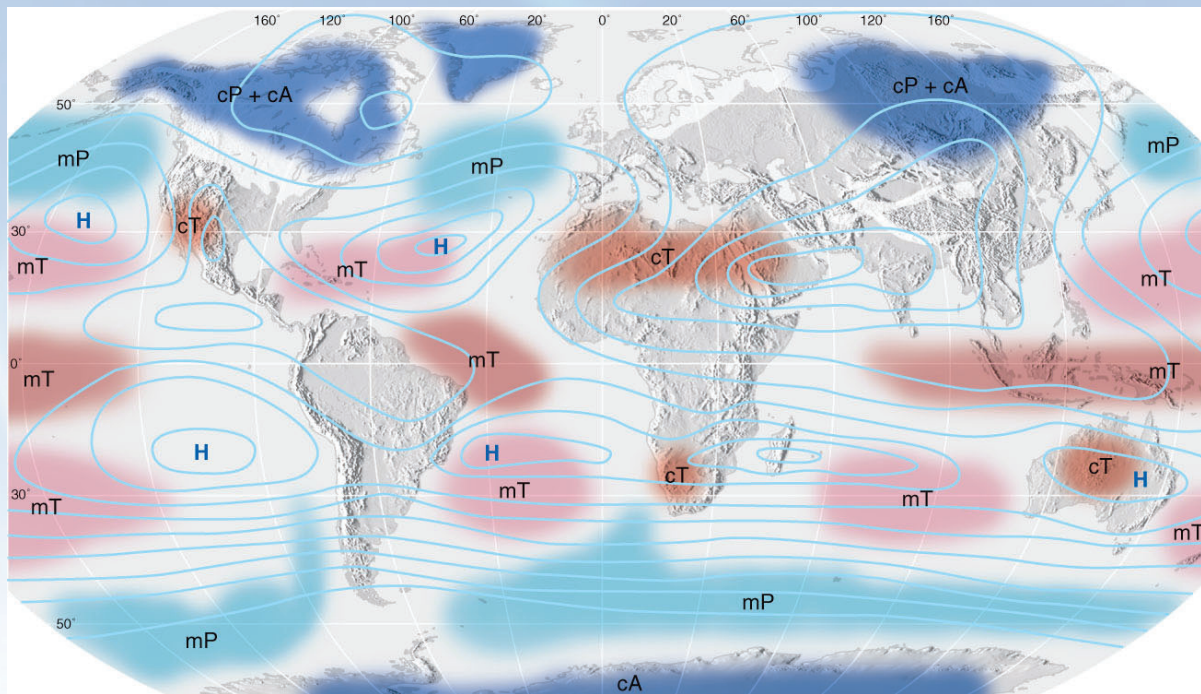
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Fig 8.1: Essentials of Meteorology 23

Air Mass Source Regions



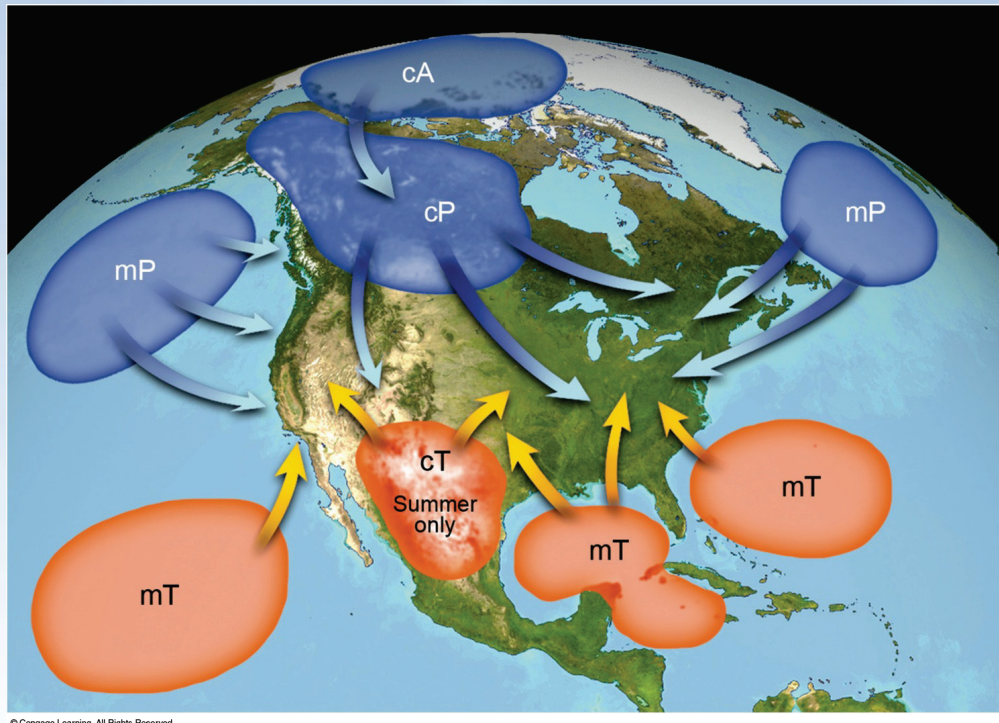
Characteristics of air mass depends on source region

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Fig 9-3 Meteorology: Understanding the Atmosphere

Air Masses that Affect North America



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Arrows indicate general direction of air flow

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Fig 8.2: *Essentials of Meteorology*

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Continental Polar (cP) and Continental Arctic (cA) Air

Cold to extremely cold and dry air masses

cP air comes from Canada and can head as far south as Florida

cA forms over frozen Arctic bringing bitterly cold temperatures

Sometimes called “Siberian Express”

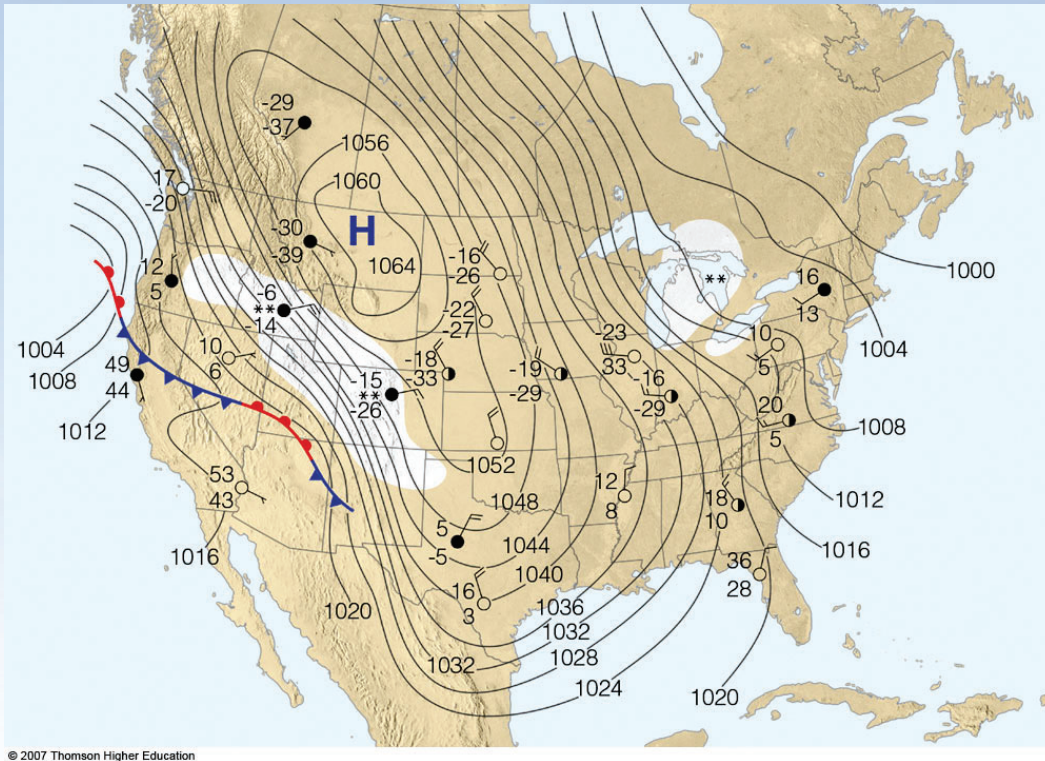
Strong winds and blowing snow can lead to blizzards

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“Siberian Express” Dec 24 1983



Large high pressure system can bring freezing air down from Arctic

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Fig 8.3: Essentials of Meteorology 27

Madison, Wisconsin, Feb 1996

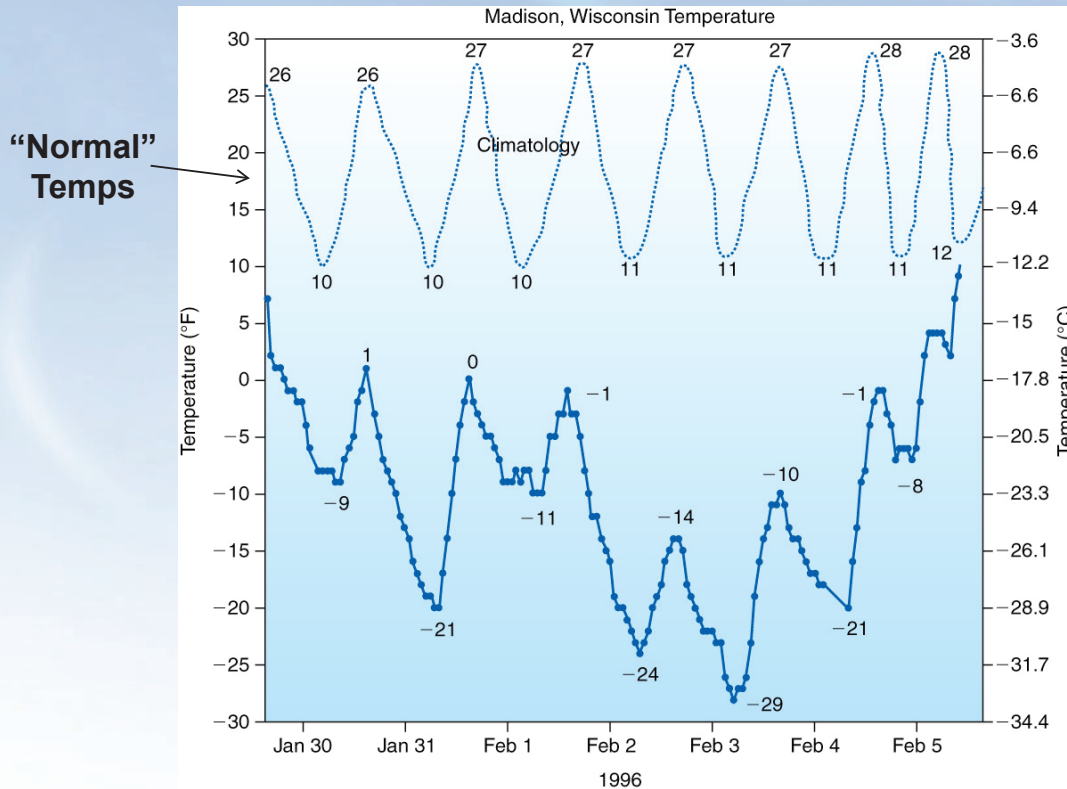


Fig 9-7 Meteorology: Understanding the Atmosphere

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Maritime Polar Air (mP)

Form over oceans at high latitudes, cool to cold and humid

In winter, mP from Pacific begin as cP from Siberia

These systems run into west coast mountains and dump lots of snow (orographic forcing)

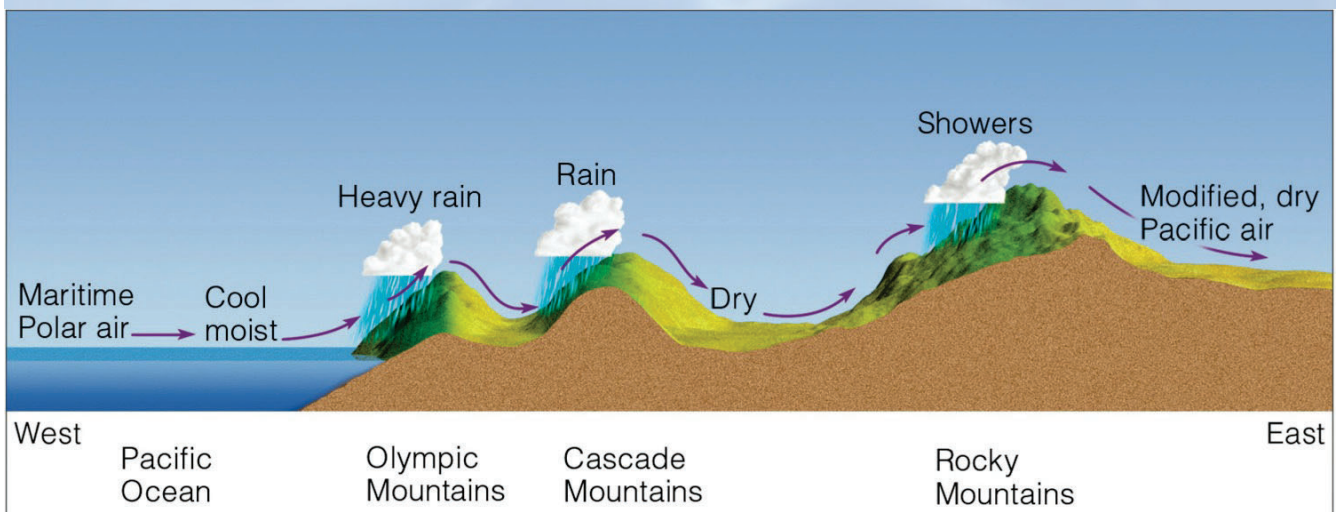
On East coast, mP brings in moist air from Atlantic over land where it meets with cP air

Can lead to large snowfalls!!!

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Maritime Polar Air (mP)



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Table 8.7: *Essentials of Meteorology*

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