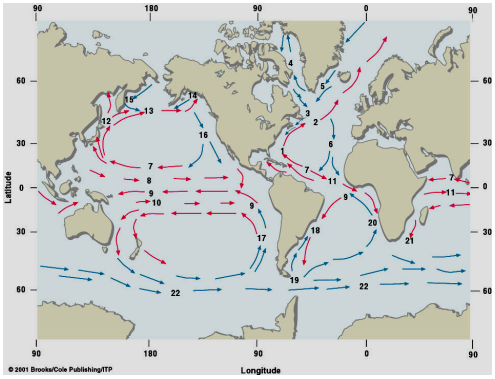
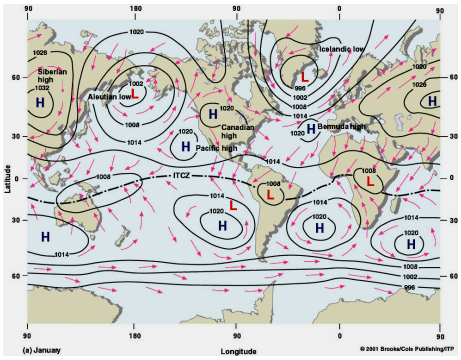
Chapter 11, Part 2

Atmosphere-Ocean Interactions

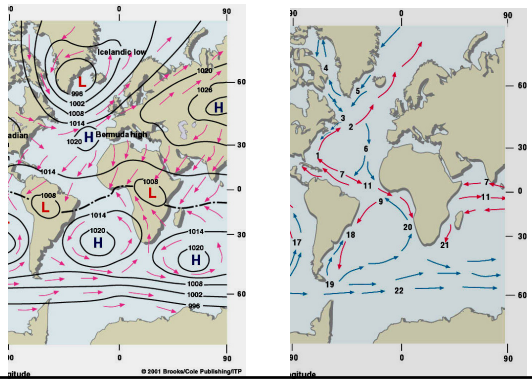
Major Ocean Currents



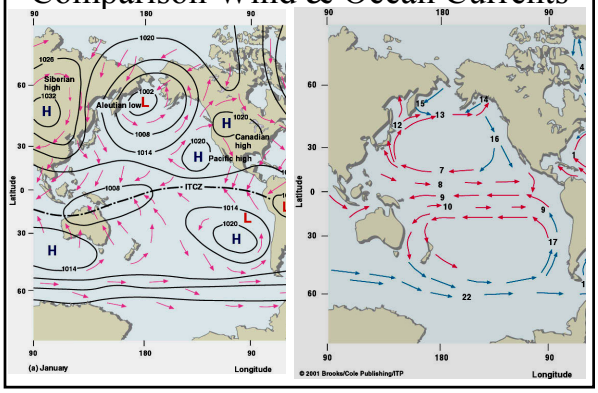
January Wind and Pressure



Comparison Wind & Ocean Currents



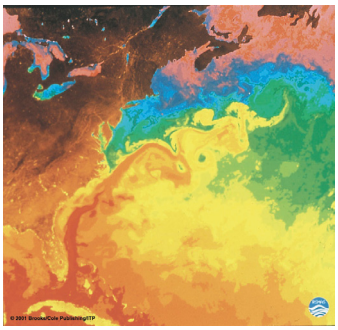
Comparison Wind & Ocean Currents



Influence of Wind on Ocean Currents

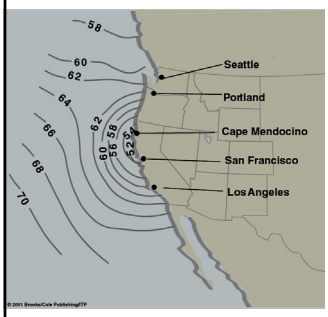
- Wind blowing over the oceans causes the surface water to drift along with it.
- Ocean currents do not follow the wind pattern exactly. They flow in semiclosed circular whirls called gyres.

Ocean Currents and Heat Transfer



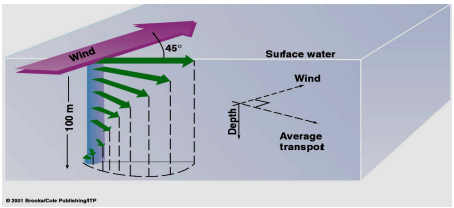
- About 40% of the total heat transport in the Northern Hemisphere comes from surface ocean currents.

Average Surface Water Temperature on the West Coast



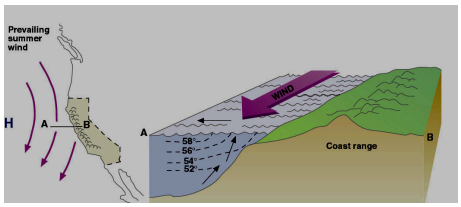
- The cool California Current flows south along the west coast.
- The water should warm as we go south.
- Why then are the coldest surface water temperatures at Cape Mendocino?

Ekman Spiral



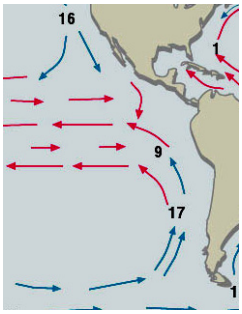
- Due to the Coriolis force, the surface water moves to the right of the wind.
- Layers further underneath the surface move to the right of the layers above, until eventually the layers at some depth (~100m) are moving opposite to the surface current.

Upwelling



- Because the surface current on the west coast is directed out to sea, this causes an upwelling of cold water from below the surface.
- The upwelling is strongest at Cape Mendocino because the wind parallels the coast.

El Niño

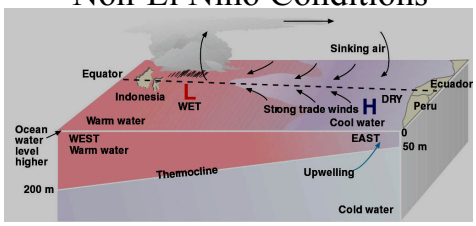


- A similar upwelling usually occurs on the west coast of S. America, bring nutrient rich cold water to the surface.
- Near the end of the year (Dec/Jan) warm water moves south, stopping upwelling.
- Called El Niño (Spanish for boy child).

Major El Niño Event

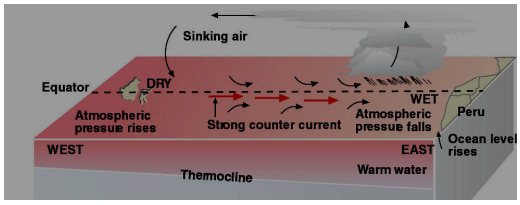
- At irregular intervals of 2 to 7 years, the warming covers a large area of the Pacific Ocean.
- Fish and birds die because of the loss of nutrients.
- Weather around the world is disrupted with some areas receiving more rain than normal and others less.

Non-El Niño Conditions



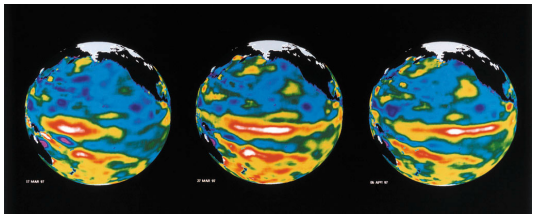
- Normally, trade winds blow toward the west (H to L).
- Surface water near the equator is cool in the east and warm in the west.
- The wind raises slightly the water in the western Pacific, producing a weak countercurrent.

El-Niño Conditions



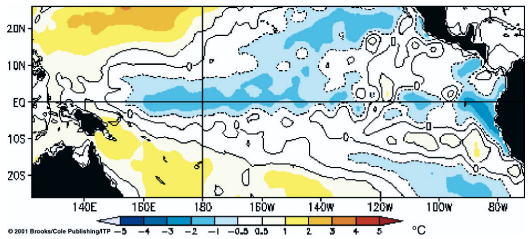
- Air pressure rises over the western Pacific and falls over the eastern Pacific, weakening the trade winds and strenghtening countercurrent.
- Surface water warms over western Pacific and heads eastwards (Kelvin wave – only 15cm high).

Kelvin Wave



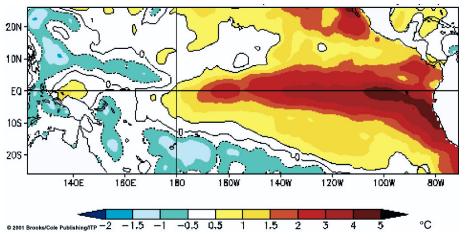
- Kelvin wave moving eastward in March/April 1997.
- White areas are 20cm (8 in.) higher than average.
- Red areas are 10cm (4 in.) higher than average.

Non-El Niño Water Temperature



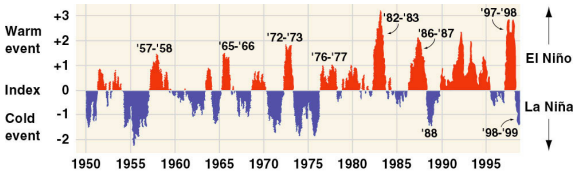
- Water is cooler in the east and warmer in the west.

El Niño Water Temperatures



- Water is warmer in the east and cooler in the west.

Southern Oscillations

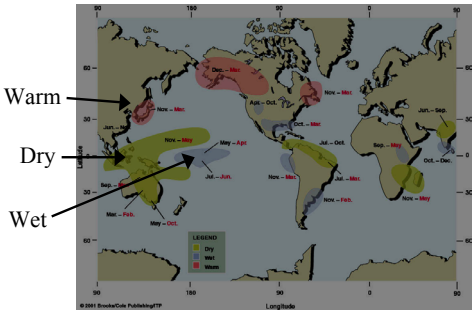


- El Niño conditions occur at irregular intervals.
- When the pressure rises in the east (opposite of El Niño), the phenomena is called El Niña (the girl child).
- Entire cycle is called Southern Oscillation.

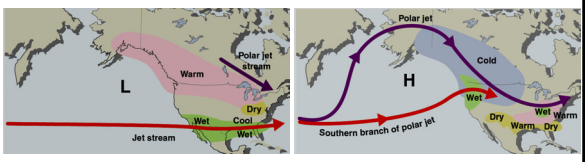
Global Effects of El Niño

- Droughts in Indonesia, southern Africa, and Australia.
- Heavy rains and flooding in Ecuador and Peru.
- Storms in California and heavy rain in Gulf Coast States.
- A strong El Niña also effects weather globally.

Regions Effected by Strong ENSO



Winter Weather Patterns over North America



El Niño La Niña

Summary

- Ocean currents flow in semiclosed circular whirls and roughly follow the wind direction.
- Wind blowing parallel to the coast can lead to upwelling of cold water from below.
- In an El Niño event water in the eastern Pacific warms and water in the western Pacific cools.