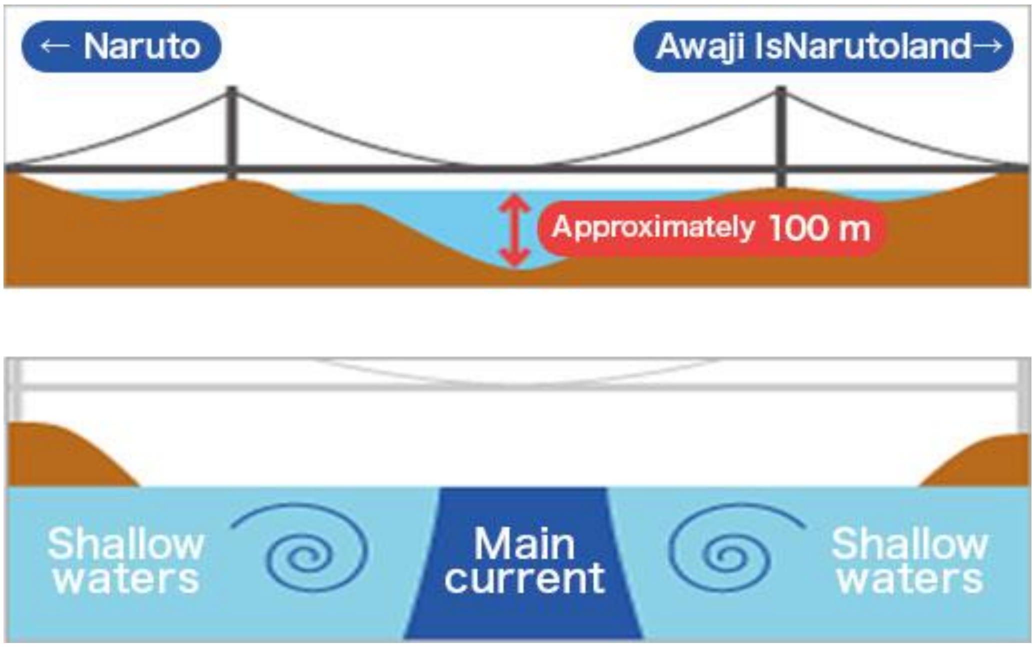
Whirlpools In addition, the changing of the tides can create another hazard known as a “whirlpool”. These are created when the water from two opposing currents meet and form a vortex. (This is NOT what happens in the sink or bathtub).



whirlpool_narutao_formation

Whirlpools become columns of circulating water, but without an “exit” so boats and ships are not “sucked down into them. Large ships can plow through them and small boats may be spun around by them. For a small boat this is very dangerous in that it can become swamped – that is water may flood into the boat and cause it to sink.

Whether or not the whirlpool appears and how rapidly it spins are a function of the tides. High tides and especially spring tides produce the most intense whirlpools. The figures given below are "highs". In some cases, these have become tourist attractions with boats taking passengers out to see the whirlpool "up close"

whirlpool_narutao_tourists

The largest whirlpools are Saltstraumen (23 mph) in Norway,

Whirlpool_Saltstraumen_Norway

Moskstraumen (17.3) also in Norway, although there are those who think this is more an “eddy” than a whirl pool

and Corryvreckan in Scotland found off the west coast between Jura and Scarpa. It has speeds of about 12 mph

Whirlpool_Corryvreckan

A dramatic encounter with Corryvreckan can be seen in the film I Know Where I’m Going. On the US/Canadian border lies Old Sow (17.1 mph) between Deer Island in New Brunswick and Moose Island, Eastport Maine. The US Coast Guard Station in Eastport regularly rescues boats that have gotten too close and do not have enough power to move them out of the current.

whirlpool_Oldsow

Near Awaji Island in Japan lie the Naruto whirlpools which have speeds of up to 12 mph.

Whirlpool_Naruto

Edgar Allen Poe’s Descent Into the Maelstrom and other fictional works have boats being sucked down into the whirlpool, but this is just fiction.

STORM SURGE

Storm winds cause storm surge by pushing the ocean up onto the shore. These are most intense with hurricanes. The speed and intensity of hurricane winds is measure by a scale called the SAFFIR SIMPSON HURRICANE SCALE

Scale Number (Category)	Sustained Winds (MPH)	Damage	Storm Surge
1	74-95	**Minimal:** Unanchored mobile homes, vegetation and signs.	4-5 feet
2	96-110	**Moderate:** All mobile homes, roofs, small crafts, flooding.	6-8 feet
3	111-130	**Extensive:** Small buildings, low-lying roads cut off.	9-12 feet
4	131-155	**Extreme:** Roofs destroyed, trees down, roads cut off, mobile homes destroyed. Beach homes flooded.	13-18 feet
5	More than 155	**Catastrophic:** Most buildings destroyed. Vegetation destroyed. Major roads cut off. Homes flooded.	Greater than 18 feet

There is a separate scale for tornados called the Fujita scale that has been enhanced.

Fujita Scale	
F–0	40–72 mph winds
F–1	73–112 mph
F–2	113–157 mph
F–3	158–206 mph
F–4	207–260 mph
F–5	261–318 mph

fujita-tornado-scale

Enhanced Fujita Scale	
EF–0	65–85 mph winds
EF–1	86–110 mph
EF–2	111–135 mph
EF–3	136–165 mph
EF–4	166–200 mph
EF–5	>200 mph

enhanced-fujita-tornado-scale

These are more intense, but more localized and can occur on the water where they form “water spouts”.

Water spouts

Hurricanes are winds around an extreme low-pressure area. The air being warmed and rising causes a low pressure. Winds then move into the low-pressure area moving to the right (counterclockwise) in the Northern hemisphere and the reverse in the Southern. This is the result of the Coriolis force or effect. Winds in the northern hemisphere veer to the right, in the southern hemisphere to the left.

This is caused by the fact that a sphere which is rotating moves faster near the "equator" than at the poles. At one foot from the pole, one can walk 360 degrees in a few steps, but at the equator the person would have to walk 24,000 miles or so. Since the world rotates on its axis once in approximately 24 hours, the part near the equator must cover about 1000 miles an hour, whereas at the poles it travels only a few feet in 24 hours.

If you imagine a line of skaters or dancers that is revolving around the center of the line, you realize the people toward then center move much slower than those at the outside. The people at the ends of the line must travel very fast while the people in the center go rather slowly. If the line rotates counter-clockwise (as the Earth does if you were to look down at the North Pole from space) the line of dancers/skaters would curve to the right as they try to catch up.

VIDEO OF SKATERS

If you looked at the Earth from outer space from over the South Pole, it would appear to rotate clockwise. A line of dancers/skaters rotating clockwise would bend to the left.

So hurricanes in the North rotate counterclockwise, since the air moving into the low pressure center begins to veer to the right.

Hurricanes season lasts officially from June 1 to Nov. 30. September is the generally to most active month. This because these are the times when the ocean temperature is higher. The hurricanes in the Atlantic begin as low pressure centers coming off the coast of Africa and then they move out over the ocean where they gain energy from the warm water. The air heats and rises causing the low pressure to drop even lower. Because of the pressure gradient (the difference in pressure horizontally in the air) the air moves into the lower pressure areas (air moves from higher to lower pressure). As it move in, the Coriolis effect causes the air moving in moves to the right, and the low pressure center has a counter clockwise turn. The water produces moisture as well and the low pressure area may intensify and when winds reach 74 miles an hour, the event is labeled a hurricane.

The eye is center of the rotation and the area immediately around it is the eye wall. On land, the eye is rather calm, but on the ocean it is an area of violent wave activity since the waves are formed by wind direction and the winds are blowing from all directions around it.

For ships at sea, being in the eye of the hurricane is the worst place to be. Waves are large and come from all directions.

On September 30th of 2015, the 791-foot long freighter, El Faro, at 791 feet long, left Jacksonville Florida en route to Puerto Rico with 391 shipping containers. AT the time, a tropical storm Joaquin in the Atlantic was building and expected to become a hurricane by the next day. The ships course would have taken it into the path of the hurricane which was rapidly intensifying. The ship took on water, began listing and then lost propulsion. The Emergency Position Indicating Beacon (EPRIRB) sent messages as to where the ships was. Two databases indicted slightly different positions, and one put the vessel in the eye wall just before all contact was lost.

Hurricane Hunters and the US Coast Guard aircraft began a search for El Faro and later they were joined by a Coast Guard vessel and a Coast Guard helicopter, but no trace of the ship was found. On October 3rd while flying in hurricane force winds, a life ring was recovered. Debris and some bodies and a damaged life boat were found. On Oct 7th the search was discontinued. On Oct 31 soundings located a vessel at 15,000 feet deep which turned out ot be the ship.

There were 33 people on the ship 28 Americans and 5 Poles. All hands were lost.

When hurricanes come on shore, they often produce large storm surges in which the water level rises dramatically. If the coast is steep, the water may not move far inland, but if the shore is gently sloping the water may move quite a distance inland. Current thoughts are that under the "right" circumstances, storm surge could raise the water level in Brooklyn so that there would be water as far inland as Ave. I.

Since the hurricane is rotating in a counterclockwise direction being on the NE corner is the worst part of the storm. At that point the water is pushing higher into the land. On the NW side, the winds are pushing away from the land. In addition to the shape of the shore line, and which part of the storm is arriving (NE or NW quadrant), there are other factors to consider. Among these is the forward speed of the storm, the speed of the wind, the nature of the land where the hurricane comes ashore (rocky, sandy etc.) and the amount of rain. Clearly a slow moving storm stays longer and hence dumps more rain. Attempts to block incoming seas imitate some natural phenomena like sand bars by building breakwaters - a kind of wall in the water. Some hurricanes have overtopped the walls, or destroyed the walls. Such walls however have an effect on beach erosion. Some of the land has plant life which has long roots and help stabilize the ground and keep it from washing away. In some cases the building of houses on the shore line leads to the loss of such plants and the destruction of sand dunes which may also help control water movement.

On Sept. 8th 1900 Galveston was struck by a hurricane struck causing incredible damage.

The city of Galveston was a hub of businesses with a population of about 36,000 people. It has a natural harbor which helped its growth. It was built basically on a sandbar, with highest point being some 8.7 feet above sea level. Some concerned citizens had suggested the building of a seawall (a wall on the beach basically) to protect the city but the majority of the population thought it unnecessary and so one was not built. There had been a good deal of building going on in the city which led to the destruction of sand dunes to fill in low areas of the city and in this way what protection there was destroyed. There had been storms before which the city had survived which led to some complacency. Isaac Cline of the weather bureau thought it would not be possible for the city to be struck by a hurricane. The weather service at that time had little information about weather at sea and relied on reports from ships.

Cuba forecasters were predicting the storm that they were experiencing, would head toward San Antonio, but the US weather bureau argued that the storm would curve and strike Florida. Isaac Cline's role and that of his meteorologist brother Joseph have been a bone of contention with some people crediting them with giving a hurricane warning before the central office approved it, while others claim their role was negative in that they resisted the idea of building the sea wall.

When the storm surge hit, the waters rose over 15 feet - almost twice the depth of the highest piece of land. The entire island was submerged and over 3,600 hundred buildings were destroyed. Estimates of the death toll rose to somewhere between 6,000 and 12,000 people (official reports claim 8,000) making it the greatest natural disaster to strike the U.S.

Disposing of the dead was a major problem and bodies were weighted and placed on barges and dumped at sea. The currents brought many of the bodies back to shore and the survivors were reduced to building funeral pyres and burning the bodies. This went on day and night for weeks after the storm.

It is reported that there were more people killed in this storm than in all the other cyclones to have struck the US.

CURRENTS:

Currents are moving water. Major currents are driven by wind and tides and differences in density. As a result currents can be on the surface or under water

So how does the wind operate? Hot air at the equator rises and starts to move north in the N. hemisphere and south in the southern hemisphere. At about 30 degrees from the equator, the air has cooled enough and become dense enough to sink down to the ground. Since the cool air is denser than the warm air toward the equator, the pressure gradient moves the air south.

Currents also operate as heat transport.

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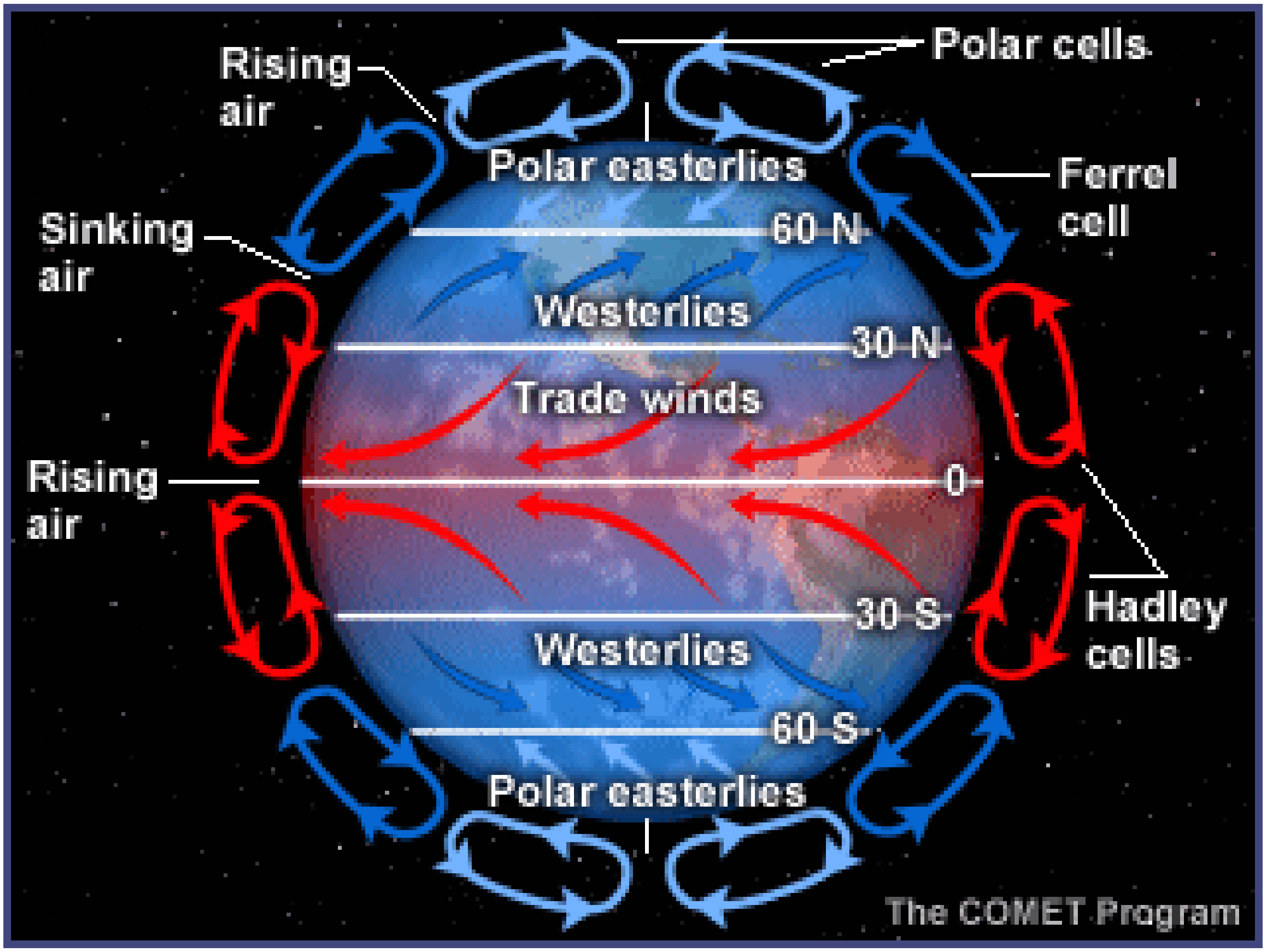
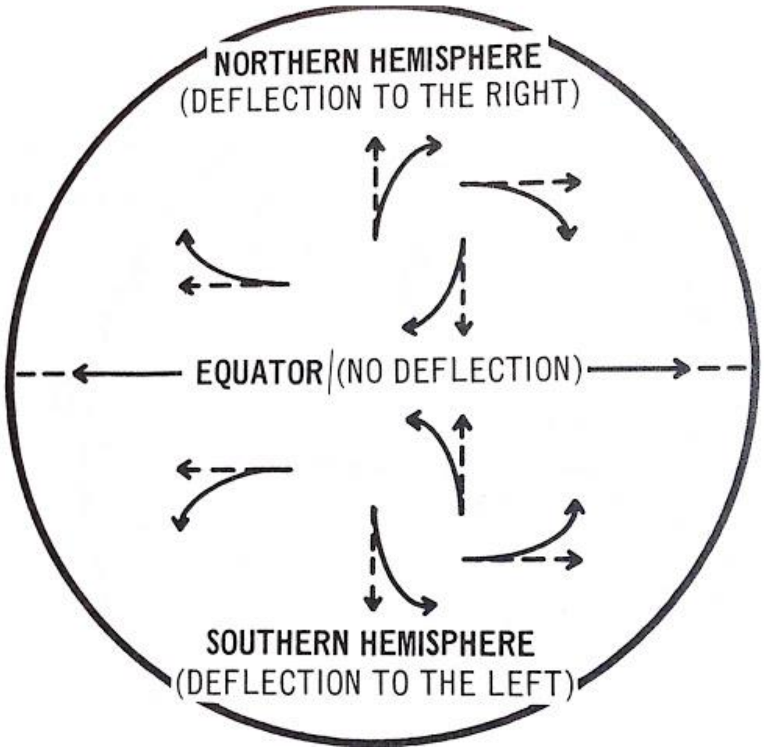


At the poles, the cold air over the poles sinks and moves south towards the warmer air. As it moves south it heats and rises at about 60 degrees from the equator. The air between the Hadley Cell and the Polar cell is moved like a gear between the two.

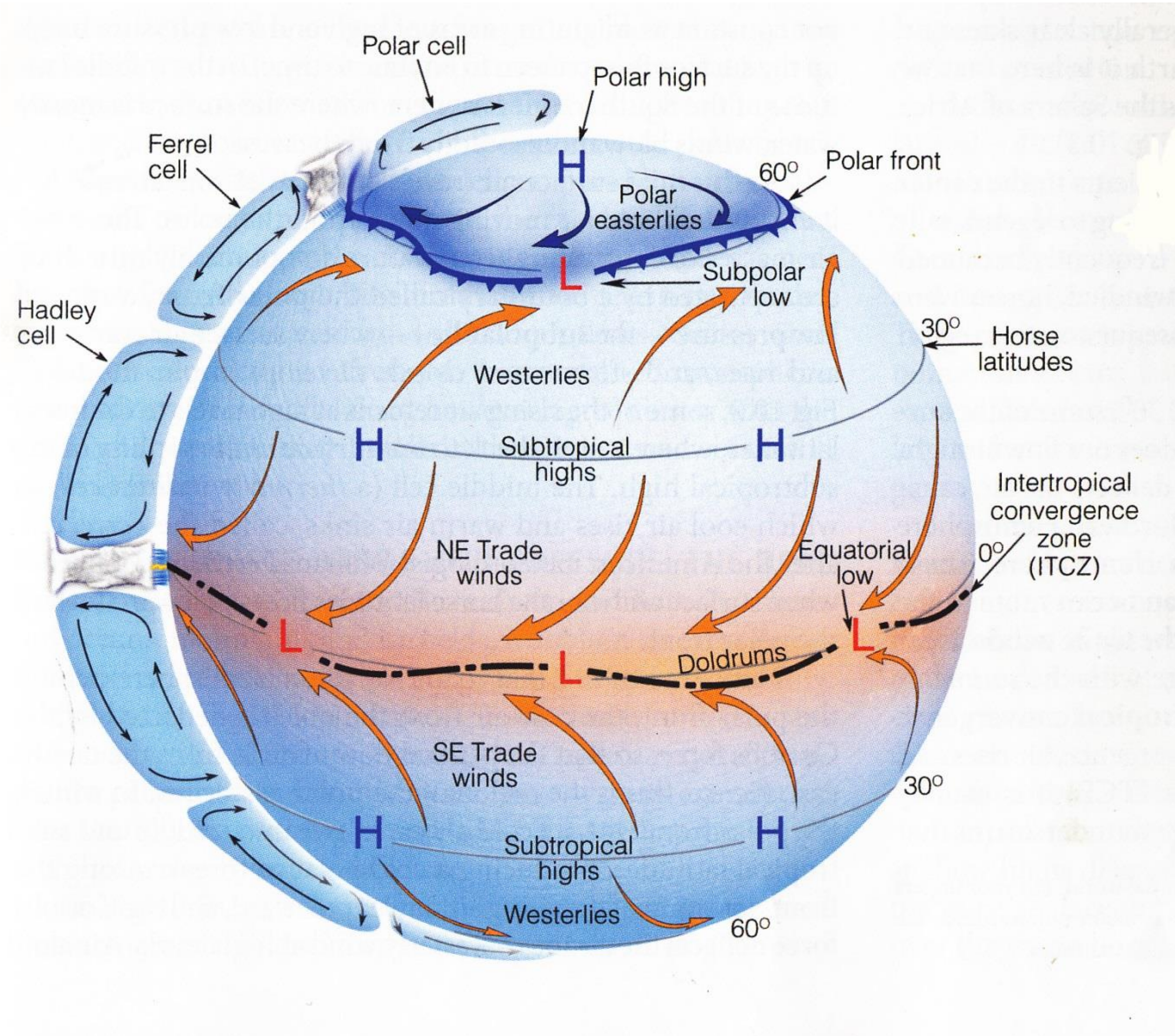
As the air on the surface of the earth moves north and south, the Coriolis Effect takes over and the winds in both directions veer off to the right.

Diagram 2



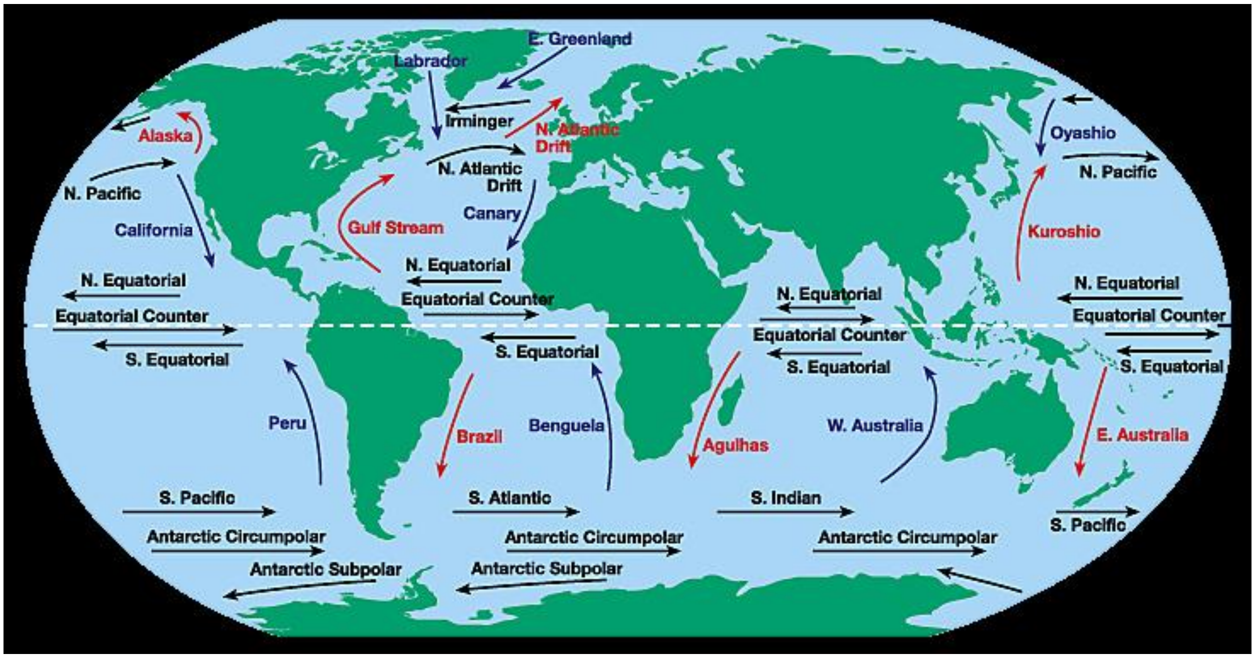
coriolis

This gives the general global wind patterns.



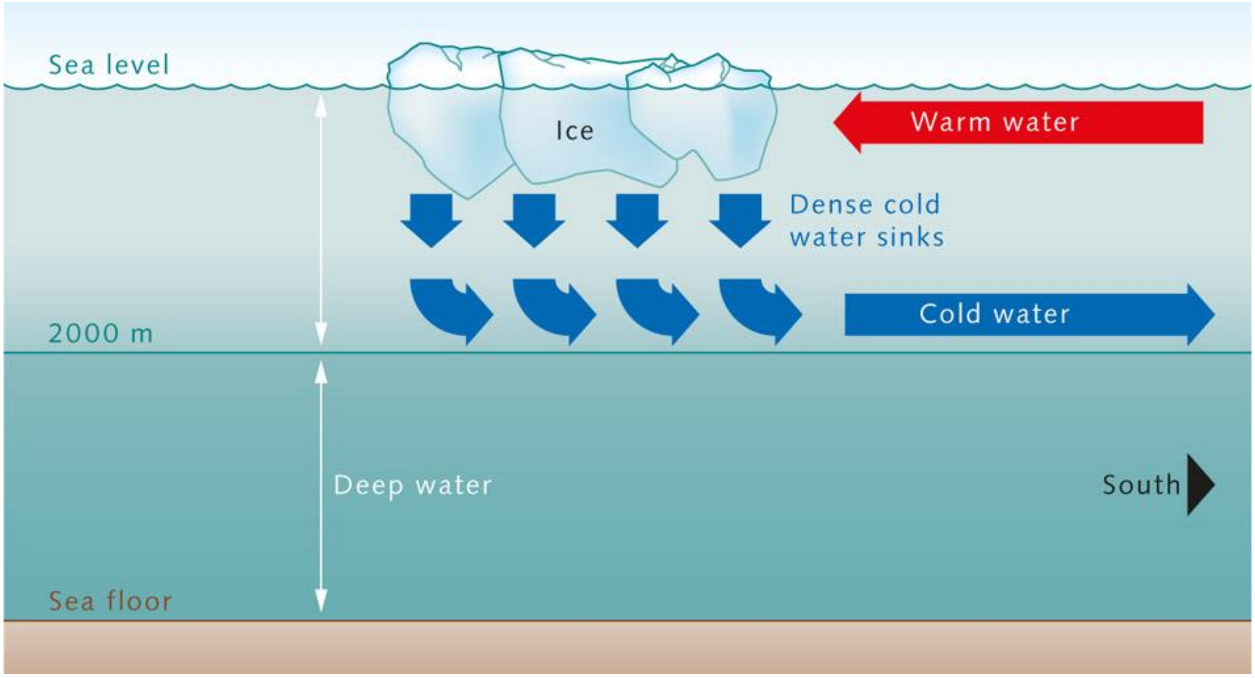
Hadley cells

As a result, ocean currents follow the pattern of the winds

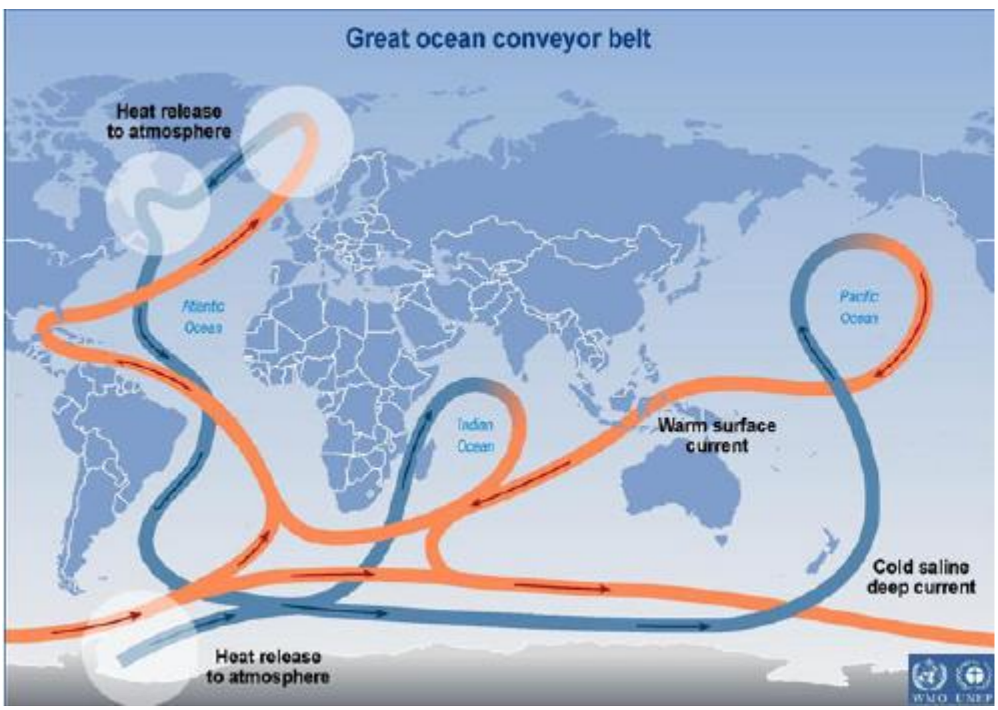


surface_currents_lg

Gulf Stream (surface) and Polar conveyer belt transport (under water) You should note at this point that there are currents that run on the surface of the ocean and those that run deep in the ocean. These have great importance in weather



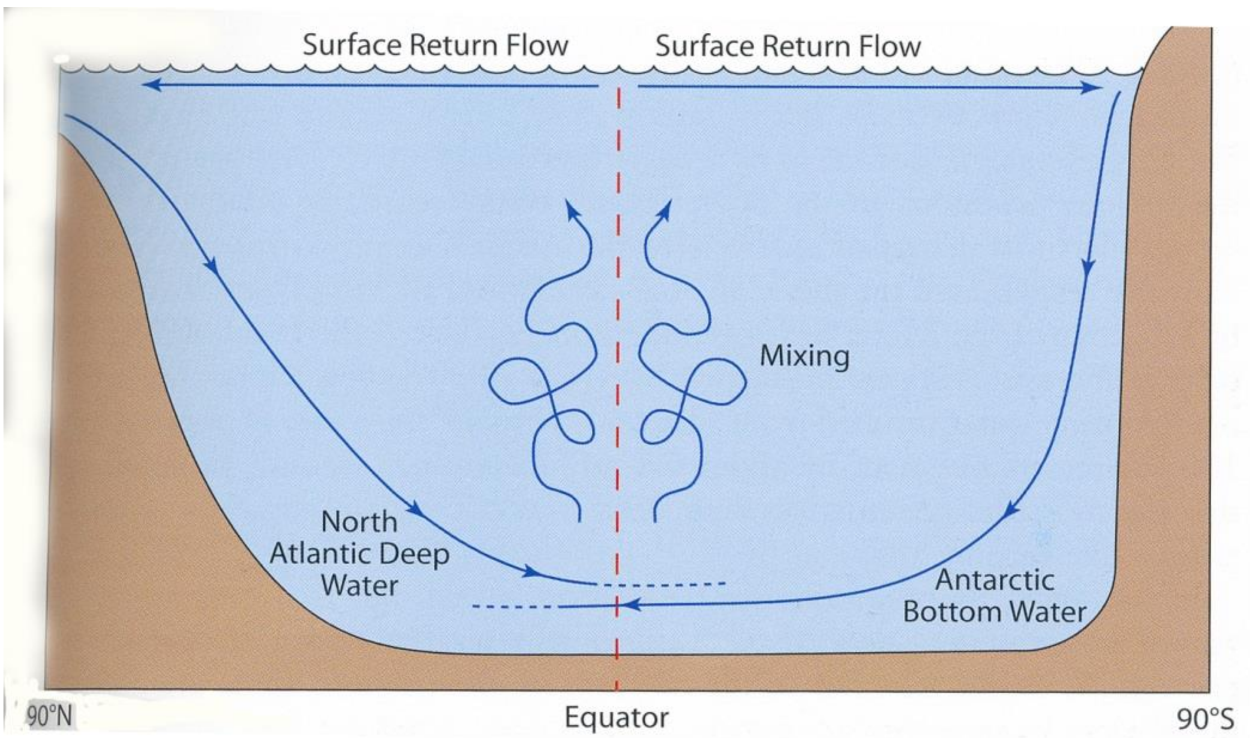
convection-current



conveyor belt

In the polar regions, the water starts to freeze and sheds salts and also becomes denser and sinks. The cold water moves along the bottom of the ocean where it ultimately meets more cold water coming from the Antarctic. Some of this is pushed upwards and mixes with the warmer water above. At the surface, this water is pushed in a northerly direction in the north and a southerly direction in the south. The north moving waters, affected by Coriolis move to the right and bring warm tropical waters across toward Europe in the Gulf Stream.

This accounts for relatively warmer climates in Europe at the same latitudes where it is colder in the US and Canada.



Polar currents

RIP CURRENTS (are not tides) Danger to swimmers who do not understand them


ESCAPE
ESCAPE
ESCAPE
ESCAPE
CURRENT
RIP CURRENT
CURRENT