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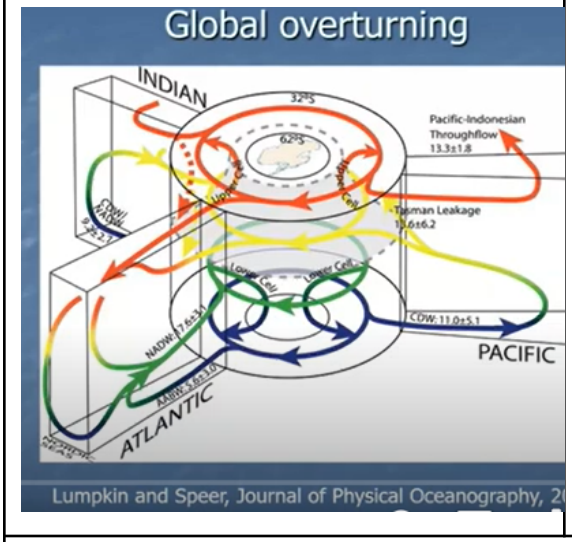
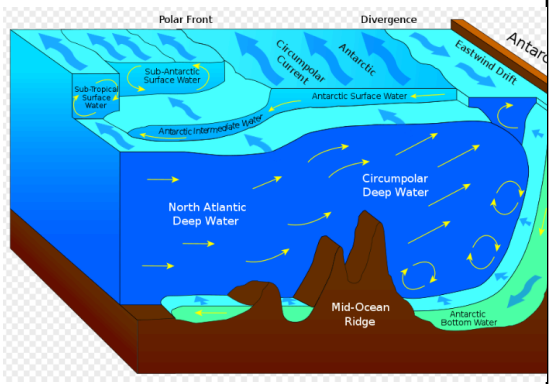
Climates are driven by how the sun's energy (see CSSG-2.1) is moved around the globe. The **Atmosphere** has a complex system of currents for moving about **60% of that energy** - which we will address in due time. Likewise, the **Oceans** are responsible for around **40% of our global climate** by moving energy with their currents**.**

In CSSG-2.5 we saw the continents shifting over the last 50 million years into something we would recognize today. **Specifically with respect to the ocean currents**, the Isthmus of Panama closed and the Antarctic continent separated from South America and Australia, providing a clear path around the Antarctic continent. **These had profound impacts, as we saw in CSSG-2.6 with the Amazing CO_2 Suckers**.

What we will NOT study this time:

In this material on the Great Conveyor,**we NOT go "in-depth" (couldn't resist that!)**. To be clear, we will complete **ONLY** a **top-level survey.** We will NOT try to make a lot of sense of:	Also, we will **NOT sort through** the complexities of the Antarctic currents, as truly interesting as they are. We will touch on them later, when we explore concerns about Antarctic ice and glacier melting and sea level impacts:
	
https://en.wikipedia.org/wiki/Antarctic_bottom_water# https://www.nature.com/articles/s41558-023-01695-4	

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What we WILL study this time:

Rather than getting totally lost in details, as usual there are some simpler things to notice first:

1. **The force that moves the Conveyor around is Gravity (!).** Winds move the surface waters generally independently of the Conveyor.
    a. If water is **heavier (denser)**, it falls to the bottom and flows where gravity takes it, just as water flows on the surface of the land
    b. If it is **less dense** than the water around it, it moves upwards.
    c. If dense water has plunged downward, or less dense water has risen, other **water must move sideways to fill the hole**
2. **The global path of the conveyor simply responds to the above**.

So, what makes water more or less dense? There are two components:

1. **Temperature** - colder water contracts a little, so more atoms fit in a given volume. So **it is more dense**.
2. **Salinity** - Salt fits in-between the H_2O molecules, so more atoms fit in a given volume. Again, **it is more dense**.

We saw this in action in CSSG-2.6 with the Katabatic winds off of Antarctica.

- The raging winds blow ice away from the coast;
- the exposed water gains salinity because of the winds and new ice formation taking away freshwater, and it also gets colder from the wind;
- This very cold and very salty water is much more dense than the surrounding water, so plunges to the abyss - forming Antarctic Bottom Water.
- Less dense (from warmth and precipitation) water moves in from the side to replace the plunging water.

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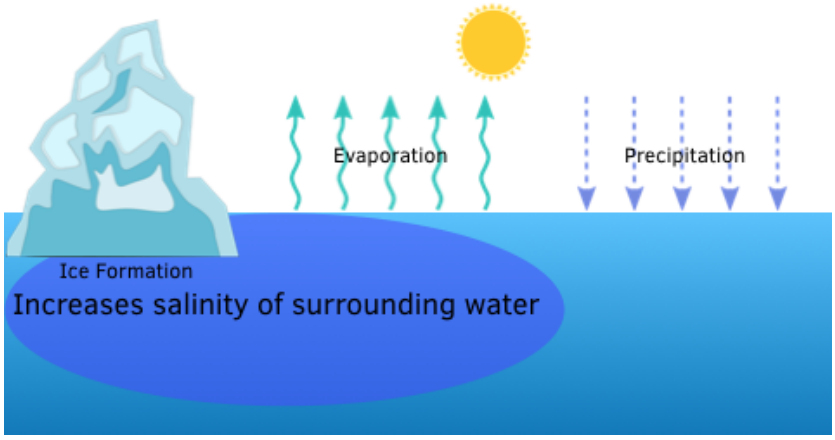
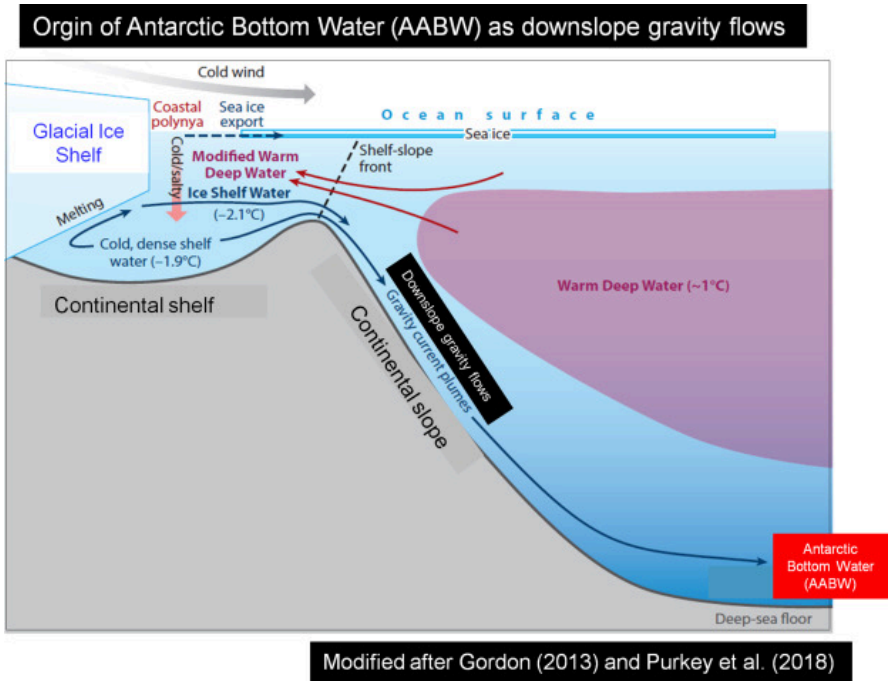


We can see these effects in the following graphic.



Antarctic Bottom Water (AABW) is the world's most voluminous water mass, comprising 30-40% of the volume of the global ocean[1]. AABW circulates from its formation sites around Antarctica throughout the global ocean as a part of the lower limb of the global overturning circulation[2] and plays a critical role in regulating Earth's climate by storing and transporting heat and carbon in the abyssal ocean[3,4]. The Weddell Sea is a key region for AABW production, being responsible for up to 50% of total AABW production[5].

https://www.sciencedirect.com/topics/earth-and-planetary-sciences/antarctic-bottom-water

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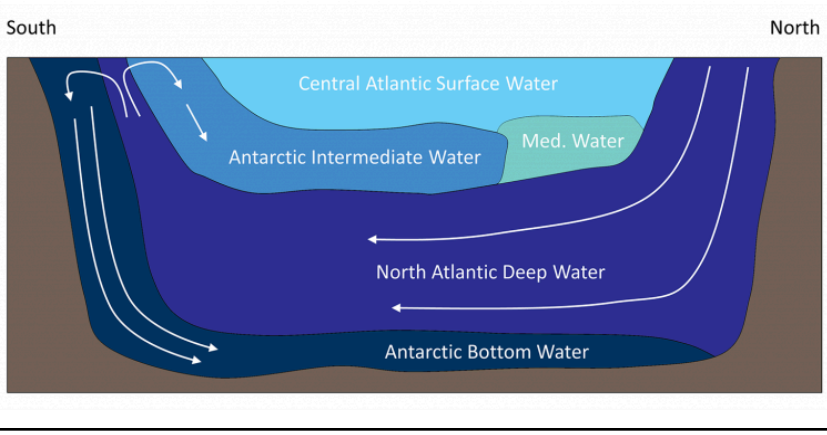
Expanding to a North-South perspective (ignoring Atlantic vs. Pacific vs. Indian Oceans) we can start to see motion sideways and up and down:



https://rwu.pressbooks.pub/webboceanography/chapter/9-8-thermohaline-circulation/

Given all the above context, I am now providing a tutorial presented helpfully by the National Oceanic and Atmospheric Administration (NOAA) in https://oceanservice.noaa.gov/education/tutorial_currents/05conveyor2.html

The Global Conveyor Belt

Thermohaline circulation drives a global-scale system of currents called the "global conveyor belt." The conveyor belt begins on the surface of the ocean near the pole in the North Atlantic. Here, the water is chilled by arctic temperatures. It also gets saltier because when sea ice forms, the salt does not freeze and is left behind in the surrounding water. The cold water is now more dense, due to the added salts, and sinks toward the ocean bottom. Surface water moves in to replace the sinking water, thus creating a current.

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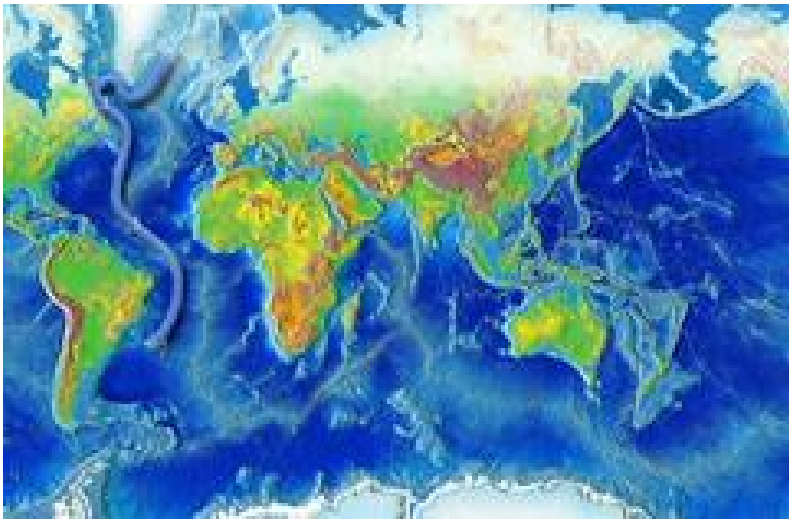
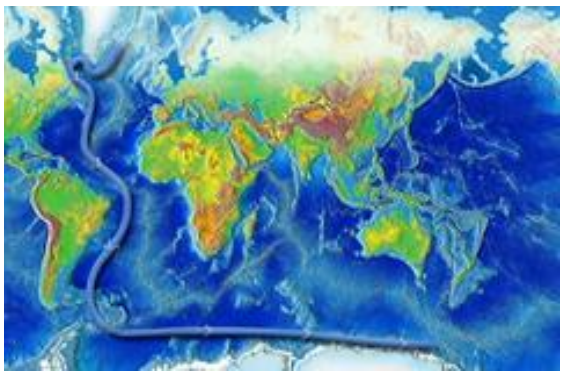
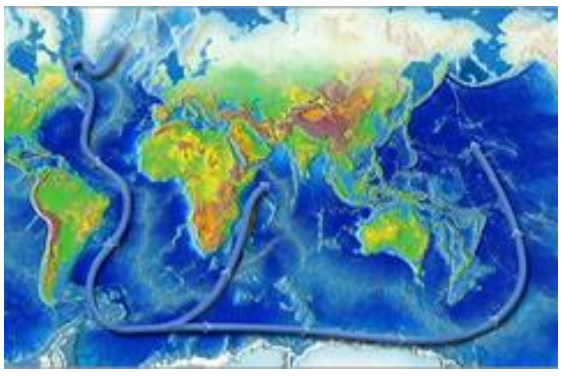


Cold, salty, dense water sinks at the Earth's northern polar region and heads south along the western Atlantic basin.

This deep water moves south, between the continents, past the equator, and down to the ends of Africa and South America. The current travels around the edge of Antarctica, where the water cools and sinks again, as it does in the North Atlantic. Thus, the conveyor belt gets "recharged." As it moves around Antarctica, two sections split off the conveyor and turn northward. One section moves into the Indian Ocean, the other into the Pacific Ocean.

	
The current is "recharged" as it travels along the coast of Antarctica and picks up more cold, salty, dense water.	*The main current splits into two sections, one traveling northward into the Indian Ocean, while the other heads up into the western Pacific*

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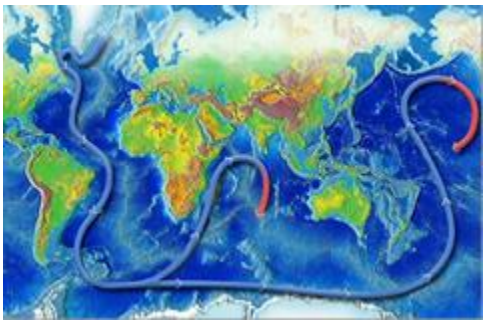
These two sections that split off warm up and become less dense as they travel northward toward the equator, so that they rise to the surface (upwelling). They then loop back southward and westward to the South Atlantic, eventually returning to the North Atlantic, where the cycle begins again.



The two branches of the current warm and rise as they travel northward, then loop back around southward and westward.

The now-warmed surface waters continue circulating around the globe. They eventually return to the North Atlantic where the cycle begins again.

The conveyor belt moves at much slower speeds (a few centimeters per second) than wind-driven or tidal currents (tens to hundreds of centimeters per second). It is estimated that any given cubic meter of water takes about 1,000 years to complete the journey along the global conveyor belt. In addition, the conveyor moves an immense volume of water—more than 100 times the flow of the Amazon River (Ross, 1995).

The conveyor belt is also a vital component of the global ocean nutrient and carbon dioxide cycles. Warm surface waters are depleted of nutrients and carbon dioxide, but they are enriched again as they travel through the conveyor belt as deep or bottom layers. The base of the world's food chain depends on the cool, nutrient-rich waters that support the growth of algae and seaweed.

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Punchline!

If you want to impress your friends, you're only one step away!

Learn this new term (I finally internalized this term only in the last year - you can do it TODAY!)

The Great Conveyor current is propelled by

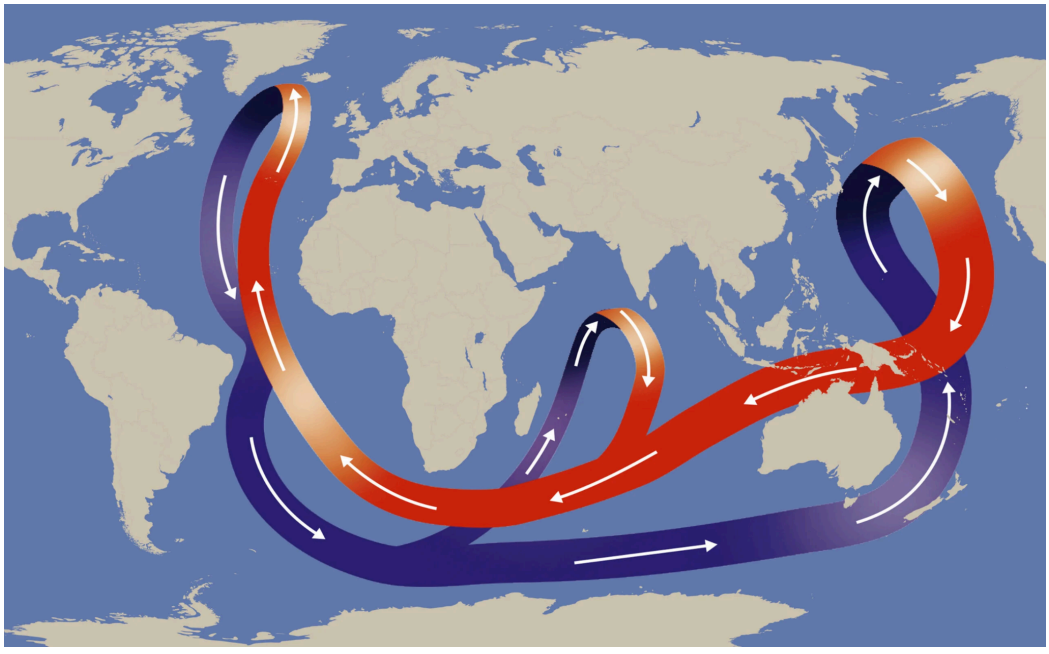
Temperature = "Thermo"

And

Salinity = "Haline" Greek "hals"=salt, brine

Say it three times with your eyes closed:

Thermohaline Circulation !



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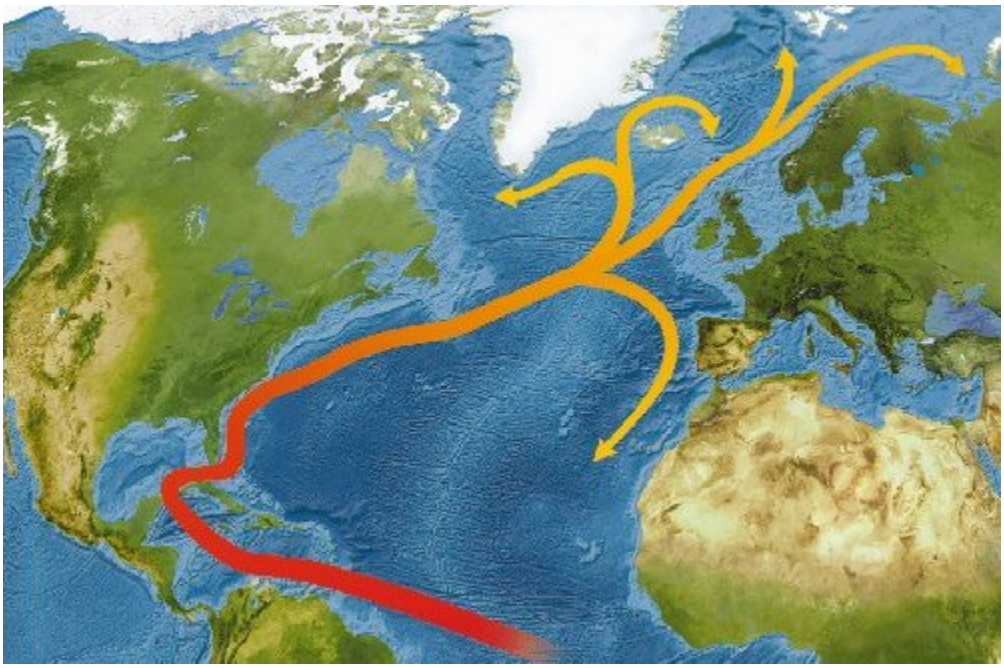
And, Joe Lankford, you and Sweden are welcome!



https://www.pik-potsdam.de/~stefan/thc_fact_sheet.html