ocean currents and the Pacific Garbage Patch

photo: Scripps Institution of Oceanography

The image above shows a net tow sample from the Pacific Garbage Patch. The sample contains small fish and many small pieces of plastic. The Garbage Patch is primarily composed of this small plastic "confetti" suspended throughout the surface water of the North Pacific Gyre, and is not a island of trash as suggested by some media outlets. The region where the trash converges in the center of the North Pacific Gyre, in a region where surface currents are weak and convergent, thus concentrating large amounts of trash in an area estimated to be close to the size of Texas.

With this slide I often show a video clip about the Garbage Patch. Although the links may change, here is one from ABC that I've used several times:

www.youtube.com/watch?v=OFMW8srq0Qk

this video is a bit over the top but it gets the point across.

There is additional information from Scripps Institution of Oceanography SEAPLEX experiment:

http://sio.ucsd.edu/Expeditions/Seaplex/

and several videos on youtube.com by searching the phrase "SEAPLEX"

Pacific garbage patch

- the worlds largest dump?
- filled with tiny plastic "confetti"

large plastic debris
from the garbage patch


photo: Scripps Institution of Oceanography

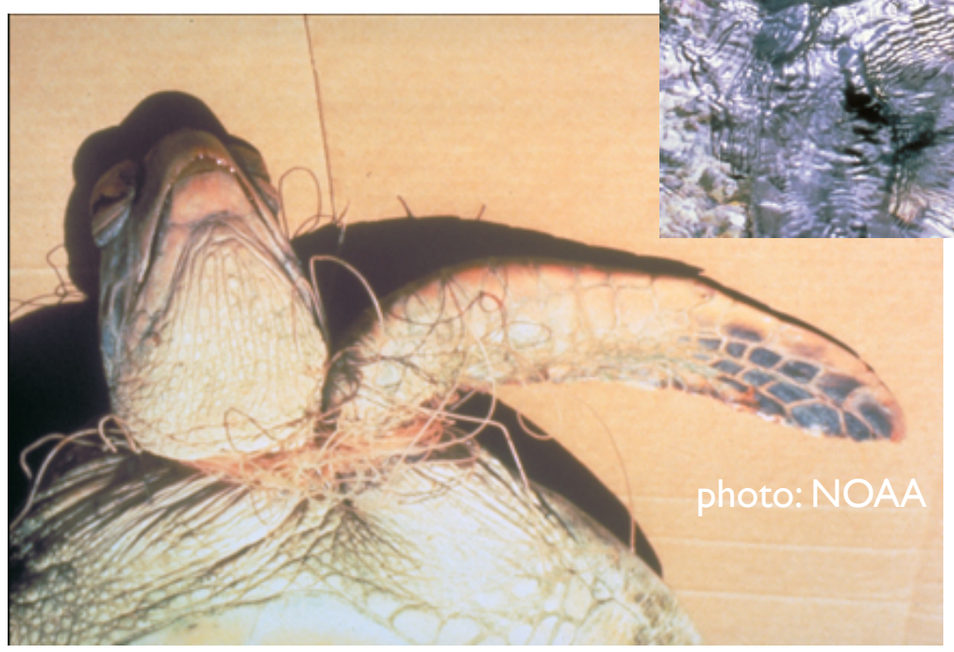
tiny plastic bits


photo: Scripps Institution of Oceanography

little jellyfish

These are some of the things you find in the Garbage Patch. The large pieces of plastic, such as bottles, breakdown into tiny particles.

Sometimes animals get caught in <u>large pieces</u> of floating trash:

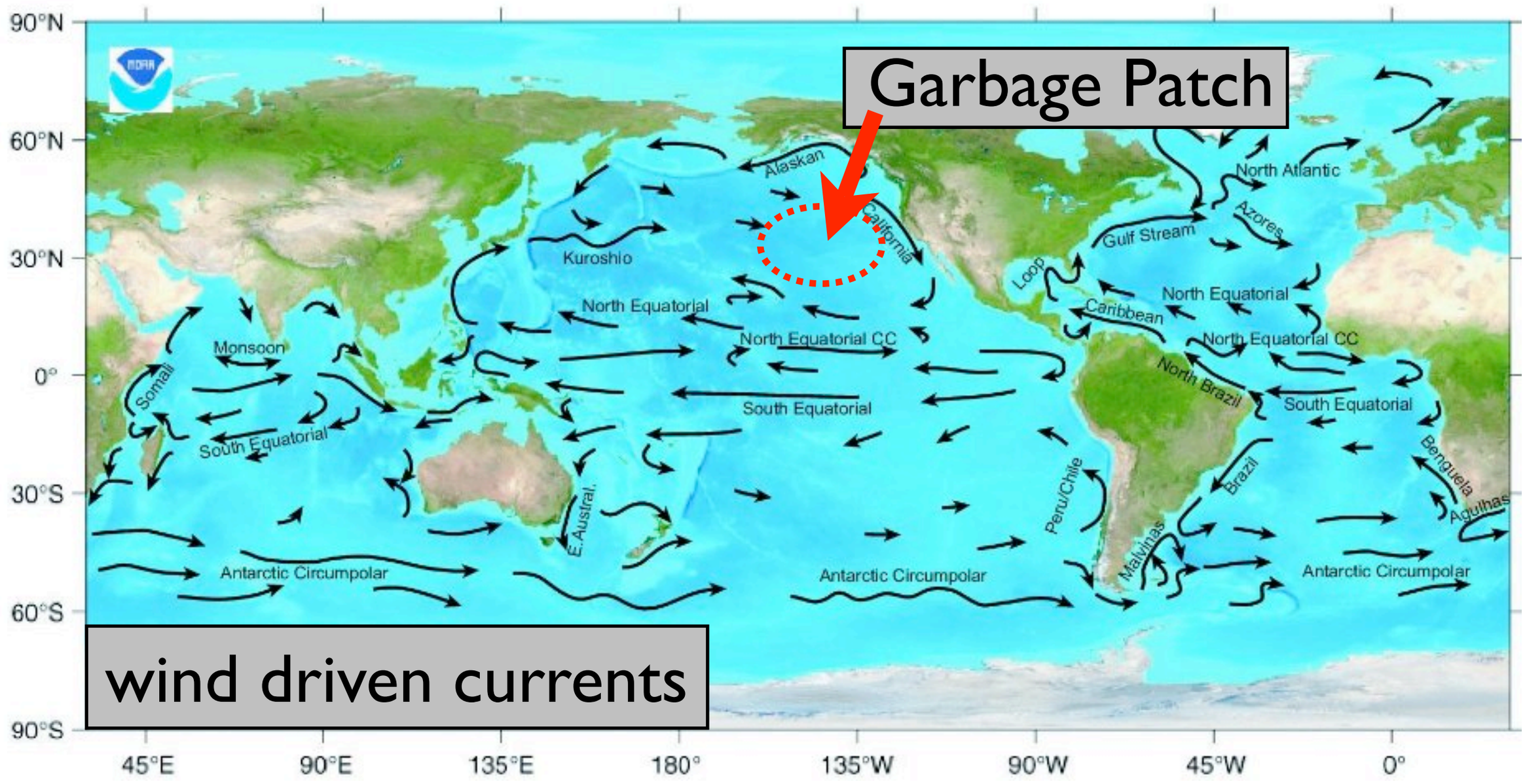


How do plants and animals interact with small <u>small pieces of plastic</u>?

Trash in the ocean can cause various problems for the organisms that live there. Animals can get tangled in pieces of rope, fishing line, rings off bottle caps, and other trash that can kill them. The pictures above are graphic, but common examples of this. Although the negative effects of large trash have been well documented, the effect of tiny plastic particles suspended throughout the water column on ocean organisms is unknown. Ongoing studies indicate that fish and other organisms may be eating the plastic, or growing on plastic as in the picture above. There is some concern that chemicals from ingested plastic may make their way up the food chain to commercially fished species that humans eat (e.g., tuna).

There is a lot of trash in the middle of the ocean, but how did it get there?

OCEAN CURRENTS

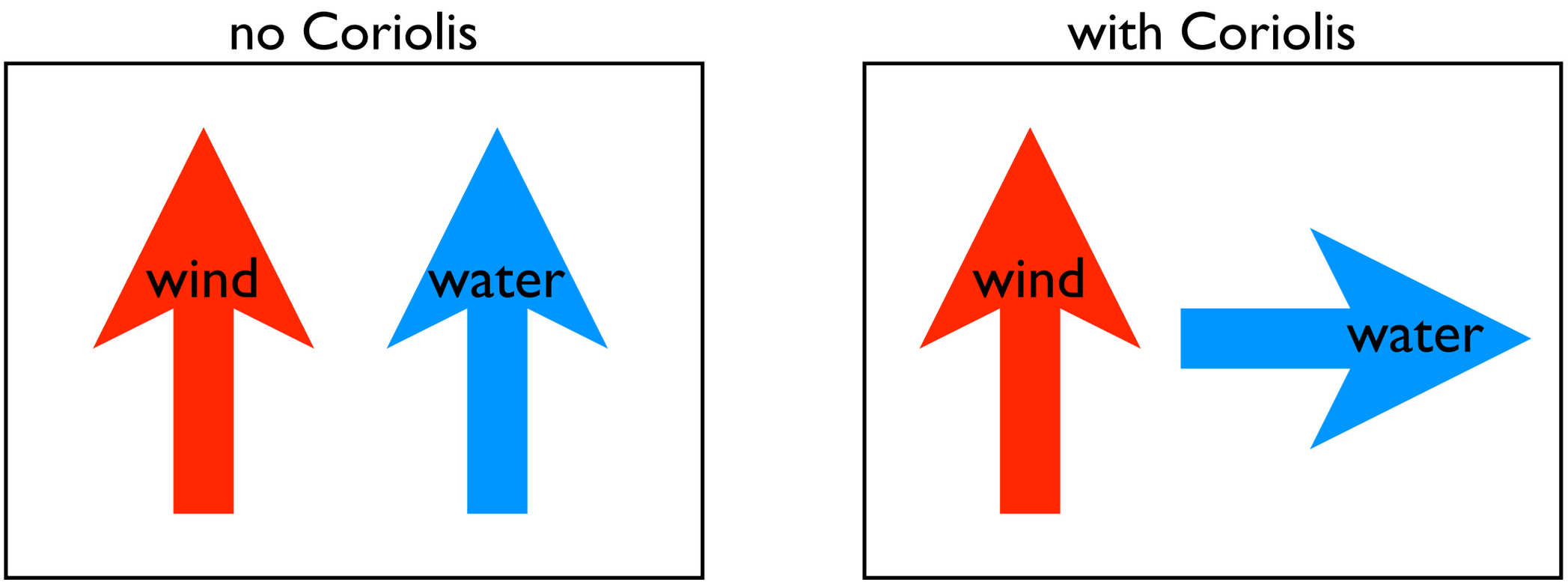


The Pacific Garbage Patch is used as motivation for studying ocean surface currents. Currents at the surface of the ocean are primarily wind driven. Some students hold the misconception that tides are the driving force behind ocean currents, and while this might be true in coastal inlets and a few places along the coast, the majority of the oceans surface currents are wind forced.

The Garbage Patch resides in an area with weak currents (indicated above) where plastic particles congregate.

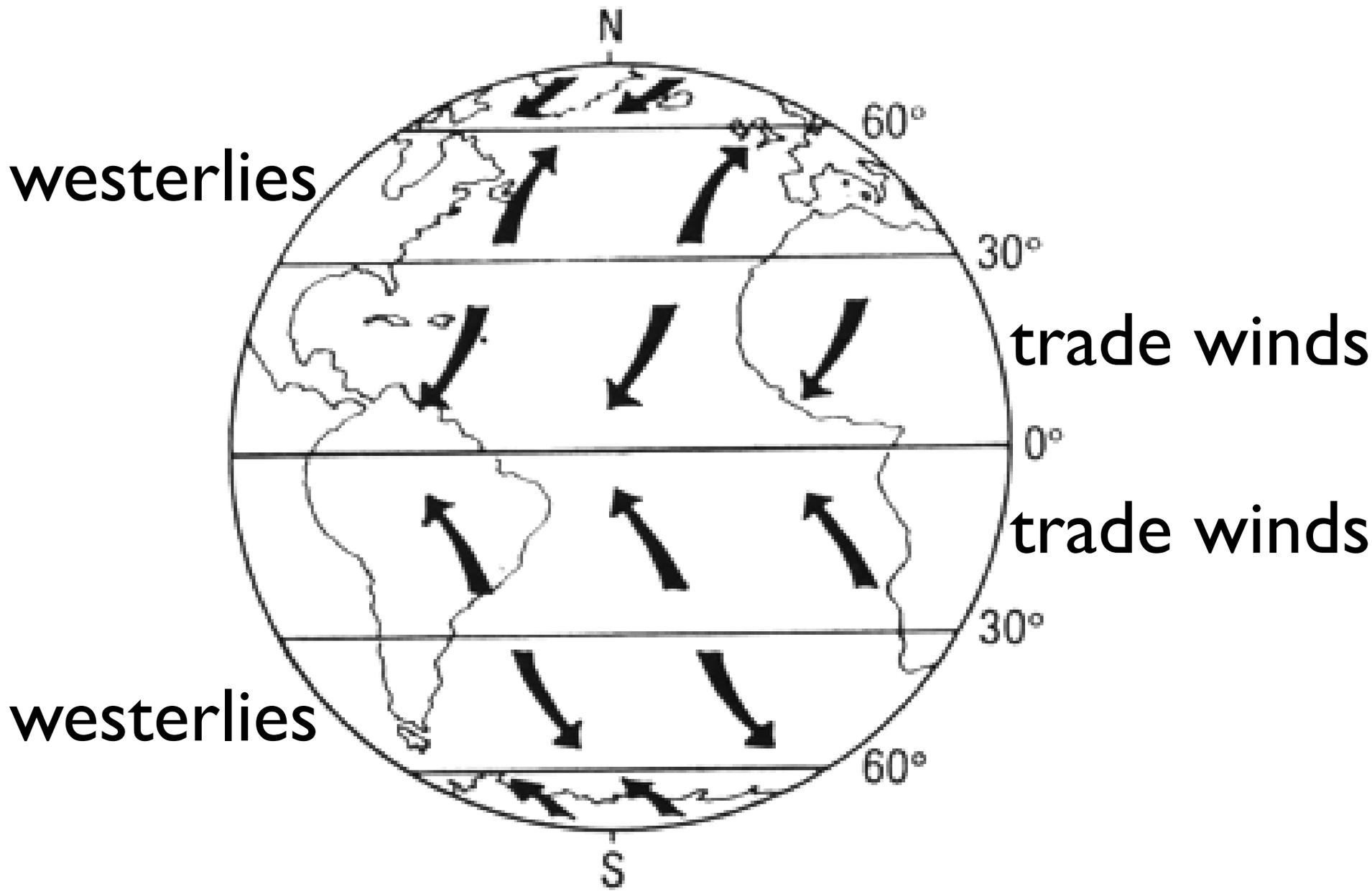
wind driven currents

Wind drives most of the currents near the surface of the ocean.

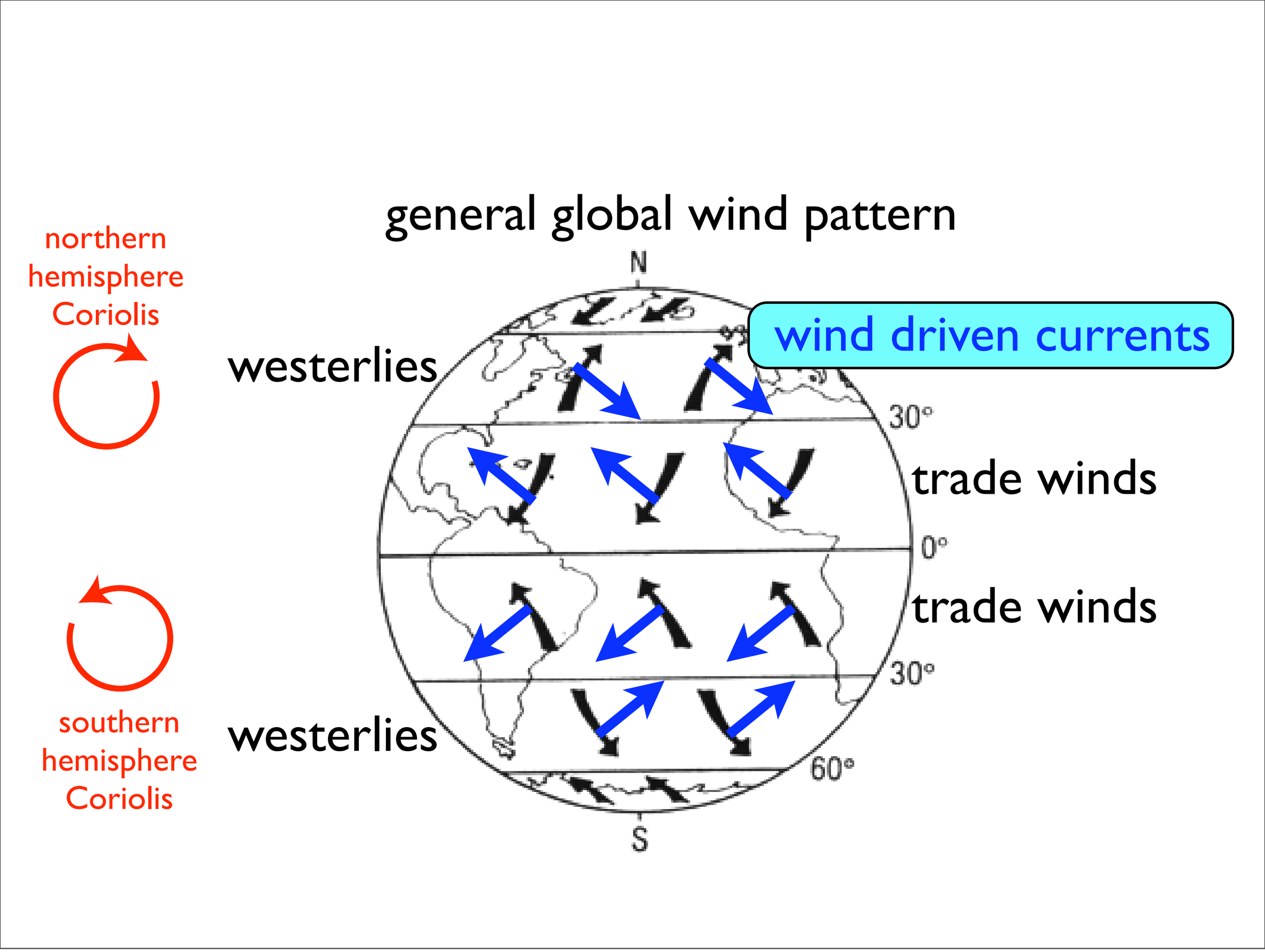


Wind blowing across the ocean exerts a stress on the water's surface, forcing the water in the same direction as the wind. However, the Coriolis Effect bends the water's path to the right (in the Northern Hemisphere). Water as the very surface of the ocean moves at a 45 degree angle to the wind, causing a stress on the water below the surface, and the subsequent layers move at greater and greater angles. This forms a vertical velocity profile the spirals downward from the surface called the Ekman Spiral. The vertically integrated transport is at 90 degrees to the wind direction. Depth of the surface driven current spiral is called the Ekman depth and typically varies from 50-100m deep. This discussion is usually too advanced for a 9th grade earth science class, so I simplified the concept to "water is transported at 90 degrees to the wind."

general global wind pattern

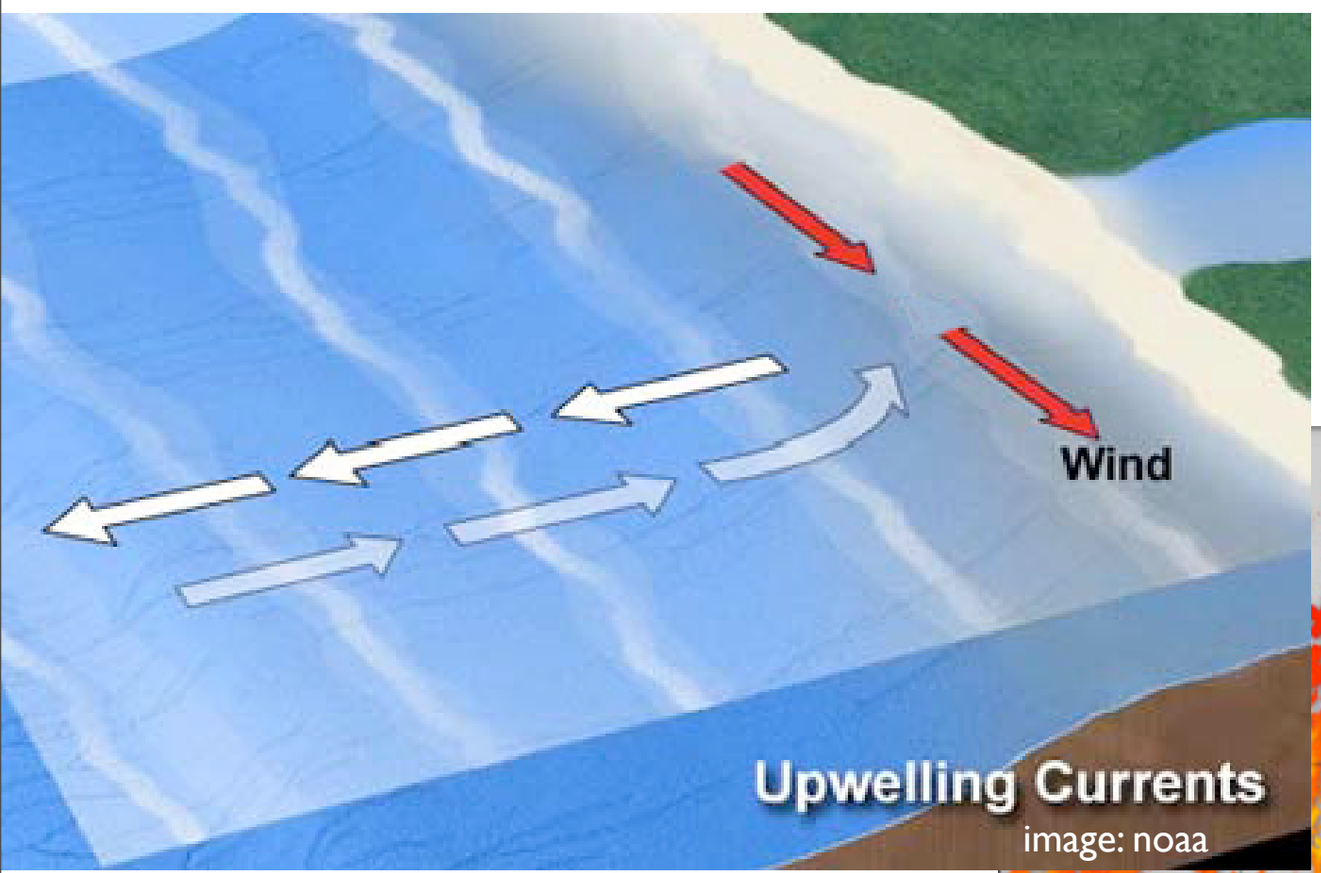


Ask students to predict which direction the currents flow given the wind field above.



This is an example of what the students will do in the activity. The water flow is 90 degrees clockwise to the wind in the Northern Hemisphere, and 90 degrees counter-clockwise to the wind in the Southern Hemisphere. In a very general sense, the trade winds and westerlies force clockwise surface flow around the northern ocean gyres and counter-clockwise surface flow around the southern ocean gyres. This is slightly complicated by geostrophy (balance between Coriolis and pressure gradients), but that is beyond the scope of this lesson. Students should understand the basic idea that surface currents are wind driven and Coriolis plays an important role.

wind driven coastal upwelling



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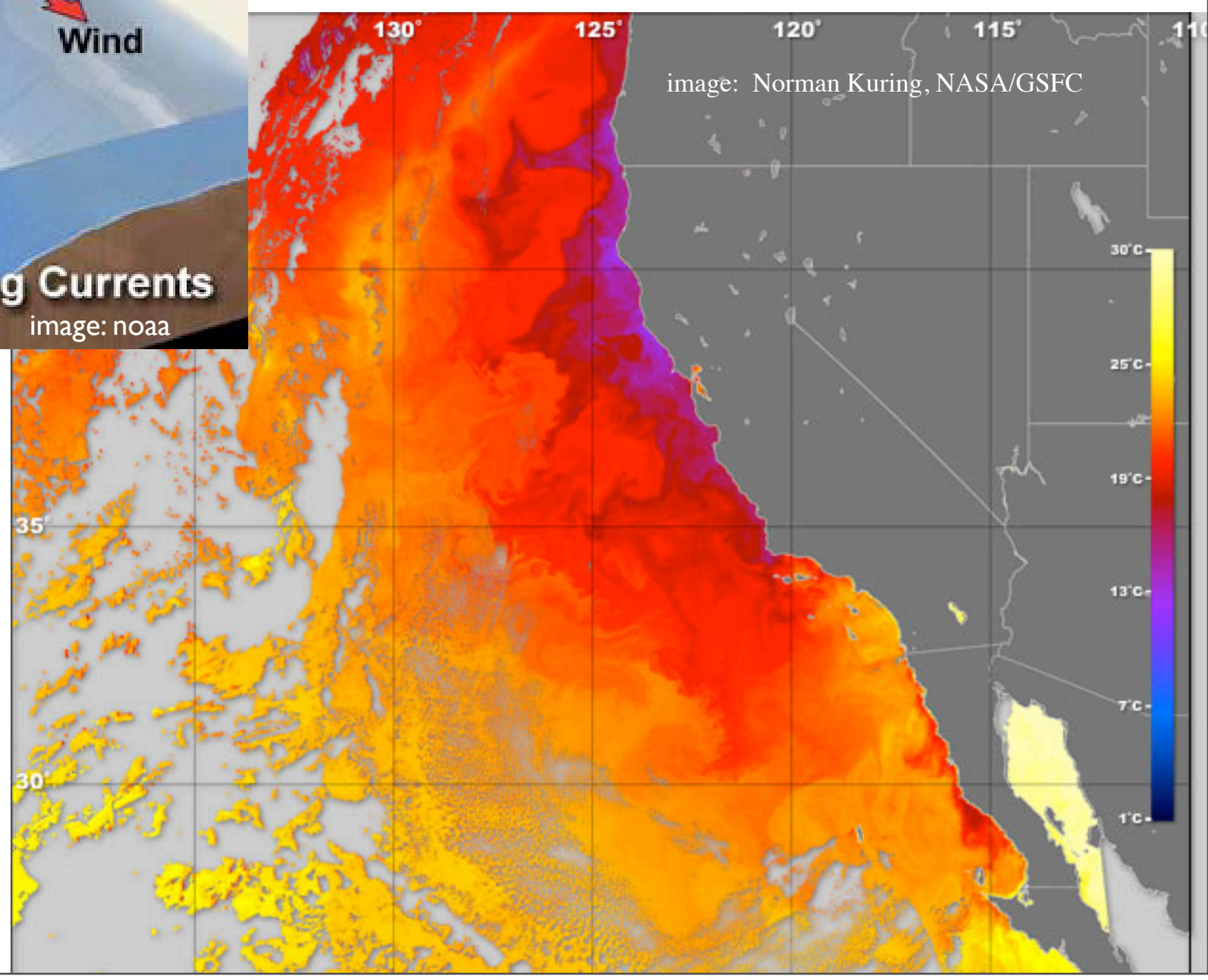

image: Norman Kuring, NASA/GSFC

Wind driven currents near the coast have special properties because of the coastal boundary. When wind blows parallel to the coast the surface water is either transported towards or away from the coast. In the top-left panel the wind forces surface water away from the coast that must be replaced by water from below. This wind forced upwelling brings cold nutrient rich water to the surface and is responsible for some of the most productive fisheries in the world.

Lower-right panel: north-westerly wind along the California coast causes strong upwelling, indicated by cold water rising to the surface very close to the coast (purple colors).