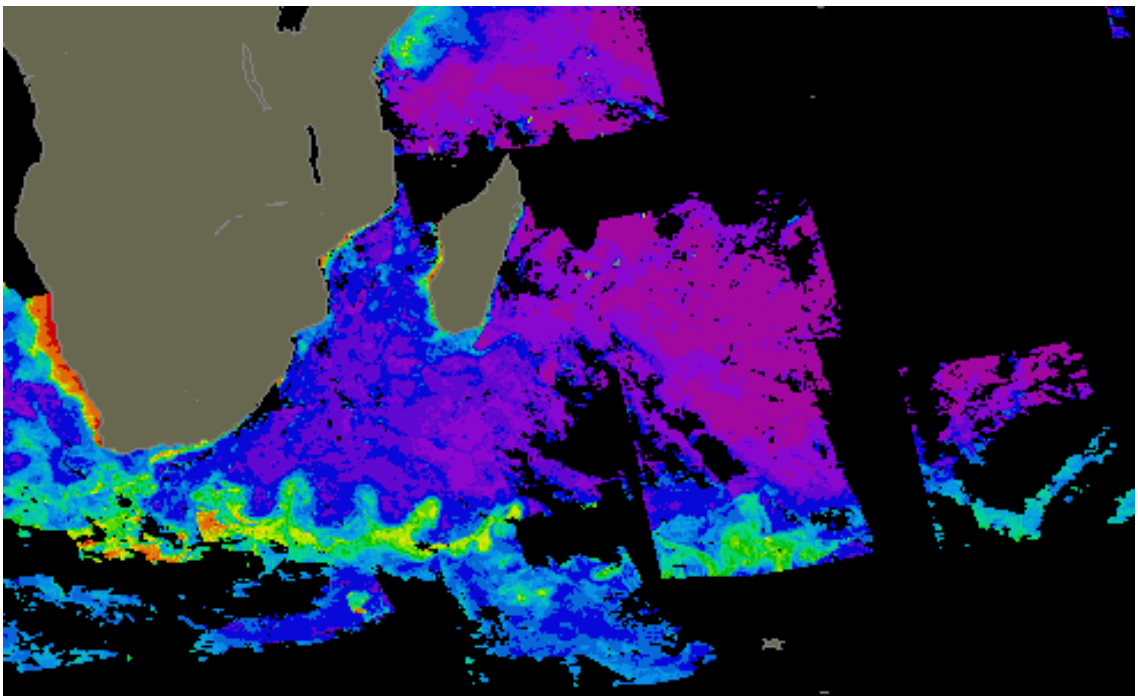
Chapter 9: The Agulhas Retroflection

In the Chapter 7 discussion on the formation of rings in the Gulf Stream system, other manifestations of this fairly common oceanic phenomena were mentioned. In particular, the zone directly south of southern Africa, a region of strong interacting currents, was singled out for discussion. This zone is called the Agulhas Retroflection.

In the Agulhas Retroflection, the Agulhas Current (the boundary current flowing southwest next to the southeast African coast) runs into the eastward flow of the Antarctic Circumpolar Current (ACC) and the northeastward flow of the Benguela Current. This collision of currents causes the Agulhas flow to bend almost completely back on itself, producing a turbulent zone of mixing. Rings formed in the Agulhas Retroflection have been observed spinning into the southern Atlantic and migrating all the way to the South American coast. This process helps transport warmer and more saline Indian Ocean waters into the southern Atlantic.



Composite CZCS image of the Agulhas Retroflection Region and southern Indian Ocean in February 1983. The Retroflection is located due south of the African continent. Standing waves in the Agulhas Return Current induced by interaction with the Agulhas Plateau are also visible, as is the Benguela Upwelling Zone along the southwestern coast.

At the same time, as seen in the CZCS composite image for February 1983 on the previous page, the collision of the Agulhas Current with the Benguela Current and ACC produces the Agulhas Return Current, which merges with the ACC and then encounters the subsurface Agulhas Plateau, approximately 1500 meters deep. The interaction of the currents with the plateau creates immense undulations in the current that are evident almost 2000 kilometers east of the Retroflection. (If composites from a longer period of time are viewed, this zone appears as a zone of high productivity, but the wave-like nature of the phenomenon is not as clearly visible.)

One way of visualizing the interactions in the Agulhas Retroflection can be done with a simple faucet. If the water is allowed to come out of the faucet so that only a very slender smooth stream is produced, and then a finger is placed in the stream 1-2 inches from the faucet, ripples will be seen traveling up and down the stream, or the stream will appear to have small bulges in it. These ripples and bulges are caused when the flow of the water bounces back upward after hitting the finger placed in the stream. Though this demonstration certainly doesn't reproduce the force of ocean currents, it does show (in principle) how energy creates large-scale features in the ocean.

The interaction of physics and biology in the ocean is also an important aspect of the Agulhas Retroflection. Due to the energy of the interacting forces, this particular area is very prominent in sea surface height data, which is obtained by altimeters such as Geosat or TOPEX/Poseidon. It is also familiar to the captains and crews of ships, because this region can spawn immense surface waves that can threaten supertankers. The interaction of the winds and currents creates "cells" of upwelling on the boundary between the warm waters of the southern Indian Ocean and the colder waters of the ACC. This process provides nutrients that nourish increased primary productivity, producing the sinuous waves of ocean color observed by the CZCS in this region.