

Exercise 9. Surface Currents

This exercise is intended to augment lecture material by requiring the students to study a current map and answer questions on individual currents and general circulation patterns. In addition, they will plot current velocities from dynamic topography contours and identify a current using temperature and salinity data. The exercise should help students understand how currents are studied and identified.

1. Current	Relative Temperature	Relative Speed
California	cold	slow
Kuroshio	warm	fast
West Wind Drift	cold	slow
Benguela	cold	slow
Gulf Stream	warm	fast
Canary	cold	slow
Labrador	cold	fast
Agulhas	warm	fast

2. If we view the Pacific countercurrent as due to trade wind-driven piling up of water (estimated to be 4 cm/1000 km) against the east sides of the continents, then we see in the Atlantic Ocean that the shape of South America deflects the South Equatorial current northward into the Antilles-Gulf Stream system. Thus, an analogous piling up in the Atlantic is inhibited by the shape and proximity of continents. The same reasoning applies if the countercurrent is viewed as the result of a tropical gyre around a low pressure system in the hydrosphere. Such gyres would rotate counterclockwise in the northern hemisphere, and vice-versa in the southern hemisphere, thus producing the countercurrents.
3.
 - a. The West Wind Drift completely circumscribes the globe in the Southern Hemisphere, mixing water between the Atlantic, Pacific and Indian Oceans.
 - b. Mariners found it difficult to leave the South Atlantic Ocean and enter the South Pacific Ocean using only sail-powered ships because they were sailing against the current and westerly winds.
4.
 - a. The water temperature off Perth would be colder (from polar currents) than off Rhode Island. The wave heights off Perth would be greater (with a larger fetch) than off Rhode Island. Current strength would be greater off Rhode Island (with the strong Gulf Stream moving in a northeasterly direction) than off Perth, with the weaker W. Australian Current moving toward the northwest.
 - b. Ocean conditions off San Diego would be more similar to those off Perth, given their similar position along eastern boundary currents from high latitudes.
5. Velocities will depend upon where the student selects to take the values. We selected a maximum velocity of 30 cm/sec and a minimum of approximately 3 cm/sec.
6.
 - a. See salinity plot on Figure 9-10 on next page.
 - b. See temperature plot on Figure 9-10 on next page.

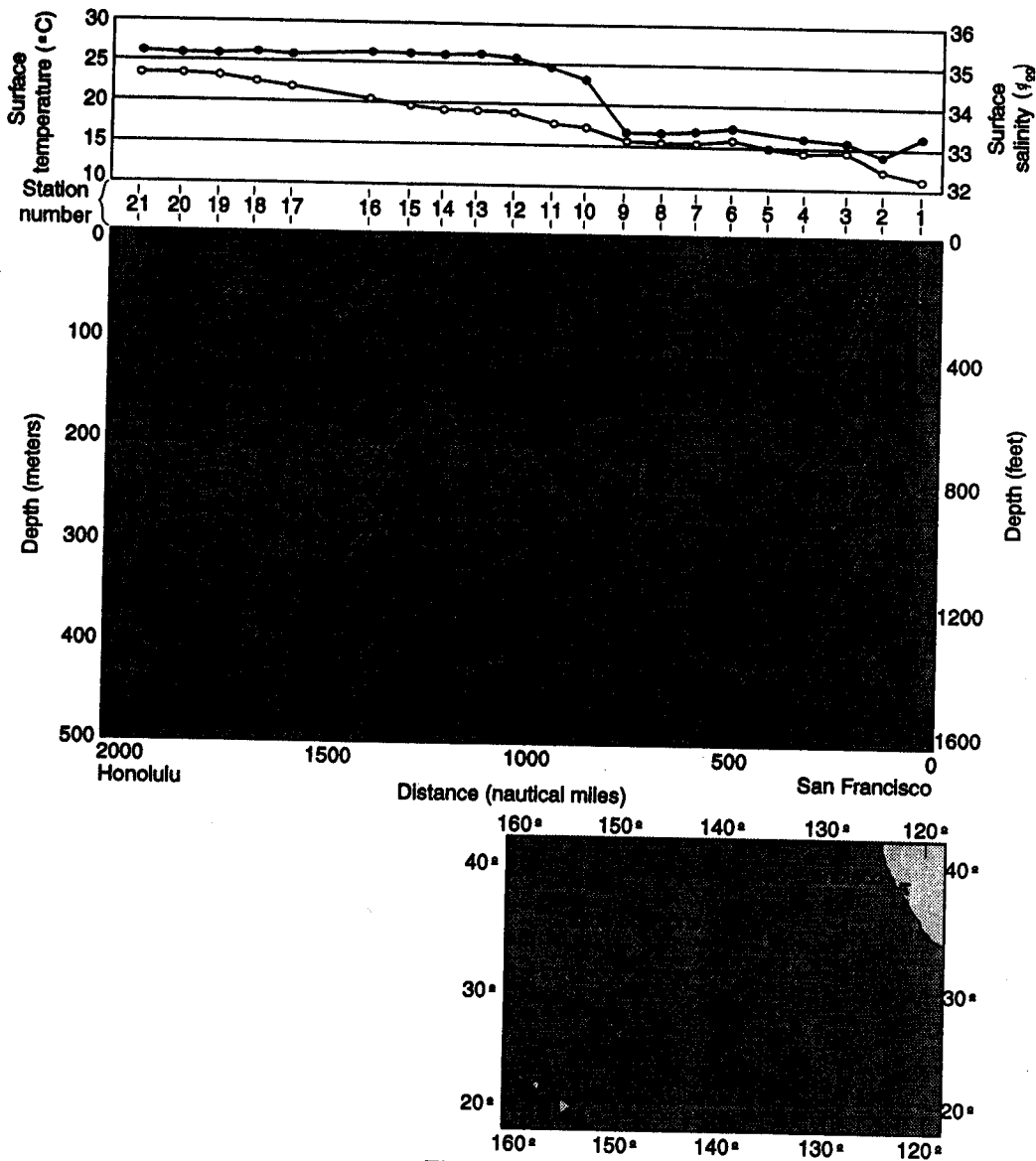


Figure 9-10

- c. The eastern North Pacific central water appears about 950 to 1000 nautical miles from San Francisco. The surface mixed layer extends to a depth of about 50 meters.
- d. The California Current is about 750–800 nautical miles wide along this section.

e.

Current	Isotherm shape	Temperature	Salinity
California Current	Very irregular	< ~16° C	< 34.0‰
Transition Zone	Moderately defined mixed layer; strong thermocline	~16–17° C	34.0–34.8‰
Eastern N. Pacific central water	Well-defined mixed layer; well-stratified thermocline	> ~17° C	> 34.8‰

7. a. The Gulf Stream is the large current in the AVHRR image in Color Plate 1 and is mostly shown in yellow, indicating an intermediate temperature.
 - b. Unlike rivers, ocean currents lack well-defined banks, and friction with adjacent water can result in the formation of waves (lateral meanders) along the current edges. Western boundary currents often meander as they flow poleward.
 - c. The feature located near 39°N 72°W in Color Plate 1 is a cold-water eddy (cold relative to the adjacent surface waters). Eddies form when looping meanders connect, creating turbulent rings. The structures trap cold (or warm) water in their centers and then separate from the main flow.
8. a. The AVHRR image in Color Plate 1 shows more detail than the surface salinity stations in Figure 7-7. The salinity contours use far fewer data points than the information provided in the color plate.
 - b. There are lateral meanders evident in the AVHRR image in Color Plate 1 that are not seen in the salinity data of Figure 7-7. Although the AVHRR data is more detailed, it does not provide information about salinity trends within the region. Therefore, it is important to send oceanographic vessels to this region to collect salinity information.