

## FAST FACTS:

# Ocean Currents, Gyres & Marine Debris



SHUTTERSTOCK

## UNDERSTANDING CURRENTS AND GYRES

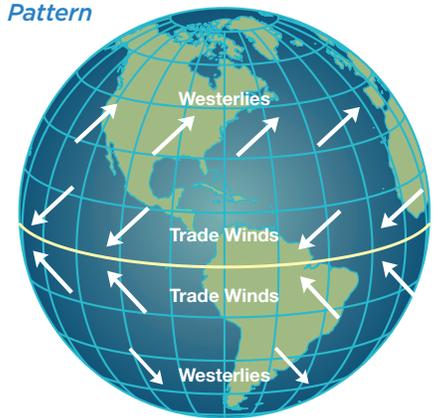
Oceanic currents are driven by several factors. One is the rise and fall of the tides, which is driven by the gravitational attraction of the sun and moon on the Earth's oceans. Wind is the second factor that drives ocean currents on or near the ocean's surface. The third factor that drives currents is thermohaline circulation—a process driven by density differences in water due to temperature (thermo) and salinity (haline) in different parts of the ocean.<sup>1</sup> These factors move water and heat around the globe, and help determine the chemical make-up of the water column.

Currents also are a major factor in ocean ecosystems.<sup>2</sup> Because ocean currents circulate heat worldwide, they have a significant impact on the movement of energy and moisture between the oceans and the atmosphere. As a result, they are important to the world's weather.<sup>3</sup>

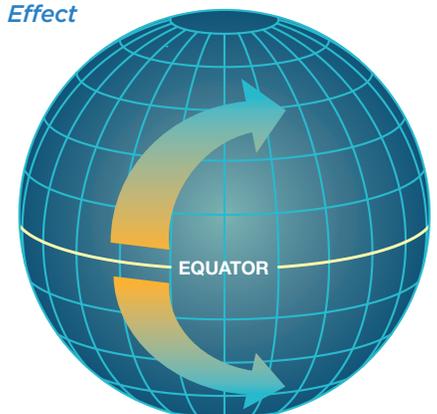
The trade winds (also called trades) are the prevailing pattern of easterly surface winds found in the tropics, within the lower portion of the Earth's atmosphere, in the lower section of the troposphere near the Earth's equator. The trade winds blow predominantly from the northeast in the Northern Hemisphere and from the southeast in the Southern Hemisphere. Winds drive currents on the ocean's surface. As the earth rotates on its axis, trade winds are deflected, moving clockwise in the Northern Hemisphere and counter-clockwise in the Southern Hemisphere.

This phenomenon is known as the Coriolis Effect.<sup>4</sup>

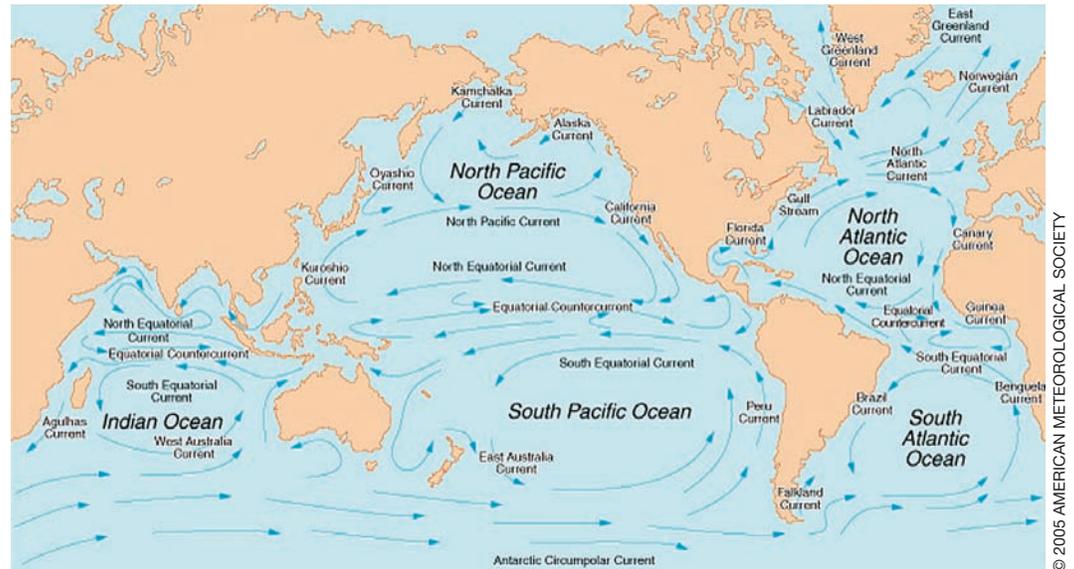
*Trade Wind Pattern*



*The Coriolis Effect*



## UNDERSTANDING CURRENTS AND GYRES



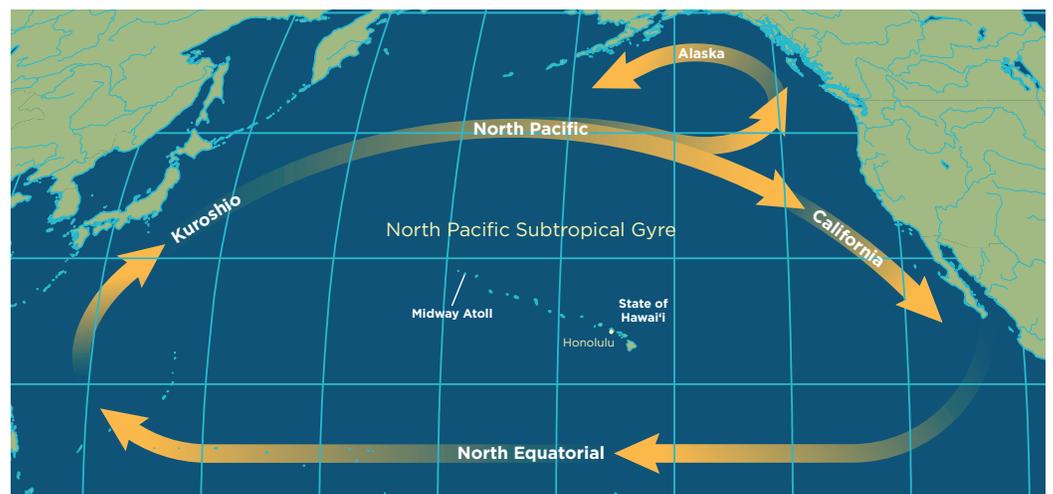
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Because the movement of wind across the water drives ocean currents, the Coriolis Effect also affects the movement of the currents. A combination of four forces—the Coriolis Effect, surface winds, the sun’s heat and gravity—circulates the ocean surface clockwise in the Northern Hemisphere and counterclockwise in the Southern Hemisphere.<sup>5</sup>

Five of the ocean’s largest currents are formed in warm, high-pressure areas called subtropical gyres—the North Atlantic, South Atlantic, North Pacific, South Pacific and Indian Ocean. Two other gyres occur in the high latitudes of the Northern Hemisphere in the Pacific and Atlantic Oceans.<sup>6</sup>

A gyre is any large system of rotating ocean currents, particularly those involved with large wind movements.<sup>7</sup> Though the circulation is not as significant as that in the atmosphere, the deflection caused by the Coriolis Effect is what creates the circular flow pattern in these gyres.<sup>8</sup>

In the North Pacific Ocean, four major currents—North Equatorial, Kuroshio, North Pacific and California—influenced by the Northeast Trade Winds and Westerlies—form the North Pacific Subtropical Gyre.<sup>9</sup> Located in the Northern Hemisphere between Asia and North America, this gyre also surrounds Midway Atoll and the other Hawaiian Islands.



## HOW CURRENTS AFFECT MARINE DEBRIS

In the ocean, currents not only move water; they can also transport marine debris. Much of the debris is composed of synthetic materials which are typically lightweight and buoyant, enabling them to travel on the water's surface for thousands of miles. Marine debris collects in the Subtropical Convergence Zone, which is located north of the Northwestern Hawaiian Islands within the North Pacific Subtropical Gyre, due to current and other atmospheric conditions. Once debris enters a gyre, it can remain trapped in these currents for long periods of time.



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Researchers have found that when certain types of debris, such as derelict fishing gear and nets, are discarded anywhere in the North Pacific Ocean, they can circulate in the North Pacific Subtropical Gyre for years.<sup>10</sup> Eventually, these materials can reach the Northwestern Hawaiian Islands,<sup>11</sup> where they pose a dangerous threat to the marine wildlife in and around Midway Atoll.

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## ADDITIONAL RESOURCES

*Learn more about ocean currents and gyres by visiting these online resources*

### **National Oceanic and Atmospheric Administration (NOAA) Ocean Service Education—Currents**

[http://oceanservice.noaa.gov/education/tutorial\\_currents/welcome.html](http://oceanservice.noaa.gov/education/tutorial_currents/welcome.html)

### **National Oceanic and Atmospheric Administration (NOAA)—Tides and Currents**

<http://tidesandcurrents.noaa.gov>

### **NASA Ocean Motion and surface currents**

<http://oceanmotion.org/html/introduction-general.htm>

### **National Oceanic and Atmospheric Administration (NOAA) Marine Debris Program—Movement of Marine Debris**

<http://marinedebris.noaa.gov/info/mvmt.html>

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## REFERENCES

- <sup>1</sup> NOAA Ocean Service Education – Currents. [http://oceanservice.noaa.gov/education/tutorial\\_currents/welcome.html](http://oceanservice.noaa.gov/education/tutorial_currents/welcome.html) (accessed May 12, 2010).
- <sup>2</sup> Ocean Currents and Climate. <http://earth.usc.edu/~stott/Catalina/Oceans.html> (accessed June 24, 2010).
- <sup>3</sup> *Ibid*
- <sup>4</sup> NOAA Ocean Service Education. “The Coriolis Effect.” [http://oceanservice.noaa.gov/education/tutorial\\_currents/O4currents1.html](http://oceanservice.noaa.gov/education/tutorial_currents/O4currents1.html) December 15, 2009 (accessed June 6, 2010).
- <sup>5</sup> Ocean Currents and Climate, <http://earth.usc.edu/~stott/Catalina/Oceans.html> (accessed June 15, 2010).
- <sup>6</sup> NASA-Ocean Motion and surface currents, Wind Driven Surface Currents: Gyres Background. <http://oceanmotion.org/html/background/wind-driven-surface.htm> (accessed June 22, 2010).
- <sup>7</sup> NOAA Ocean Service Education. “Boundary Currents.” [http://oceanservice.noaa.gov/education/tutorial\\_currents/O4currents3.html](http://oceanservice.noaa.gov/education/tutorial_currents/O4currents3.html) December 15, 2009 (accessed June 6, 2010).
- <sup>8</sup> *Ibid*
- <sup>9</sup> Molly A. Timmers, Christina A. Kistner, and Mary J. Donohue. “Marine Debris of the Northwestern Hawaiian Islands: Ghost Net Identification,” Sea Grant Publication: UNIH-SEAGRANT-AR-05-01 <http://www.soest.hawaii.edu/SEAGRANT/communication/pdf/GhostNetIdentification.pdf> (accessed May 30, 2010).
- <sup>10</sup> Dotson, A. Magaard, L. Niemeeyer, G. and Wyrki, K. 1977. A simulation of the movements of fields of drifting buoys in the North Pacific Ocean. Rep. HIG-77-3, Hawaii Institute of Geophysics, Honolulu, 59 p (as sourced in “Marine Debris of the Northwestern Hawaiian Islands: Ghost Net Identification,” Sea Grant Publication: UNIH-SEAGRANT-AR-05-01 <http://www.soest.hawaii.edu/SEAGRANT/communication/pdf/GhostNetIdentification.pdf> (accessed May 11, 2010).
- <sup>11</sup> Kubota, M. 1994. A mechanism for the accumulation of floating marine debris north of Hawaii. *Journal of Physical Oceanography* 24:1059-1064. (as sourced in “Marine Debris of the Northwestern Hawaiian Islands: Ghost Net Identification,” Sea Grant Publication: UNIH-SEAGRANT-AR-05-01 <http://www.soest.hawaii.edu/SEAGRANT/communication/pdf/GhostNetIdentification.pdf> (accessed May 11, 2010).