The Wonder of Waves

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Living on the Gulf Coast affords us the opportunity to enjoy what can truly be a relaxing pastime: watching the waves roll in, crash onto the shore, and recede once again. As we breathe in, we can taste the salt in the air, listen to the rhythmic cadence, and appreciate the play of light on the water's surface, participating in an experience that engages multiple senses. If we choose to walk along the edge of the shoreline, we can even feel the movement of the sand and water below our feet and be cooled by the foamy ripples passing over our toes.

Even though the waves in our region tend to be smaller than those seen on Florida's East Coast or in California, watching them here can still be an awe-inspiring, wonderfully soothing experience that allows us to appreciate their unique beauty. Plus, given the numerous beaches in our area, such as Caspersen (featured on our cover), one of these relaxing oases is only a short distance away at any point. Since each possesses its own distinctive character and charm—not to mention a different vantage point—it can be rewarding to explore them all and to soak in the serene atmosphere that the waves produce.

No matter where we are, however, wave-watching provides the opportunity to observe this powerful force of nature at work. When we look out beyond the rolling groups of waves, which travel collectively in what are called wave trains, it may appear that the entire body of water is rhythmically swaying. It may be surprising, however, to discover that only a relatively small amount of water is actually involved in producing the continual, balletic movements that can be observed on the surface of large bodies of water, such as our Gulf or the world's oceans. But what causes waves?

In the simplest terms, the majority of waves are produced when the surface of the water is disturbed. Perhaps one of the reasons that it may be so soothing to watch waves is that they are a restoring force at work, trying to bring calm back to the surface. Much like what happens when a pebble is thrown into a pond, wind is a force that disturbs the surface of the water. When this disruption occurs, it generates energy that moves through the water, creating waves that radiate outward from the point of impact. As these waves move, they gradually lose their momentum and, after all the energy has dissipated, the surface can once again become calm.

While waves are often the result of the interplay between water and air, they can also originate when two liquids of different densities make contact. When water from large rivers and other tributaries pours in over saltwater, what is known as an internal wave can form. Additionally, in oceanic regions along the continental shelf, when low-density water is above high-density water, waves can emerge.

Waves can range in size from the tiniest of ripples to walls of water that can reach several stories in height. Capillary waves are the small, rounded ripples that begin to form when wind blows across the surface, causing pressure and stress. Through the restorative influence of capillarity, the cohesive force that causes watery molecules to adhere to one another, the surfaces of ponds, streams, and small lakes soon are able to return to their placid state. When generated by light wind in open water, sailors often refer to these as "cat's paw" waves, since they can resemble feline paw prints.

The wide, continuous expanses of the open ocean and other large bodies of water present ideal conditions for the development of larger waves. Since winds in these environments operate on a greater surface area, more energy is transferred to the water, producing increased capillary waves and rougher seas. In these depths, gravity replaces capillarity as the restoring force, so the resulting waveforms, which achieve greater heights and wavelengths, are known as gravity waves.

Since these waves steadily move forward as they head toward distant shores, they are categorized as progressive waves, which are defined as the type of waves that form at the boundary of two liquids with different densities—in this case, open water and air. Surprisingly, the water itself does not move much in these waves: instead, friction generates energy within the water that is transferred between the water molecules in ripples that are known as waves of transition. As soon as the individual water particles receive this energy, they begin to move up and down in a circular motion; for this reason, these waves are further classified as orbital progressive waves.

Basic Terms

CREST:
the top of a wave

TROUGH:
the bottom of a wave

WAVE HEIGHT:
the difference in the elevation between a crest and trough

WAVE LENGTH:
the distance between two crests or troughs

WAVE PERIOD:
the length of time for the crests of two waves to pass a fixed point

A View From The North and South Jetty

On the ocean, this type of wave originates when wind blows on the open waters. As the wind blows more powerfully, it pushes harder against the water. This process results in greater amounts of energy being transferred to the water, producing peaks and white caps on the surface. The height and shape of the white caps are influenced primarily by three factors: how long the wind blew over the water, the strength of the wind, and the fetch length, which is defined as the surface area of the ocean affected by the wind. Wherever the white caps are, the water will be extremely chaotic, moving choppily in random directions. As the peaks churn above the surface, the wind can latch onto them and they can grow to reach greater heights: for instance, rogue waves, which are massive single waves that can pop up out on the open ocean waters, can be as tall as 50 to 100 feet.

Many other kinds of oceanic waves propagate on these open waters. Forming where waters of different densities interact, internal waves typically tend not to be fully expressed on the surface of the water, aside from the slick bands that can form over their troughs. As they continue the process of moving toward land, these waves store up energy which is released as turbulent currents.

Found in the western Pacific, Kelvin waves typically only reach heights of 10 centimeters, can grow in width to over hundreds of kilometers, and are warmer than their surrounding waters. Kelvin waves are of particular interest to scientists since they may indicate the arrival of the next El Niño.

Seismic waves, which are more popularly known as tsunamis, are extremely fast-moving forms that may result when a severe shock such as an earthquake affects the ocean. Often considerably smaller while at sea, they can reach heights above 100 feet in shallow coastal waters.

A type of standing rather than progressive wave that occurs on the open ocean, seiche waves are only a few inches in height; however, they have wave periods that can range from a few minutes to several days and have extremely long wavelengths. These water forms are named for the seiche phenomenon in which water is disturbed in a confined space and begins to rock back and forth at a particular resonant frequency.

Often created by storms thousands of nautical miles away from the coastline where they break, deep water, or swell, waves consist of numerous waves possessing different lengths superimposed upon each other. For instance, swells generated in the Indian Ocean have been recorded in California, after taking a trip around more than half of the globe. When swells travel these distances, the waves tend to be better sorted and free of chop when they reach the beach. As storms intensify and move closer toward the coast, these straight, long powerful waves can increase.

While the number of waves reaching the coastline is amazing, it is also impressive to note the many different types of waveforms that make their way to the shores. Noted for their signature curl, breaking waves are the type of wave most popularly associated with surfing, making them one of the most recognizable waveforms. Breakers occur when friction slows the bottom of the wave as it approaches the shore while allowing the top to continue moving, causing this section of the wave to lean forward. Then, when it reaches such a height and becomes so unstable that it can no longer stand, it collapses upon itself. Many different types of breakers exist, all of which are determined by the slope of the shoreline.

When the wave occurs in a region in which the ocean floor has a gradual slope, a spilling breaker can be observed. These large waves are called such because torrents of whitewater continually pour down the face of the waves as they approach the shore, helping to slowly expend the wave's energy in the whitewater. For this reason, they tend to break for longer times than other types of waves, resulting in a relatively gentle wave that is ideal for coasting in on a surfboard or floating in the surf. During windy onshore conditions, spilling breakers are more likely to happen.

If the ocean floor near the shoreline has sudden depth changes, such as sandbars or reefs, or a moderately steep slope, plunging breakers tend to predominate. In these fast-moving waves, the crest eventually becomes vertical before curling over and dropping onto the trough of the wave, instantly releasing the majority of the wave's energy for a moderately violent impact. Breaking with greater energy than spilling waves, air often is trapped and compressed under the lip of these waves, creating the audible crashing noise often associated with waves. If these breakers are substantially sized, beachgoers may even be able to feel the force of the crash on land. When offshore winds are more prevalent, plunging waves are more likely to occur.

Under the right conditions, plunging breakers can be ideal for surfing. When the wave is not parallel to the ocean floor, a smaller section of it can reach shallow water first and break. Then, as the curl follows the rest of the wave, it may move laterally across the face on the wave as it moves toward the shore, forming what surfers call "the tube," among other terms. When riding this wave, surfers try to stay near to, if not under, the lip of the wave, while they also shoot forward and out before the tube closes. Plunging waves that are parallel to the beach line can break along their entire length in an instant, making for waves that are too dangerous to ride.

When a coastline has a very steep, nearly vertical slope, surging breakers are more likely to occur. Typically formed from long, low waves, the front faces and crests of these waves stay relatively unbroken with little foam or bubbles as the waves slide up the beach, resulting in a very narrow surf zone, or no breaking waves at all.

Collapsing waves are a combination between plunging and surging waves. Although the bottom face of these waves gets steeper and collapses, the crests do not fully break. When these waves reach the shoreline, they create sea foam.

Two types of waves can be observed in coastal regions: inshore and refracted waves. Inshore waves possess a length that is shorter than the water they pass into, which has the effect of decreasing the wave's velocity. As a result, the wavelength shortens and the height increases, eventually causing the wave to break and drain the beach as a backwash. Usually seen near headlands and bays, refracted waves move through shallow water, which diminishes the wave's power and produces a curve as it approaches the shore.

The wonder of waves is undeniable, so visit our beaches and appreciate these marvels of nature for yourself!