

Letter from the Desk of David Challinor  
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When living on the shoreline of an ocean or its bays and sounds, one soon becomes aware of the lunar tidal cycle and the condition of the water surface. The sea is perhaps the most visible of our globe's dynamic processes. Meteorologists might challenge this assertion and claim it to be the atmosphere, but it is a close call. We can easily see a few thousand meters up, but we are limited to only the top few meters of the sea. I have been blest not only to have been raised on the Connecticut shore, but to have spent endless hours sailing nearby waters. I was further fortunate to exploit my interest and love for the sea by serving in the Navy during WWII. This month's letter will recount some of my seagoing experiences and those of others who have witnessed, challenged and survived the awesome power of wind and wave.

My first experience confronting the potential danger of unexpected wave dynamics was as a teenager racing my Star boat. The 22 foot long Star racing boats (which I believe are still an Olympic class) were then made of wood. Normally crewed by two, they have a 750 lb. cast iron keel and an open cockpit. The incident occurred when about 20 boats were racing in familiar local waters, in a brisk (>20 kt.) nor'easter with seas running four to five feet. We were beating to a windward mark against a strong tide; the mark was a nun buoy off a long reef exposed only at low tide. The outgoing tide was flowing directly into the wind and as we tacked to round the mark, two boats were hit with a big wave to leeward; water poured into the open cockpits and sank the boats in less than a minute. Both crews were rescued by fellow competitors and the race was wisely called off. The incident left a lasting impression on me of the dangers and vagaries of the sea. The fluke wave could have missed all of the boats or indeed sunk more than just two.

The first real storm at sea I experienced was a typhoon off Guam on an escort carrier during WWII. Our ship was lucky to have been on the fringes of this storm, but we did not come through it unscathed. Even before the storm arrived, all our planes were lashed securely on the hanger deck; nothing snapped loose to roll around and damage them. Needless to say, everyone was at general quarters as sleep was impossible. When dawn broke, we discovered that the forward starboard end of the flight deck, which overhung the bow, had been bent down by a huge wave. By afternoon the sea had calmed enough to make repairs. We used huge hydraulic jacks to bend back the damaged cross beams and to realign the flight deck. When we arrived at Guam's Apra Harbor a day or so later, we passed the heavy cruiser Pittsburgh; she was missing about 30 feet of her bow, lost to the sea in the same typhoon. At 23, I grasped the power of storm waves, an impression that is etched in my mind to this day.

The last storm at sea I experienced was in January 1997 while leading a cruise from Buenos Aires to Puerto Montt, about half way up Chile's coast. Shortly after leaving the protected fjords of southern Chile for our final destination, the sea-kindly cruise ship ran straight into a force nine (Beaufort scale) storm. Green water came over the bow and periodically the ship would vibrate loudly when a particularly large wave raised the twin screws (propellers) clear of the water. The ship had to reduce speed by half for 48 hours, but other than many seasick passengers and crew (including the ship's doctor), we came through without damage. Our Captain never left the bridge and the Safety Officer locked all the doors to the outside decks for fear some unwary tourist would want to take photos of the enormous waves and be washed overboard.

These personal experiences illustrate the element of luck in avoiding unanticipated dangerous conditions at sea. Most seafarers have been through bad storms, but occasionally conditions arise that cause a giant wave, officially known as an ESW—extreme storm wave. Other more common names for these waves are “rogue” or “freak waves.” These rarities gain their power and speed from the waves ahead and behind them. They travel so fast that a ship in their path cannot avoid them but will be hit by a speeding wall of water eighty or more feet high. If your ship is unlucky enough to be in the trough of the wave ahead of the rogue one, you are doomed to be just another of the 40 or so vessels of all sizes that Lloyd's of London estimates are lost without a trace each year. Because so few survive such a wave, the phenomenon has become almost a myth. However, the myth became reality in December 1942 when *R.M.S. Queen Mary* (now berthed as a tourist attraction in Long Beach, CA), unaccompanied and steaming east on the Atlantic at 30 kts., was hit by such a wave. The *Queen Mary* is 975 feet long, 118 feet abeam and 70 feet from the water line to the top of her forward stack. At the time, she was carrying a crew of nearly a thousand plus 12,000 American soldiers. She had successfully relied on her speed to avoid submarines during her continual five-day shuttles across the Atlantic, but on this voyage a rogue wave estimated at 100 feet crashed broadside into the 80,000 ton ship and knocked her 87° on her beam—just short of a rollover. Damage was considerable—lifeboats were washed away and hundreds of soldiers were hurt after being dropped almost vertically on the tilted decks. Her size, expert construction and luck undoubtedly saved her; she righted herself and completed the trip.

Now that the reality of ESWs has been globally accepted, what has science learned about the creation of these monsters? One of the first tools used to monitor the oceans for ESWs was radar satellite. The European Space Agency estimates that there are about 10 such waves at any moment in the world's oceans. Rogue waves differ considerably from tsunamis, which generate huge but virtually invisible swellings on the sea's surface and only appear as giant waves when they reach shore. (See my February 2005 letter on tsunamis.) Rogue waves, on the other hand, cannot generate in shallow coastal water. To qualify as an ESW, the wave must be at least 25m (82 feet) high although, theoretically, it could reach a maximum of 198 feet—equal to the size of the Statue of Liberty or the top of the dome of the Capitol in Washington. None have been actually recorded this large, but big rogue waves are about 100 feet or so—still an impressive wall of water.

All waves form when wind blows across open water. The greater the wind, the bigger the waves. In the force nine storm off Chile, the waves were about 30 or 40 feet, and the wind was strong enough to blow water off the wave crests. Pitching ships are so unstable that accurate wave heights are almost impossible to calculate. However, in early 1995, a large stable oil rig in the North Sea used its laser device to measure a rogue wave 84 feet high. This was the first hard evidence of extreme wave size. Only five years later, a British research ship using elaborate instruments measured waves up to 95 feet high in a storm off Scotland.

In November 2000, oceanographers and other scientists met in Brest, France to pool what was known about ESWs and recommend ways to predict them. They soon agreed that such waves appeared most often where strong, steady currents occur, such as the Gulf Stream or the Agulas current that flows west and then north around the Cape of Good Hope (South Africa). The Agulas current flows against the prevailing easterlies west of the Cape; several supertankers en route from Arabia to Europe are damaged by waves each year in that area. Additional evidence arose in September 2004 when hurricane Ivan crossed the Gulf of Mexico and 50 miles east of the Mississippi Delta; the Naval Research Laboratory's six wave-tide gauges unexpectedly recorded waves greater than 90 feet from crest to trough.

Besides the effect of currents and wind direction, there may also be a rapid increase in wave size when waves generated by two separate storms meet. The separate series of waves could theoretically dampen each other or have the opposite effect. There is still so much to learn, but now that the reality of ESWs is fully accepted, devices such as radar satellites are focusing on the hot spots where conditions seem favorable for their creation. Seafarers may soon have a global warning system to curb the incredible losses to maritime commerce attributed to rogue waves.

David Challinor  
Phone: 202-633-4187  
Fax: 202-673-4686  
E-mail: [ChallinorD@aol.com](mailto:ChallinorD@aol.com)

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