National Center for Atmospheric Research

Summer 2013

NCAR Fellows News

UPCOMING EVENTS

August 23: The Annual NCAR Up-the-Hill Race, Mesa Lab

3:00 pm: Foot and bicycle races up the NCAR Mesa Lab Road. Come cheer on your fellow NCAR employees.

4:00 pm: Join the celebration after the races on the tree plaza with food and drink

NEWS

NCAR will be closed on Monday September 2nd in observance of Labor Day.

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Effects of Climate Change on Surfing

by Stuart P. Bishop

Growing up as a surfer in South Florida, it naturally led me to an interest in meteorology. Surfing is dependent upon many factors based on the weather that are constantly changing. Surfing waves - i.e., surface gravity waves (SGWs) - themselves are ultimately formed by weather systems over the ocean. These systems can range from diurnal sea breezes to intense tropical cyclones, commonly referred to as hurricanes in the Atlantic Ocean and typhoons in the Western Pacific. SGWs are formed from wind blowing over the sea surface, and the quality of the surf depends on three essential ingredients: strength of the wind, fetch (which is the sea surface area over which the wind blows), and duration. Basically, the stronger the wind, the more fetch, and the longer the wind blows, the better the waves get for surfing. Based on these criteria, the best surfing waves tend to occur during the winter months when weather systems are stronger. So just like ski bums, surfers long for the winter months - contrary to popular belief that surfers are after the "endless summer."

Ideal surfing locations vary widely in geographic location on the globe, but tend to lie on the eastern side of ocean basins such as the west coast of the United States. There are certainly many exceptions to this rule (think Australia). This is due in large part to predominant movement of weather systems from west to east over the midlatitudes. Since the quality of SGWs is directly related to weather, in a world with a changing climate, one would expect that this would affect surfing. The main question for this newsletter is "what are the effects of climate change on surfing?"

In terms of the waves themselves, a recent article in *Nature Climate Change* [2] attempts to answer the effects of climate change on SGWs. From the first community-derived, multi-model ensemble of wave-climate projections, Dr. Mark Hemer and colleagues report

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that there will be a decrease in annual mean significant wave height over 25.8% of the global ocean area [2]. This decrease is not uniform in space. The greatest decreases are noted over the North Atlantic, North Pacific, and Indian Ocean during the Northern Hemisphere winter months. In contrast, parts of the Southern Hemisphere, especially south of Australia and New Zealand, will have increases that range from 5-10% above current averages.

Another effect on surfing in a warming climate will be due to sea level rise. The global average sea level rose about 1.7 mm yr^{-1} over

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Surfing(continued)

Arial view of the Ruggles surfspot in Newport, RI (credit: Surfline.com)

the 20th century [3]. However, since 1993 the sea level has been rising at an accelerated rate of around 3 mm yr^{-1} [3]. Projected sea level rise rates for the 21th century are even higher at around 4 mm yr^{-1} [3]. This rise is not uniform in space, which means that some places will be affected more than others. For instance, a recent report suggests that Miami, Florida will be completely underwater by the latter end of the 21st century. Most people don't think of Miami as being a great surfing destination, but a couple of times a year South Beach can light up with some of the best waves Florida gets. During these events, the entire population of surfers in Florida flocks to South Beach. Near the coast, waves break when their wave height is greater than 0.8 times the water depth. Where waves break will dramatically change due to sea level rise. During my lifetime, some well-known surf spots today will become a memory. However, new and better surf spots may emerge as a consequence of sea level rise.

Another consequence of climate change projections is that the background state of the climate is changing and that we should expect more storminess as a result. More storminess may in some ways lead to good surfing conditions, but may also lead to catastrophic events such as hurricane Sandy, which had actually gone through an extratropical transition before hitting the shoreline, last fall along the eastern seaboard. It's difficult to say that any individual storm is a consequence of climate change, but more storms like Sandy could become commonplace. Storms like Sandy not only cause large economic troubles, but lead to destruction of coastlines that will change the way surf breaks break. Following Sandy in Rhode Island, mitigation efforts almost destroyed the famous surf spot Ruggles in Newport. A seawall was proposed to protect Cliff Walk, a popular hiking trail along the cliffs of Newport adjacent to mansion row, from future storms. This seawall would have permanently changed Ruggles, but due to the efforts of local citizens the seawall plan was shot down.

What is probably more unclear is how the El Niño-Southern Oscillation (ENSO) will change with climate change. It is well known among surfers on the West Coast of the United States that wintertime surf is much better during El Niño years. The strong El Niños of 1982-1983 and 1997-1998 produced legendary surf in California. From my own analysis of buoy data off the New England coast, I found that significant wave heights were larger during the fall of El Niño years. ENSO is also correlated with hurricanes in the Atlantic Ocean. During El Niño years there is a decrease in hurricanes compared with neutral and La Niña years, due to larger vertical shear over the tropical Atlantic. Warmer sea surface temperatures in a warming climate may also lead to more intense hurricanes. A recent article in *Science* suggests that the ENSO cycle has become more variable and intense over the past several decades [1]. The authors reconstructed a 7000-year time series of ENSO from examining coral growth. They note that during the 20th century the variability and strength of the ENSO cycle was greater than at most points during the 7000-year record. More research certainly needs to be done, but one thing we can say for sure is that, as the climate changes, so will the surf environment.

References

[1] Cobb, Kim M., Niko Westphal, Hussein R. Sayani, Jordan T. Watson, Emanuele Di Lorenzo, H. Cheng, R. L. Edwards, Christopher D. Charles. Highly variable El Nino-Southern Oscillation throughout the Holocene. *Science*. **339**, 67-70 (2013).

[2] Hemer, Mark A., Yalin Fan, Nobuhito Mori, Alvaro Semedo, Xiaolan L. Wang. Projected changes in wave climate from a mutli-model ensemble. *Nature Climate Change*. **3**, 471-476 (2013).

[3] IPCC, 2007: Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M.Tignor and H.L. Miller (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

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