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The Little Boy and the Little Girl:

Research on the Relationship Between El Niño/La Niña Oscillations and Global Climate Trends

 It was August 2011, and it had barely been a week since we moved in when we heard forecasters calling for a hurricane to make landfall. Having just moved to a small suburb in central Maryland, it was hard enough to be in a new place, let alone dealing with a potential Category 3 hurricane passing through. I remember being terrified of that first day of eighth grade as the new kid, so I had little room to worry about the incoming storm. Fortunately for Marylanders, Hurricane Irene never made direct landfall, hitting just south of us as a Category 1 storm along the beaches of Virginia. We lost power and there was substantial damage from heavy rain, flooding, and fallen trees in nearby towns, but our neighborhoods were left intact. The inclement weather even caused our first day of school to be cancelled, so my siblings and I could put off our worries about starting at our new school for one more day.

 I remember thinking it was pretty rare for a hurricane to come as far north as Maryland, so I figured storms like Irene wouldn’t happen very often. But just 14 months later, Hurricane Sandy was on a collision course with the mid-Atlantic coast. This time, it missed us to the north, with the New Jersey coastline bearing the brunt of Hurricane Sandy, which turned out to be the second-costliest hurricane in U.S. history (NOAA, NWS).

 Within a little over a year, there had been not one but two powerful hurricanes to strike the mid-Atlantic east coast. Would hurricanes in the mid-Atlantic begin occurring more frequently? What processes are likely responsible for influencing the occurrence of hurricanes—and other natural disasters, for that matter? Weather and climate scientists have long understood the natural cycles and patterns that impact precipitation, temperature, and the presence of storms and extreme conditions, but researchers are now beginning to focus in on the human-driven causes of severe weather catastrophes.

 Many global weather patterns are influenced by natural oscillations of winds and currents that cycle from the atmosphere to the oceans (Woods Hole Oceanographic Institution). The best-known of these are El Niño and La Niña, which occur in the equatorial Pacific Ocean, caused by changes in the wind patterns and ocean surface temperatures that fluctuate about every two to seven years (National Geographic). Together, they make up the El-Niño Southern Oscillation, or ENSO for short, and cause opposite and sometimes extreme effects in climate patterns all over the world (National Geographic). El Niño, or “the little boy” is known as the warmer part of the cycle as a result of warmer ocean currents surging towards the Americas and weaker trade winds (NOAA, NOS), and its effects include wetter, cooler conditions in the southern United States and parts of South America and warmer and drier conditions in much of western North America, southern Africa, and Southeast Asia (NOAA). This tends to produce an increase in hurricane and tropical cyclone activity in the eastern Pacific around southeast Asia, while resulting in warmer-than-average winters in most of the United States (NOAA). In addition, intense flooding is more likely to occur along parts of the Gulf Shore and South American coastlines as a result of El Niño, while severe droughts may inflict regions of southeast Asia and southern Africa (NOAA). Meanwhile, La Niña, or “the little girl,” is caused by cooler-than-average ocean surface temperatures and stronger trade winds across the Pacific (NOAA, NOS), and tends to encourage warmer temperatures and less precipitation in the southern United States and colder temperatures in much of central and northern North America and western and southern Africa, while producing higher-than-average precipitation levels in Southeast Asia and parts of South America (NOAA). As a result, there tends to be colder winters in northern North America and southern Europe (Mason) and droughts in the western United States, while severe floods are more frequent in Southeast Asia and southern Africa (NOAA). In addition, the La Niña cycle usually produces a stronger subtropical jet stream in the Atlantic Ocean due to the meeting of cold and warm air currents (NOAA, NWS), causing an increase in hurricane activity in the central Atlantic Ocean. These irregular El Niño and La Niña oscillations remain difficult to predict, making it hard for forecasters to determine the likelihood of natural disasters as a result of these erratic cycles.

 The ENSO fluctuations appear to be a key factor in influencing global weather catastrophes, ranging from floods, mudslides, hurricanes, and thunderstorms to tornadoes, droughts, heat waves, wildfires, and powerful blizzards. Depending on the time of year an El Niño or a La Niña event occurs, the resulting change in atmospheric pressure and oceanic currents can produce a wide range of drastic conditions and disasters. Yet, while these irregular ENSO cycles are caused by natural changes in winds and ocean currents rather than anthropogenic causes of climate change, some studies suggest that a global warming trend caused by human activities may be contributing to increasingly extreme El Niño and La Niña events (Pearce).

 In a study by Wenju Cai, of Australia’s national science agency, the frequency of extreme El Niño occurrences—or “super El Niños”—could double over the next century as a result of higher global temperatures (Pearce). According to recorded data, the most severe super El Niño events this century have all occurred within the past forty years—one from 1982-1983, one from 1997-1998, and one from 2015-2016, with each occurrence more extreme than the previous one (Pearce). The El Niño in 2015-2016 in particular produced the most record-breaking conditions, generating a staggering 3.1 degrees Celsius surface temperature increase in Pacific waters and triggering the formation of Hurricane Alex, the North Atlantic’s first hurricane since 1938 (Pearce). In addition, it produced the worst drought and wildfires Indonesia has seen since the previous super El Niño in 1998, along with the unseasonably earlier occurrence of major tropical storms and cyclones in the North Pacific last summer (Pearce). According to Cai, the fact that all three super El Niños have occurred within the past forty years is no coincidence (Pearce). His models suggest that the usually cooler currents along the western North and South American coastlines are quickly becoming much warmer, causing a more rapid spread of warm water across the Pacific tropics (Pearce). Such an accelerated pace of warm surges of water into the Pacific Ocean is characteristic of super El Niños, and could result in a dramatic increase in temperatures as well as the occurrence of severe floods, droughts, and other disasters (Pearce).

Cai’s study also predicts an increase in the frequency of super La Niñas as a result of warmer worldwide temperatures (Pearce). His models forecast that intense La Niña events usually follow severe El Niño occurrences, suggesting that weather patterns could shift to dramatic extremes of warming to cooling and floods to droughts from year to year (Pearce).

 However, there are many who are doubtful of Cai’s models predicting an increase in extreme El Niño events due to global warming (Pearce). An analysis of surface temperatures in the Pacific Ocean over the past 12 million years has recently been released and shows no evidence of periods of frequent super El Niños—even during times much warmer than today (Pearce). Mark Pagani, a paleoclimatologist at Yale University, points to this study as evidence that our current warming trend will not lead to more severe, El Niño-based weather patterns (Pearce). In addition, many others doubt the reliability of Cai’s models, as ENSO data has only been recorded since the early 1900s (Pearce).

 Yet, while some researchers argue that there is not enough evidence to say for sure whether the frequency of super El Niños will rise, many agree that the intensity of ENSO-based natural disasters may increase as a result of a global warming pattern (Lemonick). According to Baylor Fox-Kemper at the University of Colorado, “the impacts of El Niño are changing even [if] El Niño itself doesn’t change” (as cited by Lemonick), meaning that the usual weather patterns brought by El Niño could become much more severe as atmospheric temperatures and sea levels begin to rise (Lemonick). For example, El Niño typically brings heavy rainfall to southern California during the summer, but in future years, El Niño patterns are expected to cause a dramatic increase in precipitation (Lemonick). This is because warmer atmospheres can carry more moisture, causing torrential downpours that can increasingly lead to destructive flooding and landslides (Lemonick). In addition, snowstorms usually generated by La Niña patterns also seem to be increasing in severity due to warmer air temperatures (Lemonick). Greater amounts of atmospheric moisture seem to have strengthened the unusually powerful blizzards that struck the northeastern United States in the winters of 2014-2015, driven by a strong La Niña jet stream across northern North America (Lemonick). This means that as global temperature averages rise, even a mild La Niña event could produce extreme snowfall totals in much of the northern United States (Lemonick). Further, increasing global temperatures can have devastating effects in areas affected by ENSO-induced droughts by making conditions even drier, causing destruction to water sources, crops, and wildlife (Freedman). This seems to provide supporting evidence for an increase in the frequency of extreme ENSO events—the severity will not necessarily occur in the El Niño or La Niña oscillations themselves, but in the resulting natural disasters.

 So what does this mean for the future possibility of hurricanes like Irene and Sandy making landfall in the northeastern United States? A study done at Durham University in England provides evidence suggesting that more frequent and powerful hurricanes could increasingly strike the mid- and upper- Atlantic coastlines (PHYS.org). The research indicates that the tracks of Atlantic hurricanes has gradually moved northward over the past few hundred years, likely a result of the expansion of atmospheric circulation routes in the Atlantic subtropical region (PHYS.org). Dr. Lisa Baldini, the study’s lead author, suggests that this expansion of warm air movement is driven by ocean warmer surface temperatures generated during El Niño events, but increasing temperatures and carbon dioxide concentrations as a result of “man-made emissions” (Baldini) in the atmosphere are also a key factor of the northward shift of Atlantic hurricanes (PHYS.org). Further, co-author Amy Frappier discusses how tropical storms and hurricanes in the Atlantic appear to be responding to global warming trends more intensely than inclinations of regional cooling, suggesting that increased carbon dioxide concentrations and the resulting increase in atmospheric temperature has played a significant role in shifting the paths of hurricanes towards the northern United States (PHYS.org). According to this research, it seems that before long, schools in the mid-Atlantic and the northeast will close for hurricane days rather than snow days.

 This northern movement of Atlantic hurricanes could have devastating consequences throughout major population and commercial centers in mid-Atlantic and northeastern states. It remains difficult to tell how much of an impact global warming will have on the Pacific ENSO fluctuations, but regions most prone to severe ENSO-induced natural disasters should begin preparing now. While the effects of Hurricanes Irene and Sandy were not at their most severe in our suburb of central Maryland, preparation was an important factor in keeping our town and neighboring towns as safe as possible. Neighborhoods and cities all over the world may have to cope with increasingly severe weather conditions but the implementation of safety measures, evacuation orders, and aid provisions has been proven to save lives.

 Ultimately, we can’t be sure of which natural disasters are more influenced by human activities or by the irregular, temperamental El Niño and La Niña cycles. However, if these extreme patterns do indeed become more frequent—regardless of whether they are caused by natural oceanic and atmospheric cycles or by human influences—they may serve as a reminder of the impact each individual human can have on the global climate.

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