Foreword

It is impossible for anyone who has not experienced a hurricane to understand the sheer horror of it. Like the transformation of Dr Jekyll into Mr Hyde, the beneficent tropical atmosphere of picture postcards and snow-bound Yankee dreams suddenly morphs into the howling nightmare that is the hurricane. In its immediate aftermath, it is hard to imagine why anyone would stay and rebuild, with the risk of Mr Hyde always around the corner. But stay and rebuild we do, and while we will never forget what happened, to our grandchildren it will always be just a story.

All around the world, we see that human society is finely adapted to what might be experienced in a few generations. A house in Tortola will usually withstand a Category 3 hurricane, which can be expected every few decades. But the same storm would cause much devastation in Boston, where such winds might be experienced once in a few centuries. We are clever optimizers, building for what we expect to happen in our lifetimes, but not wasting resources on something that would occur less frequently.

The trouble is that the past is no longer a good guide to the future. We have known for well more than 100 years that carbon dioxide (CO_2), though it comprises only 0.04% of our atmosphere, acts as an exquisite thermostat, maintaining a comfortable climate even as a tiny bead of mercury in a household thermostat regulates the temperature of an entire house. At the end of the 19th Century, the Swedish chemist Svante Arrhenius worried that the combustion of fossil fuels would raise CO_2 concentrations enough to affect climate and predicted that doubling its concentration would raise the average temperature by 7 degrees Fahrenheit.

Measurements have overwhelmingly confirmed Arrhenius's prediction, and we are currently on track to triple CO_2 concentrations by the end of this century, incurring serious risks for us and our descendants. Among those risks are the increasing likelihood of high intensity hurricanes like Irma.

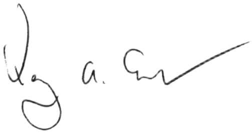
Hurricanes are fuelled by the evaporation of seawater, and the warmer water becomes, the faster it can evaporate. We have known for 30 years that increasing atmospheric CO_2 increases the speed limit on hurricanes, and it does not come as a surprise that we keep breaking hurricane records. In 2013, Typhoon Haiyan became the strongest tropical cyclone ever recorded, with winds exceeding 200 miles per hour; not surprisingly, it was also the deadliest typhoon in the history of the Philippines. Haiyan's record was broken two years later when eastern North Pacific Hurricane Patricia attained wind speeds of 210 miles per hour. Hurricane Katrina of 2005 produced the largest storm surge of any hurricane to hit the US in history, while Sandy of 2012 broke all records for the diameter of an Atlantic hurricane. Earlier this year, Hurricane Harvey produced the most rain of any hurricane on record in the US, and the 2017 hurricane season broke all damage records with totals currently estimated at over $300 billion, more than half the entire annual budget of the US Department of Defense.

Hurricane Irma was no slouch either. With peak sustained winds of 185 miles per hour, it now holds the record as the second-most intense hurricane ever recorded in the Atlantic and the most intense on record outside the Caribbean Sea. It was the most intense hurricane ever to have affected the Lesser Antilles. Irma maintained Category 5 status for 37 hours, shattering Haiyan's previous record of 24 hours to become the longest-lived hurricane at Category 5 anywhere in the world.

Sadly, we expect to see records like these broken again over coming decades. My group at MIT has spent many years researching the physics of hurricanes and learning how to apply advanced understanding to the estimation of hurricane risk. We estimate that in the year 1990, the probability of encountering a hurricane of Irma's magnitude or greater within about 200 miles of Barbuda (an island about 220 miles east of The Virgin Islands) was only about 1 in 800 in any particular year, whereas by 2017 the annual probability had increased to 1 in 180. Absent any measures to curtail further greenhouse gas emissions, we estimate that by 2090 that probability will have increased to 1 in 60 in any particular year.

Almost nothing, including the buildings and infrastructure of The Virgin Islands, is built to withstand an event whose annual probability is 1 in 800. When events like Irma become far more frequent, the results will be devastating, until, slowly, society adapts to the new reality.

Thus, if one insists on being wedded to the past, it is reasonable to regard Hurricane Irma as a freakishly unlikely event. But those with an eye on the future, looking out for their descendants, will see Irma for what it is: a foretaste of our future, unless we act very soon to curtail greenhouse gas emissions.



Professor Kerry Emanuel
Lorenz Center
Massachusetts Institute of Technology (MIT)

Kerry Emanuel is a world-renowned meteorologist and Professor of Atmospheric Science at MIT where he also co-directs the Lorenz Center, devoted to learning about climate. He specialises in tropical cyclones with a focus on hurricane physics. Professor Emanuel is also the author of "Divine Wind: The History and Science of Hurricanes," published by Oxford University Press.