



Rough Hurricane Season Ahead

Dr. Jennifer Francis
WHRC Senior Scientist

Unlike toilet paper and yeast in grocery stores these days, the main ingredients needed to cook up a busy Atlantic hurricane season are in plentiful supply. The recipe calls for lots of warm ocean water and relatively weak winds in the tropics. While the forecasts made now for summer hurricanes are far from perfect, forecasters with the best track records (such as the group at Colorado State University) agree we'll see more storms—and more strong storms—than a normal year would bring. Just what we need, right? More bad news on top of COVID-19 woes, skyrocketing unemployment, and the ongoing climate crisis.

My friends know I'm a big fan of silver linings, and while it's challenging to find a shiny one in this case, we can be grateful for this early heads-up so we can prepare and keep our ears tuned for Arthur, Bertha, and Cristobal, which will be the names of the first three that reach tropical-storm strength.

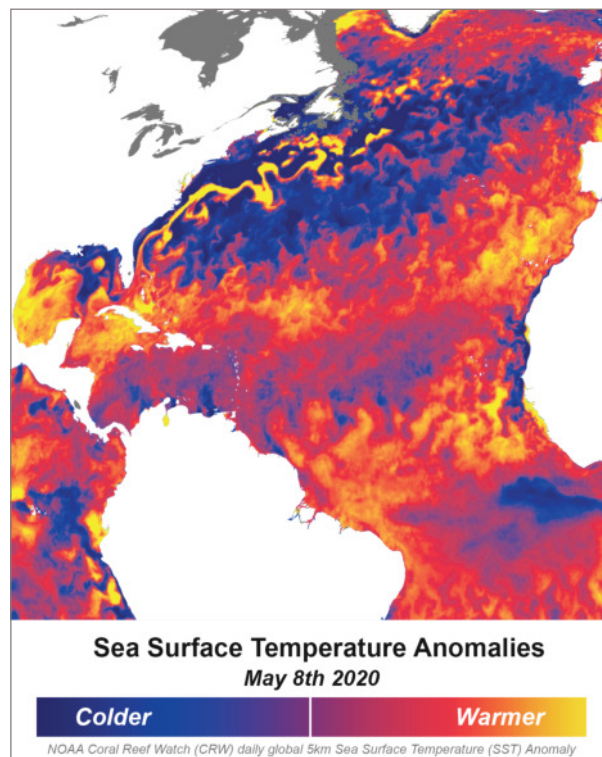
That first ingredient—warm ocean waters—is readily apparent in the map of differences-from-normal in sea-surface temperature for 8 May 2020. The swath of yellow and orange colors stretching from the Bahamas to northern Africa cover the entire zone

known as the Main Development Region—where tropical storms typically form in August and September. The main fuel for hurricanes is the heat contained in the upper layer of the ocean,

as well as the boosted evaporation that occurs when temperatures are high. When that evaporated water condenses into clouds in the storm, it releases energy that drives violent updrafts and thunderstorms. We can also see that the Gulf of Mexico and waters along the southeast coast are running a fever, so any storm that enters these areas or forms there will have plenty of fuel to tap into. About 90% of the heat trapped by increased greenhouse gases is absorbed by the oceans, contributing directly to these abnormal warm pools and to a 7% increase in water vapor since the 1970s.

In addition to ocean heat, another of the main ingredients for storm development is low wind shear. Shear occurs when winds in low and middle levels of the atmosphere blow at different speeds and/or directions, which inhibits storm

formation and can rip an existing one apart. Strong shear tends to occur when El Niño conditions are present in the equatorial Pacific Ocean, but right now there's no sign of El Niño -- in fact,



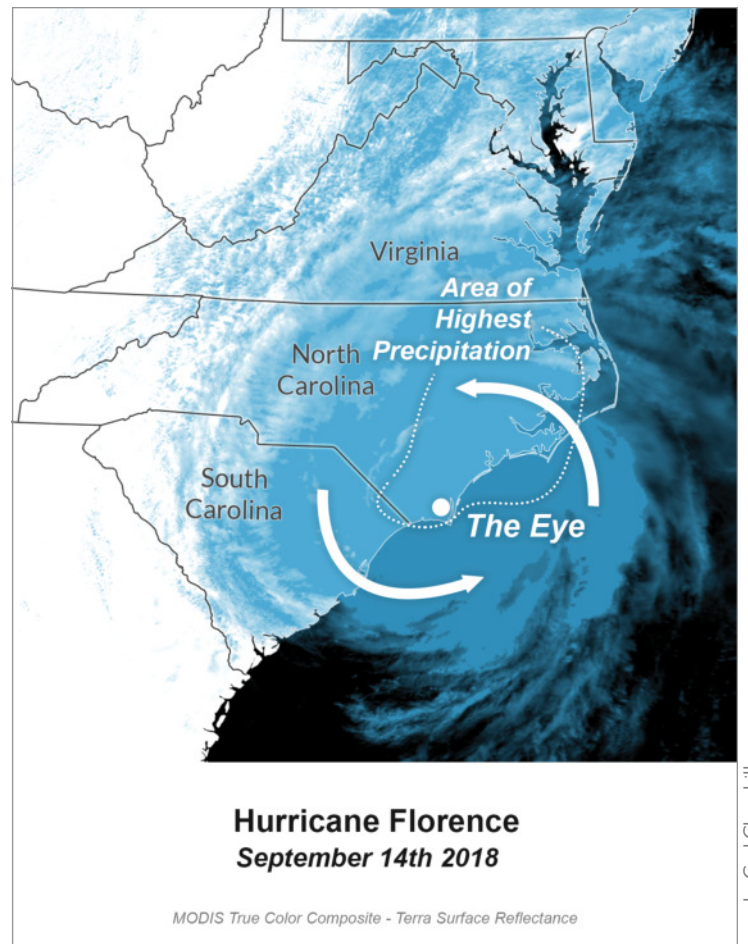
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HURRICANE SEASON *continued from front*

the opposite (La Niña) is expected to develop. So this year's storms will probably not contend with a lot of shear.

While forecasts are useful for predicting the number of storms, they have much less skill in saying if and where they might strike. That said, research on landfalling probabilities is making progress. According to the CSU group, the chances of a major hurricane (Category 3 or higher) hitting the U.S. or a Caribbean country are well above average. Very recent research points to another wildcard in this story: evidence that tropical storms are now moving more slowly, and are more likely to stall. Think Hurricanes Harvey, Florence (see image), and Dorian that wreaked havoc in the past couple of years. And bizarre tracks like Sandy that swerved westward into New Jersey are also more likely as climate change alters upper-level wind patterns that steer storms. Adding frosting to this depressing cake, we know that storms now ride on raised sea levels, so storm surges will be higher, reach farther inland, and do more damage than the same storm would have a few decades ago.

While the chefs seem well along in serving up a rough hurricane season, the dark storm clouds offer another silver lining. Research on the anatomy, health, and life cycle of tropical storms is advancing rapidly, giving us all more time to prepare when hurricane warnings go up in our communities. Scientists at the Woods Hole Research Center are at the forefront of studying how climate change is amplifying extreme weather of all sorts, and how those risks will affect our livelihoods, wellbeing, and economic opportunities.



maps by Carl Churchill

Climate risk partnership adds Ontario Teachers' Pension Plan

WHRC is expanding its groundbreaking initiative with Wellington Management, adding the Ontario Teachers' Pension Plan to our strategic relationship integrating climate science and asset management. Boston-based Wellington Management is one of the world's largest independent investment management firms, with over \$1 trillion of client assets under management through the end of 2019. Ontario Teachers' is the administrator of Canada's largest single-profession pension plan, with \$207.4 billion in net assets.

"If humanity is to meet the grand challenge of climate change, all sectors of society will need to participate. This partnership is a powerful step, because it helps the business and financial communities understand the physical risks of climate change and how they affect livelihoods," said WHRC President Dr. Phil Duffy.

Ontario Teachers' will apply findings from WHRC and Wellington's leading-edge climate research to the execution

of its investment strategies, which span a diverse set of geographies, sectors, and asset classes, and include long-term assets such as private equity, real estate, and infrastructure. This initiative will provide

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deep insights for Ontario Teachers' investment teams on the medium- and long-term financial implications of physical climate-related risks, such as sea level rise, drought, heat, and precipitation.

"Our investments, particularly those in

real assets, require careful consideration of the physical risks posed by climate change. With access to top-quality climate science data, we can build on our own expertise in this area and use the research provided to develop deeper insights," said Ziad Hindo, chief investment officer at Ontario Teachers'. "The world will not be the same after COVID-19, but our commitment to responsible investing will not change. Strong, mutually beneficial relationships, such as ours with Wellington and WHRC, will continue to be a key component of delivering on our commitment."

WHRC originally announced its partnership with Wellington in September 2018, working to apply climate-related insights to the investments of California Public Employees' Retirement System (CalPERS), America's largest public pension fund.

WHRC will continue using the research that comes out of these projects to publish academic papers and inform public policy.

WHRC research helps launch new soil testing service

There's global recognition that soil health is critically important for understanding climate change and prescribing solutions, but only about half of nations have good soil maps. WHRC is part of a coalition hoping to change that with the launch of the Soil Spectral Calibration Library and Estimation Service, which aims to give both farmers and government officials an efficient, low-cost way to understand soil health to improve productivity and reverse land degradation. The Service is an initiative of the Global Soil Partnership, part of the United Nations' Food and Agriculture Organization (FAO).

"Soil is a huge global resource but we've lacked ways of measuring it at scale. The Soil Spectral Calibration Library and Estimation Service is a big step toward trying to bring soil science into the big data era, with potentially huge benefits not just to climate science but to food production and public health," said WHRC scientist Dr. Jonathan Sanderman.

The harm of insufficient soil health monitoring is two-fold: Farmers cannot fully optimize their management strategies; and there is no way of fully assessing the success of new management efforts aimed at improving soil health. But traditional testing is expensive and time-consuming.

Soil spectroscopy offers a powerful alternative—fast, cost-effective and environmentally benign. Soil spectral analysis estimates soil properties using light absorbance measurements calibrated to conventional reference measurements, like wet chemistry soil tests. Access to a high-quality spectral calibration library and estimation service will support unprecedented high quality and quantity of soil data collection, which in turn will improve evidence-based decision-making in many fields, including sustainable soil management, food security and nutrition, and climate adaptation and mitigation.

This project will be the first to develop a true globally applicable spectral library and predictive capability by building out a global reference database, application of new statistical modeling techniques, and, importantly, by focusing on developing a simple web-based end-user interface.



"WHRC scientists use phenomenal remote sensing data when it comes to things like measuring global vegetation, but unfortunately those tools largely stop at the soil surface. WHRC has been leading the development of statistical methods of predicting soil properties from the infrared spectrum, and our next challenge is to raise the funds to support continuing to build it out," said Dr. Sanderman.

Once this service is operational, just one instrument and one staffer can provide affordable analysis of a dozen soil properties. That will allow the Soil Spectral Calibration Library and Estimation Service to bring soil measurement to many countries for the first time, while helping developed countries improve the precision of their understanding of soil health.

Spring appeal adapts to COVID-19

When the COVID-19 crisis passes, the climate crisis will remain the single greatest challenge of this century. Woods Hole Research Center's work is more important than ever.

The pandemic has impacted WHRC in many ways, including shutting down our campus. So, we have reached out to our supporters by switching our spring appeal from paper to email.

If you missed our email last week, please take a moment for the special message from WHRC president and executive director Dr. Phil Duffy, found on our website's donate page.

Your support is critical. And remember, the recent CARES Act raises the cap on itemized tax-deductible charitable giving, and allows for up to \$300 in charitable contributions to be deducted without itemizing.

Many have already responded to the email that went out last week. Thank you. If you haven't yet, please consider making a gift during our spring appeal at whrc.org/donate.





In the news : highlights

Burning wood is not a solution to climate change. *The Hill* joint op-ed by Phil Duffy, Bill Moomaw, John Sterman, and Juliette Rooney-Varga. May 5

Soy made the Cerrado a breadbasket; climate change may end that. *Mongabay* quotes Michael Coe. May 5

Pandemic brings Trump's war on science to the boil – but who will win? *The Guardian* quotes John Holdren. May 3

Disinfect the White House of quackery. *Boston Globe* editorial quotes John Holdren. May 1

McKinsey & Company released its Florida case study with climate risk analyses by Woods Hole Research Center:

Florida Real Estate Values Likely to Take a Beating From Rising Sea Levels, New Report Says. *Weather.com* quotes Spencer Glendon. April 30

Sea level rise won't sink all of Florida's real estate market, experts say. Just parts of it. *Miami Herald* quotes Spencer Glendon. April 28

New committee to advise Harvard president on sustainability goals. *Harvard Gazette* Q&A with committee co-chair John Holdren. April 20

Releasing herds of animals into the Arctic could help fight climate change, study finds. *CBSNews.com* cites WHRC's study that the Arctic is becoming a carbon source. April 20

Earth Day coverage, April 22

Climate scientists keep focus on 50th annual Earth Day. *Cape Cod Times* in-depth look at our Earth Day webinar and speakers Marcia Macedo and Jonah Gottlieb.

Marking the 50th Anniversary of Earth Day with a Call for Individual Action. WCAI features Heather Goldstone.

They Were There as the Modern Environmental Movement Began. As Earth Day Turns 50, They Say the Planet's Problems Have Gotten Worse. *TIME* includes comment from George Woodwell.

Why celebrate Earth Day? Here are 12 reasons. *Live Science* features Marcia Macedo and links to our tapir webinar.

Warmest Oceans on Record Adds to Hurricanes, Wildfires Risks. *Bloomberg* quotes Jennifer Francis. April 18

Pandemic Response Provides 'Silver Lining' In Climate Change, But Also Presents New Problems. WGBH (Boston NPR) interview with Heather Goldstone. April 17

Falmouth Scientist Analyzes COVID-19 Data To Track Pandemic. *Falmouth Enterprise* features work of Distinguished Scientist Josef Kelldorfer. April 1

COVID-19 Forces New Approach to 2020 Polaris Project

To ensure the safety of students, staff, and the communities in which we work, Woods Hole Research Center is revamping this year's Polaris Project to be primarily online and offering this year's students a chance to make the trip to Alaska in 2021.

In a typical year, Polaris Project students, guided by WHRC scientists, spend two weeks investigating climate change impacts in Alaska's Yukon-Kuskokwim Delta. Students develop individual research questions related to permafrost thaw, wildfires, greenhouse gas emissions, and other climate impacts in the Arctic. After fieldwork in Alaska is complete, students then spend two more weeks at WHRC's Falmouth campus to analyze samples and process data, and prepare their findings to present to the scientific community.

The coronavirus pandemic has dramatically altered daily operations at WHRC and many researchers' plans for summer field work remain uncertain. In the case of the Polaris Project, the remoteness of the field site and the vulnerability of local communities were key factors in the decision to cancel this year's expedition to the Yukon-Kuskokwim Delta.

All 2020 Polaris students will receive invitations to join the 2021 trip. The July visit to WHRC remains on the calendar for now, but staff will monitor and follow public health guidelines.



Despite the Alaska trip cancellation, Polaris faculty are committed to delivering an educational experience for this year's students. Participants are being asked to make scientific observations in their own backyards or communities. They'll also participate in a series of online discussions, with topics such as graduate school, current topics in Arctic research, indigenous knowledge, and diversity, equity and inclusion in the sciences.

"We value opportunities to engage with Polaris students beyond the field expedition—helping students apply to grad school and to fellowships, and

working with them on presentations and publications. There's a lot of continued involvement beyond the one month field expedition, and that's part of what makes Polaris so unique. We want to build the next generation of scientific leaders from a diversity of backgrounds to help solve our most pressing scientific and societal challenges," said Dr. Sue Natali, WHRC Associate Scientist and Arctic Program Director.

To support the Polaris Project, go to [WHRC.org/donate](https://whrc.org/donate) and under "Gift Designations," select "Arctic Research and Policy."

Webinar series delivering climate science to home audiences

As the COVID-19 social distancing period continues, WHRC is continuing to present the Spring 2020 Kaneb Webinar Series, delivering key climate science topics in a way that's educational and understandable for all ages. Around two hundred people, of varying ages and from around the world, have attended each webinar.

WHRC Senior Scientist Dr. Jennifer Francis is set to host our next webinar on May 20 at 2:30 pm, *The Arctic Meltdown & Unruly Tropical Storms: How are they connected?* Hurricane season officially begins June 1st, with forecasts warning it may be worse than the historic average. Extreme weather now costs the U.S. more than \$10 billion each year. Dr. Francis has pioneered the science linking rapid warming in the Arctic to weather here in the U.S. — from snowstorms in the northeast, to flooding and drought in the Midwest, and tropical storms in the Atlantic.

Recent webinars include:

Arctic Extremes: The Frontlines of Global Warming, featuring WHRC scientists Drs.

Rachael Treharne, Tatiana Shestakova and Sue Natali.

Climate Action: Bridging Science and Activism, featuring WHRC scientist Dr. Marcia Macedo and Jonah Gottlieb of the National Children's Campaign.

Mild to Wild: How Our Backyard Choices Impact Our Environment, featuring WHRC scientist Dr. Christopher Neill.

The Stories Rivers Tell, featuring WHRC Deputy Director Dr. Max Holmes, WHRC Scientist Anya Suslova, and WHRC Board Member and Fishpond Founder and CEO John Le Coq.

All webinars are available to watch at YouTube.com/WoodsHoleResearchCtr.



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The Big Thaw has been named the Nautilus Book Awards Gold Winner in the Ecology & Environment category, and also the Grand Award Winner. Photos by Chris Linder illustrate the work of WHRC scientists and the Polaris Project.



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