

Science AMA Series: Hi Reddit! We are Dr. Frank Marks and Commander Justin Kibbey, hurricane hunters and scientists at NOAA's Atlantic Oceanographic and Meteorological Laboratory (AOML). We fly into hurricanes to help improve forecasts! Ask us anything!

NOAAgov ¹ and r/Science AMAs¹

¹Affiliation not available

April 17, 2023

Abstract

Hi Reddit! As hurricane season is in full swing we wanted to give you the opportunity to ask us any questions you have: My name is Dr. Frank Marks. I am the Director of the Hurricane Research Division at NOAA's Atlantic Oceanographic and Meteorological Laboratory. I received my Sc.D. in Meteorology from MIT. I'm an expert in tropical cyclones (known as hurricanes here in the US) and serve as the research lead of NOAA's Hurricane Forecast Improvement Project (HFIP). I have been flying into tropical cyclones since 1980, and have logged over 10,000 hours on the P-3 aircraft! I'm here to answer all your questions about hurricanes and the latest hurricane research at NOAA. Ask me anything! I'm Commander Justin Kibbey of the NOAA Corps. I am a trained P-3 pilot. In March 2010, I was selected for an interservice transfer from the United States Navy to the NOAA Commissioned Officer Corps, at the Aircraft Operations Center in Tampa, Florida. My first hurricane flight was in September 2010, and ever since, I have flown about 20 flights per year! I help scientists gather data by piloting planes into hurricanes. Ask me anything! You can follow us on twitter @NOAA_AOML & @HRD_NOAA_AOML to stay up to date with all the different research projects at the lab! We're live! Ask us anything! 3:25pm: Thanks Reddit, our time is up! Thanks for all your insightful and thoughtful questions about hurricane hunting and all things hurricanes. This was tons of fun and a great opportunity for us to share our experiences and connect with all of you! For more information on hurricanes and hurricane hunting you can go to the following NOAA websites: Office of Marine and Aviation Operations: www.oma.noaa.gov Atlantic Oceanographic and Meteorological Laboratory: www.aoml.noaa.gov National Hurricane Center: www.hurricanes.gov To stay up to date on all things hurricane hunting & more follow us on twitter: Hurricane Research Division: HRD Twitter Atlantic Oceanographic and Meteorological Laboratory: NOAA AOML Twitter Office of Marine and Aviation Operations: NOAA OAMO Twitter NOAA Hurricane Hunters: NOAA Hurricane Hunter Twitter

[REDDIT](#)

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NOAAGOV [R/SCIENCE](#)

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You can follow us on twitter [@NOAA_AOML](#) & [@HRD_NOAA_AOML](#) to stay up to date with all the different research projects at the lab!

We're live! Ask us anything!

3:25pm:

Thanks Reddit, our time is up! Thanks for all your insightful and thoughtful questions about hurricane hunting and all things hurricanes. This was tons of fun and a great opportunity for us to share our experiences and connect with all of you! For more information on hurricanes and hurricane hunting you can go to the following NOAA websites:

Office of Marine and Aviation Operations: www.oma.noaa.gov

Atlantic Oceanographic and Meteorological Laboratory: www.aoml.noaa.gov

National Hurricane Center: www.hurricanes.gov

To stay up to date on all things hurricane hunting & more follow us on twitter:

Hurricane Research Division: [HRD Twitter](#)

Atlantic Oceanographic and Meteorological Laboratory: [NOAA AOML Twitter](#)

Office of Marine and Aviation Operations: [NOAA OAMO Twitter](#)

NOAA Hurricane Hunters: [NOAA Hurricane Hunter Twitter](#)

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CORRESPONDENCE:

DATE RECEIVED:

Dr. Marks- have tropical cyclones changed much since you started flying into them in the 80s- and if so, how? What kinds of implications do any changes in cyclone behavior over time have for the next 50 years (or beyond)?

September 23, 2016

DOI:

10.15200/winn.147454.48629

ARCHIVED:

September 22, 2016

CITATION:

NOAAgov, r/Science, Science
AMA Series: Hi Reddit! We are
Dr. Frank Marks and
Commander Justin Kibbey,
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Oceanographic and
Meteorological Laboratory
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us anything!, *The Winnower*
3:e147454.48629, 2016, DOI:
[10.15200/winn.147454.48629](https://doi.org/10.15200/winn.147454.48629)

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[basic_bruja](#)

As far as I can tell the hurricanes have not changed much. What has changed a lot is our ability to make observations in the storm and to get the all of that data directly to the hurricane center in real time. When I started flying only information from the aircraft instruments were transmitted in real time. Now we send dropwindsondes, Doppler radar data, radar imagery, and surface wind estimates. You can see pictures of some of these from our flights into Hermine on our website photo gallery: <http://www.aoml.noaa.gov/outreach/photogallery/>. We send these observations over SATCOM directly to the hurricane center and the NWS model center to be used in models to improve the forecast guidance.

-Frank

I'm currently in flight school, and hurricane hunting has always had a certain curiosity to me. How does one get into the pilot seat of a hurricane hunter? What are the qualifications and selection process for your pilots? Is there a selection for civilian pilots or is military experience required?

[hotelmango](#)

Thank you for your interest in NOAA Hurricane Hunters! It is always refreshing to hear from people pursuing their dream of flying.

Prior to joining the NOAA Hurricane Hunters, I learned to fly in the Navy, where I was trained to fly the P-3C, accumulating approximately 2,000 flight hours. Based on the needs of NOAA and because of my experience flying the P-3C, I was selected for an inter-service transfer to the NOAA Commissioned Officer Corps, which is one of the nation's seven uniformed services. The other way to become a NOAA P-3 pilot is by becoming eligible for appointment in NOAA Corps after graduating with a 4-year degree. After selection, one would take part in an intensive 4-5 month training program. From there they would normally be assigned to one of NOAA's survey or research vessels for a 2-3 year tour. Based on the needs of the service, pilot candidates are selected from this group and would go through a pilot training program. New pilots start out in our light aircraft and once they have gained experience they can apply for a pilot position in the WP-3D. To learn more about NOAA Corps and how you can join, visit <http://www.oma.noaa.gov/learn/noaa-commissioned-officer-corps>.

-- Justin

Thanks for spending time with us today!

Can you describe the seasonality of hurricanes for SE US in the context of El Niño/La Niña cycles and the impact of climate change?

[PHealthy](#)

Hurricane seasonal activity in SE US is pretty much the same as it is in the rest of the US affected by hurricanes. Hurricane activity in the Atlantic is affected on different time scales. We have seen more hurricanes in the Atlantic since 1995, largely due to a naturally occurring climate phenomenon called the Atlantic Multi-Decadal Oscillation, which causes warmer Atlantic Ocean temperatures and a stronger west African monsoon. High and low activity eras typically last from 25-40 years, and we're seeing signs that we might be transitioning out of this high activity era. El Niño/La Niña cycles affect Atlantic hurricane activity on a shorter 3-5 year time frame, where there is typically less activity during El Niño. As to climate change impacts recent studies indicate that global warming is not likely a large contributor to the increase in Atlantic hurricane activity since 1995. NOAA scientists are engaged in ongoing climate studies to better understand and quantify these impacts. --Frank

Do you think that drones could be a big game changer in hurricane hunting?

[Lehot](#)

That remains to be seen. The technology is under evaluation right now. We are working with NASA on evaluating the Global Hawk unmanned aircraft for potential use in sampling hurricanes. The Global Hawk flies at 60,000 feet so the only way it can observe the hurricane is through remote sensing and dropsondes. It is also a challenge to find the storm center from that altitude. We are also evaluating the Coyote small unmanned aircraft, which is launched from the P-3 aircraft and flies near the surface where we will not take the manned aircraft. The Coyote is the size of a large model aircraft and can provide pressure, temperature, humidity, sea surface temperature and wind observations for 1-2 hours. The Coyote flew through the eyewall of Hurricane Edouard and survived so it could potentially be used in operational hurricane hunting, especially with increased endurance. -- Frank

You've probably been asked this plenty of time before, what's the scariest experience you've had while flying into hurricanes?

[ItchyScrotumz](#)

My scariest experience had to be my first storm I ever flew in, which was Hurricane Earl in 2010. It was at night in a strong Category 3 storm with lots of lightning. I remember looking at the radar return, which was full red (high dBZ) and thinking to myself "why am I here?" After a significantly rough ride through the eyewall, we finally made it into the eye. This gave us a chance to relax and catch our breath for a brief moment. As I gathered my thoughts, there was a bolt of lightning on the opposite eyewall that lit up the the entire sky from below the plane to all the way above. It was a scary, exhilarating, and exciting rush of emotions rolled into one.

-- Justin

How the global warming can affect the formation of hurricanes?

[Fahias](#)

This isn't my area of expertise, so I'm going to reference an earlier AMA answer provided by Dr. Gerry Bell, a hurricane climate specialist and research meteorologist at NOAA's Climate Prediction Center. "Recent studies suggest that by the year 2100, greenhouse warming could actually reduce the globally averaged frequency of tropical cyclones by 6–34%, but could also increase their intensity by 2%-11%. In the Atlantic basin, recent studies indicate that man-made global warming is not likely a large contributor to the increase in Atlantic hurricane activity since 1995. NOAA scientists are engaged in ongoing climate studies to better understand and quantify these impacts. We have been seeing more hurricanes in the Atlantic since 1995, largely due to a naturally occurring climate phenomenon called the Atlantic Multi-Decadal Oscillation, which causes warmer Atlantic Ocean temperatures and a stronger west African monsoon. High and low activity eras typically last from 25-40 years, and we're seeing signs that we might be transitioning out of this high activity era." --Frank

What are the conditions like in the centre of the hurricane?

[DongWrestler](#)

It depends on how strong the hurricane is. The hurricane is composed of clouds circling around the

center or eye of the storm. In a poorly developed system it is like a dreary San Francisco day in the eye. But when you break into the eye of a well developed major hurricane, it is glorious. My favorite quote about what it is like to be in the eye is: "It was God's stadium...an almighty bowl of tranquility surrounded by epically vast stands of wind-packed white cloud climbing all about us, unbroken, smoothly towering taller than mountains. The sea writhed beneath it, spume-streaked, and the sky stared down blank and empty above. I must say, 'came a quiet voice from the cockpit, this is definitely impressive.'" - Inside the Hurricane by Pete Davies (ISBN-13 9780805065749) Here are a few pictures from memorable flights into past hurricanes:

http://www.aoml.noaa.gov/hrd/Storm_pages/floyd1999/photos/floyd_eyewall.jpg

http://www.aoml.noaa.gov/hrd/Storm_pages/katrina2005/Reye9.jpg --Frank

My son is in second grade and loves reading about weather. He would like to know: what is the biggest storm you've ever flown into?

[njb42](#)

This is a tough question because as storms evolve they change their intensity and their size. I would have to say Hurricane Ike in 2008 was the largest in size as it crossed the Gulf of Mexico heading toward Texas. It was almost 800 miles across and it had hurricane winds extending out to 100 miles from the center. As it approached Texas the hurricane winds shrunk to about 40 miles from the center as it intensified to a major hurricane. However, it was such a large storm it generated a major storm surge along the coast of Louisiana 100's of miles from the landfall point. In terms of intensity then Hugo in 1989 was the storm with the strongest wind I have flown into.

-- Frank

How does your research translate into better forecasting for individual hurricanes and/also for hurricanes generally? For example, do you work with the tropical meteorology project at Colorado State University?

[CSU_Mike](#)

The purpose of our research is to better understand how a hurricane works to make the hurricane forecasts better. Most of the forecasts are based on numerical models. We use the observations we collect in the storm to help initialize these models and also to evaluate the models to find biases in the model simulation of the storms. For example data we collected in Hurricane Hugo helped us identify a problem in the model physics. After matching the model behavior to the observations the model guidance was improved dramatically. A lot of this effort is under the NOAA Hurricane Forecast Improvement Project and Colorado State researchers work with us as part of that project.

-- Frank

What is the greatest influence on mission planning, including launch times? As an add-on, once launched, how do you work as aircraft commander and mission commander in making changes to your mission?

[bradleyent](#)

Another great question. One of the biggest things taken into consideration during mission planning is storm strength and location. Knowing how intense the storm is forecast to be when we enter helps us properly mentally prepare. Location of the storm is also crucial. If the storm is located near navigational

airways or landmass, it is imperative that we coordinate with the proper Air Traffic Control facilities so they understand what we need to accomplish.

Our launch times are dictated by the operational requirements of the mission. When we are conducting 24hr operations, our launch times are usually 0200 in the morning and 1400 in the afternoon. Since the storm is constantly changing it is up to the team, made up of the Aircraft Commander, Flight Director, and Lead Scientist, to properly decide how to adjust the mission to best meet requirements of the flight.

-- Justin

On a weekly basis, how many times do you listen to the song "Rock You Like a Hurricane" by the Scorpions.

[PoudreValley](#)

"Riders in the storm" by The Doors is our preference.

-- Frank & Justin

Dr. Marks, thank you for doing this AMA. What kinds of data are you guys gathering on your flights besides the classic humidity, temp, wind speed stuff? Do you take air samples for later analyses? If so, what are you monitoring for?

[lm_xoxide](#)

P-3 instrumentation includes flight-level data sensors, airborne radars with Doppler wind finding, cloud physics instrumentation (including electric field measurements), remote sensors for surface wind and rainfall estimation, expendables (e.g.; dropsondes, AXBTs, AXCPs, and drifting buoys), and SATCOM to transmit data back to the ground.

G-IV instrumentation includes flight-level data sensors, airborne radars with Doppler wind finding, expendables (e.g.; dropsondes), and SATCOM to transmit data back to the ground.

http://www.aoml.noaa.gov/hrd/about_hrd/aircraft.html

-- Frank

Hello! Thank you so much for doing an AMA and for doing what you do! You are an inspiration ☺

I am currently getting my Masters in meteorology at the University of Arizona and have found hurricanes to be particularly interesting. How did you guys get into your line of work? How would you suggest a student like myself gets involved in the hurricane/typhoon sector of the NWS/NOAA (especially being a scientist on the Hurricane Hunter)? Did you initially know that hurricanes were going to be your specialty when you were in school?

Thank you again for all you do!!

[malorianne](#)

Thank you! I became a hurricane researcher serendipitously. When I was finishing my doctoral degree in meteorology I learned of a position here at NOAA's Atlantic Oceanographic and Meteorological Laboratory /Hurricane Research Division. My experience in tropical meteorology and doing field work

made me a great candidate for the job, but I had never studied hurricanes. The great thing about working at HRD is that every person brings something new to the problem of improving hurricane forecasts. To be part of a hurricane hunter crew you should get at least a degree in atmospheric science, computer or electrical engineering. From there you could join the NOAA Corps or get an advanced degree taking a curriculum heavy in math, science or engineering, and set your goals for at least a master's degree in your chosen field. Another alternative is to enlist in the Air Force or Navy to get the basic technical training to be a pilot, navigator, electrical or computer technician. --Frank

what's the most rapid intensification, in terms of millibars, that you've seen in a hurricane you've flown into?

[5beats3summers](#)

About 2 millibars per hour in Hurricane Hugo. To put that in perspective, the average is about half a millibar per hour or less.

-- Frank

Is there a specific angle of flight relative to wind direction, to get to the eye?

[ringref56](#)

Very good question. If you looked at the radar on the aircraft and pointed the nose of the plane directly at the eye, you would end up somewhere in the storm, but not in the eye. This is because the winds are constantly pushing you, and though it looks like you are heading towards the eye you are tracking to another location. Depending on how strong the winds are you have to point the nose of the aircraft so that your track will lead you into the eye. The difference between heading and track is known as your drift angle. Sometimes you can have as much as 20-25 degrees of drift angle. We sometimes call this "crabbing" into the storm, where we are pointing the aircraft to the left or right to flight straight. -- Justin

Hi!

What kind of data is gathered by flying through these things that cannot be gathered by other means? (i.e by satellite).

Also, how does your aircraft handle the abuse? Im sure you've run into "severe turbulence" on more than one occasion.

[Halldr](#)

You are correct. The detailed observations, especially of the pressure and wind can not be gathered by satellite. They are unique and the US is the only country that routinely collects these types of observations and has been doing it since World War II. Hurricane flying is 95% boredom and 5% sheer terror.

The WP-3D is built like a tough old pickup truck. It can handle a lot of abuse in the storm environment and come back and fly the next day. This is mainly because of the extremely talented maintenance team at NOAA's Aircraft Operations Center (AOC). Severe turbulence can be a normal occurrence for us during a storm mission. We learn how to fly in this environment through coaching from the experienced Aircraft Commander. Their role is to keep the aircraft and aircrew safe and to teach the younger pilots how to properly fly the aircraft in this extreme environment.

-- Frank & Justin

Hurricanes are a fascinating phenomenon. How often are the models dramatically revised after you record and report the details from inside the hurricane? Is the data shown on this site typical of what is reported <http://www.tropicaltidbits.com/recon/>

Is there a Pacific version of the AOML?

[Eric1600](#)

The observations provide the best situational awareness of what is going on at that time, but the models actually produce the forecasts. The models use all of the observations we can collect to produce the best analysis, which is needed to originate a model run. However, once the models start the observations have a very limited impact on the forecast. What we hope is that providing the best initial analysis makes the outcome as realistic as possible. The actual hurricane models don't change during the season. At the end of each season the models are evaluated and compared to actual observations and upgrades are made before the next hurricane season begins.

The [tropicaltidbits.com](http://www.tropicaltidbits.com) link is showing the flight level observations we send back in real-time via SATCOM. These data available at a number other websites as well.

There is a Pacific Marine Environmental Laboratory based in Seattle, however, they do not study hurricanes. AOML is the principal US federal laboratory that does hurricane (tropical cyclone) research.

--Frank

What type of aircraft do you fly "into" hurricanes? And is this above or below storms?

[KimDongNone](#)

I fly the WP-3D, which is a turboprop aircraft. We fly directly through the storms, normally between 5,000ft - 12,000ft. -- Justin

Typhoon season is almost here on Guam. I simply cannot imagine the stress involved going into one. How long is a typical flight, and how bad is it? The machine can handle what the folks inside couldn't right? Or is it possible the wing just suddenly rips off? Awesome guys thanks!

[ZV9zV8OontJmmR](#)

Most hurricane flights are fairly boring. They last 10 hours, there are clouds above you and clouds below - so all you see is gray, and you don't feel the winds swirling around the hurricane. But what does get interesting is flying through the hurricane's rainbands and the eyewall, which can get a bit turbulent. The eyewall is a donut-like ring of thunderstorms that surround the calm eye. The winds within the eyewall can reach as much as 200 mph [325 km/hr] at the flight level, but you can't feel these aboard the plane. But what makes flying through the eyewall exhilarating and at times somewhat scary, are the turbulent updrafts and downdrafts that one hits. Those flying in the plane definitely feel these wind currents (and sometimes makes us reach for the air-sickness bags). These vertical winds may reach up to 50 mph [80 km/hr] either up or down, but are actually much weaker in general than what one would encounter flying through a continental supercell thunderstorm. Planes are generally not destroyed by strong winds while in flight. Airliners routinely fly in jet streams with winds exceeding 150 mph over the U.S. during the winter. It's the shear, or sudden change in horizontal or vertical

winds, that can destroy an aircraft, or cause its loss of control. NOAA pilots and crew routinely fly in the high-wind environment of the hurricane and don't fear it tearing the plane apart. However, they are always monitoring for "hot spots" of severe weather and shear that they can often identify on radar and avoid if it's too severe. -- Frank

What is the most exciting/intriguing thing you're looking into this season? Is there something you're really hoping to learn?

[pamplemousse2](#)

Each year we develop a [hurricane field program plan](#). One of the most important problems that the National Hurricane Center Forecasters have is how to predict intensity change correctly when storms are affected by vertical shear of the horizontal wind, especially rapid intensity changes. So many of our missions this season are collecting observations from the P-3 and G-IV aircraft to better measure the shear in the storm using the Doppler radar and dropwindsondes. Analyses of the observations are compared to the model output to see how well the model matches what we see as a way to improve the forecast guidance. We have some great cases from Hurricane Earl and Hermine, and we are flying in Tropical Storm Karl right now where shear greatly affected the forecasts.

-- Frank

If given the chance to fly any piece of equipment, what would you fly, and where would you fly?

[Ze-Man](#)

From my perspective, there is nothing more exciting or rewarding than flying a WP-3D on a hurricane mission. I truly believe that if you do what you love, you'll never work a day in your life.

-- Justin

Do other RS imaging techniques provide a lot of useful data?

From my childhood I've only seen color composites on TWC, but now I'm working on my masters, and sneaking some remote sensing courses in.

Particularly, I am curious about the [recent work done using FengYun](#).

Could SPOT be tasked to do something similar? As a secondary question, why do we not have a polarsynchronous satellite loaded with GOES architecture?

Spoiler: the answer is \$.

Edit: that's a typhoon/warm core formation study

[crowcawer](#)

We get very useful data from a large number of microwave sensors that are used to estimate sea surface temperature, surface wind speed, total precipitable water, rain, cloud and liquid water content, temperature profiles, and many more. -- Frank

Hello, I am studying meteorology in college and was wondering what the best path would be to essentially do what you do professionally Dr. Marks, or work for NOAA/AOML in general?

And also, how exciting(or exhausting) was the 2005 hurricane season for all of you?

Thank you for doing this AMA!

[atmosking](#)

Hurricane scientists usually come from atmospheric science, oceanography, or engineering backgrounds. I strongly recommend you take a curriculum heavy in math, science and engineering, and set your goals for at least a master's degree in your chosen field. As I said before "I became a hurricane researcher serendipitously. When I was finishing my doctoral degree in meteorology I learned of a position here at NOAA's Atlantic Oceanographic and Meteorological Laboratory /Hurricane Research Division. My experience in tropical meteorology and doing field work made me a great candidate for the job, but I had never studied hurricanes."

As for the 2005 Hurricane season, it was both exhilarating and exhausting because we had so many opportunities to fly. We were doing experiments with NASA, NSF, etc. For the first half, we were flying into the Atlantic performing experiments and the second half the Pacific.

-- Frank

Does flying into hurricanes ever get old for you?!

Edit: Any advice for 'storm chasers'?

[Sometime_blogger](#)

Never. Every flight is so unique that it never gets old. You think you know what you are going to experience but you are always surprised by something new. It makes work worthwhile. -- Frank and Justin

What do you think the hurricane season will be like this year in the US?

[mv_ru](#)

NOAA updated its seasonal Atlantic Hurricane Outlook on August 11. The Atlantic hurricane season is still expected to be the strongest since 2012, with 12–17 named storms. So far we have had 12 named storms in the Atlantic. People often don't pay attention to the storms that remain out at sea, but they count.

[deleted]

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In addition to drifting and moored buoys and reports from ships at sea, we also have ocean gliders deployed in the Atlantic north and south of Puerto Rico. In 2014, Hurricane Gonzalo passed over these gliders and the ocean temperature data collected was included in hurricane models. This is a new research an effort led by oceanographers here at AOML. You can read more about their work here: <http://www.aoml.noaa.gov/phod/goos/gliders/index.php> -- Frank