NOAA COMMUNICATIONS
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

TRANSCRIPT

NOAA/NASA Global Analysis for 2022

January 12, 2023 at 11:00 a.m. EST via Adobe Connect

Hosted by NOAA Satellites Public Affairs

Media advisory about briefing:

https://www.noaa.gov/media-advisory/noaa-nasa-to-announce-2022-global-temperature-climate-conditions

John Bateman:

All right. Good morning and welcome everyone to this media webinar to discuss NOAA's and NASA's data for the 2022 global temperature record and other climate highlights from the year. I'm John Bateman with NOAA Communications, and I will be facilitating today's briefing.

NOAA and NASA are two keepers of the world's temperature data and independently produce a record of changes to earth's surface temperatures based on historical observations over the ocean and land. Consistency between these two independent analyses and those analyses produced by other science agencies and other countries increases our confidence in the accuracy and assessment of the data, as well as the result and conclusions.

Today's 2022 Global Climate Briefing will feature a short introduction by NOAA's chief scientist, Dr. Sarah Kapnick, a NASA administrator, Bill Nelson, followed by a presentation of the 2022 Global Climate Analysis. After the presentation, there will be a media question and answer session, and the audio from this webinar is also being streamed live by NASA at www.nasa.gov/nasalive.

After the opening remarks from Dr. Kapnick and Administrator Nelson, Dr. Russell Vose, the chief of the Analysis and Synthesis branch at NOAA's National Centers for Environmental Information, or NCEI, will provide a summary of NOAA's 2022 global temperature and climate data. Following Dr. Vose will be Dr. Gavin Schmidt, director of NASA's Goddard Institute for Space Studies, who will summarize NASA's global temperature and climate data for 2022.

After their presentations, Dr. Vose and Dr. Schmidt will be available for questions. Also, the slides from this presentation will be available for download. Just click the link in the download window at the bottom left of your screen.

We will now kick off this briefing with some words from NOAA's chief scientist, Dr. Sarah Kapnick.

Sarah Kapnick, Ph.D.:

Thank you, John. I'm excited to join our colleagues at NASA to highlight some of the ways 2022 stood out in the global climate record. I'm appreciative of this annual collaborative effort between our agencies. Producing analyses like this help us gain a collective understanding of how our climate is changing and how we can work to build a climate-ready nation to help our communities and economy better adapt to what lies ahead.

Our agencies are able to provide this authoritative global scale climate data because of continuously collected and maintained observations. Weather, water, climate, and ocean observations gathered from instruments ranging from satellites orbiting earth to sensors on ocean buoys are the backbone of NOAA's environmental science and stewardship mission. These are the best available science and observations regularly delivered to the American people through this important agency collaboration.

I'll let our experts go into the specific climate trends for 2022. What I will say is that in addition to the climate trends that we saw last year, 2022 also produced costly climate-driven weather events here in the U.S. and worldwide. These frequent and increasingly costly extreme events have human consequences, impact, and economic punch. The U.S. had its third costliest year for weather and climate related disasters on record, exceeding 165 billion in damage. The reinsurance company, Swiss Re, estimated that natural and manmade disasters caused 268 billion of economic losses globally from January 1st to December 1st of 2022, citing disasters such as winter storms in Europe, flooding in Australia and South Africa, and hail storms in France.

In the U.S., we have consistently had both the highest total count more than any other country each year, and the largest diversity of different types of weather and climate extremes that lead to billion dollar disasters. This is generally due to a combination of two things. One, a high incidence of many extremes where both exposure and vulnerability are high for producing damage. And two, climate change is enhancing certain types of extremes that may lead to billion dollar disasters.

A warming planet, which we'll see evidence of from the statistics provided today, means we need to be prepared for the impacts of climate change that are happening here and now, like the more frequent and destructive extreme events. This is where NOAA's climate science and services are more relevant than ever before, protecting lives, lifestyles, and livelihoods, and helping build a climate-ready nation.

As we move to the future, NOAA will leverage its lifecycle approach to how we equitably develop and deliver climate science data and tools from data collection through sharing information with users to support the whole of government effort to address the climate crisis and promote economic development. We are doing this at the international scale with publicly available science and strong collaborations that help countries make science-based decisions and build climate-ready nations abroad as they shape their climate goals.

I'm excited for NOAA and NASA to share this critical climate data with you today. I'm equally excited to see how businesses, communities, and individuals will use this information to enhance our understanding of the world around us and help prepare for a resilient future.

In my capacity as chief scientist, I'm working to engage key sectors of our economy to promote the uptake of the incredible data that NOAA and the U.S. government provides, with our regular climate statistics being a prime example. In my view, it is a key part of what a climate-ready nation means when decision-makers and leaders begin incorporating this key data into their planning, decisions, and forecasts.

With that, I'll turn it back over to John for more on today's announcement.

John Bateman:

All right. Thank you, Dr. Kapnick. Now we'll hear from NASA administrator, Bill Nelson.

Bill Nelson:

Hey everybody, thanks for joining us. If you go back to the year 1880, ever since, look at the hottest years on record, the year 2022 was the fifth hottest year, sharing that alarming distinction with the year 2015. And when you look at nine of the past ten years, they're the warmest years in the modern record since 1880. Now, that's pretty alarming. And that's a trend that is growing in magnitude, and it's a trend that if we don't take it seriously and have some real action to mitigate it, there are going to be deadly effects across this globe.

Now, at NASA, we do science research. You think of us as a space agency, you think of us as an aeronautics agency. We are also a climate agency. And science leaves no room for doubt. So what we're seeing is our warming climate. It's warning all of us. Forest fires are intensifying, hurricanes are getting stronger, droughts are wrecking havoc, sea levels are rising. Extreme weather patterns threaten our wellbeing across this planet, and we need some bold action. And President Biden has sounded a call to action to tackle the climate crisis, and that requires activation at the federal, state, and local level, and internationally.

Now, NASA's value is in our extensive fleets of satellites and instruments on orbit, which provide detailed information of what's happening to the earth. NASA has the most comprehensive data on the earth as a system, and we share it with everybody. We share it around the world. This data has long been invaluable in determining changes to the earth's system, the earth's climate. Combined with the analysis and modeling that we do, we've understood why it's changing.

Now, for example, 20 years ago, data from our satellites showed unexpectedly fast changes in the earth's great ice sheets. EMIT, a mission that launched to the International Space Station last year, was supposed to be looking at how dust storms affect weather. But then, all of a sudden, we saw that it was proving to be a critical tool to measure emissions of methanes and to find the specific source on the planet where the methane was coming.

And NASA is deepening our commitment to do our part, because we're developing over the next decade, the Earth System Observatory. It's going to be a system of about five major observatories that will be state-of-the-art data on climate change, severe weather, national hazards, wildfires, and global food production, because we're going to measure very precisely what is happening to the land, the water, the ice, and the atmosphere, and have a 3D composite of that information, which we're going to share in a physical Earth Information Center, as well as sharing that information virtually to everyone.

Our partnerships across the government, with NOAA, Department of Agriculture, EPA, USAID, USGS, just to name a few, strengthens these partnerships, and that enables us to get this data into the hands of those who need it most. Folks on the ground who use it to plant their crops, to plan their harvest, to map their resources, to provide for the common defense, to protect against disaster.

So NASA designs, builds, and launches this nation's fleet of weather satellites. We turn them over to NOAA. They operate them in addition to all the other assets, the satellites and the ones that I told you that are coming in the future. And these spacecraft have delivered major improvements in global weather forecasting and undoubtedly have saved many lives. And not to mention, NASA's efforts to make the commercial aviation industry greener through sustainable fuels, more efficient airliner design, taxi and takeoff technology and more. And we're just getting ready, for example, to fly the first all electric experimental aircraft, and we are designing new wing design that will give us much more sustainable aviation.

So today's announcement underscores what we already know to be true. If our leaders, not only here, but across the world, do not act on this scientific data, our ice sheets are going to continue to melt, our oceans will become more acidic, extreme weather will intensify. So I'm going to ask you to let's recommit our resolve to take action for our future.

You're going to hear from one of our chief environmental and climate experts, Dr. Gavin Schmidt, director of NASA's Goddard Institute for Space Studies, and he's going to be telling you, later on, more about our findings and analysis. You have a good day, and remember, this is a call for action.

John Bateman:

Thank you so much, Administrator Nelson. We will now begin our review of the 2022 Global Climate Analysis with Russell Vose. Russ.

Russell Vose, Ph.D.:

Good morning, everyone, and thanks to Administrator Nelson for those opening remarks, and Dr. Kapnick as well. So I'm here to tell you, along with Gavin, about some details with respect to global temperature in 2022, and I want to get us all oriented before I kick off the details. Administrator Nelson, in particular, spoke about the fine satellites that are flown by NASA and NOAA, and Gavin and I are big fans of those. And in this case, the data we're talking about this morning are actually predominantly from surface-based observing systems. They're measurements of temperature of sea surface temperature over the ocean from ships, and buoys, and Argo floats, and from near-surface weather stations over the land. So again, we love the satellites, but this morning, we're talking about surface observations.

So onto the headlines. For this year, we're starting with NOAA, and Gavin and I will alternate throughout this presentation. NOAA ranked sixth for 2022. It was the sixth warmest year on record in the NOAA record, which dates back to 1880. If you really like the numbers, it was 0.86 Celsius or 1.55 degrees Fahrenheit above the average for the 20th century. So we were just slightly warmer than 2021.

So having set the ranks, I like to steer away from the ranks as quickly as possible because ranks only tell you part of the story. It's great if it's college football or something and you're on the top of the pile, but what's really more important here is look at the last eight dots on this time series. This time series is of surface temperature, going back to 1880. The last eight dots clearly stand above the rest of the record. The warmest eight years are the last eight years, and they really do stand apart.

If you look back a little further, meaning if I can direct your attention to the blue bars of the blue histogram, it's clear that each of the past four decades has been warmer than the decade that preceded it. And there's only been a steady, steady rise in temperature since at least the 1960s.

And you can look further back. If you look at the first 20 years of the graph, say the last part of the 19th century, and you compare that to today, well, current temperatures are about 1.1 degrees Celsius warmer than they were in the late 19th century.

Why is that important? Well, a lot of you have probably heard about the Paris Agreement, which is ideally trying to keep global warming to a level of 1.5 degrees Celsius. We're getting kind of close to that, and we've been kind of flirting with that for some years now. So the status, that's where we are.

A couple of other things I wanted to leave you with here on this plot... Actually, not on this plot, but it's worth noting. It's certainly warmer now than probably at least any time in the past 2,000 years, probably much longer. And the rate of increase over the past 50 years has been faster than any time in the past two millennia.

As for next year, well, you never know. Barring a major volcanic eruption though, it's probably going to be pretty warm. There's almost a hundred percent chance it'll be in the top 10 again. And with an El Nino potentially brewing, and Gavin could talk about that more a little later, we could be close to our record again.

And of course, all this is consistent with increasing concentrations of heat trapping gases. Carbon dioxide levels were 417 parts per million in 2022. That's a 50% increase over pre-industrial levels. By the way, methane's up 150% and nitrous oxide about 25%. So you can kind of guess where the trend is likely headed. So Gavin, onto you.

Gavin Schmidt, Ph.D.:

Thank you very much, Russ. So the NASA record is put together slightly differently from the NOAA record in terms of methodology, interpolation, and adjustments for urban heat biases and the like. But you see that overall, the trends are very, very similar.

The specific ranking for the NASA data was fifth, joint with 2015. And again, the last nine years have been the warmest nine years in the record. The last eight years have been clearly above one degree Celsius above the late 19th century. And all of the things that Russ said hold true for the NASA record as well. Next.

Russell Vose, Ph.D.:

Oops, sorry about that. We jumped two. All right, so this is a map of basically where it was warm and where it was cold in 2022, according to the NOAA analysis. And you see a lot of reds here or reddish hues. So what that's telling you is, well, it was warm over most land areas in 2022.

It was actually the second warmest year on record in Europe. And if you focus on Western Europe, it was record warm in a lot of it, like the UK and France and Spain and Italy, and the jury's still out in Germany. I think they're finalizing some of their numbers. But record warm in a lot of Western Europe.

Asia also had its second warmest year on record. Some of you probably remember what had gone on in South Central Asia, like India and Pakistan. Really, really severe heatwave that was driven by the hot weather arriving unusually early in the year.

So most of the land's surface was warm or above average. And by the way, when I talk about average, this picture is showing average relative to 1991 to 2020, so the last 30 years.

But there were a few areas that were below average parts of central North America, parts of Central Africa, Southern Australia, but not that much of the land surface. And sadly, that's actually been sort of a typical story. Most of the land surface has been warmer than average for quite some time.

Over the oceans, again, most of the oceans, the Earth's global ocean has been above average, meaning red. But there is that big chunk of the Tropical Eastern Pacific that is blue. It's well below normal. This is being driven by an event or a phenomena called La Nina. Most of you probably have heard of the term El Nino. Well, La Nina is the sister of El Nino. It's basically sea surface temperatures in the Tropical Eastern Pacific are below the long-term average. And what that tends to do is tug global temperatures down just a little bit. And Gavin has a nice slide showing some of those effects here in a couple of minutes. And speaking of Gavin, back to Gavin now.

Gavin Schmidt, Ph.D.:

Yeah, this is our anomaly map. It's with an earlier baseline, and so you're seeing more of the longer term trends. But it's clear that the La Nina effect in the Tropical Eastern Pacific was a very big part of what was going on last year, but it doesn't negate all of the things that are happening around the world. So you can see a very familiar pattern, warming more over the land than in the ocean, more in the north and in the south, and most of all, in the high Arctic latitudes. And we'll get to some of those issues as well.

There's still a very clear hotspot in the Antarctic peninsula and around Western Antarctica. That's of big concern for all of us. And there's still a cool effect in the southern oceans right close to Antarctica, and we could discuss why that might be an exception to the rest of the world perhaps a little bit later in the questions.

Russell Vose, Ph.D.:

All right, so this is kind of a depressing slide, now that I think about it. I didn't mean for it to be that way. We put out this figure every year. It's significant events of the previous year. Significant events of 2022. Select events. This is not a comprehensive, all-inclusive figure. It's as much a compromise between what happened and where there's room on the map. And what I'm going to talk about is in no particular order here, but the takeaway is there have been a lot of extreme events once again.

Let's start with precipitation, rainfall. There was record breaking rainfall in Pakistan in July and August, which caused floods that affected over 30 million people, if I'm not mistaken. Likewise, there was heavy rain that caused severe flooding over parts of Eastern Australia back in February and March, parts of Columbia in April, South Africa in April, Southern China in June, and we could go on.

On the flip side, we also had warm and dry conditions affecting much of Europe during the Northern Hemisphere summer, which exacerbated drought, fueled wildfires, and caused seasonal rivers to run at critically low levels. Similarly, you had warm and dry conditions that affected Central and Eastern China in summer, with the Yangtze River actually hitting its lowest level on record in August. Much of southern South America was also drier than normal. And of course, there was drought in a big chunk of the Western United States over much of the year. And I do acknowledge that earlier this year, we've had some of the atmospheric rivers that have changed the story a bit in California, but that's a story for 2023, not 2022.

Moving on now to the polar regions. Average annual Antarctic sea ice extent was actually the second lowest on record. So the melting continues. If we go to the other pole, average annual Arctic sea ice extent was low once again, but actually was not one of the 10 lowest years. Gavin, again, will go into that shortly.

Tropical cyclones. Overall global tropical cyclone activity was near average. There were 88 named storms in 2022. Again, that's pretty near the average. If you look at the energy that was accumulated by these storms, that was actually the fourth lowest on record. So it was an interesting year in that respect. Average number of storms, but maybe a little less energy in those storms.

But that's not really a much comfort to those who had to face these 88 storms or some of the more notorious ones like Hurricane Ian in Florida earlier in the fall, which is now the third most costly U.S. hurricane on record, or, say, Typhoon Hinnamnor in South Korea, or Noru in Vietnam and Laos.

Certainly a heck of a lot of extremes again this year in a warming world. I'm not saying all these were caused by global warming, by the way. I'm not saying that. But certainly, as the world warms up, you have more fuel for... Drives heat waves. Warmer air can hold more water, which can help fuel storms and so on. So it's a story that's likely to continue. Back to Gavin.

Gavin Schmidt, Ph.D.:

Thank you. We often get asked about the impacts of the Tropical Pacific variations on the global mean temperatures. So here, we're trying to give a sense of how important the phase of ENSO is in terms of the global mean temperatures.

So as we heard, this year, 2022, was a second consecutive year of La Nina, a cool event in the Tropical Pacific. And by regressing out the indices of ENSO, we can try and calculate what the impact is of the state of the Tropical Pacific.

So last year, we estimate that it did have a relatively significant effect, 0.06 Celsius cooling beyond what you would've seen in a neutral year. And that contrasts with years like 2016, where you had a 0.1 addition to the warming because there was an El Nino event. So those differences can make the difference between a year like 2020 and 2019. And if we try and take out that effect, you would've ended up with a situation such that 2022 would've been the second warmest year on record without the La Nina occurring.

This is, of course, the warmest La Nina year in the record. And if you look at the trends for La Nina years, they're warming up at the same rate as the trends for El Nino years or for all years put together.

So these Tropical Pacific variations, they're really like the noise on top of those long-term trends. And the long-term trends are quite predictable and we understand why they're happening, and it's obviously due to our activities dominated by the increases of carbon dioxide and the other greenhouse gases. Russ?

Russell Vose, Ph.D.:

Okay, so we're actually jumping in the hot tub now here for a minute. We're going below the surface. We're going to talk about something called ocean heat content. And 2022, sadly, was also a record year for ocean heat content.

Let me give you just a bit of background on what that is. Ocean heat content is basically the total amount of warmth or heat energy stored by the oceans. It's essential for understanding and modeling global climate because the oceans actually store 90% of the excess heat in the Earth's system.

Changes in ocean heat content are determined using measurements of ocean temperatures from various depths. In this case, this plot shows down to 2,000 meters. The measurements come from a variety of instruments, ranging from expendable, what are called bathythermographs, to gliders, to bottles, to instruments that are actually on marine mammals. I can't say there's a large fleet of dolphins doing this, but they are actually used to collect some of these data.

In 2022, the warmth of the world's oceans again hit a record. It's the highest since records began six decades ago. The four highest ocean heat content years have all been in the last four years. Just like temperature, there's been a steady upper trend since about 1970. And as with temperature, each decade has been warmer than the decade that preceded it. But there's less variability from year to year in ocean heat content because of the heat just keeps stacking up.

There are, by the way, multiple estimates of ocean heat content. This plot shows two. One is from NOAA. November for 2022 exceeds the number of 2021 by, I believe, about nine zettajoules, which is a heck of a big number, heck of a big unit of energy. The NASA ECCO record, that's E-C-C-O, is consistent with the NOAA record in showing the ongoing increase in record levels of ocean heat content.

Just to close on this slide, because changes in ocean systems occur over centuries, the oceans haven't warmed yet as much as the atmosphere, even though they've absorbed, again, 90% of the excess heat since, say, the mid-1950s. If it wasn't for the large storage capacity of the oceans, the atmosphere actually would've warmed a lot more already.

And the implications to this. Warm ocean temperatures provide heat for tropical cyclones. May affect the frequency intensity of marine heat waves. And ocean water, when it's warm, it expands slightly, which helps drive the increase in global sea level. Back to Gavin.

Gavin Schmidt, Ph.D.:

We mentioned earlier on, the increasing heat in the Arctic, where the global warming signal is the strongest. Depending a little bit on where you draw the boundary for the Arctic, the Arctic is warming between three and a half and four times as fast as the global mean, and it's seeing that warmth in all seasons.

The change in the sea ice, as you can see here, we're showing both the March and September Arctic sea ice extent changes. We've had about a 10% decrease in the maximum Arctic sea ice in March, but more like a 40% decrease in September.

There's a lot of interannual variability. And in fact, the interannual variability in the summer, sea ice is increasing because as it becomes less and is more sensitive to the weather. But these long-term trends are fully consistent with what we're expecting from climate models.

One of the things that we mentioned earlier is that the records that we've been talking about are surface-based. So they're ground-based measurements of various sorts. But we do have other ways of looking at those temperatures through reanalysis systems, which are a combination of in situ measurements, remote sensed measurements, and a climate model. And what you can see in the top row there is that the trends since 1979 in the reanalysis data and in the surface data are very consistent. There are differences in resolution. The ERA5 reanalysis has got higher resolution than we put together for the surface data, but you can see that the patterns of change are very, very consistent. Now, these are not totally independent datasets, but they are consistent datasets.

Now, the AIRS instrument is a totally independent dataset that measures ground temperatures in the IR, and that has a record that is now almost 20 years long. It, in fact, is 20 years long. And shows slightly different patterns. Overall patterns are very similar. Overall trends are very similar within the uncertainties of each measurement. So that's a totally independent test for the modern period of the ground-based measurements that we're talking about now.

So we do have independent means to demonstrate that these patterns are not just noise. They're not just urban heat island effects and the like. But they are, in fact, reflective of the changing climate and the changing temperatures that go along with that. Next.

Russell Vose, Ph.D.:

All right, we are going to close with two quick slides here. The first one here is just sort of a public service announcement. NOAA has used a version of a dataset, NOAA Global Temp version five, for several years now, and we have a new one that's going to be coming online in 2023.

The map that you see here on the screen now depicts the anomalies for 2022 in the new dataset, and there are a couple of takeaway messages here. The main one is that we now have full coverage of all land and ocean areas including the poles. So this map shows you just like the NASA map did, that the Arctic was clearly quite a bit above normal in 2022, as was a good bit of the Antarctic, which is a little bit more difficult to catch.

One of the ways we were able to achieve this coverage is by using in part the same basic methods we've used in the past, but we did go out and retrieve a lot of additional data for the Arctic Ocean from ships and buoys and in particular, ice buoys that are managed by the International Arctic Buoy Programme.

So that gives us some ability to make a better estimate of what's going on in the Arctic. We didn't feel comfortable doing that in the past. We have this now. And again, this will be what we start to use with our 2023 reports at NOAA.

Last is a message that despite all that good work, it doesn't matter too much. This plot is showing you the records from four of the major global surface temperature initiatives, if you will. And I'm not going to tell you what color each line is, because you can probably see that they all tend to agree really closely. Despite the different methodologies, somewhat different input data sets, a heck of a lot of good work to do things in slightly different ways to, in the end, get almost exactly the same answer. And in fact, you have to go back to the mid to late 19th century where we started to have somewhat differences of opinion, which isn't surprising because the amount of observations you have back then are really sparse and it's really hard to get them right.

But the point is we all tell basically the same story. While our ranks might differ a little bit from year to year, the long-term trend is up. We wish we could tell a different story, but that's not what we get paid to do. We get paid to tell you what the numbers are. So on that note, I will close and pass the microphone back to John Jones-Bateman.

John Bateman:

All right. Thanks so much, both Gavin and Russ, for that. We are going to now open the briefing to questions from the media. To ask a question, please find the Q&A box located at the bottom of your screen, type in your name, affiliation, your question, and the specific expert you would like to answer it, if possible. And as a reminder, we have Dr. Vose and Dr. Schmidt available to take your questions.

Now, guys, our first question is for either one of you or both of you. Why are the NOAA and NASA rankings for 2022 slightly different?

Gavin Schmidt, Ph.D.:

I can answer that. One of the things that you saw that was different... Sorry. My computer suddenly decides to tell me that it's going to update all of my software. Okay. One of the things that is different in the NOAA and the NASA records up until this year was the interpolation through the Arctic. Then the NASA record has been interpolating over areas of data sparsity for a while because it's been important to include the exceptional warming in the Arctic. So depending on what's happening in the Arctic from one year to another, that changes the rankings that you would get.

None of these things are really statistically significant. So the difference between fifth and sixth in our ranking is on the order of a hundredth of a degree Celsius. That's not a robust change. So a change in methodology, a change in input data could easily flip that either way. So we try and not to make too much of the specific rankings. The key thing is the long-term trends, and they're very consistent from one record to another.

John Bateman:

Wonderful. And if you have nothing to add, Russ, I'll go and ask the next question.

This is from Seth Borenstein from the Associated Press. This is for both Gavin or Russ. When do you expect the world to hit the 1.5 degrees Celsius mark? Russ said we're flirting with it. And when would you say the world's average will be at 1.5 degrees Celsius above pre-industrial, as opposed to one single year? Thank you.

Russell Vose, Ph.D.:

I'll go ahead and take a first stab at it since Seth said I was flirting with it. This is actually a slightly more complicated question because there is the question of when does an individual year hit 1.5 degrees Celsius, and then there's the issue of when does the average, let's say, a 10 or 20 year average, hit 1.5 degrees Celsius, and those are two different things.

There's actually probably, I don't know, 50% chance that we have one year in the 2020s that maybe jumps above 1.5. I think the World Meteorological Organization has already stated something to that effect. If you look at the Intergovernmental Panel for Climate Change Sixth Assessment Report, which focuses more on averages for multi-year periods, I think it projected that we'd hit 1.5 degrees Celsius of warming in the late 2030s or 2040s and sort of a sustained average.

So those are two different answers to your question, Seth. But long story short, we might hit it for any given year sooner than we will hit it on an average basis.

Gavin Schmidt, Ph.D.:

Yeah, so that's obviously true. The current rate of warming is just over 0.2 degrees Celsius per decade. So if you think we're at 1.1 now, which we do, 1.1 to 1.2, effectively we have two decades before, at a sustained continued rate of warming, we would be 1.5 and above, subsequently.

Russ is right. The first year with 1.5 anomaly will be an El Nino year probably in the early 2030s.

John Bateman:

Okay, thanks to you both. We now have another question from Aakash Nagenpure. This is for either one of you. Will the actions we take today be enough to forestall the direct impact of climate change, or is it too little too late?

Gavin Schmidt, Ph.D.:

I mean, I can address that. So we're already seeing the impacts of climate change. Our attributions of the climate changes that we've seen right now suggest that all of the trends that we're seeing are effectively due to human activities. Carbon dioxide being the number one cause, but also methane, nitrous oxides, black carbon, deforestation and the like.

That attribution, that understanding also tells us that future warming is a function of future emissions of carbon dioxide. So we, as a society collectively, we still have agency. So what we are going to do in the future is going to determine what happens in the future.

So if we continue to emit at the rate that we are emitting right now, then we are going to continue to warm and we would be pretty much rushing past 1.5. If we collectively reduce emissions quite quickly, then we can avoid the higher temperatures. I mean, we're not guaranteed to continue on a linear trend. That trend is really very much a function of what we decide to do with respect to emissions.

Pledges that countries have made through the Paris Agreement suggest that efforts are being made sufficiently globally to not exceed 2.5 or 3 degrees Celsius by the end of the century. But obviously, that's still a lot more warmer than we are seeing right now and what, I think, we should be comfortable with.

But I think that efforts will... This is, obviously, my personal opinion. I think efforts will increase and we may avoid the worst projections. But it's never going to be too late to make better decisions. At any point in the future, we can decide to do something that will reduce the emissions and reduce the temperatures in the future. So this is not a one and done deal. This is a continued, sustained issue that will continue and be sustained for the rest of this century.

John Bateman:

Great. Thank you so much, Dr. Schmidt. All right, next question for either one of you. This is from Rebecca Hersher from NPR. Gavin teased something about heat in the southern ocean. Can you say more about that? Thanks.

Gavin Schmidt, Ph.D.:

Yes, I can. So one of the interesting discrepancies between model predictions and what's been happening in these records is that the Southern Ocean warms pretty consistently in model predictions of the historical period, and that hasn't happened.

And one of the things that is not included in many of those models is the impacts of the anomalous freshwater that's coming from the Antarctic continent. So Antarctica is losing about 150 gigatons per year of mass from its ice sheets and as much again from the floating ice shelves. That freshwater is affecting the stratification and mixing in the Southern Ocean, and we think that that is likely to have been causing a local cooling despite the fact that the ice as a whole is melting because warm water from below is actually coming in and melting those ice sheets.

So we are looking at improving the modeling on this and further investigating the causes of that particular anomaly, which is both scientifically interesting, but also of practical significance because of its implications for sea level rise, both through heat thermal expansion of the ocean and through the addition of ice into the ocean.

John Bateman:

All right. Thank you so much. Next question, from Dinah Pulver. One of you mentioned volcanoes. I think that might have been you, Russ. Could either of you, or perhaps for Russ, since I believe you're the one who mentioned it, could you discuss briefly any impact seen from the Hunga Tonga eruption? Did it have a bearing on the global temperature last year?

Russell Vose, Ph.D.:

Yeah, I'll take the first stab and then Gavin can actually add content to it. That eruption was remarkable and it injected a lot of water vapor into the stratosphere. I mean a lot of water vapor. And that could, in theory, have a small positive impact or could... Meaning it could increase global temperatures a little bit. That's my understanding of it. Gavin, do you have something more you want to add to that?

Gavin Schmidt, Ph.D.:

Yeah, so at the AGU meeting in December, there were a couple of sessions specifically about the Hunga Toga eruption. Absolutely fascinating science, so I think people should be covering that as a science story in and of itself. The plume reached 56 kilometers, which is absolutely massive. But unlike most of the previous volcanoes that we have examined over the 20th century, it didn't put very much sulfate, sulfur dioxide, into the stratosphere.

So if you recall Mount Pinatubo in 1991 or El Chicon in 1982, they put large amounts of sulfur dioxide into the stratosphere, which became sulfate aerosols, which are reflective, and so had a very dramatic cooling impact on the surface temperatures, which you could see in one of the earlier slides if you were paying attention.

But Hunga Tonga did not put very much sulfate in the atmosphere at all, and what it did put in was processed very quickly. So the big effort, the big impact was in stratospheric water vapor. And it seems to have added about 10% to the total burden of stratospheric water vapor just from that one eruption.

And water vapor doesn't... It drifts around a lot. It has quite a long lifetime in the stratosphere. So we'll be tagging that anomaly for a while. But in and of itself, while stratospheric water vapor is a contributor to global warming, it's not large enough to really be seen in the noise of the interannual variability.

John Bateman:

All right. Thank you so much. Russ, if you're able to, we have a question referencing one of the slides. Are you able to go back to slide seven by chance?

Russell Vose, Ph.D.:

Yes.

John Bateman:

While you do that, I will mention the question. It is from Isao Matsunami from Chunichi, which is a daily newspaper in Japan. The question is, "On page seven of the slide, what do you mean by the influence of La Nina on average temperature? Do you mean the actual energy flow into La Nina from surrounding areas, or the mathematical impact on the averaging due to the large size of the La Nina area?"

Gavin Schmidt, Ph.D.:

So it's a little bit of both. So obviously when you have a La Nina, you have areas of the world that are cooler, and so that goes into the averages for any particular one year. But the impact of the Tropical Pacific actually has a broader impact. It changes the amount of water vapor in the atmosphere, it changes the cloud distribution. That changes the distribution of heat elsewhere, not just in the Tropical Pacific. That's why it has such a wide impact.

So when we're saying the La Nina impact on global temperature, you're including both of those effects. So both the local changes in SST, but also the far field changes in water vapor and radiation that are also affecting the temperatures elsewhere.

John Bateman:

Wonderful. And actually, there was a second part to that question. A new Global Analysis version 5.1 is available in GeoTIFF, NetCDF format? Yes or no?

Russell Vose, Ph.D.:

I believe NetCDF. I don't believe we have it in GeoTIFF. And they're actually not publicly available yet. We release those in February. So the slides I had in this presentation were sort of a teaser to give people a heads-up that this time next year, we'll be using a different product.

John Bateman:

Wonderful. Thank you for that, Russ. Next question we have, from Eric Niiler from the Wall Street Journal. It's about ocean heat content. He asked, "Can you quantify the amount of ocean heat, such as what is nine zettajoules equal to?"

Russell Vose, Ph.D.:

All right, this is always a... It's a great question. It's a strange unit, isn't it? I'll just relay a couple of analogies that I've heard used in the past to give a sense of the magnitude of this. One is the total energy consumption around the world is about a half a zettajoule annually. So there's one metric. Another one that's far more grim is something like, I think, a zettajoule is equivalent to five Hiroshima bombs going off every second or something like that. It's a massive amount of energy. That's the takeaway message.

Gavin Schmidt, Ph.D.:

Yeah, it's very big.

John Bateman:

Yeah, I agree. Yes, it sounds like it. Thank you guys both. We had another question. It was a region specific question, if you're able to answer that. And if not, the media person asking this question can reach out to me. It's from Paola Wisky from the Diario Libre from the Dominican Republic, asking what they can expect for the Caribbean in terms of extreme events coming up in 2023.

Russell Vose, Ph.D.:

Well, I'll take a first quick stab at it. It's a great question. I mean, if I was living in the Caribbean, I would really love to have an answer to that question. But I can't say anything more now than probably what you usually expect in a climatological sense. You're always going to run the risk of tropical cyclones, and that's probably your biggest risk. But I don't think that it would be possible to make a statement for what's going to go on in the Caribbean this year beyond that.

John Bateman:

Thank you, Russ. Next question. Let me see here. From Greg Harman, Deceleration News. Again, either one of you. Can you quantify how much La Nina was dragging down global temperatures in 2022 and what force that will bring as El Nino shifts into gear later this year? Given that all weather systems have imprinted of all this additional human-generated heat, is it useful for journalists to stop asking about the impact of our activities on any particular weather event, or is it time to retire that question? And actually, I'm sorry, right after that, he said, "Let me clean this up a bit." So let me re-ask that if you need to.

Gavin Schmidt, Ph.D.:

I... Yeah.

John Bateman:

Or did you guys get it?

Gavin Schmidt, Ph.D.:

I can read both, so I'll just respond. Actually, so the slide up here gives you the answer to that. So La Nina dragged down the temperature, if you like, by about 0.06 degrees Celsius, about 0.1 degrees Fahrenheit, this year.

We are in a triple dip La Nina situation. So going into 2023, we have a slightly milder La Nina event happening. That will continue to drag it down, but it won't drag it down as much as last year. So we anticipate that 2023 will be a warmer year.

Whether at the end of '23 we start moving into an El Nino situation is unknown at this point. I don't think we have good predictions that far out. But should such a thing happen, then we would anticipate that the following year, so that would be 2024, would be a contender for the warmest year on record.

The next El Nino, whether it happens at the end of this year or in subsequent years, that will trigger almost certainly a new record. We can still get a record without an El Nino event. Even a neutral event can produce a record in these temperatures, and you can see that happening if you look historically.

Now whether the impacts of global warming on weather extremes is becoming an uninteresting question, I don't think so. I think it's becoming a more pertinent question. But the question that should be asked is not whether any of these extreme events are being caused by global warming, but whether these things are being... To what extent they're being made more intense or more frequent by global warming.

That, for a whole class of events now, if it's a heat wave, the answer is yes, it's being made both more intense and more frequent by global warming. For intense precipitation, the same thing. But for droughts, tornadoes, derechos, the jury is still out on what the direct contribution is from global warming.

But it is still an interesting question, and I think it's a question that as we try and kind of add up the costs and the damages associated with climate change, it actually becomes a very pertinent question.

John Bateman:

All right. Thank you, Gavin. I just want to remind folks, we have about five more minutes left of this press briefing. And we do have another question for you. This one is from Manuel Mazzanti from Exploracion Espacial. Pardon me if I mangled that pronunciation. If you would have to name one, which industry is the one that contributes the most to global warming in your opinion?

Gavin Schmidt, Ph.D.:

It's very easy. It's power generation. It's the burning of fossil fuels for the generation of electricity, followed by the transportation sector, the burning of fossil fuels in cars, trucks, automobiles and the like.

John Bateman:

All right. Thank you, Gavin. This next one is from Mara Hoplamazian from New Hampshire Public Radio. How did snowfall look throughout 2022 compared to past years? How do you see climate change affecting snowfall, given the rise in temperatures and warmer air holding more water?

Russell Vose, Ph.D.:

I can probably take a quick one at this. 2022, it's basically Northern Hemisphere snow cover. There's not much in the Southern Hemisphere. Northern Hemisphere snow cover for 2022 was near average.

As for how climate change is going to affect snowfall, that's a somewhat more complicated question. Obviously, if it gets warmer, you might expect there to be fewer snow events and more rain events. But that depends upon where you are, and you're still going to have major snow events because you still have winter.

If you're talking about the Northeast, and I'm trying to jog my memory here, there's some indication that heavy snowfalls have been a little more frequent in the Northeast, which is consistent with increasing temperatures in the Western Atlantic and Arctic air outbreaks from polar vortex disruptions.

But again, I'm speculating since this is New Hampshire Public Radio, that's why I'm giving you that answer, but it really depends upon where you are.

Gavin Schmidt, Ph.D.:

Yeah, and let me very briefly add to that. If you look at trends in snow cover, we're seeing very strong trends in spring and summer. So we're seeing less and less lingering snow in the higher latitudes.

The winter snow cover trends are noisy, but actually quite steady. But then when you have snowfalls, like we saw very large lake-effect snowfalls in Buffalo and surrounding areas very recently. Part of that is that the Great Lakes are not freezing up as early as they used to, and so there's more moisture for lake-effect snow. So when you have an Arctic climate blast, you're seeing an increase in snowfall. So that may be particularly in the early part of the winter, and again, perhaps in the later part of the winter, early spring, you would anticipate that in some of those regions you'll be getting more and more snow or heavier snow.

But it is a complicated picture. We have work on that that we're about to submit, but it is a complicated picture. Yeah.

John Bateman:

All right. Thanks to both of you. We have one more question as we start wrapping up this press briefing. This one is from Dave Byrnes from Courthouse News. This is for either one of you guys. Mr. Schmidt talked about the need to exert collective agency to alter our climate trajectory course, but the 2017 Carbon Majors report attributed 71% of global industrial emissions to just 100 companies. If that report is accurate, at what point does NASA or NOAA say the problem is capitalism?

Gavin Schmidt, Ph.D.:

Well, I think it's unlikely that NOAA or NASA will blame capitalism that's kind of a little bit out of their wheelhouse. I mean, personally speaking, I think that that's somewhat of a misleading statistic. The companies that they're including there are the oil companies and the coal companies, but all those products are being used by people and by industries and by cities and other infrastructure. It isn't as if we could just turn around and say, "ExxonMobil, stop producing fossil fuels," and then we'd solve the problem. What we need to be doing, my personal opinion, right, is moving away from fossil fuels. But I don't think that just kind of naming and shaming the fossil fuel companies does really very much to help us on that track.

John Bateman:

All right. Thank you, guys. And I believe that is the last of our questions for today. I want to thank both of you and everyone else who participated in this, the presenters, participants, for joining us today.

I just want to remind everyone though that a recording of this media briefing will be available later. Hopefully later this afternoon. It will be on the online media advisory on noaa.gov, as well as on NOAA Satellites' YouTube channel.

If anyone from the media also has any additional questions or informational needs, you can feel free to reach out to me, John Bateman, or John Leslie, my colleague at NOAA Satellites. Our email address is nesdis.pa@noaa.gov. That is nisdis.pa@noaa.gov. And again, that contact information is also available in the media advisory. We really appreciate all of you joining us today.

Gavin Schmidt, Ph.D.:

Thank you.