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NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

TRANSCRIPT

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>> JOHN BATEMAN: Good morning, everyone. And welcome to this media webinar to discuss NOAA's and NASA's 2023 global temperature record and other climate height lights from the year, I'm John Bateman from NOAA communications facilitating the meeting. NOAA and NASA record the Earth's service temperatures based on historical observations over the land and ocean. Consistencies between these independent analyses and those produced by science agencies and other companies increases competence in the accuracy and assessment of the data and well as resulting conclusions. Today's 2023 global briefing will feature a short introduction by Dr. Sara Kapnick and NASA's chief scientist Dr. Kate Calvin followed by the presentation of the 2023 global climate analysis. After the presentation there will be a media question and answer session. We will begin the 2023 climate review with Dr. Russ Vose, chief of monitoring and assessment branch at NOAA's national centers for environmental information or NCEI who will provide a summary of NOAA's 2023 global temperature and climate data

Following Dr. Vose will be Dr. Gavin Schmidt Director of Goddard institute for space studies who summarized NASA's data for 2023. After their presentations Dr. Schmidt and Vose will be available for presentations and slide 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 media briefing with some word from NOAA's chief scientist Dr. Sara Kapnick.

>> SARAH KAPNICK: Thank you, John. I'm happy to join our colleagues at NASA to highlight some of the ways that 2023 was a truly record-breaking year in the global climate record. I'm appreciative of this annual collaborative effort between our agencies. Producing analyses like this helps us gain a collective understanding of how our climate is changing. This information is critical to inform decisions and actions to build both climate nation to help communities by protecting live, livelihoods and property. This is a core mission of NOAA. But can also be wielded to prove economic resiliency and innovation as we anticipate the change experienced and what lies ahead a duty of the agency the Department of Commerce. NOAA and NASA is able to provide this because of continuously collected observations. Weather, water climate and ocean observations ranging from operational weather satellites orbiting Earth to land-based sensors to sensors on ocean buoys are the backbone of the science mission. These are the best available science and observations regularly delivered to the American people through this important agency collaboration. I'll leave it to our experts to go into all of the specific climate observation statistic, but I have to pause and say, the findings are astounding. 2023 was an extraordinarily warm year that produced many costly climate-driven weather events here in

the United States and worldwide. These frequent and increasingly costly extreme events have human consequences, ecological impacts and socioeconomic effects.

The U.S. alone has a record-breaking 28 separate billion dollar weather and climate disasters this past year causing over 90 billion in damages. The 28 events easily surpassed the previous record of 22 events set in 2020.

Since 1980 the U.S. has been impacted by 376 weather and climate billion dollar disasters costing over $2.6 trillion. In the U.S., we have consistently had both the highest total count more than any other country each year and 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 exposure and vulnerability are high for producing damage and, two, climate changes enhancing certain types of extremes that may lead to billion dollar disasters. The enterprise will it's apart the specific cause of events in 2023 and we're committed to improving research and data products in response to observed events and damages which continue to identify vulnerable region, help for future events and build equitable climate resilience to extremes.

A warming planet which we'll see plenty of evidence from today, recapping the warmest year on record means we need to be prepared for the impacts of climate change that are happening here and now, like extreme events that become more frequent and severe. Where is where NOAA's climate services are more relevant than ever before. The vulnerability of events can be managed if we compare document changes from the past to the present and predictions and projections of the near and distant future. The science services can be wielded to protect properties to help build a climate ready nation.

As we move to the future NOAA will continually develop and collect data science and tools from data collected to support the whole effort to dress the climate crisis and protect economic development. We're doing this at publicly aill valuable science to help communities and countries build climate ready goals abroad as they shape their climate goals. I'm excited for NOAA and NASA to share this critical climate data with you today. Equally excited to see how businesses, and communities and individual use this information to enhance understanding of the world around us and help prepare for resilient future.

In my capacity as chief scientist at NOAA and Department of Commercial, I'm keeping up with the information NOAA provided. Through private sector engagement, public private agencies within the Department of Commercial and across the entire Federal Government, we're co-developing and supporting innovation in the use of NOAA science data products and technology. In my view this is a key part what climate ready nation means from local to international scale as well as private sector make use of the

Foundational work of our agencies and fully unlocking value to society.

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

>> JOHN BATEMAN: Thank you, Dr. Kapnick, we'll now hear from NASA's chief scientist Dr. Kate Calvin.

>> KATE CALVIN: Thank you, John. In regard to climate, 2023 was a record-breaking year. Last summer, we came together with our partners at NOAA to announce our findings of it being the hottest June, July and summer on record. Gavin and Russ are going to share more information about the full annual analysis, but it is clear that our planet's climate is changing.

I'd like to take a minute to discuss the importance of our research and observations and why it is important to share this information, especially when planning for the future. As NASA, one of our most important missions is our home planet. One way we study Earth is through satellites we use the unique vantage point of space to see all of Earth. We have more than two dozen satellites in orbit each of which is designed to measure something different so we can see things like vegetation, clouds and precipitation, carbon dioxide and more. We also use surface and airborne measurements to provide a more complete picture of Earth. And we've been observing the Earth for decades so we can see the state today and how it is Inge charge over time. And one of the things we're observing is climate change which is impacting people and communities around the world.

In the last year, we saw extreme heat event, heavy precipitation and flooding, wildfires droughts, long term observations are critical for understanding these changes and woe provide this information public lick so people know what is happening where they live. We work closely with partners at NOAA and many efforts. In June of last year we opened the Earth information center with NOAA and several other Federal partners as part of NASA's efforts to support open-sourced science and making data and information as accessible as possible.

Collaboration between NOAA and NASA will increase and continue with the upcoming launch of the NASA pace mission and later when we work with NOAA to launch the next satellite in the NOAA goes series. NASA's pace mission will take advanced measurements of sea and sky. PACE will provide never before seen view of aquatic ecosystems that feed fisheries but produce algae blooms. And impact of aerosols. This will build on the 06-plus Earth observation record and help us better under how the climate is changing. You'll hear from NASA and NOAA on some long-term observations focusing on surface temperature. Back you to, John.

>> JOHN BATEMAN: All right. Thanks so much, Dr. Calvin, we will now begin our review of the 2023 global climate analysis with Russ Vose.

>> RUSSELL VOSE: Thank you, John. Good to be back here with Gavin and thanks for the nice introductions from Sarah and Kate. You heard the head line in a bit. Gavin and I will take you to the gory details starting with this particular figure, yeah, 2023 ranked warmest. This figure shows more specific the annual temperature through time, from 1980 -- or 1880 to present, from NOAA's global surface temperature record. Y a-s I is the departure from the long term baseline. Each dot is temperature per year and decadal averages. NOAA and NASA analyses use surface data from ships and buoys and air temperatures from surface weather stations. Don't use satellite information or weather forecast models in our particular analyses. They are great tools we just don't use them in reconstructions. 1.18 degrees Celsius above the 1901-2000 baseline that beat the warmest career by .015 degrees Celsius. That's big. Most records are a few hundreds of a degree. This is a big jump.

Look back at the figure, it is worth noting the last ten dots represent the warmest years on record. Last ten years were the warmest years on record.

Look back, each of the past decades warmer than the decade that preceded and an increase in temperature since the 1960s and going much further back than that.

Now, as for next year, because everybody wants to know about next year, barring major volcanic eruption which we're not pulling for, the NOAA calculation suggests there's a one in three chance 2024 will beat 2023. And a chance it will rank in the top five. But for the sake of full disclosure, because those predictions often don't talk about the record, last year at this time we were saying there's only a 7 percent chance 2023 would be the warmest year on record. The point is you have to take these with a grain of salt.

The bigger point all is consistent with concentrations of heat trapping gases. Carbon dioxide is about 50 percent higher than pre industrial levels, methane is up 150 percent. Ny tress oxide 25 percent. Present day concentrations of carbon dioxide, are elevated levels, higher than the last 2 million years and might be higher than the last 14 million. It's been a long time since they've been this high.

There are other factors that contributed to the heat in 2023. Gavin will go into these in more detail one is the transition from La Niña, to strong El Niño by mid year. El Niños have a warming event for a couple reason, tropical eastern Pacific is a big chunk of the Earth's surface, a lot of the area to be above normal. El Niños can cause droughts in other areas, it is dry causes the such fast to warm up and make it warmer.

And the aerosols tiny particles Kate mentioned. Aerosols have gone down. The decline contributed to higher temperatures this year. And then there was the volcanic eruption in Tonga in 2022 which spewed a large amount of water vapor into the stratosphere and that may have had a role in nudging things up this year.

But that's where I stop. I'm going to hand the torch off to Gavin.

>> GAVIN SCHMIDT: Thank you very much. Russ, you gave a pretty good summary. Our data is very similar to that of NOAA's. The top line numbers, and the difference that 2023 was compared to the previous record is slightly different, but we're talking very, very small differences there at the 100th degree level. That's not really significant.

I it is worth pointing out that our uncertainty on the annual mean anomalies is around .05 degrees C. So, the distance by which 2023 beats the previous top years, which, in our record, for 2016 and 2020, is clearly above the measurement uncertainty. So, we're looking at this, and we're frankly astonished. One of the things that we have historically liked to do in these briefings, is given a little bit of a story about why any one year is different from any other year, and there are a lot of candidate stories this year, but none of them really work.

As Russ pointed out earlier, the predictions that we had at the beginning of the year, because we were starting with a La Niña phase in the tropical Pacific, were that, you know, this year would be pretty much on trend, and with only a small chance of being a record warm year. And that's not how it worked out. And this has been very unusual. And I think you'll see, as we go forward, quite how unusual this year was.

Russ?

>> RUSSELL VOSE: Thanks, Gavin. Now we're going to take a look at a map, if you will. This is NOAA's map for temperatures in 2023. Reddish areas had above average temperatures, and blueish areas were below average. And baseline is 1991 to 2020. Basically the last 30-year period. Temperatures were warmer than average. Reddish in color. Over the vast majority of Earth's land surface. Areas of warmth included arctic, North America, and central Asia. North America and South America and Africa had the warmest year on record. Europe ranked second. Overall it ranked second as a whole. The north Atlantic and eastern tropical Pacific stand out in this regard the latter going to El Niño which developed last year and still going strong. Overall it was the warmest year on record for the ocean surface as well.

The tiny map in the lower left tend to put the heat in perspective. I deliberately made it tiny. I want you to see the fact that most everything is red. Anything that's reddish, meaning most of the planet was much above average, meaning the temperatures in those respective areas were -- exceeded the 90th percentile for that location. This is pretty unusual. It was pretty hot. But there were, as always places that were cooler than average, meaning blueish in color, but the areas are relatively small. Eastern and western Antarctica are good examples and part of the Southern Ocean near western Antarctica was normal as was southern Greenland.

Now back to Gavin who will give a similar map but for a slightly different baseline period. This map will look a you little different.

>> GAVIN SCHMIDT: The basic picture is the same. It was warm everywhere. This is with respect to the 1955 to 1980 baseline. So, there's been more global warming. So you can see that's -- clearly you can see clearly the effect of El Niño on the tropical Pacific but the warmth extends beyond the tropics to northern hemisphere land, the arctic and the rest of the world.

What we're seeing is a pattern that is broadly predicted. The long-term patterns are broadly predicted. We expect more warmth over the land and ocean. We expect more warmth in the north and south and expect most of the north to be amplified in the arctic. And when you take the longer view, this is what you see.

And so, that part of what we're seeing is quite well predicted, and is in line with our long-term expectations for how the climate will be changing, given the changes in greenhouse gases and other forcing, but the specifics of this year are quite different, as I said. So, Russ?

>> RUSSELL VOSE: All right. Now we're going to spend just a minute or so looking at a movie for the year. What we showed you before is basically the average picture for 2023. But there's a lot of variability through the year, and that's what this animation is here to demonstrate. And, again, it shows the departures from average for each particular month. And the basic message here, things got hotter at the year went on. Early in the year which is where we are now. There are large land areas with below average temperatures such as eastern Asia and North America. That's somewhat typical. You have some areas normal and some above. There are large areas, global ocean with below average sea surface temperatures such as tropical eastern Pacific and Indian oceans. Midyear things called down, big intense areas of blue and red dated somewhat. Which is Tim Cal for summer. But what you started to see midyear the mobile oceans increasingly warmed up. They turned pinkish and reddish. This really stand out in the tropical eastern Pacific, which, again, is capturing the transition from waiting La Niña to El Niño, and the land is warm as well.

In the end, from June through December is the warmest month on record. Of the global ocean was record warm for nine months, April through December. The July temperature value was the warmest of all months on record and September anomaly value was the darkest departure from average from record.

If you want to think of things as a horse race from 2023 and next warmest year which is 2016, things went like this: 2016 was the pace setter early on. It was substantially ahead of 2023, 2016 last steam in springtime and 2023 continued to gain ground in the back stretch, leading by a nose by late summer. By the end of the race 2023 won lie a longshot. It was the largest margin of victory on record. But it was no way in any kind of photo finish.

Okay, that's enough of the video for now, let go ahead to the next slide, if we can. Gavin?

>> GAVIN SCHMIDT: So, this is where it starts to go a little bit both interesting, and perhaps a little discomforting. So, we have traditionally seen the picture of the long-term trend of the record being a contribution of the long-term trend which we think we under, because of the change in climate, and then the ups and downs in any one year, which have been historically related to volcanic eruptions, or the state of ENSO, and the way that that has worked historically, is that the state of ENSO in the spring, is the biggest predictor of what the whole year will be. And so, when we kind of pull out the state of ENSO in February and March, that generally reduces the uncertainty and makes it look like a -- less noisy. It is a big contributor to that annual noise.

Remember, in February or March we were still in a very mild La Niña phase, so, that would have predicted that 2023 would have been slightly cooler than the long-term trend. And yet, it was slightly quite a lot warmer. And so, the expectation that we had about how ENSO affects the global temperature, and the time lags that we normally expect, was totally reversed this year. And it is kind of easy to say, well, we were coming into an El Niño toward the end of the year, but the El Niño we're seeing is not an exceptional El Niño, it is not a bigger El Niño event than 2016, and in 2015, when we were ramping up to that big El Niño, we saw a change in temperatures that were less than half in the global mean than what we've seen in 2023.

And so, if we're going to claim the 2023 was because of the ongoing El Niño toward the latter half of the year, you have 0 to then explain why that's never happened before, right? We've had El Niños before, we've had bigger El Niños before, and they never had that kind of impact on the global mean temperature.

So, either this El Niño is different from all other El Niños, or the system is responding differently to how it responded to all other El Niños, or there are other factors going on that are kind of coincident with the El Niño, and that could be factors associated with the warming in the north Atlantic, so, the record temperatures we saw in the North Atlantic started before El Niño had really got going, so that seems to be an independent thing that's going on.

The changes that we saw in Antarctica, particularly the very, very low sea ice levels during their winter, so, during the northern hemisphere summer, again, does not seem to be related to El Niño, but was a contributor to the very large warmth that we saw in starting from July and on ward.

So, our normal story, our normal explanation for what's going on, does not work this year. And I think that there is a lot more work that needs to be done to really understand what happened in 2023. In 2024, we'll be seeing whether persists or whether it kind of goes back to a normal pattern. And that will be kind of telling as to whether 2023 was just a very unusual combination of things that all added up to what we saw, or whether there's something systematically different going forward. That uncertainty in the explanation, as a scientist is kind of exciting. Because we're excited by novelty and things that we have not been able to understand, but given that we're talking about the world's climate, and ongoing climate change is also disconcerting. So, I am -- I have I think the word is discomforted by the findings that we've had beyond just, oh, my gosh, another record warm year.

Anyway, next?

>> RUSSELL VOSE: So, it has not been a good year to be a climate scientist. That's what Gavin is trying to say. Let me change gears, Gavin and I have spoken mainly about temperature and there were a number of extreme heat encodes this year such as Texas and Louisiana which really had a long, hot summer, but there have been plenty of other things going on, that's what this map is here to illustrate. It's a collection of major events, and I'm going to speak to the ones related to not temperature.

For example, in January there were nine back-to-back atmospheric rivers that pummeled California. Brought 32 trillion dollars to rain and snow to the state which was great for reducing drought but but had a profound impact. We had cyclone Freddy, for more than five weeks, had ager impacts on Madagascar, mow Zach beak and Malawi. Wildfires across Canada burned more than 45 million acres, which is two and a half the record of Canadian wildfires before. These caused air quality issues through Canada and U.S. for a good chunk of the year.

In August, hurricane Dora exacerbated a wildfire on Maui, that destroyed a historic down and became the deadliest wildfire in the U.S. in over a century.

In August there were prolonged rains in Pakistan and India which flooded hundreds of villages and prompted evacuation of $100,000 people. In September we had Daniel which caused massive destruction, including burstst dams that led to the death of 20,000 people and there were many others.

Another year of extremes but, I want to mention a couple things here, clarify a couple things. First of all, we're not saying any of these things were caused by change in climate. Extreme he vents were part of the climate station. It's park to note, Dr. Kapnick said this earlier, there are more than one thing that contributes to the extreme event. Part is the event itself and part is changes in exposure, who, what lies in the path of the event and vulnerability. Meaning ability to cope. Both exacerbate the impact of the event. There's been billions of dollars of disasters due to changes this climate, exposure and vulnerability.

We expect to see more extremes in the warming world. Climate change could worsen some events this year, but individual event complicated circumstances that need sorted out on the frontier of science. You probably see more work trying to diagnose that as we move forward.

Now back to Gavin.

>> GAVIN SCHMIDT: I think it is -- as we talk about what's going on, I have two graphs here, which are of relevance to what we're doing. Obviously, the arctic sea ice has been declining for decades now, this year, had a decrease that was basically in line with those long-term trends. There is a fair bit of variability that can fool you, if you're looking for reasons to think that things are not changing.

But both March, the winter and September, minimum. Summer extent are falling in line with expectations.

The temperatures that we see in the arctic, depend a little bit on how you exactly define the arctic, but taking the 64 to 90 degree north area, the arctic is warming about 3.5 times faster than the global average. And depending a little bit on the definition, exactly where you do it, you can end up anywhere between three and four times faster.

The -- I still see people referencing very old stuff that suggests that the arctic was only warming twice as fast as the global mean, but that has not been true for many years and we should stop saying that.

If you go to the next slide, I want to point out that Antarctic sea ice trends are also changing, and are also changing in ways that are a little hard to pass. So, through to 2014, Antarctic sea ice was actually increasing. We have some work that I'm not going to go into here, suggesting that was actually related to the amount of water coming off the continent which increases and leads to more sea ice being formed. But subsequent to 2014, we saw a very rapid decline in 2016, '17, '18 to near record low, a slight recovery, and then this year, an absolutely massive low sea ice extent during the time of normal maximum sea ice extent in aren't re Antarctica. So, it is effectively an off-the-chart estimate. And something that was not expected or anticipated, and so, one other element of why 2023 is so interesting. This is -- we don't know. There's been claims that show this is now a new situation, and that will continue to be low like that, since some of the models have been predicting, but I think the Antarctic oceanography and ice sheets and sea ice interactions something that the models have generally not done a great job with. So, I don't know how much weight one should give to the model predictions for Antarctica right now.

But things are very different in Antarctica, and, again, if things go back to normal, then we will look at this as a combination of blips, and just the role of the dice. But there's a danger that it won't go back, so, this is actually the start of a new phase, and that, again, is obviously quite concerning.

Next

>> RUSSELL VOSE: Thanks, Gavin. Changing gears a little bit here, ocean heat content. This slide shows ocean heat content from the late 1950s to present. Ocean heat content is basically the total amount of warmth or heat energy stored in the oceans. It's essential for understanding the modeling global climate because the oceans absorb more than 90 percent of excess heat in the Earth system. Changes in ocean heat content are determined using measurements of ocean temperatures around the world at different depths. These come from a variety of instruments ranging from things called bathy thermographs to bottles and even mammalsen used to measure things. In 2023 the warmth of the world's ocean hit a record again, it is the highest since record began six days or decades ago. By the way this time series is the top 2,000 meters of the ocean.

The five highest heat content values have all occurred in the last five years, there's been a steady upward trend since 1970. As with surface temperature, each decade is warmer than the decade that preceded it. There's variability in the ocean content it keeps stacking up. There's are estimates of ocean heat content. NOAA has estimates, NASA hases he estimates from the ECC record. All show record levels of heat content. Changes in the ocean occur over long time period like centuries the ocean has not warmed as much as the atmosphere, even though they absorbed the heat since the 1950s. If it wasn't for the oceans and large heat storage capacity, the atmosphere would have armed even more rapidly. And there's occasion force this. Warmer temperatures provide heat for tropical cyclones, affect marine heat waves intensity and because water expands as it gets warmer it contributes to the ongoing increase in sea level.

Back to Gavin.

>> GAVIN SCHMIDT: Yeah. So, we're often asked how reliable the surface temperature assessments of global temperature are, and we have, for the more modern period, we have the possibility of evaluating those trends, against both reanalyses, which are weather forecast which bring in a lot more data from satellites and radio sound and things but don't use the same data we have. But direct measurements from satellites. So, you can look here at the top row is the comparison of the GISTEMP trend from 1979 to the present, compared to the ERA5 reanalysis from, again, 1979 to the present, and the rates of change are very similar. The patterns are change are very similar, so, we can -- you know,

we can see that the reanalyses have slightly more resolution, there isn't as much smoothing that goes on with those, but the overall patterns are very, very close, and the trends that we see are not obviously different, and statistically they are identical.

So, we can have pretty good confidence that the surface temperature net works and processing that goes with that are consistent with what we would see with the state of the art reanalyses systems, and then for totally independent view, we have things like the AIRS satellite which gives a measure of changes in ground temperatures, so, both on the -- over the ocean and over land, and there are a little bit more -- they are a little noisier, it is a shorter period, 2003 to 2023. That's a 21-year period, but, again, you can see in the bottom row, that the overall patterns, once you take into account the surface temperatures, products are slightly more smooth than the satellite data is, the patterns are very clear, and very similar. Though, there are some notable differences.

But, again, the trends are all consistent. And that's a totally independent estimate of those changes over time. Russ?

>> RUSSELL VOSE: All right. The last slide in our presentation today, basically, this is going along the same lines that Gavin was going on, in terms of validation, if you will. There are other groups around the world that track global surface temperature. The UK Hadley Center has done this for a long time. More recently, you've seen work from Copernicus service. Berkeley Earth. This shows time series for those four major analyses, and despite using different data sources and analytical methods the results diverge by much. They all say 2023 was the warmest year record and there are other groups, part of NOAA, the University of Alabama Huntsville, track atmospheric temperatures, meaning above the surface, deep slaps of the atmosphere if you will. The slide doesn't include those record. Going back to 1979 but the satellite record show 2023 was the warmest year on record again by a large margin. For example if we take University of Alabama inupsville time series. They have 2023 wing 1.2 degrees Celsius, not as big a difference as in the land record, surface record but a very, very large margin.

A couple of other point here, before we wind down, one is that there has been some work done that averages these various analyses together to get a better sense for how 2023 compares to the 1.5 degrees Celsius threshold that's been talked about in the Paris agreement, and if you average the four together, you're starting to get close to 1.5 degrees in 2023. You're not there yet. In one year, above 1.5, doesn't mean we've crossed that threshold permanently, but the message is that things are starting to approach that threshold. Which is, I think, projected to happen on a sustained basis sometime in the 2030s or 2040s. We always take our projections with a bit of grain of salt.

One last thing that's not shown but worth noting. It is certainly warmer now than any time in the past 2000 years, and you probably heard talks of 100 to 125,000 years. That may be true, it is certainly often warm. The next warmest period was about 6,000 years ago, which was a little warmer than pre industrial but not as warm as today. But, basically, it's as warm now that it has been in a long time. And that's not a trend that we expect to continue -- it's not a trend that we expect to change any time soon because there's no forces known to science that would, at that point, alter that.

So, I'm going to stop there. I think this is the point which Gavin and I take questions and Gavin corrects me on those things that I might have gotten wrong.

>> JOHN BATEMAN: Thanks so much Russ and Gavin. We'll now open the briefing to your questions. We have about 17 minutes to ask those questions. To do that, all you need to do is find the Q&A box located at the bottom of your screen, please type in your name, affiliation, your question and the specific expert you would like to answer that question, if possible. As a reminder, we'll have Dr. Vose and Dr. Schmidt available for your questions.

We already have a question in, guys. This one is Fort either Gavin Orus. This is from Craig Miller from PBS Next Avenue. Can you speak to the Jim Hanson assertion that climate breakdown is accelerating well beyond expectations I mean? Who would like to take that one?

>> GAVIN SCHMIDT: So, we have one extraordinary data point that is a little bit hard to explain. Until we have a better idea about exactly what was going on in 2023, it's very hard to say whether that means that whether that was a blip or

whether something systematic that shifted. I think it is too soon to tell. And while, you know, one is free to extrapolate. I think the history shows that extrapolating from effectively a single data point is not usefully predictive. I'm very much in a -- we need more information mode, and we're going to be working -- we're going to be working quite closely with colleagues all around the world to try and see exactly what was go on in 20 #2k3 and what is continuing to go on now.

I would not make any further claim beyond that.

>> RUSSELL VOSE: I will add one note to what Gavin said. This goes back to the theme of coming clean on predictions. Gavin and I did this in 2020. I made a comment, maybe there's a bit of acceleration in the rate of acceleration of warming. We had 2021 and 202 which were less remarkable in their ranks, now 2023. It is a bit of a game, if you will. That's the reason Gavin exercises caution in talking about that sort of -- is there acceleration in the warming for the larger climate system. It is easy to get excited when we see a big year like this, so it is important to take a step back and really try to get a grip on what is going on.

>> JOHN BATEMAN: Yep. Thank you so much, guys.

>> We have another question. I don't know if we're able to go back into the presentation slides, because I believe this was referring to some slides earlier in the presentation, if we can do that, while I ask this question, that might be helpful for reference, Jim Siegel had the question, if you can explain what each dot is, that is, how was each dot calculated, the input -- I'm sorry, El Niño map is what he wanted to get to, if you can find El Niño map. Gavin Orus if you would like to explain that?

>> GAVIN SCHMIDT: I made it so I should explain it. There's two lines there. The black line is the tell GISTEMP record we presented early on and red line is statistical estimate of what would have happened if we hadn't had -- if there had been a neutral El Niño year. So, it is trying to -- it takes out linear aggression associated with the interstate in the spring and removes that. And historically that had reduced the noise. You can see in 2016, 1998, as pointed out there, the estimate ENSO corrected estimates are lower than the actual numbers. Because El Niño in the spring, warmer temperature than the annual mean. You can see the same thing for the land.

Then when you have years that end in an El Niño, so you have an El Niño building, that would be 2015, 2009, 1997, sometimes we can get record warm years, but we don't get record warm years that are so large, and that's very different to what happened in 2023.

So, 2023, you can see that the corrected line is actually higher than the actual line, suggesting that 2023 was anomalous, beyond anything that we've seen. And you can see the years going back, that's never happened before.

So, there is -- I mean, I played around with, you know, other statistical models where you take the historical data up to, but not including 2023, and you see, okay, by using different predictors like ENSO later in the year, can I make a better estimate of what would have happened in 2023, and the answer is, no, I can't.

So, hopefully that is more clear.

>> JOHN BATEMAN: Yeah. Thank you, Gavin. We did have a follow-up question. I think this is for either one of you, also from Jim Siegel. When you say the temperatures are the warmest on record, how far back is that? 1880? How are the data from the earlier years, for example the 1800s, adjusted for the fact the most recent years, the 2000s may have more points of measurements, satellites and higher accuracy, et cetera?

>> GAVIN SCHMIDT: So, Russ gave a good estimate of -- a good description of what the data is, but I want to talk a little about the uncertainties. And there are uncertainties in all of these measurements. They come from the spacial distribution of the temperature stations, the time sampling of where there were boats and where there were measurement, and that gets -- those uncertainties get larger as we go back in time. So, the uncertainties right now for the annual anomaly are around .0 -- .05 degrees Celsius for any one annual mean number. And as you go back in time,

in the 19th century, it is closer to .15, or .2. So, the uncertainty increases by about a factor of 4 as you go back in time, and that's mainly because we have less information from the southern ocean, and the southern hemisphere all together.

And so, that uncertainty is something that we take very -- that we try and do a very good job of understanding. We have a new paper that's in pre print, that discusses a new ensemble of GISTEMP that discusses the sampling of the accuracy of the temperatures themselves.

So, we we were about that. But none of those uncertainties are large enough to change the bottom line of what we're talking about, and that -- that's the long-term trend and record warmth that we're seeing in 2023.

>> RUSSELL VOSE: Two quick things to add on to what Gavin said. I think part of the question was also, how far does the record go back. NASA goes back to 1880s NOAA goes back to 1850, and I won't go into great detail but, yes, there were many observations today than there were back then. And there's quite a bit of work done to make sure we take that into account. And if you go back, say, a hundred years ago when there are less observation, a lot of work involves making educated inform guesses in places you don't have information. So, that's all part of the soup-making if you will.

>> GAVIN SCHMIDT: Let me finish with one point there. I mean, we can reduce those uncertainties further if we support efforts to do data rescue. There are millions upon millions of both weather station and ship log measurements that are written down that have not been digitized that, as that happens, we will be able to reduce the uncertainties going back in time. And that will come up -- I'm sure people ask us about the warming since the pre industrial. Some of the uncertainty associated with that can be reduced if the Weather Services all around the world, and the data rescuers all around the world can be supported to pull more data into these databases.

>> JOHN BATEMAN: Thank you, guys. Thank you, both. We have another question, either one of you feel free to jump in and answer, it is from Andrew Freedman. Were the margins of warming in 2023 versus all previous years largest? In other words, did this warm faster than any other year in NASA's and NOAA's data? Also thank you for doing this presser.

>> RUSSELL VOSE: I'm not sure I understand the question actually if you're asking if the rate of warming from January to December was faster than any other year, I can't say we've gone back and looked at that. I can't say that the margin of victory, if you will, between 2023 and 2016, that difference was bigger than any difference we're' seen before but I may be misinterpreting your question.

>> GAVIN SCHMIDT: I was trying to do that while we were talking. I have a little thing on the side but I can't do it and concentrate on this. But I'll be happy to e-mail you the result of that after the presentation.

>> JOHN BATEMAN: Yeah. And, thank you, guys. Again, at the end of this. I'm going to let people -- I'm going to remind people how they can reach out to me with any questions we don't get to and I can send them off to both of you guys to answer later. So, stay tuned to remind you how to do that.

Another question we have, coming in from the Atlanta journal constitution, from Meris Lutz. Dr. Calvin mentioned NASA uses satellites to track carbon dioxide in the atmosphere, can you elaborate how NASA measures greenhouse gases in the atmosphere and is that something that can be seen in satellite imagery?

>> GAVIN SCHMIDT: I guess I can take that. So, we have OCO, and sear rear of satellites that measure carbon dioxide from space, and we have -- right now we have one instrument on the International Space Station that is tracking that, and that allows us to see with great precision how much carbon dioxide there is. So, you can see the seasonal cycle. You can see the changes year by year. And that, of course, you can see from space. We also have the emit instruments which normally is looking at dust but has spectral resolution for methane as well, and that is able to see hot spots of methane, and those are mostly leaks from mining, oil and gas processing, and seeps. So you can see hot spots where there's a large methane leak, and we're using that -- there are other satellites looking at that as well, GATSAT and Sentinel 6, and those are being used to track down leaks to help people fix them in very short order.

So, we are tracking carbon dioxide and methane measurements, methane concentrations in the atmosphere from satellites that complement the ground-based net works that NOAA returns in places like monologue, scripts and the like.

>> JOHN BATEMAN: Thank you, Gavin. We have a question here from "The New York Times" from Delgar. It says I wonder how each agency chooses what years it will use as baseline for comparison. I think EU Copernicus goes against that.

>> GAVIN SCHMIDT: Let me make one thing clear. The internal baselines we use are there for disstoric purposes, that's where we started. But really don't -- shouldn't be of great interest to anybody else. When we put all of these things on the same baseline, that's when we care these things, and -- when we put things on the same baseline, they line up a lot better.

Now, the Copernicus data doesn't go back to the 1850. The Copernicus data goes back to 1940. From 1940 on back, they are using a match to the Hadley CRUT data, which comes from the UK office and University of east Anglia and tacking that on to make an estimate how things changed in the present day to the pre industrial, which we're normally describing as 1850 to 1900.

There is uncertainty about what that baseline is, so, the NOAA baseline there is around .2 degrees warmer than the Hadley CRUT baseline, and that's a function of the different sea surface temperature product that go into these assessments, and that's a real uncertainty. We don't know what 19th century temperatures were like better than, to about .2 degrees Celsius.

So, the numbers that were the headline numbers from Copernicus data which is .8 above pre industrial that comes with a certain degree of uncertainty. The equivalent numbers from NOAA and NASA are 1.34 to 1.36 warmer than the pre industrial. But that's mainly due to differences in how we interpret back through the 19th century, but also in the CST product we're using.

So, WMO has a little formula for putting these things all together. They take an average of the modern things and kind of stitch it to an estimate with some uncertainty for the pre industrial level, and I think their press release had 1.45, plus or minus .12, with respect to the pre industrial, and that's a fair assessment of where we are.

>> JOHN BATEMAN: Thank you so much. Gavin. We're getting close to the end of our time. We're going to take two more questions and wrap up this media briefing. Next question is from Seth Borenstein from AP for Gavin. Can you show monthly changes in ocean heat content, or how much -- could ocean heat content be driving the anomalous readings in 2023 and is it more crucial than ocean surface temperatures?

>> GAVIN SCHMIDT: Ocean heat content is not more crucial than ocean surface temperatures. Ocean surface temperatures are what we're trying to assess when doing the temperatures, ocean heat content increases below the surface, that can increase, and SST is somewhat independent of that. Obviously, it is related. I see the increases in ocean heat content, not so much as a cause of change, but as a -- as a validation of why things are changing. Right? So, we think things are changing, because we have increased greenhouse gases that changed the energy balance at the top of the atmosphere, greenhouse gases made it such that more energy is coming in and enabled it to leave. That energy has 0 to be stored in the system, not in the atmosphere, so most of that energy is being stored in the ocean. So, the increases in ocean heat content are telling us that that energy and balance is large, and is growing, which is in line with what we expect from increases in greenhouse gases. But in and of itself, it has local impacts on eggs circulation and biology, but it isn't, in and of itself, what is causing the atmosphere and surface to --

>> JOHN BATEMAN: Thank you, and our last question, either for Gavin Orus, this is from Sabrina shankman from "The Boston Globe", what is behind the high ocean surface temperatures in the north Atlantic this year?

>> GAVIN SCHMIDT: I can take it --

>> RUSSELL VOSE: You can have that one, Gavin. That's your space.

>> GAVIN SCHMIDT: Okay. So, if you recall, the higher ocean temperatures in north Atlantic started in the spring in March, and basically increased ever since then. I -- it's interesting what caused that. So, there has been claims that this is related to changes in marine shipping emissions that have reduced over the last few years because of better regulation from the marine maritime organization, that's a plausible argument. We have got evidence that those emissions have fallen by about 80 percent in the last three years. So, that would -- everything else being equal, be expected to lead to warming but, when we've done the quantitative estimates of that, putting in those changes in the aerosol, seeing how the temperatures change, you don't get very large numbers. You get something like, you know, .1, .2 degrees in the north Atlantic, maybe .05 degrees in the global mean. It's not very large. And the reason why that is is because the marine shipping emissions, there are large component of the flux into those areas, but not a large component of the total amount of sulphate. Most of the sulphate is being produced by plannington through production of sulfide which atmospheres in the atmosphere to produce sulphate aerosols. That's a natural part of the sulphate.

So, we're seeing a change in the anthropogenic version but not a very large change in the total burden, so, the impacts that has, both directly through the absorption and reflection of radiation from the aerosols themselves but their interactions with the clouds is not expected to change by the same order of magnitude.

There are other things that could be going on. You know, early in the spring, we had a very anomalous north Atlantic oscillation pattern. We had a very anomalous lack of Saharan dust that normally goes into -- goes across the north Atlantic which is a cooling thing. So, it is possible that we're looking at the north Atlantic as something that was both triggered, and perhaps amplified by internal variability, but perhaps there's also an anthropogenic component to that as well. That's part of the research that people will be doing in the months to come.

>> JOHN BATEMAN: Thank you, once again, Gavin.

All right. As always, you both were a wealth of information today. We appreciate you being on the press briefing, we'll wrap it up after we're five minutes after the top of the hour. I would like to thank presenters and participants for joining today. As a reminder the recording will be available at NOAA.gov as well as NOAA's satellite's YouTube channel. If anyone from the media has additional questions or information at needs from Russ or Gavin. Reach out to me, my James is John Bateman. I'll spell the address it is NESDIS.PA, as in public affairs at NOAA.gov. My contact information is also available in the media advisory.

Thanks, everyone, for joining us!

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