**You may have noticed news articles recently reporting on record low levels of sea ice down in the Southern Ocean. Apparently, the maximum surface area of frozen water surrounding Antarctica this winter was not only about one-point-seven-five million square kilometres smaller than the nineteen-eighty-one to twenty-ten average, but also more than a million square kilometres less than the previous record low set in nineteen-eighty-six.**

**You may also have seen that the mighty Antarctic ice sheet, that’s been there for millions of years and is nearly five kilometres deep at its thickest point and contains seventy percent of the world’s fresh water, is now ‘shedding ice from its glaciers faster than nature can replenish the crumbling ice’. Which is not ideal!**

**Antarctica doesn’t get quite as much love as the Arctic does, up at the other end of the world, does it? Probably because it’s, like, minus eighty-degrees Celsius for large parts of the year, with two-hundred-kilometre winds howling across it, and because it’s literally thousands of miles from anywhere useful, and it’s full of penguins who don’t care where they relieve themselves. “the dirty Ba” as a result, very few scientific researchers have felt the irresistible urge to spend a great deal of time there over the years.**

**Some do go there though, and when they do, they tend to publish research that’s typically not overwhelmingly encouraging.**

**Two such publications came out in twenty-twenty-three, one of which suggests we may have totally messed up our climate prediction models for the entire continent and the other points out that so much meltwater is now dissolving into the Antarctic Sea that it’s starting to slow down the entire global ocean circulation system.**

**I mean you could probably switch off now if you want, if all you were after was the top line from today’s video. But if you’re a glutton for punishment then stick around folks, and join me as I dive into the wonderful world of Antarctic Annihilation!**

**Hello and welcome to Just Have a Think**

**Alright, so I might have over done it a bit with the annihilation thing. But the findings of these papers should at the very least be giving our global leaders some serious pause for thought.**

**Here’s the first one, published in Nature in January by a group of scientists from The Australian National University, The University of Tasmania and the Massachusetts Institute of Technology in the United States. It’s a strong title, isn’t it?**

**The basic thrust of their research is that the abyssal ocean circulation, which is the layer of water way down at depths of between four and six thousand metres, is starting to discernibly warm up in the Southern Ocean surrounding Antarctica, and scientists are not absolutely certain about what’s causing it, partly because there just aren’t enough historical measurements to usefully compare to, and partly because, according to the papers’ authors, “coupled climate models exhibit biases in the region.” Whatever that means!**

**Whatever it does mean though, it appears to be very much in our interest to find out what’s happening as soon as possible, because as the paper tells us, the abyssal ocean is a key component of the global meridional overturning circulation that I’ve looked at a few times in previous videos. It’s that immense worldwide marine conveyor belt that cycles crucial life supporting stuff like heat, carbon, oxygen and nutrients around our oceans, and if it’s heating up and slowing down then it could have profound impacts, not only on marine ecosystems but on global weather patterns and even entire climate trends in various parts of the world. The papers authors explain that predicting future changes using our current climate models is unlikely to give us accurate answers because those models are apparently not accounting for that accelerated ice crumbling that our friends at CNN so dramatically reported on earlier this year. The paper’s researchers actually the slightly more scientific description of ‘dynamic ice-sheet melt’.**

**Lots of scientific research has been carried out to establish whether the famous ATLANTIC Meridional Overturning Current is slowing down as a result of heat absorption in the waters up there, but much less focus has been placed on the vulnerability of the ANTARCTIC abyssal overturning circulation to climate change. These very deep currents are replenished by cold, dense water, which sinks down along the continental slope. Increased meltwater around Antarctica makes the top ocean layer less salty which strengthens the stratification in regions where dense water is formed. So, more meltwater on the surface tends to reduce the rate at which this dense cold water descends.**

**To get a more accurate picture of what’s happening right now, and what might happen in the coming years, the researchers employed a very high-definition model of the waters and sea ice in the Southern Ocean. That model showed that under a high-emissions scenario, warming in the abyssal waters will speed up during the next three decades, allowing warm Circumpolar Deep Water greater access to the continental shelf.**

**This chart gives us three views of the deep Antarctic Ocean starting from the turn of the century and projected forward to twenty fifty.**

**The top images with the blue green colours show what scientists call ageing in the Abyssal waters. In oceanography, the term "ageing" refers to the time that has passed since the water was last in contact with the atmosphere. It’s a very important metric because a greater level of ageing, as shown by the darker greens in the twenty-fifty map on the right here, means slower circulation, less mixing with other water masses, and a greatly diminished contribution to global ocean circulation patterns. The middle images show how, as accelerating ice melt makes the top water less salty, so less of that dense salty water drops down to the depths, which means the abyssal waters lose salinity over time as indicated by darker blue colours on the right-hand side. Then the bottom images probably speak for themselves, with a very clear increase in Abyssal water temperature towards the middle of the century.**

**That brings into play the slightly worrying phenomenon of heat erosion down at the bottom of Antarctic glacier ice shelves where they’ve historically been anchored to bedrock.**

**It’s something we looked in some detail in this video a couple of years back. You can click up there somewhere to jump back and get the deep dive on that one, quite literally! But in basic terms if you’ve got water above zero degrees Celsius constantly sloshing up against ice that’s grounded on rock, then that ice grounding line is inevitably going to retreat further and further backwards over time, making the stability of the whole ice sheet increasingly precarious. Which again, is not ideal!**

**So, the blunt conclusion of this particular paper is that we’ve got a bit of a double whammy going on here. Not only is the entire global ocean circulation impacted by increased levels of meltwater, but the stability of Antarctic glaciers and ice shelves also looks to be under threat. And when they give way and fall into the ocean, they add additional melt water, which further exacerbates the problem in one of those ‘feedback-loopy’ kind of ways.**

**And that brings us to the second piece of cheery Antarctic research to be published in twenty-twenty-three. This one comes from a team of researchers led by Mathieu Casado at the laboratory of climate and environmental science at the University of Paris, in France.**

**What Casado and his team set out to investigate is the already well-known phenomenon of polar amplification. We’ve covered polar amplification up in the Arctic loads of times, but as we’ve just seen, scientists are now seeing greater evidence of the same phenomenon down in Antarctica as well. By analysing a compilation of seventy-eight ice core records, spanning seventy percent of the continent, Casado and his colleagues produced what they describe as a ‘high-resolution reconstruction of temperatures’ over the past one thousand years for seven regions of Antarctica. That provided the researchers with lots more data points on a graph, and as your maths teacher probably told you at school, the more data points there are on a graph the better chance you have of drawing some sort of average line through them all. That’s actually my rather ham-fisted over simplification of the extremely arduous and complex number crunching the team had to do to arrive at their results, but essentially the result was a minimisation of the data noise created by unusual spikes in seasonal and annual variability, most notably caused by something called the Southern Annular Mode, which is a north – south shift of a very significant wind belt known as the Southern Westerly Winds. Too complicated to delve into in great detail here, suffice to say the position of the Southern Annual Mode in any given year or set of years, can have a very significant impact on temperatures and conditions over Antarctica, and those impacts can have the effect of distorting longer term climate trends.**

**Once they’d compiled their ‘high-resolution reconstruction’ the team compared their results against actual historical observations from weather stations during the period between nineteen fifty and two thousand and five. Now you might think that actual ‘on the ground’ observations would surely be more reliable and accurate than any kind of retrospective paleoclimatic interrogation, however clever the algorithms and calculations may be. The trouble is though, Antarctica’s ice sheet is well over fifty percent larger than the lower forty-eight states of America, and there are only twenty-three permanent weather stations across the entire region, and only three of them are located away from the coastline. The implication of that is that those local measurements have probably been very significantly influenced by the natural variability we just touched on.**

**Casado’s team didn’t stop there though. They also compared their findings to the same climate modelling system referenced in the meltwater paper we looked at earlier. It’s called the Coupled Model Intercomparison Project or C-MIP, which was started back in nineteen-eighty-five by the World Climate Research Programme in an effort to coordinate the global climate modelling community and is nowadays extensively used by the IPCC and national policymakers to assess future climate trends and impacts.**

**So, what revelations did these three data sets reveal then? Well, Casado’s team found that over the period from nineteen-fifty to two-thousand-and-five, the average temperature over the whole of Antarctica has, according to their numbers, been increasing at a rate of somewhere between zero-point two-two and zero-point-three-two degrees Celsius per decade. That compares to increases of between zero-point-one-one and zero-point-one-eight degrees Celsius based on weather station observations, and zero-point one-eight degrees Celsius produced by the C-MIP model.**

**Over in West Antarctica though, which is the more precarious part of the continent where the ice sheet is not sitting on bedrock but on a series of islands, some of which dip below sea level, Casado’s team found an increase of about zero point-three-four degrees Celsius per decade, which is double the zero-point-one-seven degrees Celsius suggested by the C-MIP model over the same region.**

**To give a bit of context, the paper points out that the overall mean GLOBAL temperature warming trend over that period is evaluated to be somewhere between zero-point-one-four and zero-point-one-eight degrees per decade. So, the warming indicated in this new study strongly suggests the presence of an Antarctic amplification effect.**

**If you’ve watched my recent videos, you’ll know that increases in sea surface temperatures across the world’s oceans are being described by some climate scientists as ‘off the charts’, and it’s highly likely that those temperatures are at least in part causing the changes down in the Southern Ocean.**

**There is a school of thought that those record high water temperatures are a direct result of a twenty-twenty regulation from the International Maritime Organization, or IMO, that drastically reduced sulphur dioxide emissions from the global shipping industry. And studies have indeed shown that the drop in those emissions did significantly reduce the formation of clouds over maritime shipping lanes. Recent analysis by Carbon Brief estimated that the likely impact will be an increase in global temperatures of about zero-point zero-five degrees Celsius by twenty-fifty. So, despite some truly foamy-mouthed enthusiasm for the theory, demonstrated by one or two climate sceptics, it doesn’t look like we’ve found our smoking gun there unfortunately.**

**The general scientific consensus, based on things like physics and data seems to be that the increased temperatures are due to the fact that our oceans have absorbed more than ninety percent of the additional heat building up in our atmosphere caused by an accumulation of greenhouse gases as a result of human activity since the start of the industrial revolution. Which, at least to me anyway, strongly suggests that stopping any more of those anthropogenic greenhouse gases going up into the atmosphere really would be a very good idea indeed.**

**The conclusion of this paper’s authors is that, at the very least, the climate models being used by policymakers around the world to help them make decisions about which climate mitigation and adaptation initiatives to implement, appear to be underestimating the impact of polar amplification, and the amount of anthropogenic warming that human activity is causing in the region.**

**What the Casado team are strongly suggesting here is that paleoclimatic work like theirs needs to be properly reconciled with the climate models to iron out these so-called ‘model–data mismatches’ and provide our global leaders with more accurate, and this case, significantly more worrying, information so that they might actually inject a bit more urgency and prioritisation into their national climate policies.**

**And to emphasise just how worried actual climate scientists are about the dramatic changes we’re now witnessing down there in the Southern Ocean, literally as I was finishing the editing of this video, a group of them from New Zealand, which I think you’ll agree is pretty close to the action, convened an emergency summit meeting, with an announcement that concluded with these words…**

**“As people who have studied the Antarctic and Southern Ocean for decades these recent changes are deeply alarming. This group calls for a dramatic reduction in greenhouse gas emissions now. It is not too late to keep the climate within liveable condition, but policy action is needed urgently.”**

**I’m sure you’ve got your own views and perhaps your own research information on this crucial topic, so if you do, then why not jump down to the comments section below and leave your thoughts there.**

**That’s it for this week though. Thanks as always to the amazing channel supporters over at Patreon, who are the sole reason I’m able to continue bringing you independent, and completely ad-free content like this here on YouTube. And I must give a special thank you to the folks whose names are scrolling up the screen beside me here, all of whom celebrate an anniversary of Patreon membership in October. If you find these videos useful and informative and you feel like you could support my weekly work here on the channel, then why not pop over to patreon.dot.com forward slash just have a think to have a look at the exclusive benefits you can enjoy there.**

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**As always, thanks very much for watching! Have a great week, and remember to just have a think.**

**See you next week.**