



FAST could help to hunt gravitational waves.

OU DONGQU/XINHUA/ZUMA

the remote Dawodang depression in the Guizhou province of southwest China. Its 500-metre-wide dish is made up of around 4,400 individual aluminium panels that more than 2,000 mechanical winches tilt and manoeuvre to focus on different areas of the sky. Although it sees less of the sky than some other cutting-edge radio telescopes, and has lower resolution than multidish arrays, FAST's size makes it uniquely sensitive, says Li.

In August and September, the instrument detected hundreds of bursts from a repeating FRB source known as 121102. Many of these bursts were too faint to be perceived by other telescopes, says Li. "This is very exciting news," says Yunfan Gerry Zhang, who studies FRBs at the University of California, Berkeley. No one knows what causes the mysterious bursts, but "the more pulses we have, the more we can learn about them", he says.

FAST examines only a tiny fraction of the sky at any one time, making it unlikely to discover many new FRBs, which are fleeting and occur in seemingly random locations. But the telescope's "impressive sensitivity" will be useful for following up on sources in detail, says Laura Spitler, an astronomer at the Max Planck Institute for Radio Astronomy in Bonn, Germany. Repeat observations could allow scientists to learn about the environment from which an FRB emerged, and to determine whether the blasts vary in energy or recur with any set pattern.

FAST will also boost the efforts of an international collaboration that is trying to spot ripples in space-time as they sweep through the Galaxy, says McLaughlin. The International Pulsar Timing Array is using radio telescopes around the world to monitor the regular emissions from pulsars, looking for

distortions that would reveal the passing of these low-frequency gravitational waves. By the 2030s, FAST should have racked up enough sensitive measurements to study individual sources of such waves, such as collisions of supermassive black holes, says McLaughlin. "That's where FAST is really going to shine," she says.

Li is particularly excited about the study of planets outside the Solar System. No exoplanets have been conclusively detected by their radio emissions, but FAST's ability to spot faint, polarized waves might allow it to find the first examples, says Li. Polarized radio signals might come from planets with magnetic fields that, if similar to the one on Earth, could protect potential sources of life against radiation and keep the planets' atmospheres attached.

Identifying a planet in FAST's wide beam is a challenge because they are so faint and small. But Li's team wants to boost the telescope's performance by adding 36 dishes, each 5 metres wide. Although the dishes are relatively cheap, off-the-shelf products, together they will improve FAST's spatial resolution by 100 times, he says.

Li hopes that FAST's telescope operations will soon move from near the remote site to a \$23-million data-processing centre being built in the city of Guiyang. He expects that the move to a major city will help to attract more technical and engineering staff.

Now, the team's biggest hurdle is working out how to store and process the enormous amount of data that the telescope will churn out. The team are negotiating with the Chinese government to get additional funding for more data storage. "A successful review will definitely help," he says. ■

## ENVIRONMENT

# Oceans under threat from climate change

*UN report says storms and floods will intensify.*

BY JEFF TOLLEFSON

The world's oceans have long helped to stave off climate change by absorbing heat and carbon dioxide from the atmosphere. But that is changing, with devastating consequences for humanity in the coming decades, leading researchers warn in a high-level report commissioned by the United Nations.

The rate at which oceans are warming has doubled since the early 1990s, and marine heat waves are becoming more frequent and intense

— trends that are reshaping ocean ecosystems and fuelling more powerful storms. And as the oceans absorb CO<sub>2</sub>, they are becoming more acidic, which threatens the survival of coral reefs and fisheries.

The special report on oceans and ice by the Intergovernmental Panel on Climate Change (IPCC) warns that without steep cuts to greenhouse-gas emissions, fisheries will falter, the average strength of hurricanes will increase and rising seas will increase the risk of flooding in low-lying areas around the globe.

The oceans "can't keep up" with humanity's greenhouse-gas output, says Ko Barrett, vice-chair of the IPCC and a deputy assistant administrator at the US National Oceanic and Atmospheric Administration (NOAA) in Washington DC. "The consequences for nature and humanity are sweeping and severe."

More than 100 scientists from 30 countries contributed to the report. The IPCC released a 42-page summary of the analysis on 25 September at a meeting in Monaco.

The report projects that sea levels could rise by up to 1.1 metres by 2100 if greenhouse gas emissions continue to rise. That is about 10 centimetres more than the IPCC estimated in its last comprehensive report on the global climate, which it released in 2013.

Richard Alley, a geoscientist at Pennsylvania State University in University Park, says that the latest report's sea-level rise projections are conservative. That's because scientists still aren't certain about when rising temperatures might trigger a rapid collapse of ice sheets, particularly in western Antarctica. If that ►

► happens, ocean levels will rise much faster than the IPCC's latest estimate.

"Sea-level rise could be a little less, a little more, or a lot more" than the report predicts, Alley says. "But it's not going to be a lot less."

Those rising seas will increase the risk of flooding during storms, the report says, and high tides will become more frequent and severe. By 2050, flooding events that now occur once per century are likely to occur annually in many coastal cities and islands — even with sharp emissions cuts.

But the report does make it clear that humanity can blunt the worst effects of climate change over the very long term. It projects that the sea level could be from 0.6 metres to 5.4 metres higher in 2300, depending in large part on whether and how quickly countries move to curb greenhouse-gas emissions.

A draft version of the special report estimated that rising seas could displace 280 million people worldwide by 2100. The IPCC removed that figure from the final analysis, after scientists decided that they had misinterpreted the findings of an earlier study, says Michael Oppenheimer, a climate scientist at Princeton University in New Jersey and coordinating lead author on the report's chapter on sea-level rise.

The IPCC report also examines the fate of the planet's ice — which it says will continue



Rising ocean temperatures are killing coral reefs.

to shrink in the coming decades. In the Arctic, where sea ice melts every summer and freezes every winter, the annual summer minimum extent has decreased by nearly 13% per decade since 1979. That rate of change is probably unprecedented in at least 1,000 years, the IPCC says. About 20% of the Arctic's permafrost is vulnerable to abrupt thaw, followed by sinking of the soil left behind. By the end of the century, that could increase by half the area of the Arctic that is covered by small lakes.

And mountainous regions with small

glaciers — from the Andes to Indonesia — could lose 80% of their ice by 2100.

The report's overarching message, Barrett says, is that climate change is affecting water from the tops of Earth's highest peaks to the depths of its oceans, and ecosystems are responding. Without steep emissions cuts, the total biomass of marine animals could shrink by 15% by 2100, and commercial fisheries could see their maximum catch decrease by up to 24%.

"These ocean changes mean big problems for the future of people," says Jane Lubchenco, a marine ecologist at Oregon State University in Corvallis and former head of NOAA.

Lubchenco is an adviser to the High Level Panel for a Sustainable Ocean Economy, which released its own report on climate change and the world's oceans on 23 September. The analysis identifies a range of actions — including promoting renewable energy and sustainable fisheries, curbing marine shipping emissions and protecting coastal ecosystems — that could reduce global carbon emissions and limit the effects of climate change.

Lubchenco says those actions would also bolster coastal economies and help lift people out of poverty. "The reality is that the ocean is central to solving many problems," she says. "The situation is quite dire and quite gloomy, but it is not hopeless." ■

ALEXIS ROSENFELD/GETTY

## nature research EDITING SERVICE



### Could you communicate your research more effectively?

Our editors understand what it takes to get published and can offer expert advice to help you optimise your research paper or grant proposal.

Learn more at [authorservices.springernature.com/scientific-editing](https://authorservices.springernature.com/scientific-editing)

nature research

A51005