

repeated freezing and thawing of ice. Orosei says that studies of the region from Mars's orbit suggest that a layer of permafrost could be hiding just below the surface.

In 1976, NASA's Viking 2 mission landed farther north on Utopia Planitia. "It's a good place to try a first landing," Flannery said before the landing. The low altitude, clear terrain and potential for finding ice also means that future missions might be able to collect samples there, and that the region could make a good landing site for crewed missions, he says.

### Measuring Mars

Zhurong is kitted out with a suite of instruments for exploring the Martian environment. Two cameras are fitted on a mast to take images of nearby rocks while the rover is stationary; these will be used to plan the journeys that it takes. A multispectral camera placed between these two navigation imagers will reveal the minerals present in these rocks.

Like Perseverance, Zhurong has ground-penetrating radar. This will reveal the geological processes that led to the formation of the regions through which it travels. With luck, Zhurong might detect the thin horizon that marks permafrost, says Orosei. Knowing how deep this lies, and its general characteristics, could offer insights into more recent climate changes on Mars, and reveal the fate of ancient water that once soaked the surface, he says.

If the researchers are really fortunate, they might even find some very ancient rocks, which could offer a window onto our own planet's history, says Joseph Michalski, a planetary scientist at the University of Hong Kong: most of the similar evidence here on Earth has been destroyed by plate tectonics, says Michalski.

Zhurong's spectrometer includes a laser-based technology that can zap rocks to study their make-up. It will also be the first rover equipped with a magnetometer to measure the magnetic field in its vicinity.

### Orbital insights

From orbit, Tianwen-1 will communicate Zhurong's insights to Earth. But the orbiter – the name of which means 'questions to heaven' – will also make its own scientific contributions with its seven instruments, including cameras, ground-penetrating radar and a spectrometer.

A magnetometer and particle analysers will study the boundary between the higher Martian atmosphere and solar winds to better understand how Mars's magnetic field operates today. Combined with data from other orbiters studying the planet's upper atmosphere, this knowledge will offer researchers "a much better picture of what goes on around Mars", says Orosei.

A successful Mars landing could usher in more-advanced Chinese missions – including a sample-return initiative, which is planned to take place by 2030.

# NASA REBOOTS ITS ROLE IN FIGHTING CLIMATE CHANGE

## Space agency aims to breathe new life into its Earth-science programme.

By Alexandra Witze

**N**ASA is best known for exploring other worlds, whether that's sending astronauts to the Moon or flying helicopters on Mars. But under US President Joe Biden, the space agency intends to boost its reputation as a major player in studying Earth – especially with an eye towards fighting climate change.

"Biden made clear that climate is a priority," says Waleed Abdalati, director of the Cooperative Institute for Research in Environmental Sciences in Boulder, Colorado. "There's a clear role for NASA to play in that," he says, given all the Earth-science research it funds and the Earth-observing satellites it launches.

In recent months, NASA has signalled its intention to reinvigorate its role in informing US climate policy, by appointing its first climate adviser and ramping up work on key missions to study how Earth's climate is changing.

The work is particularly crucial as climate change accelerates, agency officials say.

"The demand for actionable information is going to increase pretty dramatically over the next decade or two," says Karen St. Germain, head of NASA's Earth-science division in Washington DC.

Among the many US federal agencies that Biden has conscripted to curb climate change, NASA stands out because it is a leader in basic planetary discoveries. Its history of Earth observation stretches back to 1960, when it launched the TIROS-1 satellite to test the feasibility of monitoring weather from space. Over more than six decades, NASA has designed, built and launched spacecraft to observe Earth as it changes. Often working in concert with the US National Oceanic and Atmospheric Administration (NOAA), which has primary responsibility for national weather forecasting, NASA runs satellites that measure ice sheets melting and carbon dioxide flowing through the atmosphere. The agency also flies aeroplanes to gather data about planetary change and funds a broad array of fundamental climate research, such as climate-modelling



Earth as imaged by the DSCOVR satellite.

CARL HOSTETTER/NASA EPIC TEAM

studies. “Our central role is in understanding how the Earth system is changing,” says St. Germain.

Biden’s predecessor, Donald Trump, whose policies favoured industry and downplayed climate change, repeatedly tried to cancel major NASA Earth-science missions, only to see them rescued by Congress. It was part of a broader pattern across the Trump administration of undercutting climate-change research and policy. NASA escaped the worst of those attacks by keeping most of its climate-change and Earth-science research below the radar of Trump officials. But it was a politically fraught time for the agency.

Now, NASA is literally reclaiming its seat at the table. Biden initially left the agency off the high-level climate task force he established a week after taking office in January. Following some pointed phone calls, NASA muscled its way into that group, and is now represented alongside administration heavyweights such as the secretaries of the treasury and defence as they discuss the nation’s climate strategy.

“If you’re going to make policy related to scientific questions, you need to have science at the table,” says Gavin Schmidt, a climate modeller at NASA’s Goddard Institute for Space Studies in New York City and the agency’s new climate adviser.

NASA’s new administrator, former senator Bill Nelson, has said that he supports the agency’s Earth-science research. “You can’t mitigate climate change unless you measure it, and that’s NASA’s expertise,” he said at his Senate confirmation hearing on 21 April.

### Budget struggles

Among NASA’s epic observations of climate change are a 29-year programme recording global sea-level rise, measured precisely from space with French collaborators and others, and studies that began in 2002 to track ice loss from Greenland and Antarctica, done with German partners. Upcoming missions include a US-Indian radar satellite that will track planetary changes such as shifts in sea-ice cover, and a US-Canadian-French-UK spacecraft that will survey freshwater resources and ocean currents. Both are slated to launch next year.

But NASA has struggled to get some of its most anticipated climate missions under way. It intends to launch a series of spacecraft that would measure fundamental aspects of global warming, such as shifts in clouds and precipitation, and changes in Earth’s mass as groundwater dries up. These missions were shaped by an influential 2018 report from the US National Academies of Sciences, Engineering, and Medicine, which named five ‘designated observables’ that NASA should track. Collectively, NASA calls them an Earth-system observatory; they would help scientists to continue to track global change,

and give policymakers data they need to inform actions on climate change.

The report estimated that the necessary missions might cost between US\$300 million and \$800 million apiece, and suggested that they might be doable even with tight budgets. NASA’s annual Earth-science budget has hovered around \$2 billion for years, even as other agency programmes, such as planetary sciences, received huge funding increases.

**“You can’t mitigate climate change unless you measure it, and that’s NASA’s expertise.”**

In April, Biden proposed boosting NASA’s Earth-sciences budget to nearly \$2.3 billion, although Congress would need to approve it. “It’s a big help and I’m supportive of it,” says Abdalati, who previously served as NASA’s chief scientist and also co-led the 2018 National Academies report. But “as a result of underinvestment for so many years, it looks better than it is”. (NOAA also got a proposed

boost of around \$500 million for its own line of weather and climate satellites.)

Despite its budgetary struggles, NASA has managed to continue doing climate science in the past few years. It scraped together money to start work on a new instrument called Libera, which will launch in 2027 to measure solar radiation, so that the agency can maintain a crucial four-decade record of how much heat Earth’s atmosphere absorbs. But it hasn’t made the progress it would have liked on monitoring the designated observables. “Over the last year, we’ve been in an especially challenging environment with COVID,” says St. Germain.

If Congress approves a significant boost for NASA’s Earth-science division, the agency might finally be able to accelerate progress on satellites to track climate change. The funding decision is expected in the coming months.

“The switch in administration now means that we can actually start to implement some of these missions,” says Helen Fricker, a glaciologist at the Scripps Institution of Oceanography in La Jolla, California, who studies Antarctic ice loss. “We can make up for lost time and get on with it.”

## PFIZER COVID VACCINE PROTECTS AGAINST WORRYING VARIANTS

Data from Qatar provide strongest evidence yet that vaccines can stop strains thought to pose a threat.

By Ewen Callaway

**Q**atar’s second wave of COVID-19 was a double whammy. In January, after months of relatively few cases and deaths, the Gulf nation saw a surge driven by the fast-spreading B.1.1.7 variant, which was first identified in the United Kingdom. Weeks later, the B.1.351 strain, which is linked to reinfections and dampened vaccine effectiveness, took hold.

Amid this storm, researchers in Qatar have found some of the strongest evidence yet that current vaccines can quell variants such as B.1.351. People in Qatar who received two doses of the Pfizer–BioNTech vaccine were 75% less likely to develop COVID-19 caused by B.1.351 than were unvaccinated people, and had near-total protection from severe disease caused by that strain. The findings – published on 5 May in *The New England Journal of Medicine* – suggest that current messenger RNA vaccines are a potent weapon against the

most worrisome immune-evading variants (L.J. Abu-Raddad *et al.* *N. Engl. J. Med.* <https://doi.org/gjzcx>; 2021). Pfizer, based in New York City, and BioNTech, in Mainz, Germany, are developing an updated mRNA vaccine targeting B.1.351, as is Moderna, based in Cambridge, Massachusetts. Early results from Moderna’s efforts suggest that a booster shot of the updated vaccine triggers a strong response against B.1.351.

“I think this variant is probably the worst of all the variants we know,” says Laith Jamal Abu-Raddad, an infectious-disease epidemiologist at Weill Cornell Medicine–Qatar in Doha, who led the Qatari study. “We have the tools, despite these variants, to control at least the severe forms of infection – and this should work quite well on transmission.”

Researchers in South Africa identified B.1.351 in late 2020, and it’s now the predominant strain there. Laboratory studies show that the variant harbours mutations that blunt the effects of virus-blocking antibodies, and trials suggest that some COVID-19 vaccines are