Rashid Space Centre (MBRSC) in Dubai, by a team of engineers from both institutions and other US partners. Its entry into Martian orbit paves the way for the probe's science mission, during which it will make observations of the planet's atmosphere, across all times and locations.

News of the probe's successful entry into Mars's orbit was greeted by applause in the MBRSC control room. "The past seven years of our lives have revolved around preparing for this moment. And the moment was surreal," says Fatma Lootah, a member of the mission's science team at the MBRSC. "We are very excited for what is yet to come."

With a 27-minute-long burn of its 6 thrusters, the craft slowed from its cruise speed of 121,000 kilometres per hour to around 18,000 kilometres per hour, using up about half of its total fuel supply. To enter orbit after its 494-million-kilometre journey, Hope had to hit a 600-kilometre sweet spot.

It was the "riskiest point" in the project, says Omran Sharaf, project director of the Emirates Mars Mission at the MBRSC.

Engineers were unable to operate Hope remotely from mission control in real time, because signals to the red planet take 11 minutes to travel each way. Instead, the craft acted autonomously, using commands uploaded four days ahead of time. Hope was designed to have "some level of smarts" to cope with surprises during the manoeuvre, says Pete Withnell, programme manager for the mission at the University of Colorado.

### Weather map

The craft is now in an elliptical holding orbit while engineers test and commission its instruments, ready to move into the 'science orbit' from which Hope will begin its mission in earnest in mid-May. This wide, elliptical orbit is what makes the mission special. It will allow Hope's three instruments — a high-resolution imager and infrared and ultraviolet spectrometers — to observe every geographical region of Mars, at every time of day, once every nine days, to create a global map of Martian weather. Such observations have never before been made at Mars.

After processing, the data will be available to the global scientific community without an embargo. The first tranche of data should be released by September, said Sarah Al Amiri, the mission's deputy project manager and science lead, at a briefing ahead of the event. The data will allow researchers to analyse the planet's atmosphere, from dust storms in its lower reaches to its outermost layer, the exosphere from which hydrogen and oxygen escape into space. The data will also help scientists to piece together how activities in the various atmospheric regions influence each other.

Scientists are already analysing data from unplanned, "opportunistic" experiments during Hope's journey, says Al Amiri. In one, Hope looked across the Solar System at the European Space Agency's BepiColombo spacecraft, which is travelling to Mercury. By observing each other across the same stretch of space, the two craft should have seen the same levels of hydrogen, allowing teams to cross-calibrate their instruments and examine the distribution of hydrogen in the Solar System.

Hope launched from the Tanegashima Space Center near Minamitane, Japan, on 20 July 2020. "This mission has been a bold undertaking by a young nation," says Brett Landin, an engineer at the University of Colorado Boulder, who leads the mission's spacecraft team. "I could not be more thrilled to be a part of this historic endeavour."

The UAE also plans to send a rover to the Moon in 2024.

# ILLEGAL CFC EMISSIONS FALL AFTER SCIENTISTS RAISE ALARM

## Analyses suggest that China has curbed production of an ozone-depleting chemical.

**By Jeff Tollefson**

Illegal emissions of an ozone-destroying chemical once used in refrigerants and foam insulation have almost come to a halt, scientists reported this week, nearly three years after the rogue emissions were first documented. Researchers say the result is a major win for the international treaty that protects the ozone layer.

In May 2018, researchers documented[1] a mysterious spike in atmospheric concentrations of trichlorofluoromethane, or CFC-11, that had begun in around 2013. Production of the chemical had been banned since 2010 under the Montreal Protocol, a legally binding treaty that has been remarkably successful in curbing the use of ozone-depleting substances, so scientists surmised that the sudden increase was probably the result of a new source of illegal emissions. By May 2019, scientists had traced the bulk of the emissions to eastern China[2]. In response to significant international pressure, the country committed to rectifying the problem.

In a pair of studies[3,4] published in *Nature* on 10 February, scientists report that atmospheric concentrations of CFC-11 have dropped precipitously since 2018. Assuming the current trend continues, the damage to the ozone layer from several years of illegal emissions will be negligible, says Stephen Montzka, an atmospheric chemist at the National Oceanic and Atmospheric Administration in Boulder, Colorado, who led one of the studies.

"The treaty did its job," says Durwood Zaelke, president of the Institute for Governance & Sustainable Development, an advocacy group based in Washington DC. "Whoever the offending parties were — including most definitely China — they got their act together."

China's Ministry of Ecology and Environment did not reply to requests for comment on the latest results and the actions it has taken to halt illegal CFC-11 emissions. The sources of illegal emissions outside China are unknown.

CFC-11 survives in the atmosphere for about 50 years, so, if sources were completely eliminated, global emissions should decline by around 2% annually. But the actual rate is slower, owing to continued emissions from old refrigeration systems and from insulating foam exposed when buildings are demolished. Between 2002 and 2012, CFC-11 emissions fell by around 0.85% a year. But that rate halved — to about 0.4% — after 2013, a sign that around 13,000 tonnes of new CFCs were being pumped into the atmosphere each year, Montzka's team calculated in 2018.

The analysis published last week, using data from two independent global air-monitoring networks, indicates that concentrations of CFC-11 were dropping by about 1% a year by late 2019 — the fastest pace on record[3].

In a second paper[4], Montzka and his colleagues used data from air-monitoring stations in South Korea and Japan, along with detailed atmospheric-transport modelling, to show that the rogue emissions from the largest source — in eastern China — have stopped. The study results were consistent across analyses from four research groups and two models, says co-author Luke Western, an atmospheric scientist at the University of Bristol, UK.


1. Montzka, S. A. *et al. Nature* **557**, 413–417 (2018).
2. Rigby, M. *et al. Nature* **569**, 546–550 (2019).
3. Montzka, S. A. *et al. Nature* https://doi.org/10.1038/s41586-021-03260-5 (2021).
4. Park, S. *et al. Nature* https://doi.org/10.1038/s41586-021-03277-w (2021).