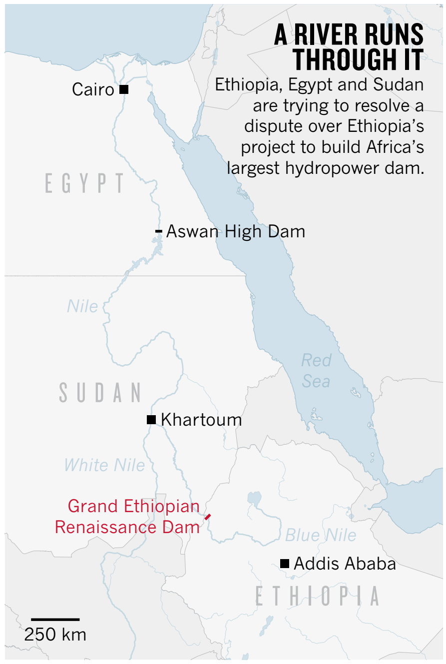
metres of water being released to countries downstream each year while the dam is being filled. Egypt says that its water supplies will be reduced during this period. It is calling for the reservoir to be filled more slowly, over 7 years, and wants more water to be released — 40 billion cubic metres per year.

Egypt and Ethiopia do not have a formal water-sharing agreement. Under the 1959 Nile Waters Agreement between Egypt and Sudan, Egypt takes 55.5 billion cubic metres of water from the Nile each year, and Sudan takes 18.5 billion. The agreement was reached shortly before Egypt began constructing its own megadam, the Aswan High Dam (see 'A river runs through it').

Ethiopia, however, was not part of this agreement and therefore does not recognize it. Ethiopian foreign-ministry spokesperson Nebiyat Getachew said at a press conference on 20 September that any proposal that did not respect "Ethiopia's sovereignty and its right to use the Nile dam" wouldn't be accepted.

"Ethiopia expects discussions and progress on our talks without the imposition of any one of the countries," says Bekele. "The issues are solvable technically and we can place the right framework on long-term operation, based on science and best practices."

Water-resources researcher Kevin Wheeler of the University of Oxford, UK, says that in a year with average rainfall, Egypt should experience little or no extra water scarcity if the reservoir is filled over 5–7 years, with at least 35 billion cubic metres of water released downstream.



NATURE PUBLICATIONS REMAIN NEUTRAL WITH REGARD TO CONTESTED JURISDICTIONAL CLAIMS IN PUBLISHED MAPS.

But Egypt is right to be concerned about extra water scarcity in dry years and those with low rainfall, adds Wheeler, who co-wrote a 2016 paper on ways to fill the dam (K. G. Wheeler *et al. Water Int.* **41**, 611–634; 2016).

Harry Verhoeven, a Nile Basin researcher based in Qatar, says that ultimately there is little Egypt can do, and policymakers in Cairo will have to adjust to having less Nile water during the dam's filling period. "Reduced water flows over several years mean tough choices, not only of who gets the water but what crops you grow and whether domestic food supply or export markets are prioritized," he says.

Verhoeven says that Egypt could take the dispute to the International Court of Justice in The Hague, the Netherlands, but that would require both sides to agree to such arbitration. Even if they did agree, he predicts, the court would be unlikely to find in Egypt's favour. "Ethiopia has a right to develop the water resources in its territory," he says.

Egypt's ministry of water and irrigation did not respond to *Nature*'s repeated requests for comment. But in a statement issued earlier this month, the ministry said that it considered "it important for the Ethiopian side to engage in serious technical negotiations", and find an agreement that would be in "the common interests of the three countries".

Although neither side has been willing to budge so far, the countries are likely to find a compromise, says Ismail Serageldin, a former vice-president of the World Bank who predicted in 1995 that twenty-first-century wars would be fought over water. "Ethiopia wants as short a period as possible, Egypt wants as long a period as possible, they will negotiate and meet somewhere in the middle — I think it's good that people are talking."

"There's still time for wars," adds Serageldin, who later became a science adviser to Egypt's prime minister. "But who knows, we may turn out to be wise; wiser than I thought possible at the time that I said that." ■

ATMOSPHERE

Stratospheric data aid climate forecasts

Including the upper atmosphere in weather models helped understanding of rare Antarctic event.

BY DYANI LEWIS

For the past month, a rare atmospheric phenomenon has been brewing above Antarctica, raising temperatures in the upper atmosphere by 40 degrees and threatening to reverse the direction of a powerful jet stream for only the second time since records began.

At the first signs of this event, known as sudden stratospheric warming, Eun-Pa Lim, a climate scientist at the Australian Bureau of Meteorology in Melbourne, plugged the rising temperatures into a model she had designed that forecasts short-term climate over the Southern Hemisphere (E.-P. Lim *et al. J. Geophys. Res. Atmos.* **123**, 12002–12016; 2018). The model predicted that the warming above Antarctica will drive hot, dry winds across eastern Australia over the next three months.

The forecast has excited meteorologists because it shows how far the field has come in understanding the stratosphere — the second major layer of Earth's atmosphere — and its effects on weather.

For decades, meteorologists thought weather was mostly driven by what was happening in the troposphere, the layer between the stratosphere and Earth's surface. Then, in 2001, daily stratospheric weather maps revealed how the two regions interact (M. P. Baldwin and T. J. Dunkerton *Science* **294**, 581–584; 2001). Now these interactions are being included in models such as the one designed by Lim to forecast short-term climate — conditions occurring between a 7–10-day weather forecast and the following 3 months — around the world. For instance, meteorologists can now predict how conditions in the stratosphere will affect a climatic phenomenon that drives heavy rainfall in the United States in winter.

"We have a much better understanding of how the stratosphere affects the weather at the surface," says Adam Scaife, head of long-range forecasting at the Met Office Hadley Centre for Climate Science and Services in Exeter, UK.

Improved accuracy and confidence in such forecasts makes a big difference to government agencies preparing for heatwaves or fires, as well as to farmers, such as those in drought-affected eastern Australia, when planning irrigation or herd-mustering schedules, says Lim.

Sudden stratospheric warming events are common in the Northern Hemisphere, occurring every second year, on average, but they are rare in the Southern Hemisphere. The first such event recorded in the south, in 2002, took scientists by surprise.

Even if they had known it was coming,

models back then couldn't have predicted how the abrupt warming in the stratosphere might affect the weather, says Harry Hendon, head of climate processes at the Australian Bureau of Meteorology.

Climate models have improved significantly over the past 15 years, partly driven by faster, cheaper computers. They're also much better at combining sources of observational data, such as satellite measurements of stratospheric temperature and atmospheric humidity.

Such advances helped meteorologists to forecast the start of the current stratospheric warming about a week in advance. The events typically start towards the end of winter, when mountains or the contrast between warm ocean temperatures and cold land masses generate continental-scale atmospheric disturbances known as Rossby waves. If these are large enough, they can reach into the stratosphere and break like a wave over a beach, compressing and warming the air in the stratosphere above the pole. This pressure can force the strong stratospheric winds encircling the pole — the polar-night jet stream — to abruptly slow and reverse, changing from being westerly winds to flowing in an easterly direction, says Scaife.

A complete reversal has not yet occurred in the current event, but wind speeds have already plummeted. Scientists at the Bureau of Meteorology don't know exactly what sparked this year's event, but they predict that it will be stronger than in 2002 — and so have a greater effect on the weather.

Lim's model, which teases out how stratospheric conditions bleed down into the troposphere, has helped to predict how this might play out. Apart from bringing warmer weather to eastern Australia, the event will drive colder, wetter conditions to western Tasmania, New Zealand's South Island and the southern tip of South America.

The warming so far has also sent an influx of ozone-rich air to counter the thinning of ozone over Antarctica that usually occurs in spring.

Meteorologists are now waiting to see whether the forecast holds. Hendon hopes that, if it does, the bureau will incorporate Lim's model into its standard operations, to provide short-term climate predictions every spring. ■

MEDICINE PRIZE

Biologists who decoded oxygen sensing win Nobel

Laureates' discovery underpins understanding of diseases such as anaemia and cancer.

BY HEIDI LEDFORD & EWEN CALLAWAY

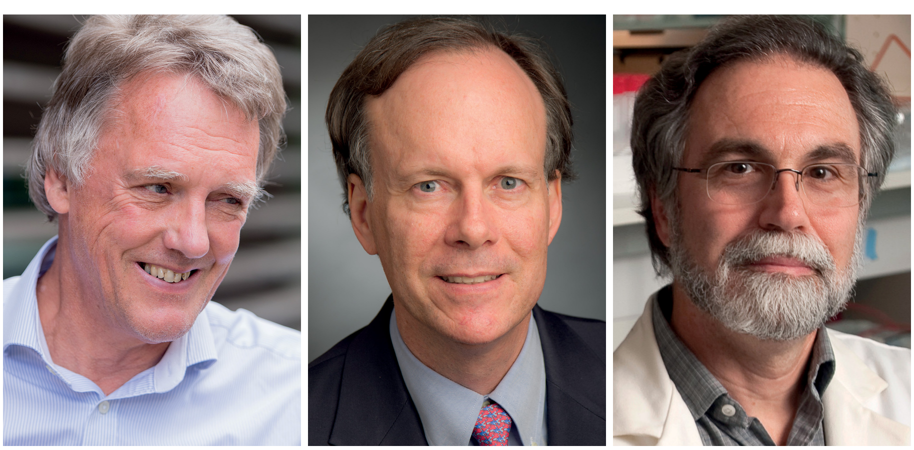
A trio of researchers has won the 2019 Nobel Prize in Physiology or Medicine for describing how cells sense and respond to changing oxygen levels by switching genes on and off — a discovery that has been key in understanding human diseases such as cancer and anaemia.

The three scientists are cancer researcher William Kaelin at the Dana-Farber Cancer Institute in Boston, Massachusetts; physician–scientist Peter Ratcliffe at the University of Oxford, UK, and the Francis Crick Institute in London; and geneticist Gregg Semenza at Johns Hopkins University in Baltimore, Maryland. The team also won the Albert Lasker Basic Medical Research Award in 2016.

Their work has helped researchers to understand how the body adapts to low oxygen levels by, for example, cranking out red blood cells and growing new blood vessels.

"This is a fundamental discovery that they've contributed to," says Celeste Simon, a cancer biologist at the University of Pennsylvania in Philadelphia. "All organisms need oxygen, so it's really important."

"The field really coalesced around this discovery, which was dependent on each one of their findings," says Randall Johnson, a physiologist at the University of Cambridge, UK, and the Karolinska Institute in Stockholm, and a member of the Nobel Assembly. "This really was a three-legged stool."



L TO R: UNIV. OF OXFORD; HARVARD UNIV.; JOHNS HOPKINS MEDICINE

Nobel prizewinners Peter Ratcliffe (left), William Kaelin (centre) and Gregg Semenza (right).

OXYGEN DEPRIVATION

The body's tissues can be deprived of oxygen during exercise or when blood flow is interrupted, such as during a stroke. Cells' ability to sense oxygen is also crucial for the developing fetus and placenta, as well as for tumour growth, because the mass of rapidly growing cells can deplete oxygen in a tumour's interior.

In work conducted in the 1990s, the scientists discovered the molecular processes that cells go through to respond to oxygen levels in the body. They found that central to this is a mechanism involving proteins called hypoxia-inducible factor (HIF) and VHL.

Semenza and Ratcliffe studied the regulation of a hormone called erythropoietin (EPO), which is crucial for stimulating the production of red blood cells in response to low oxygen levels. Semenza and his team identified a pair of genes that encode the two proteins that form the protein complex HIF, which turns on certain genes and boosts EPO production when oxygen is low.

Meanwhile, Kaelin showed that a gene called *VHL* also seemed to be involved in how cells respond to oxygen. Kaelin was studying a genetic syndrome called von Hippel-Lindau's disease; families with the disease carry mutations in *VHL*, and the condition raises the risk of certain cancers. ▶