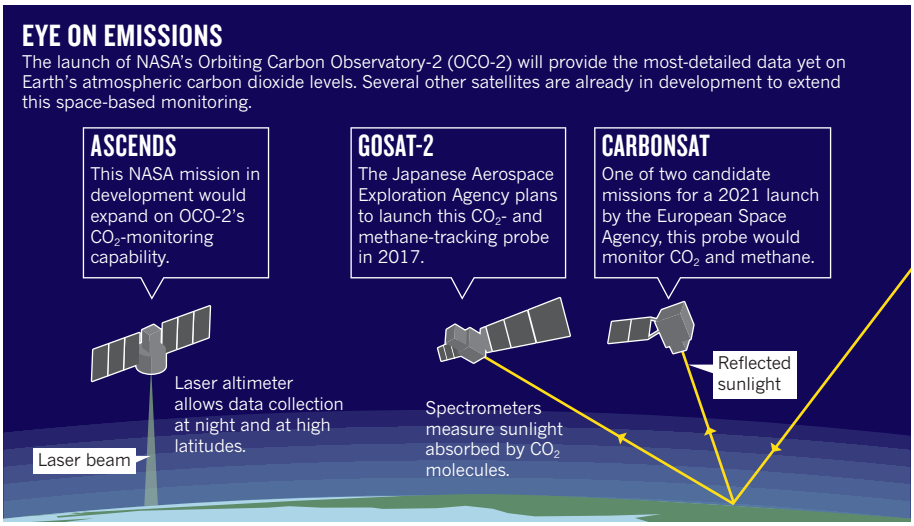


scientist at the California Institute of Technology in Pasadena who helped to develop the network of ground-based monitoring stations that will be used to test the quality of OCO-2's data. He hopes that the satellite will be able to confirm ground-based measurements that show a small increase in CO_2 levels above Pasadena each day as emissions from the greater Los Angeles area pool in the low atmosphere.

Such data, combined with ground monitoring and inventories of fossil-fuel consumption, could be a powerful tool for pinpointing greenhouse-gas sources, says Kevin Gurney, a carbon biogeochemist at Arizona State University in Tempe. "When we talk to policy-makers they say, 'One number for the whole city is lovely, but we need to know what is emitting.'"

OCO-2 will also closely monitor the carbon uptake of plants by measuring the weak fluorescence that is produced during photosynthesis as plants' chlorophyll pigments absorb light to capture energy and subsequently re-emit photons at longer wavelengths. Researchers have already tested the method using observations from GOSAT and the Global Ozone Monitoring Experiment 2 (GOME-2) instrument aboard the European meteorological satellite MetOp-A — with surprising results. An analysis of GOME-2 data published in April suggests that carbon-cycle models underestimate peak photosynthetic output by as much as 50–75% in parts of India, China and the African Sahel, and by 40–60% in the 'corn belt' of the US Midwest, which accounts for more than 40% of the world's maize (corn) production (L. Guanter *et al. Proc. Natl Acad. Sci. USA* **111,** E1327–E1333; 2014).

The results "jumped out at us right away", says Joanna Joiner, an atmospheric physicist at the NASA Goddard Space Flight Center in Greenbelt, Maryland, and co-author of the study. Joiner, who helped to develop the space-based method for monitoring plant fluorescence, is eager to take measurements using OCO-2, the small footprint of which should allow researchers to detect fluorescence signals from plants in more fragmented landscapes such as Europe's. Analyses by GOSAT and GOME-2 have been limited to vast expanses such as North America's boreal forests, the Amazon rainforest and the US corn belt.

OCO-2 is designed to last just two years, although NASA has loaded the probe with enough fuel to keep it running for 10 to 12 years. The space agency is developing another CO_2-observing satellite, the Active Sensing of CO_2 Emissions over Nights, Days and Seasons (ASCENDS) mission, to follow OCO-2. The multifrequency laser on ASCENDS would allow researchers to measure atmospheric CO_2 at night and at high latitudes in all seasons, something that the spectrometers on GOSAT and OCO-2 cannot manage, because they require sunlight to detect the characteristic absorption signal of CO_2 (see 'Eye on emissions'). Both Japan and Europe are also developing next-generation CO_2-monitoring satellites.

NASA hopes to install a duplicate of the OCO-2 instrument (originally built as a flight spare) on the International Space Station in 2017, at a cost of roughly $120 million. The station's low-Earth orbit would allow the spectrometer — dubbed OCO-3 — to gather data at different times of day from OCO-2, which follows a Sun-synchronous path and thus passes over areas in their early afternoons. Wennberg says that combining such measurements with OCO-2 data could help researchers to detect hourly variations in CO_2 production caused by plant photosynthesis — or even by rush-hour traffic in some large urban areas.

Plans for OCO-3 were dealt a blow in March, when US President Barack Obama proposed a NASA budget that did not include funding for the carbon-sensing project. But the agency says that it could revive OCO-3 if money becomes available. "We hope to get back to OCO-3," says Betsy Edwards, programme executive for OCO-2 at NASA in Washington DC. "We are putting it into a position where we could do that at any time." ■

POLICY

Africa science plan attacked

Proposed innovation strategy is low on detail and commitments from governments.

BY LINDA NORDLING

Scientists have raised concerns about a ten-year pan-African science and innovation strategy that heads of state are expected to adopt this week.

The Science, Technology and Innovation Strategy for Africa (STISA), proposed by the African Union (AU) continental grouping, aims to prioritize the use of research to drive economic and social development across the continent. It will commit signatory countries to six goals, including tackling hunger, disease and unemployment, and will set up structures that give research and development organizations leverage to pursue them.

But critics fear that the strategy's top-heavy administrative structure and lack of firm pledges may render it ineffective. They also think that its aims may be beyond the continent's limited resources, especially given that it contains few financial commitments.

"The majority of the document talks about governing structures and their responsibilities, and very little about implementation," says Paul van Gardingen, who studies international development at the University of Edinburgh, UK. "It's like trying to reach Mars whilst talking about who is responsible for designing the hot-air balloon to take you there."

Africa's research-publication output is small, but growing faster than the world average. The share of global scientific papers with at least one African author went from 1.2% a year in 1996 to 2.3% in 2012, with the number of such papers quadrupling from about 12,500 a year to 52,000.

STISA, which is likely to be signed off during this week's AU summit in Malabo, Equatorial Guinea, aims to turn this intellectual capacity into a "tool and enabler for achieving continental development goals". But the document, drafted by the AU and a group of African science policy-makers, does not give much detail on how this vision will be achieved.

It mentions the need to invest in new laboratories and other infrastructure, expand graduate and technical training programmes and create an "enabling environment" for technology transfer. But it does not commit governments to concrete spending or training targets. Nor does it provide a budget, indicating only that funds need to be sought from both inside and outside Africa. It reiterates a near-decade-old ambition to raise AU member states' spending on research and development to 1% of gross domestic product — a target that few have achieved (see 'Continental divide').

Success of the strategy will depend on the quality of research projects in individual countries. To help scientists to gain domestic support for research programmes, STISA plans to set up a research and innovation council that will bring together academies and funders to coordinate national activities. It will also take control of a European Union-funded competitive granting scheme that has spent almost €14 million (US$19 million) on research projects in water and sanitation, agriculture and energy.

Critics ask whether the new council is necessary. "The current structures look very top-heavy and could be far too expensive for the limited investments likely to be realized in the early years," says van Gardingen.

John Mugabe, a technology-studies specialist at the University of Pretoria in South Africa, is also sceptical. "I would prefer the use of existing institutions such as the African Academy of Sciences and national academies to mobilize technical expertise for programme design and implementation," he says. But Abdul-Hakim Elwaer, director of administration and human-resources management at the African Union Commission in Addis Ababa, Ethiopia, notes that not all African countries are involved in the African Academy of Sciences, whereas all AU member states will be represented by the council.

SVEN TORFINN/PANOS PICTURES

Crop research is one of several sectors set to benefit from a proposed African science strategy.

Despite their concerns, critics agree that STISA is an improvement on its predecessor, Africa's Science and Technology Consolidated Plan of Action (CPA). Launched in 2005 and adopted by the AU in 2006, it established the competitive research grants scheme and several networks of research excellence. But a review in 2013 found that the CPA had failed to link with other pan-African policies, such as continent-wide agriculture and environmental-protection projects with research programmes of their own. It also fell short of raising the funds needed for its full implementation.

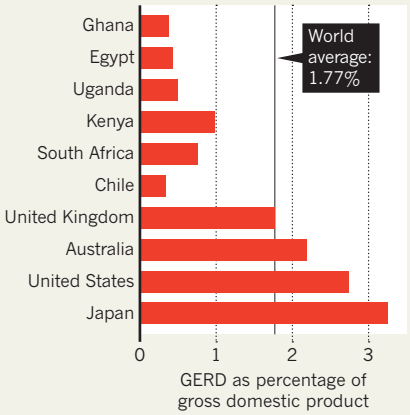
Mugabe, who helped to spearhead the CPA, expects funding to be a problem for STISA, too. "It fails to address the big issue, which is the financing of science, technology and innovation in Africa by African governments," he says. The absence of commitments mean that heads of state will probably adopt it without much debate, he adds, and governments will be able to ignore it easily thereafter.

Daan du Toit, head of international cooperation and resources at South Africa's Department of Science and Technology, is more positive. He says that the CPA generated political support for science that paid off in the continent's successful bid to co-host the Square Kilometre Array, a US$2-billion radio-telescope project being built in South Africa and Australia.

The latest strategy will provide a similar political basis on which to build future partnerships, he says. "STISA will be a very strong mandate. You can squabble about the detail, but the overall vision is most important." ■

CONTINENTAL DIVIDE

A sample of leading African science spenders shows that they lagged behind many major economies in gross domestic expenditure on research and development (GERD) in 2010.



SOURCE: AFRICAN INNOVATION OUTLOOK II/OECD