中国科学院
CHINESE ACADEMY OF SCIENCES

CASNewsletter

NO. **168** • October 2020

Executive Editor: Zhang Qingquan **Designer:** Tian Chi **Illustrator:** Ma Xuejing

Edited by Bureau of International Co-operation, Chinese Academy of Sciences
CAS Newsletter – Monthly – Editorial Board: 52, Sanlihe Road, Beijing, 100864, China

Addressing grand challenges with science

The Sustainable Development Goals (SDGs), set out in the 2030 Agenda for Sustainable Development by the United Nations (UN) in 2015, offer a roadmap towards a better world for all. From promoting health and well-being to tackling climate change, the 17 SDGs address the global challenges that humanity faces and act as a universal call to protect the planet and improve lives.

The SDGs are complex, and many need to be addressed through social, political and financial changes. Nevertheless, science and technology have a lot to contribute, and can help bring multiple benefits, building on synergies among the interrelated goals. Given the critical role of scientific research in achieving the SDGs, the UN launched the Technology Facilitation Mechanism to support the implementation of the SDGs through the sharing of information, experiences, best practices and policy advice, and the Chinese Academy of Sciences (CAS) is a member.

China released a national plan in 2016 to help with the implementation of the SDGs. As the country's leading research institution, CAS is accustomed to leveraging its strengths to advance solutions to real-world problems. So the question became: how has CAS's research contributed to addressing the SDGs? And, compared with other leading research institutions, what SDGs is CAS's research output most aligned with? This report tackles these questions using publication data tracked in the Dimensions database from 2008 to 2018. It reviews CAS's research output relevant to the 17 SDGs over the past 10 years, and identifies the top SDGs for which CAS has had the most scientific publications. It also uses case studies to highlight some of CAS's research work which has looked at developing solutions to pressing global challenges.

Here are some key findings based on an analysis of scientific publications from 2008 to 2018, as tracked in Digital Science's Dimensions database:

- Scientific research has a big role to play in achieving the SDGs, and there are a large number of research publications that can be mapped to them. Out of CAS's nearly 320,000 science-related journal publications from 2008 to 2018, nearly 15,800 are identified as relevant to SDGs. [These papers are determined by matching article topics and abstracts to descriptions of the 17 goals — and papers can contribute to more than one goal, given the interdisciplinary nature of research and the interconnection of the SDGs.]

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[IMAGE: AF-STUDIO/GETTY]

Big Earth Data facilitates Sustainable Development Goals

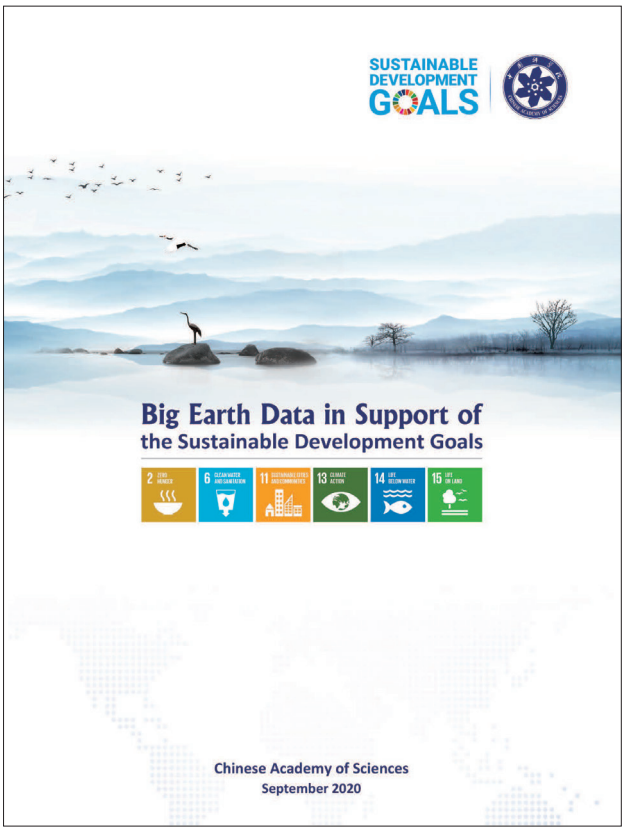
The Sustainable Development Goals (SDGs), at the core of *Transforming our world: the 2030 Agenda for Sustainable Development* adopted by the 193 Member States of the United Nations in September 2015, represent commitment to address the tri-dimensional social, economic and environmental issues mankind faces, in the most comprehensive way in human history, with the aim of achieving sustainability.

SDGs are broad, complex, and diverse with dynamic interactions amongst themselves. To support global SDG implementation, the United Nations launched the "Technology Facilitation Mechanism (TFM)", encompassing — the Interagency Task Team, supported by the 10-Member Group, the collaborative Multi-stakeholder Forum and an online platform. Fundamental to their implementation is effective monitoring and evaluation and in 2017, UN adopted a Global Indicator Framework for the Sustainable Development Goals which as voluntary and non-binding. However, several difficulties still remain in quantifying different indicators particularly in terms of data and method to make effective use of the UN's indicator framework.

Big Earth Data enables macroscopic, dynamic and objective monitoring, by making it possible to integrate and analyze data on the land, sea, atmosphere and human activities to give a holistic understanding of a vast region. It can help to achieve breakthroughs in data and methodology for the monitoring of SDG indicators. This technology can support policy-making by providing information, at a large scale with cyclical changes, on multiple SDG indicators closely related to the Earth's surface, environment and resources.

The Chinese Academy of Sciences (CAS) launched the Big Earth Data Science Engineering Program (CASEarth) in 2018. One of its objectives is to utilize the large-scale and dynamic monitoring capabilities of Big Earth Data in the service of the measurement and monitoring of SDG indicators. Led by its Chief Scientist, Academician Guo Huadong, CASEarth has selected six SDGs as a priority, including SDG 2 (Zero Hunger), SDG 6 (Clean Water and Sanitation), SDG 11 (Sustainable Cities and Communities), SDG 13 (Climate Change), SDG 14 (Life below Water), and SDG 15 (Life on Land), and completed the series of reports entitled "Big Earth Data in Support of the Sustainable Development Goals" in 2019 and 2020.

Compared to the 2019 report, the 2020 report provides more cases, and features a more systematic study of six SDGs ranging from data acquisition and data production to SDGs indicator system. 26 typical cases at the local, national, regional, and global scales are presented to showcase the studies on and monitoring results of 18 SDG targets, including 24 data products, 13 methodologies and 19 results that are of value to policy-making. They all point to the great value of Big Earth Data, related technologies, and methodologies as new analytical tools with which will enable a deeper understanding of and make better policies on the SDGs and related issues.

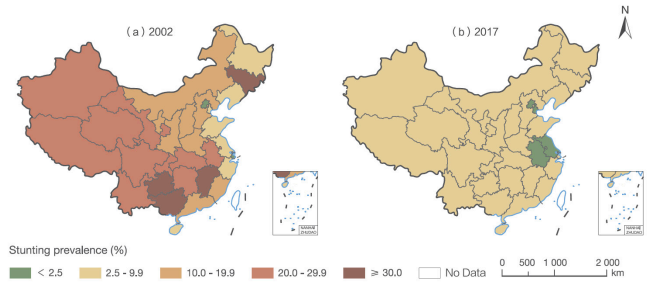


The 2020 report was released on September 26, 2020 by the Chinese government at a video-conference on Poverty Eradication and South-South Cooperation, on the occasion of the 75th anniversary of the founding of the United Nations. Both English and Chinese versions of the report could be accessed online at https://www.fmprc.gov.cn/mfa_eng/topics_665678/2030kcxfzyc/

Institute of Remote Sensing and Digital Earth, Chinese Academy of Sciences

Report Highlights

SDG 2 Zero hunger



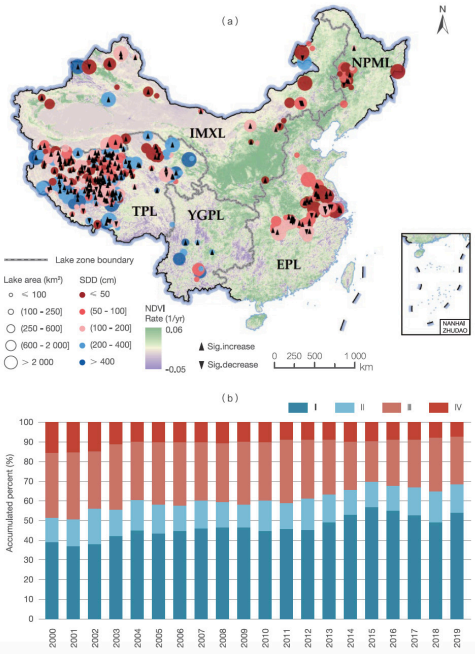
Under-five stunting in 2002 (a) and 2017 (b) by province in China

▪ China has substantially reduced the prevalence of stunting in children under 5 years of age, from 18.8 percent in 2002 to 4.8 percent in 2017, which has met SDG target 2.2 (under 5.9 percent).

▪ During the monitoring period, the prevalence of stunting among Chinese children under 5 years old decreased from 7.8 percent to 3.4 percent in urban areas and from 25.6 percent to 5.8 percent in rural areas. The gap between urban and rural areas is narrowing year by year, with a significant decline observed in rural areas.

▪ China is able to increase its grain harvest area by about 1.35×10^5 to 3.63×10^5 km^2 on existing cropland by increasing its multiple cropping index. Under the most realistic scenario, grain production is expected to be increased by 19.6 percent.

SDG 6 Clean water and sanitation

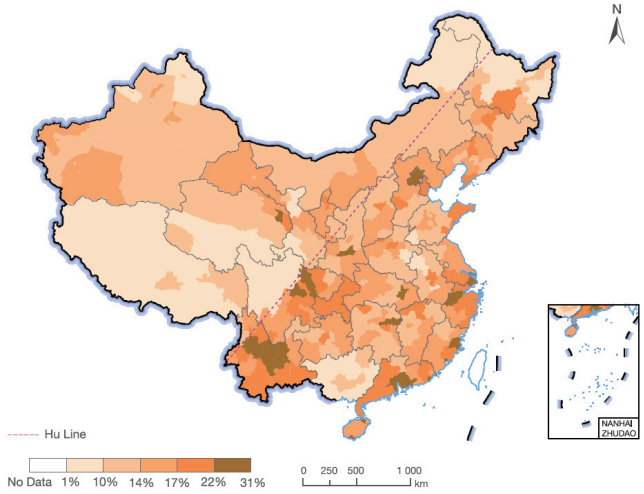


Water transparency indicated by Secchi disk depth (SDD) of China's large lakes during 2000-2019
(a) The mean SDD values; (b) Proportions of lakes with different water clarity levels
The change rate in NDVI was the linear fitting slope during 2000-2019.
IMXL: Inner Mongolia-Xinjiang Lake; TPL: Tibetan Plateau Lake; YGPL: Yunnan-Guizhou Plateau Lake; NPML: Northeast Plain and Mountain Lake; EPL: Eastern Plain Lake

▪ During 2000-2019, the water transparency of China's lakes showed a spatial pattern of "high in the west and low in the east". Overall, water clarity was good and showed a positive trend. The proportion of Types I, II, and III water bodies with good clarity increased from 84.11 percent in 2000 to 92.46 percent in 2019.

▪ Analysis of the spatial distribution of China's vegetated wetlands in 2015 and measurement of changes in mangrove forests and *Spartina alterniflora* in China between 2015 and 2018 showed that the net increase in mangrove forests was 22.11 percent, and the net decrease in invasive *Spartina alterniflora* was 2.59 percent. In China, mangrove forests have been significantly restored and the invasion of *Spartina alterniflora* is under effective control.

SDG 11 Sustainable cities and communities



Share of open public space area in prefectural-level Chinese cities in 2018

▪ The share of open public space area in built-up areas in Chinese provinces (excluding Hong Kong, Macao and Taiwan Province) averaged 19.50 percent in 2018, 1.5 percentage points higher than the 2015 figure of 17.98 percent.

▪ In prefecture-level cities, the share of open public space area in nearly 50 cities exceeded 20 percent. The share was larger on the southeast side of Hu Line than on the northwest side. It was larger in the city clusters in the Beijing-Tianjin-Hebei region, Yangtze River Delta, Pearl River Delta, Sichuan basin and central Yunnan than in their surrounding regions.

▪ In 2018, the proportion of the population with easy access to public transportation in urban built-up areas in China was 80.56 percent on average. The proportions in the eastern coastal region and Sichuan and Chongqing were higher than the rest of the country. Compared with 2015, 80 percent of Chinese cities saw higher proportions to varying degrees, while about 8 percent experienced slight declines.

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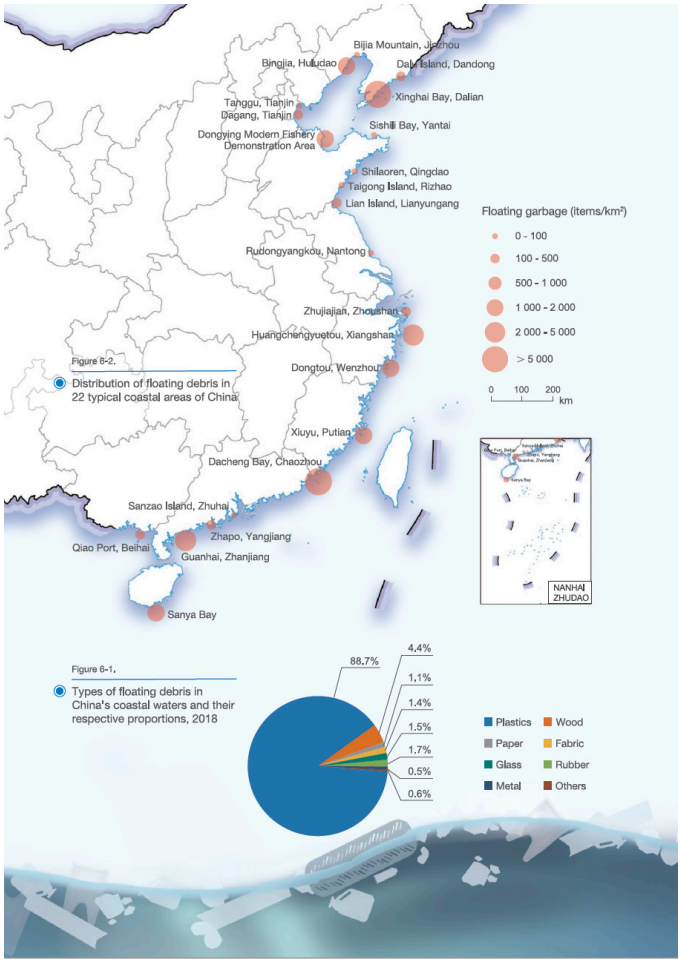
SDG 13 Climate action

▪ The spatiotemporal changes in the intensity and frequency of extreme high-temperature events and heatwaves in China have been assessed over the 1990-2018 timeframe, based on homogenized temperature series data from 754 terrestrial weather stations. They point to the significantly increased intensity and frequency of extreme high-temperature events and heatwaves in China since the late 1990s.

▪ Projections of changed phenology of China's main crops through the 2030s (2011-2040) put the probability of early maturation of wheat and maize at 90.4 percent to 91.2 percent and 62.9 percent to 64.5 percent respectively. Without appropriate interventions, climate change will lead to forward shifts in the phenology of these crops and shortened cycles of growth, with negative implications for wheat and maize yields.

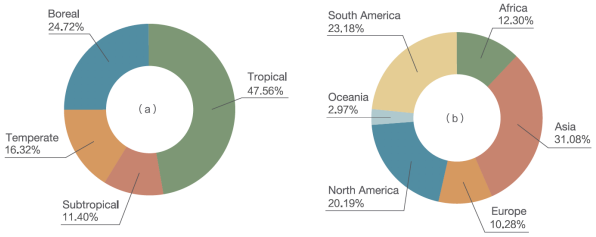
SDG 14 Life below water



▪ An analysis of the distribution and variation of floating debris in 22 typical coastal areas of China showed that the abundance of floating debris in China's coastal waters in 2018 was approximately 25 percent below the 2010 to 2014 average. Microplastics shape found in China's coastal waters in 2019 were mainly fibrous, linear, spherical, and fragmented and the distribution of microplastics varied from region to region, with the average abundance of microplastics at low to medium levels.

▪ The ecosystems of Jiaozhou Bay, Sishili Bay and Daya Bay are in relatively good health at present. For more than a decade from 2007 to 2019, the overall health of the Jiaozhou Bay ecosystem was stable with some upticks, while that of Sishili Bay and Daya Bay remained stable. The health condition of Daya Bay showed slight improvement from 2016 onward.

SDG 15 Life on land



Distribution of forests by climate zone and continent, 2019
(a) By climate zone; (b) By continent

▪ In 2019, there were 36.92x108 hm^2 of forests worldwide, covering approximately 24.78 percent of the Earth's total land area. Of all the continents, South America had the highest ratio of forest area to total land area (47.45 percent) and Oceania the lowest (12.80 percent).

▪ Since 2000, vegetation coverage on the Loess Plateau has been greatly improved, with an average increase of 17.06 percent, improving its effect on soil and water conservation by 22.00 percent.

▪ The year 2000 was a watershed in the aeolian desertification of China's semi-arid regions. Until 2000, there had been a degradation trend primarily because of irresponsible human activities such as overlogging, overcultivation and overgrazing. The aeolian desertification process began to reverse in 2000, largely thanks to the implementation of ecological protection policies.

Source: Big Earth Data in Support of the Sustainable Development Goals (2020)

Review of development of state-of-the-art perovskite tandem solar cells

Photovoltaic (PV) solar cells are one of the key technologies for realizing a decarbonized economy and offer sustainable energy supply. In order to continue to drive down the overall cost of installed PV generated electricity, increasing the overall power output of the module per unit area, i.e. power conversion efficiency, is necessary.

Multi–junction (tandem) solar cells consisting of multiple light absorbers with considerably different band gaps show great potential by absorbing light in a broader range of wavelengths. Perovskite solar cells (PSCs) are ideal candidates for tandem solar cells due to their tunable band gaps, high efficiency, and easy fabrication.

An international research group led by Dr. Li Hui from the Institute of Electrical and Engineering of the Chinese Academy of Sciences and Dr. Zhang Wei from the University of Surrey recently summarized the development of state-of-the-art perovskite tandem solar cells in a review published in *Chemical Reviews*.

The researchers introduced the strategies for improving the power conversion efficiency of perovskite tandem solar cells in combination with various types of solar cells. These strategies included but were not limited to the design considerations on the transparency of perovskite absorbers and metal electrodes, protective layers, and recombination layers/tunnel junctions, and had a particular focus on the band gap tuning and thickness adjustment of active layers.

In addition, a range of measurement techniques for the characterization of perovskite tandem solar cells could be shown, which covered other core issues that related to large–scale applications and commercialization.

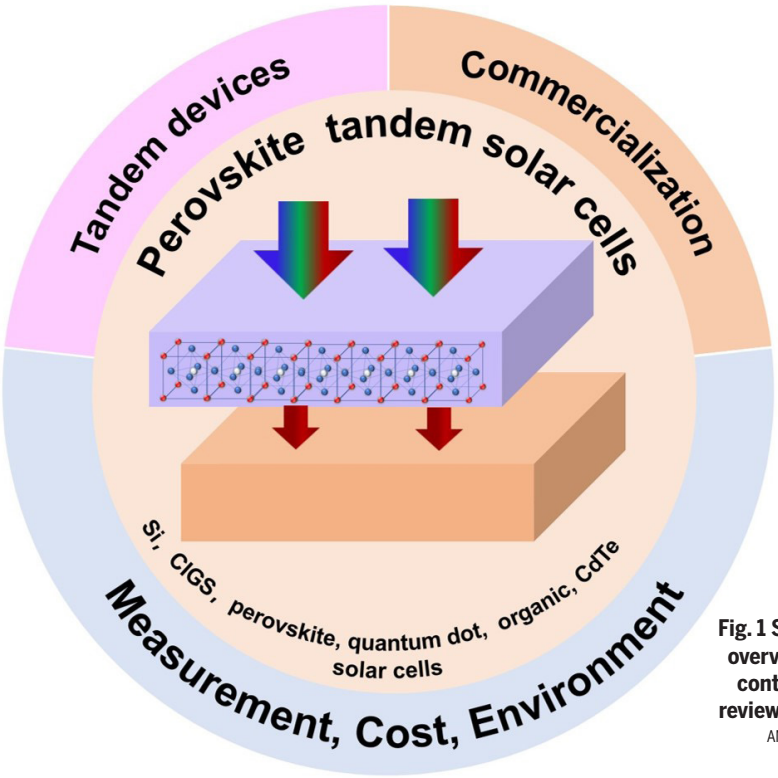


Fig. 1 Schematic overview of the content of the review [IMAGE: LI HUI AND ZHANG WEI]

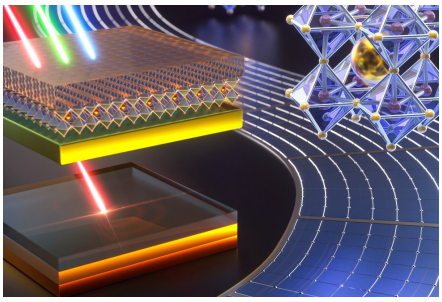


Fig. 2 Schematic structure of perovskite tandem solar cells [IMAGE: LI HUI AND ZHANG WEI]

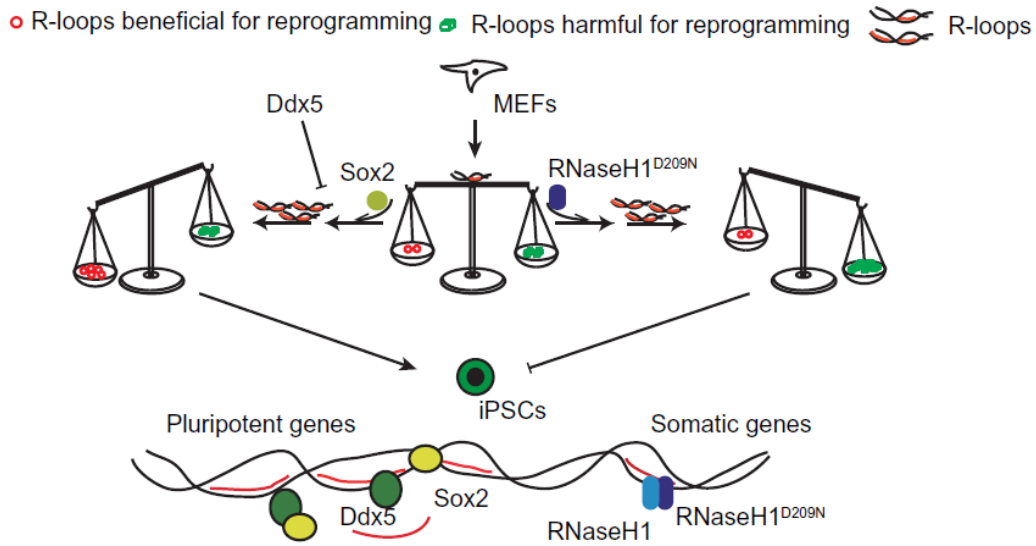
Finally, researchers gave perspectives on the future development of perovskite tandem solar cells including: large–scale fabrication and commercialization, stability and reliability assessments, applications, and lead-related environmental issues.

All in all, the review provides an effective strategy for the development of the PVs research and industry due to device performance enhancement and cost reduction for almost all types of solar cells applied in perovskite tandem solar cells.

This work was supported by the National Key Research and Development Program of China and the Newton Advanced Fellowship.

For more information, please contact:
Dr. Li Hui
E-mail: lihui@mail.iee.ac.cn
Institute of Electrical and Engineering, Chinese Academy of Sciences

Source: Institute of Electrical and Engineering, Chinese Academy of Sciences



R-loops function as a balance for somatic reprogramming. The catalytic inactivation of RNaseH1 (RNaseH1^{D209N}) blocks reprogramming via inducing R-loops accumulation of somatic genes, while Sox2 blocks the activity of Ddx5 at R-loops of pluripotent genes to promote reprogramming. [IMAGE: GIBH]

Study finds R-loops coordinate with Sox2 in regulating reprogramming to pluripotency

R-loops are unique cell structures composed of RNA-DNA hybrids and a displaced single-stranded DNA that are commonly found in and around transcribed genes. However, R-loops are also dynamic and widespread entities that play unclear regulatory and epigenetic roles in the genome. A recent study by Chinese scientists at the Guangzhou Institutes of Biomedicine and Health (GIBH) of the Chinese Academy of Sciences has shed light on the activity of R-loops in the reprogramming of somatic cells to induce pluripotent stem cells (iPSCs). Their work reveals that R-loops influence the reprogramming of somatic cells into iPSCs, and that disrupting this activity leads to defects in the reprogramming of somatic cells into iPSCs.

R-loops may act as epigenetic markers by altering transcription factor binding, chromatin modifications, and DNA methylation. Researchers mapped the landscape of R-loops during OSKM (Oct4, Sox2, Klf4, and c-Myc, four transcription factors in the reprogramming cocktail) mediated somatic cell reprogramming and showed a dynamic association between R-loop formation and dissolution and the process of somatic cell reprogramming.

"Our data indicate that R-loops cause sharp changes at both the early and late stages of reprogramming, but they have transient and subtle changes at the intermediate stage, which shows a similar pattern with chromatin opening, DNA methylation, and gene expression during reprogramming," said Yao Hongjie, author of the study from GIBH.

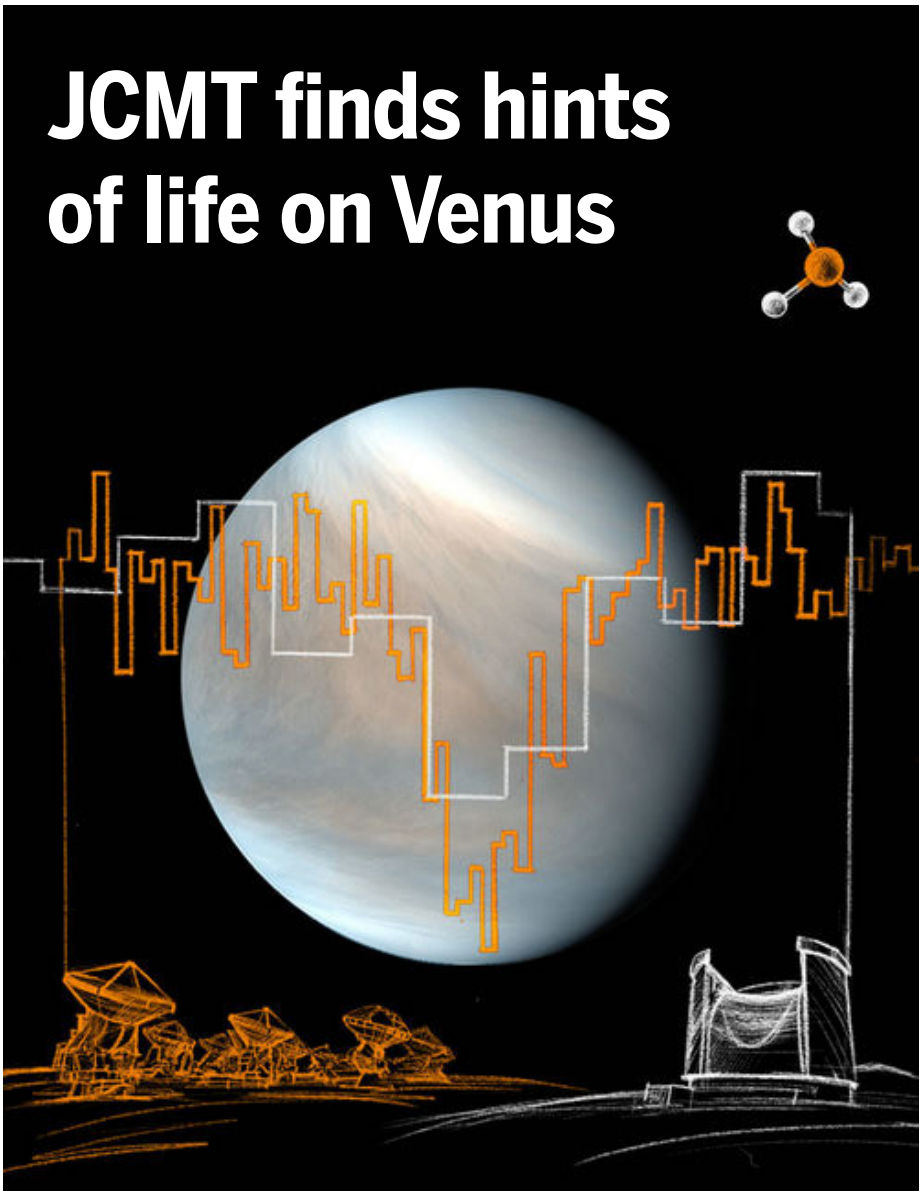
Yao and his colleagues found that some R-loops formed in advance of gene expression, suggesting R-loops are poising genes ready for transcription. Their research revealed that the transcription factor Sox2 (but not any other Yamanaka factor in the reprogramming cocktail) was intimately involved in forming a complex with R-loops. "It is not only a transcription factor that induces transcription but also an essential regulator that maintains the balance of R-loops, and further promotes reprogramming together with R-loop-resolving factors," said Yao.

The results of this study were published online in the latest issue of *Science Advances* on June 10, entitled "R-loops Coordinate with Sox2 in Regulating Reprogramming to Pluripotency".

For more information, please contact:
Yao Hongjie, Ph.D Principle Investigator
E-mail: yao_hongjie@gibh.ac.cn
CAS Key Laboratory of Regenerative Biology, Guangzhou Institutes of Biomedicine and Health, Chinese Academy of Sciences

Source: Guangzhou Institutes of Biomedicine and Health, Chinese Academy of Sciences

JCMT finds hints of life on Venus



Venus the phosphine molecule and the phosphine detection by JCMT (white) and ALMA (orange)
[IMAGE: JOANNA PETKOWSKA]

An international team of astronomers, led by Professor Jane Greaves of Cardiff University, UK, on September 14 announced the discovery of a rare molecule — phosphine — in the clouds of Venus. On Earth, this gas is only made industrially, or by microbes that thrive in oxygen-free environments.

The detection of phosphine, which consists of hydrogen and phosphorus, could point to extra-terrestrial "aerial" life. "When we got the first hints of phosphine in Venus's spectrum, it was a shock!" said Greaves, who first spotted signs of phosphine in observations from the James Clerk Maxwell Telescope (JCMT) in Hawaii.

Astronomers have speculated for decades that high clouds on Venus could offer a home for microbes — floating free of the scorching surface, with access to water and sunlight, and capable of tolerating very high acidity. The new discovery is described in a paper published in *Nature Astronomy* on September 14.

The first detection of phosphine in the clouds of Venus was made using the JCMT in Hawaii, which is operated by the East Asian Observatory on behalf of CAMS-CAS (NAOC, PMO, and SHAO), NAOJ, KASI and ASIAA. The team were subsequently awarded time to follow up their discovery with the 45 telescopes of the Atacama Large Millimeter Array (ALMA) in Chile. Both facilities observed Venus at a wavelength of about one millimeter, much longer than the human eye can see — only telescopes at high altitude can detect it effectively. "In the end, we found that both observatories had seen the same thing — a faint absorption at the right wavelength proved to be phosphine gas, where the molecules are backlit by the warmer clouds below," said Jane.

The astronomers then ran calculations to see if the phosphine could come from natural processes on Venus. Massachusetts Institute of Technology (MIT) scientist Dr. William Bains led the assessment of natural ways to make phosphine. Some ideas included sunlight, minerals blown upwards from the surface, volcanoes, or lightning, but none of these could make anywhere near enough of it. Natural sources were found to make at most one ten thousandth of the amount of phosphine that the telescopes saw. In contrast the team found that in order to create the observed quantity of phosphine on Venus, terrestrial organisms would only need to work at about 10 percent of their maximum productivity. Any microbes on Venus will though likely be very different to their Earth cousins. Earth bacteria can absorb phosphate minerals, add hydrogen, and ultimately expel phosphine gas.

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JCMT opens for morning observing with the shadow of Maunakea evident behind as it rises over Hualālai. JCMT is able to observe during the daytime as it operates at sub-millimeter wavelengths. [IMAGE: TOM KERR]

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Team member and MIT researcher Dr. Clara Sousa Silva had thought about searching for phosphine as a 'biosignature' gas of non-oxygen-using life on planets around other stars, because normal chemistry makes so little of it. She comments "Finding phosphine on Venus was an unexpected bonus! The discovery raises many questions, such as how any organisms could survive. On Earth, some microbes can cope with up to about 5 percent of acid in their environment — but the clouds of Venus are almost entirely made of acid."

The team believes this discovery is significant because it rules out many alternative ways to make phosphine, but they acknowledge that confirming the presence of "life" needs a lot more work. Although the high clouds of Venus have temperatures up to a pleasant 30 degrees centigrade, they are incredibly acidic — around 90 percent sulphuric acid — posing major issues for microbes to survive there. Professor Sara Seager and Dr. Janusz Petkowski, both at MIT, are investigating how microbes might shield themselves inside scarce water droplets.

The team is now eagerly awaiting more telescope time to establish whether the phosphine is in a relatively temperate part of the clouds, and to look for other gases associated with life. This result also has implications in the search for life outside our Solar system.

On hearing the results of the JCMT study, the JCMT's Deputy Director Dr. Jessica Dempsey said "These results are incredible" and went on to say "this discovery made in Hawaii, by the JCMT, was made with a single pixel instrument.

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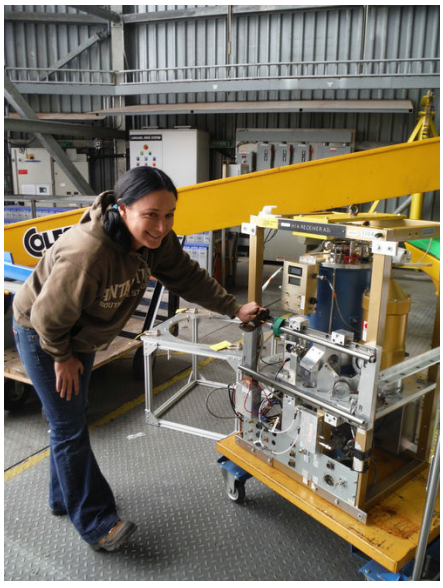

JCMT Deputy Director Jessica Dempsey stands beside the now retired instrument, Rx-A3m, that made this first detection of phosphine on Venus. The instrument has since been replaced by a more powerful instrument called Nāmakanui that is available to all EAO astronomers. [IMAGE: HARRIET PARSONS]

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This is the very same instrument that also took part in capturing the first image of a Black Hole, Pōwehi. The discovery of phosphine in the atmosphere of Venus really showcases the breadth of cutting-edge research undertaken by astronomers using the JCMT. I am so pleased by the efforts from all our staff here in Hawaii."

The JCMT instrument that captured the phosphine discovery has since retired and been replaced by a new and more sensitive instrument known as Nāmakanui. On the potential of this new instrument, Jessica commented "Like its namesake, a big-eyed fish hunting food in the dark waters, we will turn the far more sensitive Nāmakanui back to Venus in this hunt for life in our universe. This is just the beginning, and I've never been more excited to be a part of our boundary-pushing JCMT team."

With a diameter of 15m (50 feet), the JCMT is the largest single dish astronomical telescope in the world designed specifically to operate in the submillimeter wavelength region of the electromagnetic spectrum. The JCMT is used to study our Solar System, interstellar and circumstellar dust and gas, evolved stars, and distant galaxies. It is situated in the science reserve of Maunakea, Hawaii, at an altitude of 4,092m (13,425 feet).

The JCMT is operated by the East Asian Observatory on behalf of CAMS-CAS (NAOC, PMO, and SHAO), NAOJ, ASIAA, KASI, as well as the National Key R&D Program of China. Additional funding support is provided by the STFC and participating universities in the UK and Canada.

For more information, please contact:
Dr. Jessica Dempsey
Email: j.dempsey@eaobservatory.org
James Clerk Maxwell Telescope, East Asian Observatory

Source: James Clerk Maxwell Telescope, East Asian Observatory

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▪ CAS's SDG contribution has grown over the past 10 years, from fewer than 400 in 2008 to more than 3,000 in 2018; a compound annual growth rate (CAGR) of 23 percent. Research output associated with responsible consumption and production (goal 12) has had the fastest growth, given its low base value. Meanwhile, research publications relevant to climate change, clean energy, and good health are all growing strongly, with CAGRs of 22 percent or more.

▪ In global comparisons, CAS has the most SDG-related papers published between 2008 and 2018 among the 11 world's leading institutions studied here, and has the highest growth rate of SDG-related publications over this 10 year period.

▪ CAS has contributed publications to all 17 goals, demonstrating the diverse fields of research covered at CAS. Climate action (goal 13), clean energy (goal 7), good health (goal 3), sustainable cities (goal 11), and life on land (goal 15) are the SDGs for which CAS has the largest number of relevant research publications. Specifically, 58 percent of CAS's SDG-related research publications are in the area of climate action, and 48 percent looked at clean energy.

▪ Compared with its peer institutions, CAS has the highest research output for six (goals 6, 7, 11, 12, 13, 15) of the 17 goals, with its lead most pronounced for climate action and clean energy. For the former, it has slightly more than 9,100 articles, while affordable and clean energy has nearly 7,600 articles.

▪ Good health and well-being has the third largest SDG-related output for CAS. But as CAS is still catching up with its peer institutions in overall life science and medical research, it is still behind in research output relevant to this SDG. Publications relevant to this goal are growing strongly though, at a CAGR of 27 percent.

▪ Most of CAS's research output relevant to SDGs can be categorized in the fields of engineering, chemical, biological, Earth, or environmental sciences, which, except for environmental sciences, are also the research fields in which CAS has produced the most research.

▪ CAS's primary strengths in chemical sciences and engineering translate into strong contributions to a variety of SDGs, and in particular may explain CAS's strength in clean and affordable energy (goal 7). Chemical science accounts for 34 percent of CAS's clean energy papers, while engineering provides 45 percent of CAS's clean energy output.

▪ For CAS's papers related to climate action (goal 13), the majority are in Earth and biological sciences, which together account for half of climate action-related output.

Measuring contribution to SDGs is not easy. Research publications are just one aspect, and they may not directly translate into solutions. But reviewing CAS's relevant output does suggest that scientific research has a big role to play in achieving the SDGs, and that there are a large number of research publications that can be mapped to them. And this review, by aligning CAS's research strengths with its contribution to SDGs, could guide research for the future, leading to innovations that support sustainable development.

Broadening collaboration networks

On a global scale, the Chinese Academy of Sciences (CAS) collaborates with other world-leading institutions. But dig down to the regional level, and there is growing diversity in its collaborators.

When looking at CAS's collaborators, a trend towards diversification emerges. As well as emphasizing collaborations in general, CAS is also broadening its network, forging partnerships in previously under-reached regions as well as growing multinational partnerships.

CAS's collaborators are largely concentrated in the developed regions of the world. Half of CAS's international papers involve at least one researcher in North America, while more than one-third are co-authored with Europe-based researchers, primarily in western or northern Europe. Researchers in Asia — primarily eastern Asia, including Japan and South Korea — contribute to one-quarter of international papers. Over the past 10 years, less than 4 percent of CAS's international papers have involved researchers from Africa, with this total split fairly evenly between the northern and sub-Saharan regions.

However, patterns of collaboration have changed over the past decade. Co-authorship with researchers based in northern Africa is increasing at a CAGR of 56 percent, the fastest growth rate for any region. This is possibly because of its low base value. But if the growth rate continues, within five years CAS will be producing more papers with researchers from northern Africa than from Latin America, and potentially even from eastern Europe (including Russia). These changes are probably intentional. In line with China's Belt and Road Initiative, CAS has launched several projects to connect countries that lack good research infrastructure and to improve cooperation, in the hope of increasing their contribution to scientific research.

In every research field, the greatest proportion of co-authors on CAS's international papers were based in North America, amounting to more than 40 percent of all cases. Co-authors from this region, particularly the US, appeared on roughly the same proportion of CAS's papers across broad research fields. Often, collaborations are driven by personal relationships. Many CAS researchers have experience in the US, so co-authorship with former colleagues or supervisors is probably a strong driver of these results.

The influence of the US is most evident in medical science papers, where the majority of CAS's international output involves at least one US-based researcher. This is not surprising given the US's leading position in the medical sciences. Most of the other regions' collaborations with CAS focus on the physical sciences.

Demystifying biodiversity

Booming economic development and a steeply increasing population have led the Southeast Asian sub-region into multiple ecological and environmental issues that demand analysis and resolution by China and ASEAN countries in tandem, as regional players continue expanding international exchanges and cooperation on biodiversity. China Report ASEAN interviewed Quan Ruichang, Executive Director of the Southeast Asia Biodiversity Research Institute of the Chinese Academy of Sciences (CAS-SEABRI) and a researcher at Xishuangbanna Tropical Botanical Garden of CAS, who elaborated on cooperation between China and Southeast Asia in the field of biodiversity.

China Report ASEAN: What is the current situation regarding biodiversity in Southeast Asia?

Quan Ruichang: Southeast Asia is one of the world's three core tropical rainforest distribution areas and has some of the most abundant biodiversity and unique species in the world. It is also a key region for researching the origin, maintenance, and evolution of biodiversity. The adverse impacts of the booming population, rapid economic and social development, over-exploitation of natural resources, global climate change, exotic species invasion and hunting and illegal trade have caused the biodiversity resources in the region to fall under serious threat. A wide range of species have gone extinct rapidly, so protection of biodiversity has become an urgent and difficult task.

China Report ASEAN: CAS-SEABRI is a scientific and educational institution established overseas by CAS and committed to conducting cooperation on biodiversity research, conservation, and sustainability, but what are its main day-to-day functions?

Quan: CAS-SEABRI focuses on three aspects. First, we organize and implement major scientific research projects and interdisciplinary, trans-regional, and transnational investigations. So far, CAS-SEABRI has carried out nine large-scale joint expeditions in Myanmar, three joint scientific expeditions in northern Laos, and four joint field expeditions to study Cenozoic flora in Vietnam. A research platform for the "forest belt at 101 degrees east longitude" has been preliminarily completed. It consists of 10 large dynamic forest zones including four in China's Yunnan Province, five in Thailand, and one in Malaysia which together form a forest belt spanning the core area of tropical Asia and stretching to the hinterlands of the Qinghai-Tibet Plateau/Hengduan Mountains.

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Second, we carry out strategic research and policy consulting on biodiversity conservation and sustainability. In response to declining forest resources in Myanmar, CAS-SEABRI provided technical consulting for the construction of the "China-Myanmar Eco-Friendly Demonstration Forest" in Myanmar, which involved planting 150,000 trees on 100 acres of wasteland. Since 2017, the research team of CAS-SEABRI has cooperated with universities and research institutions in Myanmar to carry out experimental Chinese hybrid rice planting. The growth period of Chinese hybrid rice grown in Myanmar is 30 to 40 days shorter than in China. Compared with local rice varieties, the Chinese hybrid rice varieties grown at two experimental sites have shown better performance in terms of yield, disease resistance, and lodging resistance, with output up by 23.87 percent and 47.65 percent, respectively.

Third, we provide personnel training, technical training, and science popularization in the fields of biodiversity and ecological protection. Since 2016, CAS-SEABRI has organized training courses such as "Myanmar's Tropical Plant Identification and Forest Management Training," "Biodiversity Conservation and Community Development Workshop in Laos," "Training Course on Breeding and Production Techniques of Major Crops in Southeast Asia," "Advanced Field Course in Tropical Ecology," and "China-Laos Trans-Boundary Wild Animals and Plants Joint Protection and Monitoring Technology Training." The CAS-SEABRI has trained nearly 300 scientific and technological professionals in Southeast Asian countries.

China Report ASEAN: What difficulties and challenges have you encountered while researching biodiversity?

Quan: Intensification of human activities has caused the rate of species extinction to continue accelerating. Many species have gone extinct without ever being named, and many genes have been lost. Different ecosystems are facing fragmentation and sharp reductions in area because of human activities. We urgently need to strengthen the research, protection, maintenance, and rational utilization of biodiversity.

In terms of studying biodiversity in Southeast Asia, the biggest difficulties and challenges are as follows:

First, traditional slash-and-burn methods and large-scale planting of single cash crops such as rubber and oil palm have severely damaged forests in Southeast Asia.

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Second, hydroelectric development in the Mekong River Basin poses a threat to the habitat of animals and plants, and mining has created a particularly serious threat for karst landforms.

Third, hunting and trading of wild animals is the greatest threat to the survival of many species. High-value species are still commodities actively sought by criminal groups, while species of lower value are traded for medicinal usage or food.

Fourth, supervision is weak. Due to relatively backward economic development, many governments have not paid much attention to biodiversity, and the corresponding regulatory and organizational structure is lacking.

Fifth, biodiversity transcends borders, and more attention needs to be placed on cross-border protection actions.

China Report ASEAN: Could you share one of your most memorable experiences studying biodiversity?

Quan: While doing research, we need to investigate, collect samples, and make specimens. The conditions for scientific expedition can be relatively difficult. Sometimes, we find bridges destroyed by floods and end up wading through water. In field investigations, it is normal to eat and sleep in the open air. If we are lucky, we can stay with a local family. We must beware of beasts, snakes, insects, and mosquitoes everywhere. You don't want to get malaria.

One evening in June 2019, on our journey back from a scientific expedition in Htamanthi, Myanmar, a team member found a strange animal on the bank of a river several kilometers from our camp. It was lurking in the darkness, then turned sharply and ran away into the bushes. A colleague rushed to capture a snapshot with a macro lens normally used on plants. After returning to the camp, we guessed that the creature was a crocodile from the blurry photos. According to data, 23 species of crocodile have been recorded worldwide. It would be huge if we could discover a new species of crocodile.

So, we were determined to find it again and organized a "crocodile squad." The next morning, the squad set off in two small wooden boats, fixed their cameras with telephoto lenses and high-speed continuous shutters, but found nothing after a half day of searching. Everyone still had enthusiasm, so we decided we would look again whenever we had the chance. Searching, discovering, and researching are our daily routines. Difficult conditions do not stop our enthusiasm and love for scientific research.

China Report ASEAN: Since the establishment of the CAS-SEABRI, how many new species have been discovered in Southeast Asia?

Quan: We have completed nine comprehensive field expeditions in many places in Myanmar, and discovered 63 new species of animals and plants. Among them, Magnolia kachinensis (Magnoliaceae) and Platea kachinensis are extremely rare tree species found in recent years. The scientific expedition team found white-bellied herons, of which only about 500 are estimated to exist globally, as well as many rare and endangered species such as Bengal tigers, Panthera pardus, and clouded leopards. From 2018 to 2019, three joint field expeditions were carried out in northern Laos, and many animals and plants were photographed and recorded. So far, papers describing four new plant species and seven newly-recorded species of plants have been published.

The research team of CAS-SEABRI has compiled two special journals on new taxonomy of animals and plants and published related research in international science journals such as *Zoological Research* and *Plant Diversity*. Two special issues on new classifications of plants and related research were compiled on *PhytoKeys*, a peer-reviewed, open access, rapidly published journal. Through biodiversity surveys, we can correctly evaluate the status quo and trends of the fragmentation of the ecological environment in Southeast Asia, study patterns of biodiversity, formulate protection measures, and collect better data.

Quan Ruichang, Executive Director of CAS-SEABRI

Source: China Report ASEAN

Personal profile

Professor Quan Rui-Chang, is a professor (since 2013), doctoral supervisor (since 2017), and executive director of the Southeast Asian Biodiversity Research Institute, Chinese Academy of Sciences (since 2015). He is full of passion about ecology and biodiversity conservation research in tropical China and Southeast Asia. As team leader, he has overcome various difficulties and led his team to conduct nine large-scale joint biodiversity survey field projects in uninhabited areas of northern Myanmar over the past five years. "Each of the nine field trips lasted for more than a month," he said. "There is no communication and no modern vehicles in the boundless primary forest region, so every one of us has experienced the difficulties of missing home and losing weight. But what we feel happy about is that there is always a reward for our efforts, and each time the harvest has also been very rich."

0.5°C matters: seasonal contrast of rainfall becomes intense in warming target of the Paris Agreement

The Paris Agreement in 2015 proposed a target of limiting global warming to less than 2°C and a pursuit of efforts to limit warming to less than 1.5°C. Since then, great efforts have been to explore the impacts of the 1.5°C and 2°C warming scenarios.

A recent work published in *Earth's Future* by a team of researchers from the Institute of Atmospheric Physics (IAP) of the Chinese Academy of Sciences has found that the seasonal cycle of precipitation is likely to be enhanced at stabilized 1.5°C and 2°C warming scenarios.

"Based on the output data of the Community Earth System Model low-warming experiment, we conclude that the enhancement is mainly caused by the increase in water vapor," said Chen Ziming, the first author of the study and a doctoral student from the IAP.

The intensity of the seasonal cycle is defined as the difference in precipitation between wet and dry seasons, representing the contrast of precipitation within a year. The wet and dry seasons are usually fixed as June to August and December to February, respectively, in the Northern Hemisphere and vice versa in the Southern Hemisphere. Neither spatial distinctions nor temporal shifts in the wet and dry seasons have previously been considered.

"In our study, the intensity of the seasonal cycle is represented by the difference between mean precipitation in the wet and dry seasons for different regions and for each year," said Chen.

Chen and his collaborators at the IAP found that based on the above metric, the intensity of seasonal cycles is enhanced by 3.90 percent and 5.27 percent under 1.5°C and 2°C warming. With an additional 0.5°C of warming, a pronounced enhancement in seasonal cycle occurred over 22 percent of land regions.

The enhancement was associated with enhanced precipitation during wet seasons caused by thermodynamic responses due to the increased moisture. It indicated that the contrast between the wet and dry seasons would become stronger, resulting in a more uneven distribution of freshwater resources within a year. The probability of flooding would increase in the wet season.

"This study emphasizes the pronounced enhancement in seasonal cycles over land regions associated with the additional 0.5°C warming, despite the insignificant increases in the annual precipitation," added Chen. "The change in temperature may seem small, but 0.5°C still matters."

The work was supported by the National Natural Science Foundation of China and the National Key Research and Development Program of China.

Source: Institute of Atmospheric Physics, Chinese Academy of Sciences

Science Data Bank recommended as generalist repository of Scientific Data and Springer Nature

Science Data Bank (www.scidb.cn), or "ScienceDB", was certified as a recommended generalist data repository for authors by *Scientific Data* and *Springer Nature*. ScienceDB is China's first repository included in the generalist subsection of the recommendation list, complementing the other six well-known repositories such as Dryad and figshare.

ScienceDB is a public and non-profit generalist data repository developed by the Computer Network Information Center of the Chinese Academy of Sciences. Established in 2014, ScienceDB has spared no effort to implement FAIR (findable, accessible, interoperable and reusable) principles of data sharing and standardized data management across disciplinary boundaries in China. ScienceDB has also been actively engaged in the international efforts to make public-funded research data as open as possible and as closed as necessary. Built on the China Science and Technology Cloud which supports cross-border interconnection and interoperability, the repository allows visitors out of China to access published data with no barriers. The portal provides English and Chinese bilingual services, enabling foreign research teams to understand the contexts and download valuable data from China. Previously, ScienceDB was also recommended to authors by the American Geophysical Union (AGU) as a generalist repository.

Source: Computer Network Information Center, Chinese Academy of Sciences