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Implications of geoengineering under the 1.5 °C target: Analysis and policy suggestions

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Abstract

The Paris Agreement introduced a 1.5 °C target to control the rise in global temperature, but clear arrangements for feasible implementation pathways were not made. Achieving the 1.5 °C target imposes high requirements on global emission reduction. Nationally Determined Contributions of all Parties are far from the 1.5 °C target, and conventional emission reduction technologies and policies will also have difficulty in fulfilling this task. In this context, geoengineering is gaining interest in the international arena. The Paris Agreement includes afforestation, carbon capture, utilization and storage, and negative emission technologies such as bio-energy with carbon capture and store. All of these techniques are CO_2 removal technologies that belong to geoengineering. Solar radiation management, which is highly controversial, has also attracted increased attention in recent years. Although the outline of the IPCC Special Report on 1.5 °C does not include a specific section on geoengineering issues yet, geoengineering is an unconventional technical option that cannot be avoided in research and discussions on impact assessment, technical options, ethics, and international governance under the 1.5 °C target. On the basis of analyzing and discussing above-mentioned issues, this paper proposes several policy suggestions for China to strengthen research on and response to geoengineering.

Keywords: Paris Agreement; 1.5 °C target; Geoengineering

1. Introduction

The Paris Agreement, a legally binding instrument applicable to all countries, has created institutional arrangements for global actions to address climate change. It is, under the United Nations Framework Convention on Climate Change (UNFCCC), another milestone and novel start of international climate governance since the Kyoto Protocol (He, 2016). The Paris Agreement has established a long-term goal for the control of global temperature by "holding the increase in the global average temperature to well below 2 °C above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5 °C above pre-industrial levels"[1] and via the "bottom-up" targets of Nationally Determined Contributions (NDCs). The global stocktake will occur every five years to check the achievement of NDCs on emission reduction.

The introduction of the 1.5 °C target in the Paris Agreement has stirred up wide international discussion. Numerous related studies have recently been published. Their focuses are mainly

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[1] For details of the Paris Agreement, see the Official Gazette of the Conference of the Parties to the United Nations Framework Convention on Climate Change (COP-21) http://unfccc.int/resource/docs/2015/cop21/chi/l09r01c.pdf.

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on three aspects: prediction of the situation and influence of climate change under the 1.5 °C target (UNDP, 2016; Seneviratne et al., 2016; Rogelj et al. 2015); analysis of the disparity between NDCs and the 1.5 °C target, and how to close the gap (UNEP, 2016; UN, 2016; ECAT, 2016; IEA, 2015; Gao and Deng, 2015; Cui et al., 2016) and determination of possible pathways for emission reduction to realize the 1.5 °C target (ECAT, 2016; Hare et al., 2014; ETC, 2016; Zhang et al., 2016). Additionally, some scholars have discussed the potential influence of international climate negotiations after the introduction of the 1.5 °C target (Bodansky, 2015; Gillis, 2015; Victor, 2015; Winkler, 2015). Both scientists and politicians generally hold a census that the 1.5 °C target, compared with the 2 °C target, presents a much more difficult challenge in such a short amount of time.

Against the abovementioned background, the discussion on geoengineering for the 1.5 °C target is gaining prominence worldwide. For instance, Lewis (2015) analyzes functions of carbon dioxide removal (CDR) in geoengineering in the post-Paris time. Horton et al. (2016) have pointed out that geoengineering will play an important role in the realization of the 1.5 °C target. Parker and Gedon (2016) cautions about serious challenges for global climate governance after the implementation of geoengineering under the 1.5 °C target. In China, research on this matter is few and still weak. How can we understand the implications of the 1.5 °C target on global climate actions and geoengineering? How do we integrate advance geoengineering into the framework of global climate governance under the 1.5 °C target? How will China cope with international controversies on geoengineering under the 1.5 °C target and layout climate policies? These questions are some crucial issues for in-depth study.

2. Implications of the global 1.5 °C target

Although the Paris Agreement has introduced the 1.5 °C target, it lacks a clear roadmap to the realization of this target. To date, the international community still has no common ground on how to fulfill this goal. The Paris Climate Conference passed a resolution that IPCC will provide a special report on "the impacts of global warming of 1.5 °C above preindustrial levels and related global greenhouse gas emission pathways" (SR 1.5). In October 2016, the 44th session of the IPCC in Bangkok, Thailand, settled the outline of the report (Zhao et al., 2016). The final special report will not be available before 2018. However, based on current research, a huge disparity exists in the pathways to realize the 2 °C and 1.5 °C targets, thereby posing a tremendous challenge for global actions to address climate change.

First, the 1.5 °C target is associated with strict requirements for global emission reduction pathways. Based on the analysis of global carbon budgets by early 2011 according to the Synthesis Report of the IPCC Fifth Assessment Report (AR5), after the reduction of the actual emissions between 2011 and 2015, if the current rate of emissions in 2015 continues, with a probability of 66%, "as of the beginning of 2016, five years and two months of current CO_2 emissions would use up the 1.5 °C budget," and "the equivalent remaining budgets for a 66% chance of staying below 2 °C and 3 °C are 20 years and three months" (CB, 2016). According to the analysis of the IPCC AR5 (IPCC, 2014), to achieve the 2 °C target, the level of global greenhouse gas emissions has to be lowered in 2050 by 40%−70% compared with the level in 2010, and zero emission must be obtained between 2080 and 2010, in which global industrial CO_2 emission has to be reduced by 35%−80% in 2050 compared with that in 2010, and zero emission between 2060 and 2075 must be realized. The 1.5 °C target requires rapid acceleration in the rate of decarbonization in the energy system. Zero emission must be implemented for the electricity sector in advance by 2050. Compared with the descent rate of CO_2 emission speed between 2050 and 2010, the rate is 1.2%−1.8% annually to achieve the 2 °C target and 2.0%−2.8% annually to achieve the 1.5 °C target (ECAT, 2016; Zhang et al., 2016).

Second, a huge disparity exists between NDCs and the realization of the 1.5 °C target. According to data from the official website of the UNFCCC by the end of 2016, a total number of 190 Parties, or 96% of all Parties to the UNFCC, have submitted 162 NDCs, in which the 28 members of the EU submitted one as a whole.[2] In May 2016, the secretariat of the UNFCCC completed a full analysis on the NDCs. It concluded that the temperature would still rise by 2.2−3.4 °C in 2100, even with a full completion of NDCs (UN, 2016). A large distance to the emission pathways remains of the 2 °C target under the confidence interval of 66% by the IPCC AR5, but the distance to the emission pathways of the 1.5 °C target is even larger. The Emissions Gap Report 2016 issued by UNEP (2016) in November 2016 suggests that an emission reduction gap of 12−14 $GtCO_2$ before 2030 is necessary to fulfill the goal of controlling global temperature rise below 2 °C in this century; for the 1.5 °C target, the gap expands to 15−17 $GtCO_2$ (UNEP, 2016). The World Resources Institute collects from a number of research bodies a range of predictions (50% probability) on how the global temperature will rise after the realization of NDCs. It comes up with a number between 2.7 °C and 3.7 °C, which means that countries fail to fulfill the temperature control target in the Paris Agreement. To compensate for such a huge gap in emissions, all countries must increase their force in emissions control. Global greenhouse gas emissions have to hit the peak before 2020, either for the 1.5 °C target or the 2 °C target (UNDP, 2016). The next decade will be crucial to global emission reduction. Absence of effective actions will result in the loss of opportunity to reach the 1.5 °C target and even the 2 °C target by the end of 2020 (Hare et al., 2014). The outlook for global emissions is nothing far from an emergency.

Third, conventional emission pathways will not be sufficient to fulfill the 1.5 °C target. The IPCC AR5 (IPCC, 2014) has assessed a great number of research findings on the economic models of climate change. It is positive on the fulfillment of the 2 °C target. All emission scenarios, however,

[2] http://unfccc.int/focus/indc_portal/items/8766.php.2017-01-04.

are under strict prepositions. For instance, negative emission must be popularized after 2080. Whether low-carbon technologies would be applied in mass commercial production around the world remains uncertain. With the 1.5 °C target in mind, time is extremely limited for the development of low-carbon technologies. For such a severe pressure of emission reduction, Rogelj et al. (2015) worries that we can only fulfill the 1.5 °C target by applying strict, down-to-the-root, and exaggerated “de-carbonization” technologies of mitigation, with the contribution of negative emission technologies. Nevertheless, even if all these “exaggerated” technological prospects are realized, powerful governmental intervention is essential to force the mainstream high-carbon economic structure to transform completely into a low-carbon structure in such a short amount of time, which would counter or even sabotage the market mechanism. Eventually, there will be an undesirable cut of economic welfare. The loss outruns the gains. On November 16, 2016, the Climate Action Tracker (CAT) of Ecofys published a report titled “The Ten Most Important Short-term Steps to Limit Warming to 1.5 °C (ECAT, 2016).” The report urges ten short-term actions in electricity, coal, road transport, building, industry, land use, commercial agriculture, and carbon removal (Table 1). Based on the global situation of technological development and application, the realization of those goals would be almost improbable.

In summary, the introduction of the 1.5 °C target into the long-term global emission goal of the Paris Agreement is derived from political consideration. The realistic emission reduction pathways to fulfill that goal remain unclear. The grave challenge for conventional emission reduction technological pathways is the background of the heated international discussion on geoengineering.

Table 1
Ten most important short-term steps to limit warming to 1.5 °C.

Step	Content
Step 1: Electricity	Sustain the growth rate of renewables and other zero and low-carbon power until 2025 to reach 100% by 2050
Step 2: Coal power	No new coal plants, reduce emissions from coal power by at least 30% by 2025
Step 3: Road transport	Last fossil fuel car sold before 2035
Step 4: Aviation and shipping	Develop and agree on a 1.5 °C compatible vision
Step 5: new buildings	All new buildings fossil-free and near zero energy by 2020
Step 6: Building renovation	Increase rates from <1% in 2015 to 5% by 2020
Step 7: Industry	All new installations in emissions-intensive sectors are Low-carbon after 2020; maximize material efficiency
Step 8: Land use, land-use change and forestry	Reduce emissions from forestry and other land use to 95% below 2010 levels by 2030, stop net deforestation by the 2020s
Step 9: Commercial agriculture	Keep emissions at or below current levels, establish and disseminate regional best practice, expand research
Step 10: CO_2 removal	Begin research and planning for negative emissions

Source: ECAT (2016).

3. No evading discussions on geoengineering to reach the 1.5 °C target

Geoengineering, or climate engineering, is the deliberate large-scale human intervention in the Earth's natural systems to counteract climate change. It includes CDR and solar radiation management (SRM), which involve different technologies and methods (Table 2) (IPCC, 2014; Xin, 2016). The introduction of the 1.5 °C target into the Paris Agreement has brought momentum for research and discussions on geoengineering in the world, with new results continuously surfacing.

3.1. CDR techniques hinted in the Paris Agreement

CDR techniques aim to remove CO_2 from the atmosphere by ocean fertilization, land use management, CO_2 capture, storage and usage (CCS, CCUS), bio-energy with carbon capture and storage (BECCS), and other human interventions. In contrast to SRM, CDR directly reduces greenhouse gases in the air and shares many theoretical and technological traits with traditional reduction methods (Heutel et al., 2015). Several international scholars have applied Integrated Assessment Models for climate change in the analyses of multiple pathways to realize the 2 °C target, with all assuming the implementation of CDR on a large scale, such as the wide use of BECCS and afforestation (Horton et al., 2016; Parker and Geden, 2016). The IPCC also provides a rather systematic evaluation on CDR. In the section on the realization of the 2 °C target in its AR5, it assumes wide use of CCS and a general application of negative emissions after 2080.

The 1.5 °C target cannot be realized without CDR technologies. According to the UNDP (2016), apart from conventional emission reduction pathways, at least 15% of the CO_2 in the atmosphere by the end of the century has to be processed by carbon removal to fulfill the 1.5 °C target. Recent reports by CAT and ETC also emphasize the reliance of CCS and CCUS in reaching the 1.5 °C target (ETC, 2016; ECAT, 2016). Besides, current framework of international climate

Table 2
Catalogs of geoengineering.

Category	Method	Example technique
CDR	Increase in carbon sink in land biosphere	Afforestation
	Carbon capture and storage in the lithosphere	Biochar
	Carbon capture and storage in the ocean	Ocean fertilization Ocean current acceleration Ocean alkalinity enhancement
SRM	Increase in reflection rate, reduction in Earth's absorption of short-wave radiation	Stratospheric aerosols Space reflectors Albedo enhancement (whitening) Roof whitening, desert greening

governance basically covers CDR-related geopolitical, global economic, and environmental issues (Pan, 2012). Therefore, few disputes occur in regard to the application of CDR (Xin and Pan, 2016).

The Paris Agreement has not clarified any formation of the CDR mechanism in its framework, but the techniques it has mentioned and included in its plan of mitigation measures insinuate CDR technology. Article 4, paragraph 1 of the Agreement states that "in order to achieve the long-term temperature goal … so as to achieve a balance between anthropogenic emissions by sources and removals by sinks of greenhouse gases in the second half of this century, on the basis of equity", in which "removal by sinks" is closely connected with CDR. Forest carbon sinks, BECCS, and other technical solutions proposed by the UNFCCC are all CDR-related. Article 5, paragraph 1 of the Agreement stipulates that "Parties should take action to conserve and enhance, as appropriate, sinks and reservoirs of greenhouse gases as referred to in Article 4, paragraph 1 (d), of the Convention, including forests." Article 5, paragraph 2 further proposes "positive incentives" (UNFCCC, 2015) for Parties who take actions in the advancement of related technologies. All those articles written in the Paris Agreement have reserved policy space for the application of CDR.

In general, either the 1.5 °C or 2 °C targets can hardly be achieved without CDR applications. Whether this condition has been pointed out in the Paris Agreement or other related actions to deal with climate change, CDR and other geoengineering techniques have already taken part in global climate actions.

3.2. 1.5 °C target has stirred greater attention on SRM

Will the introduction of CDR settle the realization of the 1.5 °C target? Many scholars remain negative. Given the constraint of high-carbon economic pattern, David Keith, Horton, and Andy Parker, among others, believe that the level of completeness of NDC goals and the slow transition into a globally sustainable economic structure determine only two-thirds of probability to fulfill the 2 °C target, even though powerful emission reduction methods are coupled with the implementation of CDR technologies on a large scale. All these efforts are far from sufficient for the 1.5 °C target. SRM in geoengineering must be considered. The abovementioned researchers have all published articles recently, asserting that the 1.5 °C target in the Paris Agreement predicts a new and vital role for SRM in coping with climate change. Their judgment, however, does not represent their support for the application of SRM technologies. Instead, they are more likely to express worries on the probability of an increase in the application of SRM technologies (Horton et al., 2016; Parker and Geden, 2016).

SRM aims at a "direct reduction" of Earth's temperature by controlling solar radiation. It largely includes methods and techniques that change the reflection rate of the Earth's surface, such as stratospheric aerosols, space reflectors, albedo enhancement via roof whitening, and desert greening (IPCC, 2014; Pan, 2012). Given that SRM cannot physically reduce the amount of greenhouse gas in the atmosphere, the majority of scientists who worry about possible effects on the enthusiasm of conventional emission reduction pathways in Parties avoid or even reject SRM. In 2010, the Convention on Biological Diversity held the COP10 and passed a resolution, which specifically states that prior to scientific evaluation on the social, economic, and cultural impact of geoengineering, no Parties should start massive geoengineering activities that could potentially affect biological diversity (Yin et al., 2013). In 2014, the IPCC AR5 evaluated ARM in its report, which cautions on any premature SRM practices without adequate research (IPCC, 2014).

However, conventional emissions reduction techniques all fall short for the 1.5 °C target. SRM may be, as some might say, the only doable fast track to reduce temperature (ECTNARCC, 2015; TNA, 2015), or the last resort after everything else has been exhausted. In April 2016, the U.S. Senate Appropriations Committee called for a strengthening of research on the reflectivity of the Earth to combat global warming. Funds will be dispatched to the United States Department of Energy, the United States Army Corps of Engineers, among other institutions, to conduct related research (CSN, 2016), from which SRM techniques are not absent. Hoesung Lee, Chairman of the IPCC, demanded recently that the IPCC conduct a research report exclusively for SRM techniques (Goldenberg, 2016). SRM has definitely become a hot issue in climate change, so increasing attention is expected from all Parties.

3.3. Political factors may play key parts in pushing the implementation of geoengineering

Political factors have played key parts in the formation of global temperature control targets, which will illuminate geoengineering. The ultimate objective, as originated in the second article of the UNFCCC, is "to achieve … stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system." (UN, 1992) Such a generalization fails to guide global climate actions, which brings together a consensus to form a clear, specific target for temperature control. The EU first proposed a 2 °C target, which has not been established as the long-term strategic target of the European Council until its 2632 meeting in 2004 (EU, 2015). After systematic scientific estimation and multilateral political pressures, the Cancun Agreements finally drew a definitive note on this target (UNFCCC, 2010; Zhang et al., 2016). Thus, concerns about a regional disparity of risk in the global 2 °C target remain; for instance, the average temperature in a high-latitude region will outscore that in a low-altitude region (Meinshausen et al., 2009; Schleussner et al., 2016). In light of this scenario, the Alliance of Small Island States (AOSIS) and the Least Developed Countries first pushed together for the 1.5 °C target and drafted a resolution to the UNFCCC, which recognized the 1.5 °C target in its 2015 report (UNDP, 2016), leading to a central issue in the Paris Climate Conference. In the final stage of signing the Paris Agreement, the High Ambition Coalition of the 1.5 °C target grouped by the EU, U.S., Canada, and Africa, Caribbean, and Pacific Group of States assumed the high stand in public opinion (Zhang et al., 2016).

The establishment of the 1.5 °C target in the Paris Agreement is a result of scientific estimation, interest demand, and political simulation. The predominant factor is difficult to determine at this stage, but political involvement is apparently a crucial factor. Apart from the enduring struggle of the AOSIS and LDC, developed countries who completed industrial transformation also joined in to push the campaign for the 1.5 °C and made vital contributions. One of the governance risks of geoengineering is the possibility of independent actions by individual countries. If political factors play a vital or decisive part in the fulfillment of the 1.5 °C target, politics may bypass science in pushing the implementation of geoengineering with the insufficient time limit for the 1.5 °C target.

3.4. Great urgency for international governance of geoengineering with the 1.5 °C target

Obviously, the avoidance of geoengineering is not advisable in the long run for the 1.5 °C target. International governance of geoengineering must be constructed and perfected, guidelines for the research and implementation of geoengineering should be set, and irreversible damage in the process ought to be avoided.

International agreements that can specifically provide norms for the implementation of geoengineering by a country or an institution are currently unavailable (Parson and Ernst, 2013). For some countries or companies (for example, high-pollution enterprises) that enjoy strong momentum for economic growth but face huge pressure for emission reductions, geoengineering presents visible advantage in cost and efficiency. An example of one application is the delivery of sulfate aerosols into the stratosphere via SRM. If allowed, easily applicable techniques can be developed rapidly, which is of tremendous attraction (Xin, 2016). The "free-driver" feature of geoengineering would also encourage unilateral actions by Parties who have the power to do so (Weitzman, 2015). Moreover, given the increasing tendency of laxness of "bottom-up" international climate governance, normalizing actions by all Parties would be difficult as long as countries have the motive and technical capabilities to carry out unilateral actions.

The EU and U.S. have intensively studied previous research to explore the international governance of geoengineering. Related research includes the decision principles for unilateral and multilateral actions of geoengineering, the implementation of regional sovereignty designation, and other important issues (Humphreys, 2011; Scott, 2013; Parson and Keith, 2013). In 2013, scholars from the University of Oxford proposed the Oxford Principle: 1) to be regulated as a public good; 2) public participation in geoengineering decision making; 3) disclosure of geoengineering research and open publication of results; 4) independent assessment of impacts; and 5) governance before deployment (Rayner et al., 2013; Chen, 2016). Geoengineering is at its initial stage with the formation of international governance, and the fixation of principles is merely the first step. Questions, often complicated and controversial, regarding governance subjects, decision-makers, evaluation methods, and other international mechanisms must be answered (Chen, 2016; Scott, 2013). The IPCC, UNFCC, and Convention on Biological Diversity are crucial in organizing, coordinating, and evaluating the results of geoengineering. Further studies should explore how to incorporate the 1.5 °C target and combine the Paris Agreement to expand the governance mechanism of geoengineering.

4. Primary thoughts and advice on Chinese position and actions

China has actively contributed to the governance of global climate and is a key party in the draft of the Paris Agreement. China has the largest total carbon emissions and carbon emission average per capita; China's own energy resources and the stage of economic development also determine a long-term high-carbon energy structure (Xin and Pan, 2016). Some Western scholars tend to, consciously or not, list China as one among the countries with the highest potential in implementing geoengineering. They also insinuate that China may unilaterally conduct geoengineering projects such as stratospheric aerosols.[3] Under the 1.5 °C target, the pressure of emission reduction mounts further on China. International discussion on geoengineering can hardly bypass the "Issue of China." The Chinese government should attach prominent importance to geoengineering problems to actively arrange related strategies and actions.

First, the problem of geoengineering must be scientifically and reasonably understood with the 1.5 °C target in mind. The introduction of the 1.5 °C target aims to reduce risk and loss in global climate change as much as possible. However, the implementation of geoengineering for the fulfillment of the 1.5 °C target, especially SRM with its considerable uncertainty, brings new high risks. Scientific and reasonable understanding is necessary to deal with geoengineering. The mechanisms underlying different geoengineering methods, as well as their social impact and risks, vary. Therefore, they refuse to be treated in a bundle. The potential risk of geoengineering has to be acknowledged, while objectivity and openness must be retained. Related research on geoengineering does not necessarily affect conventional emission reduction actions. New momentum might be added as potential risks are revealed (Chen, 2016). The large picture of global actions against climate change should be combined with China's needs in dealing with this issue. The strategy of the development of geoengineering must be elaborated. Replacing scientific judgment with political preference, or rejecting geoengineering, is not advisable (Xin and Pan, 2016; Chen and Liu, 2013).

[3] http://www.policyinnovations.org/ideas/commentary/data/000292.

Second, geoengineering should be included into China's strategic framework of dealing with climate change. In light of the shared goal of dealing with climate change, non-conventional geoengineering techniques and conventional alleviation and adaption actions not only share close ties but also overlap with each other. With the serious challenge of the 1.5 °C target, geoengineering has to be included into the large strategic framework of climate change. Geoengineering provides not only scientific value, but it is an important technical reservoir for the future. Moreover, it presents strategic significance for global climate safety.

Third, the commercialization of CCS/CCUS techniques should be rigorously encouraged and the application of BECCS must be explored via diverse policies. Massive commercial application of CCS/CCUS techniques is inevitable. Current commercial examples demonstrate a near maturity of those technologies. Encouragement should start now, and related incentive policies must be carried out (e.g., policy subsidy based on the amount of carbon emissions and the inclusion of carbon trade). Energy and material expenditure should be reduced as far as possible to lower costs. Reliable surveillance methods must be developed to caution risks and secure safety. Thus, the prospective application that combines biomass energy and the negative emission techniques of CCS should be highlighted. Efforts should be deployed in overcoming the techno-economic difficulty of carbon capture and storage.

Fourth, research on SRM techniques ought to be strengthened with a merge between natural science and social science. The current stage should center on SRM research. Key research areas include the use of climate models to conduct simulation analyses of all kinds, the adoption of socio-economic circumstances to reinforce the evaluation of environmental risk and comprehensive impact, theoretical discussion from an ethical perspective, and the study of international governance mechanisms. Though a scientific technique, SRM also deals with economic, political, ethical, legal, and other areas of social science. Progress has been made constantly in the scientific understanding of SRM, but the controversies and disparities in the understanding of social science continue to expand. Only by strengthening a merge between natural science and social science can the study of SRM be deepened. Compared with computer simulation analysis, SRM small outdoor scientific experiments are prone to international attention and misunderstanding. Therefore, extra caution is needed and a strict monitoring system should be established.

Finally, China must actively engage in the international governance of geoengineering and make its own voice heard in the world. Geoengineering has not been included as an issue for climate negotiations, within or outside the UNFCCC. Discussions on the international governance of geoengineering have taken place and will be carried into the foreseeable future. There are large policy and rule blanks in the international governance of geoengineering. If China heads to lead international governance, geoengineering could be a potential issue. China should actively participate in leading the international governance of geoengineering and upholding justice and equality in the international climate system. Communications and clarifications are expected more in response to some Western scholars' concern and worry toward the possibility of unilateral actions (Moore et al., 2016). Since the establishment of the first national geoengineering research project, the 973 project, Chinese scholars have intensively engaged in global communications and dialogs. Related research and opinions are gaining increasing recognition from international counterparts. At present, we are in the crucial period as the IPCC has organized a discussion involving global scientists in preparation for the Special Report 1.5 °C report. Chinese scholars should extend their attention on the 1.5 °C target and possible controversies, related scientific background, and political implications so that China can present related issues prevent western dominance.

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