

# CHINA'S CLIMATE CHANGE RESEARCH CONTRIBUTIONS FROM A GLOBAL PERSPECTIVE

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OBSERVATIONS

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Climate change is a global challenge that requires the collective cooperation and actions of all countries to mitigate its impacts and address its far-reaching consequences. Over the past few decades, both developing and developed countries have responded to the issues of climate change, and the strategy of The People's Republic of China (PRC, herein after China) is an essential component of this effort. The rapid expansion of funding for Chinese scientific research since the 2000s has served to raise Chinese quantitative and qualitative output of scientific publications.<sup>1</sup> If Chinese authors with an address outside of the PRC are included, i.e., those working in organizations in the US, Europe, and Japan, the extent of scientific publications by Chinese researchers would be even larger than usually reported, so that the actual estimated contribution of Chinese researchers of global scientific output would amount to 36 percent.<sup>2</sup>

A recent report reveals that China now outpaces other major economies in terms of its publication of academic research articles in journals indexed in the Web of Science (WoS), including both the US and the EU. Moreover, China is now publishing a proportion of its research with a citation impact above the global average, similar to the US and Germany. China's most highly cited research contributions are strongly represented in the disciplines of chemistry, engineering, and materials science. China's leading research fields include green technologies, such as solar cells and fuel cells, while also contributing core papers to top research relating to microwave absorption and electromagnetic radiation.<sup>3</sup>

There are a number of scientometric studies that have investigated the patterns of international scientific publications regarding the climate on a global scale, typically based on the WoS database.<sup>4</sup> This type of research has also been used to examine the key research trends related to global climate change.<sup>5</sup> However, few international studies have investigated the specific contributions of China's scientific publications in the field of climate change. Likewise, there are few studies that investigate the patterns of funding and the role of co-authorship in relation to China's climate change research.

This paper seeks to throw more light on Chinese scientific publishing related to climate change in the context of global publications, addressing the following research questions:

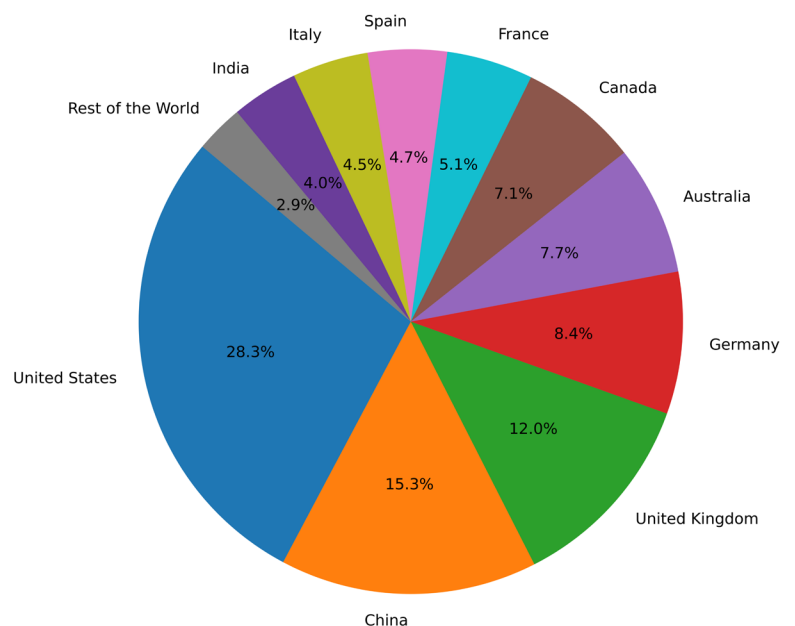
1. What is the Chinese share of international climate change publications?
2. What are the main funding sources for Chinese research on climate change?
3. To what extent do Chinese climate researchers collaborate with their foreign counterparts?

## Source Material and Sampling Approach

Scientific databases like the WoS and Scopus serve as primary data sources for bibliometric studies. While some differences exist, e.g., data volume, and coverage, there are no substantial disparities. We filtered the reference dataset, sourced from Scopus from 2000–2023, for academic articles using the keyword “climate change” (in the titles, abstracts, or keywords) together with additional search criteria e.g., English language and document type. This process yielded 45,488 publications of Chinese authors affiliated with PRC-based institutions and 297,682 publications from all countries. We analyzed the publications through a bibliometric analysis using python.

## Quantitative Trends for Chinese Publications on Climate Change

The analysis of China's English-language publications can be seen as an indicator for China's international involvement in the issue of climate change when considered in the context of the English-language publications by authors from the rest of the world.<sup>6</sup> Figure 1 shows the proportion of scientific articles on climate change published from 2000 to 2023 by the nationality of authors. During this period, China's research contributions were responsible for 15.3 percent of articles in English journals, coming second after the US with 28.9 percent of publications. It is important to note that from 2000 to 2009, China had comparatively few publications on this issue; during those years China was a rapidly developing economy and



**Figure 1: Percentage of climate change publications in English by country, 2000-2023**

focused on promoting economic growth. At the time, climate change had not yet become a focus for China's public policy agenda. However, the quantitative gap between numbers of climate change publications for the US and China changed significantly during the period 2015-2023, indicating that China's scientific contributions on global climate issues were on the rise, as shown in Figure 2.

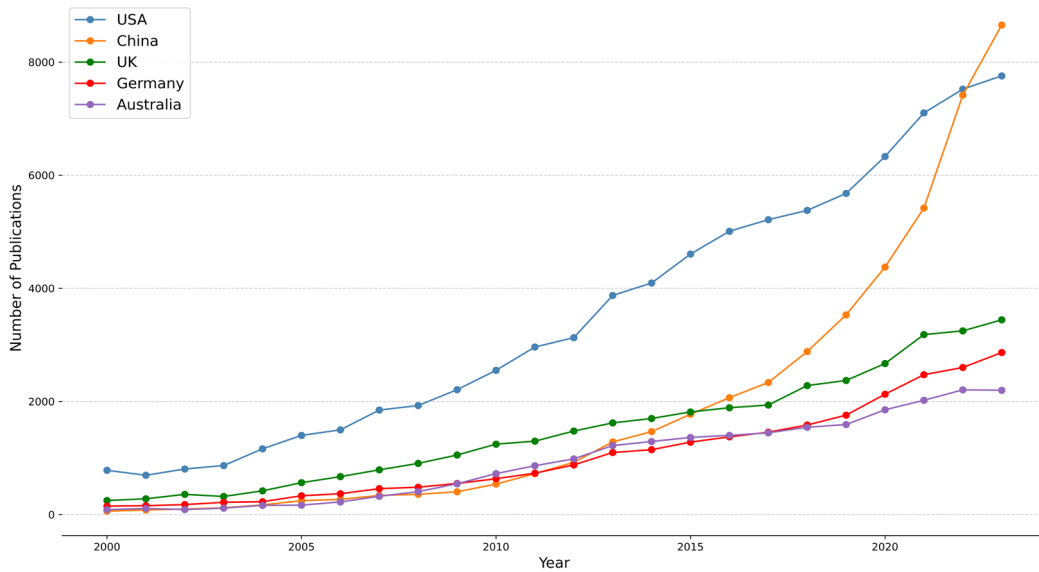


Figure 2: Publications on climate change in English for the top five countries

It is likely that the expansion of Chinese scientists' publications addressing climate change internationally is related to support from the Chinese leadership. China published its national policy on climate change in 2007, which signaled a stronger commitment to solving domestic issues related to greenhouse gas emissions. Moreover, the aftermath of the 2009 United Nations Climate Change Conference probably also motivated the Chinese leadership to engage in a more constructive role for international mitigation of carbon emissions during subsequent years. In September 2020, President Xi Jinping announced that China aims to peak its carbon emissions before 2030 and reach carbon neutrality by 2060.<sup>7</sup> By December, Xi had announced a series of new targets for China by 2030 at the Climate Ambition Summit, including carbon dioxide emission reductions, development of non-fossil energy, and increases in forest carbon sinks. One year later, President Xi Jinping stated that China would vigorously support green and low-carbon energy technology in developing countries and no longer build new overseas coal-fired power projects.<sup>8</sup> The potential effect of these policy statements can be discerned in Figure 3, where China's international publications on climate significantly increased in 2022-2023, accounting for nearly 30 percent of total international publications in the field.

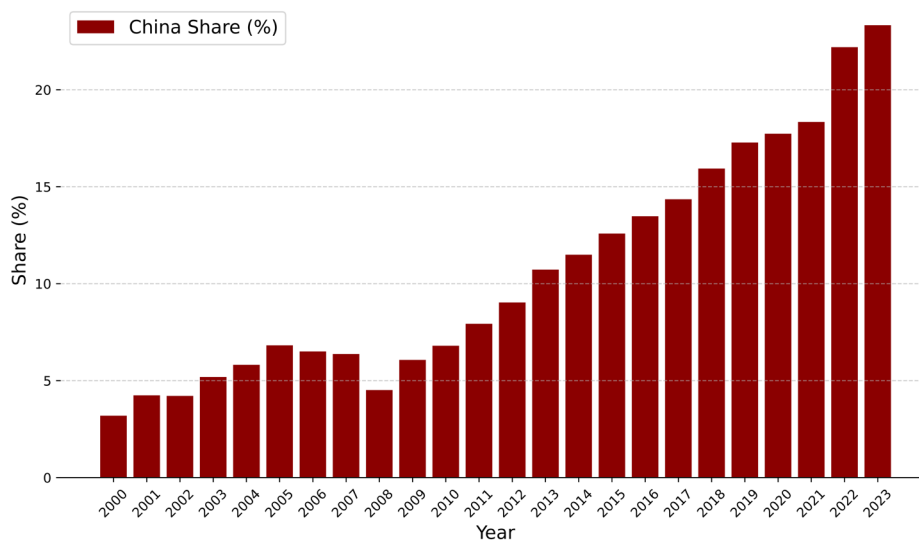


Figure 3: China's share of total international climate change publications per year, 2000-2023

## Sources of Research Funding

An analysis of funding agencies provides insights into the research commitment of different countries and the extent that funding institutions have prioritized global climate change. The data analyzed below provides a quantitative analysis based on the number of publications, but it does not reflect the amount of funding provided, as those figures are seldom reported.

Figure 4 shows the number of publications that report funding commitments to climate change science and support from major research funding agencies around the world between 2000 and 2023. This visualization shows which institutions are the main providers of funding for climate change research, and reveals the global pattern of the distribution of scientific research funding in the field. Interestingly, the National Natural Science Foundation of China (NSFC) comes out on top, having supported 8.3 percent of the reported scientific research. This is closely followed by the US National Science Foundation that funds 5.6 percent of the research. This figure highlights the important role these organizations play in supporting international climate change research.

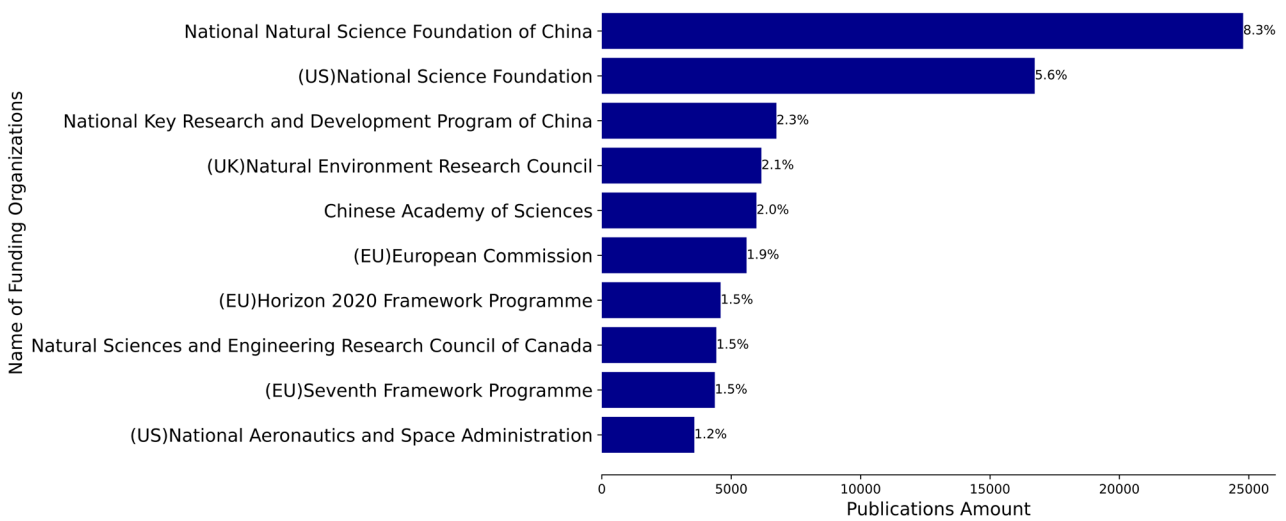


Figure 4: Top ten funding sponsors of international climate change research

The NSFC is the largest funding organization for basic science in China. Figure 5 shows that over the past two decades, articles funded by the NSFC have accounted for more than half (54.7 percent) of the total number of climate change-related articles by Chinese authors.<sup>9</sup>

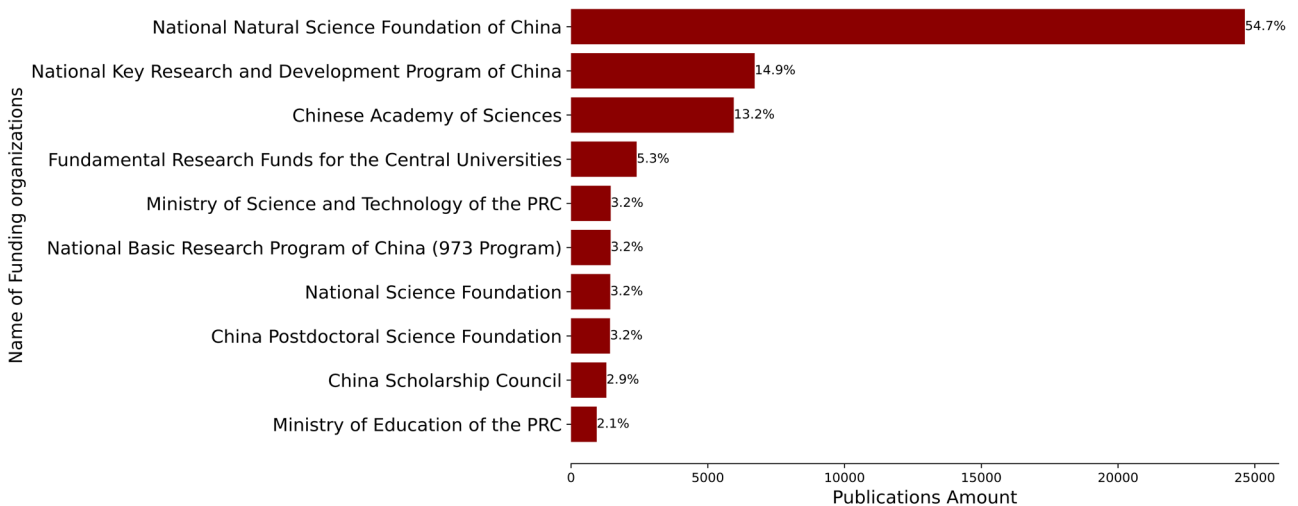


Figure 5: Top ten funding sponsors for Chinese and international publications

An analysis by NSFC administrators from the Department of Management Science indicated that China's climate change policy started late, and the number of Chinese project applications before 2009 in this field was low, with only 1-2 funded projects each year. When the Chinese government listed “Energy and Climate Change” as one of the priority areas for funding in the 12th Five-Year Plan (2011-2015), they then raised the number of funded projects to 30 in 2011.<sup>10</sup>

This reprioritization is also illustrated in the number of China’s research contributions shown in Figure 6, where we can delineate the NSFC's focus on climate change research into three phases: 1. The period spanning 2000–2010 which denotes a phase of relative inertia. 2. This phase covers 2010–2015, marked by notable shifts in publication dynamics owing to the incorporation of climate change as a pivotal funding area in the 12th Five-Year Plan (2011-2015). The 13th Five-Year Plan that the Chinese government issued in 2016 included a chapter dedicated to actively addressing global climate change. 3. This phase stretches from 2015 to 2023 and signifies heightened attention internationally and in China, witnessing a further surge in publications after the Paris Agreement. The availability of targeted funding in turn has a direct impact on the research output in the focused areas.

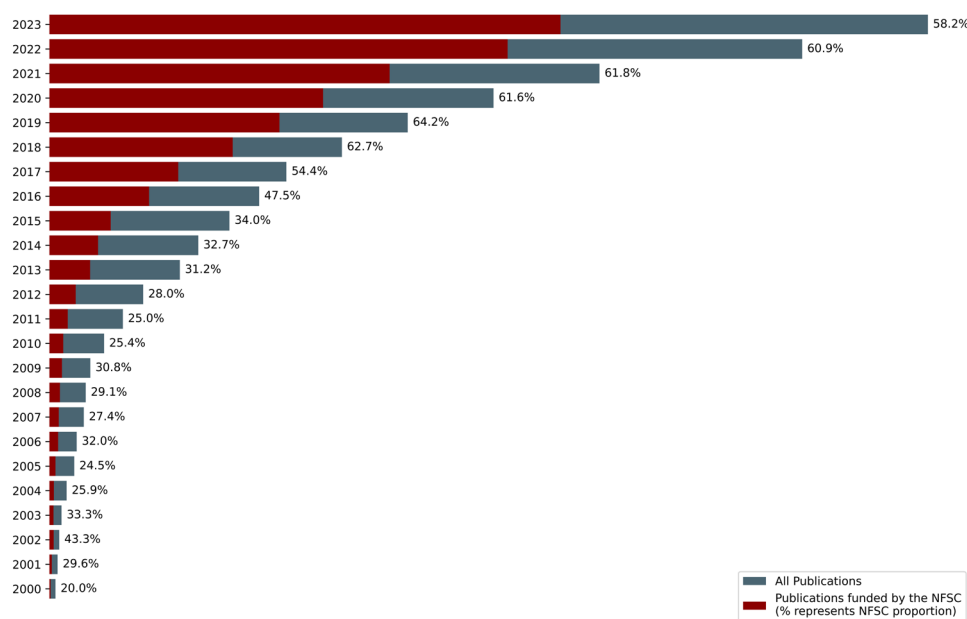


Figure 6: Climate change publications funded by the NSFC proportional to all publications from Chinese institutions.

To some extent, these three phases correspond to the evolution of the Chinese government’s policies on climate change. Moreover, the Chinese government established a 20 billion RMB China South-South Cooperation Fund on Climate Change and announced the launch of the “Ten-Hundred-Thousand” South-South Climate Cooperation Project in 2016.<sup>11</sup>

### International Cooperation for Chinese Publications

The pattern of co-authorship with overseas researchers provides some interesting clues into the influence of geopolitics. A breakdown of the nationality of co-authors over time demonstrates that, up until 2015, Chinese scientists’ cooperation with international authors constituted approximately half of the number of publications, while the other half represented cooperation with domestic Chinese co-authors.

What emerges from Figure 8 below is that, since 2015, Chinese publications regarding climate change are increasingly the result of cooperation with other domestic Chinese co-authors, several times the number co-authored with international authors. This is likely the effect of a significant upgrading of the domestic talents and capabilities for scientific research related to climate change in China.

Although cooperation with the US has traditionally had a dominant position in Chinese authors’ climate change publications, that position has dropped dramatically since 2017, as illustrated in Figure 8. While collaborations with

other countries have remained more or less constant, collaboration with authors in the US declined from around 25 percent in 2017 to 13 percent by 2023. Most likely this is a consequence of US policies that began questioning scientific cooperation with China in 2017, which, in turn, are connected to US-China geopolitical rivalries.

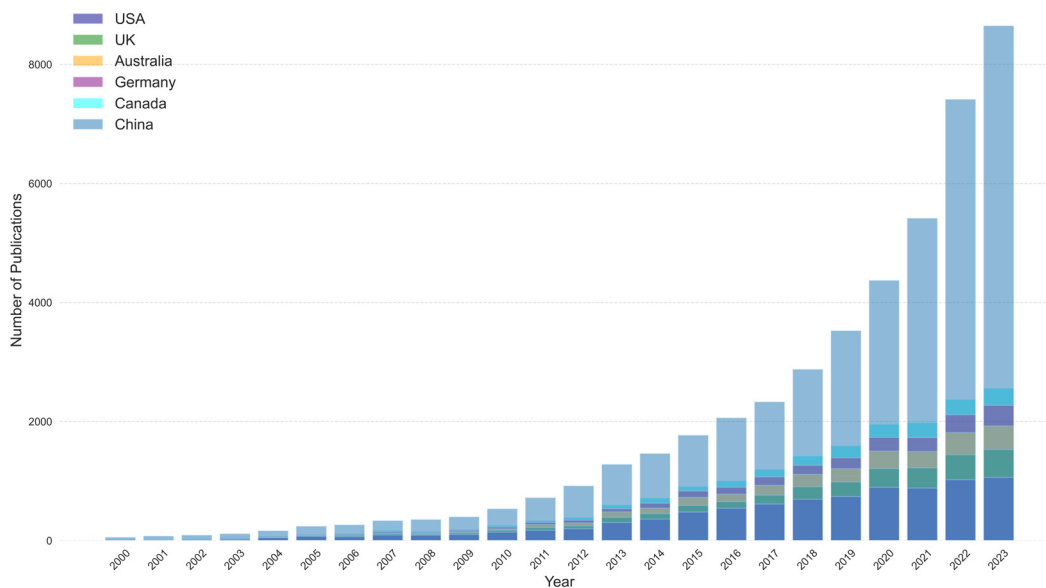


Figure 7: The number of co-authors from China and overseas (top five countries)

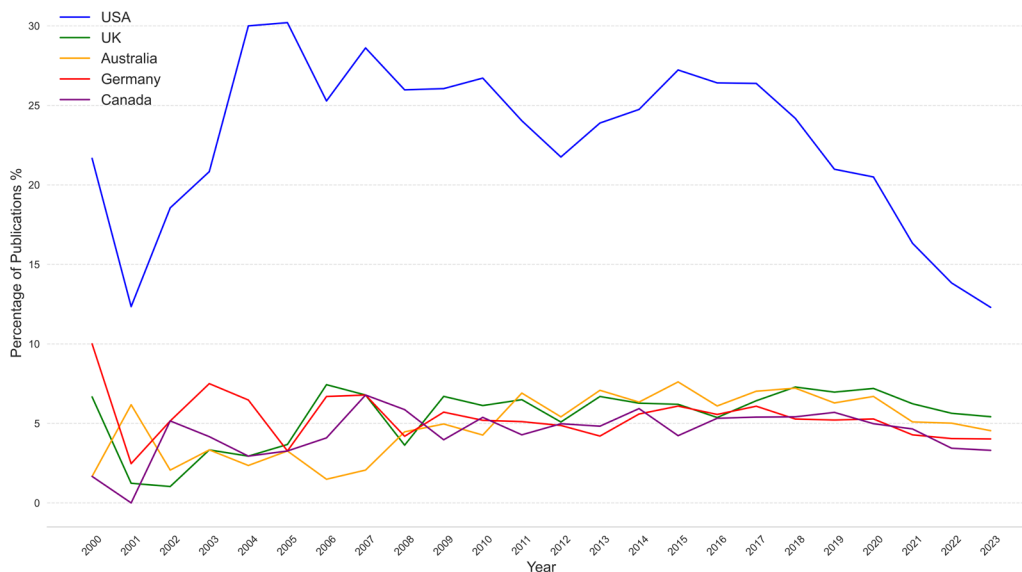


Figure 8: Proportion of publications with Chinese and international authors (top five countries)

The analysis above indicates that cooperation with overseas authors has been vital for the growth of Chinese contributions to the international literature on climate change. Even if such cooperation can be influenced by geopolitical tensions, it is likely to continue as an essential element of Chinese contributions to global science.

### Analysis of Citations: Quantitative and Qualitative Assessment

In order to provide an assessment of the potential impact of Chinese scientific research on climate change, an analysis of the relative citation ratio (RCR) can provide interesting insights about the impact of articles by authors from the US, Germany and China respectively. The RCR is an improved method to quantify the influence of a research article by making novel use of its co-citation network—that is, the other papers that appear alongside it in reference lists—to apply field normalization to the number of times it has been cited. Among the top five percent of most-cited articles, the top ten most-cited journals are overwhelmingly dominated by US-based papers, in terms of both the number of

publications and the total number of citations. The US thus achieves the highest median RCR (approximately 1.05) with the narrowest distribution, indicating stable and consistent academic influence across journals. China obtains an RCR ratio that indicates a relatively lower citation impact but it also has the largest variability in RCR, with remarkable contributions in specific journals such as *Global Environmental Change* and *Journal of Geophysical Research: Atmospheres*, but weaker influence in the top five journals.

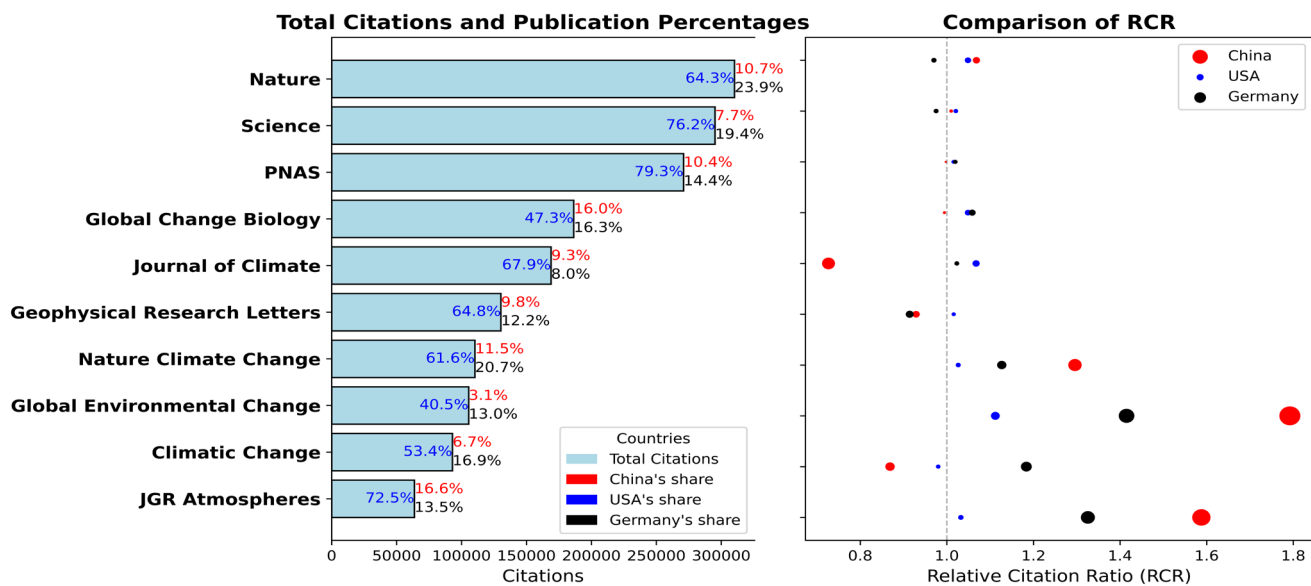


Figure 9: Total citations and relative citation ratio for climate change articles<sup>12</sup>

## Conclusions and Future Research Opportunities

Chinese publications have witnessed a remarkable growth rate from 2000 to 2022, gaining a leading position among the top five countries. Although the US accounted for 28 percent of the world's publications for much of the period, data shows that China surpassed the US in 2023 to become the country with the highest number of publications. Secondly, the funding for Chinese climate change research includes a number of organizations. In particular, funding provided by the NSFC since 2010 has been instrumental in supporting the growth of scientific research and publications in the field. This is similar to most countries, where a political focus is expressed in the targeted research funding agendas of science policy.<sup>13</sup> Thirdly, global publication trends highlight the role that international cooperation plays in the output from China's climate change scientists. During the past twenty years, the US has been the country with the most co-authored papers with China on climate change, accounting for more than 20 percent of all Chinese publications. Nevertheless, collaborations between China and the US declined recently, due both to the controversial China Initiative launched by the US administration in 2018 which only ended in 2022,<sup>14</sup> as well as to geopolitics and the US' increasingly strict scrutiny of science, technology, and data security, which have gradually limited international scientific collaboration. China's collaborations with other countries, such as the United Kingdom, Australia, Germany, and Canada, have remained relatively stable.

Future avenues for research in continuation of the present analysis could take a more focused perspective on the networks behind these publications, or explore Chinese contributions in a comparative setting. This paper has, in a sense, surveyed the Chinese position in international scientific publication on climate issues at the macro level. While our analysis has demonstrated key macro trends for international collaboration, there are definitely opportunities for research at the micro level. For instance, a future project could look into how individual Chinese scientists engage with international organizations to promote cooperation on scientific research and policy related investigations. Moreover, it could be interesting to develop the comparative analysis of co-authored publications by climate scientists from the US, the EU, and China, revealing particular strengths in individual disciplines contributing to climate science, or particular topics related to climate change, and how these change over time.

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