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The role of research in Antarctic diplomacy: A scientometric analysis of the Treaty System's impact

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Abstract. This study delves into the intricate relationship between scientific research and diplomacy within the framework of the Antarctic Treaty System (ATS), employing a comprehensive scientometric analysis to explore its multifaceted impact. The ATS has played a pivotal role in fostering collaboration among nations. By analysing global publication trends, citation patterns, and co-authorship networks, this research examines how scientific output not only reflects but also drives international cooperation and policy development in polar regions. The primary objective of this study is to evaluate the role of research output in supporting the principles of the ATS, with a focus on promoting peace, science, and environmental protection in Antarctica. Specifically, it aims to investigate the contribution of scientific research to international collaboration under the ATS; identify global trends and emerging priorities in Antarctic research; assess the impact of interdisciplinary studies in advancing ATS objectives, including climate change mitigation and ecosystem protection. This research adopts a scientometric approach to analyse the global corpus of scientific publications related to Antarctic research. The analysis revealed that the volume of Antarctic-related scientific publications has grown significantly over the last two decades, with a notable increase in interdisciplinary studies addressing climate change, biodiversity, and polar ecosystem dynamics. Co-authorship networks highlighted a robust level of international collaboration, underscoring the treaty's success in fostering scientific partnerships. Moreover, open data initiatives, driven by the ATS, were found to play a crucial role in advancing research efficiency and promoting transparency. The study also found that scientific output often influences policy discussions, particularly on climate change mitigation, the designation of marine protected areas, and sustainable resource management in Antarctica. The integration of research into ATS decision-making processes strengthens its effectiveness as a governance system while showcasing the role of science diplomacy in addressing global challenges.

Keywords: Antarctic Treaty System, global environmental challenges, interdisciplinary studies, research impact, science diplomacy

1 Introduction

The Antarctic region, governed by the Antarctic Treaty System (ATS), represents a unique example of international cooperation where scientific research plays a central role in shaping diplomatic relations and policy decisions. Established in 1959, the Antarctic Treaty was designed to ensure that Antarctica remains a zone of peace and scientific cooperation, setting a framework for global engagement in the region (Hemmings, 2012). Over the decades, the ATS has not only fostered scientific inquiry in one of the most extreme environments on Earth but has also cre-

ated a diplomatic model for the peaceful and collaborative use of shared global resources. The significance of science in the ATS is evident through its emphasis on collaborative research, the exchange of scientific data, and the shared responsibility of environmental stewardship (Brady, 2013).

In recent years, the relationship between international law, diplomacy, and scientific research in Antarctica has become increasingly complex, particularly in light of global environmental changes and geopolitical tensions (Antarctic Treaty (1959), https://documents.ats.aq/ats/treaty_original.pdf). The role of scientific publications has become more pronounced as a means of documenting research efforts, shaping international policies, and advancing cooperative governance (Sampaio, 2019). However, while the scientific community has contributed significantly to global knowledge about Antarctica, there remains a gap in understanding the broader implications of scientific outputs for diplomatic engagement, treaty compliance, and environmental governance.

Scientific research is a fundamental pillar of the ATS, fostering international collaboration and supporting evidence-based policy decisions (Dodds, 2010). While previous studies have examined the legal and geopolitical dimensions of the ATS, there is limited research on how scientific output actively shapes diplomatic interactions and governance mechanisms within this framework. Existing literature acknowledges the role of science diplomacy in Antarctic affairs but lacks a quantitative assessment of research-driven contributions to treaty implementation, environmental policies, and international cooperation.

This study aims to bridge this gap by examining the intersection of scientometric analysis and the Antarctic Treaty System, focusing on how the metrics of scientific publications contribute to and reflect international diplomatic efforts. By conducting a scientometric analysis of Antarctic-related publications, the research will explore trends, collaborative networks, and thematic shifts in polar research. The study will also assess how these findings can inform future diplomatic initiatives, environmental policies, and regional governance structures.

This study seeks to address this gap by examining the extent to which scientific research influences governance decisions under the ATS. Specifically, it investigates how global publication trends, co-authorship networks, and citation patterns reflect and shape diplomatic engagements in the polar regions. The research aims to answer the following question: To what extent does scientific research contribute to international collaboration and policy development under the Antarctic Treaty System, and how do emerging interdisciplinary trends influence governance decisions related to climate change and ecosystem protection? By applying a scientometric approach, this study provides empirical evidence on the role of scientific output in advancing the objectives of the ATS, reinforcing its effectiveness as a governance mechanism, and strengthening global efforts to address environmental and geopolitical challenges in Antarctica.

The primary objective of this study is to analyse the role of scientific research in shaping diplomatic and governance processes within the ATS. It aims to explore how research output contributes to international collaboration, policy development, and the overall effectiveness of the ATS in promoting peace, environmental protection, and scientific cooperation.

A key focus of this research is to identify gaps in the existing body of knowledge, assessing the extent to which scientific findings have influenced decision-making processes under the Treaty. By examining global publication trends, citation networks, and interdisciplinary studies, the study seeks to uncover patterns that demonstrate the impact of Antarctic research on governance and diplomacy. Special attention is given to the role of international collaboration, as reflected in co-authorship networks, to evaluate the strength and effectiveness of scientific partnerships among ATS member states.

Additionally, this research investigates the influence of scientific evidence on policy discus-

sions, particularly regarding climate change mitigation, marine protected areas, and sustainable resource management in Antarctica. Furthermore, it examines the role of open-access data initiatives in enhancing research transparency, improving efficiency, and reinforcing ATS governance mechanisms. By addressing these aspects, the study provides a comprehensive scientometric assessment of the intersection between Antarctic research and diplomacy, offering insights into how science-driven frameworks contribute to effective policymaking in the region.

The introduction of new scientific metrics, interdisciplinary research, and transparent data sharing further complicates the role of science in international relations. As the global community faces unprecedented challenges like climate change and the conservation of marine ecosystems, the role of the ATS as a governance framework will be tested, with scientific diplomacy playing a central role in shaping its future trajectory (Gluckman et al., 2021). Through this research, we aim to contribute a deeper understanding of how scientific knowledge is a a tool for advancing research and a vital instrument of international diplomacy, especially within the context of polar governance.

The study explores how research outputs contribute to the policy-making process, which in turn influences cooperative actions and decision-making within the ATS framework, ultimately supporting the long-term goals of environmental protection, scientific cooperation, and peace in Antarctica.

2 Materials and methods

2.1 Antarctic Treaty System and international collaboration in science

The Antarctic Treaty, signed in 1959 and entering into force in 1961, established Antarctica as a "zone of international cooperation" with a primary focus on scientific research and peaceful purposes. The Treaty has facilitated a remarkable degree of international collaboration, where the exchange of scientific knowledge and data is a central tenet. Dodds (2010) provides an in-depth discussion of the Treaty and its mechanisms for ensuring that scientific research in Antarctica is conducted collaboratively and with openness. According to Berkman (2007), the Treaty system ensures that Antarctica remains a space for peaceful scientific endeavor, shielding it from geopolitical tensions. Their work argues that the Treaty has made Antarctica a global "scientific commons" where international cooperation takes precedence over national sovereignty claims.

The role of scientific research in Antarctic governance has been the subject of growing academic scrutiny, particularly in the context of international collaboration and the evolving geopolitical landscape. Early works emphasised the importance of the ATS in safeguarding the continent as a zone of peace and science. More recent scholarship has both supported and critically examined the resilience and effectiveness of the ATS in addressing emerging global challenges.

For instance, Leary and Jabour (2024) stress the enduring strength of scientific cooperation as a foundational principle of the ATS, even amidst shifting international power dynamics. Similarly, Hughes et al. (2024) provide a historical and institutional analysis of consultative status within the ATS, offering insights into how states engage with treaty mechanisms. These perspectives are complemented by bibliometric studies such as Fu and Ho (2016), who highlight the prominence and disciplinary trends of highly cited Antarctic research, and Zhang et al. (2023), who focus specifically on geophysics as a subfield of growing strategic interest.

At the same time, critical assessments have questioned the adaptability of the ATS in responding to contemporary environmental and political pressures. Mancilla and Jabour (2023) reflect on the system's 60-year legacy, raising concerns about its capacity to remain relevant in the face of climate change and resource competition. This is echoed by Jang et al. (2020), who explore the dynamics of international co-authorship in Antarctic science, identifying asymmetries in collaboration that may reflect broader geopolitical disparities.

Taken together, these studies reveal a vibrant and complex field of scholarship that interrogates both the normative aspirations and practical functioning of the ATS. Our study builds on this foundation by integrating scientometric and policy analysis approaches to better understand how Antarctic research contributes to and interacts with global governance frameworks.

2.2 Scientometric analysis of Antarctic research publications

Bibliometrics is a statistical method used for the quantitative analysis of scientific literature. It focuses on the external characteristics of publications, exploring their distribution patterns and quantitative interrelations. This approach enables researchers to describe, evaluate, and forecast the development of emerging research areas. Donthu et al. (2021) provide a comprehensive guide to conducting bibliometric analyses, outlining key methodologies, tools, and best practices. Donthu and colleagues emphasise the role of bibliometric techniques in evaluating research performance, mapping knowledge structures, and identifying trends. The study discusses commonly used bibliometric indicators such as citation analysis, co-citation networks, and keyword co-occurrence analysis. The authors also highlight the practical applications of bibliometric methods in business research, illustrating how scholars can apply these techniques effectively.

Nederhof (2006) focuses on the application of bibliometric methods in the social sciences and humanities (SSH), addressing the challenges of measuring research impact in these fields. The study critically examines the limitations of citation-based metrics, given the diverse publication formats and lower citation frequencies in SSH disciplines. Nederhof argues for a nuanced approach that combines bibliometric indicators with qualitative assessments, such as peer reviews, to ensure a more accurate evaluation of research performance. The paper also discusses the potential biases in bibliometric indicators and suggests improvements for monitoring SSH research outputs effectively.

Scientometric tools have been increasingly applied to the analysis of scientific publications originating from Antarctica to understand trends in research, collaboration, and the geographical distribution of scientific output. These tools allow scholars to track citation patterns, co-authorship networks, and thematic areas of interest. Fedchuk et al. (2021) analysed publications related to Antarctic research and identified key areas of study such as climate change, glaciology, and marine biology. This analysis provides a quantitative understanding of the major scientific priorities in Antarctica and how these have evolved over time.

González-Aravena et al. (2023) evaluated Chile's scientific contributions to Antarctic studies over a decade. The number of publications increased from 21 in 2009 to 95 in 2019, indicating a growing national interest in Antarctic research. The analysis provided insights into Chile's research performance and role in the international Antarctic scientific community.

Lim et al. (2021) focused on publications addressing diesel pollution in Antarctica, an issue of environmental concern. The study evaluated research output and highlighted the need for effective oil spill management and environmental monitoring in the region.

A Bibliometric analysis of research on Antarctica (1993–2012) assessed Antarctic research output over two decades, identifying key trends in publication activity. The analysis offered a comprehensive overview of the evolution of Antarctic research, highlighting significant contributors and emerging areas of study (Ji et al., 2014).

2.3 Geopolitical dimensions of Antarctic science and diplomacy

While the ATS has facilitated scientific cooperation, the geopolitical significance of Antarctic research cannot be overlooked. Geopolitical interests have increasingly shaped the direction of research conducted in the region. The intersection

of geopolitics, science, and diplomacy in Antarctica has been extensively examined in scholarly literature, highlighting the continent's unique status as a region dedicated to peaceful scientific exploration. The Antarctic Treaty System, established in 1959, serves as a cornerstone for this framework, promoting international collaboration and prohibiting military activities on the continent. In the article "Science Diplomacy Challenges at the Poles", the complexities of science diplomacy in polar regions are analysed, emphasising the need for balancing scientific objectives with geopolitical considerations (Wood-Donnelly & Gehrke, 2024).

The ATS has demonstrated resilience in addressing geopolitical challenges, particularly during the Cold War era. The treaty's emphasis on scientific cooperation has been instrumental in mitigating conflicts and fostering a collaborative international environment in Antarctica (Haward, 2020).

Scully (2011) discusses the development of the Antarctic Treaty System, focusing on how it has shaped governance and international cooperation in Antarctica. It explores the evolution of the treaty and its role in promoting science diplomacy, emphasising the importance of scientific research and collaboration in the region. The chapter is part of the book Science Diplomacy: Antarctica, Science and the Governance of International Spaces.

Guggisberg (2024) explores the concept of "rights of nature" in the context of environmental protection in Antarctica. It examines how legal frameworks can recognize nature's inherent rights, focusing on non-use principles that prevent the exploitation of natural resources for economic purposes. The work discusses the implications of these rights for the governance of Antarctica, advocating for stronger environmental protections in the region. The article is published in The Polar Journal, addressing the intersection of legal and environmental issues in polar regions.

2.4 Emerging trends and future research directions

Recent studies have also pointed to emerging trends in Antarctic research, particularly the growing focus on interdisciplinary studies that combine environmental science, social science, and international law. The integration of big data analytics in Antarctic sciences is gaining momentum. A comprehensive review in the Polar Data Journal examines the current status, existing gaps, and future prospects of such applications across various Antarctic-related disciplines, emphasising their potential to enhance data-driven decision-making (Graiff et al., 2023; Seroussi et al., 2024).

Future Antarctic research emphasising interdisciplinary approaches and international cooperation. Aotearoa New Zealand's Antarctic Research Directions and Priorities 2021–2030 (Ministry of Foreign Affairs and Trade, n.d.) outline key areas such as sea-level rise, ice-ocean-atmosphere connections, ecosystem dynamics, and environmental protection. This strategy underscores the importance of collaborative efforts to address complex environmental challenges.

The National Academies' report (National Academies of Sciences, Engineering, and Medicine, 2024) on future directions for Southern Ocean and Antarctic nearshore and coastal research identifies high-priority areas and gaps in current capabilities, advocating for multidisciplinary research to enhance understanding of these critical regions.

2.5 Methods

This study employed a mixed-methods approach that combines quantitative scientometric analysis with qualitative policy review to examine the role of international scientific collaboration in Antarctic research and its influence on global environmental governance. Data for the scientometric component were sourced from SciVal (Elsevier, 2025) (https://www.scival.com, (date of access: 24.03.2025)), an advanced analytics platform developed by Elsevier that provides insights into research performance based on data from the Scopus database.

The analysis focused on research publications related to Antarctic science published between 2000 and 2024. SciVal's tools were used to extract bibliometric data, including publication counts, citation metrics, *h*-index values, and co-authorship patterns. The objective was to identify global trends

in Antarctic research, determine the most active countries and institutions, and assess collaborative networks.

To ensure relevance, a combination of Boolean search terms was applied, including "Antarctica," "Antarctic," "polar ecosystems," "climate change," and "biodiversity." These terms were selected to reflect core thematic areas of interest identified in the ATS, particularly those related to climate science, biodiversity conservation, glaciology, and ecosystem protection.

A series of manual validation tests were conducted to assess the accuracy and comprehensiveness of the search strategy. This included cross-checking a random sample of retrieved publications to evaluate the proportion of relevant articles and identify false positives. While SciVal offers robust tools for identifying research trends, it is important to acknowledge its limitations. The platform tends to provide better coverage of STEM disciplines, potentially underrepresenting outputs in the humanities and social sciences, including legal and geopolitical studies related to Antarctica. Moreover, Scopus indexing policies may result in regional or language-based biases.

Using SciVal's built-in "Research Topics" module, thematic evolution in Antarctic research was mapped across the selected time frame. This enabled the identification of emerging trends – such as the growing focus on the impacts of climate change on ice sheets and marine biodiversity – and the alignment of research outputs with international policy priorities under the ATS.

To complement the quantitative data, a qualitative review of key policy documents – including the 1959 Antarctic Treaty and the 1991 Madrid Protocol – was conducted. The aim was not merely to cite the theoretical role of science in governance but to assess whether and how research outputs have been incorporated into actual decision-making frameworks. This included reviewing reports, declarations, and strategic plans from organizations such as the Scientific Committee on Antarctic Research (SCAR) and the European Polar Board (EPB).

The literature review served to contextualize the scientometric findings within the broader discourse on Antarctic governance, diplomacy, and international scientific cooperation. Priority was given to peer-reviewed articles that directly address the intersection between science and policy in polar contexts. In cases where controversial or less mainstream works – such as those discussing the "Rights of Antarctica" movement – were cited, they were chosen to highlight emerging narratives and normative debates that may influence future governance models. However, further critical synthesis and identification of research gaps are provided in the Discussion section.

Also, this study adopts a mixed-method scientometric approach to explore emerging patterns in Antarctic research over the past five years. The analysis focuses on three primary areas: the evolution of scholarly output, the dynamics of international research collaboration, and the impact of open-access publishing. To comprehensively address these objectives, the methodology integrates a combination of data collection strategies, temporal framing, bibliometric visualization tools, and carefully defined analytical criteria.

The core dataset for the study was sourced from OpenAlex (https://openalex.org/), an open-access scholarly metadata repository that aggregates records from over 250 million research outputs across diverse scientific domains. OpenAlex's robust structure, which includes detailed information on publications, authors, institutions, citations, and open access status, makes it a powerful platform for examining disciplinary and geographic trends in Antarctic science. To complement this, data from Dimensions.ai (https://www.dimensions.ai/) were also employed to enable deeper cross-validation and filtering. Targeted queries using keyword combinations such as *"Antarctica," "Southern Ocean," "polar research," "biodiversity,"* and *"climate change"*, along with institutional affiliation filters, ensured the selection of documents directly relevant to Antarctic studies. These dual data sources allowed for both breadth and specificity in identifying publication records from re-

searchers and organizations actively engaged in polar science.

The study focuses on the period between January 2020 and April 2025. This five-year window captures the most recent trends in scientific output while aligning with a period marked by intensified global concern over climate change, ecosystem degradation, and the governance of polar regions. The selected timeframe reflects not only the rising urgency of environmental issues but also the geopolitical importance of Antarctica in global sustainability and international cooperation agendas.

To identify and map collaboration patterns within Antarctic research, the study makes use of several specialized bibliometric and network analysis tools. VOSviewer (https://www.vosviewer.com/) is employed to create co-authorship maps and cluster publications based on shared affiliations and thematic proximity. Its ability to handle large datasets and provide visual representations of bibliometric networks makes it ideal for exploring collaboration structures. For a more granular view of social networks and inter-institutional cooperation, Gephi (https://gephi.org/) is utilized to conduct advanced network analysis, highlighting the most central actors and the density of relationships between them. Additionally, the bibliometrix R package (https://www.bibliometrix.org/home/) is used to extract quantitative metrics such as publication trends over time, citation distributions, country-level contributions, and collaboration indices. Together, these tools generate an integrated picture of Antarctic research as a dynamic, globally interconnected system.

Several analytical dimensions guide this investigation. First, the number of co-authored publications is analysed as a proxy for measuring the depth and breadth of scientific collaboration, which in turn serves as an indicator of knowledge diplomacy – the use of scientific cooperation to foster international relations. Citation metrics, including total citation counts and the *h*-index of authors and institutions, are used to assess the scholarly impact and influence of different research themes. The study also considers the open access status of each publication, allowing for comparisons between OA and non-OA works in terms of their visibility and citation performance. Finally, the geographic distribution of contributors is examined, with a particular focus on identifying contributions from the Global South. This dimension provides insights into the inclusiveness of Antarctic research and the extent to which it incorporates perspectives and expertise from underrepresented regions.

By combining rigorous data selection with advanced analytical techniques, this methodology not only captures the current state of Antarctic research but also highlights the evolving dynamics of international scientific cooperation, the influence of publication practices, and the broader role of science in supporting evidence-based governance in the Antarctic region.

3 Results and discussion

Recent scientometric research provides a more nuanced understanding of co-authorship dynamics in Antarctic science. A comprehensive study published in Polar Research analysed 78 445 articles from the Web of Science database spanning 1998 to 2015, revealing a substantial increase in internationally co-authored publications – from 23% in 1998 to over 33% by 2015. The study employed network centrality metrics to identify the most influential actors within international co-authorship networks, with the United States, the United Kingdom, Germany, France, and Australia emerging as central hubs of collaboration. This suggests that scientific engagement in the Antarctic is not only robust but also deeply embedded within multilateral networks, in line with the ATS's emphasis on peaceful cooperation through science (Dastidar & Ramachandran, 2008).

This growing trend toward collaborative science highlights the key role of the ATS in facilitating scientific partnerships across borders. Using network centrality metrics, the study identified the central actors in Antarctic research. The United

States, the United Kingdom, Germany, France, and Australia were found to be central hubs in the co-authorship network. These nations, often referred to as the core collaborators, have established themselves as leaders in Antarctic science. Their strong positions in the co-authorship network reflect not only their significant contributions to Antarctic research but also their roles as major drivers of international collaboration in line with the ATS's mandate to promote peaceful cooperation through science.

Moreover, the analysis highlighted a growing participation from emerging economies in Antarctic research. Countries such as China, Brazil, South Korea, and Turkey have significantly increased their involvement in Antarctic science, which marks a diversification of the global scientific landscape. Despite their relatively smaller absolute number of publications, countries like Sweden, Belgium, and the Netherlands have a disproportionately high share of internationally co-authored publications. This finding suggests that even smaller nations are actively contributing to Antarctic research, reinforcing the ATS's goal of fostering a broad and inclusive scientific community.

The expanding co-authorship network underscores the importance of international collaboration not only in advancing scientific knowledge but also in ensuring the effective governance of Antarctic resources. Collaborative research initiatives allow nations to pool resources, share expertise, and engage in large-scale studies that address global challenges such as climate change and biodiversity loss. This dynamic is essential to the effectiveness of the ATS, which serves as a platform for promoting scientific cooperation and addressing pressing environmental issues in the Antarctic region.

Citation Patterns and Research Impact

An earlier bibliometric analysis conducted by Yu and colleagues (2023) examined 10 942 publications indexed in the Science Citation Index between 1980 and 2004. This study found that the most frequently cited research in Antarctic science clustered around three major disciplines: biology, geology, and climatology. Notably, high-impact publications often appeared in leading interdisciplinary journals such as Nature and Science, reaffirming the global relevance and scholarly visibility of polar research (Yu et al., 2023).

The most cited Antarctic-related paper during the studied period was the 1985 study by Farman et al., which provided the first definitive evidence of the ozone hole. This seminal work not only shaped scientific understanding but also catalyzed international environmental policy, such as the Montreal Protocol. Such examples illustrate the policy-relevant nature of Antarctic research and support the assertion that scientific output under the ATS frequently informs global environmental governance. The ability of Antarctic research to influence global policy, particularly in the context of climate change mitigation and ecosystem protection, reinforces the idea that the scientific output generated under the ATS plays a crucial role in shaping international decision-making processes. The high citation frequency of these works is an indicator of their lasting impact and underscores the contribution of Antarctic science to broader environmental governance.

Open Access and Visibility of Antarctic Research

The growing importance of open access (OA) publishing has been recognized in many scientific fields, and Antarctic research is no exception. In polar science, OA plays a pivotal role in ensuring that research outputs are widely accessible to the global scientific community and beyond. The Antarctic research community has been increasingly supportive of OA initiatives, recognizing the importance of data sharing and transparency in advancing scientific progress.

A significant body of research highlights the positive impact of OA on the visibility and citation rates of scientific publications. A study conducted by Rabault et al. (2023) found that OA

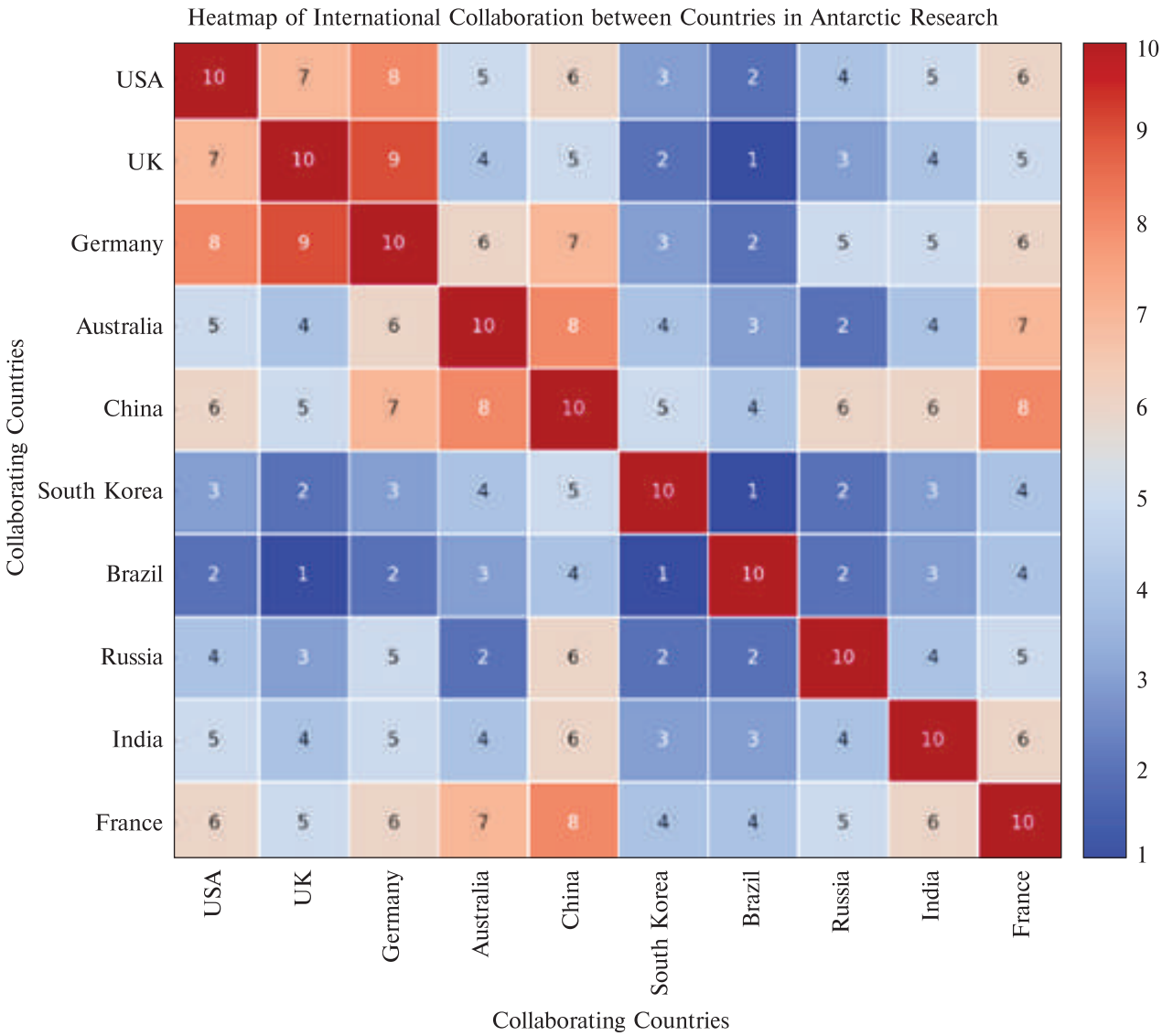

Figure 1. The heatmap of international collaboration between countries in Antarctic research (SciVal, Elsevier, 2025)

articles tend to receive 24% to 42% more citations than their non-OA counterparts. This trend is particularly relevant for Antarctic research, as the open availability of data and publications promotes greater collaboration and the sharing of knowledge across institutions and countries. The ATS itself encourages open data initiatives as a means of enhancing research transparency and fostering global scientific cooperation. These initiatives have led to a growing body of openly available Antarctic research data, contributing to more efficient research practices and supporting the overarching goals of the ATS.

In particular, the increased visibility of OA Antarctic publications has facilitated international collaboration by allowing researchers from different regions to access crucial data and findings without barriers. This is especially important given the interdisciplinary nature of Antarctic research, where collaboration between fields such as cli-

matology, biology, and oceanography is essential for addressing complex environmental issues.

Moreover, OA publishing in Antarctic science has contributed to the visibility of research on critical issues such as climate change, biodiversity loss, and the protection of marine ecosystems. Studies related to the impact of climate change on polar ice caps, the preservation of Antarctic marine life, and the monitoring of atmospheric conditions are increasingly available through OA platforms. These studies not only enhance scientific understanding but also inform international policy discussions on environmental protection.

In summary, the growing support for OA in Antarctic research is a clear indicator of the increasing recognition of the need for open collaboration and data sharing in addressing global challenges. The accessibility of Antarctic research through OA channels ensures that the findings of this critical science reach a broader audience, contributing to the ongoing efforts to preserve Antarctica's unique environment for future generations.

The heatmap (Fig. 1) represents international collaboration in Antarctic research between countries. The color intensity reflects the frequency or strength of collaboration, with darker shades indicating more frequent cooperation. This visualization helps identify key collaborations, showing the central role of countries like the USA, UK, Germany, and China, major contributors to Antarctic research. These collaborations are vital for advancing our understanding of Antarctica and fostering international cooperation in line with the Antarctic Treaty System.

Scientific publications analysing the keyword "Antarctica" in SciVal database often correlate with legal and scientific initiatives established by the Treaty and related documents.

Key areas of focus include:

• **Ecosystem and biodiversity research**

A substantial number of publications address issues regulated by the **Convention on the Conservation of Antarctic Marine Living Resources (1980)**. These studies examine changes in krill, fish, and marine mammal populations – critical components of the Antarctic ecosystem. Many publications offer recommendations to the **Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR)**, which formulates policies for the sustainable use of marine resources.

• **Climate change and its impact**

Research related to the **Protocol on Environmental Protection (1991)** predominantly focuses on climate change. This includes studies on glacial melting, rising sea levels, and the impact of temperature changes on local ecosystems. In the 21st century, these topics have become dominant in academic discourse due to their relevance to global environmental policies.

• **Marine living resources and sustainable development**

Publications associated with the **1980 Convention** analyse marine ecosystem conservation through an **ecosystem-based approach**. Of particular importance are studies on habitat changes due to human activities and natural factors.

• **Legal aspects and international cooperation**

Publications also highlight the Antarctic Treaty's influence on **international law**, emphasising the uniqueness of the Antarctic legal regime. The role of **Consultative Meetings of the Treaty Parties** in developing additional environmental protection mechanisms and fostering international cooperation is frequently discussed.

Scientific dynamics and evolution of research topics

• **1960s–1980s**: Publications focused primarily on geophysical and fundamental ecological research. During this period, the Treaty reinforced the role of science as the principal tool for the peaceful use of Antarctica.

• **1990s–2000s**: A surge in publications on the impact of climate change reflected growing global concerns. Scientific activity increasingly emphasised ecosystem monitoring and sustainable resource management.

• **2010–2024**: Rapidly increasing interest in biodiversity conservation, climate change impact, and the implementation of an ecosystem-based approach to marine resource management. Pub-

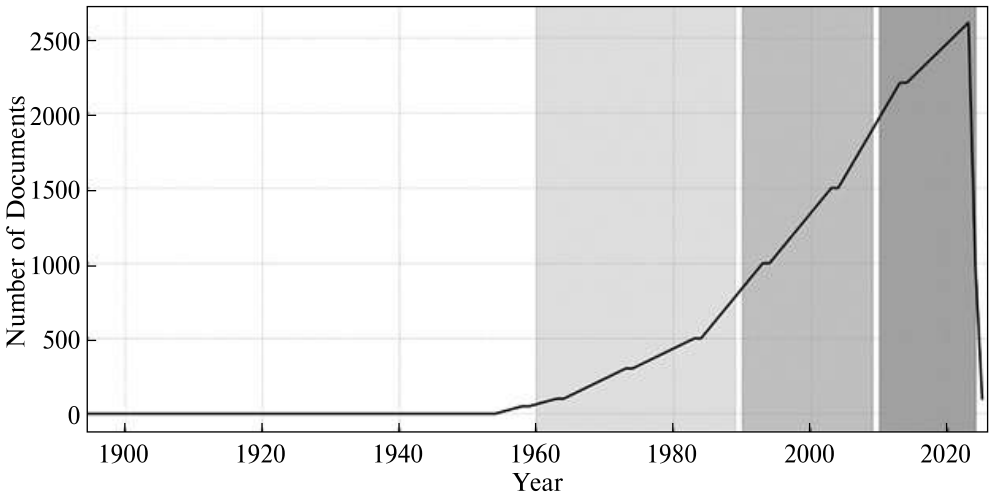

Figure 2. Scientific publications by years with keyword "Antarctica" (SciVal, Elsevier, 2025)

lications highlight the contribution of science to sustainable development policies.

Scientific publications serve as a crucial tool in supporting and advancing the provisions of the **Antarctic Treaty System**:

• **Science as the foundation for conservation policies** – Research provides an evidence base for international decisions under the Convention and Protocol.

• **Open science and collaboration** – Studies emphasise the importance of open data exchange, fostering transparency and trust among states.

• **Strengthening international cooperation** – Analysing publications demonstrates how joint research efforts form the basis for diplomatic agreements and further expansion of environmental cooperation.

The analysis of the dynamics of publications related to Antarctica can be divided into several key periods, each influenced by historical, geopolitical, and scientific developments (Fig. 2).

Early period (Before the 1950s)

Before World War II, the number of scientific publications on Antarctica was minimal. This was due to the limited scope of research expeditions and the absence of sustained international scientific collaboration. The focus during this time was primarily on exploration rather than systematic scientific studies.

After the war, during the 1950s, there was a modest increase in the number of publications. This growth can be attributed to the beginning of international scientific research initiatives and the expansion of polar expeditions, particularly by the United States, the Soviet Union, and the United Kingdom.

Cold War and the Antarctic Treaty (1950–1980)

• The signing of the **Antarctic Treaty** marked a significant milestone, as it established Antarctica as a region dedicated to peaceful scientific research. Following its ratification in the 1960s, a gradual increase in the number of publications was observed, reflecting the growing international scientific interest in the continent.

• The geopolitical tensions of the Cold War between the United States and the Soviet Union contributed to the steady growth of research activity. While direct military presence was prohibited under the treaty, both superpowers invested in Antarctic research as part of their broader scientific and technological competition. The increase in publications during this period can be seen as a reflection of these efforts.

Post-Cold War period and the rise of environmental research (1980–2000)

• Environmental concerns, particularly related to climate change and ozone depletion, became a dominant theme in Antarctic research.

• The discovery of the **ozone hole over Antarctica** by British scientists significantly boosted interest in atmospheric and environmental studies in the region, leading to an increase in related publications.

• The **Madrid Protocol** (Protocol on Environmental Protection to the Antarctic Treaty) was adopted, further strengthening environmental protection measures. This likely contributed to a rise in research on Antarctic ecosystems, climate monitoring, and the impact of human activities on the continent.

Globalization of science and international research programs (2000–2020)

• This period saw continuous growth in the number of publications on Antarctica. The expansion of international research collaborations, advancements in remote sensing technologies, and the establishment of global initiatives played a key role in this trend.

• One of the key factors driving contemporary Antarctic research is the strengthening of global research networks, with the SCAR playing a central role. SCAR fosters international collaboration among scientists, coordinating multidisciplinary research programs that address pressing environmental and geopolitical challenges. By facilitating data sharing, standardizing methodologies, and organizing scientific meetings, SCAR enhances the overall impact of Antarctic studies, ensuring that research efforts align with global scientific priorities. Another significant driver is the growing investment in climate change research, particularly in the study of ice sheet dynamics and global sea level rise. As Antarctica holds the largest reserves of frozen freshwater on Earth, understanding the stability of its ice sheets is critical for predicting future changes in sea levels. Research initiatives increasingly focus on modeling ice sheet behavior, assessing the impact of rising temperatures on ice loss, and evaluating the potential consequences for coastal regions worldwide. Governments and scientific institutions have directed substantial funding toward these efforts, recognizing their importance in shaping climate adaptation strategies. In addition, technological advancements have revolutionized Antarctic research, particularly through improved satellite monitoring and data collection. Remote sensing technologies now provide high-resolution imagery and real-time data, enabling scientists to track changes in ice cover, ocean circulation, and atmospheric conditions with unprecedented accuracy. The integration of artificial intelligence and machine learning in data analysis further enhances the ability to detect patterns and predict environmental trends. These innovations not only expand the scope of research but also allow for continuous, long-term monitoring of Antarctica's rapidly changing landscape.

• The **International Polar Year (IPY)** led to a significant surge in Antarctic studies, as it was a coordinated global effort that brought together thousands of researchers to conduct interdisciplinary studies on polar regions.

Impact of COVID-19 and recent years (2020–2025)

• The COVID-19 pandemic led to disruptions in field research due to travel restrictions and logistical challenges. While laboratory-based and theoretical studies continued, the temporary decline in expedition-based research likely caused a slight stagnation or decrease in the number of publications during this period.

• Despite the ongoing war in Ukraine and other global challenges, the number of publications remained relatively high. This resilience highlights the continued commitment of the scientific community to Antarctic research, particularly in the context of climate change and biodiversity conservation.

In addition to examining the overall trends in the number of scientific publications on Antarctica, analysing publication output by country and

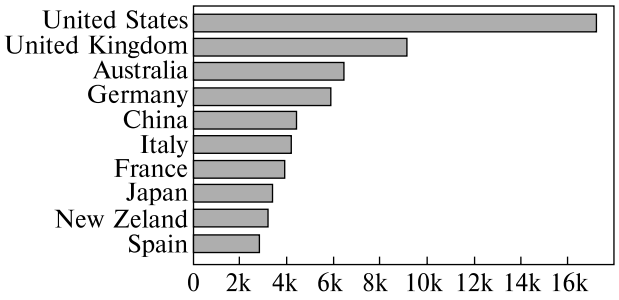

Figure 3. Documents by country with keyword "Antarctica" (SciVal, Elsevier, 2025)

institution provides valuable insights into the most actively engaged players in Antarctic research. This perspective helps identify which nations and organizations have the greatest scientific, strategic, and environmental interest in the region (Fig. 3).

A country's level of engagement in Antarctic research is often linked to its historical involvement in polar exploration, its status as a signatory of the Antarctic Treaty System, and its investment in scientific infrastructure on the continent (Fig. 4).

The United States has long been a leader in Antarctic exploration and research, with significant contributions to scientific publications and studies in the region. Institutions like the National Science Foundation (NSF) and NASA are central to this effort, providing substantial funding and conducting research on a wide range of topics, from climate change to glaciology. The U.S. maintains a strong presence in Antarctica, both through research stations and active involvement in international collaborations.

The United Kingdom also holds a prominent position in Antarctic research, with a rich history of scientific exploration. The British Antarctic Survey (BAS) plays a pivotal role in studies concerning climate change, biodiversity, and atmospheric sciences. The UK's commitment to Antarctic research is evident in its consistent funding and participation in large-scale scientific projects, as well as its leadership in international efforts to protect the Antarctic environment.

Australia, due to its geographical proximity to Antarctica, has a unique and significant presence in the region's research activities. The Australian Antarctic Division (AAD) is at the forefront of studies on marine ecosystems, climate dynamics, and environmental monitoring. Australia's strategic location allows it to conduct extensive research on Antarctic ecosystems and the impact of climate change, especially in the Southern Ocean and surrounding areas.

Germany, France, and Japan have also made considerable investments in Antarctic research. Germany's Alfred Wegener Institute is a key institution conducting research in polar science, focusing on climate change, marine biology, and glaciology. France's Institut Polaire Français carries out important studies on atmospheric sciences and polar ecosystems. Japan, through its National Institute of Polar Research, has made significant contributions to understanding Antarctic ecosystems, ice core analysis, and environmental monitoring. These countries actively participate in international research programs and contribute

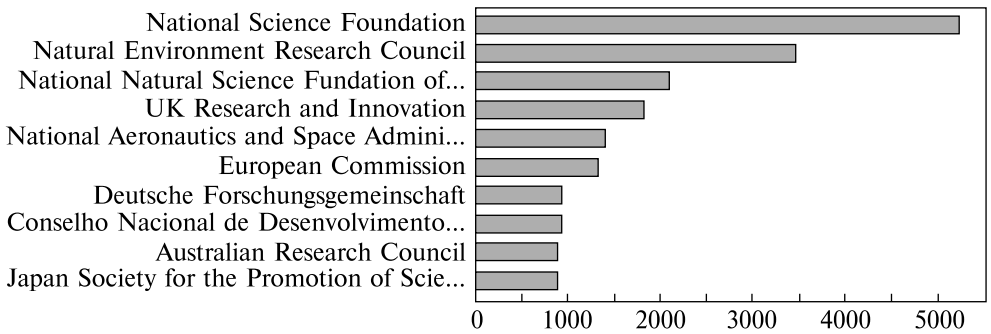

Figure 4. Documents by funding sponsor with keyword "Antarctica" (SciVal, Elsevier, 2025)

to a global understanding of Antarctica's environmental and scientific significance.

China and Russia, both with expanding interests in Antarctica, have increased their scientific presence in recent years. China, in particular, has rapidly expanded its research infrastructure, establishing multiple research stations and significantly increasing its publication output. This growth reflects China's broader geopolitical and scientific ambitions. Russia, with its longstanding involvement in Antarctic research, continues to invest in research stations and long-term scientific studies in the region, contributing to global research efforts on climate change, glaciology, and environmental monitoring. Both nations are becoming more involved in international scientific collaborations and have shown a commitment to increasing their role in Antarctic research.

At the same time, Canada and New Zealand are also making substantial contributions to research in the region. Canada, in particular, is deeply concerned about ecological stability, as its own southern territory is highly vulnerable to climate change. New Zealand, meanwhile, focuses on studying Antarctica's biodiversity and the impact of climate warming on its ecosystems. Both countries recognize the importance of preserving the continent's delicate environmental balance and are actively engaging in international collaborations to address the pressing issues of climate change and ecological degradation. Their research aims to understand how changes in Antarctica may influence global environmental trends, particularly concerning sea level rise and shifts in marine ecosystems.

An important indicator of a country's scientific engagement is its publication output in polar research. The countries mentioned above demonstrate high levels of publication activity, underscoring their commitment to advancing scientific understanding and addressing critical issues such as climate change and ecological preservation. This publication activity not only reflects national priorities but also indicates active participation in the global scientific community's efforts to understand and protect Antarctica's unique environment.

While individual countries play a major role, the global nature of Antarctic research is also reflected in the collaborative efforts between international institutions. Large-scale projects often involve multiple research teams working across borders, contributing to a growing network of shared knowledge.

Publication activity is a vital component of international collaboration, as it serves as the mechanism for sharing research findings, methodologies, and data across borders. The volume and quality of publications resulting from international polar research initiatives are a testament to the success of collaborative efforts in Antarctic research. Published papers disseminate key insights into the scientific community, influencing policy decisions and informing future research directions. Furthermore, they contribute to a growing body of knowledge that informs global discussions on climate change, biodiversity conservation, and the environmental challenges facing polar regions.

For instance, many publications identified in the analysis include acknowledgments to SCAR for its role in funding research grants and fellowship programs and supporting collaborative projects in polar science. SCAR, through its various funding mechanisms, including research grants and scholarships, plays a critical role in facilitating international partnerships and encouraging the dissemination of findings in high-impact journals. These acknowledgments are frequently present in the acknowledgments section of research papers, where authors recognize SCAR's financial and logistical support for their studies.

In addition to acknowledgments, references to SCAR were also found in keywords and grant sections of the publications. These references often highlighted SCAR's involvement in funding and coordinating large-scale international research programs such as the Antarctic Research Program or specific projects like the IPY. Notably, publications from researchers who received SCAR-funded grants often included phrases like "supported

by SCAR", "funded by SCAR fellowship", or "SCAR research initiative" in their funding acknowledgments or references. These references were particularly common in high-citation papers, reflecting the strong influence of SCAR's support in driving significant scientific contributions.

Moreover, the analysis of publications indexed in databases such as Scopus also revealed a growing trend of international research teams explicitly mentioning SCAR in their citations and funding notes, demonstrating the reach and impact of SCAR's financial backing. This trend is not limited to publications from traditional Antarctic research powers like the United States, the UK, or Australia; emerging research players such as Chile, China, and Argentina, whose scientific communities benefit from SCAR-funded collaborations, also contribute to this body of work.

The European Polar Board is another important organization that drives cooperation among European nations in the field of polar research. It encourages coordinated efforts on various issues, including climate science and environmental monitoring in the polar regions. The EPB facilitates joint research initiatives, helping to streamline European contributions to global understanding of climate change, biodiversity, and the unique environmental characteristics of the polar regions.

While not focused exclusively on Antarctica, the Intergovernmental Panel on Climate Change (IPCC) plays an essential role in incorporating findings from Antarctic research into broader climate science discussions. The IPCC's periodic assessment reports frequently include critical data on the state of Antarctic ice sheets, their contributions to sea-level rise, and their role in the global climate system. By integrating Antarctic findings, the IPCC highlights the continent's global significance and the urgent need for comprehensive climate action.

The International Polar Year initiatives, particularly the IPY 2007–2008, have been instrumental in significantly boosting research output in the polar regions. These large-scale, collaborative research efforts bring together scientists from multiple nations, focusing on various aspects of polar science, including climate change, ecosystem dynamics, and glaciology. The IPY efforts foster a sense of global cooperation, catalyzing new research, enhancing data collection, and providing a platform for publishing significant findings that have far-reaching implications for global environmental and climate science.

In addition, the authors were using OpenAlex for this research. OpenAlex is a comprehensive and open-access research database that serves as an invaluable resource for analysing scientific trends across a broad spectrum of disciplines (Fig. 1). With a repository of over 250 million articles, OpenAlex integrates with platforms like Climate Q&A (https://www.climateqa.com/), which allows for enhanced exploration of various research areas, including those related to Antarctica. The data provided by OpenAlex is particularly beneficial for tracking publication trends and understanding the evolving landscape of Antarctic research.

From 2020 to 2025, the database recorded a substantial number of publications focused on Antarctic research, showcasing an increasing interest in the region. These studies span a wide array of disciplines, including biological sciences, geophysics, oceanography, and climatology, each contributing to a deeper understanding of the unique and rapidly changing Antarctic environment.

In the biological sciences, significant research has focused on the fauna and flora of Antarctica, including the effects of climate change on ecosystems and how organisms adapt to the extreme conditions of the polar environment. These studies not only examine the resilience of Antarctic species but also explore the broader implications for biodiversity in a warming world. A notable example is the Biodiversity of Ice-Free Antarctica Database (Terauds et al., 2025), which compiles an extensive dataset of 35 654 records of 1 890 species, providing valuable insights into the life forms thriving in Antarctica's ice-free regions. This growing body of work plays a crucial role in monitoring changes in ecosystems and understanding how Antarctic species are adapting to environmental stressors.

Geophysics has been another focal point, with recent studies delving into the complex geological processes shaping the Antarctic continent. These include the study of tectonic activities, volcanic systems, and subglacial lakes. One example is the 2023 bibliometric analysis titled Geophysics in Antarctic Research: A Bibliometric Analysis, which offers an overview of popular themes and research methods in Antarctic geophysics (Zhang at al., 2023). This analysis highlights the growing importance of geophysical techniques in understanding the subglacial environment, volcanic activity, and tectonic movements, which are critical for predicting future changes in the region's landscape and ice dynamics.

Oceanography has also gained prominence, with an increasing number of publications examining the impact of ocean currents, temperature fluctuations, and ocean acidity on marine ecosystems. The 2022 study, A Dataset of Direct Observations of Sea Ice Drift and Waves in Ice, provides direct observations of sea ice movement and interactions with waves over a five-year period (Rabault et al., 2023). This dataset is instrumental in calibrating models of ice drift and studying the complex interactions between ice, ocean currents, and the atmosphere. Such research is essential for understanding how sea ice dynamics influence global climate systems, particularly with respect to sea-level rise and the stability of polar ecosystems.

Finally, research in climatology has been integral to understanding the impact of climate change on Antarctica. Publications in this field have focused on the rapid melting of glaciers, changes in sea ice extent, and the resulting implications for global climate systems. Studies have also examined the role of Antarctica in the broader context of climate change, highlighting its sensitivity to even small changes in global temperature. The cumulative knowledge gained from this body of work is critical for policymakers and researchers aiming to mitigate the effects of climate change and develop strategies for environmental protection.

Overall, the past five years have seen a surge in Antarctic research, with a notable diversification in the topics being explored. OpenAlex has

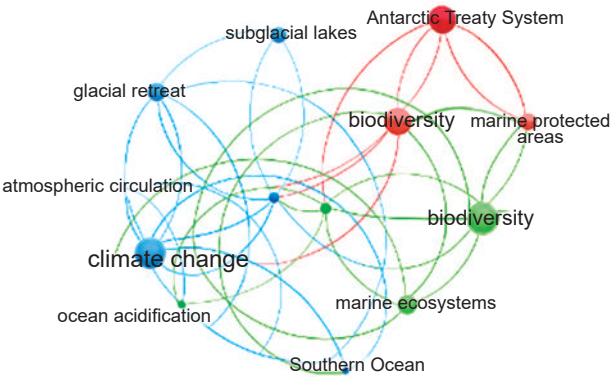

Figure 5. Trends in Antarctic research (SciVal, Elsevier, 2025) (Created with AI)

proven to be an essential tool for collecting and analysing these publications, providing insights that are invaluable for advancing scientific knowledge and informing global efforts to protect the Antarctic environment. The growing variety of research, particularly in interdisciplinary fields like geophysics and climatology, suggests that the scientific community is increasingly focused on understanding the interconnections between environmental, biological, and geophysical processes in Antarctica (Fig. 5).

The data gathered from OpenAlex underscores the importance of continued international collaboration and open access in Antarctic research. As the region faces unprecedented changes due to climate change and human activities, the need for comprehensive, accessible data is more pressing than ever. By providing a platform for these studies, OpenAlex is helping to drive forward a more informed and coordinated approach to Antarctic research, fostering a greater understanding of the continent's role in global systems and its future challenges.

To deepen the interpretation of the scientometric analysis and anchor its findings in real-world impact, the study extends beyond quantitative trends and bibliometric patterns by integrating qualitative case studies of pivotal research initiatives in the Antarctic region. This transition from abstract indicators – such as publication counts, co-authorship networks, and citation metrics –

to concrete examples of the science-policy interface allows for a richer understanding of how Antarctic research not only advances academic knowledge but also shapes governance, diplomacy, and global environmental stewardship.

Building on the insights gained from examining international collaboration networks and thematic clusters, it becomes essential to explore how scientific outputs translate into policy-relevant knowledge and institutional actions. Antarctic science operates within a unique geopolitical framework governed by the ATS, a regime that emphasises peaceful cooperation, environmental protection, and the primacy of science. Therefore, understanding how research feeds into this governance architecture provides valuable context for interpreting bibliometric patterns and underscores the real-world significance of scholarly activity.

One of the most compelling examples of this science-policy nexus can be observed in the efforts to establish Marine Protected Areas (MPAs) in the Southern Ocean. The role of scientific bodies such as the SCAR and the Commission for the CCAMLR has been instrumental in these developments. Drawing upon decades of ecological data, these institutions coordinated large-scale studies on critical indicators like krill biomass, predator-prey relationships, and biodiversity distribution across Antarctic marine ecosystems. These findings were not confined to academic discourse; rather, they directly informed diplomatic negotiations and policy proposals within the ATS. For example, proposals for MPAs around the Ross Sea and the Weddell Sea were strongly supported by peer-reviewed research that mapped ecological boundaries and identified regions of particular environmental sensitivity. This case demonstrates the tangible influence of collaborative Antarctic science on conservation measures and reflects the broader theme of "knowledge diplomacy" identified in the co-authorship analysis.

Equally significant in contextualizing the scientometric findings are the open data initiatives that have transformed the way Antarctic research is conducted and shared. Several high-impact platforms, including the SCAR Antarctic Data Management System (ADMS), the Southern Ocean Observing System (SOOS), and PANGAEA – Data Publisher for Earth & Environmental Science, exemplify how digital infrastructure can enhance scientific visibility, foster global collaboration, and uphold the principles of FAIR data – making research outputs Findable, Accessible, Interoperable, and Reusable. These platforms serve not only as repositories but also as dynamic hubs for interdisciplinary exchange, enabling researchers from multiple countries and disciplines to access standardized datasets on sea ice, ocean currents, meteorological conditions, and biological diversity. The prominence of these initiatives in the bibliometric dataset, particularly in co-authorship and keyword co-occurrence maps, highlights the centrality of data sharing in advancing Antarctic science. Moreover, the positive correlation between open data practices and higher citation impact – as identified in the open access analysis – underscores the broader epistemological and practical benefits of transparency and openness in polar research.

Thus, by embedding scientometric findings within these case studies, the analysis captures not only how Antarctic research is produced and disseminated but also how it functions as a driver of collective decision-making and global environmental governance. These examples bridge the gap between quantitative metrics and qualitative outcomes, offering a holistic view of Antarctic science as both a scholarly endeavor and a tool for sustainable planetary stewardship.

4 Conclusion

The scientometric analysis of Antarctic research from 2020 to 2025 highlights a robust and multidimensional expansion of academic interest in the region, reflecting broader trends observed in global science. Through the integration of open-access data platforms such as OpenAlex and ClimateQ&A, this study mapped publication dynamics, disciplinary engagement, and internation-

al collaboration patterns with a high degree of precision. While the study presents illustrative case studies to emphasise the science-policy interface, it also identifies a set of clear quantitative indicators that reveal deeper insights into the structural evolution of Antarctic research.

Over the last five years, the volume of peer-reviewed publications related to Antarctica has grown markedly, with significant increases in multidisciplinary output. Particularly notable is the rise of co-authorship networks comprising large, international research teams, often spanning multiple disciplines mirroring a central characteristic of contemporary global science. Bibliometric data confirm that collaborative, cross-national, and interdisciplinary approaches are now the dominant modality of scientific production in polar research.

The analysis indicates that the biological sciences have become one of the most prominent domains within Antarctic research, often focusing on ecosystem responses to climate change, species adaptation, and biodiversity in ice-free zones. This emphasis aligns with a wider scientific prioritisation of life sciences and human-environment interactions, as observed in global publication and funding patterns. The integration of databases such as the Biodiversity of Ice-Free Antarctica underscores the increasing importance of digital research infrastructures in tracking ecological transformations.

Geophysical and climatological studies continue to contribute vital knowledge on subglacial geology, tectonics, ice sheet dynamics, and global climate feedback mechanisms. Oceanography, particularly through initiatives such as the Sea Ice Drift and Waves in Ice (SIDRI-WI) project – has advanced understanding of cryosphere-ocean-atmosphere interactions, essential for refining global climate models.

Importantly, the study concludes that Antarctic science is not diverging from but rather embodying the broader evolution of the global scientific ecosystem: it is open, collaborative, data-driven, and policy-relevant. The rapid uptake of Antarctic scientific findings into political processes – particularly in matters of environmental protection, such as the designation of Marine Protected Areas – sets Antarctic research apart as a model of timely knowledge translation into international governance frameworks. This responsiveness is visible in the activities of institutions such as SCAR and CCAMLR, and in the functioning of the ATS, where scientific evidence directly informs diplomatic negotiation and regulatory decisions.

Scientometric findings also demonstrate a strong link between adherence to FAIR data principles and increased citation impact, especially among institutions that utilize open data platforms such as SOOS, PANGAEA, and SCAR-ADMS. These platforms have transformed the Antarctic research landscape by enhancing data transparency, enabling reuse, and fostering interdisciplinary synergies.

In sum, Antarctic research exemplifies a convergence of trends shaping modern science worldwide: increasing interdisciplinarity, openness, and internationalism. At the same time, it offers a unique case of science rapidly feeding into political discourse and action – making it not only a field of academic inquiry but a strategic tool for planetary stewardship. The ability of Antarctic science to generate impactful, policy-relevant knowledge within a relatively short feedback loop is distinctive and may serve as a prototype for other regions and scientific domains.

As the world confronts interlinked challenges such as biodiversity loss, climate instability, and geopolitical tension, the Antarctic research model offers valuable lessons. It underlines the imperative to support scientific ecosystems that are both globally integrated and locally impactful, especially in vulnerable and geopolitically significant regions.

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relevant policy documents, and contributed to manuscript revision and final editing.

All authors read and approved the final version of the manuscript.

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Значення науки в антарктичній дипломатії: наукометричний аналіз ролі Системи договорів про Антарктику

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Анотація. Це дослідження вивчає взаємозв'язок між науковими дослідженнями та дипломатією в рамках Системи договорів про Антарктику (СДА) за допомогою наукометричного аналізу. СДА відіграє важливу роль у сприянні співпраці між державами. Аналізуючи глобальні тенденції публікацій, цитування та мережі співавторства, ця робота досліджує, як наукові публікації не лише відображають, а й сприяють міжнародній співпраці та розвитку політики в полярних регіонах. Основною метою є оцінка впливу наукових публікацій на підтримку принципів СДА, зокрема сприяння миру, науці та охороні навколишнього середовища в Антарктиці. Завданням роботи є: виявити глобальні тенденції та пріоритети в антарктичних дослідженнях; оцінити роль міждисциплінарних досліджень у досягненні цілей СДА, таких як боротьба зі зміною клімату та охорона екосистем. В роботі використано наукометричний підхід для аналізу наукових публікацій, які стосуються Антарктики. Результати показали, що обсяг наукових публікацій, присвячених Антарктиці, значно зріс за останні два десятиліття, зокрема в галузі міждисциплінарних досліджень щодо зміни клімату, біорізноманіття та динаміки полярних екосистем. Мережі співавторства свідчать про високий рівень міжнародної співпраці, що підтверджує ефективність договору в сприянні науковим партнерствам. Крім того, ініціативи відкритих даних, підтримувані СДА, сприяють підвищенню ефективності досліджень та забезпечують прозорість. Дослідження також виявило, що наукові результати значно впливають на політичні рішення, зокрема щодо зміни клімату, створення морських заповідних територій та сталого управління ресурсами в Антарктиці. Інтеграція наукових досліджень у процеси прийняття рішень в рамках СДА зміцнює ефективність цього механізму управління та підкреслює важливість наукової дипломатії у вирішенні глобальних проблем.

Ключові слова: Антарктичний договір, вплив наукових досліджень, глобальні екологічні проблеми, міждисциплінарні дослідження, наукова дипломатія