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The ATCM and the Emerging Regime on Microplastic Pollution in Antarctica: a Review of Challenges and Opportunities

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Abstract

Plastic pollution is one of the most pressing environmental challenges of our time, affecting ecosystems and communities worldwide. Not even the remote and relatively untouched Antarctic region is immune to this threat, with growing evidence of widespread microplastic contamination and accumulation in Antarctic environments—from coastal seawater and snow to the digestive systems of marine organisms and seabirds. Addressing this issue is not only vital for the health of Antarctic ecosystems but also for the global fight against marine plastic pollution. The Antarctic Treaty Consultative Meeting (ATCM) has a critical role to play in spearheading international efforts to prevent and mitigate plastic waste in this fragile region. While research and monitoring efforts are growing, however, policy actions remain fragmented and underdeveloped. This article provides an analysis of the latest developments at the ATCM level, highlighting key challenges, opportunities and recommendations in light of global negotiations for a Global Plastics Treaty. By linking Antarctic initiatives to broader global frameworks, the ATCM can contribute meaningfully to a more comprehensive and effective global response to plastic pollution.

KEYWORDS

Microplastics, ATCM, Antartica, Southern Ocean, Global Plastic Treaty

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Introduction

The proliferation of plastics represents one of the most pervasive forms of anthropogenic pollution. Global plastics production exceeds 400 million tonnes annually, with an estimated 11 million tonnes entering the oceans each year (OECD, 2022; Pew Charitable Trusts, 2020). Once in the environment, plastics fragment into smaller particles—microplastics (<5 mm) and nanoplastics (<1 μm)—that persist for centuries and interact with biological systems. Comprising particles made of synthetic polymers, microplastics were first identified in the 1960s and subsequently described in the 1960s (GESAMP, 2015), and have since been detected in the ocean, atmosphere and the digestive tracts and faeces of living organisms. Primary microplastics come from a range of marine and terrestrial sources, including wastewater, which may contain microplastic fibres and fragments from synthetic fabrics in laundry water and microbeads from personal hygiene products. Secondary microplastics originate from the breakdown of larger macroplastic items, such as abandoned, lost, or discarded fishing gear (ALDFG), marine plastic pellets (nurdles), ropes, paints and antifouling systems (Yang et al., 2021). The Antarctic, long thought to be protected by geographic isolation and legal safeguards, is not immune to this trend with microplastics having been identified in the Southern Ocean, Antarctic snow, sediments and wildlife (Aves et al., 2022; González-Aravena et al., 2024; Isobe et al., 2017)[1]. Their presence in such a remote environment illustrates the transboundary nature of plastic pollution.

This article aims to analyse how the Antarctic Treaty System (ATS) and, in particular, the Antarctic Treaty Consultative Meeting (ATCM) have responded to the growing evidence of microplastic contamination in the region. By analysing the evolution of scientific evidence, policy debates and institutional responses, the paper seeks to identify the main governance gaps, challenges and opportunities for strengthening Antarctic environmental protection within the broader context of global plastic governance. The analysis is based on a qualitative review of scientific literature and policy documents, including ATCM Resolutions, CCAMLR Conservation Measures, and records from ATCM 46 and 47 (Kochi, 204; Milan, 2025). Through this combined assessment, the paper traces how knowledge generated by Antarctic research is informing policy discussions and explores how the ATCM can serve as a bridge between regional conservation initiatives and future global frameworks.

This paper is structured as follows: Section 2 reviews the most significant scientific literature regarding sources, transport mechanisms and ecological impacts of microplastics in Antarctica, situating these findings within the broader context of polar contamination. Section 3 expands the analysis to global governance efforts addressing plastic pollution, including recent negotiations towards a UN Global Plastics Treaty. Section 4 examines the existing regulatory framework under the ATS, followed by an assessment of the evolving role of the ATCM in shaping policy action on plastic pollution. Section 5 identifies the main challenges and opportunities for strengthening the Antarctic response to plastic pollution and presents policy recommendations. The paper concludes by discussing how the ATS can take a leading role in advancing global environmental governance in the age of plastics.

Literature Overview: Microplastic Pollution in Antarctica

Microplastic contamination in Antarctica arises from both local and distant anthropogenic sources. The main local contributors include research stations, tourism and fishing operations, while long-range transport via atmospheric and oceanic currents introduces additional inputs (Cunningham et al., 2022; Isobe et al., 2017; Napper & Thompson, 2016; Primpke et al., 2024). Early research on Antarctic plastic debris, predating the focus on microplastics, documented/registered macroplastic accumulation on beaches and fishing gear losses as early as the 1980s (Barnes et al., 2009; Gregory, 1989). These foundational studies established how human activity at research stations and in fisheries introduced synthetic materials to the region.

Recent evidence shows that microplastics are widespread across Antarctic environments and ecosystems. with their presence having been detected in coastal seawater near the Antarctic Peninsula (Lacerda et al., 2019), in snow samples from Ross Island (Aves et al., 2022), and in sediments of Terra Nova Bay (Munari et al., 2017) and near Rothera Research Station (Reed et al., 2018). Comparable contamination levels have been reported in the Southern Ocean and Ross Sea, with some concentrations approaching those of highly polluted coastal regions in other areas of the world (Switzerland, 2024). A growing body of research also documents atmospheric deposition, confirming that microplastics are transported via precipitation, including snow (Allen et al., 2021; Illuminati et al., 2024). Indeed, Illuminati et al. (2024) measured an average daily atmospheric flux of ~1.7 ± 1.1 particles m^{-2} d^{-1}, dominated by polypropylene, polyethylene and polycarbonate fragments, demonstrating that both local and long-range inputs contribute to Antarctic contamination. Likewise, Kelly et al. (2020) identified fourteen polymer types in land-fast sea-ice cores from East Antarctica, highlighting sea ice as a significant sink and secondary source of plastic debris.

The transport and deposition mechanisms of these pollutants are diverse. Microplastics reach the continent via atmospheric circulation, drifting ice and ocean currents, while local wastewater, packaging waste and ALDFG intensify contamination near human installations (Allen et al., 2021; Obbard et al., 2018; Primpke et al., 2024). Studies increasingly emphasise the coupling of these pathways: Jones-Williams et al. (2023) showed that even inland regions of Antarctica exhibit a microplastic footprint dominated by < 50 µm polyamide particles, implying the combined effect of long-range atmospheric transport and local emissions. Similarly, Zhang et al. (2022) found that microplastic distribution in the Southern Ocean reflects both southward transport from lower latitudes and local Antarctic sources.

The ecological presence and biological uptake of microplastics are now well-established and have been identified in the digestive tracts and faeces of penguins, krill, fish and benthic filter feeders, revealing trophic transfer within Antarctic food webs (Dawson et al., 2018; Fragão et al., 2021; Zhu et al., 2023). Bessa et al. (2019) found microplastic fibres in approximately 20 % of Gentoo penguin faecal samples at Bird and Signy Islands, while a more recent study by Fragão et al. (2021) detected microplastics and other anthropogenic particles in three penguin species. More recently, Bhattacharjee et al. (2024) identified microplastics in penguin internal organs, highlighting a previously unrecognised exposure pathway, while a study synthesising data from the late 1980s to 2023 found that 97 % of sampled Antarctic birds contained at least

one microplastic fragment or fibre (Taurozzi & Scalizi, 2024).

Zhu et al. (2023) detected microplastic ingestion in four Antarctic fish species and contamination of Antarctic krill (Euphausia superba), highlighting the entry of synthetic particles at the base of the Southern Ocean food chain. Microplastics can also be ingested by planktonic suspension and filter feeders such as krill, which are particularly vulnerable due to their feeding strategies (Dawson et al., 2018). This vulnerability is further intensified by sea-ice dynamics that enhance the uptake of microplastics by algae and krill (Rota et al., 2022). Once ingested, these particles can exert toxicological effects on keystone species, influencing entire ecosystems through bioaccumulation and biomagnification (Waller et al., 2017). Moreover, microplastics may act as vectors for pathogenic bacteria (Caruso et al., 2022) and can degrade into nanoplastics (< 1 μm). The unique environmental conditions of the Southern Ocean—low temperatures, intense UV radiation and strong turbulence—likely accelerate the fragmentation of larger plastics into micro- and nanoplastics, increasing their ecological risks (SCAR, 2023). Laboratory evidence shows that krill digestion can actively fragment microplastics into nanoplastics (Dawson et al., 2018), enhancing their bioavailability and capacity to cross biological barriers. The interplay between sea-ice dynamics, microbial colonisation and mechanical abrasion thus creates a continuous cycle of fragmentation that transforms macroplastics into microplastics and ultimately into nanoplastics permeating the Antarctic food web.

González-Aravena et al. (2024) further found microplastics in Laternula elliptica clams around King George Island, and microplastics have also been detected in Antarctic sediments and deep-sea environments, revealing that remote benthic ecosystems are not exempt from human pollution. Cunningham et al. (2020) recorded microplastics in 93% of deep-sea sediment samples from the Antarctic Peninsula, South Georgia and South Sandwich Islands, suggesting that these sediments act as long-term sinks.

Taken together, existing research shows that microplastic particles are present in the Antarctic environment and biota, in some cases in high concentrations (Leistenschneider et al., 2024). Pellegrino et al. (2025) stress that Antarctica's isolation does not protect it from microplastic contamination across marine, freshwater and terrestrial systems, as was once thought, with microplastics originating from both local and long-range anthropogenic sources. Moreover, De-la-Torre et al. (2025) add that accumulation of macro-, micro-, and nano-plastics is increasingly constraining the health and resilience of Antarctic benthic and pelagic communities.

Global Governance for Plastic Pollution

Plastic pollution has evolved from a localised waste-management concern into a global governance challenge that transcends borders, ecosystems and jurisdictions. Its durability, mobility and ubiquity ensure that even the most remote environments are affected by its accumulation and degradation products. Yet, despite its global scale, international responses have long remained fragmented, often limited to voluntary initiatives or sector-specific regulations, with little coordination between production, trade and waste management. Addressing this crisis requires not only improving recycling but also developing a comprehensive regulatory framework capable of governing the entire

life cycle of plastics. The search for such coherence has prompted renewed diplomatic attention and intergovernmental negotiations aimed at elevating plastic pollution to the same level of urgency as climate change and biodiversity loss.

Academic literature has increasingly examined the structural weaknesses that undermine global plastic governance. Da Costa et al. (2020) observed that although the number of laws, regulatory initiatives and soft-law guidelines addressing plastic and microplastic pollution has grown worldwide, these instruments remain disjointed, lacking effective enforcement mechanisms and scientific grounding. Similarly, Knoblauch et al. (2021) synthesised forty-five policy studies and found that most national and international frameworks are piecemeal, struggling to address the systemic drivers of plastic production, consumption and waste. Their complementary research on policy capacities and institutional constraints highlights persistent fragmentation across sectors and governance levels, limiting the effectiveness of existing instruments. Nagtzaam et al, (2023) traced the historical evolution of plastics regulation and demonstrate that, despite mounting urgency, international initiatives remain insufficient and poorly coordinated. Collectively, this body of literature indicates that the principal challenge of plastic governance lies not merely in the creation of new instruments but in achieving institutional coherence, scientific alignment and enforceable obligations capable of confronting the transboundary and systemic nature of plastic pollution.

Recent diplomatic initiatives have begun to address these long-standing weaknesses in the global governance of plastic pollution. In November 2021, the International Maritime Organisation's (IMO) Marine Environment Protection Committee (MEPC) adopted its Strategy to Address Marine Plastic Litter from Ships. This initiative represents the first coordinated global effort within the maritime sector to prevent plastic waste discharges from vessels. Its overarching objective is to achieve "zero plastic waste discharges to sea from ships by 2025" (IMO, 2021). The strategy focuses on three complementary pillars: improving waste management practices onboard ships, strengthening port reception facilities and enhancing monitoring and enforcement mechanisms under MARPOL Annex V. By emphasising the life-cycle management of shipborne plastics—including fishing gear, packaging materials and operational waste—the IMO strategy seeks to reduce both intentional and accidental discharges. It also promotes technological innovation, such as biodegradable materials and retrieval systems for lost gear, and elevates plastic pollution to a core element of maritime environmental governance, influencing regional port authorities and industry compliance standards.

Building on this momentum, the United Nations Environment Assembly (UNEA) took a decisive step in March 2022 by adopting Resolution 5/14, which mandates the negotiation of an international legally binding instrument (ILBI) in the form of a Global Plastics Treaty by the end of 2024. This Resolution marked a turning point in multilateral environmental diplomacy, recognising plastic pollution as a planetary crisis requiring a comprehensive response across the entire plastic life cycle—from production and product design to waste management and remediation. To implement the Resolution, UNEA established an Intergovernmental Negotiating Committee (INC) tasked with drafting the treaty text, supported by a Secretariat and technical working groups. The treaty's core objectives include eliminating problematic and avoidable plastics, curbing the release of microplastics, fostering circular economy principles and promoting technology transfer and capacity building for developing countries.

The fifth negotiating session (INC-5.1), held in Busan, South Korea, in November 2024, represented a crucial milestone in the Global Plastics Treaty process, consolidating diverse national positions into a preliminary framework. Despite this progress, however, negotiations concluded without consensus, revealing persistent division among member states. The draft treaty proposed ambitious measures—including global product design standards, a phased ban on harmful polymers and chemicals, and limits on plastic production—but progress was blocked by a small number of countries opposing binding production caps and global restrictions. Consequently, key decisions were postponed to INC-5.2, held in Geneva, Switzerland in 2025, which again ended without agreement. INC-5.3 is scheduled to be held in Geneva, Switzerland, in February 2026; however, this meeting will not involve further negotiation on substance, and the future of the proposed treaty is uncertain.

Despite the inability of parties to reach an agreement at this time, these negotiations have nevertheless reshaped the global discourse on plastics, aligning it more closely with governance models developed for climate and biodiversity regimes, and underscoring a growing recognition of plastic pollution as a planetary crisis demanding coordinated, science-based action.

Regulation of Plastic Pollution under the Antarctic Treaty System

The ATS constitutes the overarching governance framework for all human activities south of 60° South latitude. Established through the 1959 Antarctic Treaty, it provides the legal and institutional basis for maintaining Antarctica as a zone dedicated to peace and science. The ATS encompasses several interlinked instruments, including the Protocol on Environmental Protection to the Antarctic Treaty (commonly known as the Madrid Protocol), the Convention for the Conservation of Antarctic Marine Living Resources (CCAMLR), the Convention for the Conservation of Antarctic Seals (CCAS) and the Treaty itself. Collectively, these instruments seek to establish a cooperative regime aimed at protecting Antarctic environments and ecosystems. In practice, however, fragmentation and limited monitoring and enforcement capacity pose challenges for the effective management of emerging pollutants such as microplastics and nanoplastics, which cross jurisdictional and sectoral boundaries.

The Madrid Protocol provides the basis of environmental governance in Antarctica. As a legally binding agreement, it commits Parties to the "comprehensive protection of the Antarctic environment and dependent and associated ecosystems", designating the continent as a "natural reserve, devoted to peace and science" (Art. 2). The Protocol contains several provisions of direct relevance to plastic pollution.

- Annex I on Environmental Impact Assessment (EIA) requires Parties to undertake EIAs for all activities conducted within the Antarctic Treaty area, including the adoption of mitigation measures to minimise environmental impacts.
- Annex III on Waste Disposal and Management mandates the removal of plastic wastes from the Antarctic Treaty area (Art. 2).
- Annex IV on Marine Pollution includes specific prohibitions:
    - The disposal from ships into the sea of all plastics, including synthetic ropes, fishing nets and plastic garbage bags (Art. 5[1]); and
    - The discharge of untreated wastewater from vessels within twelve nautical miles of the coast (Art. 6[1a])[2].

National Antarctic Programs (NAPs), coordinated under the Council of Managers of Antarctic Programs (COMNAP), have also taken steps to mitigate plastic pollution within their operational scope. The COMNAP Environmental Protection Expert Group has issued a series of recommendations discouraging unnecessary plastic use in the Treaty area, including voluntary bans on personal care products containing microplastics, and strategies to minimise the release of textile-derived microfibres from laundry and wastewater systems. These measures illustrate an emerging awareness among operational stakeholders of the need to integrate pollution prevention into daily logistical activities. However, they remain largely voluntary and fragmented due to the absence of a binding, ATS-wide framework supported by systematic monitoring, technological innovation and clear compliance and enforcement mechanisms[3].

Similarly, CCAMLR has addressed aspects of plastic pollution, particularly those arising from fishing activities. Through Conservation Measure 26-01, vessels are required to report lost or abandoned fishing gear, a primary source of marine debris in the Southern Ocean. Yet, the scope of this measure remains narrow, focusing mainly on gear loss reporting rather than prevention or retrieval, and its enforcement is inconsistent across fleets and jurisdictions (CCAMLR, 2023). Expanding the measure to include mandatory retrieval programmes, gear-tracking systems, or financial disincentives for non-compliance could significantly enhance its effectiveness in mitigating marine-based plastic inputs.

When taken together, the existing provisions under the Madrid Protocol, CCAMLR and COMNAP could, in principle, provide a robust normative foundation for plastic waste prevention. In practice, however, their implementation remains uneven. Many NAPs face logistical and infrastructural challenges in managing waste at remote research stations, compounded by extreme environmental conditions and the reliance on ship-based controls under MARPOL Annex V (IMO, 2021). Moreover, the Madrid Protocol—negotiated before the recognition of microplastics and nanoplastics as a global threat—lacks specific provisions addressing these pollutants. It contains no binding requirements for filtration systems, airborne dispersal mitigation, or the management of secondary microplastic sources, such as synthetic textiles or polymer coatings. This regulatory lag has left the ATS struggling to adapt to emerging forms of pollution whose scientific understanding and transboundary impacts exceed the scope of its original design.

As Zhang et al. (2020) note, while the ATS has increasingly focused on locally generated plastic waste (from research stations, vessels and tourism operations) it remains poorly equipped to address plastics transported into the region via oceanic or atmospheric pathways. This gap exposes a broader governance dilemma: the ATS can regulate human activity within the Treaty area but holds no authority over global or extra-regional sources. Its reliance on voluntary measures, soft-law instruments and limited compliance monitoring reflects structural challenges that also affect other international environmental regimes confronted with transboundary pollutants.

Beyond intergovernmental mechanisms, private-sector and programme-level initiatives are beginning to complement the formal regulatory framework. Some commercial fishing and tourism operators have adopted voluntary measures to reduce plastic discharges; for example, some fishing vessels have trialled laundry filtration systems to capture microplastic fibres (ASOC & COLTO, 2018). Meanwhile, the International Association of Antarctic Tour Operators (IAATO) has incorporated

plastic reduction measures into its field operations manual, aligning them with the CCAMLR Marine Debris Form and ATCM Resolution 5 (2019), while developing new visitor guidelines to reduce single-use waste[4].

Plastic pollution and the ATCM

The ATCM is the principal decision-making forum under the ATS, bringing together Treaty Parties, expert organisations and observers to discuss the protection and management of the Antarctic environment. While not a regulatory body stricto sensu, the ATCM provides the political and normative platform through which Decisions, hortatory Resolutions and legally binding Measures are proposed, negotiated and adopted. Measures become legally binding once adopted by all Consultative Parties and implemented through national legislation, while non-binding Resolutions provide guidance for national policies. As new environmental pressures emerge, the ATCM has become a key forum for framing Antarctic responses to global challenges such as climate change and, more recently, plastic pollution.

Growing scientific evidence of plastic contamination in the Southern Ocean has drawn the ATCM's attention to this issue. A working paper submitted to the ATCM by the United Kingdom in 2019 (see UK, 2019) identified marine plastic pollution as "a major global conservation issue", noting that the Antarctic may be particularly vulnerable to microplastic pollution due to patterns of surface circulation across the Southern Ocean, which may transport surface-floating plastics from northern latitudes into polar waters, and high levels of UV radiation, which accelerate the breakdown of macroplastics into microplastics.

In response to this paper, the ATCM adopted Resolution 5 (2019) on Reducing Plastic Pollution in Antarctica and the Southern Ocean. The Resolution recommends reductions in the use of personal care products containing microplastic beads, and information exchanges between Parties on minimising microplastics in wastewater. The Resolution also invites the Scientific Committee on Antarctic Research (SCAR) to report on new information about the presence and risks of plastic pollution, calling for greater monitoring of plastic pollution in Antarctica. Finally, it recommends that the issue of microplastic release be considered in connection with any possible future revisions of Annexes III and IV to the Protocol on Environmental Protection.

Since 2019, the ATCM's engagement with plastic pollution has expanded significantly, reflecting a growing alignment between scientific evidence and policy deliberation. Against this evolving backdrop, the 46th ATCM, which convened in Kochi, India from 20 to 30 May 2024, represented a defining moment in the Antarctic dialogue on plastic pollution. The following section examines in greater depth the key findings, proposals and debates that shaped these discussions.

Microplastics at the 46th ATCM

The 46th ATCM took place amid heightened global attention to environmental governance in Antarctica, with discussions encompassing climate change, waste management, biodiversity conservation and marine protected areas. Among these themes, microplastic pollution emerged as

one of the most prominent and unifying issues, reflecting both the growing scientific recognition of its pervasiveness, and the evolving engagement of the ATS with global pollution challenges.

Building on earlier commitments, in particularly Resolution 5 (2019), the 2024 meeting provided the most extensive and detailed exchange to date on plastic contamination in the Antarctic region. A total of eight information papers (IPs) formed the scientific foundation of these discussions, complemented by a draft Resolution on Ending Plastic Pollution introduced by the Netherlands (ATCM 46-CEP 26, 2024)[5]. Collectively, these contributions signalled a maturation of the policy debate, shifting from preliminary awareness towards the design of potential institutional responses within the ATS framework.

One of the key contributions came from Switzerland, summarising research on microplastic pollution in the Weddell Sea and Dronning Maud Land (WSDML), a remote area with minimal human activity. The multi-year study conducted by the Alfred Wegener Institute, the Royal Netherlands Institute for Sea Research and Utrecht University found that small microplastics (11 μm–500 μm) constituted 98% of plastic particles identified, with concentrations comparable to heavily impacted regions such as the Norwegian and Chinese coasts. Microplastics were also identified in snow, sediments, sea ice and organisms including fish, seals and penguins—demonstrating their extensive presence in the food web. The paper emphasises the need for multidisciplinary research to better understand microplastic interactions with environmental variables, trace their origins and transport pathways, and develop effective mitigation and conservation strategies.

In its IP, Belarus presented the first findings on microplastic contamination in the soils and freshwater systems of East Antarctica, a region historically understudied compared to the marine ecosystems of West Antarctica. The research revealed unexpectedly high concentrations of microplastics in freshwater samples from Thala Hills, highlighting the urgency of continued research and international collaboration. Peru contributed a comprehensive literature review on plastic pollution in Antarctica, identifying persistent methodological gaps, particularly the absence of standardised sampling and analysis protocols, and recommending the implementation of quality control mechanisms in waste management, along with assessments of pollution originating from scientific bases and human activities.

Argentina reported on the Nuclear Technology for Controlling Plastic Pollution (NUTEC) Plastics Initiative, a collaborative project carried out at Carlini Base and aboard the ARA Almirante Irízar in cooperation with the International Atomic Energy Agency (IAEA). The initiative emphasised the need to harmonise microplastic monitoring methodologies and offered Argentina's technical expertise to other Parties interested in adopting comparable approaches.

The Antarctic and Southern Ocean Coalition (ASOC) urged stronger measures to combat plastic pollution within the Antarctic Treaty Area. ASOC highlighted the ecological risks associated with microplastics, including ingestion by krill, bioaccumulation across trophic levels and potential ecosystem-wide impacts, and identified local operations such as research stations, tourism and fishing activities as major contributors. The paper recommended developing a regional action plan, reviewing existing management provisions under the Environmental Protocol, and supporting global initiatives aimed at reducing plastic production and use.

Together, these papers stressed the urgency of addressing microplastic pollution through standardisation, collaboration and stronger international measures. In response, the CEP reviewed the draft Resolution on ending plastic pollution proposed by the Netherlands, which expressed concern over the increasing presence of plastics in Antarctic ecosystems and their associated environmental risks. Although the Committee did not reach consensus, it forwarded the draft to the ATCM for further consideration. However, despite broad support for the initiative, formal adoption was ultimately hindered by procedural and jurisdictional disagreements. Several Parties contended that ongoing negotiations towards a UN Global Plastics Treaty rendered new Antarctic-specific measures premature, while others viewed regional action as a necessary complement to global efforts. The subsequent plenary discussions reflected this tension between environmental ambition and diplomatic caution, a recurring feature of ATS decision-making. Many Parties expressed appreciation to the Netherlands for elevating the issue, but procedural objections persisted, particularly concerning compliance with submission protocols and the translation of documents into all official languages. It was also noted that the ATCM should await technical guidance from global fora with specialised expertise on plastics. To advance the process, several Parties proposed mandating the CEP to provide technical, scientific and environmental advice on plastic pollution, ensuring that future deliberations are informed by consolidated evidence and aligned with evolving international frameworks.

Overall, the deliberations at ATCM-46 revealed both progress and constraint: while there is growing scientific consensus on the pervasiveness and ecological risks of microplastics, the institutional caution and procedural rigidity that characterise Antarctic environmental governance continue to limit the speed and scope of collective action.

Microplastics at the 47th ATCM

Microplastic pollution remained a topic of significant discussion the following year at the 47th ATCM held in Milan, Italy between June 23 and July 3, 2025, with two working papers (WPs) and eight IPs submitted on the topic.

An Argentinian IP presented the initial findings of the Argentine Antarctic Programme's NUTEC Plastics Initiative, highlighting their adoption of a standardised methodology of sample analysis and the use of specialised equipment as prescribed by the IAEA. Switzerland and Germany submitted an IP presenting the final results and conclusions of their comprehensive microplastic research in the WSDML region between 2017 and 2025, reiterating the "high abundance" of microplastics in the region, advising a precautionary approach to policy and operations in respect of microplastics, and offering several mitigation strategies to address local sources. Ecuador submitted an IP presenting national initiative, including microplastic monitoring, toxicological studies and capacity building, while an IP submitted by Brazil reported on microplastics research undertaken by the Brazilian Antarctic Program (PROANTAR) and a new partnership with the NUTEC Plastics Initiative and the IAEA. The United Kingdom submitted a Working Paper addressing plastic pollution arising from field operations, specifically the degradation of polyester flags used for marking safe routes in Antarctica.

SCAR submitted two IPs concerning microplastic pollution. The first presented the conclusions of a long-term study of deep-sea sediment-dwelling organisms, which found that a third of sampled

organisms had ingested microplastic and other anthropogenic debris every year between 1986 and 2016, noting that the level of contamination was similar to that found in the Arctic, despite the significantly lower population. The second reviewed policy responses to plastic pollution under the ATS, concluding that "further actions on assessment, monitoring and mitigation are now needed to comprehensively address the issue of plastic pollution in the Antarctic Treaty area". In collaboration with twelve Parties, SCAR also submitted an IP to report on a workshop entitled "Monitoring Chemical Pollution in Antarctica – Tackling future Challenges together". Workshop attendees, which included expert researchers and environmental stakeholders, identified an "urgent need for increased coordination" to improve monitoring and analysis of pollutants including microplastics, and to inform the development of policies. Most of the above papers highlighted the importance of introducing standardised, comparable methodologies and protocols for sampling and analysis, as well as implementing long-term, systematic monitoring programmes to inform policy.

Finally, the Netherlands presented their WP proposing that the ATCM adopt a Resolution "Towards ending plastic pollution in the Antarctic Treaty Area". The Meeting agreed, adopting Resolution 5 (2025), which calls on Parties to, inter alia, share information on best practices for addressing plastic pollution, strengthen research and monitoring efforts, and engage in international discussions on plastic pollution.

Challenges, Opportunities and Policy Recommendations

Challenges

While considerable progress has been made in identifying the sources, pathways and ecological impacts of microplastics in the Antarctic environment, the capacity of the ATS to address this issue effectively remains limited. The complexity arises not only from the logistical and physical characteristics of the region but also from institutional fragmentation and uneven scientific data. Nonetheless, these same constraints reveal strategic opportunities to strengthen Antarctic environmental governance, deepen scientific collaboration and position the ATS as a leading actor in global plastic governance.

A primary challenge lies in the persistent data gaps and lack of standardised monitoring protocols across Parties. As such, despite growing awareness, microplastic research in Antarctica remains spatially and temporally fragmented, making it difficult to establish long-term baselines or detect regional trends. Sampling methodologies vary widely, and most studies are concentrated around research stations and tourist routes, leaving vast areas of the continent and surrounding ocean unexplored. Without harmonised procedures—something SCAR's Plastic Action Group has repeatedly emphasised—data comparability remains weak, constraining both scientific understanding and policy coherence.

A second challenge, as noted above, concerns the fragmented governance landscape of the ATS. Responsibilities related to plastic pollution are dispersed among multiple institutions, including the ATCM, the CEP, COMNAP and CCAMLR. Although these bodies share a common commitment to environmental protection, there is limited cross-referencing of policies or data exchange mechanisms between them. This absence of an integrated framework has led to duplicated efforts, inconsistent

monitoring and policy gaps—particularly between land-based and marine-focused initiatives.

Logistical constraints further compound the problem. Waste management and retrieval in the Antarctic are extremely costly and technically challenging due to remoteness, harsh weather conditions and seasonal access limitations. Even well-intentioned waste reduction measures encounter barriers in transportation, storage and disposal. As a result, operational activities such as research, tourism and fishing continue to generate plastic waste, including lost gear and packaging materials, some of which escape containment and enter local ecosystems.

The difficulty of monitoring and enforcing compliance also undermines the effectiveness of existing regulations. Moreover, emerging forms of pollution—such as microplastics, nanoplastics and airborne plastic particles—fall outside the scope of current regulatory frameworks, revealing the need for adaptive governance capable of addressing evolving environmental challenges.

Category	Key Issues / Actions	Description / Explanation	Relevant Actors / Sources
Scientific & Data Challenges	Data gaps and inconsistent methodologies	Lack of standardised monitoring protocols across Parties limits comparability and long-term assessments; most studies focus on accessible areas near stations.	SCAR Plastic Action Group (2023); ATCM Parties
Institutional Fragmentation	Weak coordination among ATS bodies	Overlapping mandates of ATCM, CCAMLR and CEP result in policy gaps and limited cross-referencing of measures.	ATCM, CEP, CCAMLR
Operational Constraints	Logistical and financial barriers to waste management	Harsh conditions and high transport costs hinder retrieval and disposal of waste; local operations continue to generate plastic leakage.	Research programs, COMNAP, IAATO
Enforcement Limitations	Voluntary compliance and limited inspections	Most provisions are non-binding; few mechanisms for enforcement or systematic compliance monitoring.	Treaty Parties, ATCM inspectors

Table 1. *Key challenges in addressing microplastic pollution under the ATS*

Opportunities

Despite these obstacles, several opportunities do exist to transform the Antarctic response into a model of proactive, science-based environmental management.

The ATCM Resolution 5 (2019) and Resolution 5 (2025) represent important steps towards acknowledging and addressing the threat of microplastic pollution in Antarctica. It is important to note, however, that these documents were drafted in the context of constructive negotiations towards an ILBI to address plastic pollution, which were ongoing at the time. The collapse of these negotiations at INC-5.2 (2025) has resulted in a regulatory void in respect of plastic pollution.

The ATS is well-positioned to introduce region-specific regulations that will fill the gap left by the paused Global Plastics Treaty. There is widespread agreement amongst Parties that plastic pollution in the Antarctic needs to be addressed: the ATCM 47 "reiterated the importance of addressing plastics pollution in the Antarctic Treaty area" (ATCM 47 Final Report (304)), and many Parties have indicated their support for the implementation of standardised research methodologies and protocols, and systematised monitoring.

Standardisation and collaboration can be achieved through the development of systematic monitoring protocols and harmonised reporting systems under the leadership of SCAR and COMNAP. Such efforts would enhance data consistency and facilitate the integration of Antarctic findings into global plastics assessments.

Innovation also plays a critical role in the process. Emerging technologies, including on-site wastewater filtration, biodegradable material substitution and circular supply chains for remote operations, can substantially reduce plastic leakage. Research stations could serve as experimental sites for piloting sustainable logistics systems and closed-loop material cycles. In addition, promoting collaboration between scientific, logistical and commercial actors—such as SCAR, COMNAP and IAATO—can ensure that operational sustainability translates into measurable environmental outcomes.

Institutional leadership is another area offering an important opportunity. The establishment of an ATS Task Force on Plastic Pollution would provide a formal mechanism for coordinating policy, monitoring data and facilitating dialogue between the ATCM, CCAMLR and other relevant

Key Issues / Actions	Description / Explanation	Relevant Actors / Sources
Standardisation and collaboration	Develop harmonised monitoring protocols and shared reporting frameworks under SCAR and COMNAP guidance.	SCAR, COMNAP, CEP National programmes,
Innovation and best practice	Implement circular logistics, wastewater filtration and biodegradable materials in Antarctic stations and vessels.	COMNAP
Institutional leadership	Establish an ATS Task Force on Plastic Pollution to coordinate data, policy and engagement with global processes.	ATCM, CCAMLR, CEP

Table 2. *Strategic opportunities to strengthen the Antarctic response to plastic pollution*

organisations. This Task Force could prepare joint recommendations, oversee the implementation of Resolutions and participate in international fora on plastics as appropriate, ensuring that Antarctic priorities are represented in global policy discussions.

Policy recommendations

In practical terms, addressing these challenges requires a comprehensive set of policy actions. The ATS should adopt an overarching Action Plan on Plastic Pollution encompassing macro-, micro-, and nanoplastics, covering both land-based and vessel-based sources. This plan should assign clear responsibilities to relevant institutions and actors, ensuring accountability and coordination. Standardised monitoring and reporting obligations, guided by SCAR's Plastic Action Group, would help generate consistent datasets and enable long-term trend analysis.

Enhanced cooperation between the ATCM and CCAMLR is also crucial. Developing joint measures on marine debris management and ALDFG, supported by retrieval incentives and sanctions for non-compliance, could bridge the divide between terrestrial and marine governance. Integrating plastic management into Environmental Impact Assessments (Annex I of the Environmental Protocol) would further institutionalise preventive measures, including mandatory wastewater filtration systems and microplastic risk assessments for all new facilities and vessels operating in the region.

Finally, broader awareness and behavioural change must complement technical and institutional reforms. Education and outreach initiatives targeting researchers, logistics operators and tourists

Key Issues / Actions	Description / Explanation	Relevant Actors / Sources
ATS Action Plan on Plastic Pollution	Adopt a comprehensive plan covering macro-, micro-, and nanoplastics from land- and vessel-based sources.	ATCM Secretariat
Standardised monitoring and reporting	Establish guidelines for comparable data collection and trend analysis through SCAR coordination.	SCAR, COMNAP
CCAMLR Conservation Measures	Introduce retrieval incentives and penalties for gear loss; coordinate marine debris monitoring.	CCAMLR, ATCM
Integration into EIAs	Require filtration and microplastic risk assessments in all Environmental Impact Assessments (Annex I).	CEP, national programs
Education and awareness	Promote sustainable logistics and reduce single-use plastics through operator and tourist engagement.	IAATO, COMNAP, research institutions

Table 3. *Policy recommendations for addressing plastic pollution in Antarctica*

can promote the reduction of single-use plastics, sustainable material choices and a culture of environmental responsibility within Antarctic operations. Linking these initiatives to global movements—such as UNEP's Clean Seas campaign or IMO's Marine Plastic Litter Strategy—would amplify their visibility and impact.

Taken together, these measures can form a roadmap for transforming the ATS response to microplastic pollution from reactive and piecemeal to proactive and adaptive, through an approach capable of addressing the multifaceted challenges of plastic pollution. Through standardisation, innovation and institutional cooperation, Antarctica could serve not only as a sentinel for global environmental change but also as a testing ground for governance solutions that advance planetary stewardship in the age of plastics.

Conclusions

Plastic pollution constitutes a growing and complex risk to Antarctic and Southern Ocean ecosystems, operating through poorly understood pathways of ingestion, bioaccumulation, transformation and biomagnification of micro- and nanoplastics. Evidence reviewed in this article demonstrates that no Antarctic ecosystem—whether marine, terrestrial, or atmospheric—remains unaffected. Yet despite clear scientific signals, policy responses under the ATS continue to lag behind the scale and urgency of the challenge. In order to address and tackle this emerging threat, it requires both scientific consolidation and institutional innovation. A such, standardised methodologies for monitoring, sampling and analysis must be prioritised to generate comparable data and establish robust baselines to inform policy. However, the absence of full datasets should not be used as grounds for inaction. In line with the precautionary principle, early preventive and adaptive measures are warranted to avoid irreversible ecological impacts.

At the policy level, the ATCM should play a catalytic role by developing a comprehensive ATS Action Plan on Plastic Pollution, encompassing macro-, micro-, and nanoplastics from both land- and vessel-based sources. This plan should clearly delineate institutional responsibilities among the ATCM, CCAMLR, COMNAP and SCAR; establish mechanisms for data sharing and capacity building; and promote the deployment of technologies such as filtration systems, biodegradable materials and circular logistics within Antarctic operations.

Enhanced international coordination is equally important. Aligning Antarctic policies with global initiatives such as the IMO Strategy to Address Marine Plastic Litter from Ships will help ensure policy coherence and strengthen Antarctica's contribution to global plastic governance. By engaging proactively with these frameworks, the ATS could position itself as a model for science-based regional cooperation in addressing transboundary pollutants. Ultimately, the Antarctic response to plastic pollution must evolve from a reactive posture to become a proactive, integrated and adaptive governance model. To do so this will entail bridging the divide between scientific research and policy implementation, reinforcing compliance and monitoring mechanisms, and fostering behavioural change among operators, researchers and visitors. By doing so, the ATS can not only safeguard one of the planet's last great wildernesses but also afford a valuable precedent for global environmental governance in the age of plastics.

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EDNOTES

1. An IP presented by SCAR to the 45th ATCM summarised available information on the occurrence of macroplastics (> 5 mm), microplastics (1 μm-5 mm) and nanoplastics (< 1 μm) in Antarctica (SCAR, 2023).

2. Parties are not compelled to treat wastewater released from their scientific research station, beyond maceration (Annex III; Article 5, 1b).

3. An educational poster with suggestions on how National Antarctic Programs can reduce plastic pollution is available at: https://static1.squarespace.com/static/61073506e9b0073c7eaaf464/t/613fe40109a713366b37b86a/1631577091358/COMNAP-Understanding-sources-of-plastics-in-the-Antarctic-Treaty-Area.pdf

3. IAATO guidelines can be consulted here: https://iaato.org/wp-content/uploads/2020/04/Reducing-waste-visitor-guidelines.pdf

5. IPs were submitted by Belarus (IP 2), Argentina (IP 15), Switzerland (IP 44), India (IP 58), Peru (IP 148), Uruguay (IP 170), and the Antarctic and Southern Coalition (IP 140). Although Chile's paper (IP 23) focuses on conservation challenges of Fildes Peninsula in general, it does mention plastic pollution as one of the threats affecting the area. Quotations for all these IPs are provided in the references section of this article.

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