SCOR Working Group Proposal

(5835 of 6250 words, excluding Appendix)

Title: Partnerships for Investigations of Clouds and the biogeoChemistry of the Atmosphere in Antarctica and the Southern Ocean

Acronym: PICCAASO

Summary/Abstract (250 of 250 words)

The Southern Ocean plays a critical role in regulating Earth's climate through tightly coupled interactions among marine ecosystems, aerosols, clouds, and radiation. Owing to its relative isolation from major anthropogenic pollution sources, the region provides one of the last natural laboratories for investigating biogenic aerosol–cloud–radiation processes under near-pristine conditions. However, persistent biases in Earth System Models—particularly related to cloud phase and shortwave radiation—highlight fundamental gaps in process-level understanding and translation of observations into model-relevant parameterizations. Building on the foundational efforts of the PICCAASO (Partnerships for Investigations of Clouds and the biogeoChemistry of the Atmosphere in Antarctica and the Southern Ocean) initiative launched in 2023, this SCOR Working Group will address these challenges through coordinated international synthesis, integration, and capacity building, which was previously unachievable due to PICCAASO's resource constraints. The Working Group will identify critical knowledge gaps in marine ecosystems–cloud coupling, foster sustained interdisciplinary collaboration among observationalists and modelers, and develop mechanisms to share and discover knowledge of past, ongoing, and planned research activities. The group will support a two-way model–observation exchange aimed at improving the representation of aerosol–cloud–radiation processes in Earth System Models. Key deliverables include an open-access synthesis paper, a metadata-driven website enabling variable-based discovery of Southern Ocean research campaigns, and practical workflows using benchmark case studies for observation-model evaluation. Together, these outcomes will unite the southern high-latitude research community and establish a durable framework for advancing understanding of Southern Ocean and Antarctic ecosystem–atmosphere interactions under a changing climate.

Scientific Background and Rationale (1239 of 1250 words)

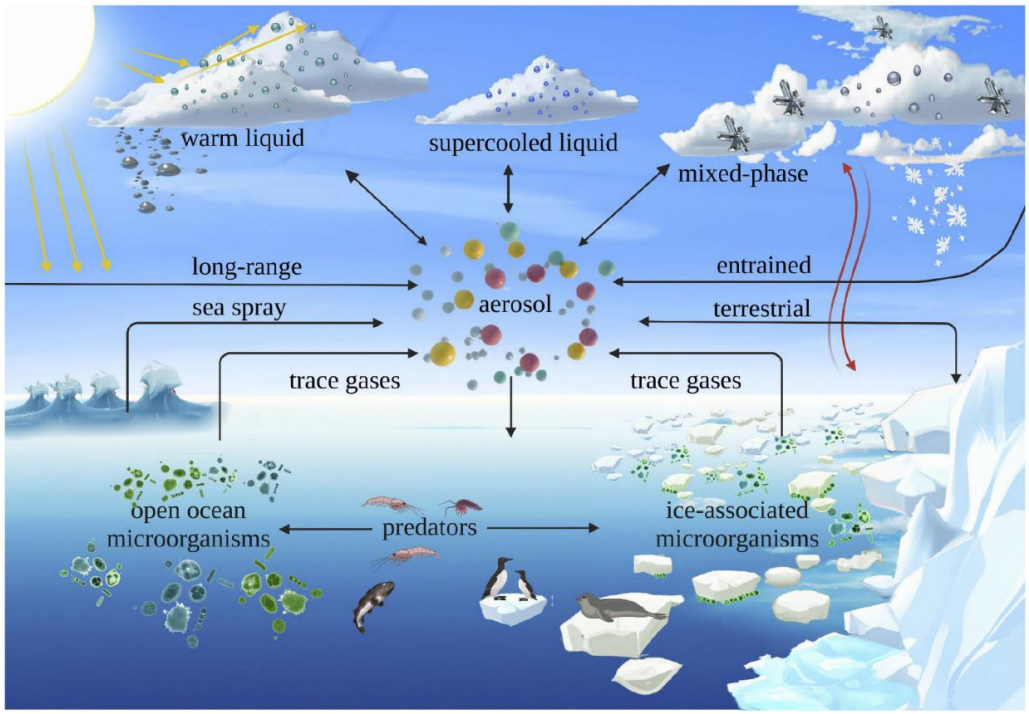

Figure 1: Interactions between microbiota, gases, aerosol, clouds, radiation, and precipitation in the Southern Ocean and Antarctic.

The Southern Ocean (SO) and Antarctica, collectively referred to as the Southern Ocean and Antarctic Region (SOAR), are situated far from major anthropogenic sources of air pollution, leaving their atmospheric states dominated by natural aerosols and vapors (Hamilton et al., 2014). As some of the most pristine and unspoiled atmospheric environments remaining on Earth, they provide an invaluable natural laboratory that approximates a pre-industrial aerosol baseline, which is essential for quantifying the impact of human activities on the global atmosphere (Ulas et al., 2026). Recent high-throughput DNA sequencing of airborne microorganisms shows that bacterial populations over the SOAR are almost exclusively of marine origin (Uetake et al., 2020), contrasting with the Northern Hemisphere where continental sources dominate. However, despite its remoteness, the region is no longer immune to anthropogenic influence. The diffusion of greenhouse gases, stratospheric ozone depletion, local pollution from increasing tourism, and the influx of microplastics are increasingly evident (Aves et al., 2022; Cordero et al., 2022). These emerging pressures underscore the urgency of characterizing aerosol–cloud processes in the SO before ongoing human-induced changes compromise this natural baseline.

The SO marine ecosystem is a central driver of atmospheric composition and cloud formation, releasing a wide range of gases and aerosols through highly complex biological, chemical, and physical pathways (Figure 1; Mallet et al., 2023). Biogenic emissions influence cloud formation and properties through a range of complex processes. Secondary marine aerosols, derived from the oxidation of phytoplankton-emitted dimethyl sulfide (DMS), one of several marine biogenic sulfur compounds, can act as important cloud condensation nuclei (CCN) that facilitate the

formation of cloud droplets (e.g., Fossum et al., 2023). Simultaneously, primary organic particles, such as organic matter are suggested to be essential ice nucleating particles (INPs) that form cloud ice crystals (e.g., McCluskey et al., 2018). By regulating cloud abundance, phase partitioning, and microphysical properties, these biogenically sourced aerosols exert a control on the regional radiation budget. Given that SOAR is one of the most persistently cloud-covered regions on Earth, these aerosols exert a significant control over the regional and global radiation budget, albeit that their role in modulating cloud microphysical structure is yet not understood (He et al., 2025)

The SOAR functions as a highly integrated system where marine and sea-ice biogeochemical processes, atmospheric chemistry, cloud microphysics, and the regional radiation budget are fundamentally coupled. For example, biogenically derived aerosols modify cloud microphysical properties, thereby regulating the shortwave radiation reaching the ocean surface. This radiative shift, in turn, influences the primary productivity and ecological dynamics of marine biota. Despite its importance, it remains unclear how these coupled interactions will respond to ongoing and future climate change. Establishing a mechanistic understanding of these couplings within the current pristine state is an essential prerequisite for predicting the system's sensitivity to future anthropogenic forcing. Addressing such complexity requires an explicitly interdisciplinary framework that bridges traditionally separate oceanographic, ecological, cryospheric, and atmospheric research communities.

In current Earth System Models (ESMs), many critical marine biogeochemical and atmospheric chemistry processes and feedbacks are either entirely omitted or represented in extremely simplified forms. In parallel with these structural limitations, many of these models consistently overestimate the amount of shortwave radiation reaching the ocean surface (Fiddes et al., 2022). Significant discrepancies persist between CMIP6 simulations and satellite observations regarding this energy balance, highlighting a fundamental lack of understanding of SOAR cloud formation and evolution (Mallet et al., 2023). This shortwave radiation bias is primarily linked to the inability of models to accurately capture the frequent occurrence of supercooled liquid water (SLW) clouds, which are a dominant feature of the region. Most ESMs typically overpredict the conversion of liquid droplets to ice crystals (over-glaciation) which leads to premature cloud dissipation and a drastic reduction in cloud reflectivity (e.g., Gettelman et al., 2020). The resulting anomalous surface heating disrupts simulated meridional temperature gradients, triggering cascading biases in global atmospheric and oceanic circulations.

Resolving these persistent biases requires more than just meteorological tuning; it necessitates a quantitative, process-level understanding of how the marine ecosystem modulates atmospheric composition and cloud microphysics. In particular, uncertainties in the production, transformation, transport, and air–sea exchange of volatile compounds and particles released by marine microorganisms directly limit the accuracy of emission inventories used in models. Without robust constraints on these biological–atmospheric linkages, ESMs will remain unable to capture the true sensitivity of the SOAR climate engine to future environmental change.

Launched in 2023, the PICCAASO initiative has already established a foundational framework for addressing these multidisciplinary challenges. A primary achievement of the community was the

publication of a comprehensive white paper (Mallet et al., 2023), which systematically identifies the most critical knowledge gaps and defines the priority research topics required to advance SOAR science. To facilitate broader community engagement, the initiative developed a dedicated website (https://www.piccaaso.org/) that aggregates and tracks various international observation and modeling campaigns. By the date of submission of this document, 70 people have joined the PICCAASO mailing list, via which regular quarterly newsletters are distributed.

Why a SCOR working group?

Despite the foundational achievements of PICCAASO, new scientific challenges have rapidly emerged since the publication of the 2023 white paper (Mallet et al. 2023). The SOAR is undergoing environmental shifts, including glacial and sea ice retreat and human impacts. Simultaneously, the diversification of research tools through advanced measurement technologies and artificial intelligence has opened new avenues for investigation yet also added complexity to data integration. While numerous SOAR-related international projects are currently underway across various institutions, they often represent spatial and temporal snapshots, making it difficult to assess the universality or generalizability of their findings. This challenge is further compounded by the persistent lack of effective integration between marine ecosystem research and atmospheric research communities, despite their strong physical, chemical, and biological coupling in the SO system.

While the PICCAASO website has mapped some known research campaigns, its effectiveness is limited by the lack of in-person meetings. This absence of face-to-face interaction leads to gaps in information exchange and fragmented collaboration. Significant operational gaps still exist, particularly the absence of a comprehensive registry that catalogues the breadth research campaigns due to the lack of resources and in-person networking avenues. Currently, there is no central system to provide up-to-date details on platforms, instruments, and specific measured variables. Furthermore, there is no sophisticated discovery mechanism that allows researchers to search by biological, chemical, and physical variables. Such a system should be able to link external metadata to identify key details (who, what, where, and when). There is also no standardized approach for identifying high-quality observational benchmark case studies suitable for model evaluation and intercomparison. Addressing these multifaceted challenges requires a comprehensive, face-to-face venue where researchers worldwide can strategically consult on the future direction of SOAR observation and modeling efforts. This is especially timely given the upcoming international, interdisciplinary Antarctica InSync effort (https://www.antarctica-insync.org/), which will target synchronized field measurements in the SOAR from late 2027 through 2029 and the Fifth International Polar Year (IPY) in 2032-2033 (https://ipy5.info/), which aims to address urgent global challenges by advancing polar research, focusing on the impacts of climate change in the Arctic and Antarctic. Numerous new datasets will become available from several established long-term research sites, voyages, and airborne measurements, all of which will need to be coordinated within a centralized reference framework in the context of historical measurements to assess how the SOAR coupled system has changed over time.

Terms of Reference (249 of 250 words)

T1. Identify critical knowledge gaps in the coupling between marine ecosystems and cloud properties through a synthesis of existing research and literature. This activity will include a systematic review of existing observational, experimental, and modeling studies to pinpoint missing or poorly constrained process-level links in biogenic aerosol–cloud interactions, thereby defining a prioritized and achievable research agenda for the SOAR.

T2. Facilitate sustained international and interdisciplinary collaboration among observational and modeling communities in marine biogeochemistry, ecosystem science, atmospheric chemistry, and meteorology. Through a series of face-to-face workshops, the working group will promote direct interaction between observationalists and modelers, enabling cross-disciplinary exchange, co-development of scientific questions, and mutual understanding of observational constraints and modeling needs essential for advancing integrated studies of the SOAR climate system.

T3. Develop a mechanism to share and discover comprehensive knowledge of past, ongoing, and planned research activities relevant to marine–atmosphere coupling. This information hub will ensure the efficient coordination of international efforts and facilitate disparate research into a global context in preparation for Antarctica InSync and IPY.

T4. Support two-way knowledge exchange between observationalists and modelers to improve the representation of aerosol–cloud–radiation processes in Earth System Models. This will prioritize the identification of high-quality observational case studies, the establishment of community-endorsed data standards for essential variables, and the development of practical workflows for translating field-based insights into model-ready formats, acknowledging that while model improvement is a long-term challenge, tangible guidance for model evaluation and intercomparison can be achieved within 3–4 years.

Deliverables (236 of 250 words)

D1. Open-access Synthesis Paper based on a PICCAASO-led Copernicus Special Issue: The Working Group will produce a peer-reviewed, open-access synthesis paper that integrates outcomes from the PICCAASO-led Copernicus Special Issue, which is planned to be launched in the near future. This paper will identify major scientific advances, assess remaining process-level knowledge gaps in marine ecosystem–cloud coupling, and articulate a prioritized research agenda for the SOAR (**T1**).

D2. Enhanced PICCAASO Community Website: The existing PICCAASO website (https://www.piccaaso.org/) will be transformed into an advanced, open-access web portal that supports sustained interaction among observational and modeling communities. The portal will host synthesized outcomes from Working Group activities, provide discoverable documentation of international research efforts, and promote cross-disciplinary integration by connecting marine ecosystem, atmospheric, and modeling perspectives (**T2**, **T3**).

D3. Community Research Registry: We will establish a metadata-driven registry documenting past, ongoing, and planned observational and modeling campaigns. Using standardized descriptors and variable-based discovery, it will enable researchers to identify campaign details without central data hosting. This will support cross-campaign synthesis and enhance the reuse of high-quality observations for Earth System Model evaluation (**T4**).

D4. Observational Benchmark Case Studies and Workflows for Model Evaluation: The Working Group will develop community data guidelines for essential SOAR variables. We will produce practical resources (e.g., guidebooks and Python notebooks) to help researchers efficiently process field data into model-ready formats with consistent metadata. These resources will directly facilitate initial observation-model evaluation studies (**T4**).

Working plan (984 of 1000 words)

Steps to Fulfill Terms of Reference

Synthesis of Existing Knowledge and Identification of Critical Gaps (T1):

Building on the forthcoming PICCAASO-led Copernicus Special Issue, the Working Group will undertake a structured synthesis of peer-reviewed literature (**D1**) and community knowledge to clarify mechanistic links between marine ecosystems and cloud properties in SOAR. This synthesis will focus on how biogenic emissions and primary marine particles drive populations of CCN and INPs, and how these particles regulate cloud phases, supercooled liquid water persistence, and shortwave radiation. Beyond advancing process-level understanding, the synthesis will explicitly assess current capabilities and limitations in quantifying marine biogenic emissions, including uncertainties in production rates, air–sea exchange, and atmospheric processing. Particular emphasis will be placed on how observational constraints can be translated into emission estimates that are suitable for use in ESMs, and on identifying pathways toward improved, process-informed emission inventories for SOAR.

Facilitation of Interdisciplinary and Model–Observation Dialogue (T2):

To bridge longstanding divides between marine ecosystem and atmospheric researchers, and modeling communities, the Working Group will facilitate sustained international and interdisciplinary dialogue. This will be achieved through coordinated face-to-face and hybrid scientific sessions associated with major international meetings (e.g., SOLAS, EGU, AGU, SCAR), complemented by focused topical discussions. These interactions will explicitly promote two-way exchange between observationalists and modelers, enabling marine scientists to communicate ecosystem constraints and variability, while modelers articulate the chemical and microphysical information needed for improved parameterizations. This directly supports Deliverable **D2** by fostering shared conceptual frameworks.

Development of a Community Knowledge and Discovery Mechanism (T2, T3):

The Working Group will design a distributed mechanism for sharing and discovering research relevant to marine–atmosphere coupling. SCOR-funded workshops will allow international observationalists and modelers to collectively determine functional requirements, standardize metadata, and finalize the platform's design. Building on the existing PICCAASO website, this yields an enhanced knowledge portal linking to external metadata without requiring centralized data hosting. As a blueprint for that approach, the implementation of the metabase (projects.au.dk/cleancloud/the-cleancloud-meta-database) of the Horizon Europe project CleanCloud will be adapted. In parallel, the group will define the structure for a dynamic research registry that documents observational and modeling campaigns using standardized descriptors, enabling discovery by biological, chemical, and physical variables, as well as by who, what, where, and when. This step underpins Deliverables **D2 and D3** and directly addresses the current fragmentation of international efforts identified in the Scientific Background.

Guideline and Workflow Development and Model-Observation Integration (T4):

To support improved representation of ocean biogeochemistry-aerosol–cloud–radiation interactions in ESMs, the Working Group will identify representative SOAR observational benchmark case studies that capture key cloud and aerosol regimes. Using these cases, observationalists and modelers will collaboratively establish community data guidelines and standards for essential variables and develop practical workflows (e.g., guidebooks and Python notebooks) for translating complex raw observational data into model-ready formats (**D4**). While full model improvement lies beyond the lifetime of the Working Group, the Working Group will directly apply these guidelines and practical workflows to execute initial observation-model evaluation studies within its lifetime. This step will deliver tangible outcomes and best practices for model–observation comparison (**D3, D4)**.

Timeline

Month 1: Initiation and Coordination

The Working Group will establish its operational structure through an initial virtual meeting, confirming leadership roles and task teams aligned with ToR **T1**–**T4**. Early activities will focus on outlining the scope of the synthesis effort and defining standards for the research registry.

Months 2–12: Strategic Design and Community Engagement

The group will prioritize consultation and the establishment of a formal dialogue. We will initiate a comprehensive consultation phase with PICCAASO members to define the functional requirements, design, and long-term direction of the upgraded website, ensuring it meets the needs of the global SOAR research community. A key milestone will be the organization of a dedicated session at the EGU General Assembly in 2027. This session will invite participants from both the ocean, sea-ice, and atmosphere communities to present the current needs and barriers

in observational and modeling fields. During these initial in-person interactions, observationalists and modelers will collaboratively identify existing standards for essential SOAR variables and outline the requirements for community-endorsed data guidelines. PICCAASO members will also lead the effort to collect information on the latest research plans and progress, ensuring that these updates are accurately reflected on the website to foster real-time collaboration. Concurrently, a writing team will be established to begin the synthesis of research and meet in person for a working-side meeting to establish writing tasks, general structure and assign tasks for progression.

Months 13–24: Integration and Infrastructure Development

International dialogue will be sustained through dedicated sessions at major conferences (e.g., EGU), providing continued face-to-face exchange between marine ecosystem, atmospheric, and modeling communities (**D2**). These interactions will consolidate shared research priorities identified in the first year. In parallel, the Working Group will guide the transition from design to implementation of the enhanced PICCAASO community website and the research registry (**D3**). The technical deployment and population of the registry will be executed leveraging contributions from partner institutions (e.g., student assistants funded by TROPOS). Core functionality, including standardized metadata and variable-based discovery, will be deployed. Concurrently, task teams will identify benchmark case studies and co-develop practical resources to process raw data into model-ready formats (**D4**). The writing group will meet virtually and in-person to advance the synthesis document.

Months 25–36: Synthesis, Delivery, and Legacy

The final year will focus on synthesis and delivery of the Working Group's core outputs. The open-access synthesis paper will be completed and submitted, integrating results from the Copernicus Special Issue and broader community engagement (**D1**). The community knowledge portal (website) and research registry will be finalized and publicly released (**D2, D3**). Building on the scientific synthesis, sustained dialogue, and registry infrastructure established under ToR **T1–3**, the Working Group will finalize and publish the community-endorsed data standardization guidelines and practical workflows, and execute initial observation-model evaluation studies using the established benchmark cases (**D4**).

Capacity Building (1108 of 1500 words)

The PICCAASO Working Group recognizes that the SOAR is a vast and highly complex system that no single nation, institution, or discipline can fully characterize. Its remoteness, harsh environmental conditions, and strong seasonality impose substantial logistical, technical, and financial barriers that limit access to observations and sustained research efforts. Accordingly, our capacity-building strategy is designed to create long-lasting global capability through sustained international collaboration, shared knowledge infrastructure, and active engagement across career stages that will extend through Antarctica InSync, the next IPY, and beyond. Capacity building within PICCAASO is not treated as an ancillary activity but as a central scientific

objective: building the human, organizational, and digital capacity required to understand and model SOAR ecosystem–atmosphere coupling is itself a prerequisite for scientific progress in this domain.

1. Enhanced PICCAASO Website as a Long-Term Hub for Global Collaboration

A central pillar of the capacity-building strategy is the enhanced PICCAASO Community Website (**D2**), which will function as a long-term, open-access, and community-driven knowledge hub rather than a static dissemination platform. The Working Group's effort will be dedicated to fully developing and updating the platform to ensure it can be easily maintained and will not cease to be updated after the SCOR term concludes. The design philosophy of the portal explicitly reflects the need to lower entry barriers to SOAR research, particularly for researchers who lack direct access to polar and sub-polar infrastructure such as icebreaking vessels, aircraft campaigns, or long-term Antarctic stations.

Through coordinated development under the Working Group, the website will enable discovery of research activities in biological, chemical, and physical disciplines, as well as thematic focus areas and methodological approaches. This functionality directly empowers researchers, educators, and Early Career Scientists (ECSs) to independently identify relevant research efforts, integrate their work into the broader international context, and initiate new collaborations. In doing so, the portal actively distributes scientific capacity across the global community rather than concentrating it within a small number of well-resourced institutions. This is especially important, as it enables ECSs to engage with the established SOAR community and prepare for their involvement in Antarctica InSync and IPY research activities.

By hosting synthesized outcomes from Working Group activities and providing direct links to the Community Research Registry (**D3**), the website will also serve as an enduring educational resource. It will support a shared conceptual framework linking marine ecosystem processes, aerosol emissions, cloud microphysics, and radiation, thereby addressing one of the most persistent barriers to interdisciplinary research in the SOAR. This integrative function is especially important for enabling dialogue between observational and modeling communities, whose research cultures and priorities often differ substantially.

Recognizing that research on marine ecosystem–cloud coupling is inherently dynamic and that new scientific challenges will continue to emerge as the SO environment changes, the long-term sustainability of the website is treated as a core capacity-building outcome. The Working Group will therefore develop governance and maintenance guidelines to ensure that, following the conclusion of the SCOR term, the platform can transition into a self-sustaining, community-maintained resource. By embedding stewardship responsibilities within the broader PICCAASO community, the website is intended to evolve organically in response to future scientific needs, rather than becoming obsolete once initial funding concludes.

2. Building a Multinational and Interdisciplinary Research Community

Capacity building within PICCAASO is intrinsically international and interdisciplinary, reflecting

both the global importance of the SOAR and the distributed nature of expertise required to study it. The Working Group draws on the complementary strengths of participating nations—including Australia, Canada, France, Germany, India, Japan, New Zealand, South Africa, Spain, Switzerland, the USA and the UK.—each of which contributes distinct observational assets, modeling capabilities, and regional perspectives.

A key objective of the Working Group is to move beyond fragmented spatial and temporal snapshots collected by individual national programs and toward a coherent, globally integrated understanding of SOAR ecosystem–atmosphere coupling (**T1**). To achieve this, the Working Group will function as a strategic coordination layer, connecting national and institutional efforts rather than replacing existing research structures. In particular, PICCAASO will act as a bridge across established international initiatives such as CATCH (Cryosphere and Atmospheric Chemistry), BEPSII (Biogeochemical Exchange Processes at Sea-Ice Interfaces) and SOLAS (Surface Ocean-Lower Atmosphere Study), fostering alignment of scientific priorities and facilitating the transfer of knowledge across traditionally separate communities.

Face-to-face scientific interactions play a critical role in this process. Sustained interpersonal exchange is essential for building trust, resolving disciplinary misunderstandings, and co-developing shared research questions—all of which are fundamental components of long-term capacity building. Through recurring in-person and hybrid engagements, the Working Group will promote deeper integration between marine ecosystem scientists, atmospheric chemists, meteorologists, and Earth system modelers (**T2**).

Special attention will be given to inclusive participation. By actively encouraging involvement from researchers in under-represented regions, including the Global South, the Working Group aims to broaden the geographic and cultural base of science in the SOAR. This approach not only strengthens scientific capacity but also enhances the resilience and adaptability of the global research community as new environmental and societal challenges emerge.

3. Early Career Scientist Development through Active Operational Roles

A defining feature of the PICCAASO capacity-building strategy is the intentional integration of ECSs into the operational core of the Working Group. Rather than positioning ECSs as passive recipients of training or data, PICCAASO will actively involve them in the development, maintenance, and long-term stewardship of the community website and research registry (**D2**, **D3**). For instance, dedicated student assistants supported by institutional in-kind funding will provide the core operational workforce for the portal's technical implementation. Through direct engagement in curating campaign metadata, synthesizing community knowledge, and facilitating cross-disciplinary communication, ECSs will gain an exceptionally broad and systems-level understanding of the SOAR ecosystem–atmosphere interactions. This exposure enables young scientists to move beyond narrow disciplinary expertise and develop an appreciation of how observational constraints, modeling needs, and theoretical understanding intersect within Earth system science.

In parallel, ECSs will acquire practical, transferable skills that are rarely emphasized in

conventional academic training but are essential for future scientific leadership. These include metadata standardization, international coordination, stakeholder engagement, and the management of distributed digital research infrastructure. Such experience directly supports their capacity to design, lead, and participate in large-scale, interdisciplinary research initiatives that will be required to address the evolving challenges of climate change and environmental transformation. By embedding ECSs within both the scientific and organizational fabric of PICCAASO, the Working Group ensures that capacity building extends beyond knowledge transfer to include the cultivation of future leaders capable of sustaining and advancing SOAR research communities over the coming decades. This approach creates a generational legacy that aligns closely with SCOR's mission to build durable global capacity in ocean science.

Working Group composition (374 of 500 words)

The membership composition has been designed to spread across scientific discipline, geographical location, gender, and career stage as well as to represent established and emerging polar programs. Members have demonstrated leadership in international collaboration efforts (e.g. SOLAS, PICCAASO, Antarctica InSync) and are typically the domain leaders in their area of expertise in their respective countries.

Full Members

Name	**Gender**	**Years since degree***	**Country and institution of affiliation(s)**	**Expertise relevant to proposal**
1. Atsushi Yoshida (Co-Chair)	M	6	National Institute of Polar Research, **Japan**	Atmosphere-ocean particle exchange, aerosol measurements
2. Ruhi Humphries (Co-Chair)	M	10	Commonwealth Scientific and Industrial Research Organisation, **Australia**	Antarctic & marine aerosols, cloud-forming aerosol
3. Jessie Creamean	F		Colorado State University, **USA**	Aerosol-cloud interactions, ice nucleation, bioaerosols
4. Patric Seifert	M		Leibniz-Institute for Tropospheric Research (TROPOS), **Germany**	Remote sensing of aerosols and clouds, aerosol-cloud interactions
5. Holly Winton	F	9	Victoria University of Wellington, **New Zealand**	Ocean-atmosphere processes, phytoplankton, organic aerosol
6. Anoop Mahajan	M		Indian Institute of Tropical Meteorology, **India**	Atmospheric Chemistry, Air-sea interactions

7. Katye Altieri	F		University of Cape Town, **South Africa**	atmospheric chemistry, ocean-atmosphere interactions
8. Markus Frey	M		British Antarctic Survey, **UK**	Polar atmospheric chemistry, chemical air-snow/ice exchange fluxes, cloud-forming aerosol
9. Xu-Cheng He	M	4.5	University of Helsinki, **Finland**	Atmospheric chemistry and aerosol formation, gas and aerosol measurements, Earth system modeling of aerosols

* Field only required for members identified as early career: 10 years or less post-degree, not counting time off for family leave.

Associate Members

Name	**Gender**	**Years since degree***	**Country and institution of affiliation(s)**	**Expertise relevant to proposal**
1 Marc Mallet	M	9	Bureau of Meteorology, **Australia**	Aerosol-cloud interactions, remote sensing, Earth system models
2. Alexander Böhmländer	M	1	Karlsruhe Institute of Technology, **Germany**	Ice-nucleating particles, aerosol-cloud interactions
3. Sonya Fiddes	F	5.5	University of Tasmania, **Australia**	Aerosol-cloud modeling
4. Catherine Hardacre	F		University of Canterbury, **New Zealand**	Atmospheric chemistry-composition-climate interactions (Earth system modelling)
5. Santiago Gassó	M		U. of Maryland/ NASA,**USA**	Remote sensing of aerosols, high latitude dust
6. Jakob Boyd Pernov	M	4.5	Queensland University of Technology, **Australia**	Polar atmospheric chemistry and physics, measurement techniques, data-driven modeling

* Field only required for members identified as early career: 10 years or less post-degree, not counting time off for family leave.

Working Group contributions (748 of 750 words)

Atsushi Yoshida is an ECR that specializes in the development of analytical methods for measuring particles in seawater and the atmosphere to understand how oceanic and terrestrial aerosols influence Southern Ocean ice-cloud formation, and is a member of the Japanese Antarctic Research Expedition (JARE). As the current PICCAASO secretary and proposed co-chair, Atsushi will bring an established international coordination role and a strong Japan–international network that directly supports oversight, alignment, and delivery across all Working Group outputs.

Ruhi Humphries is a Principal Research Scientist focused on in-situ observations of atmospheric aerosols, their formation, and interactions with clouds/climate in pristine remote marine environments, having been a PI/Lead Scientist for several major campaigns and long-term WMO-GAW observations (Kennaook/Cape Grim and RV Investigator). As a PICCAASO co-founder member of CATCH, IGAC, and SOLAS, co-author of the Antarctica InSync Theme 6 White Paper, and proposed co-chair, he provides a link between the Australian research community and his broad international network that strengthens coordination and impact of all deliverables.

Jessie Creamean is a Senior Research Scientist and expert in aerosol–cloud interactions, ice nucleation, and bioaerosol observations in polar regions, currently leading three projects within SOAR. Having key leadership roles in PICCAASO, CATCH, CIce2Clouds, U.S. DOE ARM, and Antarctica InSync Theme 6, she brings a wide international and programmatic network that links directly into the North American research community, accelerating community uptake and having access to various training/mentorship pathways.

Patric Seifert is an expert in radar- and lidar-based remote sensing of Southern Ocean aerosols and clouds, including their interactions and contrasts with northern-hemisphere counterparts, being the current PI of the 18-month goSouth-2 field experiment (since Aug 2025) in Invercargill, New Zealand. With close collaborations across ACTRIS, the U.S. ARM program, and partners in New Zealand and Australia, he contributes a strong remote-sensing community bridge and regional network that improves harmonization of methods and expands Southern Ocean observational reach.

Holly Winton is a biogeochemist and paleoclimateologist and leads a research programme on biomarkers at the ocean-atmosphere-ice sheet interface in the SOAR including land and marine field campaigns. She is the New Zealand national representative for SOLAS and part of the Scientific Committee on Antarctic Research (SCAR) Scientific Leadership Group of Antarctic InSync.

Anoop Mahajan is a world leading atmospheric chemist with a focus on the climatic impacts of oceanic emissions and has lead multiple campaigns with Indian Scientific Expeditions of the Southern Ocean program. He has had international leadership roles in CATCH, CIce2Clouds WG, and SOLAS, and will ensure his strong connections and coordination of Indian Southern activities are integrated with the proposed Working Group activities.

Katye Altieri is an expert in Southern Ocean marine biogeochemistry and atmospheric chemistry, their ocean-atmosphere interactions, and the role of biogenic trace gases and marine aerosols. She holds close collaborations with the international Surface Ocean-Lower Atmosphere Study (SOLAS) program and the South African marine science community, and will strengthen the Working Group's capacity-building initiatives while ensuring vital representation from the Global South.

Markus Frey is an expert in air-snow-sea ice chemical interactions, has pioneered work on sea-salt aerosol production from blowing snow, and has had leadership roles in large-scale field programs including MOSAiC. Through leadership roles in CATCH, Antarctica InSync Theme 6, and a contributor to SCAR and WCRP, he brings high-level international leadership and a cross-disciplinary network of expertise that aligns strongly with the Working Group deliverables.

Xu-Cheng He is an expert in atmospheric aerosol formation and iodine chemistry in marine and polar environments, and a co-PI of the CLOUD experiments at CERN with particular focus on the mechanisms by which iodine, sulfur and organics drive aerosol and CCN formation under pristine conditions characteristic of the SOAR. His integration of chamber experiments, ambient observations, and Earth system modelling is directly relevant to the Working Group's goal of bridging process-level understanding and model parameterization of biogenic aerosol-cloud-radiation coupling in the SOAR.

Contributions of the Associate members

Associate members broaden the expertise, skills, network and diversity of the Working Group. In particular, associate members add critical modelling capability—including development, running, and evaluation of Earth system models (e.g. UKESM/ACCESS), laboratory investigations of atmospheric chemistry and CCN formation in marine and polar regions, or field expeditions focused on SOAR. They also contribute data-science and machine-learning expertise that will be important for bringing together geographically and temporally sparse data across different disciplines. Geographically, they extend reach through strong networks spanning Europe, North America, and Australasia, with collaborative links into community infrastructures and coordination bodies (e.g., ACCESS-NRI, SOLAS, CATCH/PACES, and PICCAASO).

Relationship to other international programs and SCOR Working Groups (315 of 500 words)

PICCAASO complements the missions of SOLAS (Surface Ocean-Lower Atmosphere Study) by focusing on the synthesis of Southern Ocean-specific processes. It builds on and integrates critical mechanistic insights from programs like CATCH (Cryosphere and Atmospheric Chemistry) and BEPSII (Biogeochemical Exchange Processes at Sea-Ice Interfaces) provide critical mechanistic insights into biogenic emissions (e.g., DMS and organics) and sea-ice interface processes. PICCAASO will act as a synthesis platform for these programs by cross-cutting more

than 22 international field campaigns. Our goal is to evaluate the outputs from these specialized communities through the lens of model uncertainty, identifying which biogenic variables are most critical for reducing the persistent shortwave radiation biases in ESMs. This ensures that the high-quality process data generated by SOLAS, CATCH, and BEPSII are directly translated into broader climate impacts.

PICCAASO builds upon the successful foundation laid by CIce2Clouds (SCOR WG 163), which significantly advanced our understanding of interactions between sea ice, aerosols, and clouds (Creamean et al., 2026; Ishino et al., 2026). PICCAASO represents a strategic evolution of this work by broadening both the geographic and biological scope beyond the sea-ice zone to encompass the entire SOAR, including open-ocean phytoplankton blooms. Moreover, in response to the scientific gaps identified by CIce2Clouds, PICCAASO will provide the practical digital infrastructure—the Web-Portal and Research Registry—necessary to harmonize the snapshots from independent campaigns into a continuous, variable-based discovery environment.

PICCAASO serves an important role in contributing to Antarctica InSync and IPY. PICCAASO has been involved in the design and preparation of Antarctica InSync since its inception, which aims to enhance the understanding of the coupling mechanisms between the ocean, sea ice, the atmosphere, clouds, and radiation across all parts of SO. The IPY aims to advance polar research to address urgent challenges. PICCAASO will focus on developing a critical shared knowledge framework, including community website (**D2**) and the research registry (**D3**), which will support large-scale polar initiatives.

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