Network of Observation Systems

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Summary

Well-supported long-term monitoring programs of the physical and living environment are essential to understand ongoing environmental changes in Antarctica. The more coordinated and integrated such observing efforts are, the better placed to respond to the challenge. This paper explores the state of coordinated observing efforts and suggests a need for and actions towards further coordinated, comprehensive and complimentary observation networks.

Introduction

SCAR’s Antarctic Climate Change and the Environment (ACCE) decadal update report, submitted and discussed at ATCM XXLIV, notes that the Antarctic Treaty Parties have declared an obligation to implement the mitigation and adaptation actions that will reduce climate change-related and other human impacts on Antarctic marine and terrestrial environments, their ecosystems and biodiversity, and the ecosystem services they deliver. To meet this obligation ACCE highlights inter alia well-supported long-term monitoring programs of the physical and living environment as essential element to meet this obligation.

The more coordinated and integrated observing efforts are, the more complete spatial distribution of observations and the more cost-efficient it will be. This again will strengthen the Antarctic Treaty Parties’ and Antarctic National Programs’ joint ability to in a timely manner contribute to closing key knowledge gaps in order to understand large-scale Antarctic changes and their effects on the global system.

Observations and observation systems in Antarctica

Antarctica and the Southern Ocean is obviously not void of observations, observation systems or observation networks.

Most of the research stations in Antarctica have ongoing observational efforts in one or more realms. A simplified overview of these capabilities can be found in the COMNAP Antarctic Station Catalogue (2017) which in addition to station details provides information about the observational capacities at the stations.

There are also many stations and national programs that have designed holistic observational networks as a fundament for the research efforts in the region. The Troll Observing Network (TONe) is one such example (see further information below).

System of networks exist for some observations. An obvious example of this is weather observations through the Antarctic AWS network, which has successfully been used for a wide range of science activities as well as for weather forecasting.

There are also a number of efforts and initiatives aiming to coordinate and facilitate observation efforts that are comprehensive, compatible and coordinated, many of these within SCAR, and often thematically oriented within scientific disciplines. For example, ANTPAS aims to develop an internationally coordinated monitoring system on Antarctic permafrost and soils. ANTOS which aims to establish biologically focused, integrated and coordinated Antarctic-wide observation is another example.

The Southern Ocean Observing System (SOOS) is one of few examples of an ongoing comprehensive coordinated effort. SOOS is a coordinating body to enhance and ensure the delivery of Southern Ocean data across nations, organizations, programs and stakeholders, and to provide the infrastructure for organization of community networks to develop sustained observing systems and syntheses of existing Southern Ocean datasets. See more at soos.aq.

Despite all these initiatives and efforts, there still seem to be gaps and challenges to be overcome to allow for an efficient and systematic observation data gathering effort in Antarctica.

Observations during the 2018 Norwegian inspection

The 2018 Norwegian inspection (ref. ATCM XXLI WP 26) in Dronning Maud Land noted in its concluding reflections that at the well-established year-round research stations emphasis is given to ensure the longevity of fundamental and important time series feeding into global observation systems. The inspection team furthermore observed that there seems to be a fairly large degree of comparable observations ongoing at the various research stations, while at the same time it was not always clear if these individual observations were fed into (as part of an) a systematically coordinated effort. This may also raise questions with respect to optimal spatial distribution, comparability and/or complementarity of observations, the input and use in global observation systems and processes, etc. On this basis the inspection team recommended that there could be merit in getting an overview and assessment of Antarctic observation efforts in order to enhance their use and robustness, as well as identifying gaps in observation needs.

Furthermore, the 2018 inspection noted that there are many innovative and exciting technological approaches developed with regard to observation and data collection both in the physical and biological scientific field. Many of these technical solutions seem to have universal applicability and usability. However, while knowledge across stations seem limited, and there thus is a potential for more exchange of information also on technological solutions for research and observation efforts in Antarctica.

Troll Observing Network – a node in a pan-Antarctic observation network?

Troll Observing Network (TONe) is a comprehensive infrastructure which aims to contribute significantly to observation and data gathering efforts, centred at the Norwegian Antarctic research station Troll. By utilizing TONe infrastructure and observations the research community will will be able to answer questions and generate knowledge related to climate and sea-level change, atmosphere dynamics, solid Earth structure, cryosphere dynamics, space weather effects, robustness of communication networks, quality of weather and climate models, and the effects of global changes on marine ecosystems. The data collected through the eight TONe observatories are in themselves part of the TONe research infrastructure and will be openly available to the entire science community in line with Article III of the Antarctic Treaty For further information about TONe, refer to XXLIV IP 73 XXLIV and www.npolar.no/en/tone.

In establishing TONe, care was taken to consider how the observatories sit in the context of other international observation initiatives, envisioning the TONe observation network simply as one module in a pan-Antarctic observation network in the future.

Troll research station has a unique location; no other permanent station is located further inland in Dronning Maud Land (DML), or anywhere else on the slope of East Antarctica. As such TONe fills a observational void in this region. Its location on the slope provides unique atmospheric observations, and the seismic array at Troll is the only one in Antarctica located on the bedrock.

There are currently some 70 permanent research stations scattered across Antarctica. In DML there are six all-year stations mostly on or near the coast. The COMNAP Antarctic Station Catalogue served a good basis when designing TONe, and the TONe partners strived to ensure complementarity and comparability with the programmes at the stations having similar observatories.

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| **TONe infrastructure description** | **Landscape of similar observational capacities** |
| Integrated Cloud Observatory (ICO). | Some relevant measurements at Princess Elisabeth/Neumayer; Same suite at several Arctic sites |
| Atmosphere Composition Observatory (ACO) | Neumayer, Amundsen-Scott South Pole, McMurdo, Syowa |
| Infrasound Array (IA) | All other at the coast: Neumayer, Siple, Windless Bright |
| Ionosphere Observatory (IO) | Maitri, Syowa, SANAE-IV, Halley, Zhongshan |
| Seismic Array (SA) | No other SA on bedrock. Neumayer, South Pole, Concordia on ice |
| Fimbulisen Ice-shelf Observatory (FIO) | Filchner Ronne, Amery, Ross ice shelves, Thwaites, Langhovde Glacier, Gerorg VI & Larsen |
| Multidisciplinary Ocean Moored Observatory (MOMO) | 30E (NIPR), 17W (AWI, UEA), Maud Rise, S. Weddell & Penninsula (UiB, NORCE, BAS, AWI, L'OCEAN, AWI, SU) |
| Seabird Monitoring Observatory (SMO) | Atka Bay (AWI), Adelie Land, Antarctic Peninsula, Ross Sea |

Conclusions and recommendations

The urgency in closing knowledge gaps (and therefore observation gaps) is ever increasing while the cost of Antarctic research is increasing at the same time. In this context it will be ever more important for Antarctic Treaty Parties and Antarctic National Programs that their investments in Antarctic observation systems gives the best possible value for the investments. A clear understanding of where the gaps are and how they should be filled would facilitate good investments. To enable well-founded investments, it is suggested that:

1. ATCM should invite SCAR to give Parties an overview and assessment of Antarctic long-term observation efforts in order to enhance their use and robustness, as well as identifying gaps in observation needs.
2. ATCM should consider mechanisms for and encourage further exchange of information on technological solutions for observation efforts in Antarctica, and in this manner strengthen the long-term capacity for a pan-Antarctic observation effort.