Troll Observing Network (TONe) – A new research infrastructure supporting Earth System science with data from Dronning Maud Land

Troll Observing Network (TONe) – A new research infrastructure supporting Earth System Science with data from Dronning Maud Land

**Submitted by Norway**

**Summary**

Resolution 8 (2021) calls for Parties to support efforts to undertake research about Antarctic climate change and its impacts. An infrastructure project recently funded by the Norwegian Research Council - the Troll Observing Network (TONe) – is a response to this call. TONe is a comprehensive infrastructure which aims to contribute significantly to observation and data gathering efforts, centred at the Norwegian Antarctic research station Troll. Through TONe the research community will contribute to answering questions relating to climate change 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 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.

**Background**

The Antarctic Treaty Parties have over the last decade on numerous occasions underlined the importance of Antarctic climate change and climate change research, For example, in 2021 the Parties discussed the linkages between the observed and projected impacts of global climate change in Antarctica and the Southern Ocean on the Earth system and expressed their concerns about the implications for Antarctica arising from a warming global climate. The Parties agreed to urge their governments to support ongoing efforts to undertake research about climate change and its impacts (Resolution 8 (2021).

Antarctica and the surrounding Southern Ocean are key drivers of Earth’s oceanic and atmospheric systems and are connected to the rest of the world through oceanic and atmospheric circulations. For our entire planet, atmospheric pressure, humidity, air temperatures and wind patterns are interconnected and greatly influenced by processes originating in the far south, and we will not be able to fully understand how the Earth system works without comprehensive knowledge of the physical, biological, chemical and geological processes taking place within and above Antarctica and its surrounding Southern Ocean. An extensive observation and data gathering effort is required across the entire continent and its surrounding ocean in order to gain the necessary knowledge needed.

***The new Norwegian initiative – Troll Observing Network (TONe) – will be an important contribution to ongoing data gathering in Antarctica, filling important gaps, and pave the way for substantial and important knowledge production***, in line with the call made by Parties in Resolution 8 (2021).

**The Troll Observing Network**

***The 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.*** The main aim of TONe is to provide data and generate knowledge from the Dronning Maud Land (DML) region in eastern Antarctica, one of the most data-poor areas of the continent. TONe will in particular focus on the transition zone between the coast and the high plateau, where few other Antarctic stations are located.

Through TONe the research community will contribute to answering questions relating to climate change 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.

TONe includes **eight distinct observatories** that each will provide data relevant to study these key global processes. Through the observatories we will gather data that are relevant to further our understanding of *inter alia*:

* The radiative effects of clouds and aerosols, which are two of the largest uncertainties in global climate models, especially in the polar regions (Integrated Cloud Observatory).
* The atmospheric circulation and transport of pollutants into DML, and through this provide inputs to large-scale models in the polar regions (Atmospheric Composition Observatory)
* The stratospheric polar vortex and disruptions to this important circulation system, as well as elucidating atmospheric tides. Data will also be utilised to detect and locate acoustic events and study atmospheric gravity waves, which play an important role in the transfer of middle atmospheric momentum and can influence the dynamics of the upper atmosphere (Infrasound Array).
* The upper atmosphere and space weather processes, which amongst other can impact man-made systems, such as satellite-based navigation and radio communications (Ionosphere Observatory)
* The dynamics of the ice and solid earth in DML (Seismic Array),
* The ice-shelf – ocean boundary layer structure and turbulence to gauge melt parameterizations in models, important as ocean-ice shelf interactions significantly influence Antarctica’s contribution to sea-level rise (Fimbulisen Ice-shelf Observatory)
* The physical, biogeochemical and biological properties in the Weddell Gyre inflow/Antarctic Slope Front, off the DML coast in the ocean area Kong Haakon VII Hav (Multidisciplinary Ocean Moored Observatory).
* The biology of important seabirds populations and through them the health of the marine environment (Seabird Monitoring Observatory)

TONe also includes a **drone service** open to all at cost-price to be used for various research campaigns. The drones will have data collection capability horizontally and vertically to cover large parts of DML. Sensor packages include VHF radar for bedrock and bounding line mapping, GHz radar for snow precipitation mapping, aerial cameras for, e.g., seabird, marine mammal and sea-ice mapping, sensors for meteorological, cloud and aerosol profile measurements and hyperspectral sensors for measurements of chlorophyll and primary production.

Finally, TONe will ensure **wide and free access to the observational data** from the observatories and drone service to the entire national and international research community to be used to acquire new knowledge of societal importance. The Antarctic Treaty (Article III) requires open data sharing in Antarctic science, a cornerstone of the successful, international science collaboration in Antarctica. Open data access is also a core principle in the Norwegian national strategy for scientific data (*Nasjonal strategi for tilgjengeliggjøring og deling av forskningsdata*). Making the most of collected data is particularly important in Antarctic science, due to the extremely costly nature of Antarctic operations. A common data infrastructure and common data management policy are correspondingly important parts of TONe, including a robust on-site infrastructure for data management, and a unified data access point. TONe metadata will be harvestable for Antarctic Master Directory (AMD) and hence available to all users also through the AMD interface.

The entire TONe concept is illustrated in Figure 1 and Figure 2.

Diagrama

Descripción generada automáticamente

**Figure 1**: *TONe will provide access to data through a network of multi-disciplinary scientific observatories for comprehensive long-term observations based at and around Troll along with a drone service that will support data collection on a campaign basis.Together,this infrastructurewill contribute to and strengthen the knowledge base required to understand Antarctica’s role in the Earth system and its impact onglobal issues of societal importance.*

Et bilde som inneholder kart

Automatisk generert beskrivelse

**Figure 2***: The geographical location of the eightobservatories.*

The TONe infrastructure project is managed by the Norwegian Polar Institute with the University of Oslo, the University of Bergen, the Norwegian Air Research Institute (NILU), the seismology research instate NORSAR and the Norwegian Research Centre (NORCE) as partners, as well as British Antarctic Survey (BAS), University of Leeds and University of Washington.

In December 2021 the Norwegian Research Council (RNC) awarded 22 new applications for research infrastructure over the National Financing Initiative for Research Infrastructure, allocating a total of NOK 1.4 billion to the new projects. TONe was one of these 22 projects, receiving support in the neighborhood of NOK 160 million.

The TONe infrastructure will be built up over the next 5-year period (2022-2027), and all parts of the infrastructure will be fully operational from the second quartal of 2027.

NPI and partners will continue to look for opportunities to expand the TONe concept in the future, in order to continue to build a holistic observation system for the Norwegian and international research community. The current first phase of TONe will provide an extremely robust and attractive foundation for future developments and expansions.

For further information or queries, contact the Norwegian Polar Institute at [postmottak@npolar.no](mailto:postmottak@npolar.no).