



## Troll Observasjonsnettverk

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## Observatorier



8 observatorier som samler inn lange tidsserier som beskriver jordsystemet.

## Tjenester



En dronetjenste som komplementerer datainnsamlingen fra observatoriene.

## Datasystem



Et dataforvaltnings-system som tar vare på og tilgjengeliggjør dataene til alle brukere.

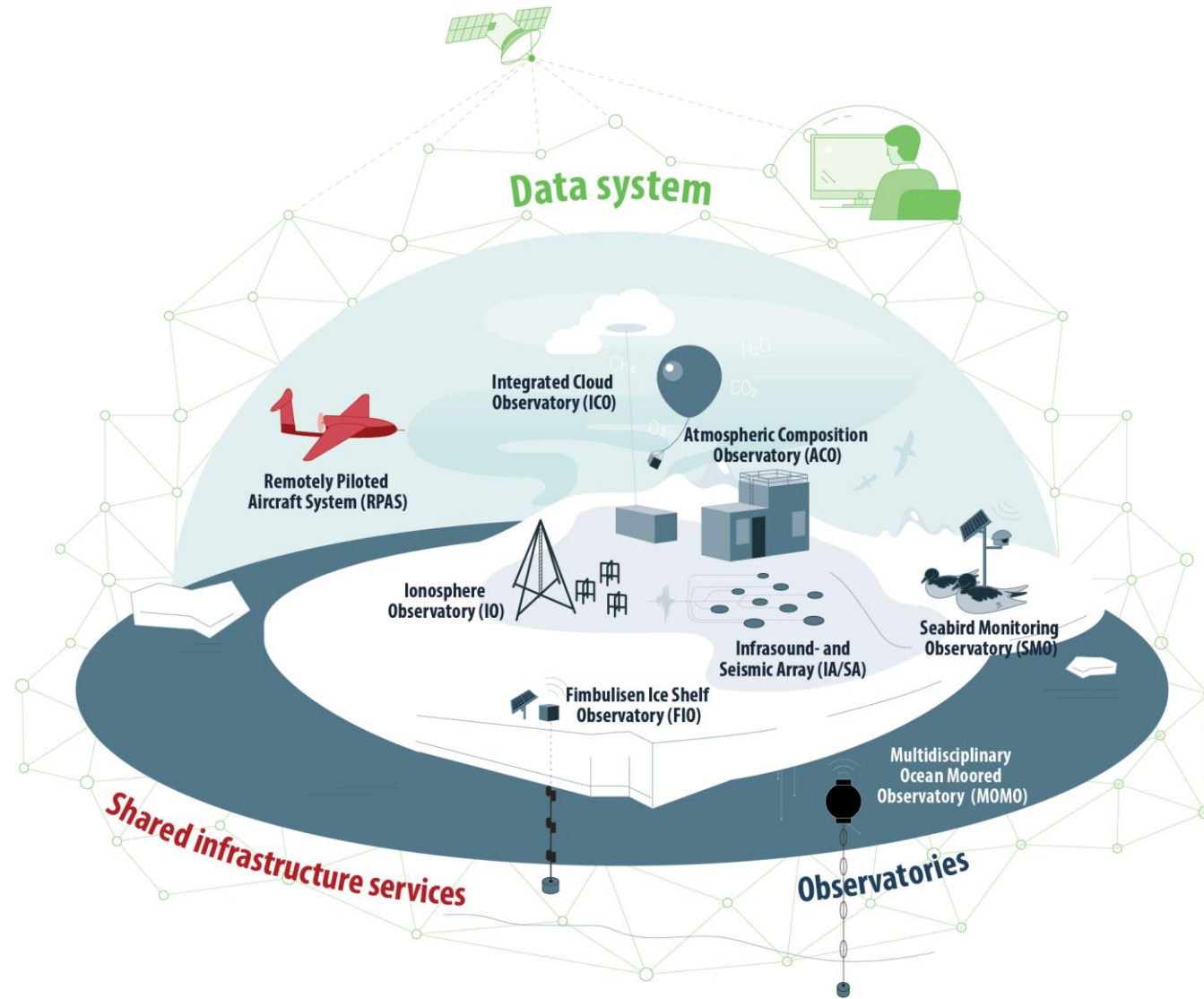
## Observatorier



## Tjenester



## Datasystem







# Ionosfæreobservatoriet IO



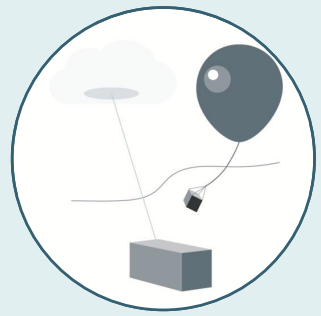
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- Digisonde: radar (elektrontetthet)
- Supplerer eksisterende UiO instrumentering; GPS; GNSS; all sky kamera, m. fl.

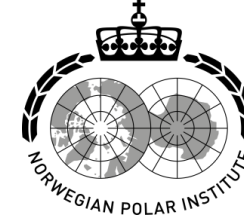
Til sammen øke kunnskap om romværeffekter og sørlys



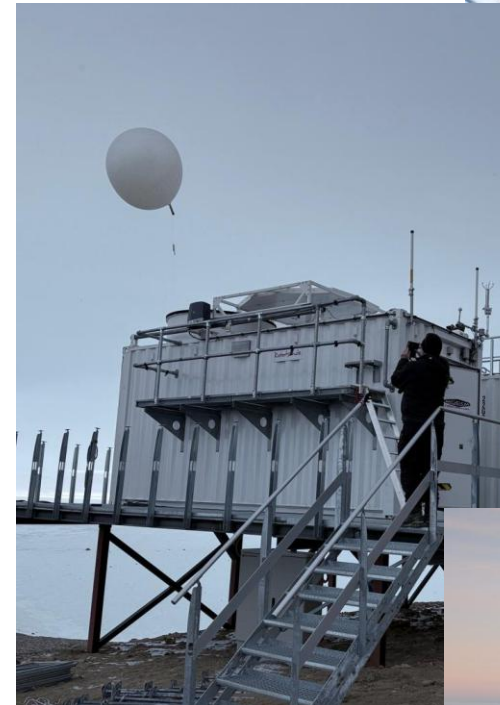


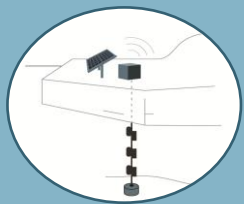


# Det integrerte skyobservatoriet (ICO)



- Passive og aktive fjernmålingsinstrumenter som måler temperature- og fuktighetsprofiler, sky og aerosol karakteristikk:  
Infrarød spektrometer, to lidar-systemer, sky-radar
- Værballonger (radiosonde) måler temperatur, fuktighet og vind opp til 30 km - viktig data for validering av fjernmålingsinstrumentene





## Fimbulisen isbremobservatorie (FIO)

Endringer i isbremdynamikk

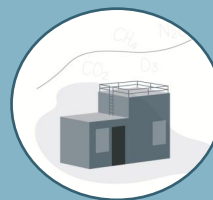


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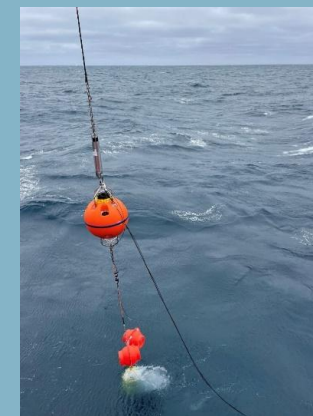
## Sjøfuglovervåkingsobs. (SMO)

Ta pulsen på det marine miljøet i Sørishavet

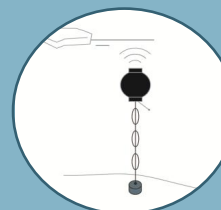


## Multidisiplinært havriggobs. (MOMO)

Fysiske og biologiske prosesser i havet



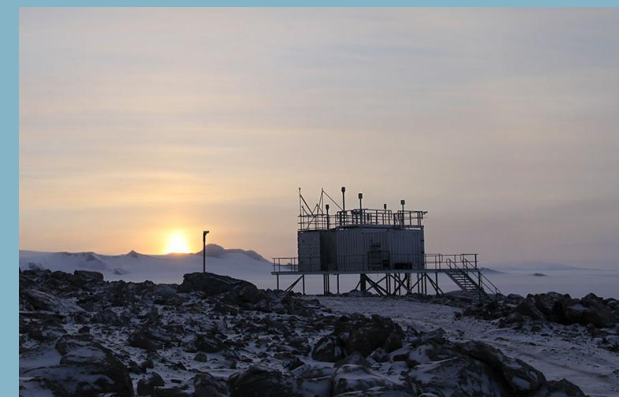
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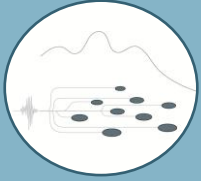


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## Atmosfærekjemiobservatoriet (ACO)

Transport og effekt:  
forurensning på global skala





# Seismisk (SA) & Infralyd Array (IA)

Atmosfæredynamikk og vertikal kobling  
Bevegelser fra seismiske kilder

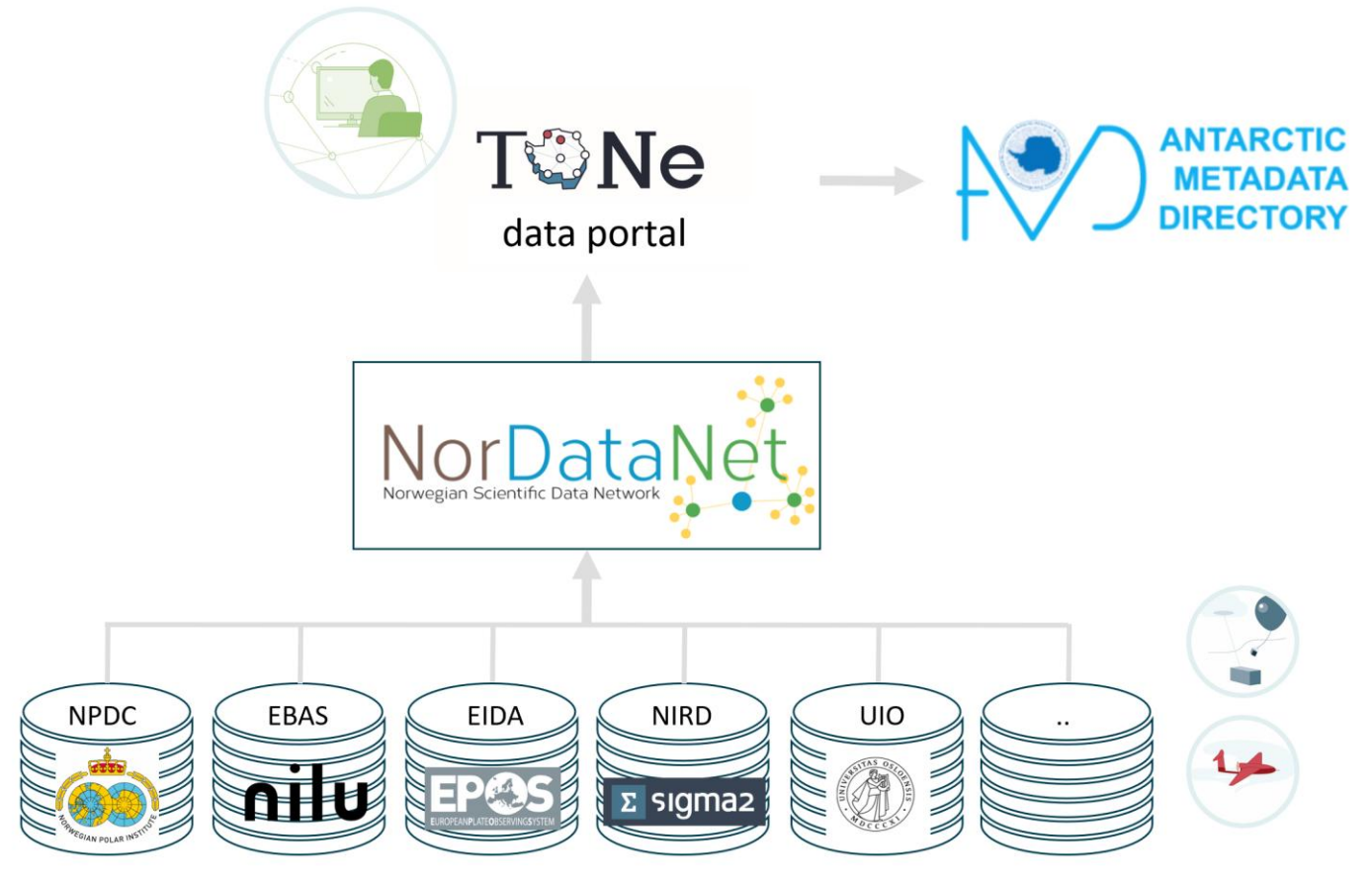
**NORSAR**





# Dataforvaltningssystem (DATA)

- Datainnsamling i Antarktis er komplekst og dyrt – viktig prinsipp å utnytte alle data så godt som mulig.
- Antarktistraktatens krav
- I TONe: felles prinsipp for dataforvaltning og deling
- Sikker lagring og hjemtransport av data
- Ny TONe dataportal hos NP

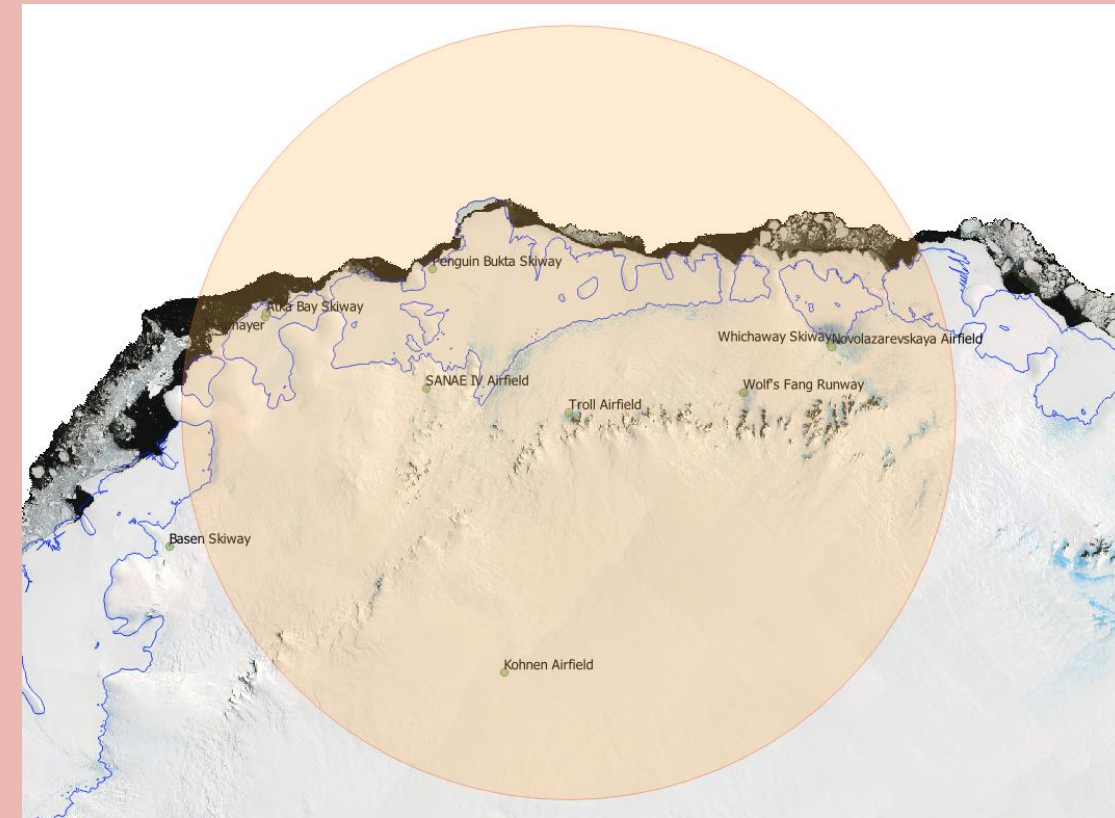






# Remotely Piloted Aircraft System (RPAS)

- Antarktisk er svært
- Dronebaserte målinger og sensorsystemer kan bidra med unike data og dekker gapet mellom in-situ målinger og satelittbaserte målinger.
- Bidrar til smart og kostnadseffektiv datainnsamling med et minimalt fotavtrykk
- Komplementerer datainnsamling fra observatoriene





# Remotely Piloted Aircraft System

TONe Drone Services



## Aircraft Specifications

### Windracer Ultra 2 drone:

- Endurance: up to 800 km, 8 Hrs
- Payload capacity: 150 kg
- Broadband Satcom: Starlink
- Runway Requirements: 300 m



### CW Fox X8

- Cruise speed: 50 kph
- Range: up to 20 km
- Payload capacity: 20 kg



### CW Shark VTOL

- Cruise speed: 70 kph
- Range: 100 km
- Payload capacity: 2 kg

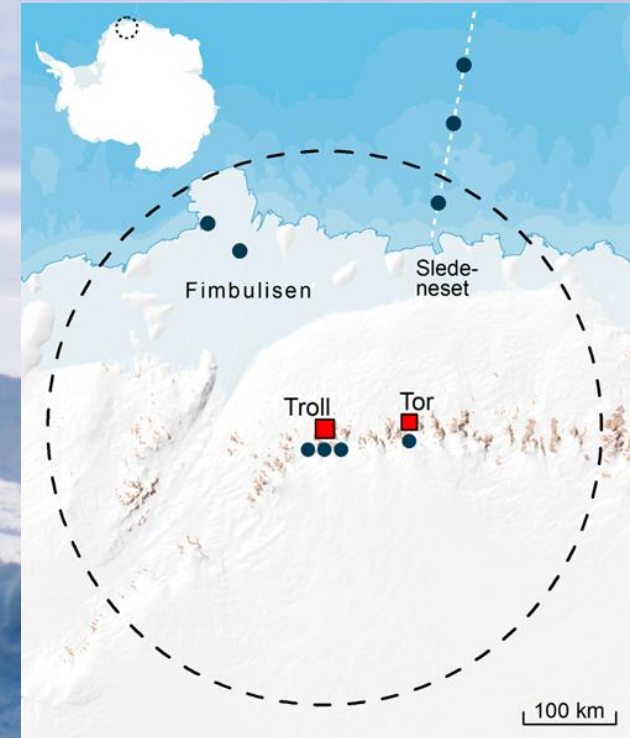
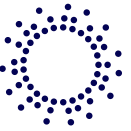


Photo: Carl Robinson - BAS



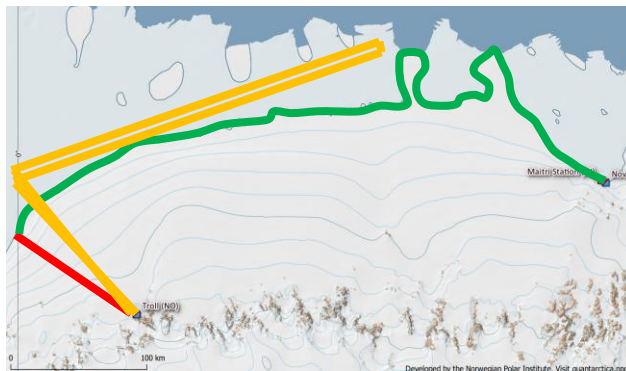


# Drone Sensor Systems and Applications

## Radar Sensors

- VHF radar for bed topography/bounding line mapping. Subglacial lake and hydrology mapping
- UWB radar (2-8 GHz) for snow stratigraphy mapping. Past snow accumulation rates.

Ice mass balance and dynamics.



## Optical Sensors

- Hyperspectral imager
- High resolution aerial camera

Sea-ice properties, ice fraction, spectral albedo

Primary production, chlorophyll-A, algae

Seabird monitoring

Marine mammal surveys



## Meteorology

- Basic PTH sensors
- Broadband SW and LW radiometers

Basic meteorological parameters in the boundary layer

Net radiation / broadband and spectral reflectance and albedo / Heat fluxes







# Drone as a Service (Pilot Season 2026-27)

## On demand data collection

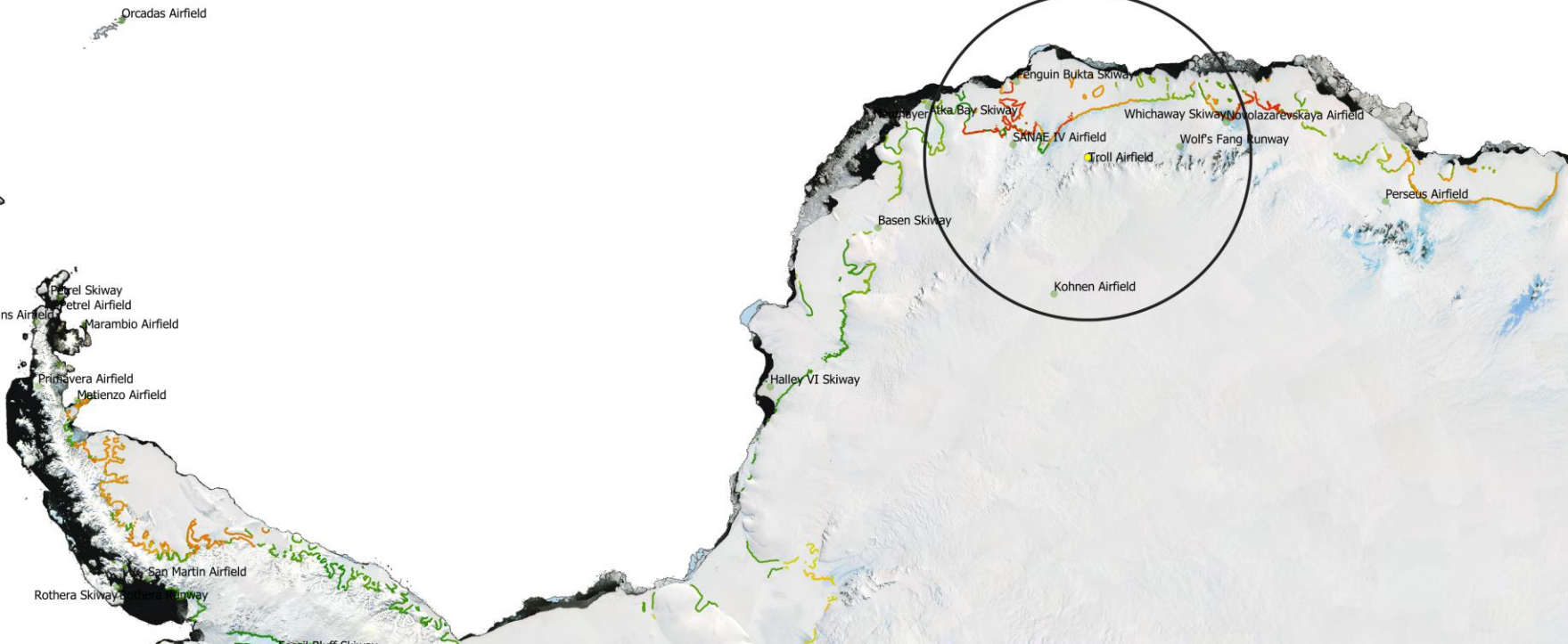
Goal: Demonstrate the full capability of the drone systems.

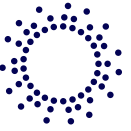
## Pilot season

Flight program for the pilot season to be finalized by the end of the year.

## Your Opportunity!

Request datasets and suggest missions for the pilot season.





# Call for access to Drone as a Service during the pilot season

## Opportunity

4 week deployment at Troll:

Mid November to mid December  
2026 or mid January to mid  
February 2027

Propose missions to collect data for  
your research projects at no charge.

## Selection Criteria

Scientific quality and relevance

Technical feasibility and risk

Capacity and diversity of missions

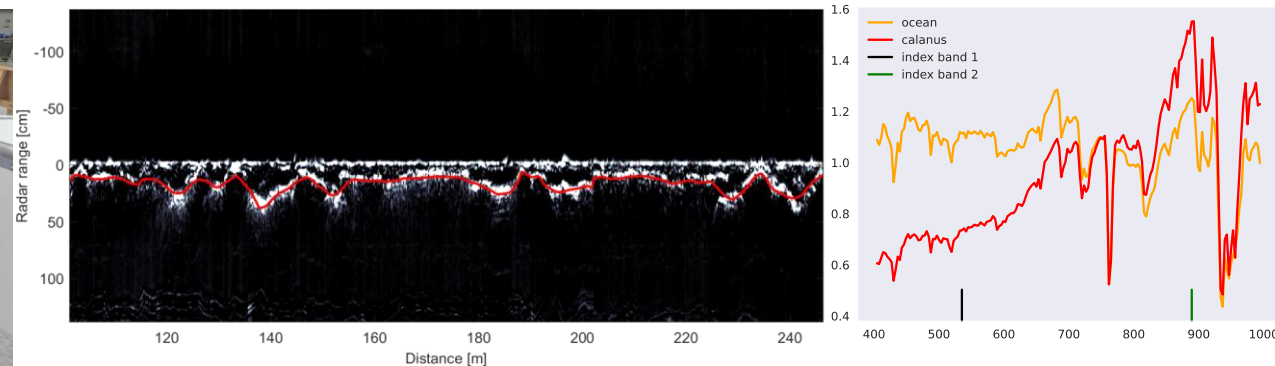
## Your Opportunity!

Contact us to discuss opportunity  
and get advice.

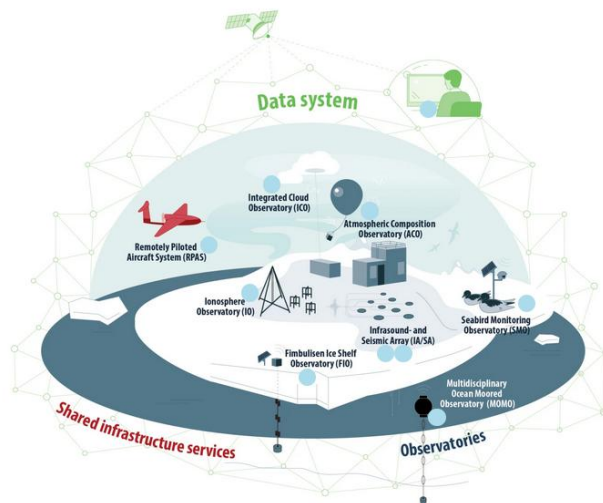
**A simple application form will be  
made available by August 2025 and  
deadline will be in November 2025**

Contact: Rune Storvold

Email: [rust@norceresearch.no](mailto:rust@norceresearch.no)



TONE website: <https://npolar.no/tone/>



## PERSPECTIVE

### The Troll Observing Network (TONE): plugging observation holes in Dronning Maud Land, Antarctica

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## Abstract

Understanding how Antarctica is changing and how these changes influence the rest of the Earth is fundamental to the future robustness of human society. Strengthening our understanding of these changes and their implications requires dedicated, sustained and coordinated observations of key Antarctic indicators. The Troll Observing Network (TONE), now under development, is Norway's contribution to the global need for sustained, coordinated, complementary and societally relevant observations from Antarctica. When fully implemented within the coming three years, TONE will be a state-of-the-art, multi-platform, multi-disciplinary observing network in data-sparse Dronning Maud Land. A critical part of the network is a data management system that will ensure broad, free access to all TONE data to the international research community.

## Keywords

Research infrastructure; access to data; international collaboration; atmosphere; solid Earth; marine–cryosphere interaction

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## Abbreviations

ACO: Atmospheric Composition Observatory (TONE)  
ATCM: Antarctic Treaty Consultative Meeting  
DML: Dronning Maud Land, Antarctica  
FIO: Fimbulisen Ice Shelf Observatory (TONE)  
IA: Infrasound Array (TONE)  
ICO: Integrated Cloud Observatory (TONE)  
IO: Ionosphere Observatory (TONE)  
MOMO: Multidisciplinary Ocean Moored Observatory (TONE)

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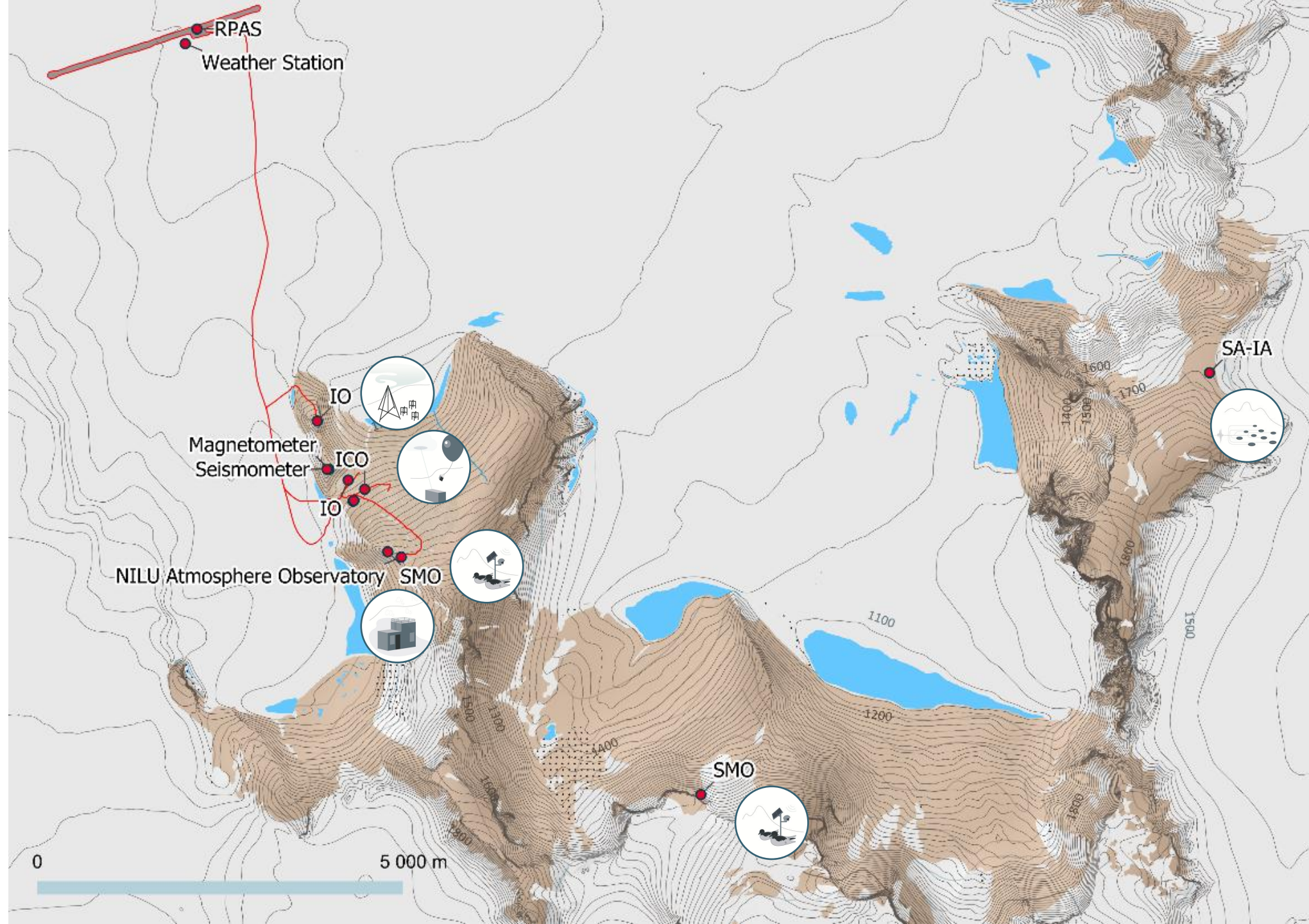




# For å maksimere effekten av TONe



- må han ha et stort nok interessert miljø av norske forskere som vil jobbe i og med Antarktis
- må det legges til rette for finansiering av forskning som utnytter data fra TONe-observatoriene og benytter seg av dronetjenesten
- må det på plass en robust basisinfrastruktur i form av en ny stasjon som støtter opp om drift av TONe-infrastrukturen





**Table 1** Overview of the TONe observatories and services, their instruments, observations, owners and responsible researchers.

Observatory or service <sup>a</sup>	Infrastructure owner (responsible researcher)	Instruments and observed variables
ICO	NPI (Stephen Hudson)	Year-round measurement programme; microwave radiometer, two lidar systems, cloud radar and weather balloons/radiosondes; measures cloud properties (temperature, height, thickness, density and particle size, shape and phase) and their impact on the surface energy balance.
ACO	NILU (Wenche Aas)	Three new instruments: a Piccaro cavity ring-down spectrometer measuring CO <sub>2</sub> , CH <sub>4</sub> and CO; a TSI aerosol particle sizer for larger particles (0.6 – 25 µm), a Pandora remote sensing spectrometer for vertical column of trace gases (O <sub>3</sub> , NO <sub>2</sub> , SO <sub>2</sub> and formaldehyde).
IO	Univ. of Oslo (Wojciech Miloch)	Digisonde-Portable-Sounder-4D (a digital ionosonde produced by Lowell Digisonde International), including multiple antennas (transmitter and receiver). The system measures electron density profiles, turbulent structures and their movement in the ionosphere.
IA	NORSAR (Johannes Schweitzer)	An infrasound array consisting of nine sensors (co-located with the nine SA sites) measuring low-frequency sound signals from events in the atmosphere and the ice.
SA	NORSAR (Johannes Schweitzer)	A seismic array consisting of 10 sensors at nine locations will provide information on seismic activity in DML, throughout Antarctica and the whole globe. It estimates amplitude, frequency, velocity and direction of seismic signals caused by earthquakes, icequakes, explosions, etc.

FIO	NPI (Tore Hattermann)	For time series of ice-shelf mass balance and warm-water inflow, instrumentation at two locations will measure currents, temperature and salinity in the water column beneath the ice shelf, turbulence in the ice-shelf–ocean boundary layer, sound sources for future glider campaigns under the ice and melt rate.
MOMO	NPI and Univ. of Bergen (Tore Hattermann and Elin Darelius)	Instrumented ocean moorings over the continental shelf at 6°E for measuring temperature, salinity, currents, ice thickness, oxygen, carbon dioxide, chlorophyll-a, echo soundings and passive acoustics. Navigational instruments for under-ice gliders.
SMO	NPI (Sébastien Descamps)	Automated monitoring using time-lapse camera to provide information about colony size, breeding phenology and breeding success. These observations will be complemented with regional studies from RPAS.
RPAS	NORCE and NPI (Rune Storvold and Stig Flått)	Two large fixed-wing aircraft, with VHF radar system, GHz UWB radar, aerial camera, meteorological sensors and a hyperspectral imager. Encrypted communication system with high bandwidth for line-of-sight transmissions up to 200 km, in addition to satellite communication beyond this. Flight endurance of 10 hours, providing a range of 1000 to 1500 km.
DATA	NPI (Stein Tronstad)	At Troll RS, data are stored on two servers in a cluster, to ensure maximum uptime and secure storage. Via the local station network, they will communicate with the observatories to collect data. Data from observatories that are not connected to the local network will be manually transferred to the server when researchers return from the field.

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