



Troll Observasjonsnettverk

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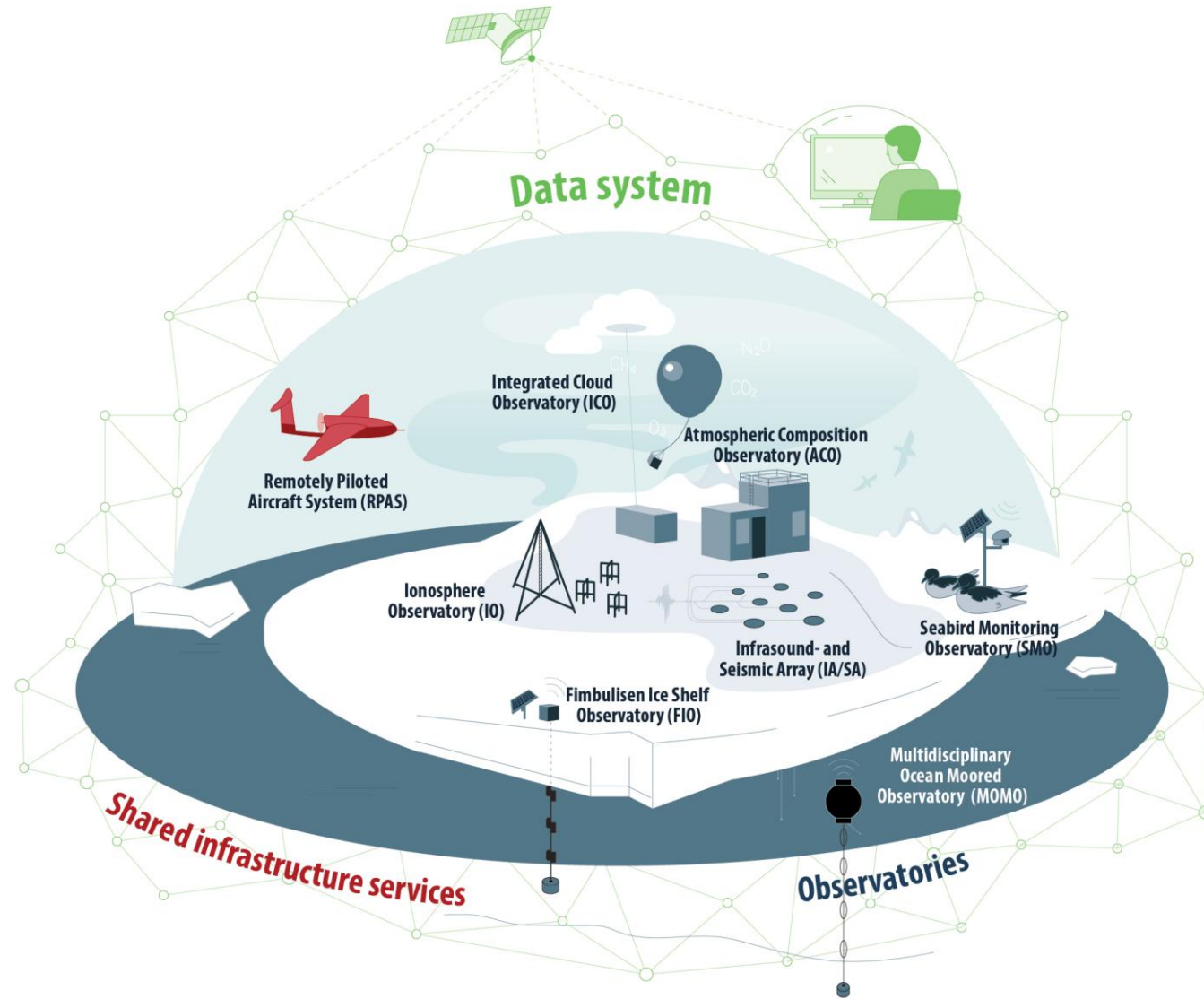
Observatorier



Tjenester

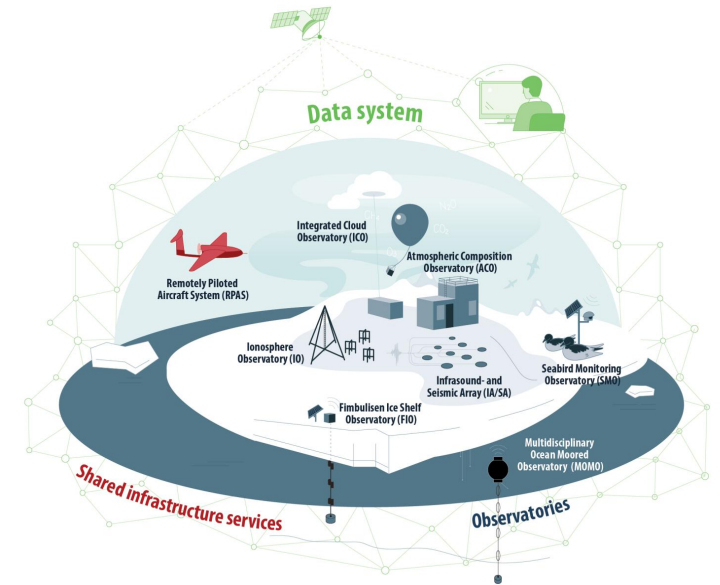


Datasystem



TONe-drone infrastruktur

- Tjeneste som etableres under TONe infrastrukturen
- Drone tjenesten tilbys til forskere fom. 2027/28 sesongen
- TONe prosjektet finansierer: innkjøp av fly og nyttelast, testing, og gjennomføring av pilotkampanje på Troll sesongen 2026/27
- Nå skal vi designe pilotsesongen og ønsker innspill fra hele det norske forskningsmiljøet. Pilotsesongen er helfinansiert av Forskningsrådet. Vi kan dermed tilby data uten noen "kostnader" for brukerne.



Agenda dagens webinar

- Utlysningen (5 min, CAP)
- TONe-drone: kapasitet, rekkevidde, data oppløsning etc. (5 min, RS)
- Nyttelast-pakkene: instrumenter og dataleveranser (15 min, RS)
- Mulighet for forskerne å delta hjemmefra (Nlive) (5 min, RS)
- Tid for spørsmål - 30 min

Utlysningen

<https://npolar.no/nyhet/the-troll-observing-network-tone-drone-access-call/>



The Troll Observing Network (TONE) drone access call

TONE is proud to announce a pilot season access call to the new TONE drone service infrastructure. TONE has built a new and unique capability with long range instrumented drones infrastructure that will support the research in Dronning Maud Land (DML). The infrastructure will be deployed in the field from the Troll Research Station for the first time in the 2026-27 austral summer season.

Christina Pedersen

9 september 2025

Antarktis, Antarktis, Forskning, TONE

TONE is proud to announce a pilot season access call to the new TONE drone service infrastructure. TONE has built a new and unique capability with long range instrumented drones infrastructure that will support the research in Dronning Maud Land (DML). The infrastructure will be deployed in the field from the Troll Research Station for the first time in the 2026-27 austral summer season.

The pilot campaign is already financed by Research Council of Norway through the TONE project, and therefore this presents an opportunity for scientists to propose

The Troll Observing Network (TONE)

TONE is a research infrastructure under implementation at and around Troll Research Station in DML. In

Formål

- Generere data som komplementerer pågående forskning på eller rundt Troll inklusive TONe observatorier, for å vise fram, potensialet til TONe-drone.
- Dataene blir viktig for framtidige forskningssøknader og tiltrekke nye brukere av tjenesten.

-> Ønsker innspill fra hele det norske vitenskapelige miljøet til å utforme et optimalt og effektivt flyprogram for denne første TONe-drone pilot kampanjen.



Søknadsskjema

- Informasjon om forskningsprosjektet datainsamlingen støtter
- Detaljert informasjon om
 - hvilken data som ønskes
 - hvilke områder
 - tidsperiode
 - oppløsning/flyhøyde etc.



The Troll Observing Network (TONE) drone access
call application form

See the full call on <https://npolar.no/tone/>

Part A: PERSONAL INFORMATION

Project name	
Project acronym	
Project type	
Name principal investigator (PI)	
Email PI	
Affiliation PI	
Investigator and contact information for access request (if it differs from the PI)	
Partner institutions (if any)	
Name of collaborators at partner institution	

Tidslinja

- **9. september 2025: Utlysningen åpnes**
- **20. oktober 2025: Dagens webinar**
- **14. november 2025: Søknadsfrist**
- **Februar 2026: Resultat fra utlysningen offentliggjøres**
- **medio november-medio desember 2026
ELLER medio januar-medio februar 2027:
Pilotkampanjen gjennomføres på Troll**



Foto: BAS

Kristerier for valg av prosjekter

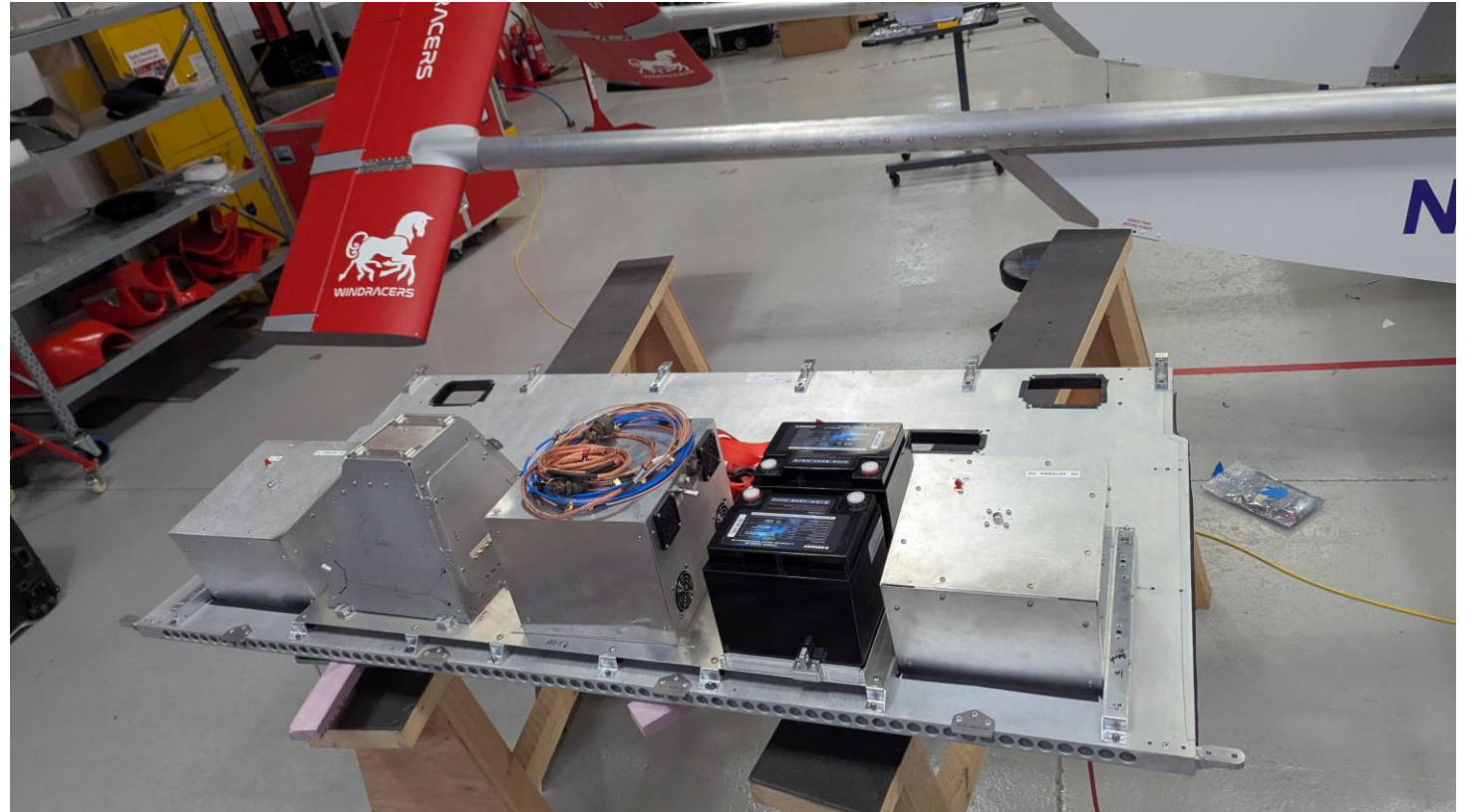
- Excellence of science supported – advancement of science
- Relevance for Norwegian Antarctic research priorities
- Feasibility of conducting the proposed missions – technical and risk
- Capacity – since this is the pilot season the priority will be to conduct a set of missions spanning a wide range of topics.
- Complying with rules and regulations pertaining to Antarctica, in particular Regulations relating to the protection of the environment and safety in Antarctica and associated guidelines.
- Supported by a funded research project/program

TONE-drone: Capacity, Range and Data



TONE-drone: Capacity

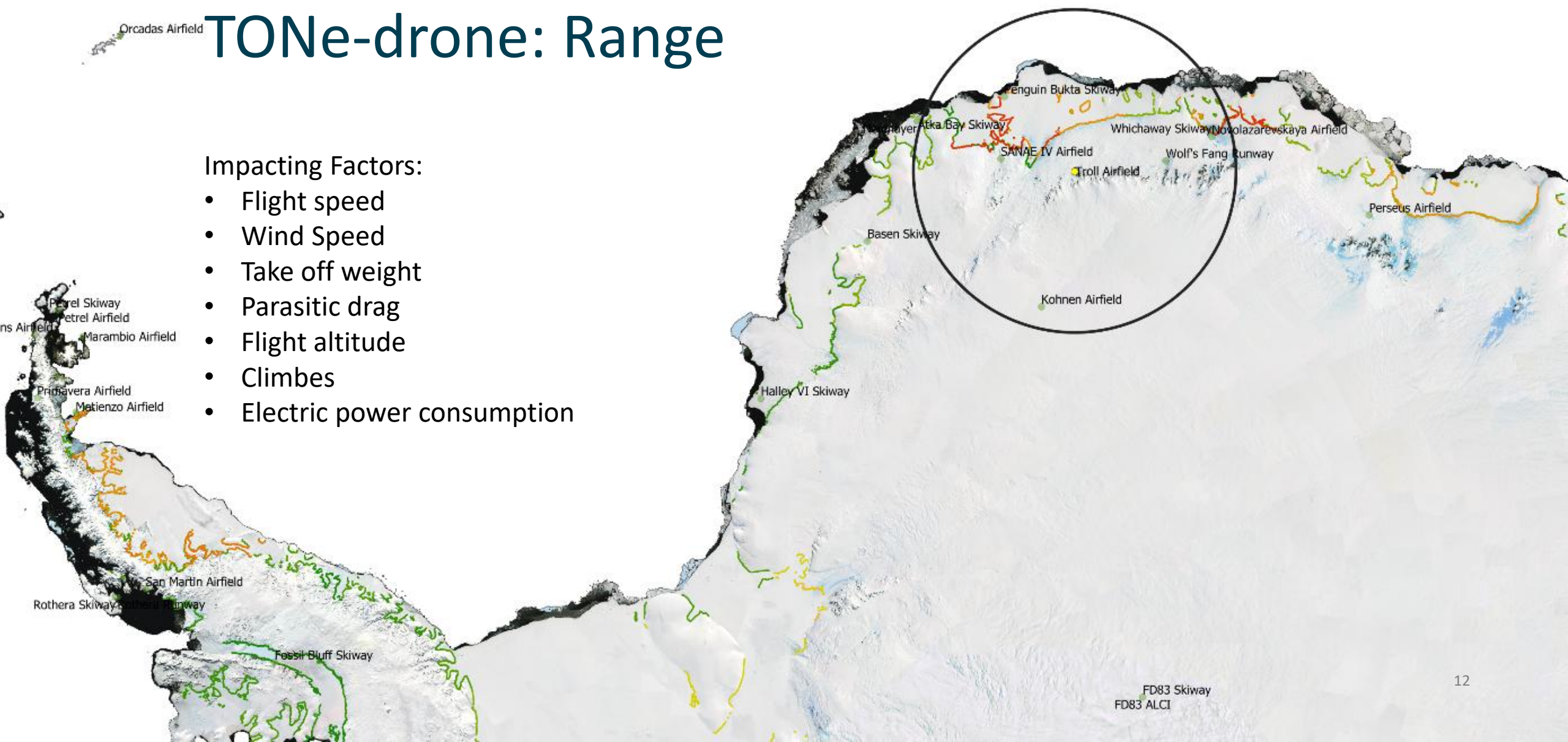
Max takeoff mass:	550 kg
Payload capacity:	150 kg
Max endurance:	8 – 10 hours
Max range:	700 – 1000 km
Optimal cruise speed	130 km/t
Max speed	173 km/t
Fuel capacity (95 oct)	120 liters
Electric power available	300 Watt
Communication bandwidth	20 MB



TONE-drone: Range

Impacting Factors:

- Flight speed
- Wind Speed
- Take off weight
- Parasitic drag
- Flight altitude
- Climbs
- Electric power consumption



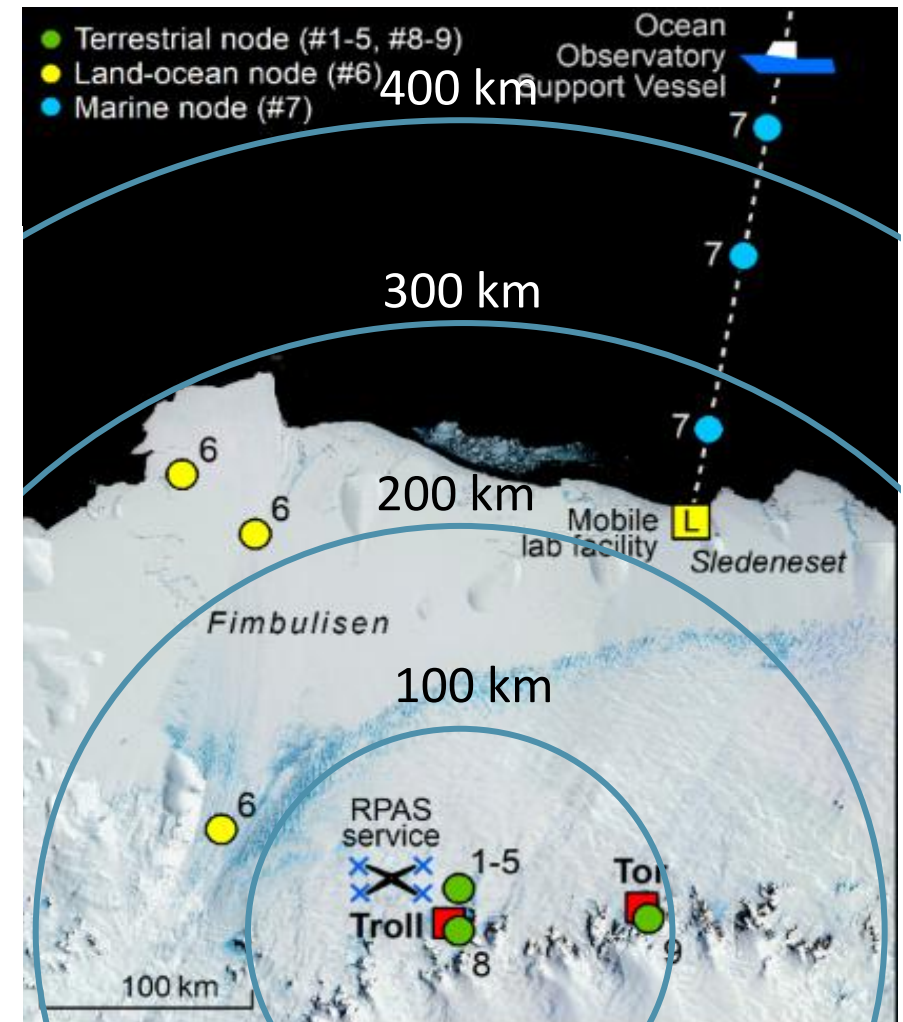
TONE-drone: Range what does it mean

Things to consider:

Distance to target

Time needed on target

Fuel reserves need to be larger when
distance to target area increase



TONE-drone: Data flow

During flight:

Data and metadata stored on SSD

Metadata stored in a chained database

Onboard processing of QL for data assurance

Data acquisition and instrument settings are logged and may be changed in flight

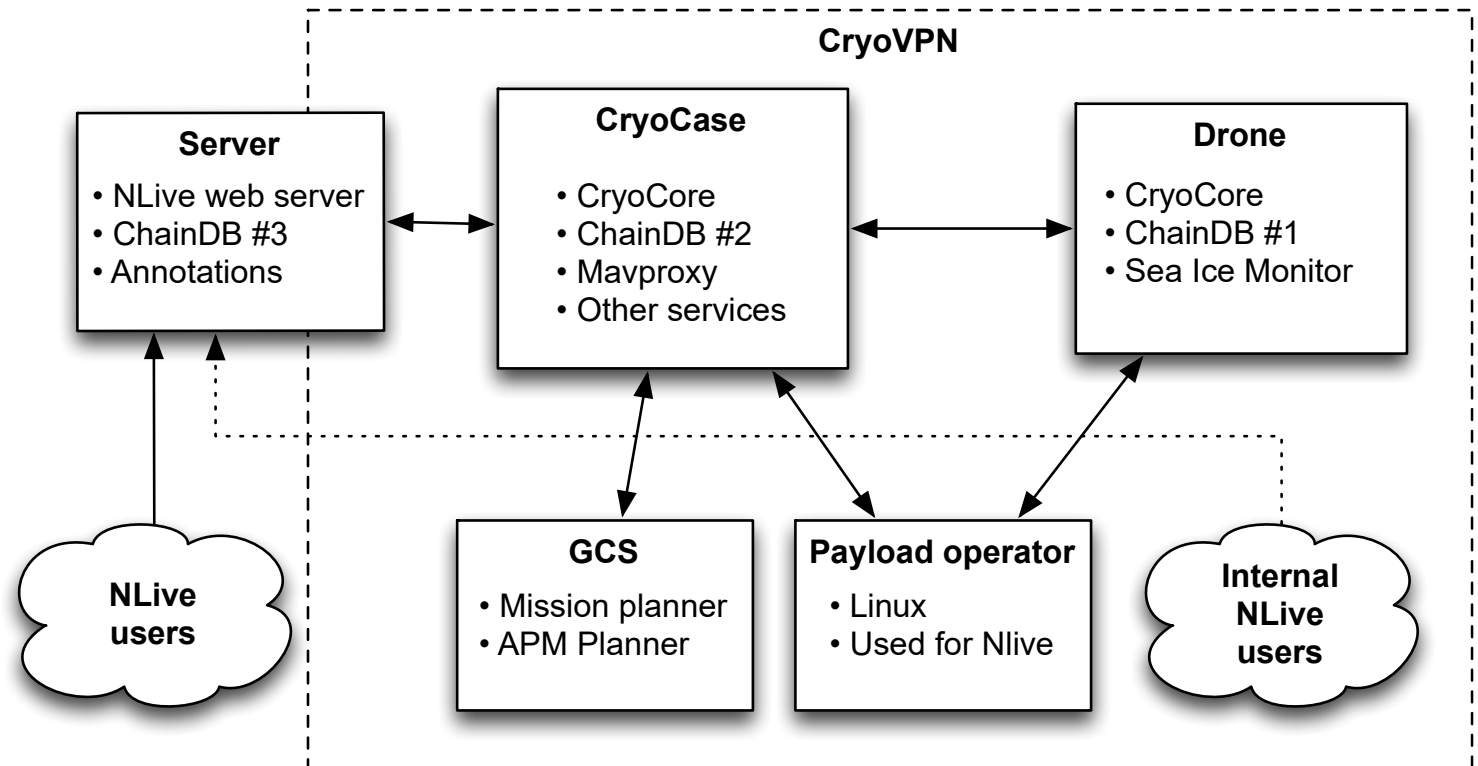
After flight:

Data copied to Troll data system

Data will be processed to Level 1B

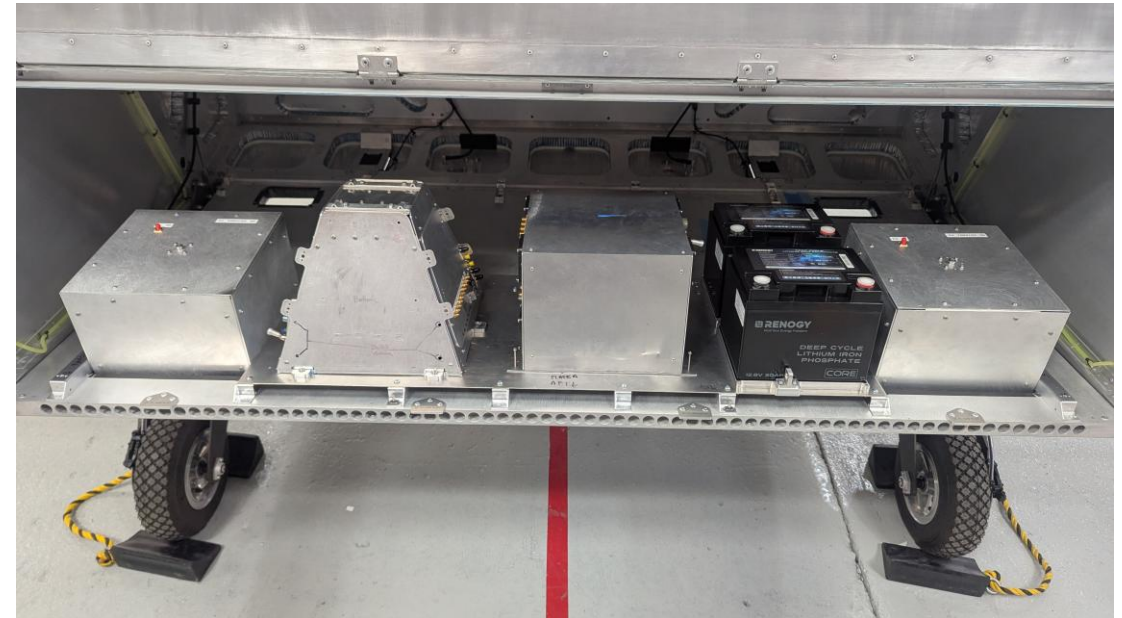
Based on amounts and bandwidth some of these data may be retrieved from Troll.

Raw data and bulk data transferred with crew at end of deployment and made available



TONE-drone payload: Overview

- Met Pack - PTH - Temperature, Humidity and Pressure
- Hyperspectral Imager
 - Max resolution @ 700 m is 20 cm this gives a swath width 250 m
- High resolution cameras
 - Max resolution @350 m is 5 cm this gives a swath width of 1000 m
- UWB Radar
- VFH radar



TONE-drone payload: Hyperspectral imager (HSI), Hyspex V-1240

MAIN SPECIFICATIONS	
Spectral range	400-1000 nm
Spatial pixels	1240
Spectral channels	200 400
Spectral sampling	3 nm 1.5 nm
F-number	f/1.8
FOV	20°
Pixel FOV across/along	0.275/0.275 mrad
Bit resolution	12 bit
Noise floor (native)	3.2 e- 2.3 e-
Dynamic range	> 13200 >11700
Peak SNR (at full resolution)	> 260 > 220
Max speed (at full resolution)	250 fps
Power consumption	50 W*
Dimensions (l-w-h)	250 - 175 - 170 mm
Weight*	< 4 kg*



TONE-drone payload: Hyperspectral imager, Hyspex V-1240 - Data formats

A line scan instrument where typically about 100-200 lines per second are recorded. For every 8 lines, a trig signal is sent to the navigation system so that the exact time is stored, and a real-time navigation solution is also produced (lon, lat, alt, roll, pitch, heading) that we store in the database.

The data from the instrument is stored raw as a BSQ data cube (ENVI img format).

We have software that can process the data and we will always process the data to radiance (level 1B) and this is stored as ENVI BSQ, BIL or BIP cube. If we have an elevation model, we can geocode the data and then we produce a ply (polygon file format) mesh as well. The PLY file also contains RGB preview, so the user can view the data quickly and easily. Based on the radiance data and the ply file, the user can convert the data into a fully georeferenced data cube or geotiff. We have scripts we will publish for this.

The hyperspectral imager produces 100-200 spectrograms per second, where each spectrogram has 1240 spatial pixels and where each spatial pixel has 186 spectral values. I.e. $1240 \times 186 \times 100 \times 2 \times 3600$ Bytes/s = 167-334 GB/hour

TONE-drone payload:

High resolution RGB camera array (4 cameras)

Blackfly S BFS-U3-161S7C-C	
Model Name	Blackfly S BFS-U3-161S7C-C
Resolution	5320x3032
Max Frame Rate	7 FPS
Max Compression Frame Rate	16 FPS
Megapixels	16.1 MP
Sensor	Sony IMX542, CMOS, 1.1"
Readout Method	Global shutter
Pixel Size	2.74 μm
Lens Mount	C-mount
ADC	8-bit / 10-bit / 12-bit
Minimum Frame Rate	1 FPS
Gain Range	0.0 to 47.0 dB
Exposure Range	17.0 μs to 30.0 S
Acquisition Mode	Continuous, Single Frame, Multi Frame



TONE-drone payload:

High resolution RGB camera array (4 cameras)

Tone drone has an array of 4 synchronized cameras, and for each image taken, a navigation solution is produced in real time and a time in the raw data. 20000 pixel swath

Each camera has a parameter file with lens calibration and boresight.

Each camera produces tiff images and for each tiff image a json file is stored in real time containing camera parameters: camera serial number, integration time, gain, aperture and gps time.

Each raw image (16.1 Mpix) is about 50 MB. If we take 1 picture per camera per second, this will be 720 GB/hour. A frame per second is probably excessive. If we fly at 700m AGL, this is reduced to 1 frame per 3 seconds, giving a data rate of 240 GB/hour with a resolution of 10 cm and a swath width of 2000 meters. Max resolution flying at 350 m is 5 cm at 1000 m Swath

TONE-drone payload: Applanix APX-20

Metadata for high-quality georeferencing

The raw data is stored in a proprietary format where we have a Pospac license to read, process and export navigation data.

The device delivers and outputs real-time data at up to 100Hz, as well as messages when the instruments (Hypsax and/or RGB camera trigger). We store this data in the cryocore database on board. With RTK, lateral accuracy is typically around 10 cm.

For Tone operations, this data is uploaded after each flight, and will be processed daily. The data can be exported as ascii and it is typically navigation data per "instrument trig" that is stored. The APX-20 has two event inputs. I.e. two independent instruments can be connected and the navigation system will store trig from both instruments.

PS! The maximum trigger frequency for the APX-20 is 50Hz. (hence every 8th line triggering setup on the HIS)

TONE-drone payload: Snow Radar

Cresis UWB 2-8 GHz Radar

Name: Snow Radar

Center frequency: 5.0 GHz

Bandwidth: 6.0 GHz

Transmit power: 200 mW

Number of channels: 1

Power Consumption: 75 W

Vertical resolution ~5 cm



TONE-drone payload: Cresis VHF Radar

Name: Ice Radar

Center frequency: 67 MHz

Bandwidth: 10 MHz

Transmit power: 0.5-3.2 kW

Number of channels: 4 Tx/Rx

Power Consumption: 75 W

Vertical resolution <30 m



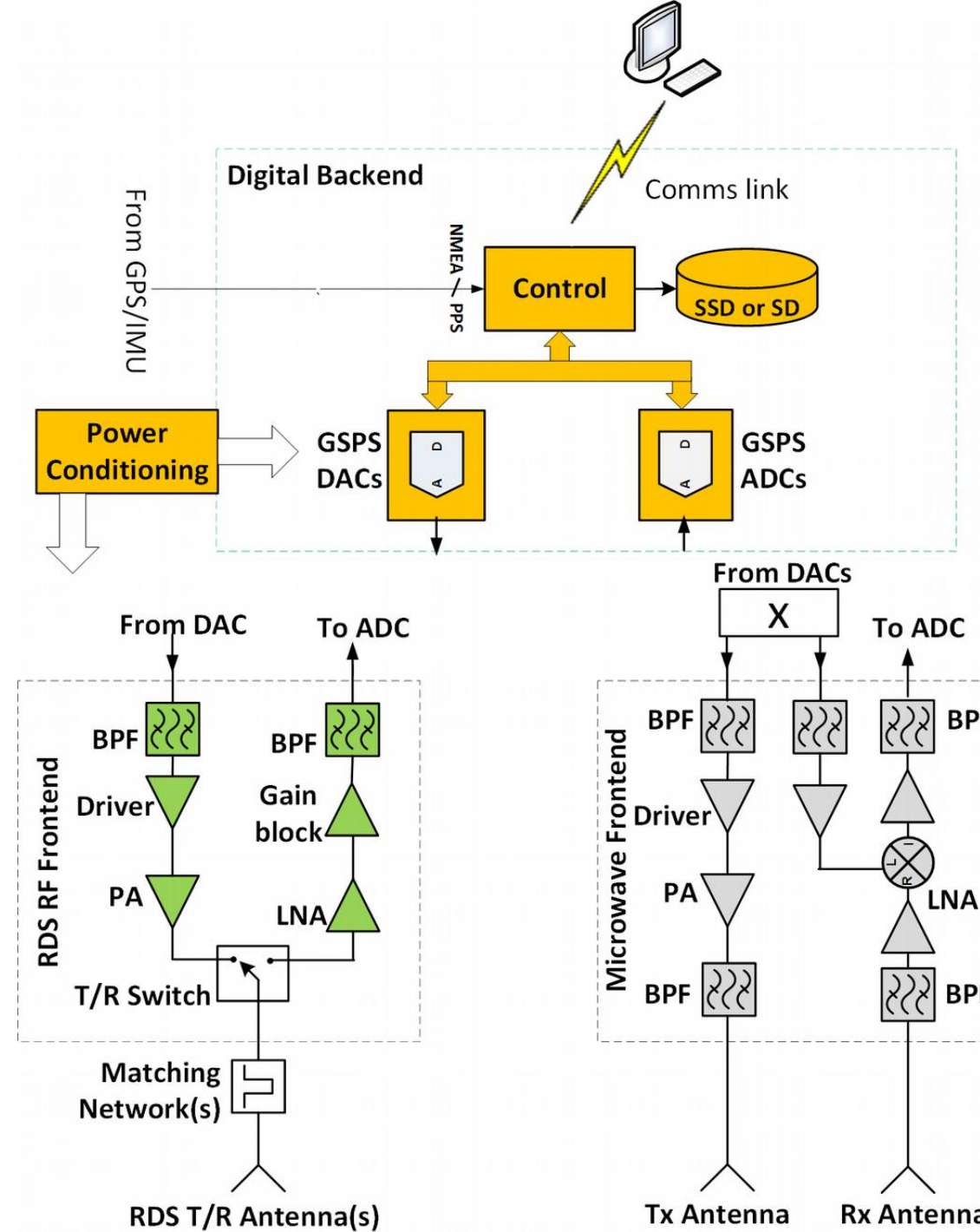
TONE-drone payload: Cresis Radars

Data:
Echograms and L2 (geocoded layer tracking) data

Open Source Software Platform:

Open Polar Radar
<https://gitlab.com/openpolarradar/opr/-/wikis/home>

More information can be found at the Open Polar
Server at Cresis <https://ops.cresis.ku.edu/>



TONE-drone Real Time: NLive

NLIVE Software for sharing, storing and presenting data in real time.

Researchers can monitor flights and data collection in real-time while flight is conducted and interact with operators and other scientist through the web-app

Background layers and maps can be selected and low resolution data downloaded.

Calanus Flight

Press to see Live



Remotely Piloted Aircraft System

TONe Drone Extra Services

NORCE



Aircraft Specifications

CW Fox X8

- Cruise speed: 50 kph
- Range: up to 20 km
- Payload capacity: 20 kg
- UWB radar 0.5-4 GHz (5 cm vert. resolution)
- Easy integration of custom payloads



CW Shark eVTOL

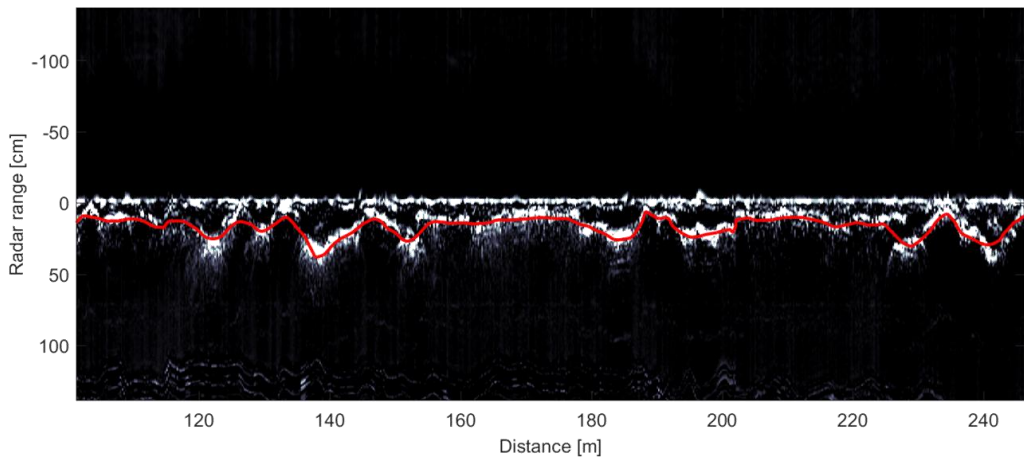
- Cruise speed: 70 kph
- Range: 100 km
- Payload capacity: 2 kg
- IR Camera
- RGB camera



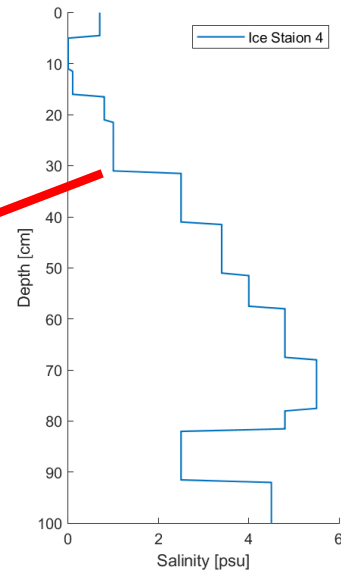
Photo: Carl Robinson - BAS

Example: Sea Ice Measurements With Drone-Mounted UWB Radar

Objective: Investigate radar measurement performance on sea ice.



B-scan image showing the automatic detection of subsurface interface (red) corresponding to low-high salinity interface.



In situ salinity profile taken from the same ice floe.



Spørsmål?



Troll Observing Network

Kontakt:

Rune Storvold rust@norceresearch.no - drone og nyttelest

Christina A. Pedersen xtina@npolar.no - utlysningen og TONE generelt



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: Infrared Array (TONE)
ICO: Integrated Cloud Observatory (TONE)
IO: Ionosphere Observatory (TONE)
MOMO: Multidisciplinary Ocean Moored Observatory (TONE)
NPI: Norwegian Polar Institute
RPAS service: Remotely Piloted Aircraft System service (TONE)
SA: Seismic Array (TONE)

Polar Research 2024, 43, 10370,
<http://dx.doi.org/10.33265/polar.v43.10370>



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KAMPANJE 2028/29

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2031/32, 2032/33

