

# From the Arctic to the Antarctic: Essential groundwork for space

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ESA is an international organisation with **22 Member States**.

## What does ESA do?

- ESA's job is to develop and execute the European space programme.
- ESA's programmes are designed to study the Earth, its immediate space environment, our Solar System and the Universe
- To develop satellite-based technologies and services, and to promote European industries.
- ESA also works closely with space organisations outside Europe.

## How many people work for ESA?

~ 2200 staff from all the Member States and include scientists, engineers, information technology specialists and administrative personnel.



# ESA establishments and facilities

## Headquarters (Paris)

Location of the Director General and the majority of the Programme Directors. Where the decisions concerning ESA's present and future activities are made.



## ESTEC (European Space Research and Technology Centre, The Netherlands)

The largest ESA establishment, a test centre and responsible for the technical preparation and management of ESA space projects.



## ESRIN (Centre for Earth observation, Italy)

Manages the ground segment for ESA and maintains the largest archive of environmental data in Europe.



**ECSAT** (Centre for Space Applications and Telecommunications, UK)  
Supporting activities related to telecommunications, integrated applications, climate change, technology and science.



# ESA establishments and facilities

**EAC** (European Astronaut Centre, Germany)  
Training facility and home base for all European astronauts.

## Kourou Guiana Space Centre (CSG)

In Kourou, in French Guiana. It has a workforce of some 1500 people, mainly from the French space agency CNES, Arianespace and European industry.

## ESOC (European Space Operations Centre, in Germany)

Ensures the smooth working of spacecraft in orbit. Its control rooms, track and control satellites.

## ESAC (European Space Astronomy Centre, Spain)

ESA's astronomy and planetary missions centre.

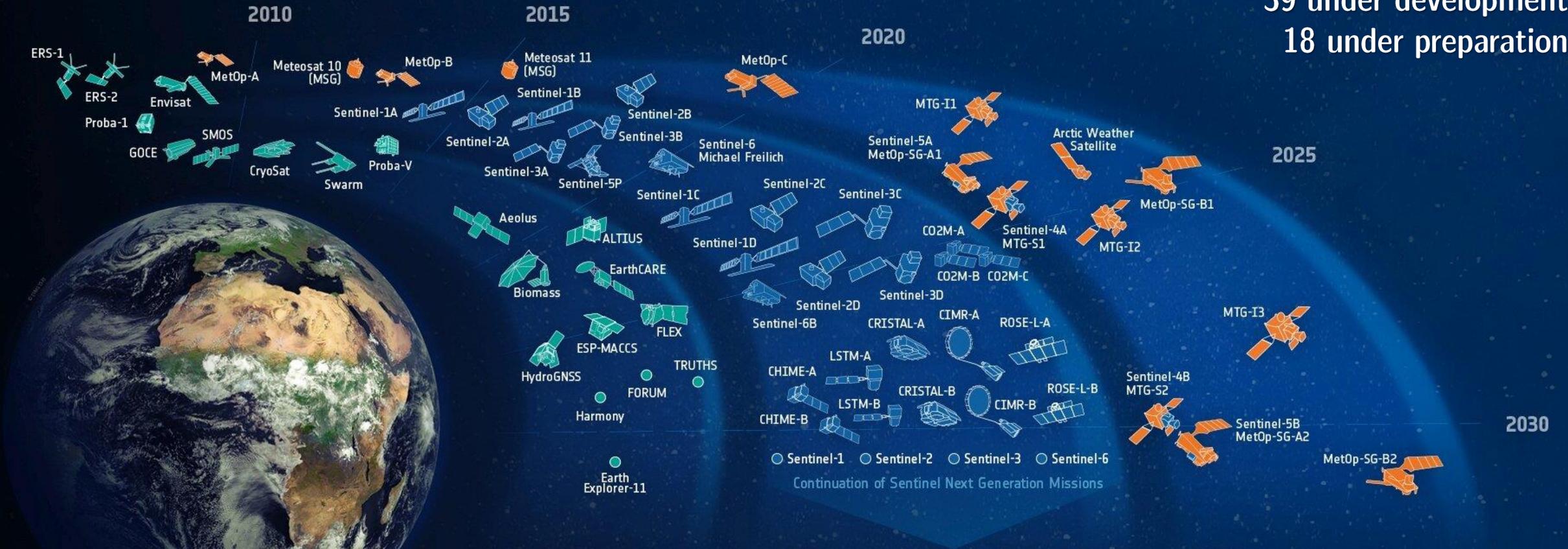
## 2021 Astronaut Vacancy Notice

Country	Male	Female	Total
Austria	349	115	464
Belgium	785	234	1019
Czech Republic	165	37	202
Denmark	110	36	146
Estonia	35	22	57
Finland	248	59	307
France	5475	1662	7137
Germany	2663	1037	3700
Greece	220	60	280
Hungary	116	34	150
Ireland	194	76	270
Italy	1507	353	1860
Latvia	60	21	81
Lithuania	62	18	80
Luxembourg	53	12	65
Netherlands	698	300	998
Norway	258	55	313
Poland	421	128	549
Portugal	256	61	317
Romania	199	56	255
Slovenia	49	13	62
Spain	1045	299	1344
Sweden	232	52	284
Switzerland	551	119	670
United Kingdom	1419	560	1979
<b>Total</b>	<b>17170</b>	<b>5419</b>	<b>22589</b>

# ESA-Developed Earth Observation Missions



**Satellites**  
 15 in operation  
 39 under development  
 18 under preparation



Science

Copernicus

Meteorology

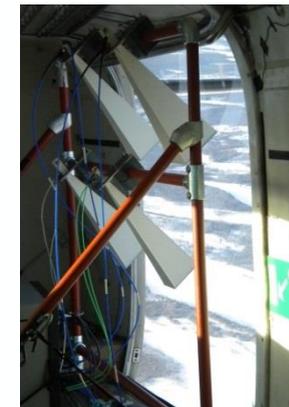


# ESA EO Campaigns: Why do we need them?

The main objective of Earth Observation campaigns is to support all phases of ESA space missions

Campaigns are required to:

- Explore Earth observation possibilities
- Prove concepts
- Develop interpretation
- Develop calibration
- Simulate data products
- Validate results





# Let's start our world tour: 1<sup>st</sup> stop Greenland



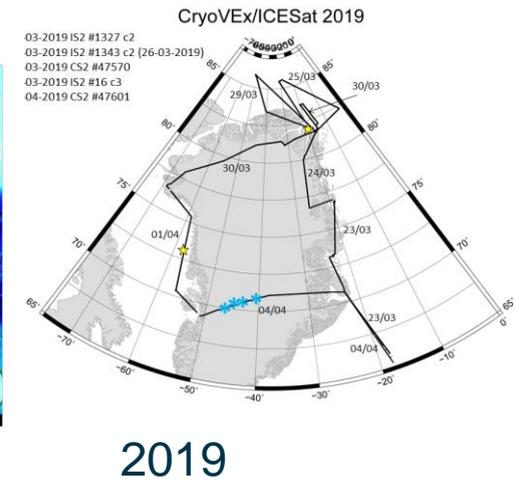
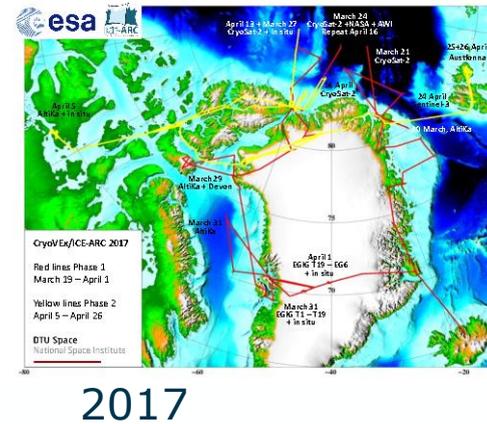
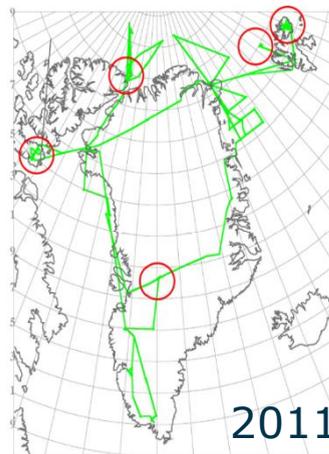
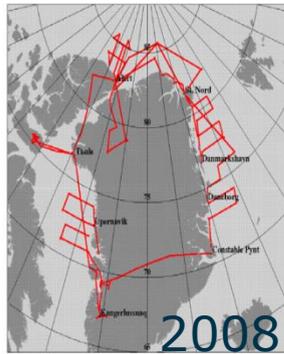
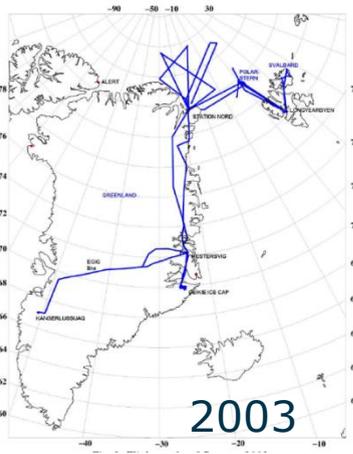
# Campaign(s): CryoVEx, satellite mission: Cryosat-2



CryoSat-2 (ESA's ice mission) measures the thickness of polar sea ice and monitors ice-sheet changes in Greenland and Antarctica (launched in 2010)

The CryoVex campaigns:

- Started in 2003
- Usually every 2-3 years



# CryoSat: CryoVex 2014

## Objectives

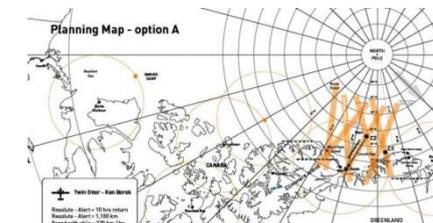
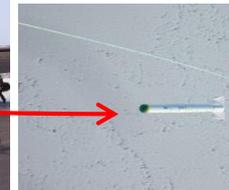
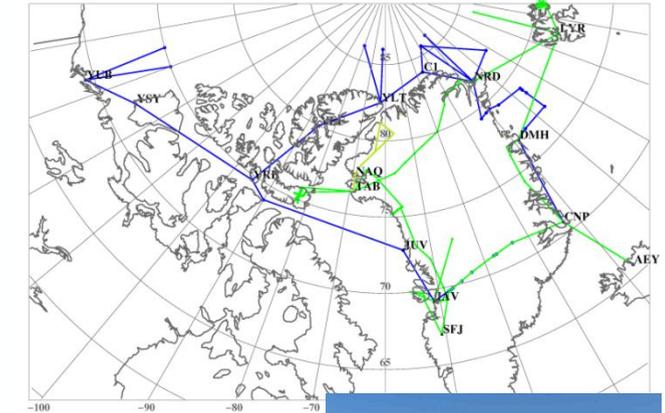
- Address data gaps and temporal change in land and sea ice properties
- Assess Cryosat-2 data quality and quantify sources of uncertainty

## Campaign details

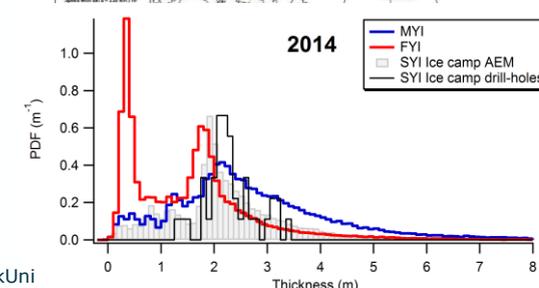
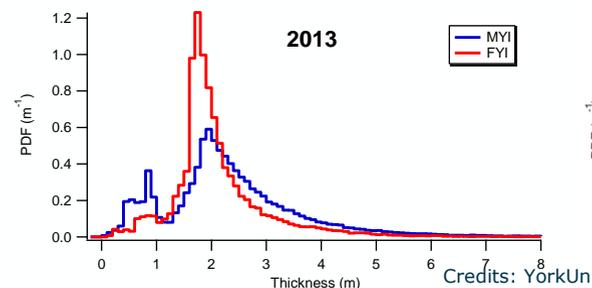
- Sea-ice field work in March 2014, land ice in April 2014
- Joint flights with NASA
- **Main results showed the disappearance of extensive thick MYI in the Arctic**

➤ Data available in ESA's campaigns archive

## Ground and airborne



ESA ice camps



# CryoSat: CryoVEx/KAREN 2017



## Objectives

- Verify upgraded CryoSat L1 and L2 processors
- Support assessment of Ka- and Ku-band altimetric mission concept

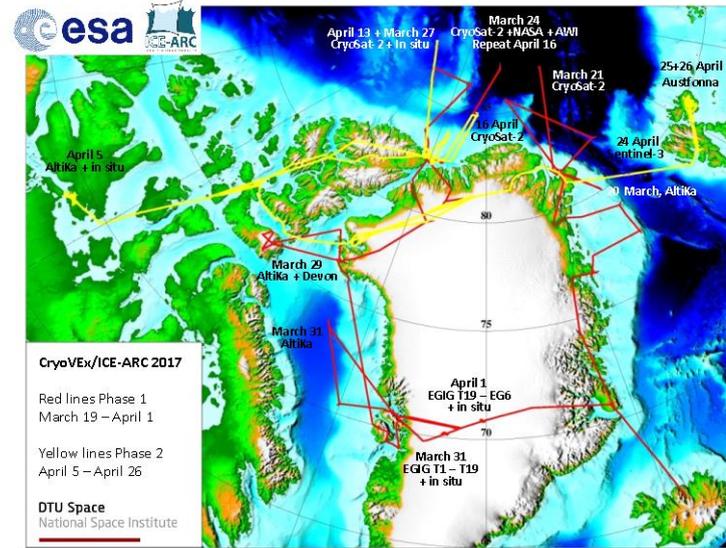
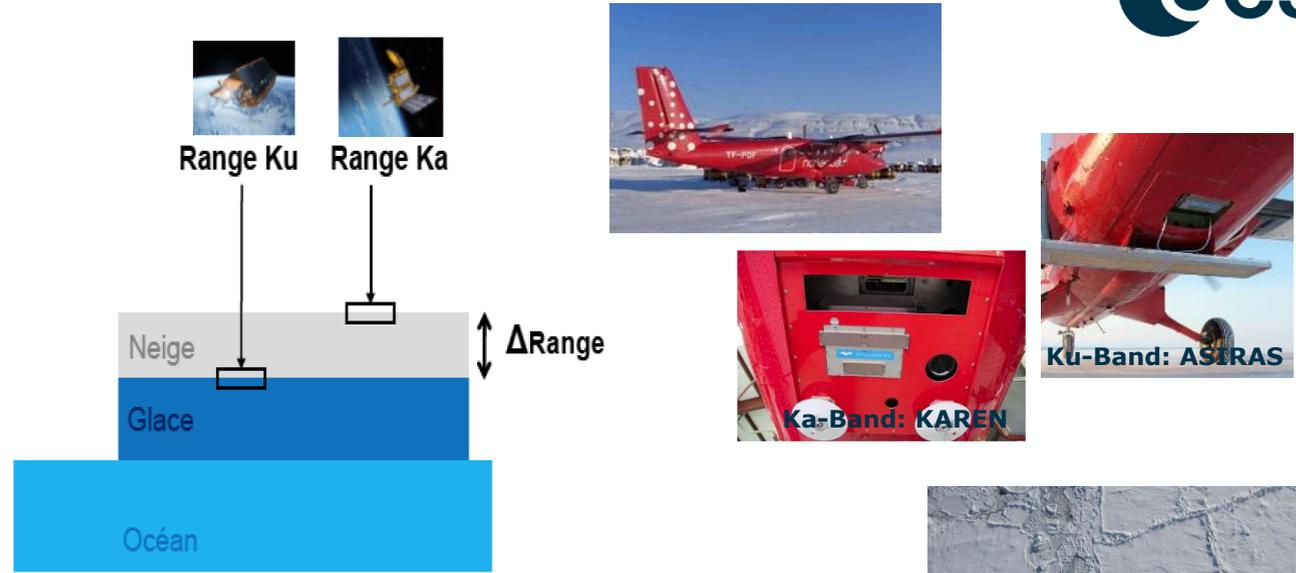
## Campaign details

- DTU Space (DK), AWI (DE), BAS (UK), Leeds Univ. (UK) and MetaSensing (NL)
- First full-scale campaign flying a Ku-Ka band radar simultaneously
- Sea & land ice measurements (airborne & ground) in Mar/Apr 2017
- Collaboration with NASA/JAXA and CNES

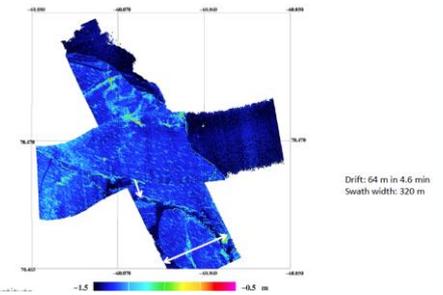
## Results

- First airborne radar snow depth values derived from difference in Ku-Ka bands (underestimated)

➤ Data available in ESA's campaigns archive



Drift vector from repeated ALS: 3.9 km/day S-SE



**British Antarctic Survey**  
NATURAL ENVIRONMENT RESEARCH COUNCIL



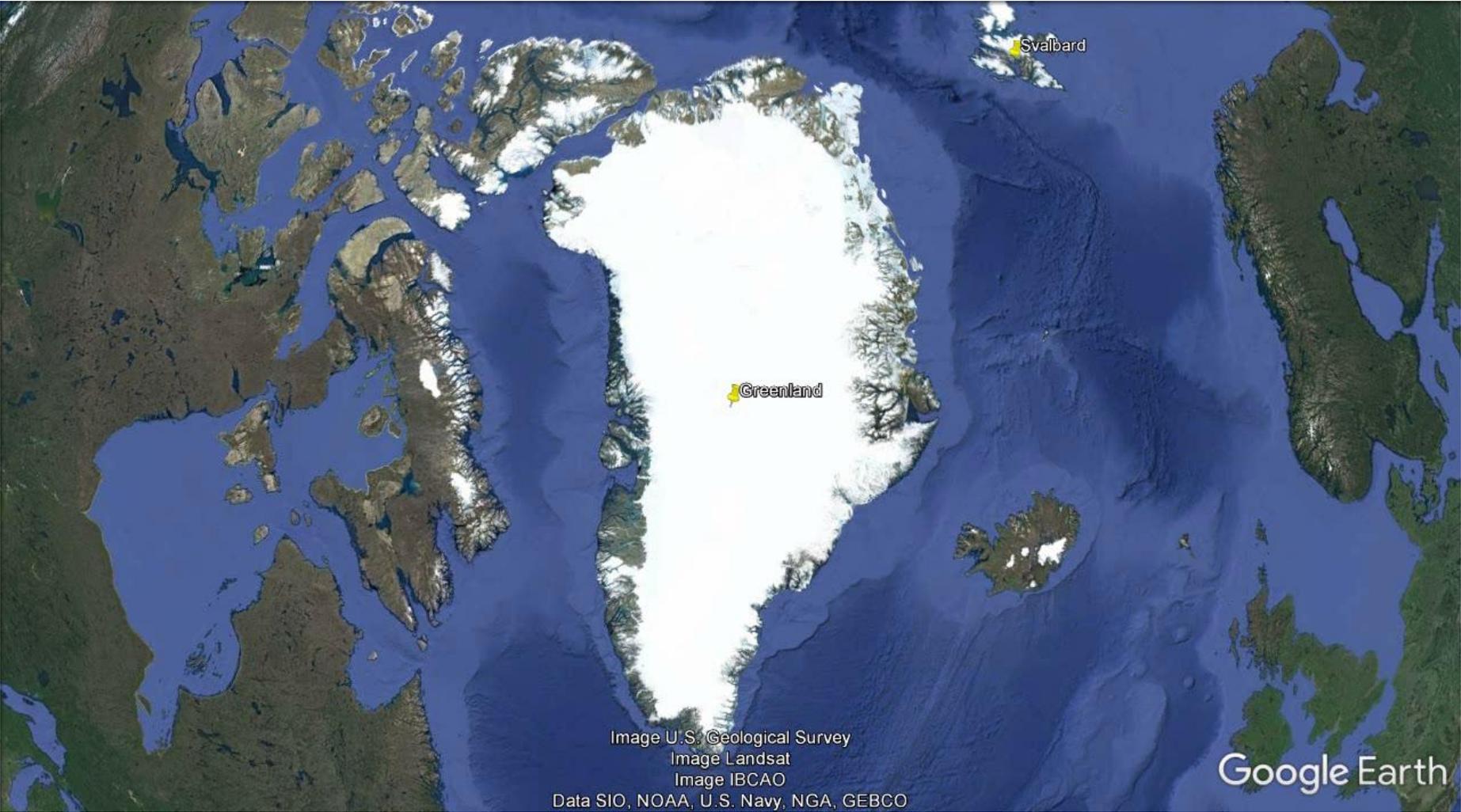
UNIVERSITY OF LEEDS



# Greenland from the air



# Moving on to Svalbard



# Campaign: SMOSice, satellite mission: SMOS



SMOS (Soil Moisture and Ocean Salinity), ESA's water mission launched in 2009

SMOSice Campaign designed to look at thin sea-ice

## Objectives

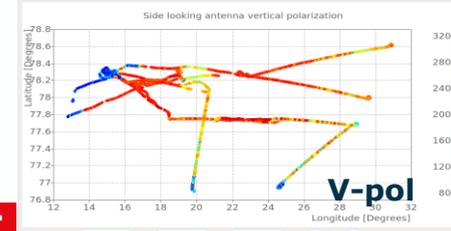
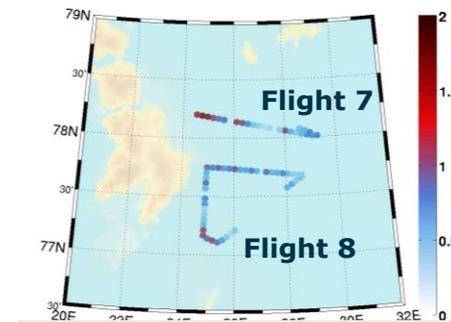
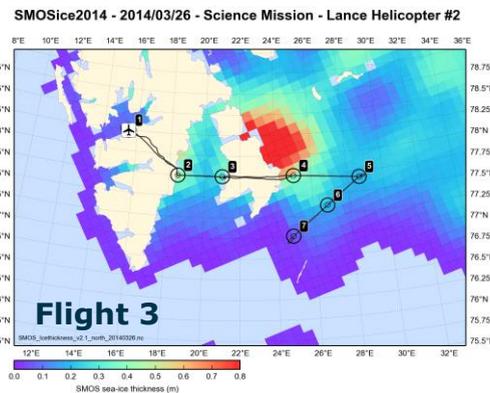
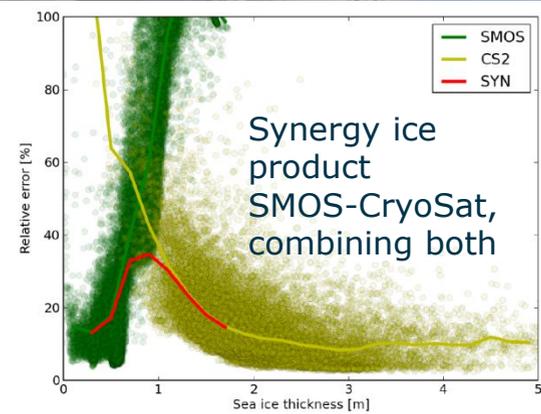
- Document relationship between observed sea ice thickness and microwave measurements
- Support synergies with the CryoSat mission

## Campaign details

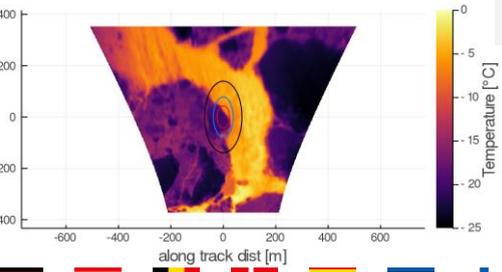
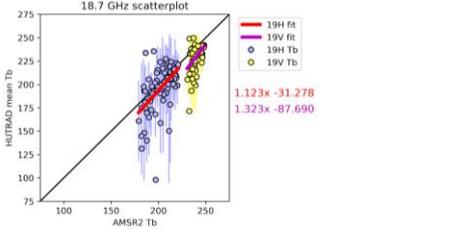
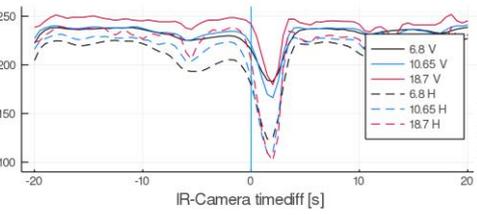
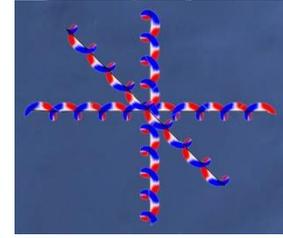
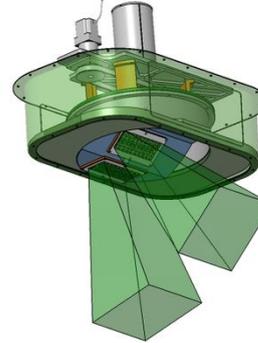
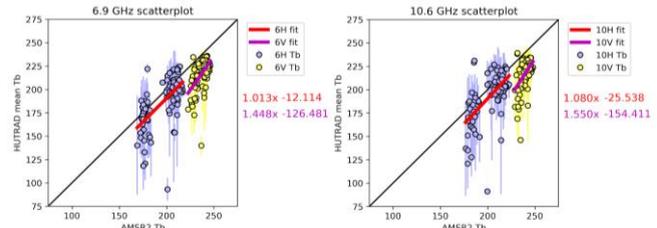
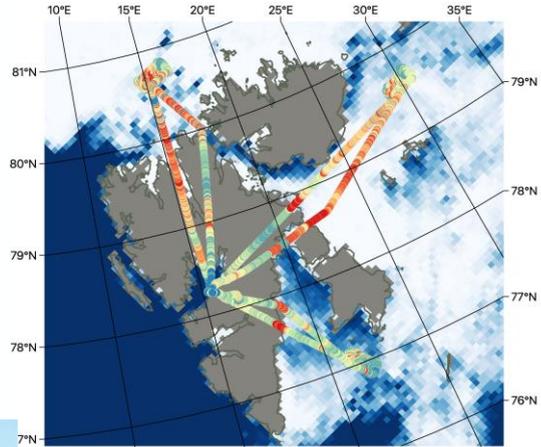
- Field campaign in March 2014
- Airborne, helicopter and shipborne campaign

## Results

- SMOS captures the sea-ice gradient (mean sea-ice of ~80 cm)
- Data available in ESA archives



# More recent campaigns: CIMRex (CIMR) and SKIM (EE9)

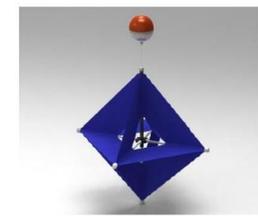


class (interpretation)	temperature condition
open water/thin (bare) ice	$T > 270$ K
thin ice/moderate snow cover	$270$ K $>$ $T >$ $260$ K
thicker ice/thicker snow cover	$260$ K $>$ $T$

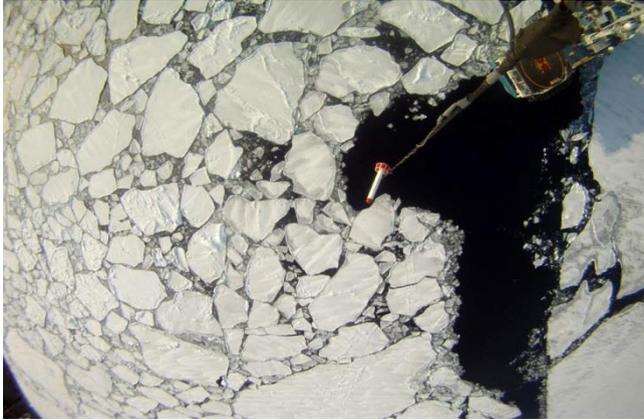


## DRIFT4SKIM

Surface current measurements : drifters



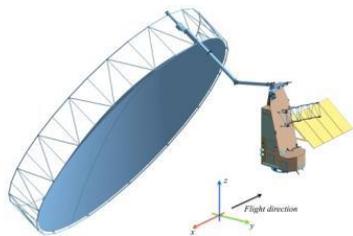
# Svalbard spectacular scenery



# Next stop: Africa!



# Campaign: AfriSCAT, satellite mission: Biomass



Biomass is ESA's tropical forest mission due to launch in 2023.

AfriSCAT is designed to sample the same tropical forest area to look for temporal changes.

## Objectives

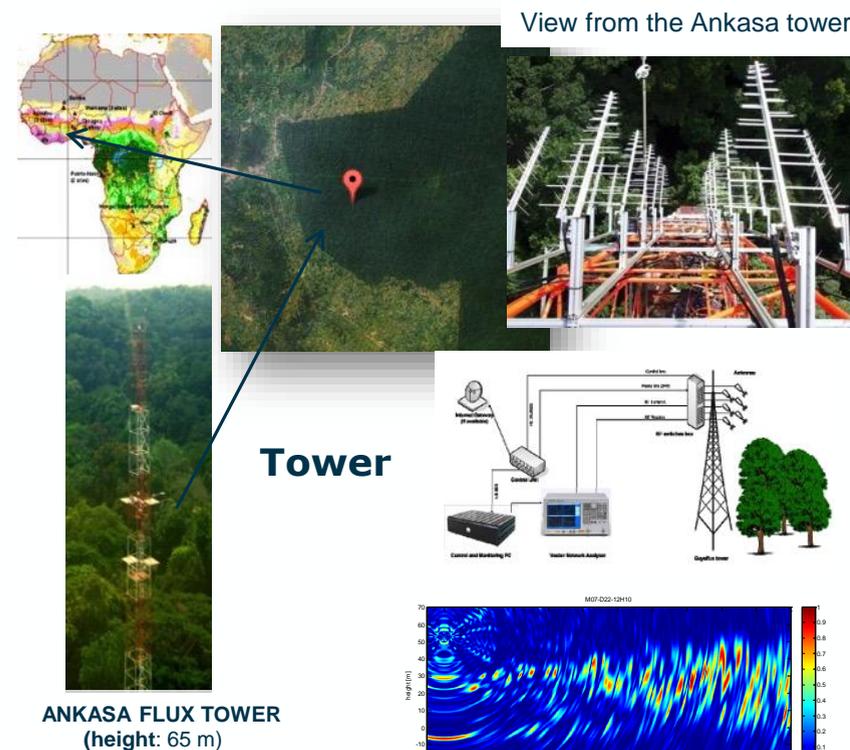
- Extend results from previous TropiScat campaign in French Guiana to African context
- Provide feedback to BIOMASS mission on data product development and quality

## Campaign details

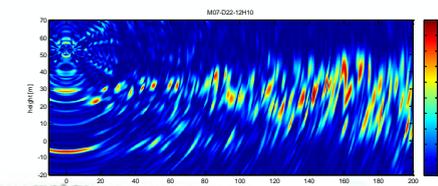
- Test Site: Ankasa Conservation Area Forest, in Ghana
- Tower installation of instrumentation at 65 m height
- Continuous measurements since July 2015 till Jan 2017.

## Results

- Behavior overall similar to TropiScat
- Different forest signatures between rainy and dry seasons



ANKASA FLUX TOWER  
(height: 65 m)



POLITECNICO DI MILANO



ONERA

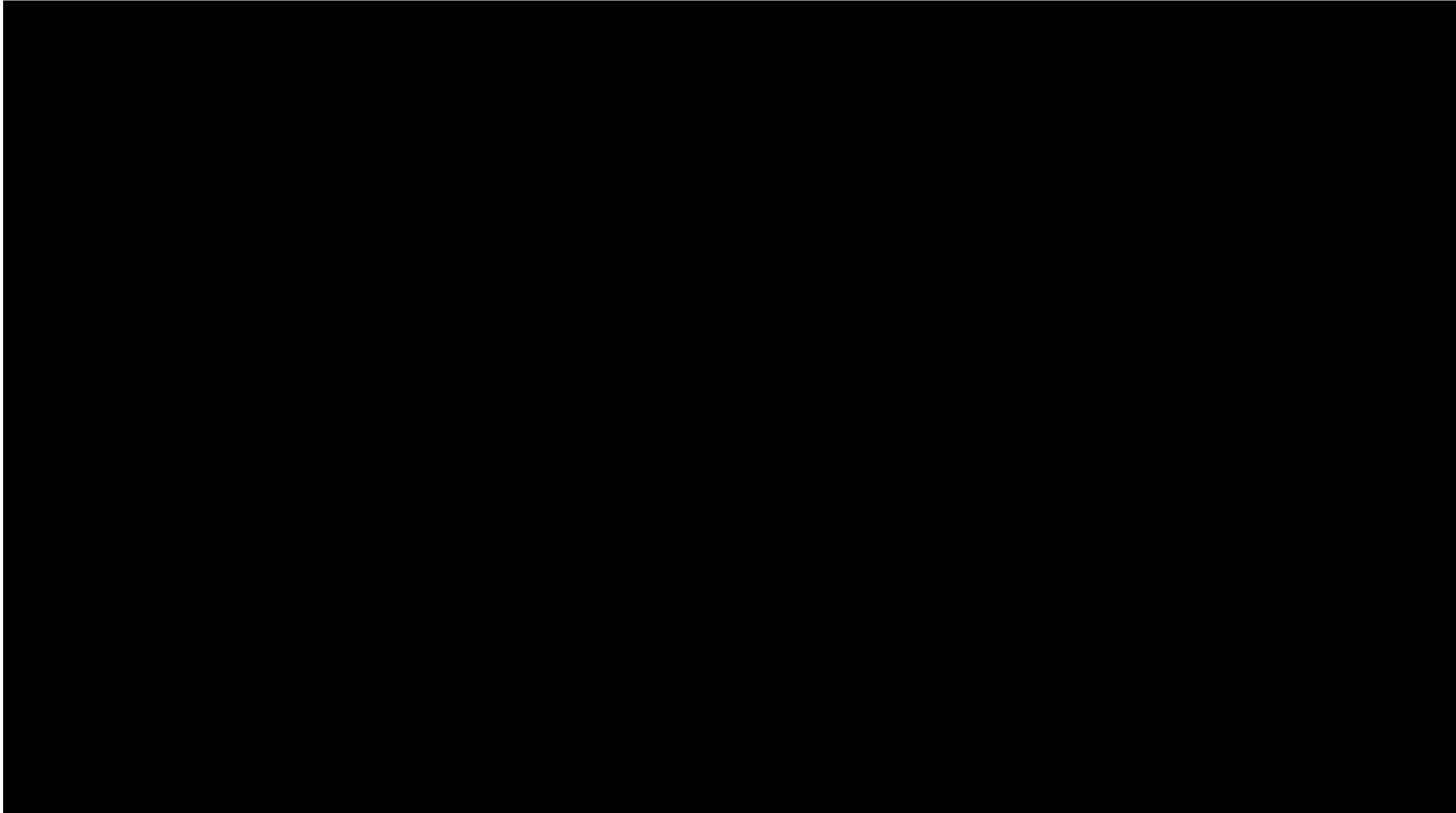
THE FRENCH AEROSPACE LAB



cmcc  
Centro Euro-Mediterraneo sui Cambiamenti Climatici



# A drone view of Ankasa and the tower



# Biomass: AfriSCAT ground

## Objectives

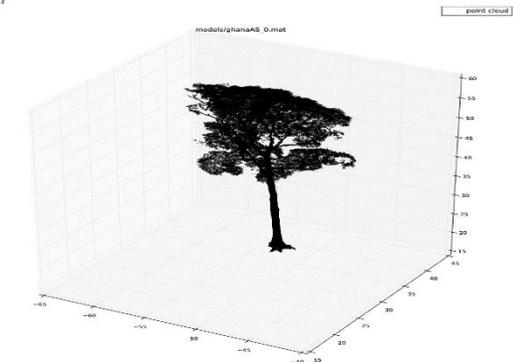
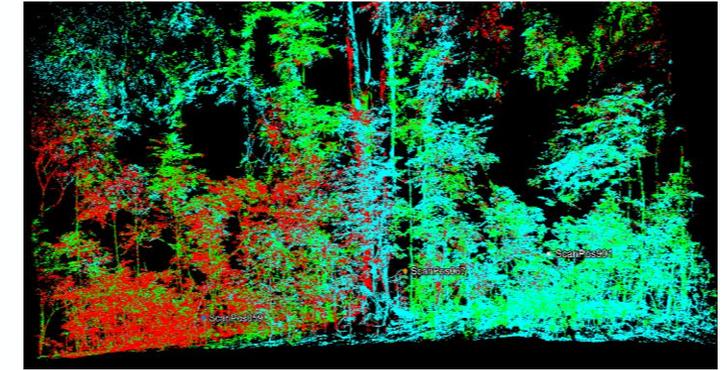
- To determine the plot biomass and biomass of individual trees in the footprint of the AfriScat instrumentation (70x100 m)

## Campaign details

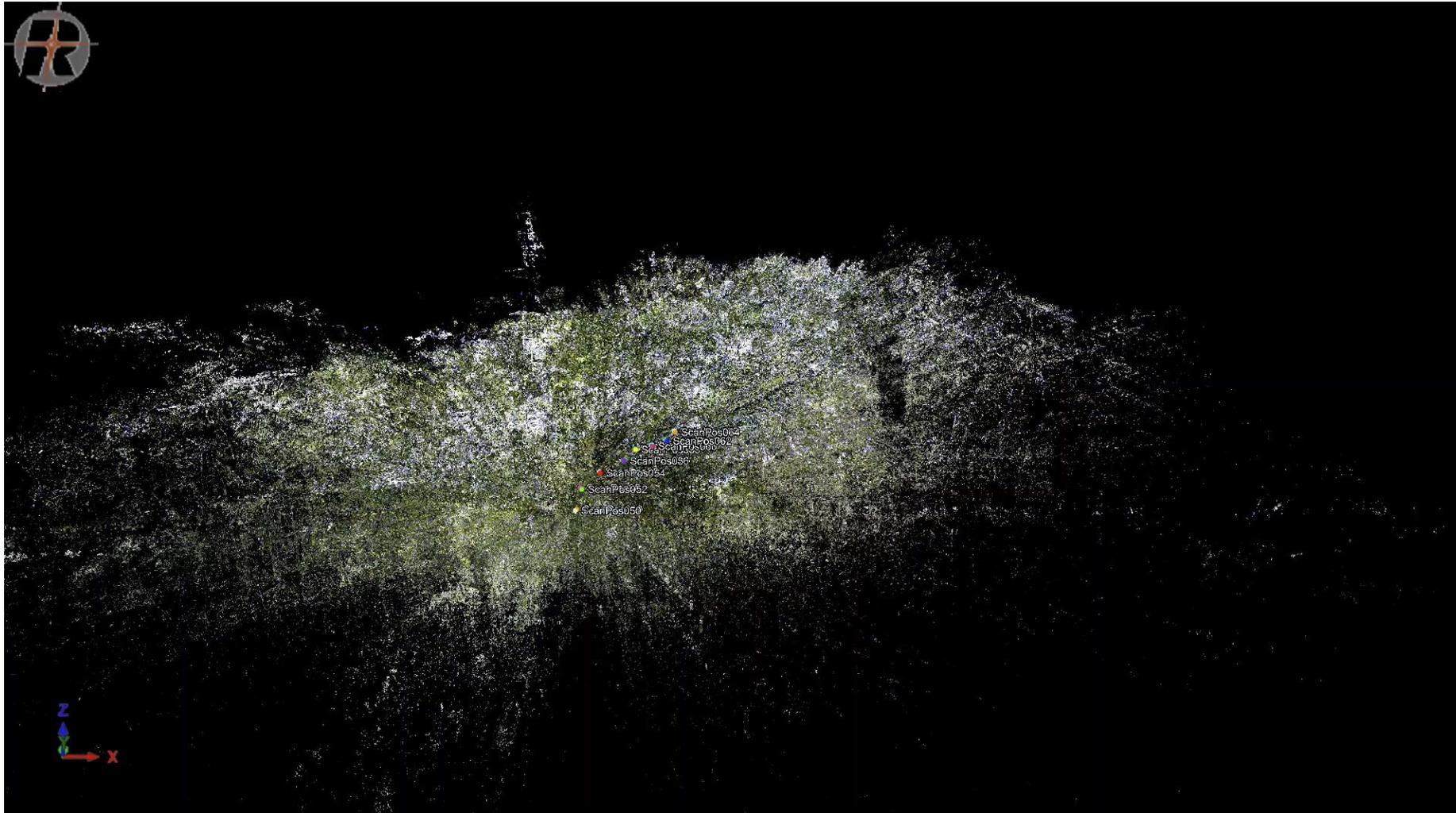
- Test Site: Ankasa Conservation Area Forest, in Ghana
- Terrestrial Laser Scanning (TLS, a novel technology in forest mapping) and forest inventory
- Two weeks in March 2016

## Results

- Total AGB contained in the plot is: **234 tons** estimated from the TLS
  - Two trees with with 3 km or more of branches and over 35 m high
- Data available in ESA archives



# Ankasa TLS point cloud from AfriSCAT Ground



# BIOMASS: AfriSAR



Ground and airborne

## Objectives

- Extend results from the previous TropiSAR campaign in French Guiana to an African tropical rain forest with different structure and environmental conditions
- Provide feedback to BIOMASS mission on data products

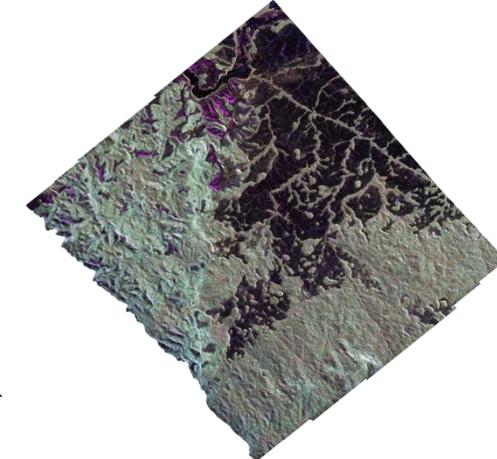
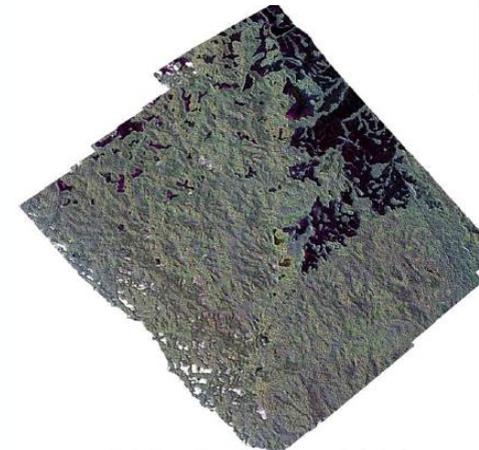
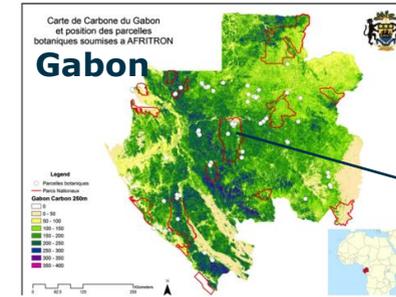
## Campaign details

- Several test Sites in Gabon
- Two flight campaigns:
  - July 2015 and Feb 2016

## Results

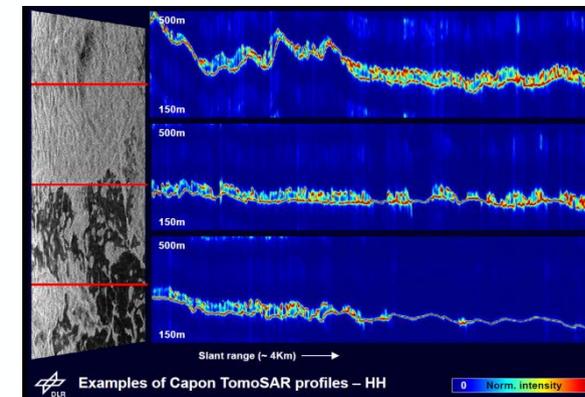
- First Mosaic over La Lopé
- First forest height tomograms

➤ Data available in ESA archives



DLR (February 2016)

ONERA (July 2015)



Agence Nationale des Parcs Nationaux



# Reached our final destination: Antarctica



# Campaign: PolarGAP 2015/2016 satellite mission(s): GOCE/CryoSat



GOCE was ESA's Gravity mission, lifetime from 2009-2013.

PolarGAP was designed to collect gravity over the Antarctic polar gap.

## Objectives

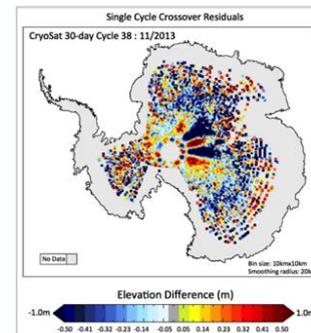
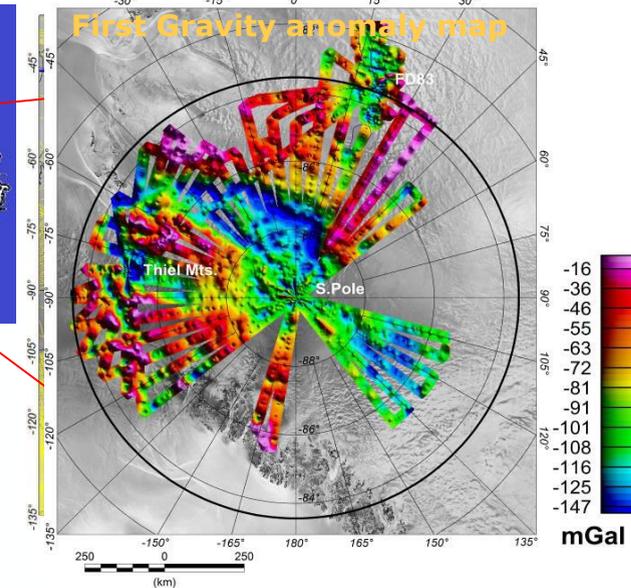
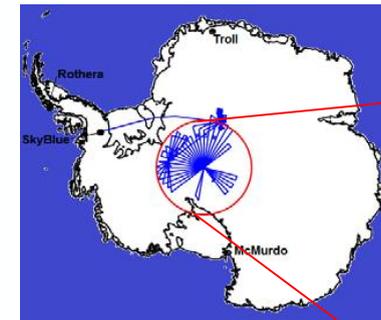
- Measure airborne gravity covering the full polar gap in Antarctica in order to
- Collect radar measurements to improve our understanding of the CryoSat features around the pole

## Campaign details

- Flights during the Antarctic Austral summer of 2015/2016

## Results

- First south pole map of gravity field
- Data available in ESA archives



# SMOS: DOMEX-3

## Objectives

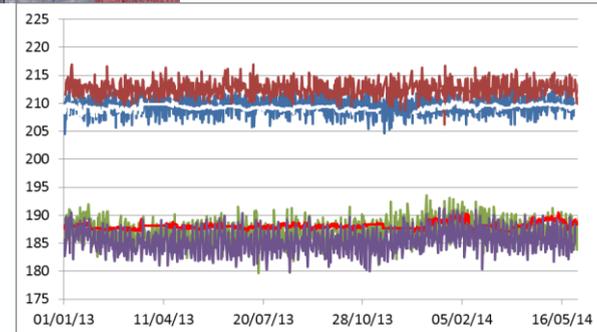
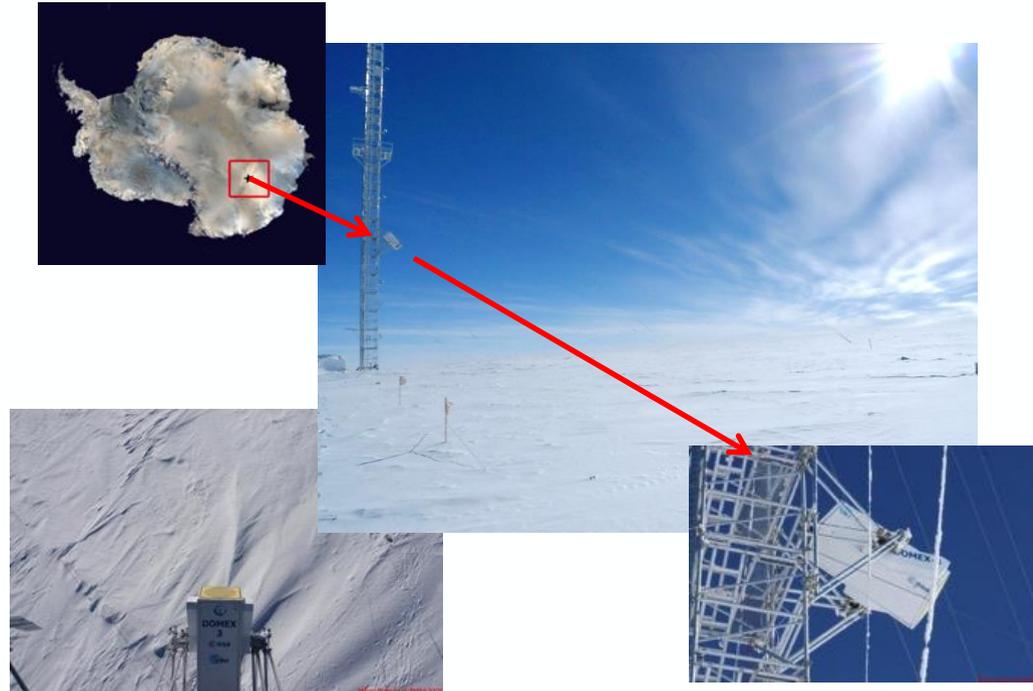
- Support to SMOS calibration over DOME-C, Concordia station in Antarctica (w. links to NASA Aquarius/SMAP missions)
- Long-term experiment providing a continuous data record

## Campaign details

- Instrument mounted on a tower at 15 m height
- Continuous measurements since Nov 2012 till the end of 2017

## Results

- RADOMEX and SMOS data are in good agreement
- DOMEX-3 data agrees well with the previous DOMEX-2 campaign



	DOMEX 3		SMOS 620		SMOS 505	
	TbV	TbH	TbV	TbH	TbV	TbH
mean (K)	209.35	188.12	212.45	187.27	209.57	185.49
std dev (K)	0.48	1.43	1.59	2.28	1.6	1.9



# CryoSat: CryoVEx/KAREN Antarctica 2017/18



## Objectives

- Support assessment of Ka- and Ku-band altimetric mission concept
- Understand the role of snow on sea/land ice in a key climatic sensitive region

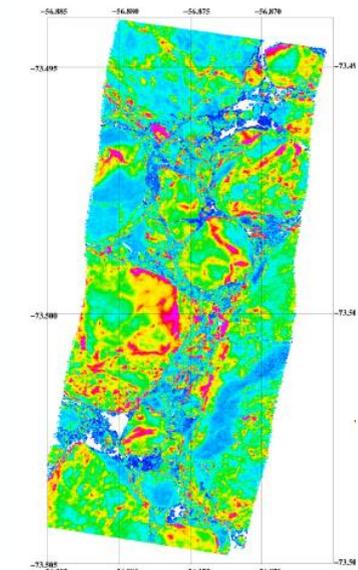
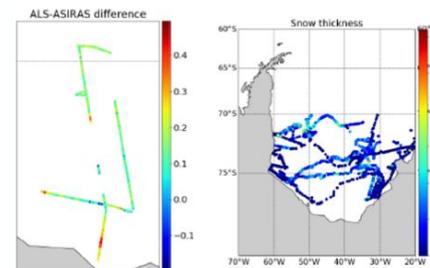
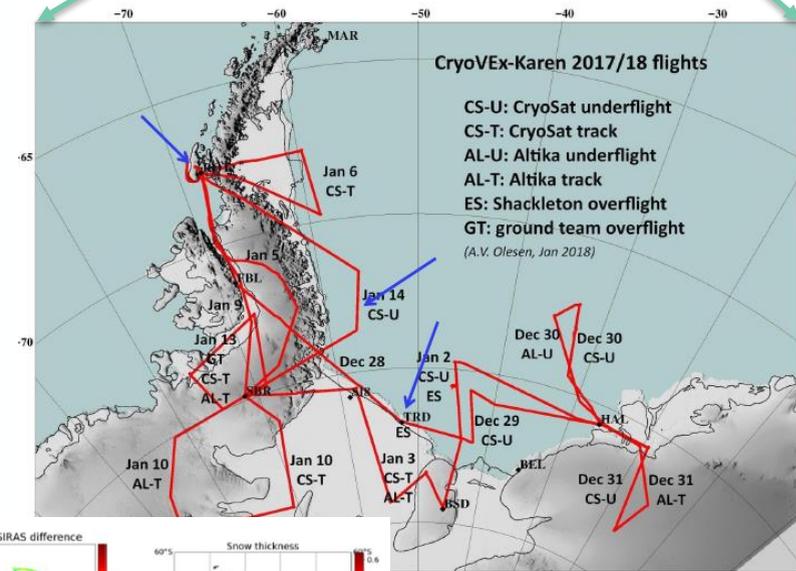
## Campaign details

- DTU Space (DK), BAS (UK), Leeds Univ. (UK) and MetaSensing (NL)
- First Antarctic full-scale campaign flying a Ku-Ka band radar simultaneously
- Airborne and ground sea & land ice measurements in Dec 2017/Jan 2018
- Collaboration with JAXA and CNES

## Results

- First snow depth estimates in Antarctica using the dual frequency bands

➤ Data in ESA archives and soon in <https://cryo2ice.org/>



Snow depth (cm)	Mean	Std. dev
ALS-ASIRAS	15.8	8.2
KAREN-ASIRAS	10.2	9.9
ASPeCt	7.2	9.0
Observations 2017-18*	26.6	17.0



# Access ESA Campaign Data

<https://earth.esa.int/eogateway/>



## Overview

### What was the purpose of CryoVex KAREN Antarctica 2017 2018

ESA's CryoVex/Karen 2017-18 campaign took place in Antarctica in from Dec 2017 to Jan 2018. The campaign was composed of an airborne and in-situ campaign and acquired extensive data sets of scanning lidar, Ku- and Ka-band nadir-looking radar, and auxiliary imagery for validation of the ESA CryoSat-2 satellite (Ku-band radar altimetry) and the French-Indian AltiKa mission (Ka-band radar altimetry).



Twin Otter aircraft over Antarctica

The campaign was also designed to acquire data for studying the radar penetration of Ku- and Ka-band radar in snow and firn over the Antarctica sea ice and ice sheet. The airborne radar and laser survey was supported by 2 ground teams, one that took shallow cores on the southern part of the Antarctic Peninsula and the other collected sea ice thickness and snow depth in the Weddell Sea.

### Outcome of the campaign

Estimated freeboard (elevation above local sea level) from radar Ku (ASIRAS), Radar Ka (KAREN) and ALS (near infrared laser) was calculated. The L1b radar products were retracked (using TFRMA 50%) to give elevations similar to the ALS product. Results show that the freeboard from ALS provides the highest freeboard values, ASIRAS the lowest and KAREN is in between.

Freeboard differences for a single flight compared with snow thickness observations from ASPeCt (Antarctic Sea ice Processes and Climate) observational data (Worby et al. 2008) spanning The ASPeCt dataset spanning from 1981-2005 showed that the observed snow depth during ASPeCt is generally lower than the ALS/ASIRAS difference.

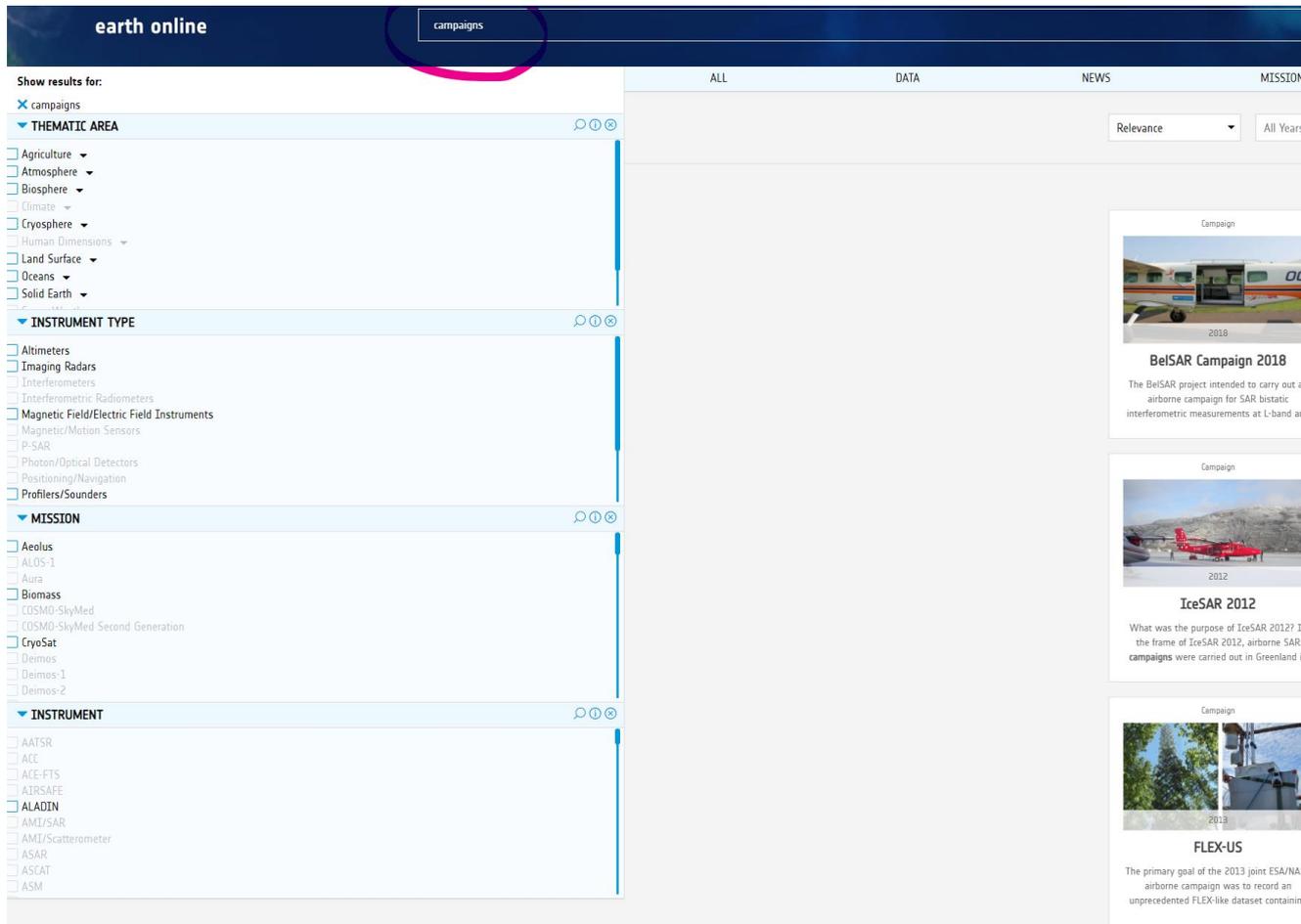
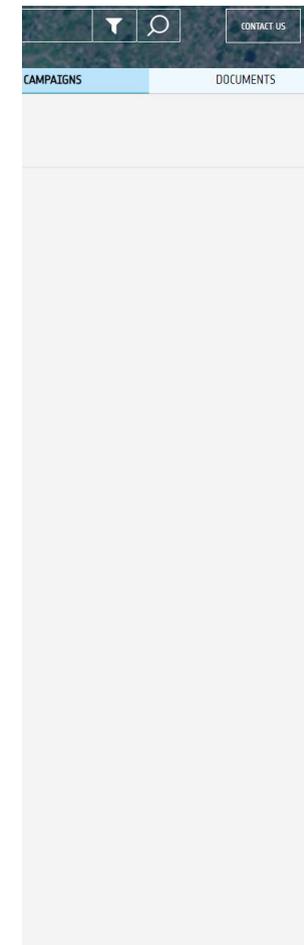
[Download the CryoVex Ant 2017-2018 Final Report](#)

### Campaign Summary

Year	2017/2018
Geographic Site	Antarctica (West)
Field of Application	Radar altimetry, land and sea-ice
Dataset Size	70 Gb

Data Citation Users, who, in their research, use ESA Earth Observation data that have been assigned a Digital Object Identifier (DOI), are asked to use it when citing the data source in their publications:

**Digital Object Identifier:** <https://doi.org/10.5270/ESA-628233c> - European Space Agency, Cryovex/KAREN Antarctica 2017/18



# ESA campaigns BLOG

<https://blogs.esa.int/campaignearth/>

Blog grid content:

- CIMREX: It's a wrap** (11/03/2019)
- CIMREX: Measuring from the air** (11/03/2019)
- FIRMOS: A new view of water vapour and clouds** (08/03/2019)
- CIMREX: From Iceland to Svalbard** (06/03/2019)
- CIMREX: Heading out to the Arctic for new mission concept** (04/03/2019)
- CIMREX: twice flown despite the cold** (08/03/2019)



# Career opportunities (YGT, Research Fellows etc...)

## YGT

The ESA YGT Programme offers young graduates with a Master a unique opportunity to work on inspiring space missions at the heart of European space activities. Join our family of scientists, engineers and business professionals from all over Europe working together in an international and friendly environment.



[https://www.esa.int/About\\_Us/Careers\\_at\\_ESA/Apply\\_now\\_for\\_the\\_2021\\_YGT\\_opportunities](https://www.esa.int/About_Us/Careers_at_ESA/Apply_now_for_the_2021_YGT_opportunities)

## Space Academy

- **Hands-on Space Projects**, a continuing programme that enables university students to gain first-hand, end-to-end experience of space-related projects.
- **Training and Learning Programme**, an initiative offering university students a portfolio of different training sessions and learning opportunities.

[https://www.esa.int/Education/ESA\\_Academy/What\\_is\\_the\\_ESA\\_Academy](https://www.esa.int/Education/ESA_Academy/What_is_the_ESA_Academy)

## Postdocs: Research Fellowship

ESA's postdoctoral Research Fellowship programme aims to offer young scientists and engineers the possibility to carry out research for two years in a variety of disciplines related to space science, space applications or space technology.

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Safety Systems Engineer	ESTEC, Noordwijk, Netherlands	Permanent	08 November 2021
Technology Development Engineer	ESTEC, Noordwijk, Netherlands	Permanent	08 November 2021
System Engineer	ESTEC, Noordwijk, Netherlands	Permanent	19 November 2021
Radio Navigation Engineer	ESTEC, Noordwijk, Netherlands	Permanent	08 November 2021
Galileo G2 PRS Engineer	ESTEC, Noordwijk, Netherlands	Permanent	29 November 2021
Systems and Concurrent Design Facility (CDF) Engineer	ESTEC, Noordwijk, Netherlands	Permanent	16 November 2021
Digital Payload Engineer	ESTEC, Noordwijk, Netherlands	Permanent	30 November 2021
Intern in the Guidance, Navigation & Control Section	ESTEC, Noordwijk, Netherlands	Intern	30 November 2021
Intern in AOCS & pointing Systems Section, GNC, AOCS & Pointing Division, System Department	ESTEC, Noordwijk, Netherlands	Intern	30 November 2021
Head of the Commercialisation Department	ESTEC, Noordwijk, Netherlands	Permanent	15 November 2021
Manufacturing Quality Verification Engineer	ESTEC, Noordwijk, Netherlands	Permanent	01 December 2021
Microwave Payload Engineer	ESTEC, Noordwijk, Netherlands	Permanent	29 November 2021
Exploration Scientist - Space Biology	ESTEC, Noordwijk, Netherlands	Fixed-Term	07 November 2021
Intern in Commercialisation and Innovation Department in Space Exploration	ESTEC, Noordwijk, Netherlands	Intern	30 November 2021

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