2015
Annual Report

CIRFA – Centre for Integrated
Remote Sensing and Forecasting
for Arctic Operations

Photo: Sebastian Gerland, Norwegian Polar Institutes

Contact information

Host institution
UiT The Arctic University of Norway, Faculty of Science and Technology, Department of Physics and Technology

Visiting address
Forskningsparken 3, 3rd floor, SIVA Innovasjonssenter, Sykehusvegen 21, Tromsø
http://cirfa.uit.no/

Centre Leader
Prof. Torbjørn Eltoft, UiT
torbjorn.eltoft@uit.no

Administrative Coordinator
Ellen Ingeborg Hætta, UiT
ellen.i.hatta@uit.no

Work Package leaders
WP1: Prof. Harald Johnsen, Norut
WP2: Dr. Wolfgang Dierking, UiT/AWI,
      Assoc. Prof. Anthony Doulgeris, UiT
WP3: Assoc. Prof. Camilla Brekke, UiT,
      Dr. Christian Petrich, Norut Narvik
WP4: Dr. Rune Storvold, Norut,
      Prof. Tor Arne Johansen, NTNU
WP5: Dr. Kai Christensen, MET,
      Prof. Rune Graversen, UiT
WP6: Dr. Sebastian Gerland, NPI,
      Assoc. Prof. Camilla Brekke, UiT,
      Dr. Rune Storvold, Norut
WP7: Dr. Mari-Ann Moen, KSAT,
      Dr. Nick Hughes, MET

CIRFA Board members
Morten Hald, UiT (Chair)
Kjell Arild Høgda, Norut
Nalan Koç, Norwegian Polar Institute
Nora Hveding Bergseth, ENI
Richard Hall, Statoil
Jan Petter Pedersen, KSAT
Edmond Hansen, Multiconsult

Contents

FOREWORD

**Prof. Torbjørn Eltoft,
CIRFA centre leader,**
UiT

CIRFA, the Centre for Integrated Remote Sensing and Forecasting for Arctic Operations, was one of 17 centres for research-based innovation (SFI in Norwegian) to be appointed by the Research Council of Norway in November 2014. In addition to receiving financing from the Research Council, the host institution and partners fund the activities within the centre.

The appointment of the centre is a great recognition and a reward for the hard and targeted work that has been done to build up and strengthen research and technology relating to remote sensing, especially radar remote sensing, in Norway over the last 20 years. It is also recognition of the fact that, even if we already have the technological abilities to collect enormous amount of remote sensing data from spatial and airborne platforms over the Arctic, we still have a long way to go to optimise information retrieval and knowledge creation from these data. This is the mission of CIRFA. CIRFA provides a great opportunity to build a visible knowledge hub for Arctic remote sensing, and through the research activities, technical developments and education of the next generation, remote sensing researchers make a big contribution to a sustainable development in the High North.

CIRFA has a broad and ambitious research programme, which aims to develop remote sensing technology to a new level of maturity in Arctic applications. As a result of climate change and the retreat of sea ice, the Arctic has become more attractive for industrial operations and exploitation of resources. Our work will be extremely important as it aims to make tools available that can allow for reliable monitoring of the environmental conditions, and hence make sure that human activities are conducted in a sustainable and environmentally safe manner.

The strong alliance and partnership between research institutes and industry, a requirement for an SFI, is extremely valuable. It ensures that the research carried out in the centre is of relevance to industry, and at the same time offers communication of research results back to industry. We have a consortium of research partners in CIRFA that covers a wide range of scientific disciplines and has broad experience in Arctic research. Our consortium of user partners has already shown great interest in the science and technical challenges to be pursued by the centre. CIRFA is hosted by the Department of Physics and Technology at the Faculty of Science and Technology at UiT The Arctic University of Norway. UiT acknowledges the responsibilities associated with hosting big research centres, and has already committed itself to significant in-kind contributions and administrative support to CIRFA. We appreciate this, and would like to express our appreciation of the trust, involvement and contribution made by all our partners.

CIRFA formally started its research programme on 1 September 2015, after months of hectic preparations. The centre is now up and running with a dedicated and expert staff of scientists, who are well supported by the user partners. We have been through a first round of hiring. We announced seven PhD positions in June 2015, and had 46 applicants. We are pleased to report that all positions are now filled with very good candidates. In addition, CIRFA has so far hired two postdoctoral researchers, one adjunct professor and one administrative coordinator. Our staff will gradually expand in the coming years.

Detailed research plans are currently being worked out for all seven work packages. We have also already seen good initiatives in work package collaboration, which of course is a very important requirement for being able to achieve the ambitious goals we have formulated for the centre. The centre management will put a lot of effort into enabling and stimulating smooth collaboration between the work packages, and between the researchers and industry. This is done both by establishing formal meeting places, like the technical committees, of which we have established three, but also by encouraging informal interactions.

In the work so far, we have had extremely good assistance from the administrative staff of the Faculty of Science and Technology, and we acknowledge this. We also would like to take the opportunity to thank the administration team of the Department of Physics and Technology for its help and support in setting up the centre. In March we moved into our new office space in Forskningsparken, after residing in the Nofima Building for a few months. In Forskningsparken, we will be a close neighbour of Norut, the second largest research partner in CIRFA, and we think this will be a good working environment for CIRFA in the coming years.

So even if the centre has only been operating for a few months, we think it is fair to say that the centre is in good shape. We look forward to a long-term, interesting and inspiring research and collaboration in CIRFA in the years to come.

Prof. Torbjørn Eltoft
Centre Leader, CIRFA

About the SFI scheme
The main objective for the centres for research-based innovation (SFI) is to enhance the capability of the business sector to innovate by focusing on long-term research based on forging close alliances between research-intensive enterprises and prominent research groups.

The SFI scheme will:
- Encourage enterprises to innovate by placing stronger emphasis on long-term research and by making it attractive for enterprises that work in the international arena to establish R&D activities in Norway.
- Facilitate active alliances between innovative enterprises and prominent research groups.
- Promote the development of industry-oriented research groups that are at the cutting edge of international research and are part of strong international networks.
- Stimulate researcher training in fields of importance to the business community, and encourage the transfer of research-based knowledge and technology.

The SFI centres are co-financed by the host institution, partners and the Research Council of Norway. The centres will be established for a maximum of five plus three years.

sfi = Centre for Research-based Innovation
The Research Council of Norway

CIRFA EXECUTIVE SUMMARY 2015

CIRFA – Centre for Integrated Remote Sensing and Forecasting for Arctic Operations started formally on 1 September 2015.

In the preparatory phase prior to 1 September, CIRFA was widely presented in many meetings and conferences, among these the "Oljeindustriens Miljø & Teknologikonferanse" oil conference in Stavanger, "Interspill" in Amsterdam, in a meeting with the Standing Committee on Education, Research and Church Affairs at the Norwegian Parliament and in a meeting with the Ministers of Fisheries and of Justice and Public Security on Svalbard.

CIRFA has set up its Centre Management and Board. The Board had its first meeting on 2 November 2015.

In the period before the start-up of the centre, the work was focused on various administrative tasks, including finalizing the Consortium agreement, getting administrative tools and routines in place, budgeting, and building a website (http://cirfa.uit.no).

CIRFA has been through an initial hiring process and has recruited eight PhD fellows, two postdoctoral researchers, one adjunct professor and one administrative coordinator.

In 2015 the scientific activities were focused on planning the research activities within the different work packages, including defining PhD projects for the new students. CIRFA also had the opportunity to collect several remote sensing data with proper in-situ information in connection with campaigns that some of our partners and collaborators conducted. During the N-ICE2015 campaign organised by NPI from January – June, several unique QUAD-polarisation data sets in X, C, and L-band of sea ice were collected. These will be thoroughly analysed by researchers in WP2 and WP6 in the coming years. CIRFA members were also actively involved in both the planning and the data collection during NOFO's oil-on-water campaign in June 2015. Here we collected time series of both satellite and airborne SAR data over several oil slicks.

CIRFA members have already published a first journal paper based on data collected during the N-ICE-2015-campaign, and were co-authors of several papers presented at IGARSS 2015 in Milan, Italy. For more details on the 2015 activities, we would refer readers to the respective work packages and publication lists.

VISION

CIRFA aims to become an international leading research centre into integrated remote sensing and forecasting for the Arctic, providing:

- An attractive environment to scientists, young researchers and students

- Outstanding scientific contributions

- High-level research training for new researchers in the field

CIRFA shall become a facilitator for collaboration between industry and academia on issues related to remote sensing of Arctic phenomena, providing:

- Innovative integrated solutions to challenges in Arctic operations

- Scientific support to industry on issues related to remote sensing technology

- Decision support to policymakers and authorities

WHY IS CIRFA INTERESTING TO THE OIL INDUSTRY?

Nora Hveding Bergseth, CIRFA Board member,
Eni Norge AS

Richard Hall, CIRFA Board member
Statoil Petroleum AS

Historically, Arctic exploration has consistently shown that success is best achieved through co-operation, and that this success can be transferred to any region or subject.

Today, there are an ever-increasing number of satellites providing a huge amount of data which the oil and gas industry has identified can only be successfully managed and turned into information by co-operation with all parties. While sensor technology is not new, integrating multiple sensors and platforms into organised systems is now possible. The question is how to optimise and keep an overview of all the data sources.

CIRFA's main focus areas includes observations from satellites and aircraft – both manned and unmanned. In particular, the new Unmanned Aircraft Systems have great potential in collecting data safely over the more remote regions around the world. Each of these systems has distinct advantages and disadvantages but potentially, when used together in synergy, their full potential can be realised to optimise the process of extracting information from the data collected to support decision-making processes.

The second focus area for CIRFA is numerical met-ocean forecasting, which will further exploit the observations made by satellites and aircraft systems.

Thirdly, CIRFA is not just about improving our understanding of the environmental system. It is also about basic science investigation to discover what does and does not work, while at the same time inspiring the next generation of scientists and engineers. While CIRFA's results can be applied throughout the world, the proximity of the Barents Sea to the Centre means that this will be a test bed for theories that are developed.

The new licence rounds in the Barents Sea are naturally of interest to the oil and gas industry. A better understanding of the ice edge region and its movements is important to all involved parties in determining what is possible. The remoteness of where the ice edge is located leads to the use of remote surveillance to provide continuous monitoring. The results from CIRFA are therefore used too.

The possibility of systematic monitoring will give access to new data essential for developing and improving models for simulation and forecasting of variations in the sea state. Modelling of currents and drifting is already extensively used, but we see a need for improvement. Detection of sea ice and in particular growlers (small icebergs) is challenging as they lie low in the water, but new modelling tools will be of great help.

Oil spill response in the Barents Sea is also an area of great focus in the industry. A lot of time and money has already been spent in developing and improving the oil spill contingency response plan for the southern Barents Sea. With new technology and better access to data these plans can be further improved.

CIRFA can provide more confident observations and forecasts of the environment so that uncertainty, and therefore risk, can be

Some of CIRFA's partners and stakeholders (from left): Wolfgang Dierking, UiT/Alfred Wegener Institute; Frank J. Øynes, Spacetec; Nora Hveding Bergseth, Eni Norge; Jan Petter Pedersen, Kongsberg Satellite Services; State Secretary Dilek Ayhan, Ministry of Trade, Industry and Fisheries; Ivan Burkow, Northern Research Institute; Torbjørn Eltoft, UiT; Nalan Koç, Norwegian Polar Institute; Richard Hall, Statoil; Ottar Minsaas, Total. Photo: Torger Grytå.

reduced about when we can and cannot operate due to the presence of ice, algal blooms or other seasonal environmental conditions and met-ocean conditions. This therefore increases the operational windows and minimises interruptions.

While these results would be focused on the Barents Sea, they can be applied wherever we encounter ice (also globally) due to the improved detection of oil spills.

The CIRFA team includes industry, scientists and institutes. By working together, it has the expertise and the opportunity to optimise all the sensors and platforms available for observing the environmental system. This increases our understanding of this complex system.
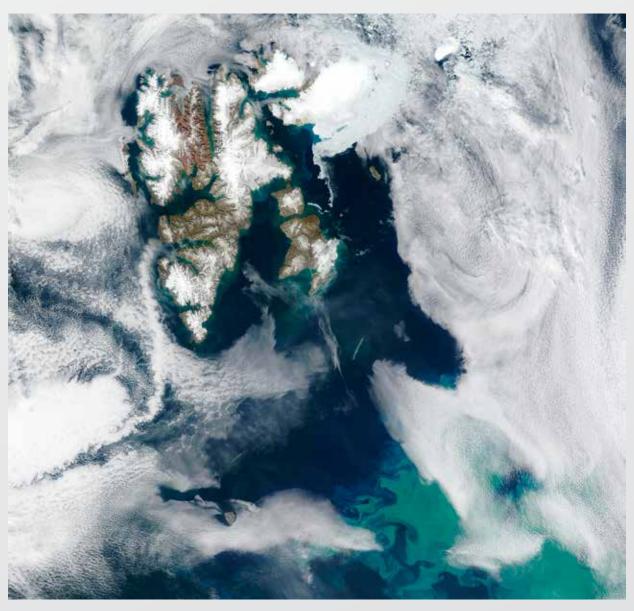
We will be better together and together we will develop leaner, faster and smarter solutions!

CIRFA'S RESEARCH PROGRAM

THE DECREASE IN THE EXTENT of sea ice has generated increasing interest in industrial activities in the Arctic, including oil and gas, shipping, fishing tourism and mining. In 2007 the summer (September) extent of the Arctic sea ice reached a hitherto unexpected minimum, which was followed by another even lower minimum in 2012. Since then, scientists, politicians and different stakeholders have paid increased attention to the recent and decadal variations of the sea ice cover in the Arctic. This is because they are an indication of global warming and have a strong impact on the environment, infrastructure and access to natural resources in the Arctic. The information on the Arctic-wide variations of sea ice extent and other ice properties has been obtained from satellite instruments that are capable of mapping the whole Arctic Ocean within one day. Such instruments take image strips that are typically between 1500-1800 km wide. Time series of large-scale variations of the Arctic ice cover are important for climate research, e.g. for validating and improving computer models for simulating future climate impacts on the Earth's environment.

Maritime industries face new challenges in the High North, as the Arctic environment is characterised by low temperatures, remoteness, low visibility, darkness for several months of the year and a vulnerable natural environment. The winter climate especially may be extremely harsh, with swift changes in weather and wave conditions, and the ocean circulation has more abrupt variations than are known further south along the Norwegian coast or in the North Sea. In addition, the Arctic Ocean and the adjacent shelf seas are affected by sea ice. Small and large icebergs frequently break off from glaciers around Greenland and Svalbard and float through the icy Arctic waters. The disadvantage of wide-swath satellite instruments mentioned above is that they have only a coarse spatial resolution, which lies between a few and tens of kilometres. This means that details of ice cover structure and ice property changes are not revealed. The research carried out in CIRFA therefore focuses mainly on space-borne radar systems that are operated at swath widths of 30-500 km and at spatial resolutions between 1 and 1,000 m. Data acquisitions with radar are independent of cloud cover and light conditions, and are well suited for observations of regional and local variations of parameters characterising the state of the sea ice cover. Radar data are hence useful for validating results obtained from the coarse-resolution instruments mentioned above. Operational services, which have to provide sea ice maps and forecasting of ice conditions for seasonally or perennially ice-covered waters in support of marine transportation and offshore operations, use radar images for their analyses and ice chart production.

Sustainable future industrial operations in this area thus place new demands on monitoring and forecasting technologies with respect to accuracy, spatial and temporal resolution, reliability, robustness and automation of information services offered. These challenges call for innovative solutions, where emphasis is on efforts to extract valuable information from the enormous amounts of data that are being collected. CIRFA's emphasis will be on integrated remote sensing and forecasting. Integrated remote sensing and forecasting is to be understood as the process of combining remote sensing data from multiple platforms, multiple sensors, and surface-based measurements, and integrating the derived information into numerical models to provide predictions of ocean and sea ice conditions on local and regional scales.

CIRFA will create knowledge and develop new methodologies and technical innovations which can enable safer maritime operations in the environmentally sensitive Arctic area. The research in CIRFA will be conducted in close collaboration with national and international research partners, and with industry actors with designated interest and expertise in these topics.

It is noted that the research and innovations to be performed in CIRFA will generate interest and impact on many aspects of Arctic research. Improved remote sensing and forecasting technology is of great significance in relation to environmental monitoring and resource management in the North, and will, in the long term, prove invaluable for the monitoring and understanding of climate change.

WP1

OCEAN REMOTE SENSING

WPL: Prof. Harald Johnsen
Norut

The objectives of WP1 are to develop the use of satellite technology to monitor and advance our understanding of ocean processes and dynamics. More specifically, it will contribute to better prediction of polar lows, nowcasting and short range forecasting of ocean state through coupling with high-resolution numerical models.

Objectives and motivation:

Synoptic maps made from space of ocean surface wind, waves and current are important inputs to better characterisation and parameterisations of oceanic mesoscale and sub-mesoscale dynamics as well as support for advances in ocean-atmosphere research and modelling activities. With the launch of the Sentinels, the capabilities of providing such high-resolution information from space is significantly improved due to better time and space coverage.
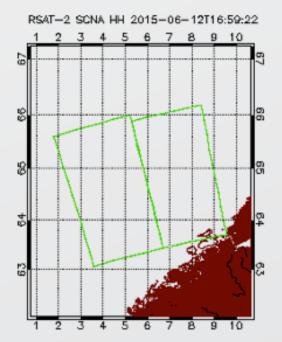
The research shall:

- Develop physical and statistical methodology to improve the reliability of satellite-derived geophysical parameters as well as take advantage of the diversity of observations and account for the multivariate dependencies of the problem.
- Develop algorithms, products and processing system for providing ocean state parameters from satellite observations beyond what is achievable today.
- Perform extensive product calibration and validation analysis.

The methodologies, tools and products developed will be integrated with the sea ice mapping of WP2 and the modelling activities of WP5 (assimilation) to produce information products for the pilot service demonstrations to be performed in WP7.
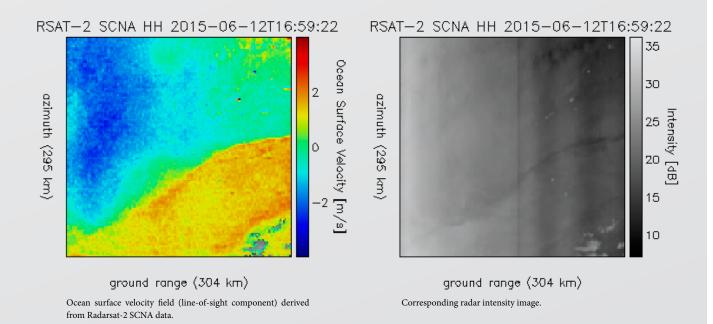
Work and achievements in 2015:

A satellite data-processing system is being developed that is capable of processing sea state information from various satellite missions, with the main focus on the Sentinel 1 and Radarsat missions. A first version is already installed and undergoing tests running on a server at Kongsberg Satellite Services using Radarsat 2 data.

A dedicated calibration and validation campaign, scheduled for April 2016, has been planned in co-operation with WP5. Ocean drifters are ordered and software for colocation and merging of numerical weather model outputs from met.no with satellite observations is under development.

RSAT–2 SCNA HH 2015–06–12T16:59:22

Footprint of the acquisition area of the two SCNA swaths. The data is acquired over Haltenbanken and clearly shows an atmospheric front with rapid change in wind direction over the front.

RSAT–2 SCNA HH 2015–06–12T16:59:22

Ocean surface velocity field (line-of-sight component) derived from Radarsat-2 SCNA data.

RSAT–2 SCNA HH 2015–06–12T16:59:22

Corresponding radar intensity image.

A PhD student (Vegard Nilsen) has been hired, and the PhD project has been defined with the working title "Synergetic sea state retrieval from satellite observations".

The research activities and achievements have been presented at two international workshops. One was given at SOLAB Workshop, St. Petersburg from 23-25 June 2015, and at the 2nd ESA Ocean Current Workshop, Brest on 2-3 Nov 2015 (http://www.congrexprojects.com/2015-events/15c13/proceedings).

WP2
MONITORING SEA ICE AND ICEBERGS

WPLs: Dr. Wolfgang Dierking
AWI/UiT

Assoc. Prof. Anthony Doulgeris
UiT

The objectives of WP2 are to improve the mapping of the temporary variation in spatial distribution of ice types, the retrieval of ice drift velocity (magnitude and direction) and the detection and tracking of icebergs.

Sea ice is a very dynamic medium. Dependent on air temperature and other environmental parameters, ice thickness increases from a few centimetres typical for the stage of a thin, skin-like new ice cover to several metres for multi-year ice that has survived one or more summer melting periods. The major fraction of the Arctic ice cover consists of drifting pack ice moving due to forces exerted by wind and ocean currents. Different zones of ice may drift with different velocities due to spatial variations of the driving forces, while obstacles such as islands, coastlines or icebergs may limit the mobility of fractions of the ice cover. In such situations the ice may break and pile up, forming various compression structures such as linear ice ridges or extended rubble fields that pose a hazard to maritime traffic. Divergent movement of the ice generates open water leads that are preferred pathways for ships navigating in the ice. A systematic analysis and monitoring of Arctic ice conditions thus not only requires the separation of different ice types but also the monitoring of varying ice motion.

Although surveillance techniques have improved considerably since the sinking of the Titanic, icebergs are still a hazard to maritime operations both in the open ocean and in ice-covered waters. Larger icebergs 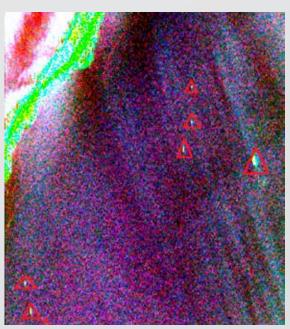with lengths of several hundred metres are relatively easy to detect with modern satellite instruments. Monitoring smaller ones (lengths of less than 100 metres) remains a challenge.

This work is carried out making use of the most recent developments in radar technology. It involves the combination of data acquired with different polarisation and frequencies of the electromagnetic waves transmitted and received by the satellite radar system. Modern statistical methods and image processing techniques are applied to develop robust and reliable procedures for ice type classification, ice drift retrieval, and iceberg detection and tracking, with the radar data as starting point. Supplementary optical and thermal data are used for interpreting and analysing the radar imagery. For an assessment of data products generated on the basis of the developed procedures, field campaigns from ships or coastal test sites in the Arctic are planned to collect in-situ ice data while satellite images are taken. This also includes data taken with remotely-piloted aircraft systems (RPAS). Besides the scientific and technical progress in radar data handling and ice charting, another goal is to optimise the developed procedures such that they can be integrated into the workflow of the operational ice centres.
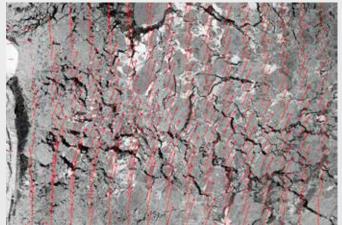
Work and achievements in 2015:

The early stages of the project, even from before the official start in September, involved a great deal of planning towards the early hiring of researchers for WP2. This included one professor II, one postdoctoral researcher and two PhD positions. General project descriptions had to be decided that were distinct and covered the goals for WP2. These were advertised, some jointly with other positions, and the evaluation process took place in late 2015. The professor II position, the first PhD candidate, Johannes Lohse (at UiT in Tromsø) and a postdoctoral researcher, Jean Negrel (at NPI in Tromsø, in collaboration with WP6) were accepted to start from beginning of 2016. The second PhD (at NERSC in Bergen) had not started by the end of year. In addition, various associated positions (funded by other projects) started work towards the goals of WP2, for example on iceberg detection and other sea ice classification work. Collaborations were identified as relevant.
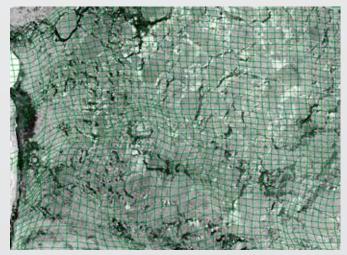
Another significant event in 2015 was the kick-off meeting at the end of November. Work towards this meeting involved producing a roll-up style poster representing WP2. This meeting generated quite productive discussions for WP2, in particular in connection to modelling in WP5 and questions and preferences from the industry partners. These ideas are being considered in further WP2 planning.
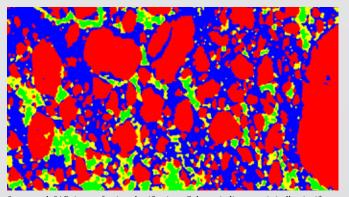

Ice drift vector fields are used to depict the direction and rate of ice drift.
Figure: Jakob Griebel, AWI

Ice deformation grid maps can be used to indicate movement and stress within the icepack. Figure: Jakob Griebel, AWI

Segmented SAR image for ice classification. Colours indicate statistically significant differences in radar signatures. Figure: Anthony Doulgeris, UiT

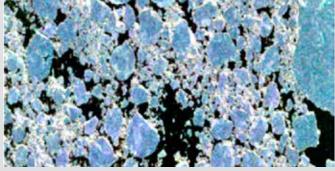Coloured polarimetric SAR scene with detected icebergs, marked by red triangles. Figure: Vahid Akbari, UiT

Polarimetric SAR image showing loosely assembled sea ice floes.
Figure: Anthony Doulgeris, UiT

WP3

OIL SPILL REMOTE SENSING

WPLs: Assoc. Prof. Camilla Brekke
UiT

Dr. Christian Petrich
Norut Narvik

The objectives of WP3 are to develop techniques for reliable oil spill detection and characterisation, and to improve the modelling of oil in sea ice-covered waters.

Oil can be released into the marine environment during accidents in connection with oil production or transportation, or when done intentionally (often by illegal dumping from ships). Remote sensing is a valuable tool for detecting illegal oil spills and for monitoring an oil slick during a clean-up operation. Satellite synthetic aperture radar (SAR) data is used for oil spill detection on the open ocean on a daily basis. However, more innocent, natural phenomena such as thin, newly-formed sea ice can be mistaken for oil in SAR images. In addition, there is currently no method for obtaining information on oil spill properties such as thickness from these data. Therefore, further research on these topics is needed.

As human activity, e.g. the shipping and petroleum industries, is moving further north, the task of oil spill detection in ice-covered regions is also becoming more relevant. Although SAR is used operationally for detecting oil spills on the open ocean, there are no proven and available remote sensing technologies for detecting oil under ice or snow. Different types of sensors may be needed and various solutions may be advantageous depending on season, ice conditions and the distribution of oil in ice (under, in or above). Experiments are needed to understand how oil behaves in ice and how different sensors can be used to observe a surface of oil and ice.

Within WP3, techniques for detection and characterisation of oil spills on open water and in sea ice regions will be studied. The work will be based on data collected during large-scale campaigns in the North Sea and Framstrait, as well as ice tank experiments.

Work and achievements in 2015:

An important activity for WP3 in 2015 was data collection during the Norwegian Radar Oil Spill Experiment 2015 (NORSE2015). This was a dedicated remote sensing experiment that took place during the annual oil-on-water exercise conducted by the Norwegian Clean Seas Association for Operating Companies (NOFO) in the North Sea. It was a collaboration between NOFO, UiT and the Jet Propulsion Laboratory (JPL) / National Aeronautics and Space Administration (NASA). Oils of different origin and properties were released onto the surface and imaged from both airborne and satellite borne sensors. The NASA Uninhabited Aerial Vehicle Synthetic Aperture Radar (UAVSAR), which is mounted on an aircraft, was airborne for several hours after the releases were made. This resulted in a very interesting time series of the developing slicks. The NORSE2015 data set will be used for a number of interesting analyses, including evaluation of the effect that different sensor properties,

slick characteristics and weather conditions have on the ability to detect and characterise oil spills. The experiment was presented at the International Geoscience and Remote Sensing Symposium (IGARSS) in Milan in July 2015.

During the second half of 2015, the work on analysing the data from the 2015 campaign started, including:
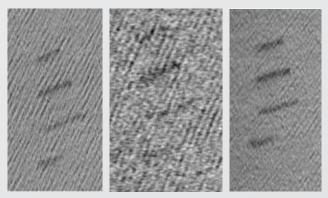
- Comparison between conventional quad-polarisation data and the more recently available compact polarisation data. This is important for increasing the knowledge on the possible use of these new products, which are of special interest as they allow imaging of larger areas on the ground than the quad-polarisation mode.
- Comparison of near coincident images from different sensors and different frequency bands, to increase the knowledge on the use of different sensors, their advantages and limitations.
- Investigation of data acquired under high versus low wind speed conditions. Wind speed is an important factor for SAR imaging over the oceans and oil spills can only be detected within a limited range of wind conditions. Therefore, increasing the knowledge on the applicability of different data types and methods under various wind conditions is important to improve the reliability of the operational services.
- Investigation into how the oil spill age affects different parameters extracted from the SAR data. As the properties of an oil spill continuously change as the spill ages and weathers, it is important to increase the knowledge of how this may affect the SAR imagery and methods based on these, to improve the reliability of the data interpretation.
- Comparison between modelled oil spill drift using buoys and actual drift observed in the SAR imagery. This can be used to assess how well the buoys actually predict the oil drift, and to improve oil spill drift models.
- Estimation of oil volume content in emulsions from multi-polarisation SAR, which is an important step towards quantitative characterisation of oil spills.

SAR data were collected during NORSE2015 using the NASA UAVSAR. Photo: Armstrong Flight Research Center NASA.

SAR images from NORSE2015 acquired from three different sensors less than six minutes apart. Left:UAVSAR , middle: Radarsat-2, right: TerraSAR-X. The four dark patches are experimental oil spills with different properties. UAVSAR data are courtesy of NASA/JPL-Caltech. Radarsat-2 Data and Products ©MDA LTD. (2015). All rights reserved. TerraSAR-X ©2015 Distribution Airbus DS, Infoterra GmbH.

Photo of NORSE2015 oil spill taken shortly after release. Photo: Øyvind Breivik, MET Norway.

Oil on melting ice in early June 1975 following oil releases through the winter. Note people on the ice for scale. Photo: D. Dickins.

Aerial photo of an oil release during the NOFO oil-on-water exercise in June 2015. Photo: NOFO oil-on-water exercise, LN-KYV.

WP4

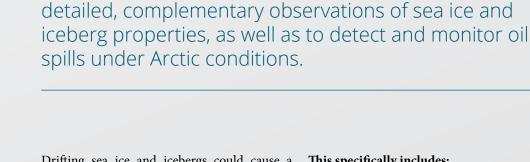# REMOTELY PILOTED AIRCRAFT SYSTEMS (RPAS) TECHNOLOGY

WPLs: Dr. Rune Storvold
Norut

Prof. Tor Arne Johansen
NTNU

The objectives of WP4 are to develop robust and efficient RPAS platforms and sensors that can handle the widest possible range of environmental conditions. They are to be integrated into an observing system to enable detailed, complementary observations of sea ice and iceberg properties, as well as to detect and monitor oil spills under Arctic conditions.

Drifting sea ice and icebergs could cause a threat to ships and installations. Hence, detailed knowledge of position and properties of the ice is critical for managing the operation in a safe and cost-effective manner. RPAS have the potential to achieve accurate high-resolution surveillance measurements, but have limitations when it comes to spatial coverage and range, and they are weather-sensitive. Systems needed by operators in the Arctic must be robust and reliable, and able to handle disruption in service by individual components.

This specifically includes:
Platform improvements:
- Icing detection, icing avoidance and de-icing.
- Improved wind tolerance.
- Improved fault tolerance.
- Ship take-off and landing capabilities.
- Improved communication links, robustness and bandwidth.

Sensor improvements:
- For ice thickness measurements.
- Iceberg tracking.
- Oil spill thickness distribution.
- Oil spills in partly ice-covered areas.
- Ocean wave heights and wave spectra.
-

Operational improvements:
- Concepts of operation that allow integration in non-segregated airspace.
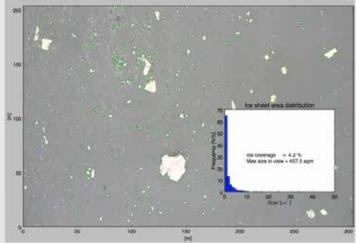- Onboard processing and data.

Work and achievements in 2015:

The WP4 CIRFA team, in collaboration with Arctic EO and AMOS teams, performed a one-week field campaign in Ny-Ålesund from 22–29 September. The objectives were to:

- Fly over icebergs and growlers in the inner part of Kongsfjorden to collect optical data for estimation of positions and sizes of icebergs. The data collection by RPAS was timed to coincide with RadarSAT overpasses which would allow validation of detection performances of satellite-based iceberg detection algorithms.
- Test the use of the Radionor MBR radio under Arctic conditions, both as a relay for RPAS and the coverage and range from Havnerabben airfield.
- Conduct initial field tests on the carbon coating de-icing system in the Arctic.
- Conduct initial Arctic field tests of the NTNU sensor feedback system for iceberg tracking.
- Work was also done to:
- Prepare the Cryowing Explorer aircraft with a new autopilot and capabilities for auto-landing.
- Develop a new payload module for the Cryowing Scout to enable
  - sensor-based feedback navigation and increased compatibility with the NTNU system.
  - better control of sensors and increased accuracy of metadata due to improved time-stamping accuracy which will allow results and data to be more easily transferred across the consortium.
- Prepare and plan the icing tunnel experiment, as well as the 2016 field activities and priorities.
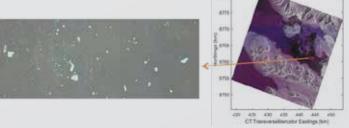
Scout flight for mapping sea ice and glaciers. This figure shows the the flight path in Kongsfjorden, Svalbard. An automatic algorithm has been developed for fast detection and size estimation of icebergs/growlers. Work is ongoing on coupling of autopilot metadata and videostreams to achieve accurate geolocation information in near real time.

Icebergs and growlers detected in videostream.

Kjell-Sture Johansen and Rune Storvold prepares the Cryowing Scout for flight outside the new ASUF Facility in Ny-Ålesund. Photo: Pål Kvaløy, NTNU

RPAS image with 300 m swath and 5 cm resolution captured from 300 m altitude and a Radarsat fine quadpol image covering Kongsfjorden, 12 m resolution 25 km swath width.

NTNU X8 ready for flight in Ny-Ålesund. Photo: Kim Sørensen, NTNU.

WP5

DRIFT MODELLING AND PREDICTION

**WPLs: Dr.
Kai Christensen**
MET NORWAY

Prof. Rune Graversen
UiT

The objectives of WP5 are to assimilate observations collected within CIRFA into an ocean ice forecast model and to produce probabilistic ocean, sea ice and drift forecasts.

The ocean and sea ice forecast models at MET Norway will assimilate new satellite-based information obtained in CIRFA to improve the models' forecasting capabilities. The main aim of WP5 is to develop an integrated geophysical modelling system that provide a basis for downstream services such as iceberg and oil spill drift applications. Central to this development is a so-called ensemble prediction system (EPS), in which several instances of the ocean and sea ice models are run simultaneously to assess the uncertainties in the forecasts.

WP5 contains three main tasks:
1. EPS-based ocean forecast system with variational data assimilation.
2. EPS-based sea ice forecast system with Kalman filter data assimilation.
3. EPS-based forecast system for Lagrangian drift (oil spills, icebergs, search and rescue).

A dedicated high resolution ocean-sea ice modeling system is being configured for CIRFA related work. This regional modeling system will utilize the detailed observations that will be made available in CIRFA. It will be forced by a fully coupled surface wave/atmospheric circulation model and nested into state-of-the-art basin scale ocean model.

Work and achievements in 2015:

A field experiment using satellite-tracked drifting buoys was carried out in the summer of 2015 as part of the annual NOFO oil-on-water experiment (in collaboration with WP3). Two types of drifting buoys, spherical floating drifters (iSpheres) and CODE drifters were deployed at locations where NOFO released oil. These two drifter types sample the Lagrangian currents at the surface and about 70 cm depth respectively. Preliminary results support the previous claims that the near-surface oil concentration profile is of critical importance for correctly modelling oil spill drift, and that the upper ocean mixing and wave-induced drift must be properly resolved to achieve good results (e.g. Drivdal et al., Ocean Sci., 10, 2014).

Satellite-tracked drifting buoys. The spherical orange drifter is an iSphere and the cardboard cylinder contains a CODE type drifter of the same type as that deployed in summer 2015. From the 2013 Eni/NOFO HF radar experiment. (Courtesy K.H. Christensen)

A PhD student, Sindre Fritzner, was appointed within WP5 in January 2016. He will work on improving forecasts of sea ice and ocean
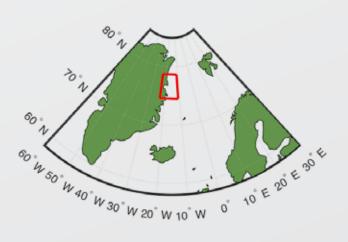
currents in the Arctic by taking into account modern remote sensing observations of sea ice. The predictions are based on a coupled ice-ocean model system and the quality of the predictions is dependent on the initialisation of the model. The initial model state should be as close to reality as possible, which is pursued by implementing sea ice and ocean observations by a mathematical procedure, referred to as data assimilation. In the coming year, we will develop and test procedures for assimilating satellite-based sea ice observations into a state-of-the-art sea ice model that will be used within the sea ice-ocean forecast system.
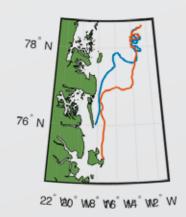
A unified framework for ocean drift applications is under development within CIRFA WP5. This framework (OpenDrift) will be used for a range of drift applications, including oil, icebergs and search and rescue (man-over-board, lifeboat etc.). OpenDrift has been adapted to be able to take input from any atmospheric, wave and ocean models relevant for the Arctic. Some first model tests have been made with drifting oil encountering sea ice from the Arctic Ocean model of MET Norway and will provide the basis for more sophisticated parameterisation of oil-ice interaction to be developed. A foundation has also been laid to take input from ensemble ocean and atmospheric models, which will give a more realistic picture of the uncertainty and variability of the drift trajectories.

A second PhD student, Runa Skarbø, has been appointed in WP5 at CIRFA. She started her work in October 2015 and her research project will be on ice drift prediction. Her main work in 2015 has been related to courses and working out the project plan for her PhD. She also drafted a conference paper for the IAHR ICE 2016 on drift prediction of icebergs and ice floes in the Greenland Sea.
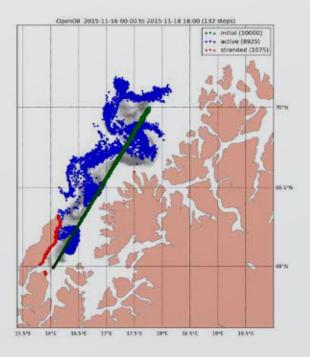
Observed drift trajectories of an iceberg (in blue) and an ice floe (in red) from a field survey in 2013. Drift models for icebergs and sea ice are being developed within WP5. (Courtesy R. Skarbø)

Satellite tracked drifting buoys. The spherical orange drifter is an iSphere and the cardboard cylinder contains a CODE type drifter of the same type as was deployed in summer 2015. From the 2013 Eni/NOFO HF radar experiment. (Courtesy K.H. Christensen)

The image shows a simulation of drifting oil (blue dots, grey trajectories) released from a ship sailing along the coast of Troms (green dots), with some oil stranding on the coast (red dots). (Courtesy K.-F. Dagestad)

WP6
DATA COLLECTION AND FIELD WORK

WPLs: Dr. Sebastian Gerland
NPI

Assoc. Prof. Camilla Brekke
UiT

Dr. Rune Storvold
Norut

The main objective of WP6 is to organise dedicated field campaigns on Arctic sea ice to combine accurate direct measurements of sea ice properties, remotely-operated aircraft (RPAS or UAV) and satellite data, and improve validation shortcomings by seeking new and refined methods.

This work package deals with the design of focused remote sensing validation measurement setups in connection with field campaigns and which ensure remote sensing coverage to relevant scales in space and time. Partners centrally involved in this work package are the Norwegian Polar Institute, Norut, and UiT, The Arctic University of Norway. Several other CIRFA partners are also involved.

New Earth observation algorithms need to be validated through comprehensive testing. However, it is not always easy to obtain sufficient and proper ground truth and validation data for these purposes. This CIRFA work package is meant to highlight the importance of carefully designed field campaigns in connection with satellite and RPAS measurements, and to actually plan and conduct such field campaigns. The Arctic sea ice is highly dynamic, with rapidly changing shape, physical and mechanical properties. This leads to a changing appearance, on time scales from minutes to hours, seasons and decades.

In CIRFA, this work package functions as a validation and calibration platform for remote sensing data, as well as giving ground truth data for assessing the work conducted in other work packages. Besides new expeditions to be conducted by CIRFA, long-term monitoring data from land stations are also planned to be used for calibration and validation purposes, or at least to support the work. Data collected are to be used by CIRFA in the assessment and validation of algorithms and RS products. Data come from the N-ICE2015 expedition and annual campaigns of the Norwegian Polar Institute, the annual oil-on-water exercises in the North Sea and from other national and international projects (such as the planned MOSAiC drift in 2019-20, see www.mosaicobservatory.org) and data providers.

Work and achievements in 2015:

A major part of the work in WP6 was the planning of fieldwork to be performed in 2016. Activity that gives access to sea ice-covered areas in 2016 include fjord ice work off Svalbard (Kongsfjorden), and studies on drifting sea ice and iceberg-fast sea ice in Fram Strait.

Information about the fieldwork component of CIRFA was given to PhD students and

Physical properties of sea ice are crucial to understanding the state of the ice. They also affect remote sensing imagery. Here, the temperature-depth profile of the ice is measured on a newly-drilled ice core in Fram Strait, the region between Greenland and Svalbard. The Norwegian Polar Institute runs annual cruises to Fram Strait with its research vessel Lance. Photo: Sebastian Gerland, Norwegian Polar Institute.

postdoctoral researcher candidates at the kick-off meeting of CIRFA.

An important step for this WP in 2015 was the employment process for the postdoctoral research scientist at the Norwegian Polar Institute. The processes were completed with the hiring of Jean Negrel as sea ice remote sensing postdoctoral researcher. He took up his position 1 February 2016.

At an invited talk (Gerland et al. 2015) at the Fall Meeting of the American Geophysical Union (AGU) in San Francisco, an overview of the sea ice physics work during N-ICE2015 was given. CIRFA activity is connected to this work, and the data used for satellite remote sensing calibration and validation was highlighted.

Sea ice thickness measurements are done along transects using an electromagnetic technique. Here, surveys were made during the N-ICE2015 expedition, where the research vessel Lance was frozen into drifting sea ice north of Svalbard. Results will be merged with information from helicopter surveys and remote sensing imagery, and parts of this are also used within CIRFA. Photo: Sebastian Gerland, Norwegian Polar Institute.

Icebergs such as this can be seen in western Fram Strait. Once grounded, they play a role for the sea ice, such as holding fast sea ice in place. The photo illustrates the difference in the appearance of sea ice in the foreground and the iceberg. Photo: Sebastian Gerland, Norwegian Polar Institute.

WP7

PILOT SERVICE DEMONSTRATION

WPLs: Dr. Mari-Ann Moen
KSAT

Dr. Nick Hughes
MET.no

The main objective of WP7 is to demonstrate the provision of and prepare for an integrated remote sensing service that complies with the stringent demands in Arctic regions.

Satellite-based operational capabilities including oil spill detection, ship traffic monitoring and sea ice mapping have been demonstrated and developed into regular use. However, there are still requirements for industrial maritime operations that have not been met. Oil and gas companies operating in the environmentally sensitive Arctic areas need monitoring technologies integrated into their day-to-day operations for operational decision support.

The main objective of WP7 is to demonstrate the provision of and preparation for an integrated remote sensing service that complies with the stringent demands in Arctic regions.

The service will be based on multi-sensor data acquired from various sensors and platforms, accessed via improved communication infrastructure and brought into analysis and decision though dedicated interfaces.
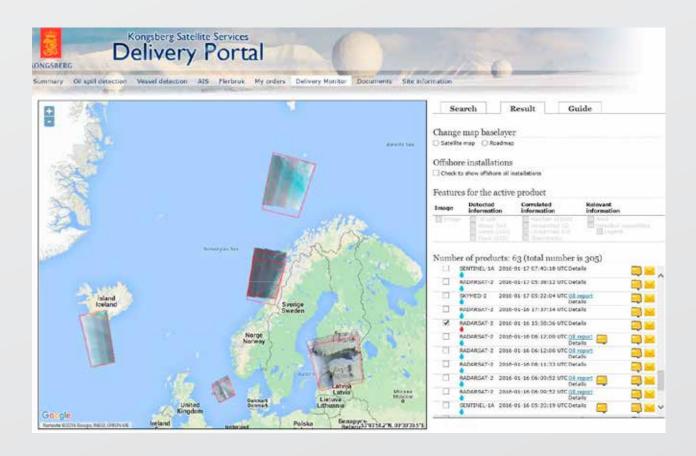
The R&D results from the other work packages in CIRFA form the basis of the pilot service demonstration. New integrated remote sensing services will be tested out in an operational setting. The output information will be distributed to end-users, who in turn will provide feedback on the operational utility and usefulness of the information. Based on their assessments, further development and/or

improvement may be necessary before services are developed for operational use.

An additional objective of WP7 is to establish an infrastructure that allows the WP partners to access and perform processing on the project data in a technically efficient way close to the data storage. The traditional approach for EO-based research and development has been to distribute the actual data from the reception and archiving facilities to the research scientists. The new generation of missions like the Sentinels creates large data volumes: several terabytes per day. Following the traditional multiple data dissemination approach would imply repeated dissemination of large volumes of data, which is time-consuming and requires large and costly communication infrastructure.

Work and achievements in 2015:

During the first phase of CIRFA, quite a different approach has developed. Instead of disseminating the data to the partners, the preference is to establish an infrastructure framework that will allow the CIRFA research activities to assess the satellite data close to where they are stored. The first activity in this work package will therefore be to make an assessment of how this could be implemented.

One solution now being discussed is to extend the "KSAT cloud system" to include a capacity for CIRFA data access and processing activities. This will allow the CIRFA partners to access and perform processing close to the data stored at KSAT. It is recognised that limited resources have been allocated within CIRFA for implementing and operating this solution. Additional resources will be needed and an important outcome of this activity will be a model for how such an establishment should be implemented and operated. The initial assessment has been initiated and it is planned to have initial infrastructure available before mid-2016.

The first picture above illustrates the Earth observation service operations production at KSAT in Tromsø. The second picture illustrates the web-based service portal applied by KSAT for maintaining the information flow to the customers. WP7 from CIRFA is expected to do come up with innovative ways of providing Earth observation services and communicating with customers.

PRESENTATION OF TWO YOUNG SCIENTISTS

Martine Mostervik Espeseth

Martine Mostervik Espeseth (25) started her PhD in CIRFA WP3 in December 2015, and will spend the next four years doing research on oil spill detection and characterisation using SAR. Her main focus will be on compact polarimetric data.

Why did you want to do a PhD on this topic?
I did my Master's degree at UiT on the same topic. After finishing my Master's thesis, I was curious to know more about this field. I knew that I was far from done with this topic and ultimately chose it as my main area of interest.

Why is your research important and how can it be used operationally?
To find good and efficient ways of detecting and characterising various oil types in different conditions is an important task, both for industry and for the environment. My research can improve the process of detecting and understanding oil slicks in SAR data. This might help decrease the response time when an oil spill occurs, and result in better decision-making.

What are you currently working on?
I am currently on an exchange at NASA Jet Propulsion Laboratory (JPL) working with the UAVSAR time series collected during NORSE2015. I compare different parameters that may be useful for oil spill detection and classification, including how they change as the slick properties vary over time.

What is your goal for your PhD, what do you hope to achieve?

My main goals and hopes are to acquire new academic skills, as well as increasing connections with people from the industry and academia. I also want my research to be a contribution to the remote sensing field.

What are you looking forward to in 2016?
I am looking forward to just being here, acquiring new skills and talking to the people around JPL. To be at JPL is an incredible experience, and I feel really privileged to be here. I'm also looking forward to submitting my first journal paper, and to starting to teach students when back at UiT.

CIRFA PhD student Martine Mostervik Espeseth is currently studying abroad at NASA Jet Propulsion Laboratory (JPL) in California. From left: Martine Espeseth, Brittany Zajic, Mark Barker, Erika Higa, Steven Kerns, Nick Rousseau, Christine Elowitt and Emily Beck.

Johannes Lohse (29) started his PhD in CIRFA WP2 in January 2016, and will spend the next four years doing research on sea ice classification using SAR.

**Johannes
Lohse**

Johannes, where do you come from, and what is your educational background?

I come from northern Germany. I studied Geophysics at the University of Hamburg and spent one year in Longyearbyen at UNIS, specialising in polar geophysics. Ever since my stay on Svalbard I have been hooked on everything related to polar research. For my Master thesis I conducted a measurement campaign on Ekstrømisen, Antarctica, acquiring ice thickness data and investigating the influence of tidal motion on the flow velocity of the ice shelf. After finishing my Master's I returned to Antarctica and wintered at the German research base "Neumayer III", operating the geophysical observatory for 14 months.

Why did you choose UiT/CIRFA for your PhD studies?

I wanted to conduct a PhD study in a sea ice-related topic and UiT/CIRFA offered a perfect opportunity to do this. I find it a lot easier to focus on the work when I am living in an area or environment that is actually linked to the theme I am working on. So in some ways I would say doing research on sea ice is a lot easier for me here in Tromsø than it would be in Germany.

Furthermore, I think that the scientific education differs between universities and I therefore liked the idea to do my PhD somewhere other than where I did my Master. I feel that in this way I can learn a lot of new things and I hope I can also bring new aspects and ideas into the Earth Observation group here at UiT.

Could you please briefly describe your project?

In my PhD project I am working on sea ice classification from SAR data. First I will focus on fully polarimetric SAR data, using polarimetric features to test and improve existing algorithms or develop new strategies for sea ice segmentation and classification. While segmentation in this case implies clustering pixels with similar statistical properties of polarimetric features, classification requires labelling these segments with respect to their ice type. The classification therefore requires an understanding of the relation between features and ice types.

Later stages of my project will involve tests of classification algorithms under varying acquisition conditions of the SAR data (e.g. changing incidence angles or different frequencies) and to go from fully polarimetric to dual-polarised data or compact polarimetry in order to get larger spatial coverage on the ground.

What benefits do you expect from this work for your professional development?

In the first place, I hope that working on this project will give me a chance to improve my knowledge and understanding of sea ice physics in general. With a more pronounced background in solid earth geophysics and a lot of previous fieldwork experience, I am also looking forward to improving my skills in statistical methods and to working with remote sensing in order to obtain expertise in these fields.

The CIRFA organisational structure is designed to involve all partners in an efficient way and to ensure that the Centre: 1) coordinates legal, contractual, research and technology development, patent applications, ethical, financial and administrative work; 2) organises and completes tasks within deadlines, resources and quality levels; 3) optimises future innovation and value creation for the user partners, other segments of Norwegian business and society; and 4) delivers reports that meet expected quality standards.

The day-to-day CIRFA management group consists of the Centre Leader, Prof. Torbjørn Eltoft, work package leaders and administrative coordinator. There are fortnightly management meetings where the management group gets together in person and videoconference.

The CIRFA organisation consists of the following bodies:

Centre Board (CB):

The CB is CIRFA's main decision-making body. The CB consists of representatives from the user partners and research partners. The firm members of the CB are representatives from UiT (Chair), Norut, ENI, Statoil, KSAT and Multiconsult. Partners not represented on the Board have the right to attend the meetings as observers. The CB meets at least twice a year.

The CB is in charge of the overall direction of the centre. In particular, the CB is responsible for:

- Monitoring and developing the centre strategy, research training, finances and budget, and ensuring a recruitment policy that takes account of gender balance.

- Ensuring maximum dissemination and knowledge development important for future innovation and value creation for the user partners, other segments of Norwegian business and society.
- Ensuring that the intentions and plans underlying the contract for the project are fulfilled and that the activities discussed in the project description and the funding plan are completed within the approved time frame.
- Ensuring that CIRFA operates according to high ethical standards in all of its activities.
- Ensuring that none of CIRFA's activities cause any harm to humans or the physical environment.

General Assembly (GA):

The GA serves as an arena for information exchange (results and ideas) between the research partners and industry partners. All industry partners and research partners have the right to attend the GA. Scientific results presentations and progress reporting are essential parts of the

GA meeting agenda. The GA elects members of the Centre Board. The Centre Leader arranges regular meetings (at least yearly).

Scientific Advisory Board (SAB):

A SAB consisting of international experts with outstanding reputations in the relevant fields (RS, forecast modelling, RPAS technology) has been established to ensure excellence in research. The SAB will provide scientific input, review progress reports and provide support for networking and internationalising the Centre's activities. The Centre Leader arranges regular meetings (at least yearly). The SAB members are presented on the next page.

Innovation Advisory Board (IAB):

The IAB will have representatives from the industrial partners plus external experts on innovation. The role of the IAB is to help bridge the gap between research and innovation, in particular by:

- Providing input and ideas on technical developments, and discussing project progress with the Centre Leader and Work Package leaders.
- Evaluating project results for (preferential) use and development by the user partners.
- Identifying innovation with potential for commercial utilisation and making recommendations for alternative routes for protection and technology transfer.

The Centre Leader arranges regular meetings (at least yearly).

It is up to the Centre Board to decide that a result is of commercial value and shall be protected in the manner and to the degree that is deemed appropriate.
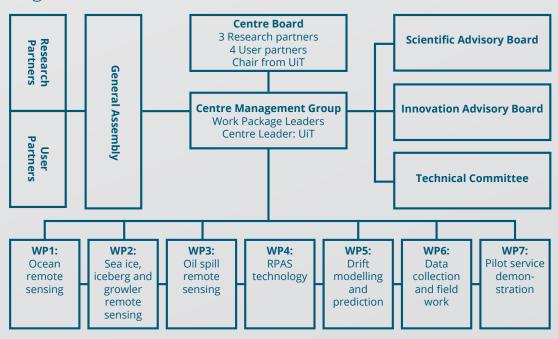
Technical Committee (TC):

The involvement as well as the valuable feedback from each of CIRFA's partners is important to make sure that the activities and results are relevant for the user partners as well as for the scientific community. The TC is an arena where technical staff from the user partners meet with scientific personnel from the research partners. Three TCs have been established based on the application domains of CIRFA:

- Ocean Remote Sensing.
- Sea Ice, Iceberg and Growler Remote Sensing.
- Oil Spill Remote Sensing.

The role of the TCs is to provide a link to related activities and user partners' needs, ensuring the relevance of research for the application domains and to make recommendations for new actions and activities.

Organizational chart

PRESENTATION OF THE SCIENTIFIC ADVISORY BOARD

Prof. Dr. rer. nat. Irena Hajnsek has been Professor of Earth Observation at the Swiss Federal Institute of Technology (ETH) Zürich, Institute of Environmental Engineering since November 2009, and at the same time head of the Polarimetric SAR Interferometry Research Group at the German Aerospace Center, Microwaves and Radar Institute. Her main research interests are in electromagnetic propagation and scattering theory, radar polarimetry, SAR and interferometric SAR data-processing techniques, environmental parameter modelling and estimation. She gained her Dipl. degree (Honours) in 1996 from the Free University of Berlin, Germany, and the Dr. degree (Honours) in 2001 from the Friedrich Schiller University of Jena, Germany. Since 2010 she has been the science coordinator of the German satellite mission TanDEM-X. She was Technical Programme Co-chair of the IEEE IGARSS 2012 Symposium in Munich. She has been a member of the IEEE GRSS AdCom since 2013.

Dr. Charlotte Hasager is senior researcher at the Wind Energy Division, Risø National Laboratory for Sustainable Energy, part of the Technical University of Denmark, Roskilde. She received her M.Sc. and PhD from the University of Copenhagen's Institute of Geography in 1992 and 1996 respectively. Her area of specialisation is satellite remote sensing, micrometeorology, turbulence and wind energy – in particular offshore and wind at high levels. Dr. Hasager has been employed at Risø since 1993 and was a visiting scholar at the Department of Meteorology, Pennsylvania, USA, in 1995. She has been involved in the international projects EU-Norsewind, EU-WEMSAR, EU-WATERMED, EU-MEAD and ESA EOMD EO-Windfarm. She is Principle Investigator of the national projects SAT-MAT-CLIMATE, SAR-WAKE, SAT-WIND, 12MW, Satellite Eye for Galathea 3 and VirtualGalathea3. Dr. Hasager was elected President of the Atmospheric Science Division at the European Geosciences Union in 2007-2011, was Co-Chair for Wind Energy

Community of Practice (WECP) at Global Earth Observation (GOSS) in 2005 and member of the steering committee of the Danish Space Consortium from 2003 to 2010. She has more than 200 publications in this area.

James Maslanik is affiliated with the University of Colorado in Boulder, Colorado, USA, where he holds the title of Emeritus Research Professor in the Department of Aerospace Engineering Sciences, having recently retired after over 30 years in polar research. His studies have focused on the use of satellite and aircraft data to observe sea ice characteristics, including physical properties such as ice type, age, thickness and ridging, as well as on investigations of regional to hemispheric-scale variability in response to climatic conditions. A particular emphasis of his work has been on the use of unmanned aircraft as research platforms for studies in the Arctic and Antarctic.

Henning Skriver (M'09) gained M.Sc. degree and PhD in electrical engineering from the Technical University of Denmark (DTU), Kongens Lyngby, Denmark, in 1983 and 1989 respectively. Since 1983, he has been with DTU as Associate Professor, the Head of Microwaves and Remote Sensing, and the Deputy Head of Department at the National Space Institute. His work has been primarily concerned with topics related to the utilisation of SAR data for different applications. These include sea ice parameter retrieval from SAR data, as well as different aspects of land applications of SAR data, such as forestry, agricultural, environmental and topographic mapping applications using both satellite SAR data and data from polarimetric SARs, e.g. the Danish airborne polarimetric SAR, EMISAR and the German experimental SAR ESAR. His research interests include methods for the processing of SAR data, SAR image simulation, SAR image filtering, speckle statistics and texture analysis, segmentation, calibration, change detection, classification and polarimetric analysis and processing.

Prof. Dr. rer. nat. Irena Hajnsek

Dr. Charlotte Hasager

James Maslanik

Henning Skriver

CIRFA EVENTS 2015

Partner meeting, 25 February 2015

The meeting took place in Linken at Forskningsparken in Tromsø, and had representatives from almost all partners in CIRFA. The main objective of the meeting was to meet physically and exchange ideas about the project, get a common understanding of the work to be done within the SFI and discuss issues related to organisation and management.

From top left: Harald Johnsen, Nick Hughes, Kai Christensen, Thomas Kræmer, Torbjørn Eltoft, Camilla Brekke, Anthony Doulgeris, Christian Petrich and Marit O. Helgesen.

Official Opening of CIRFA, 13 November 2015

The opening ceremony of CIRFA was held on 13 November 2015 in the new Technology building on the UiT campus. State Secretary Dilek Ayhan, the Norwegian Ministry of Trade, Industry and Fisheries, Rector Anne Husebekk, UiT The Arctic University of Norway, and Department Director Elise Husum, Research Council of Norway, performed the official opening of the centre. The event gathered an audience of about 60 people, including the Mayor of Tromsø, Jarle Aarbakke. Almost all partners were present.

From left: Torbjørn Eltoft, CIRFA; Anne Husebekk, Rector at UiT; Elise Husum, Deputy Director of the Research Council of Norway. Photo: Torger Grytå

CIRFA kick-off meeting

The CIRFA kick-off meeting took place from 30 November-1 December 2015 and gathered all partners of CIRFA. The meeting was held in the Technology Building (TB) on the UiT campus and the first day consisted of quite in-depth presentations of the whole Centre and the research plans of its various work packages. Day one ended with a social gathering in the evening in the staff room of the. The second day was allocated to interdisciplinary package discussions and resulted in several interesting initiatives for interdisciplinary package collaborations.

The participants at the CIRFA kick-off meeting in November with representatives of all partners.

Communication and dissemination activities

The nature of the results means they will be available through different channels and to different audiences, through CIRFA-organised workshops, conference contributions and the CIRFA website.

The CIRFA website cirfa.uit.no provides external information, with the intention of presenting the centre's activities. We will strive to disseminate published results on this website as well as regular newsletters. A first version of a CIRFA brochure has been published on cirfa.uit.no and distributed at relevant events. The brochure gives a brief overview of the centre's objectives, work packages and consortium.

Results are already starting to appear and in 2015 one paper was accepted in a peer-reviewed journal (published in 2016). CIRFA staff have been active in conferences such as IGARSS 2015, POAC 2015 and the ALOS-2 workshop. Please see the list of publications below for a complete list.

A SharePoint intranet site was established from the very beginning to secure a good flow of information between the partners. The intranet includes results, meeting planning and minutes, plans, reports and a project calendar containing deadlines for reports, official CIRFA meetings, etc. Board members and work package leaders have access to the intranet, and it is planned that all participants involved in CIRFA will gain access at a later stage.

Other important communication arenas between the academic and industrial partners include a PhD/postdoctoral research forum, consortium board meeting, the CIRFA Annual Workshop, technical committees and Innovation Advisory Board.

The participants at the kick-off meeting in November with representatives from all partners.

Key figures

Key researchers

Name	Institution	Main research area
Torbjørn Eltoft	UiT	Centre Leader, WP2 Sea ice remote sensing
Harald Johnsen	Norut	WP1 Ocean remote sensing
Wolfgang Dierking	AWI/UiT	WP2 Sea ice remote sensing
Anthonoy Doulgeris	UiT	WP2 Sea ice remote sensing
Camilla Brekke	UiT	WP3 Oil spill remote sensing
Christian Petrich	Norut Narvik	WP3 Oil spill remote sensing
Rune Storvold	Norut	WP4 RPAS technology
Tor Arne Johansen	NTNU	WP4 RPAS technology
Svein Jacobsen	UiT/Norut	WP4 RPAS technology
Kai Christensen	MET	WP5 Modelling
Rune Graversen	UiT	WP5 Modelling
Sebastian Gerland	NPI	WP6 Data collection and field work
Jan Petter Pedersen	KSAT	WP7 Pilot service demonstration
Nick Hughes	MET	WP7 Pilot service demonstration
Mari-Ann Moen	KSAT	WP7 Pilot service demonstration

Visiting Researchers

Name	Affiliation	Nationality	Topic
Cathleen E. Jones	Jet Propulsion Laboratory, California Institute of Technology, USA	USA	WP3 Oil spill remote sensing
Benjamin Holt	Jet Propulsion Laboratory, California Institute of Technology, USA	USA	WP3 spill remote sensing
Dingsheng Hu	Institute of Electronics, Chinese Academy of Sciences (IECAS), Beijing, China	China	WP2 Sea ice remote sensing
Boularbah Souissi	Faculty of Electronics and Computing, USTHB university, Algiers, Algeria	Algeria	WP2 Sea ice remote sensing
Wenhai Lang	Hefei University of Technology, Hefei, China	China	WP2 Sea ice remote sensing

Postdoctoral researchers linked to CIRFA

Name	Gender	Topic
Stine Skrunes[1]	F	WP3 Oil spill remote sensing
Jean Negrel[1]	M	WP2 Sea ice RS/WP6 Data collection
Malin Johansson[2]	F	WP3 Oil spill remote sensing
Vahid Akbari[2]	M	WP2 Sea ice remote sensing

PhD students linked to CIRFA

Name	Gender	Topic
Martine Mostervik Espeseth[1]	F	WP3 Oil spill remote sensing
Sindre Fritzner[1]	M	WP5 Modelling
Johannes Lohse[1]	M	WP2 Sea ice remote sensing
Vegard Nilsen[1]	M	WP1 Ocean remote sensing
Runa Skarbø[1]	F	WP5 Modelling
Alberto Arienzo[1]	M	WP3 Oil spill remote sensing
Richard Hann[1, 3]	M	WP4 RPAS
Thomas Lavergne[1, 3]	M	WP5 Modelling
Xu Xu[2]	M	WP2 Sea ice remote sensing
Temesgen Gebrie Yitayew[2]	M	WP2 Sea ice remote sensing
Thomas Kræmer[2]	M	WP2 Sea ice remote sensing
Jakob Grahn[2]	M	WP2 Sea ice remote sensing

[1] PhD and postdoctoral researchers with financial support from the CIRFA budget

[2] PhD and postdoctoral researchers linked to CIRFA, but with financial support from other sources: UiT, NORUSS (Research Council of Norway) and Arctic EO (Research Council of Norway)

[3] From May and July 2016.

Accounts

(All figures in NOK 1,000)

Funding source	
The Research Council	1,806
The host institution, UiT The Arctic University of Norway	605
MET	201
Norut	330
NTNU	15
Sum, research partners	547
Det norske	165
ENI	213
KSAT	259
Multiconsult	64
OMV	192
Statoil	165
Total	212
Sum, industry partners	1,271
Total	**4,229**

Costs per partner	
The host institution, UiT The Arctic University of Norway	1,208
MET	451
Norut	1,973
NTNU	217
Sum, research partners	2,641
Det norske	-
ENI	48
KSAT	218
Multiconsult	40
OMV	26
Statoil	-
Total	47
Sum, industry partners	379
Equipment	-
Total	**4,229**

Costs per activity	
Adm	1 177
WP1	645
WP2	29
WP3	162
WP4	1,285
WP5	669
WP7	260
Total	**4,229**

Publications

Peer-reviewed publications

Espeseth, M.M., Brekke, C., Anfinsen, S.N. (2016): *Hybrid-Polarity and Reconstruction Methods for Sea Ice with L- and C-band SAR.* IEEE Geoscience and Remote Sensing Letters, vol. 13, no. 3, March 2016. DOI: 10.1109/LGRS.2016.2519824

Other publications

Akbari, V., Anfinsen, S.N., Doulgeris, A.P., Eltoft, T. (2015): *A Change Detector for Polarimetric SAR Data Based on the Relaxed Wishart Distribution.* IGARSS Milan, Italy, 26-31 July 2015

Brekke, C. (2015): *Joint UiT/JPL/NASA oil spill campaign: first impressions.* SOLab workshop "Remote Sensing and Modelling of the Atmospheric-Ocean System"; 22-24 June 2015

Brekke, C., Pedersen, S.W. (2015): Innslag på TV2 Nyhetskanalen. 2015

Doulgeris, A.P., Eltoft, T. (2015): *Aspects of model-based decompositions in radar polarimetry.* IGARSS Milan, Italy, 26-31 July 2015

Eltoft, T. (2015): *Centre for Integrated Remote Sensing and Forecasting for Arctic Operations (CIRFA).* Oljeindustriens Miljø & Teknologikonferanse, 2015

Eltoft, T. (2015): *Monitoring Sea Ice with Space-borne Synthetic Aperture Radar.* ALOS-2 Symposium, Akihabara, Tokyo, Japan, 17 Nov, 2015

Eltoft, T. (2015): *Remote Sensing - hvordan kan fjernanalyse bidra til å løse utfordringer i nordområdene.* Arctic Safety Summit 2015

Eltoft, T. *CIRFA: Radar remote sensing of Arctic sea ice.* SOLab workshop, St. Petersburg, Russia, 22-24 June 2015

Eltoft, T., Brekke, C., Skrunes, S. (2015): *Centre for Integrated Remote Sensing and Forecasting for Arctic Operations (CIRFA): Oil Spill Detection and Characterization.* Interspill 2015, Amsterdam, Netherlands, 2015

Eltoft, T., Doulgeris, A.P., Brekke, C., et al. (2015): *Imaging sea ice structure by remote sensing sensors.* POAC Trondheim, Norway, 14-18 June 2015

Eltoft, T., Grahn, J., Doulgeris, A.P., et al. (2015): *A first analysis of polarimetric Arctic sea ice scenes from PALSAR-2.* ALOS-2 2nd PI Workshop, 2015

Fors, A.S., Doulgeris, A.P., Renner, A.H.H., et al. (2015): *On the relation between polarimetric synthetic aperture radar (SAR) features and sea ice melt pond fraction.* IGARSS Milan, Italy, 26-31 July 2015

Gerland, S., Spreen, G., Granskog, M., et al. (2015): *Seasonal Changes of Arctic Sea Ice Physical Properties Observed During N-ICE2015: An Overview.* Fall Meeting of the American Geophysical Union, San Francisco, USA, December 2015

Hu, D., Doulgeris, A.P., Qiu, X. (2015): *An unsupervised method for equivalent number of looks estimation in complex SAR scenes.* IGARSS Milan, Italy, 26-31 July 2015

Johansson, M, Brekke, C., Spreen, G., King, J. (2015): Newly formed sea ice in Fram Strait leads monitored by X-, C- and L-band SAR. ALOS-2 Symposium, Akihabara, Tokyo, Japan, 17 Nov 2015

Johnsen, H. (2015): *Sentinel-1A Ocean Data - experiences, challenges, opportunities.* SOLab workshop, St. Petersburg, Russia, 22-24 June 2015

Johnsen, H. (2015): *Ocean Currents and Sentinel 1.* Ocean Current Workshop, IFREMER, Brest, Germany, 2-3 Nov 2015

Petrich, C. (2015): *ColdTech and oil in ice in Narvik.* Nordområdekonferansen 2015, Narvik, 17 Nov 2015

Skrunes, S., Jones, C.E., Holt, B., Brekke, C. (2015): *Norwegian Oil-on-Water Exercise Campaign for Development of a Multi-Frequency SAR Slick Characterization Capability.* IGARSS Milan, Italy, 26-31 July 2015

CIRFA is is a Centre for Research-based Innovation (SFI) and is funded by the Research Council of Norway (237906) together with 6 research partners and 12 industry partners. The consortium brings together extensive experience in Arctic research, and expertise in the relevant scientific disciplines, ranging from technology for RPAS operations to numerical forecast modelling.

Research partners:

UiT The Arctic University of Norway

The Northern Research Institute

Norwegian Meteorological Institute

Norwegian Polar Institute

Norwegian University of Science and Technology

Nansen Environmental and Remote Sensing Center

User partners:

Kongsberg Satellite Services	Total E&P Norge
Kongsberg Spacetec	Aker Solutions
Statoil	Multiconsult
ENI Norge	Globesar
Det Norske Oljeselskap	Aranica
OMV Norge	Maritime Robotics