CIRFA

CENTRE FOR
INTEGRATED REMOTE SENSING
AND FORECASTING FOR ARCTIC OPERATIONS

UNIVERSITY OF TROMSØ

sfi Centre for Research-based Innovation

CIRFA

Centre for
Integrated Remote Sensing
and Forecasting for Arctic Operations
is funded by the Research Council of
Norway (237906) together with
6 academic and 12 industry partners

CIRFA

Centre for Integrated Remote Sensing and Forecasting for Arctic Operations

Existing monitoring systems have serious shortcomings. The spatial resolution of available sea ice maps is too low, the parametric detail level of sea ice, icebergs and ocean conditions is not sufficiently accurate, numerical forecast models are too coarse and do not have the capability of assimilating high-resolution satellite information.

CIRFA shall do research on methods and technologies that can reliably detect, monitor, integrate and interpret multi-sensor data describing the physical environment of the Arctic, enabling

- Improved understanding of important geophysical processes in the Arctic
- Improved assimilation methods and forecasting models
- Technologies for environmentally sound industrial operations

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.

Principle investigators

Centre Leader

Torbjørn Eltoft
UiT

WP1

Harald Johnsen
Norut

WP2

Wolfgang Dierking
AWI

Anthony Doulgeris
UiT

WP3

Camilla Brekke
UiT

Christian Petrich
Norut Narvik

WP4

Rune Storvold
Norut

Tor Arne Johansen
NTNU

WP5

Kai Christensen
MET

Rune Graversen
UiT

WP6

Sebastian Gerland
NPI

Camilla Brekke
UiT

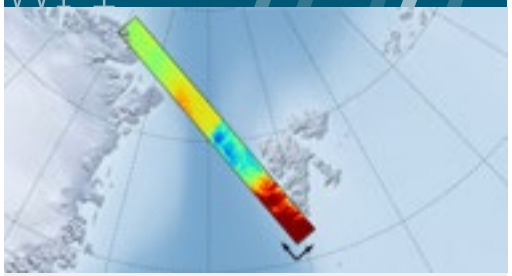
Rune Storvold
Norut

WP7

Jan Petter Pedersen
KSAT

Nick Hughes
MET

WP1

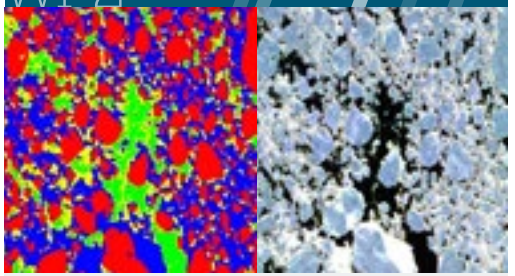


Ocean Remote Sensing

The objectives of this work is to develop the use of satellite technology to monitor and advance the understanding of the Arctic Ocean processes and dynamics, and contribute to better prediction of polar lows, nowcasting, and short range forecasting of ocean state through coupling with high-resolution numerical models. The research shall:

- Develop physical and statistical methodology to improve the reliability of satellite derived geophysical parameters as well as to take advantage of the diversity of observations and to account for the multivariate dependencies of the problem.
- Develop algorithms and processing system for providing ocean state parameters from satellite observations beyond what is achievable to day.
- Define and develop geophysical satellite products suitable for use in other work packages of CIRFA and in particular for assimilation in numerical ocean models.
- Product calibration and validation – error analysis.

WP2



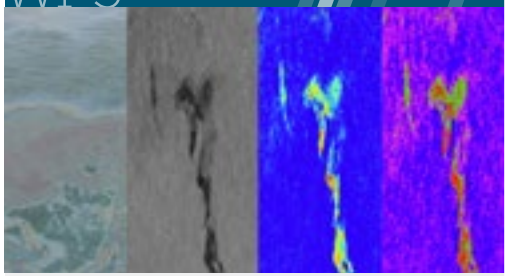
Sea Ice, Iceberg and Growler Remote Sensing

The objective of WP2 is to further develop remote sensing methodologies and algorithms to enable detailed characterisation and mapping of Arctic sea ice conditions, and to provide improved detection and characterisation of icebergs and growlers. Within this WP CIRFA develops algorithms for:

- Classification and characterization of sea ice
- Estimation of sea ice drift velocity field
- Iceberg and growler detection and characterisation

SAR data will be the key data source in this work, as the signatures of radar backscatter from sea ice and ice objects, such as icebergs, are highly correlated with physical ice properties such as salinity, temperature, wetness, thickness, roughness and degree of deformation. Studies will focus on the analysis of polarimetric parameters and decomposition techniques, on tracking ice drift and variations of sea ice conditions, and on multivariate statistical properties and anomaly detection. An important aspect of this study is the use of multi-frequency radar data and their fusion with optical and IR instrument data for sea ice applications.

WP3



Oil Spill Remote Sensing

The objective of this work package is to develop accurate remote sensing information retrieval techniques for reliable oil slick detection and characterization, and to improve modelling of oil behavior and fate in sea ice covered waters. Within this WP CIRFA develops algorithms for:

- Detection and characterization of oil spills on open water
- Detection and characterization of oil spills in sea ice.

SAR is the main sensor for detection and characterization of oil on open water. Due to a variation of oil distribution in sea ice depending on season and ice type, a suit of sensors is likely to prove advantageous in Arctic conditions. In this WP, CIRFA carry out research on multiple remote sensing sensors (such as PolSAR and optical systems) acquired by various platforms (such as satellite, aircraft, and RPAS).

Knowledge of the physical mechanisms of hydrocarbon spills in sea ice causing scattering, absorption and emission of electromagnetic signals is required to develop the information retrieval algorithms based on the remote sensing data. This involves understanding the fundamental science of the oil's behaviour through observations and modelling. Within this WP, CIRFA takes part in and collects data through large-scale experiments and fieldwork dealing with both oil on open water and oil in sea ice.

WP4

RPAS Technology

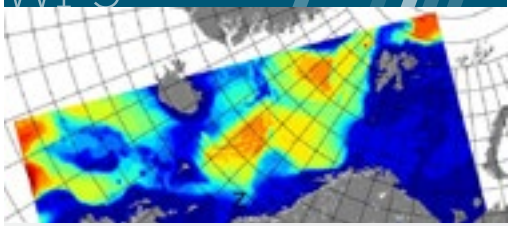
In WP4 the focus will be on developing a Remotely Piloted Aircraft Systems (RPAS) based measurement system for measurements of sea-ice properties, detection and tracking of icebergs, detection and characterization of oil-spills. It is currently not possible to develop a aircraft system that could work under all weather conditions. Icing and high winds and turbulence limits flight window at low altitude. However we will look at new designs and technologies to maximize the operational window, while still keeping cost and size at a manageable level. New sensors are needed to accurate measure sea-ice thickness on a fine scale and detect oil in partly ice covered waters. Time of year, weather and ice type affects the penetration and accuracy of sensors used on sea-ice. A compromise must be made when it comes to weight, power consumption, and resolution. Multiple sensors may be needed to retrieve these properties and the combination of sensors might depend on time of year and weather.

Within WP4 CIRFA develops:

- Weatherization, like de-icing, cold climate robustness, wind tolerance.
- Radar and optical sensors for ocean state, sea-ice property and oil spill retrieval and detection
- Drop sondes for tracking of sea-ice and icebergs

WP4 will support WP1–WP3 data collection and algorithm validation in collaboration with the modelling and field activities in WP5 and WP6.

WP5



Drift Modelling and Prediction

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

Ocean and ice forecasting at high latitudes, including the forecasting of drift of icebergs, oil-spills and other pollutants, is challenging due to a severe lack of observations of oceanic 'weather'. Improved operational forecast systems will require increased amounts of high-resolution observations and the assimilation of such data into ocean and ice models. Also, because of the large observational uncertainties and the chaotic nature of the flow, the forecasts have to be probabilistic, i.e. presented as a range of possible outcomes based on an ensemble of slightly different model runs.

So assimilation and ensemble forecasting are the central issues to be addressed within WP5. The work will utilize ocean-ice models and assimilation techniques already in use at MET Norway today, but substantial advances will need to be made. The most crucial steps ahead are 1) to form proper descriptions of the errors or uncertainties for the new types of observations to be assimilated, and 2) to optimize the coupling between the assimilation system and the ensemble prediction system (EPS). The coupled system will also allow for the optimization of exchange coefficients of fluxes (momentum, heat, fresh water) between ocean, sea ice and atmosphere.

WP6

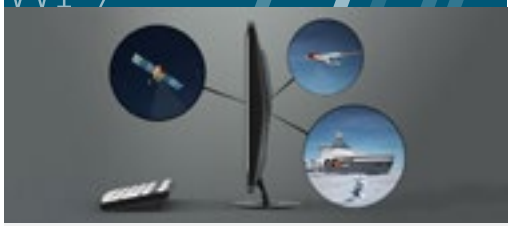
Data Collection and Field Work

The objective of this CIRFA work package is to organize dedicated field campaigns on and over Arctic sea ice and ocean to combine accurate in-situ, Remotely Piloted Air Systems (RPAS), aircraft and helicopter observations, and satellite data, and improve validation shortcomings by seeking new and refined methods. The acquisition of sufficient ground truth and validation data is a major limiting factor to the development of Earth observation techniques. With this WP, CIRFA highlights the importance of carefully designing field campaigns in connection with satellite surveys, especially using synthetically aperture radar (SAR), RPAS measurements, such as the Cryowing from Norut, and JPL/NASA's Unmanned Aerial Vehicle Synthetic Aperture Radar (UAVSAR).

WP6 will be serving as a validation and calibration platform for remote sensing data, as well as giving ground truth data for assessing the work conducted in WP1, WP2 and WP3. WP6 will be responsible for the design of focussed RS validation measurement setups in connection with field campaigns and ensure RS coverage at relevant scales in space and time.

Data collected during field campaigns like the N-ICE campaign organized by the Norwegian Polar Institute, other annual campaigns of the Norwegian Polar Institute, Norwegian Clean Seas Association for Operating Companies' (NOFO's) oil-on-water exercise will be available to CIRFA.

WP7



Pilot Service Demonstration

In this work package we will demonstrate a pilot service system showing the provision of integrated environmental information to end-users involved in Arctic operations. Some satellite based operational services have already been developed and put into regular use (e.g. ship traffic monitoring, sea ice mapping). However, none of these meets the requirements for industrial maritime operations. Oil & Gas companies operating in the environmentally sensitive Arctic areas need monitoring technologies integrated into their day-to-day operations for operational decision support (e.g. multi-sensor data captured from several sensors and platforms, communication infrastructure, analysis, and interface).

The methodologies, tools and products developed in WPs 1–5 will be validated using data from WP6, and integrated into information products for the pilot service demonstrations to be performed in WP7. The experience and feedback from the end-users will be fundamental in the development of these services and found the basis for operational service deliveries.

The CIRFA consortium consists of 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.

Centre Management:
UiT The Arctic University of Norway, Department of Physics and Technology

Torbjørn Eltoft
Centre Leader
Tel: +47 776 45184 Mob: 950 07 345
E-mail: torbjorn.eltoft@uit.no

Ellen Ingeborg Hætta
Administrative Coordinator
Tel: +47 776 44673
E-mail: ellen.i.hatta@uit.no