M.SC. PROJECT: CHALLENGING SPACEBORNE RADAR DATA PROCESSING FOR EARTH AND MARS

KIMIS@DTU.DK

Repeat-satellite-altimetry is a key tool in monitoring the evolution of Earth's ice sheets and studying the surface of extraterrestrial bodies. Most modern radar satellites employ some form of Synthetic Aperture Radar (SAR) signal focusing techniques to improve the spatial resolution of their measurements in areas of complex topography. This project will investigate what impact the choice of a constant aperture length has on downstream terrestrial (i.e., Sentinel-3) and/or Martian (i.e., SHARAD) radar data products.

SYNTHESIS, B.SC. OR M.SC. PROJECT: TESTING CRYOSAT-2 PSEUDO-LOW-RESOLUTION-MODE OVER SEA AND LAND ICE

HSKO@DTU.DK AND RMFHA@DTU.DK AND SSIM@DTU.DK

Early satellite altimeter missions acquired data in a low-resolution mode, and later high-resolution missions have implemented data emulating this low-resolution mode to ensure consistency. This project will evaluate the low-resolution-mode of CryoSat-2 over land and sea ice for study cases of interest, to evaluate the limitations and differences between the high- and low-resolution data.

M.SC. PROJECT: A NEW FRONTIER IN SEA ICE RADAR ALTIMETRY

KIMIS@DTU.DK

Conventional satellite radar altimetry studies of sea ice are often one dimensional, focusing on deriving sea ice freeboard as the sole measurement of interest for understanding the impacts of climate change. This project will investigate the applicability of more exotic radar analysis techniques to the study Arctic sea ice. The purpose is to maximize our use of the radar measurement to produce a more complete picture of sea ice conditions from existing satellite altimetry datasets using imagery, side-looking SAR, or laser altimetry as validation data.

B.SC. OR M.SC. PROJECT: SURFACE DENSITY OF SNOW AND FIRN ON THE GREENLAND ICE SHEET FROM ICESAT-2

MAIWIN@DTU.DK

Surface snow and firn density is a key parameter for converting elevation changes of the Greenland Ice Sheet into mass changes. Traditional methods rely on in-situ measurements or radar altimetry, but recent studies suggest that photon penetration depth from ICESat-2 laser altimetry may offer a novel proxy for estimating near-surface density. In this project, you will derive a measure for the subsurface penetration depth from the ICESat-2 photon cloud and assess its consistency with existing radar-derived density estimates and available in-situ observations.

SYNTHESIS, B.SC. OR M.SC. PROJECT: IMPACT OF EXTREME EVENTS ON FLADE ISBLINK – AN ICE CAP IN THE HIGH ARCTIC

SLSS@DTU.DK AND RMFHA@DTU.DK AND SSIM@DTU.DK

The Arctic is warming four times as fast at the global average, and extreme events (such as melt, sea ice decline, weather) are becoming more frequent and severe. This project will identify extreme events over Flade Isblink – an ice cap in North Greenland – and investigate the impact they have on the ice cap and its surroundings.

M.SC. PROJECT: EVALUATING CLIMATE MODEL SNOW DEPTH SIMULATIONS USING SATELLITE-DERIVED OBSERVATIONS OVER ARCTIC SEA ICE

MAIWIN@DTU.DK

Snow depth on sea ice plays a critical role in sea ice thermodynamics, affecting both growth and melt processes. Recent advances have enabled snow depth estimation from combined ICESat-2 and CryoSat-2 altimetry since 2018, as well as an extended time series (2012-) using calibrated microwave satellite data. With these observational datasets now available, this project focuses on evaluating how well climate models simulate snow depth on Arctic sea ice. You will compare the satellite-derived snow depth estimates with outputs from selected climate models, focusing on seasonal patterns, spatial variability, and long-term trends. The analysis will help identify biases and uncertainties in model representations of snow processes and inform future model development.

B.SC. OR M.SC. PROJECT: INFLUENCE OF BASAL TOPOGRAPHY ON ICE FLOW AND SURFACE TOPOGRAPHY IN UPDATED PISM SIMULATIONS

MAIWIN@DTU.DK

The Parallel Ice Sheet Model (PISM) is widely used for simulating ice sheet dynamics and projecting future changes. Recent updates to PISM have introduced significant improvements in physical parametrizations governing ice flow. As result, the basal topography may influence the modelled ice dynamics differently in the two PISM versions. In this project, you will analyze existing simulations from both PISM versions to investigate how the bed topography is expressed in terms of ice velocity and surface topography, and compare these to satellite observations. Through comparative analysis, the project aims to identify differences in model behavior and assess the implications for future ice sheet modeling efforts.

SYNTHESIS, B.SC. OR M. SC. PROJECT: USING NEURAL NETWORKS TO DETECT LEADS IN POLAR SEA ICE FOR BETTER SEA-LEVEL AND SEA ICE TYPE ESTIMATES FROM RADAR ALTIMETRY

STINE@DTU.DK AND RMFHA@DTU.DK

Accurately identifying open-water leads and classifying sea-ice types in polar oceans is key to improving sea-level measurements in icy regions. This project develops advanced methods using radar satellite altimetry, with neural-network-based machine learning to distinguish open water and different sea-ice types. By combining lead detection and sea-ice type classification, the work aims to reduce sea-level uncertainties and sea ice thickness estimates driven by complex ice–ocean surfaces. You will engage in tasks ranging from signal processing and algorithm development to neural-network modelling, ultimately contributing to more accurate estimates in polar environments.

SYNTHESIS, B.SC. OR M.SC. PROJECT: ROUGHNESS AND VOLUME TRACING OF ICEBERGS, FAST ICE AND SEA ICE (MELANGE) IN GREENLAND FJORDS

HSK@SPACE.DTU.DK AND RMFHA@DTU.DK AND SLSS@DTU.DK

The stability of marine-terminating glaicers and their ice caps appears closely link with the presence and volume of the abutting mélange and fast ice conditions. Here, the project will estimate the roughness and volume of the melange from high-spatial sampling laser altimeter, ICESat-2 useful in linking potential extreme events with high instability observed at the glacier front.

DTU PROJECT DAY 2025

STUDENT PROJECTS

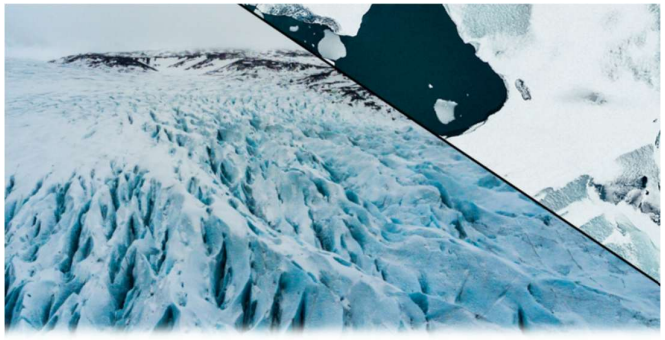
DIVISION OF GEODESY AND EARTH OBSERVATION

CRYOSPHERE GROUP

As a part of the Geodesy and Earth Observation (GEO) Division at DTU Space (Department of Space Research and Space Technology), the Cryosphere group monitors the recent and ongoing changes of the ice-covered regions of the Earth, observing both ice sheets and sea ice. This is done using both satellite remote sensing and airborne surveys. This group has a long history of monitoring the cryosphere, planning and carrying out airborne campaigns and applying state-of-the-art techniques to evaluate satellite observations.

Research carried out by the Cryosphere group involves data from several satellite altimetry missions. These satellites can map the elevation of ice sheets, allowing surface elevation changes over time, as well as the thickness of the sea ice, directly affecting polar navigation and our planet's climate in general. The Cryosphere group has strongly contributed to the validation of satellite altimetry measurements, especially from the ESA's CryoSat-2 mission, by collecting airborne and in-situ measurements in Greenland, the Arctic Ocean and Antarctica.

Read more CRYOSPHERE projects in this folder



@DTUCryo @dtucryo.bsky.social

www.space.dtu.dk/english/research-divisions/geodesy-and-earth-observation/research-areas/cryosphere

M.SC. PROJECT: REGIONAL CLIMATE MODEL EMULATOR

SSIM@DTU.DK AND ANNPU@DTU.DK

Our project focuses on developing regional climate model using scientific machine learning (SciML). This SciML model will learn to replicate the behavior of complex climate models using machine learning techniques, providing a simplified and computationally efficient tool for researchers and policymakers. You will work on developing and training a SciML model on historical data and validate its performance against existing numerical model outputs from regional climate models, aiming to enable a more accurate exploration of regional climate scenarios and impacts.

B.SC. OR M.SC. PROJECT: EXPLORING THE POLAR SEA ICE FROM AIR

HSKO@DTU.DK AND RMFHA@DTU.DK

In this project, we will explore the Arctic sea ice from a combination of various instruments on different airborne platforms, which were flown on the same day along the same track, as part of a project funded by the European Space Agency. The study will provide invaluable knowledge of the properties of sea ice and pave the way for a better understanding of the upcoming Copernicus high-priority candidate satellite altimeter mission CRISTAL abilities.

M.SC. PROJECT: INVESTIGATION OF SURFACE SAMPLING VARIATIONS IN CRYOSAT-2 RADAR FOOTPRINTS

SMH@DTU.DK

The project aims to characterize the variations in surface sampling within a radar satellite footprint using airborne validation datasets from Operation IceBridge and CryoVEx campaigns. Hence, the project will investigate the effect of variability of sea ice floes and leads within a satellite footprint on the satellite retrieval. Two airborne validation datasets exists and these will be used in combination with different levels of coincident satellite data.

SYNTHESIS, B.SC. OR M.SC. PROJECT: RECONCILING SATELLITE ALTIMETRY OBSERVATIONS ACROSS THE GREENLAND ICE SHEET

MAIWIN@DTU.DK

Satellite altimetry is a key tool for monitoring ice sheet elevation and detecting changes over time. However, radar and laser altimeters interact differently with snow and ice surfaces, leading to systematic biases in elevation measurements. This project aims to quantify these discrepancies between CryoSat-2 and ICESat-2 datasets by analyzing elevation differences at satellite cross-over points. Using spatial interpolation techniques such as kriging, bias maps will be generated to characterize regional variations. These maps will form the basis for correcting radar altimetry data, enabling consistent integration with laser-derived elevations. The resulting fused dataset will support improved surface elevation models and enhance our ability to monitor ice sheet dynamics and climate-related changes.

B.SC. OR M.SC. PROJECT: ARCTIC SEA ICE ALBEDO FROM AIRBORNE, SATELLITE AND MODELS

HSKO@DTU.DK AND RTT@DTU.DK

The ice-albedo feedback mechanism is a key driver for the Arctic Amplification and the acceleration of the shrinking sea ice cover. In this study you will have hands-on radiometer and infrared thermometer data from airborne campaigns conducted in 2015 and 2017 in collaboration with the British Antarctic Survey (BAS) to look at the albedo over sea ice and open water and could be evaluated using satellite data from the Copernicus program i.e., the Sentinel's, and/or a combination of scattering models.

SYNTHESIS, B.SC. OR M.SC. PROJECT: STATE-SPACE MODELING OF SURFACE ELEVATION CHANGES UNDER EXTREME EVENTS

NAAND@DTU.DK AND SLSS@DTU.DK

The dSEC (surface elevation changes) model is a state-space model designed to capture seasonal and long-term variability in ice sheet and ice cap surface elevations. However, its ability to resolve short-lived extreme events (e.g., sudden snowfall, melt, or surface collapse) is less well understood. In this project, students will artificially impose an extreme event in the input data (e.g., adding a strong positive or negative elevation anomaly for a single month) and test how the dSEC model responds to and propagates this signal.

B.SC. PROJECT: IMPACT OF EXTREME WILDFIRES ON GLACIER MELT

STINE@DTU.DK AND SLSS@DTU.DK

The deposition of black carbon (BC) and other particulates from wildfires can significantly impact the albedo of ice and snow, accelerating melt rates. In July 2012, over 97% of the Greenland Ice Sheet experienced surface melt, a rare event in the satellite observation era. This project will investigate whether there is a correlation between enhanced ice melt and the presence of particulates in the atmosphere, such as black carbon, carbon monoxide, and aerosols, particularly during or after major wildfire events.

SYNTHESIS, B.SC. OR M.SC. PROJECT: IMPROVING THE SEA LEVEL TIME SERIES IN THE POLAR OCEANS USING MACHINE LEARNING

STINE@DTU.DK

The Polar Oceans have warmed due to climate change and have in recent years gained a lot of interest from the public. In this project, we will make a time series of sea surface heights from Polar Ocean altimetry. We will build a time series model and study the interannual and seasonal signals, error analysis. This study will provide critical insights into the evolving dynamics of polar sea levels and refine our understanding of climate impacts on the world's most vulnerable oceans.

B.SC. OR M.SC. PROJECT: SEA ICE AND FAST ICE NEAR NORTHEAST GREENLAND; IDENTIFYING EXTREME EVENTS

SMH@DTU.DK AND HSKO@DTU.DK

In a changing climate the sea ice cover is declining. This has a large impact on coastal regions, especially in Northeast Greenland. This project aims to investigate extreme events in the sea ice and fast ice conditions east of Greenland.

B.SC., SYNTHESIS OR M.SC. PROJECT: SEA ICE SURFACE TOPOGRAPHY AND ICEBERGS FROM SWOT SATELLITE

HSKO@DTU.DK AND OA@DTU.DK

In this project the aim is to work with data collected by newly launched NASA/CNES Surface Water and Ocean Topography satellite SWOT in polar oceans to investigate sea ice surface topography as well as icebergs. The new satellite technique is prior to existing classical nadir-looking altimeters, as it senses the surface in a swath and thus can provide detailed information of the 3D surface topography. More information of the satellite mission can be found on https://swot.jpl.nasa.gov/.

M.SC. PROJECT: MACHINE LEARNING FOR RADAR ALTIMETRY RETRACKING

SSIM@DTU.DK AND ANNPU@DTU.DK

This project encompasses a data-driven machine learning approach for radar altimetry retracking, a vital remote sensing technique for monitoring sea levels, ice topography, and terrain. We propose a deep learning solution, e.g., using neural networks to improve retracking accuracy and robustness over the ice sheet where the observations combine multiple physical signals. In this project you will work with data preprocessing (and theoretical modeling), neural network development and training, thorough validation, and optimization. By utilizing machine learning, we can significantly enhance the quality of radar altimetry data, benefiting applications such as climate monitoring, oceanography, and environmental management.

SYNTHESIS PROJECT: MULTISPECTRAL CAMERA CONTROL FOR CRYOSPHERE SURVEY

SSIM@DTU.DK AND HSKO@DTU.DK

Our synthesis project is dedicated to developing a cutting-edge control unit for a multispectral camera designed for cryospheric monitoring through airborne surveys. Our primary objectives include designing a robust control unit capable of managing a wide range of multispectral imaging modes, optimizing data acquisition and processing, and ensuring compatibility with airborne survey platforms. We will also focus on integrating real-time data telemetry and control from a ground station, enabling remote monitoring and adjustments during flight. The resulting system will enhance the accuracy and efficiency of cryospheric monitoring, providing critical insights into ice and snow dynamics, climate change impacts, and environmental trends.

M.SC. PROJECT: MAPPING SURFACE ROUGHNESS FOR IMPROVING ICE SHEET ENERGY BALANCE

MAIWIN@DTU.DK

Small-scale surface roughness significantly influences the local energy balance on the Greenland ice sheet, affecting mass loss. However, it remains a poorly constrained parameter in current climate models. This project aims to explore methodologies for generating daily surface roughness maps by integrating high-resolution ICESat-2 laser altimetry data with albedo maps. The research will focus on a specific region in northern Greenland where in-situ data is available for validation purposes.