Artificial Intelligence for Cold Regions (AI-CORE)

a Pilot to bridge Data Analytics and Infrastructure Development

Ingmar Nitze, Long Phan, Julia Christmann,

Martin Rückamp, Angelika Humbert, Guido Grosse, Stephan Frickenhaus, Tilman Dinter, Konrad Heidler, Sophia Barth

Data Science Symposium, GEOMAR 22.01.2021

HGF initiative „Helmholtz Incubator, Information & Data Science“

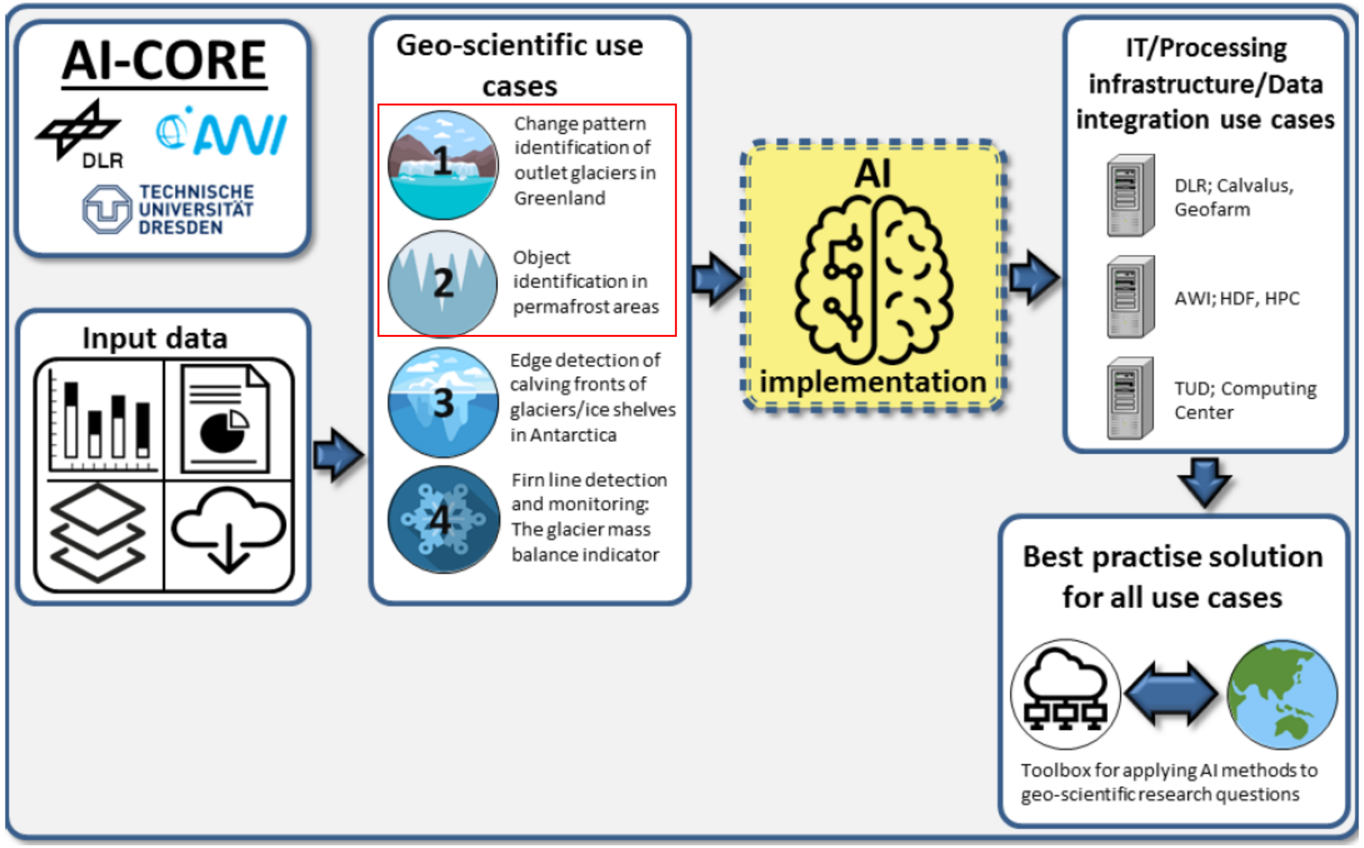


Figure 1: Workflow of AI-CORE

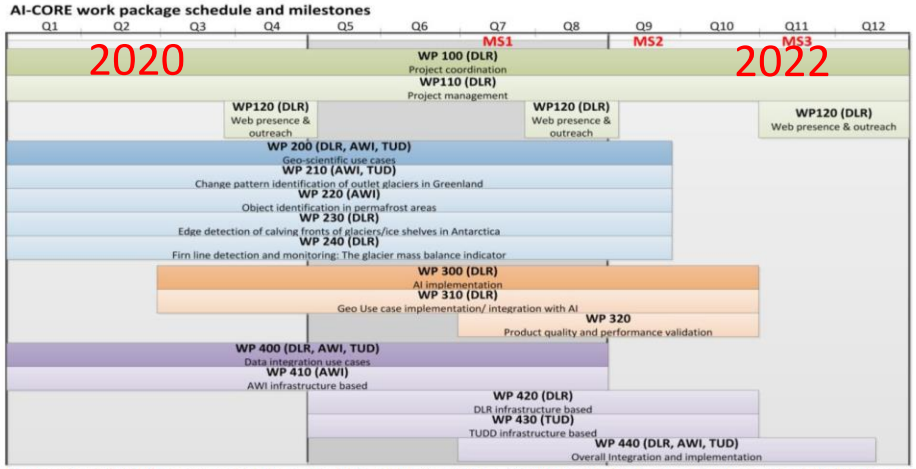


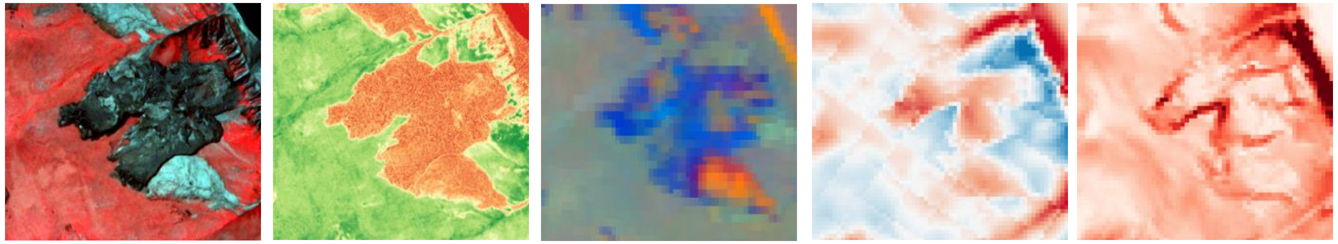
Figure 2: AI-CORE work package schedule and milestones. Partners leading an activity are included in brackets after the work package number

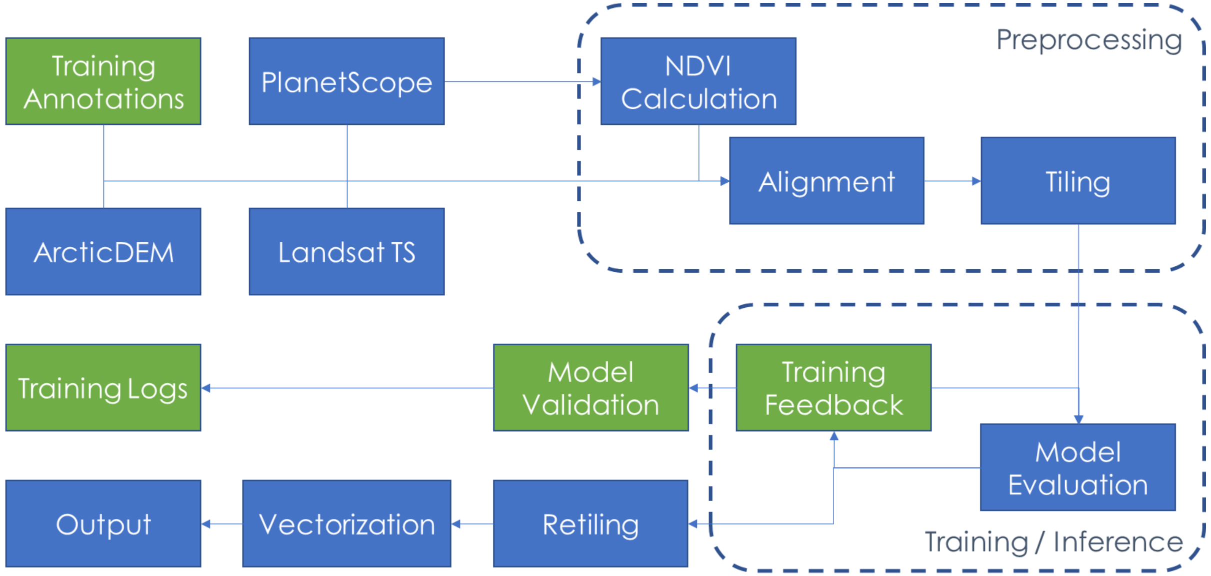
Mapping Retrogressive Thaw Slumps in Permafrost

- Remote Sensing
- Object Detection/Segmentation
- Dynamic Features
- Auxiliary Info available
- Sparse training data
- Diverse landscape

Automated Processing

- Deep Learning (UNet)
- Remote sensing Data
  - Planet, ArcticDEM, AuxData
- Highly automated workflow
  - Data Management
  - Data Preprocessing
  - Model Training
  - Model Validation
  - Inference





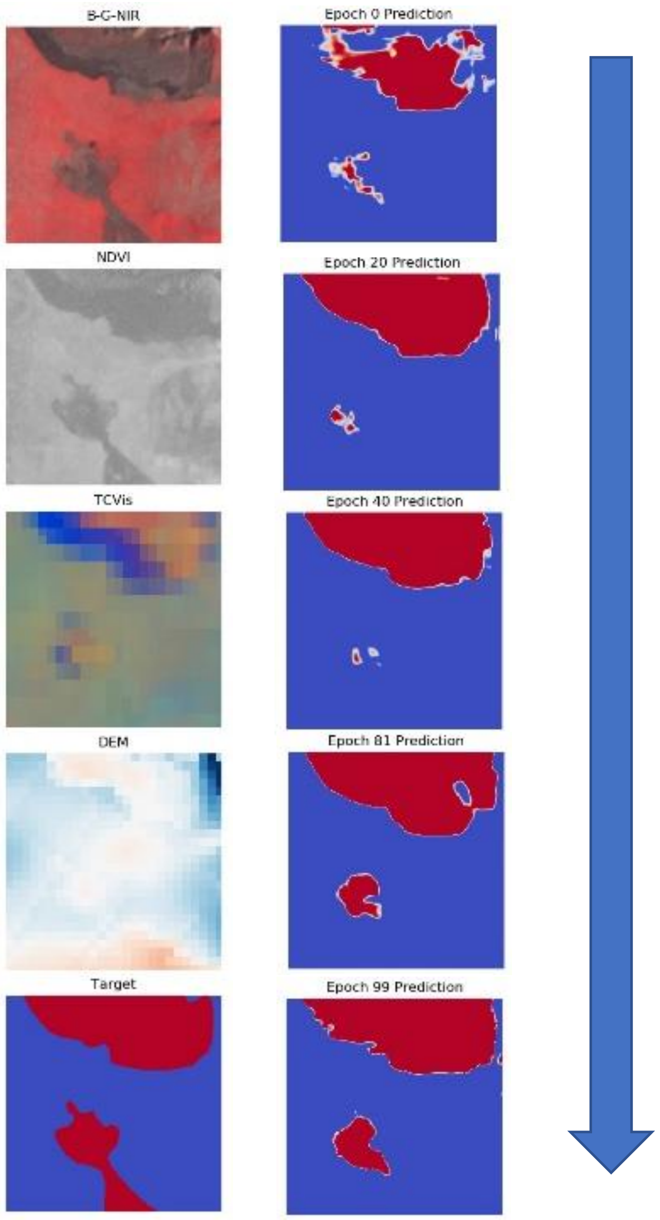
First results

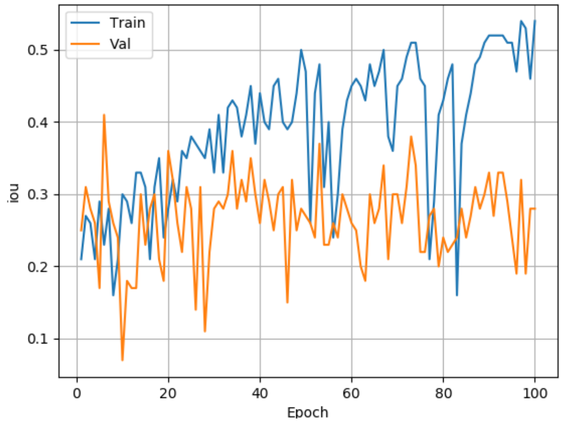
- Regional CV/LOO
- Varying results
- High FP rates

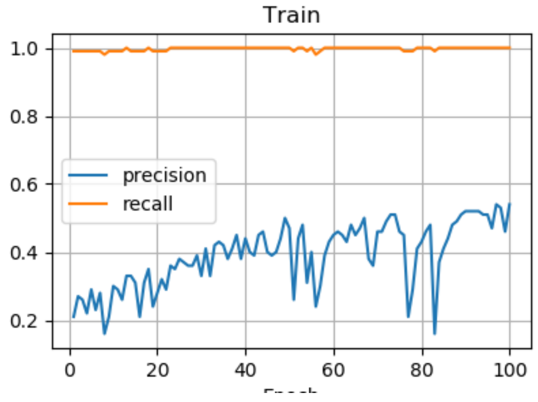
Challenges:

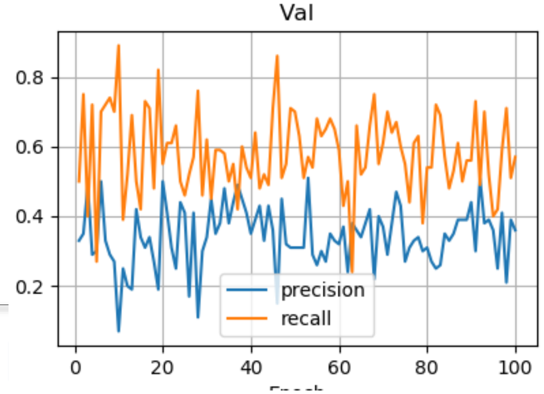
What is a thaw slump?

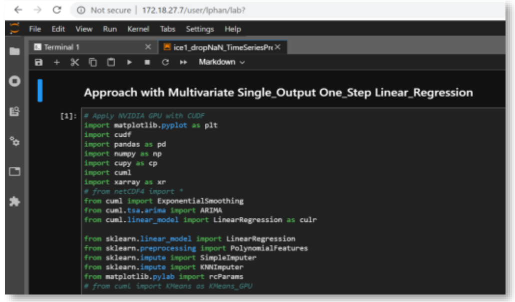
Regional differences



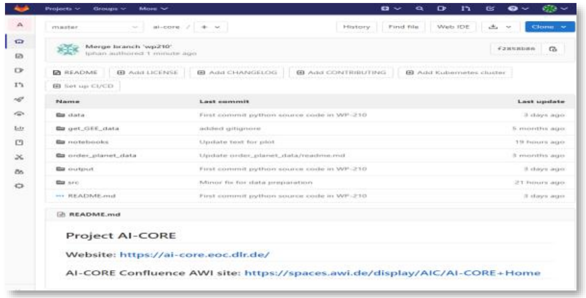








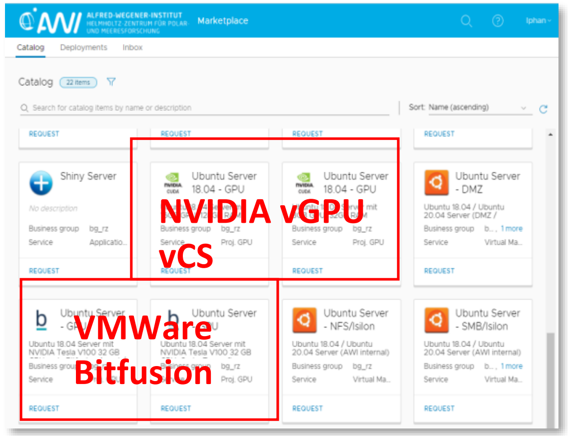
NVIDIA CUDA
ML: RAPIDS, Scikit-Learn, Pandas, Numpy, Prophet ..
DL: Tensorflow, Keras, Tensorboard ..
(Nvidia-) Docker, Kubernetes
Streamlit
MLFlow, Kubeflow
Database
Python, Matlab, Julia

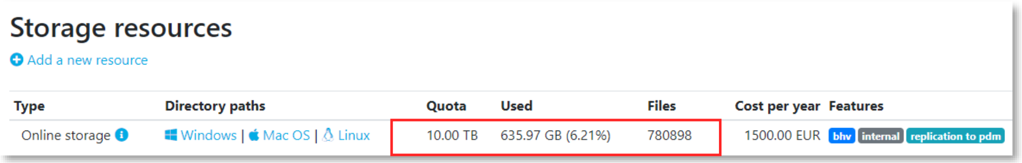


https://jupyterhub.awi.de/

https://gitlab.awi.de/ai-core/ai-core

AWI_RZ_Marketplace GPU System → AWI_RZ_JupyterHub Software Development → AWI_RZ_Online Storage → AWI_Gitlab AI-Core → AWI_Confluence



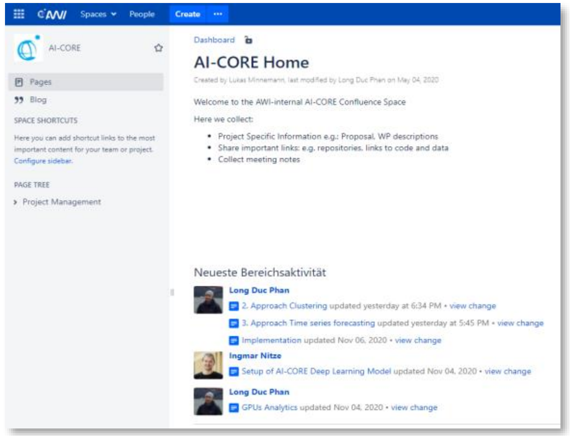


Storage resources

Add a new resource

Type	Directory paths	Quota	Used	Files	Cost per year	Features
Online storage	Windows | Mac OS | Linux	10.00 TB	635.97 GB (6.21%)	780898	1500.00 EUR	bhv internal replication to pdm

https://cloud.awi.de/#/projects/p_aicore



https://marketplace.awi.de/

Aim: MLOps

https://spaces.awi.de/display/AIC/AI-CORE+Home

Experimental design for marine ice sheet-ocean: MISMIP+

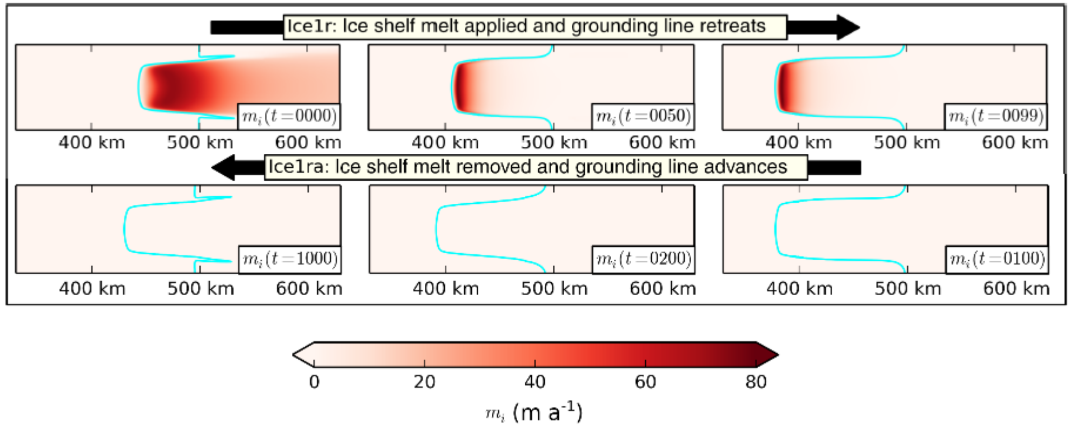


Figure: ice shelf melt rate mi fields during the Ice1r and Ice1ra experiments from a BISICLES run. Melt rates are applied when 0 < t < 100 a, causing the ice shelf to thin and grounding line to retreat. Once t > 100 a, no melt is applied, the ice shelf thickens, and the grounding line advances*

Aim: Clustering regions of small, middle and high change of grounding line migration with time.

Approaches with AI (Machine/ Deep Learning)

Simulation Data from Ice-sheet and Sea-level System Model (ISSM)

- Different data samples (structured multi-dim)
- Format NetCDF (.nc), Matlab (.m)
- Size (MB to GB)

Descriptive Analytics

- Data Preparation, Cleaning, Wrangling, ..
- Data understanding, Time-series analysis ..

Clustering K-Means+

- Observe the movement of GL in 3 clusters, ..

Univariate (Multi) Time series Forecasting in 1 step, 2 steps

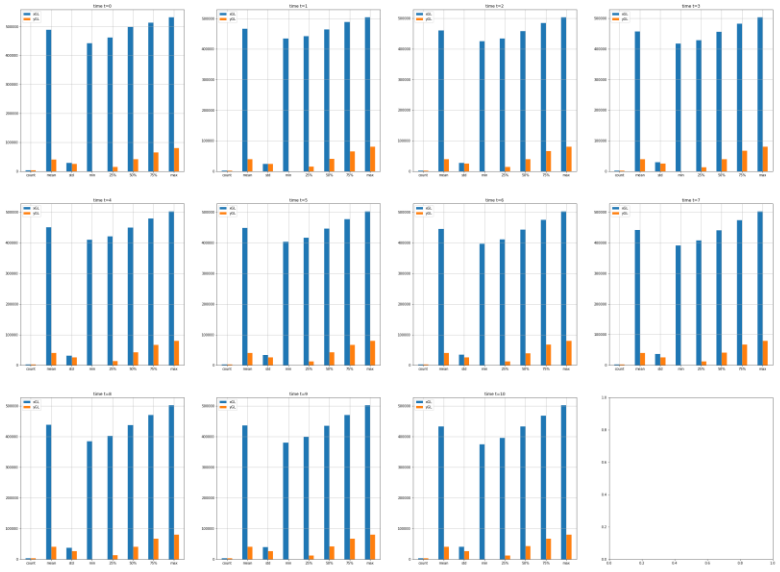
- Auto Regressive Integrated Moving Average (ARIMA)
- Exponential Smoothing (ETS)
- Multilayer Perceptron (MLP)
- Convolutional Neural Networks (CNN)

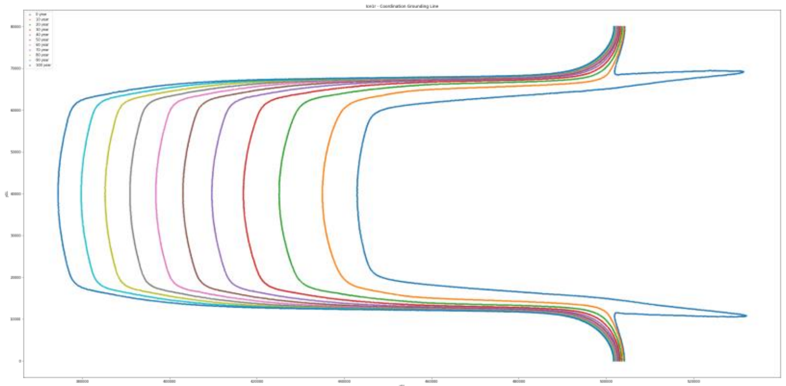
Implementation

- Python, Tensorflow, Pandas, Scikit-Learn, Matplotlib, ..
- Modular Programming

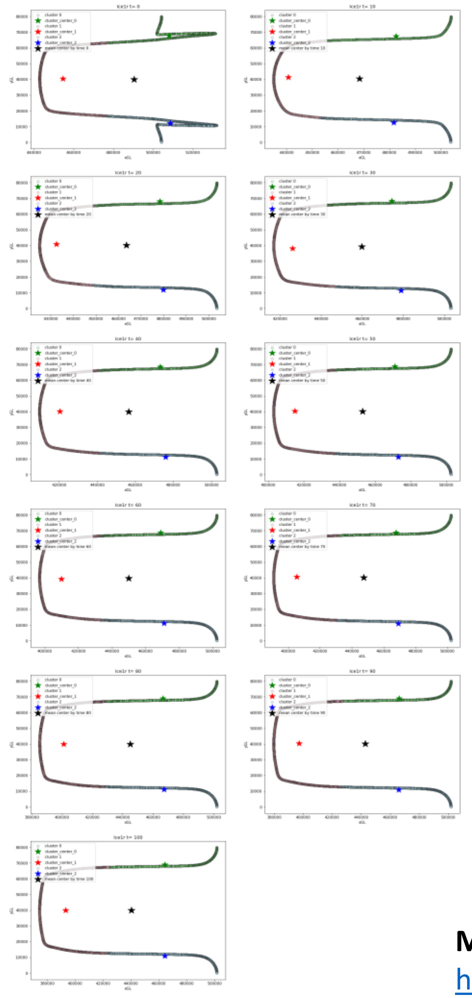
*Source: Experimental design for three interrelated marine ice sheet and ocean model intercomparison projects: MISMIP v. 3 (MISMIPC), ISOMIP v. 2 (ISOMIPC) and MISOMIP v. 1 (MISOMIP1), 2016, Asay-Davis et al.

Descriptive Analytics

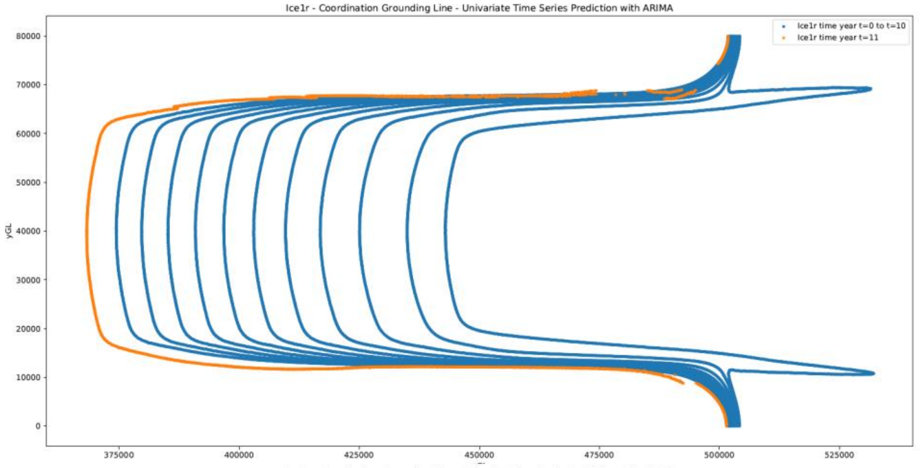


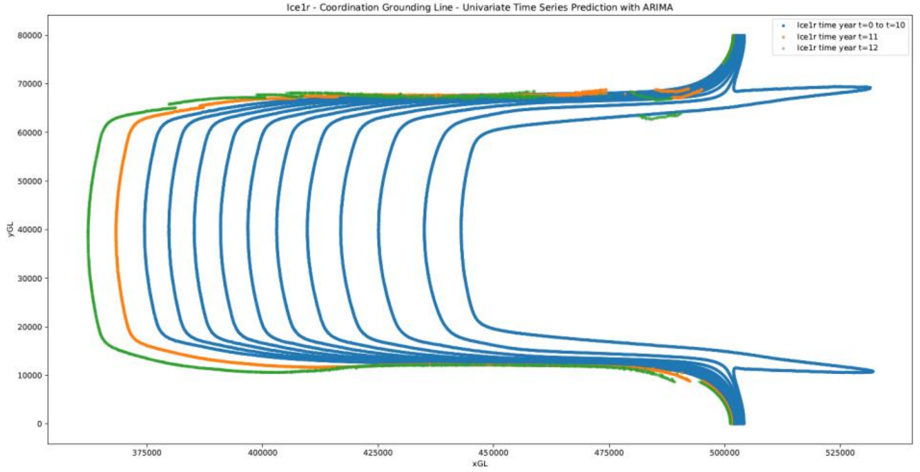


Clustering (2D, 3D, PCA)



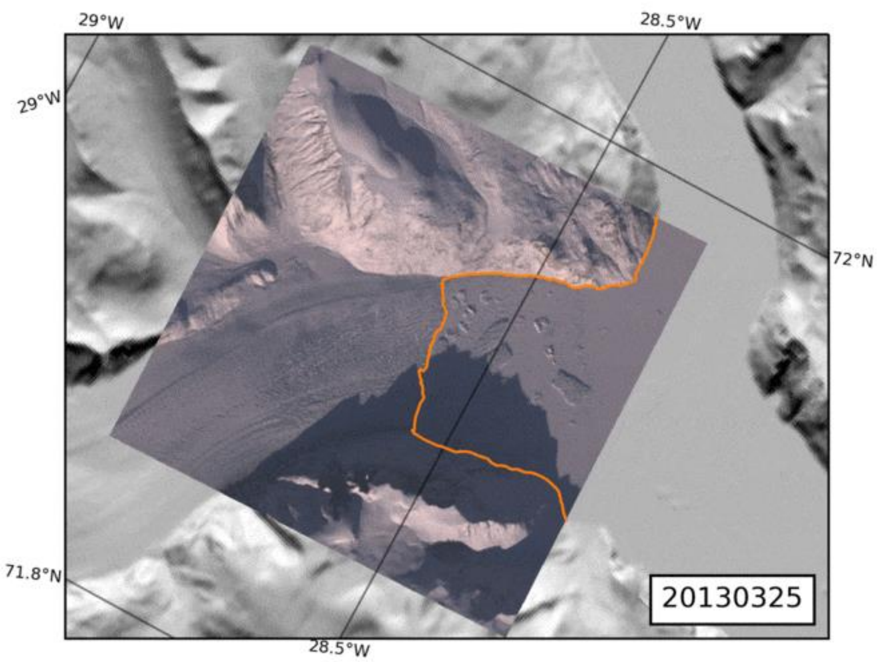
Time Series Forecasting (ARIMA result)





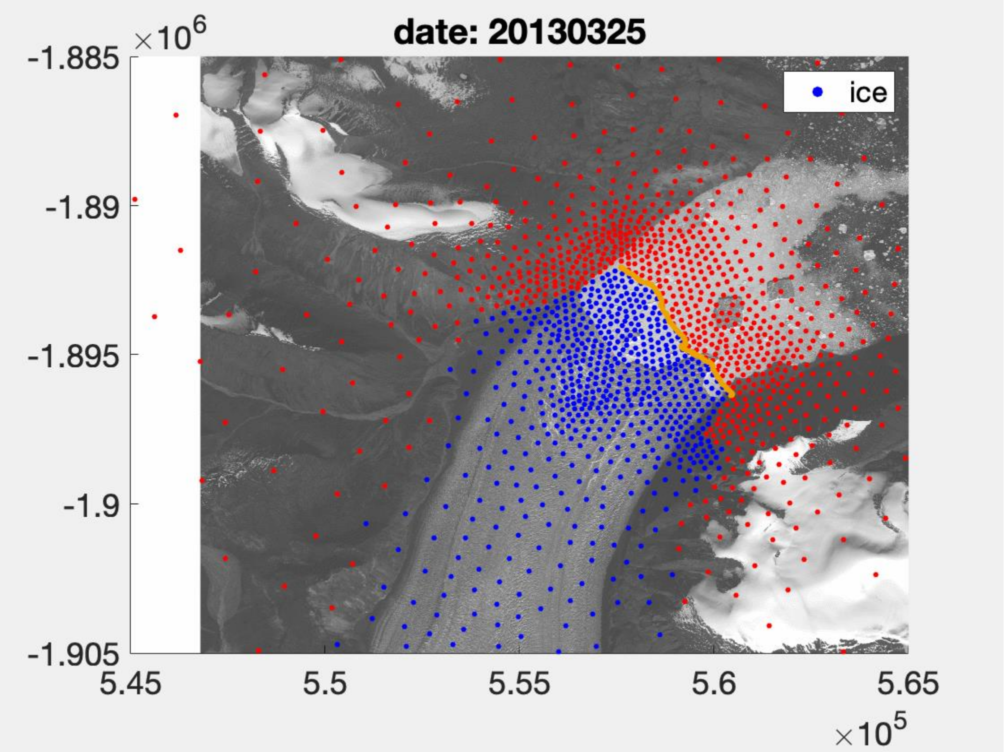
More:
https://spaces.awi.de/display/AIC/AI-CORE+Home (AI-CORE Confluence)

Detect Calving Front Position: Daugaard Jensen



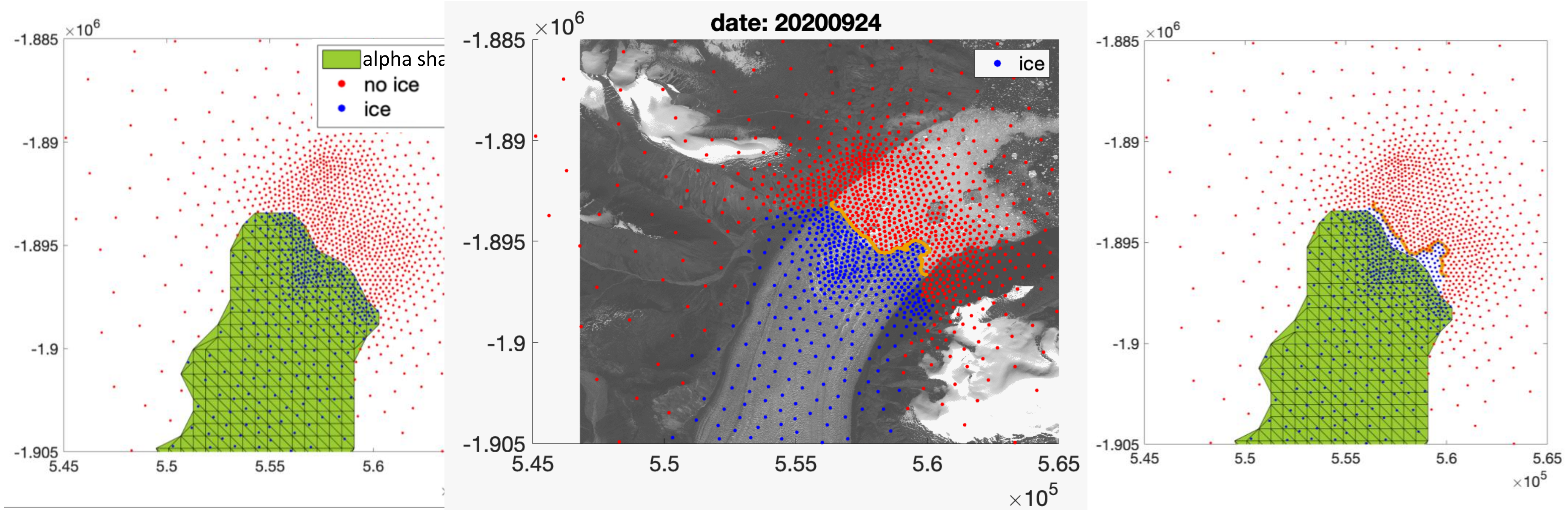
© Erik Loebel, University Dresden

- extract calving front positions from multi-spectral Landsat-8 imagery (convolutional neural network, statistical textural feature analysis, topography data)



- generating ice mask for ISSM
- level set to incorporate the derived calving front positions to ISSM

Detect Calving Front Positions in Greenland



- alpha-shape method to detect ice domain and boundary
- get new ice front from satellite image
- determine points inside the polygon of ice boundary and new ice front