# Field work Frænfjorden 14. – 18. September

Objectives

* Perform operations with LAUV to adaptively monitor the tailings discharge in Frænfjorden.
* Collect data of particle size and concentration to support AUV data analysis.
* Gain experience of use of LAUV for particle measurements (i.e. using SilCam).
* Obtain current measurements of fjord from AUV.

Participants

Emlyn Davies [ED] (fieldwork leader, SilCam)

Gunhild Berget [GB] (PhD student, adaptive AUV)

Frederic Py [FP] (PostDoc, adaptive AUV)

Dave Williamson [DW] (AUV pilot, SilCam)

AUR-Lab pilot [AUR-L] (AUV pilot until Dave takes over)

Tor Nordam [TN] (project leader)

Small boat driver [SB] (TBC.)

Emilie [E] (big boat)

Corona

* Do not pack cars full of people (use more cars if necessary)
* Minimum number of participants
* Risk of quarantine is significant. Frode should not join because of this.

Schedule

|  |  |  |
| --- | --- | --- |
| **Date** | **Tasks** | **People** |
| 20th August | SinMod started | Finn Are & William |
| 25th August | Planning & status meeting    Gunnhild to get access to SinMod data  Tor to setup DREAM | All |
| 7th – 9th September | AUV hardware testing in Trondheim  Testing of SilCams + battery pack | GB, FP  ED, FL |
| 8th September | Pressure test AUV |  |
| 10th September | Collect van (and trailer?)  Pack of equipment | ED  All |
| 11th September | Transport of equipment  Bedframe assembly  Bedframe deployment | E, ED, TN/FL |
| 12th-13th September | weekend | none |
| 14th September | Travel to Frænfjorden  Start AUV missions  Recover bedframe  Profiling of particle instruments  Recover AUV, data offload, charging | AUR-Lab, GB, FP, SB  AUR-Lab, GB, FP, SB  E, ED, TN/FL  E, ED, TN/FL  AUR-Lab, GB, FP, SB |
| 15th September | AUV missions  Dave arrives – hand-over from AUR-Lab  Profiling of particle instruments  Recover AUV, data offload, charging | AUR-Lab, GB, FP, SB  DW, AUR-Lab  E, ED, TN/FL  AUR-Lab, GB, FP, SB |
| 16th September | AUV missions  Profiling of particle instruments  Recover AUV, data offload, charging | DW, GB, FP, SB  E, ED, TN/FL  AUR-Lab, GB, FP, SB |
| 17th September | AUV missions  Profiling of particle instruments  Recover AUV, data offload, charging  Start demob | DW, GB, FP, SB  E, ED, TN/FL  AUR-Lab, GB, FP, SB  All |
| 18th September | Demob at Hustadmarmor  Return to Trondheim  Demob at TBS and SeaLab | All |

## AUV Missions

The operation will take place in the Frænfjorden area to detect sediment release from a mining operation by the factory Hustadmarmor AS.

The operation will take place in a restrained area as can be seen in the figure below. The operational area is chosen to be the rectangle of size 260m X 1.2 km.

The maximum depth of the area is 50m or more, and the maximum planned depth of the vehicle is set to 30 m.

**Equipment:** LAUV Thor

A picture containing text, map

Description automatically generated

The waypoints are decided within T-REX through a GP process with a predetermined grid of waypoints. All these waypoints are within the described area. The vehicle will transit from grid node to grid node based on updating the GP model with turbidity data, and two different sampling strategies will be tested. Algorithm 1 has the objective to reduce the variance in the GP model and create a map of the sediment distribution. This means the vehicle will go at points where it believes it either does not have sufficient information or revisit nodes that have been visited too long ago.

Algorithm 2 uses a similar GP model, but with the objective of reducing the misclassification probability with respect to the ES. The waypoints should not be outside of the grid which should then ensure the vehicle would never go outside of the predefined operation area.

# Methods

## Algorithm 1 (Mapping)

In this method the spatial field is modelled by a spatio-temporal GP. The linear temporal model is built using SPDEs. The sampling strategy of the method is based on reducing the variance in the predicted field.

**Pre-run:** We want to run a “pre-run” to see how the sensor values relates to our model data. We let the AUV explore the area and use the maximum value from turbidity or Silcam sensor to scale the prior of our model.

**Preparation:** Before the AUV is deployed, a prior needs to be built based on DREAM and SINMOD-data.

**Input during mission:** One value from turbidity sensor or Silcam at the waypoint.

**Output:** Next waypoint located within the operational area.

**Desired AUV-path:** Yoyo path, with maximum depth 30 meters. The vehicle comes to the surface after every waypoint.

**Duration:** As long as possible.

## Algorithm 2 (Excursion set)

An area where some quantity of interest is above a given threshold or critical limit is called an *excursion set* (ES). This algorithm uses a spatio-temporal GP as in Algorithm 2, but the sampling strategy is different. We now choose the next waypoint with the goal of minimizing the misclassification probability with respect to the ES.

**Pre-run:**  As in Algorithm 1. The limit for the excursion set will also be scaled in this pre-run.

**Preparation:** Prior needs to be built based on DREAM and SINMOD-data.

**Input:** One value from turbidity sensor or Silcam at the waypoint

**Output:** Next waypoint located within the operational area.

**Desired AUV-path:** Yoyo path, with maximum depth 30 meters. The vehicle comes to the surface after every waypoint.

**Duration:** Run a mission for at least 1 hour.

## Suggested plan AUV missions

Day 1 (14th September)

* Traveling and set up
* Collect data and run pre-run

Day 2 (15th September)

* Algorithm 1 (the whole day)

Day 3 (16th September)

* Algorithm 2 (half a day)
* If time: Run Algorithm 1 again

Day 4 (17th September)

* Lawn mower for “ground truth”?

Day 5 (18th September)

* Pack up and leave