

Undergraduate Research Experiences in geoscience courses at UiB and UNIS in 2021-22

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Aim

This report presents examples of undergraduate research experiences in geoscience courses at The University of Bergen (UiB) and The University Centre in Svalbard (UNIS).

The documentation of undergraduate research experiences is collected in the context of iEarth Focus Area 2 (FA2, A Learning Environment for Students). A key step for FA2 is to *provide course-based undergraduate research experiences*. FA2 aims to establish such a framework early in the geoscience programs through repeated exposure to collaborative research projects in the classroom, the field, and in the lab. In this report we present examples of field and lab-based undergraduate research experiences currently in operation at UiB and UNIS. Information about the design of undergraduate research experiences was collected through interviews with course responsible teachers and described in step-by-step instructions.

Field-based research project (terrestrial)

Polar Meteorology and Climate (AGF-213), UNIS

Teacher: Marius Jonassen

Polar Meteorology and Climate is a semester-long course at the Arctic Geophysics department at UNIS. This course includes a student research project (term project) where students work in groups with data collection, data processing and report writing. Data are collected during a multiday stay at a remote research station in Svalbard. The projects are reported in writing with two rounds of student peer review and the results are presented in a conference-style presentation prior to the final submission of the report. The term projects are carried out in a number of steps presented below:

- 1) Information about fieldwork and term projects is available on Canvas by the start of the course.
- 2) During the first week of the course, students are introduced to a list of term project subjects. Each student is applying for three different subjects listed in the order of preference and with a motivation for their choices.
- 3) The course responsible will decide groups of two or three students based on student background and project preferences.
- 4) Before fieldwork, students get a Canvas quiz on the instruments that will be used in the field. For the next time the course is taught the course responsible plans to add hands-on exercises on instrument use, first in the classroom and then in the field close UNIS.
- 5) Data are collected at field sites where the different instruments are used. These sites are located in the vicinity of the remote research station. Students work in groups and each group gets to practice collecting data at all field sites.
- 6) Students work with data processing in the evenings at the research station with supervision by the course instructors.
- 7) Back at UNIS, the data processing continues with supervision by course instructors and a status report is presented by each group one week after coming back from the field, and students get feedback on their projects.
- 8) Students write the term project report in groups. There are two deadlines where the groups read each other's drafts. A rubric is used for the peer review process and student groups write an evaluation report of each other's first drafts. Instructors then give feedback on the evaluation reports.
- 9) Oral group presentation of term projects. All students and teachers attend the conference. 15 minutes presentation and 5 minutes questions.
- 10) Final hand in of project reports where students have the possibility to include feedback from the oral presentations.



Figure 1: AGF-213 students are collecting data for their research projects at two different field sites in the area around Isfjord Radio, Svalbard.

Field-based research project (marine cruise)

Polar Ocean Climate (AGF-214), UNIS

Teacher: Ragnheid Skogseth

Polar Ocean Climate is a semester-long course at the Arctic Geophysics department at UNIS. This course includes a student research project (term project) with data collection in groups and individual written reports. Data collection is carried out during a multi-day marine cruise. The project is reported in writing with two rounds of student peer-review and the results are presented in a conference-style presentation prior to the final hand in of the report. The project (oral presentation and written report) counts 30% of the total grade of the course. The student research projects are carried out in a number of steps:

- 1) Information is sent out before the course starts: here students are informed about the dataset (real data collected yearly since 1996) and a list of suggested project titles divided either in geographic area or in methods.
- 2) During lectures, students get theory of instruments and data collection methods.
- 3) Field preparation step 1: Students are working in groups (divided based on research topic). The groups are responsible for one instrument each. They familiarize themselves with this specific instrument by reading and getting hands-on training.
- 4) Field preparation step 2: during a classroom exercise, all the groups demonstrate their instruments to each other.
- 5) Cruise: Data are collected and processed around the clock on the ship and students work in shifts. There are several instructors on the cruise, and there is always at least one together with students collecting data. Before shifts student groups get instructions on what to do. There is no formalized feedback or reflection sessions which is something that the course responsible recommends adding.
- 6) Back at UNIS, there is a post-cruise workshop when all instructors and students are attending. Students present the status of their data and get feedback. The course responsible recommends that the next time the course is taught there will be deadlines for when students should have suggestions for research questions, when the data processing should be finished and when data figures should be completed.
- 7) Writing report. There are two deadlines where students read each other's drafts (peer automatically assigned through Canvas) and a third deadline that is optional with oral feedback from teachers.
- 8) Oral conference-style presentation of individual research project. All students and teachers attend the conference. 15 minutes presentation and 5 minutes questions.
- 9) Final submission of project reports where students have the possibility to include feedback and realizations from the conference.



Figure 2: AGF-214 students collecting data onboard the ship. The groups work in shifts around the clock with the data collection and they are supervised by the course instructors.



Figure 3: During the multiday cruise AGF-214 students spend part of their days processing data onboard the ship.

Field-based research project (terrestrial)

Environmental change in the high-Arctic landscape of Svalbard (AG-220), UNIS

Teacher: Michael Retelle

The course extends over about five weeks in the summer and is taught at the department of Arctic Geology at UNIS. This is a field-based course which is focused on individual student research projects.

The first ten days of the course is centered at UNIS with introductory lectures and exercises preparing students for working on their research projects. About 10 days of fieldwork is undertaken at localities in the vicinity of UNIS and at a remote field station. During fieldwork at the local sites, students are introduced to all aspects of the research activities and trained in field techniques and the use of monitoring and sampling instruments. Data and samples collected at the remote field station will form the basis of the research projects. Students will work collaboratively as part of various research teams and data collected from logging instruments will be shared among students pursuing different research projects. The field-based student projects are carried out in the following steps:

- 1) One week before leaving for the remote research station students present proposals of their intended research. The proposals include information on what the students want to do in their research projects and what equipment they need to collect and analyze the data. Students base their proposals on literature from the course reading list and on one-on-one supervision by course instructors.
- 2) Students collect field data in small groups at different workstations in the area around the research station.
- 3) At the field station, students have the opportunity to work in the evenings on their data and samples. During the evenings students can get feedback and discussions with the course instructors.
- 4) Progress reports on the projects are presented the first day after coming back to UNIS.
- 5) At UNIS, students will synthesize data and analyze samples under the supervision of the course instructors.
- 6) During the last week, students deliver a final oral presentation and a written report on their research.



Figure 4: AG-220 students download data from the weather station in the Linné Valley close to Isfjord Radio, Svalbard.

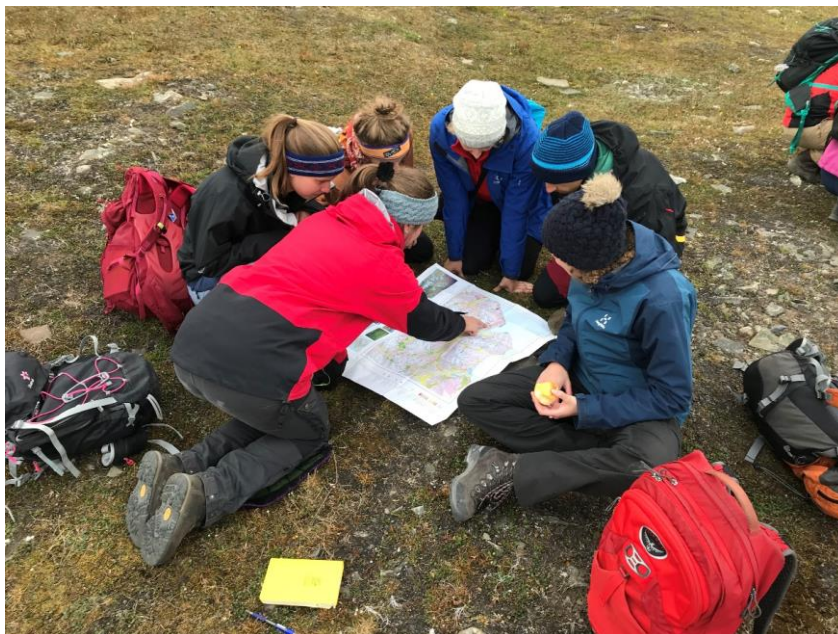


Figure 5: AG-220 students plan their day in the field.

Field-based research project (terrestrial)

The Quaternary geology of Svalbard (AG-210), UNIS

Teacher: Mark Furze

The Quaternary geology of Svalbard is a semester-long course at the Arctic Geology department at UNIS. This course includes a student research project (term project) with data collection in groups during fieldwork at a remote site with overnight stays. Based on data collected during fieldwork each student defines a research topic with supervision from the course instructors. The project work is supervised one-on-one. Term projects will be presented through a written report in the format of a scientific paper and through an individual conference-style oral presentation.

- 1) Field preparation: Students get hands-on practice with data collection methods during exercises in the classroom and right outside the UNIS building.
- 2) Fieldwork: At the remote field site, students collect data in small groups at different workstations in the forefield of a glacier.
- 3) During fieldwork at the remote site, students work on their data in the evenings and get feedback from the course instructors.
- 4) Back at UNIS, there is a workshop which all instructors and students attend. During the workshop, students present preliminary results from the fieldwork. Each group present findings from one or two workstations. The aim of the workshop is to help with knowledge transfer and bring what has been learned in the field back to the classroom.
- 5) Students develop research questions for their individual term projects with supervision from course instructors.
- 6) Data are processed during a scheduled full week in the laboratory. Following the week in the lab there is a seminar where each student presents and get feedback (from fellow students and instructors) on preliminary versions of all the data figures for their projects.
- 7) Approximately three weeks at the end of the course are scheduled for writing up project reports with one-on-one supervision by the course instructors. There is a deadline for handing in a first draft and get feedback from one instructor. This submission is optional.
- 8) The finished project report is submitted prior to the oral presentations. Individual conference-style oral presentation are given in an auditorium in front of the class and the instructors. The presentations are open to all students and staff at UNIS.



Figure 6: A group of AG-210 students investigate the glacial sedimentology at one of the work stations in the Aldegondabreen forefield, Grøn fjorden, Svalbard.



Figure 7: AG-210 students map glacial features for their research projects.

Laboratory-based project

Introduction to Geobiology (GEOV114), UiB

Teachers: Bjarte Hannisdal and Sven Le Moine Bauer

Winogradsky column experiments: Microbial metabolisms are fundamental to understanding biogeochemical cycles and the functioning of the Earth system. Although traditionally absent from geoscience curricula, microbiology is asserting itself with rise of geobiology as a topic of research and teaching. However, engaging geoscience students in learning activities on the "invisible" world of microbiology is hampered by complex experimental lab protocols involving unfamiliar methods and equipment. Hence, microbial ecosystems and processes remain as a knowledge gap for geoscience students. In an attempt to remedy this gap, we have introduced 5th semester geology students in our program to experimenting with Winogradsky columns. This method uses sediment-filled flasks to visualise the response of phototrophic microbes to geochemical gradients.

- 1) We let the students choose their environmental sample and which experimental variable they would like to investigate (e.g., temperature, nutrient or organic matter concentrations, pollution, pH, salinity). The simplicity of the Winogradsky column holds several advantages, because it involves very little equipment, there is no need to work in sterile conditions, and the phototrophic organisms have colourful pigments that “make the invisible visible”.
- 2) The students design their own controlled experiment and make repeated observations, including microscopy, and oxygen optode measurements.
- 3) The experiment runs through an entire semester before the students present their results in a scientific poster session with both student peer and teacher feedback. The teachers plan to expand the Winogradsky column activity across multiple courses in the program by letting students revisit their columns from the previous year and make use of DNA sequencing technologies to add a level of complexity and authenticity to their understanding of the microbial that rule the planet.



Figure 8: Winogradsky column experiments.