Small TLEF Innovation Project – Proposal Form

All proposals must be submitted by 3:00 pm on November 17, 2022

- *Before proceeding, please read all TLEF criteria and application instructions at: **http://tlef.ubc.ca***
- *Applications should be written in language that is understandable to a non-specialist.*
- *The online application system is plain text. You will not be able to add tables, graphs, or charts in your proposal.*

Project Title (200 characters max.)

Do not use all-caps.

Math and EOAS Collaborate to Improve Climate Education at UBC

Principal Applicant

For administrative purposes, there must be one Principal Applicant who should be a full-time UBCV faculty or staff member. A UBC student may also apply as a Principal Applicant provided there is at least one co-applicant who is a full-time UBCV faculty member who will act as a co-principal signatory.

Principal Applicant's name:

Sven Bachmann

Principal Applicant's title(s) (e.g. Assistant Professor, Instructor, Professor of Teaching, etc.):

Associate Professor

Principal Applicant's primary (UBC) email address:

sbach@math.ubc.ca

Principal Applicant's role:

x Faculty
☐ Staff
☐ Student
☐ Other

Principal Applicant's Faculty, College, or administrative unit:

☐ Faculty of Applied Science
☐ Faculty of Arts
☐ Faculty of Dentistry
☐ Faculty of Education
☐ First Nations House of Learning
☐ Faculty of Forestry
☐ Faculty of Graduate Studies
☐ Faculty of Land & Food Systems
☐ Allard School of Law
☐ Faculty of Medicine
☐ Faculty of Pharmaceutical Sciences
☐ Sauder School of Business
x Faculty of Science
☐ UBC Health
☐ UBC Library
☐ Vantage College
☐ VP Academic
☐ VP Students
☐ Other

(Please specify)

Principal Applicant's Department, School, or unit:

Co-Applicants & Project Team Members

Please indicate all other co-applicants' names as well as their corresponding titles, affiliations, role in the project and UBC email address, separated by commas (e.g. Jane Doe, Associate Professor, History, Faculty of Arts, jane.doe@ubc.ca). If your proposal is successful, this list will be published on the UBC website (emails will be removed).

Math UBC-V:
Sven Bachmann, Associate Professor, Math, Faculty of Science, sbach@math.ubc.ca (Math Lead UBC-V)
Daniel Coombs, Professor and Head, Math, Faculty of Science, head@math.ubc.ca
Eric Cytrynbaum, Associate Professor, Math, Faculty of Science, cytryn@math.ubc.ca
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Anthony Peirce , Professor, Math, Faculty of Science, peirce@math.ubc.ca

Math UBC-O:
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Sarah Wyse, MSc Student, Computer Science, Mathematics, Physics and Statistics, I.K Barber Faculty of Science, swyse@student.ubc.ca
Chad Davis, Lecturer, Computer Science, Mathematics, Physics and Statistics, I.K Barber Faculty of Science, chad.davis@ubc.ca

Earth Ocean and Atmospheric Sciences:
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Susan Allen, Professor EOAS, Faculty of Science, sallen@eoas.ubc.ca

UBC Sustainability Hub
Oliver Lane, Manager Teaching and Learning, UBC Sustainability Hub, oliver.lane@ubc.ca (Sustainability Hub lead)
Meghan Wise, Coordinator, UBC Climate Hub, meghan.wise@ubc.ca

Department Head Approval

The Department Head/Unit Head, Director, or equivalent of the Principal Applicant, has been consulted on the nature of the project, is aware of potential resource commitments, and has agreed to support the project. If there are resource commitments from the departments of any co-applicants, their Department Heads should also be aware, and in support of, the project.

☐ Yes

Dan Coombs, Philippe Tortell

Name of Department Head(s) who you have consulted with on this application:

Project Summary (150 words max.) (120)

Describe your project in a manner that is accessible to a non-specialist. Please specify what you hope to change or see as a result of this project. If your proposal is successful, this summary will be published on the UBC website.

By breaking down disciplinary barriers, this project aims to significantly increase climate education in key Math courses, emphasise the role of mathematics as a tool to address climate

related challenges and highlight climate education in EOAS by:

- Creating and fostering collaboration between faculty members committed to teaching climate content in Math and EOAS courses
- Developing a set of scaffolded, climate-focused examples, quantitative assignments, modules and activities that can be used in MATH and EOAS courses to develop climate literacy and mathematical capabilities.
- Exposing students in large 1st year Math courses (around 5000 students) to climate scientists and climate science problems
- Highlighting quantitative, climate-focussed paths of learning
- Supporting curricular continuity so students gain math skills needed for senior climate related courses.

Students Reached by the Project

Please fill in the following table with all known courses and sections that will be reached by your project and in which academic year (e.g. HIST 101, 002, 2023/2024, Sep).

Course Code	Section	Academic Year	Term (Sep/Jan/May)
Math 100	all	2023/24	Sep
Math 101	all	2023/24	Jan
Math 215/255	all	2024/25	Sep
Math 257/316	all	2023/24	Sep and Jan
Math 360 (Mathematical Modelling in Science, in development)	101	2023/24	Sept
Math 361 (Intro to MathBio)	all	2024/25	Usually Sep
Math 255 (UBC-O)	all	2023/24	Jan
Math 100 (UBC-O)	all	2023/24	Sept and May
Math 101 (UBC-O)	all	2023/24	Jan and May
EOSC 340	all	2023/24	Sep and Jan
EOSC XXX (Climate Physics in development)		2024/25	Jan
EOSC 410	101	2023/24	Sep
ATSC 404	201	2023/24	Jan
ATSC 409	201	2023/24	Jan
SCIE 001	all	2023/24	Sep and Jan

If your project does not pertain to a specific course, or if there are additional contexts in which your project will have impact, briefly describe the overall student reach in all academic year(s).

How many students overall do you estimate will be reached by this project annually? (Please provide a number)

7000

Project Objectives (500 words max.) (511)

Clearly state the project's rationale, overall objectives, and expected impacts/changes with particular reference to how it meets TLEF criteria.

In 2019 UBC declared a Climate Emergency. It is critical UBC prepare students to understand and address climate change— a core recommendation of the Climate Emergency Task Force is to expand climate education opportunities for the UBC community and broader public. Recently

UN Secretary-General Antonio Guterres said "... our planet is fast approaching tipping points that will make climate chaos irreversible. We are on a highway to climate hell with our foot still on the accelerator." Students, as citizens facing the climate crisis, need to understand complexity and evidence-based decision making that is developed through Math and EOAS curricula.

Climate Science combines math, physics and computation to study, characterize and predict behaviours of the Earth's physical climate system. At UBC, first year science students must take math courses, but they have no requirement for learning about climate science. Introducing more examples and problems related to the climate crisis in 1st year math emphasizes the universality and modernity of mathematics and exposes students to aspects of climate science early in their educational pathway. Embedding climate content throughout the math curriculum will provide current and meaningful contexts, thus enhancing learning and retention in traditionally challenging math courses. It will also emphasise the connections between Math and EOAS, highlighting pathways of further climate learning. These initiatives will represent an effective followup to the currently funded curriculum renewal projects in EOAS (OCESE and QUEST).

This collaboration between the departments of Math and Earth, Ocean and Atmospheric Science is a means to:

- expose science students to climate science in 1st year
- support and develop climate literacy in science students beyond 1st year
- highlight paths of learning so students can purposefully deepen their climate literacy over time.
- contextualise the math curriculum using examples that are critical to society today
- increase student interest in math and quantitative earth science

The objectives of this project are to:

- Make students more familiar with the quantitative nature of climate science
- Create and foster collaboration between faculty members teaching climate content in Math and quantitative EOAS courses.
- Develop a set of scaffolded, climate-focused examples, quantitative assignments, modules and activities that can be used in MATH, ATSC and EOSC courses to progressively develop student's quantitative and climate literacies
- Develop pedagogy on how to teach these examples
- Expose students in large 1st year MATH courses to climate scientists and climate science problems and highlight quantitative, climate-focussed paths of learning
- Encourage students' interdisciplinary interests through concrete examples involving math, physics, chemistry and earth science

This project targets both teaching and learning enhancement.

Teaching Impacts: 12+ faculty members in Math and EOAS will improve their ability to teach disciplinary and interdisciplinary climate related content. Where possible, the developed teaching resources and aligned pedagogies will be shared beyond the project team as open source materials.

Learning Impacts: Approximately 5500 students per year will be impacted by this project through renewed and revised education materials and pedagogies resulting in higher interest levels, better student engagement, better learning of core math methods, increased mathematical literacy related to climate science and acquisition of interdisciplinary skills.

Project Focus Areas

Please select all the areas that apply to your project.

x Resource development (e.g. learning materials, media)
☐ Infrastructure development (e.g. learning technology tools, learning spaces)
x Pedagogies for student learning and/or engagement (e.g. active learning)
☐ Innovative assessments (e.g. student peer-assessment)
☐ Teaching roles and training (e.g. teaching practice development, TA roles, learning communities)
x Curriculum (e.g. program development/implementation)
☐ Student experience outside the classroom (e.g. wellbeing, social inclusion)
☐ Experiential and work-integrated learning (e.g. co-op, community service learning)
☐ Indigenous-focused curricula and ways of knowing
☐ Diversity and inclusion in teaching and learning contexts
x Open educational resources
☐ Other

(Please specify)

Summary of Work Accomplished to Date* (1000 words max.)

With reference to what you originally intended for the project, what has already been completed and what is the project on track to accomplish by the end of the funding year (i.e. March 31)? Please include in your update the total amount of TLEF funding that has been spent to date by the project at the time of this application.
**(This section to be completed for returning projects seeking second- or third-year funding only.)*

N/A

Project Work Plan, Timeline & Milestones (1000 words max.) (394)

Provide a clear work plan for how you will achieve the stated objectives of the project. Please include major milestones to indicate when you will initiate project development, when you will implement the project with students, and when you will evaluate whether your project's intended impact has been achieved.

Current activity contributing to / preparing for this project:

- 2021 Climate Education Grant supported the development of 6 assignments with climate content for MATH 225 (UBC-O): Rebecca Tyson PI
- Project scoping: four meetings between Math and EOAS faculty with support units
- One assignment for the Math component of Science 001 has been shared with EOAS colleagues. Opportunities for integrating climate content into teaching differential equations have been identified and discussed.
- Guest lectures by EOAS faculty in Science 001 have been organised for 2022WT2
- MATH 101 UBC-V: climate change related assignments will be piloted in 2022WT2

Proposed project activities:

Mar - Aug, 2023:

- 2 Math / EOAS workshops to break down disciplinary barriers and build interdisciplinary

understanding of Math and Climate Science curriculum: mapping the curriculum to identify core topics to tackle.

- 6 Math / EOAS workshops focused on particular models used in Climate Science: Building interdisciplinary understanding of Math and Climate Science curriculum, identifying linkages between course learning objectives
- Scoping ~ 6 sets of scaffolded examples / assignments / activities / modules / assessments.
- Scoping of additional isolated examples and assignments to fit smoothly in the math curriculum
- Development of ~ 6 sets of scaffolded examples, assignments, activities and modules with appropriate assessments and pedagogical wrappers
- Development of additional assignments to be used in Math 100 and Math 101
- 1 workshop for faculty on navigating and supporting faculty and student welling-being that shares and builds strategies for supporting faculty and student emotional responses to teaching and learning about the climate crisis - run by the Sustainability Hub and Climate Hub.
- Focus group: Initial piloting of new educational and wellbeing materials with students

Sept-Dec 2023:

- New examples, problems, assignments and pedagogies deployed in 1st term courses: Math 100 (UBC-V and UBC-O), Math 360, Math 257/316, EOSC 340, EOSC 410, SCIE 001
- Climate distress and wellbeing workshops / support groups for students (3 / term)
- Evaluation of the first deployment
- Revision of examples, problems, assignments and pedagogies
- Workshop: Debrief Term 1

Jan-March 2024:

- New examples, problems, assignments and pedagogies deployed in 2nd term courses: Math 101 (UBC-V and UBC-O), EOSC 340, SCIE 001, ATSC 404, 409
- Climate distress and wellbeing workshops / support groups for students (3 / term)
- Evaluation of the first deployment
- Revised materials and pedagogies deployed in 2nd term courses:
- Workshop: Debrief term 2

Summer 2024:

- Revision of educational materials and pedagogies.
- Development of additional material.

Fall 2024 / Winter 2025:

- 1st deployment in Math 361
- Second deployment and evaluation
- New material introduced in Math 215/255
- Development of additional material.
- Climate distress and wellbeing workshops for students (3/ term)
- Formatting of source material: for fast online access, for use in WebWork where appropriate

Project Outputs, Products or Deliverables (500 words max.) (398)

List or describe the project's intended tangible outputs, products, or deliverables. What will the project do or create as a result of the implementation of its work plan?

The primary deliverables from this project are:

- 20+ faculty learn to teach climate content with an interdisciplinary lens while developing relationships across disciplines.
- 6 sets of new teaching and learning materials developed for use in 15 courses
- 12+ problem sheets for math courses with climate related content
- 3 student wellbeing workshops / support group meetings focussed on climate distress
- Compilation of climate distress support resources on campus
- The beginnings of a portfolio of open source learning resources to share with educators beyond UBC

Below we outline the details of these deliverables:

Faculty Professional Development and Community-Building:
Through a series of workshops Math and EOAS faculty from UBC-V and UBC-O will develop an interdisciplinary approach and the skills to teach climate related content in a variety of classes ranging from first - fourth year. Through these workshops, new relationships will be built and previous relationships will be deepened creating a network of colleagues with complementary skills. Faculty will also be trained to navigate their own climate emotions and to support and provide resources for students in distress as a result of studying the climate crisis.

Development of new teaching materials and pedagogies:
The new climate-focussed teaching and learning resources will progressively develop topics, concepts and skills that are covered in the following courses:

- Math 100 / 101: Analysis of functions arising from climate modelling, simple differential equations involving climate forcings and feedbacks, equilibria and their stability
- Math 215 / 255: Analysis of climate related models, equilibria and asymptotics, elementary bifurcation and their importance in climate change, heat exchange
- Math 257 / 316: Shallow water equations
- Math 360: Modelling planetary glacial cycles, clouds and atmospheric, lithium battery charging.
- EOSC 340: Physical processes driving climate change on all timescales
- EOSC 410: Data analysis and empirical modelling performed on climate datasets
- ATSC 404 / 409: Multidimensional Taylor series and linearization; shallow water model
- SCIE 001: Elementary differential equations with applications to carbon concentration, thermodynamics and climate change, heat exchange

Pedagogies:
The new teaching and learning materials will incorporate evidence-based, active learning and inclusive design to engage with real world examples of climate change. Emphasis will be put on the meaning of the equations, the interpretation of their solutions and the evaluation of the models. The "sets" of materials will allow courses to engage with the same materials, appropriately scaled, in different courses to foster effective transfer of knowledge and skills.

Student Support Resources:
As part of the integrated support model for engaging climate distress and wellbeing, a relevant resource toolkit will be provided to help connect students to UBC and broader community networks that can provide direct, peer-to-peer and community based support services. This

ranges from UBC counseling services specializing in climate anxiety, to lists of student groups and community organizations that engage climate anxiety to wellbeing and action opportunities.

Development of Open Educational Resources:
Where permissions can be obtained, teaching resources developed as part of this project, including materials, assessments and pedagogic guidelines, will be delivered as OERs to UBC's Open Ed resource repository.

Project Impact (500 words max.)
Referring to the project's objectives and expected outputs, what are the direct and short-term, as well as sustainable, benefits to students or instructors that you expect to achieve? What changes or impacts do you hope to see as a result of this project? Explain how these will contribute toward the enhancement of teaching and learning.

As a result of this project:

- UBC will advance the Climate Emergency Task Force Report recommendation to expand climate education opportunities and resources for the UBC community and the broader public

- Relationships between faculty members in Math and EOAS will be created and strengthened, including faculty on both the Vancouver and Okanagan campuses. As a result, more faculty will understand climate models, have teaching skills related to climate and math and have a community of colleagues to engage with when questions arise. Once developed the relationship between faculty members in Math and EOAS will be sustained through ongoing guest lectures in SCIE 001 and by departmental commitments to keep up to date teaching relevant climate science. It is also likely that these relationships will lead to additional opportunities to create resources beyond the scope of this TLEF.

- A bridge will be built connecting instructors at UBC-O with instructors at UBC-V. Though research relationships might exist, at a research intensive university like UBC, it is common for individual instructors to feel isolated in relation to their teaching. Connecting UBC-O and UBC-V colleagues around teaching will provide more support to isolated individuals and more opportunities to discuss ongoing and new educational initiatives.

- The Math curriculum will be updated and revised to include climate content in multiple courses demonstrating the relevance of math in contemporary society. Renewed student interest in mathematics will result from examples exploring current issues.

- More students will gain climate related knowledge and skills and be better prepared, as citizens facing the climate crisis, to understand complexity and make evidence-based decisions.

- More students will become aware of and pursue pathways for developing climate literacy in EOAS, deepening student ability to quantitatively analyse the climate crisis and model the climate system.

- More faculty will be trained with wellbeing strategies to manage their own emotional response to teaching the climate crisis and to support and empower students experiencing climate distress.

- A compilation of examples, activities, assignments, assessments and associated pedagogy that progressively develop quantitative climate literacy will be developed to ensure curricular continuity. Whenever appropriate, these resources will be designed and made available as open educational resources.

Evaluation Plan (500 words max.) (243)

Describe how you will find out if the project resulted in the intended impact(s). What evaluation strategy will be used? What data will you collect to evaluate the project's impact(s), and how will you collect these data? Outline any key indicators that will be used to determine the project's success/performance.

To evaluate the "intended impacts" above, we will collect data relating to the following categories using the methods indicated below:

a) Improved interest, literacy, and awareness of climate and mathematics.

- Student focus groups and interviews
- "light weight" survey questions embedded with assignments asking about prior and changing levels of interest, workload related to climate-related math tasks, desire for more, and other ideas that will emerge as course improvements are implemented.
- Compare "before" and "after" experiences of faculty teaching EOSC 340, and other courses. Are students better able to do more sophisticated things in these courses? Do instructors find students are more capable (although this is a rather "long term" expectation - or "hope").

b) Improved faculty knowledge and skills related to teaching about climate and math.

- Interviews, focus groups, and written reflections from participating faculty; what worked, what didn't, how to improve, etc. Suitable short interviews can be carried out by students, once a semi-structured protocol has been developed (with CTLT support).

c) Improved relationships and interactions between Math and EOAS department faculty

- Obtain feedback from Faculty during project discussions and workshops.
- Characterize concrete new teaching partnerships, guest spots, and others.

d) OER resources - point to data demonstrating use, effectiveness and appreciation

- Piloting the new assignments with a focus group of students.
- From first deployments: scores, articulation of where difficulties arose and how teaching teams addressed them (e.g. by making adjustments).
- Placing these in UBC's (or MATH's) OER repository to indicate "done & tested".

Student Involvement (250 words max.) (153)

Describe how students were consulted and involved in preparing and reviewing this proposal, and how they will be involved in the implementation of the project.

Proposal:

- This proposal was in part motivated by students' suggestion in SCIE 001 to increase the use of climate examples.
- Sara Wyse, a co-investigator on this project, is a graduate student at UBC-O who developed climate content for the introductory ordinary differential equations course. Her work will be used as a starting place for the curriculum workshops.
- Feedback on this proposal was solicited from the EOAS Climate Emergency Committee, including 2 undergraduate students and 6 graduate students.
- Feedback on this proposal was solicited from the student executives of the Environmental Science Student Association, the Storm Club, and Dawson Club.

Implementation:

- A graduate student research assistant and 2 undergraduate work learn students will be hired to support this project.
- Throughout the project, feedback will be solicited from Math undergraduate students and students enrolled in targeted classes through surveys and focus groups as well as midterm and end of term feedback and evaluations.
- Students from the Climate Hub will be trained to run climate distress and wellbeing workshops and discussions to engage effective models of peer-to-peer climate community building.

Meaningful Engagement with Equity, Diversity, and Inclusion (250 words max.) (148)

How does your approach align with UBC's priorities for equity, diversity, and inclusion? What steps will you take to ensure that you consider accessibility needs for students in the development and implementation of this project?

All educational materials produced for this project will be developed with universal design principles in mind. To aid students in planning and organising educational materials, developing goals and self-regulating, and applying learning strategies:

- the new learning materials will be simple and employ clear headings and icons
- the supporting documents will be concise and limited in length
- when appropriate check-lists and self-tests will be included to provide timely feedback
- prompts or hints will be provided to get students started on practice problem sets

Wherever possible, context provided with the educational material (modules, examples, problems) will point to socio-economic aspects, climate justice, systemic inequalities.

All workshops will be held in accessible spaces and individual access needs will be solicited in advance of the meetings to ensure that we are able to support full participation by all participants. Additionally, student surveys and focus groups will include opportunities for feedback on the accessibility of the materials developed and the pedagogies employed.

While an improved quantitative climate science literacy can be expected to empower students to face the climate crisis, the reality might trigger feelings of distress: the educational materials and workshops developed will provide information about inclusive UBC supports and resources provided through the Climate Hub, Sustainability Hub, Student Services and UBC counselling.

Climate distress and wellbeing workshops will incorporate EDI lenses to facilitate inclusive discussions and provide a range of strategies to support students in addressing and navigating climate related anxieties. Support materials and workshop engagements will actively recognize and support the wide variety of student lived experiences.

Special Classroom or Facilities Requirements (150 words max.)

Does the implementation of your project require any special classroom/facilities or scheduling support (e.g. video-conferencing, lecture capture, flexible classroom space, etc.)?

No

Project Budget

If this proposal is successful, do you anticipate that your project will seek second- and/or third-year funding from the TLEF?

☐ No, only one year is anticipated
x Yes, two years are anticipated
☐ Yes, three years are anticipated

Title of previously funded TLEF project (if different from title of this proposal):

Funding Requested from the TLEF

Indicate the funding being requested. Please also indicate the historical funding for the project in its first, or the first and second year(s), if applicable, as indicated:

Example	Year	Funding Requested
Year 1 – Historical funding:		
Year 2 – This year's funding request:	*23/24*	*27,893*
Year 3 – Anticipated funding request:	*24/25*	*22,107*
Total Project Budget		$50,000

Total Project Budget

The total budget of a Small TLEF Innovation project cannot exceed $50,000.

Other Funding

$???? - Contributions from Math and EOAS

Indicate any funding from other sources outside of TLEF being applied to this project:

If applicable, please list any other active TLEF-funded projects currently held by the Principal Applicant:

Small TLEF Innovation Project Budget

Please use and upload the Excel template provided in .xlsx format:
https://tlef2.sites.olt.ubc.ca/files/2022/09/2023-TLEF-SP-Budget.xlsx

Information on funding criteria and cost estimates for TLEF proposals as well as the budget template can be found on the TLEF website, under Application > Process.

In preparing your budget, please refer to the rates published on the TLEF website for costs of services and salaries relating to staff and students at UBC: https://tlef.ubc.ca/application/application-process/