CCI VISION (2025-2030)

INTRODUCTION

The Climate Change Institute (CCI) is an internationally recognized leader in interdisciplinary climate research. CCI in combination with its University of Maine (UM) academic, research, and outreach partners, offers a robust array of graduate and undergraduate research opportunities. The Institute integrates transformational field, laboratory, and modeling activities to understand the physical, chemical, biological, and socio-cultural components of the climate system of the past and present, and to better predict future changes in climate and their impacts here in Maine and across the globe. Institute investigations span the last 2+ million years to the present - a time of multi-millennial to centennial scale climate changes punctuated by abrupt (multi-annual) shifts in climate. These investigations inform predictions for future climate change based upon an understanding of the full dynamic range of the natural climate system and the evolving dramatic influence of human activity. CCI has a legacy of major scientific contributions to understanding the timing, causes, and mechanisms of natural and human-forced climate change, and the effects of physical and chemical climate changes on the biological, economic, social, and political conditions of humans and the ecosystem.

CCI's mission is vitally linked to the widely accepted realization that an understanding of climate change (natural and human-forced) and its implications is critical to the future of society, ecosystems, the economy, and governance. CCI continues to experience ever-broadening interaction with other disciplines, with other UM researchers, academic and outreach units, and with local, national, and international partners. Because climate change underpins the fabric of our society, CCI faces rapidly emerging opportunities for the application of its findings and expertise to critical issues including: climate change-induced hazards (e.g., severe storms, floods, sea level rise, coastal erosion, drought, heat waves); health threats (e.g., heat stress, drought/flood, disease, air pollution, storms); economic and social challenges (e.g., water availability and quality, energy, food security, military security, civil unrest, agriculture, recreation, urbanization, mass migration); and climate change-based decision-making by individuals, NGOs, industry, and governmental units.

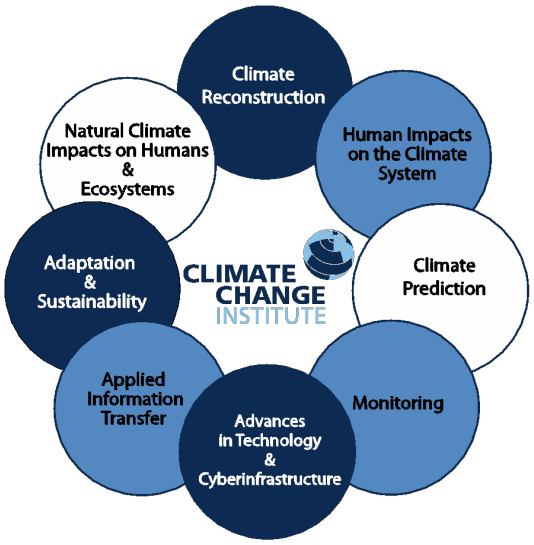
One of the ways that CCI addresses the evolving challenges posed by climate change is through its five-year vision plans.

FOUNDATION for CCI VISION (2025-2030)

Part of planning forward is making sure that CCI builds upon its legacy values:

(1) Maintaining and expanding CCI's role as a national and international leader in the "exploration and discovery" of the integrated physical, chemical, biological, and socio-cultural components of climate change research, education, and outreach. CCI has a legacy of expertise, expeditions worldwide, and data exploration, recovery, analysis and synthesis.

(2) Continuing to enhance the quality and expand the scope of the Institute's eight primary themes while continually evaluating the potential and necessity for reorientation and/or additional avenues of research in the world's most rapidly evolving security issue – climate change.



(3) Expanding the Institute's 50+ year, highly successful, role model status of shared faculty partnerships with academic units to build a fully coupled, world-class undergraduate and graduate climate change research and education program at the University of Maine.
(4) Continuing the critically important research and planning partnerships that help to make the State of Maine a national leader in climate change research, policy and education.
(5) Functioning as a point of coordination and creating a framework for University of Maine System climate change research, education, and outreach that includes CCI and non-CCI partners so that the University's full potential and value in climate change research, policy, and education is realized.

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In the spirit of a forward-thinking research institute, plans for CCI in 2025-2030 include, but are not constrained to the following:

(1) UM Strategic Priorities for 2024 Forward. CCI will continue to be a major contributor to these priorities:

"Sustaining the health of our planet and confronting climate change."

CCI's past/present/future climate change research addresses local to global understanding of the physical, biological, chemical, and socio-cultural aspects of climate change. The spatial and temporal climate change perspective afforded by CCI research offers the foundation and perspective that is essential to dealing with the challenges of current and future change. Without this foundation, climate game-changers such as abrupt climate change and local-to-regional scale climate variability will not be included in decision-making.

"Integrating research and teaching tomorrow's innovators."

CCI researchers teach and provide on-the-ground apprenticeship-type experience to help in resolving major real-world issues – "climate change is one of the major security issues of the 21st century". A recent example, developed by CCI collaboration with the UM Law School and the UM Portland Gateway, is the Interdisciplinary Complex-Problem Solving Partnership (IP-SP) and an accompanying graduate-level course (Complex Problem Solving for Future Leaders) that integrates multiple disciplines, methodologies, and tools to broaden student's problem-solving understanding and skills. In another example, undergraduate and graduate students in CCI's partner the Department of Anthropology produce climate adaptation plans for Maine communities (Climate Change, Societies, and Culture) and collect stories of climate risk and resilience throughout the State to inform climate planning (Human Dimensions of Climate Change).

"Growing a thriving and inclusive community."

CCI has a legacy of introducing faculty and student researchers to different cultures and environments around the world. These researchers develop an awareness and appreciation of the varied societal norms and world views through their experiences. Our joint student/staff/faculty DEI committee developed a report that is reviewed and updated annually in addition to a survey to solicit feedback on current areas of success and areas for growth. CCI is one of the first units in the University to do so. In addition, CCI has a student RA position, supported through private funds, co-chairing the standing DEI committee since 2021. The committee has facilitated numerous engagements in response to the surveys to promote equity, diversity, and inclusion such as a graduate student resource handbook, hosting microaggression awareness trainings from the UM Office of Diversity and Inclusion, a writing in community workshop, and an interdisciplinary student and faculty meet-and-greet. CCI strives to continue to affirm its commitment to creating and maintaining safe, diverse, equitable, and inclusive working and learning environments.

(2) Continue to Fortify UM R1 Status. CCI has been a major contributor to the University's ability to attain R1 status by maintaining a strong research funding program (for FY 2024 CCI administers 53 funded research grants (~$12 million)). CCI associated researchers are involved in a broad range of research activities across the University (for FY 2024 ~$32 million), and they advise many of the doctoral students among CCI's academic partners. CCI is one of the University's first signature programs and

continues this legacy of leadership and coordination as demonstrated by the recent CCI led Climate Challenge Consortium Survey that revealed that >400 faculty/staff across the University of Maine System are involved in climate change research/education/outreach.

(3) Continue CCI's Legacy for Sustainability Leadership. Since 2003, CCI has led the way for cutting edge campus sustainability initiatives. CCI students, faculty, and staff were instrumental in hiring a full-time sustainability professional for the university, joining the Governor's Carbon Commitment, creating the university's first Climate Action Plan, and committing the university to carbon neutrality by 2040. Unfortunately, CCI's primary campus home, Sawyer Environmental Research Building, is one of the most energy intensive buildings on campus. Ensuring that its HVAC systems are operating correctly and efficiently should be a priority. The Sawyer Renovation Project should ensure that CCI's campus home is operating at peak efficiency and will function as a reliable and professional CCI workspace for decades to come. It is encouraging that meetings between Honeywell HVAC and CCI Sawyer residents/labs are underway and that significant infrastructure improvements, including replacement, are moving forward.

(4) Partners and Associations. CCI has many academic and research partners throughout the University of Maine System, the State of Maine, and internationally. In addition, CCI is the lead representative on behalf of UM to the University Corporation for Atmospheric Research (UCAR), the University of the Arctic, and several national and international research programs.

(5) Graduate Students. As an interdisciplinary institute, CCI is composed of many affiliated graduate students across multiple disciplines. Annually, all associated students formally present their research at CCI's legacy venue the Harold W. Borns, Jr. Symposium. CCI seeks to continue building a strong, interdisciplinary graduate student cohort community by enhancing the student orientation and offering it each semester that new students join. CCI seeks to provide additional, graduate student discussion and development courses that promote high-level interdisciplinary discourse such as those offered pre-pandemic (Climate Analysis).

(6) Undergraduate students. About a decade ago, CCI-affiliated faculty were instrumental in designing two undergraduate programs with a climate change focus: the Anthropology Department's major in "Human Dimensions of Climate Change" and the School of Earth and Climate Sciences' B.S. degree in Earth Sciences with a Climate Sciences concentration. Most classes in both majors are taught by CCI-affiliated faculty. In addition, CCI faculty are engaged in the Research Learning Experiences program designed for incoming undergraduate students.

(7) Monitoring. CCI is expanding into new frontiers for measuring and monitoring climate change impacts across a spectrum of physical, cultural, chemical and biological environments. Currently, CCI conducts several types of monitoring including, glacier health and extent on several continents, widely distributed automatic weather stations, coastal cultural site integrity in Maine, and water quality including release and mobility of contaminants in Greenland, Maine, the Himalayas, Southern Ocean and Antarctica. CCI, in collaboration with the Maine College of Engineering and Computing and the Frontier Institute for Research in Sensor Technologies (FIRST), is and will continue to seek opportunities to develop low-cost, energy efficient sensors to monitor environmental parameters for use locally and in extreme environments, including sample collection and sensor deployment by drones.

(8) Reducing Climate Prediction Uncertainty. Climate prediction underlies all planning for the near future (years to decades) to longer-term climate change and resultant impacts and solutions. CCI's Climate Futures Initiative utilizes plausible scenario planning based on past and climate reanalysis-based modern analogs to reduce climate prediction uncertainty. In combination with the Maine College of Engineering and Computing, CCI continues to investigate the potential to enhance the temporal (seasonal – multi-decadal) and spatial (local to global) robustness of weather/climate prediction by combining artificial intelligence and machine learning skills from Engineering/Computing, and plausible scenario approaches from CCI that invoke modern data (weather data from state-of-the-art global climate reanalysis, and weather forecasts) coupled with past climate records, and both physics-based and analog-based models. This work reduces climate prediction uncertainty to allow informed decisions for future climate and impacts at local to global scales for policymakers, public, business, and agriculture.

(9) Climate and Health. CCI has a demonstrated legacy of research and outreach that addresses the impacts of climate change on humans and ecosystems (e.g., toxic substances in air and water, epidemics, publicly available physical and chemical climate software). CCI and the UM Institute of Medicine are in the process of developing stronger collaborations to further such research and outreach. CCI researchers are actively involved in Maine Climate Council strategies that advocate for strengthening public health monitoring, education, and prevention, as well as increased awareness and action related to the mental health impacts of climate change.

(10) Climate Adaptation and Resilience. CCI has made crucial climate information readily available to educators and planners through its online data visualization tools (ClimateReanlyzer.org, 10green.org), Maine State Climatologist, Maine Climate Office, and Climate Futures Initiative, but there is much more to do in applying this information to on-the-ground climate adaptation. Additionally, climate change impacts and resulting adaptation and mitigation efforts can negatively impact natural and historical cultural resources that provide a sense of place and societal inclusion for local and indigenous communities. CCI can make important contributions to fostering inclusive adaptation and resilience planning that is equitable and takes a systems-based approach to avoid unintended consequences.

(11) Growing and Sharing Climate Knowledge with Indigenous Partners. CCI has experience in collaborating with Indigenous communities in research programs (e.g., Maine, Alaska, Nepal, Peru, Chile, Sápmi). It is essential to continue this engagement and enhance respectful, non-extractive and reciprocal information exchange, knowledge co-production, and exchange of personnel and training opportunities with local communities where we conduct our research. It is important that CCI maintain and build respectful and equitable relationships around climate data and its applications for mutual benefit.

(12) Climate Policy, Law, and Security. The UM School of Law and CCI have been collaborating extensively on climate change induced issues in the Arctic through a joint course (Arctic, Law, Science and Policy). CCI faculty and students (in collaboration with the School for Policy and International Affairs, UM Maine Law, and the Department of Anthropology) have been attending the IPCC annual COP meetings to observe how governments, NGOs, industry and researchers debate and plan for solutions to climate change. This opportunity provides essential exposure to policy formation and opportunities for research ranging from, for example, global climate governance and adaptation finance to the role of Small Island States in the formation of rhetoric about Loss and Damage. Enhancing the foregoing is essential to keeping climate change science at the forefront of policy and decision-making.

(13) Maintain Excellence in Polar Research and Education and Foster Transdisciplinary Arctic Work. CCI has over 50 years of experience conducting interdisciplinary polar research and has well-established and new international Arctic training programs including co-leadership of both the Juneau Icefield Research Program (JIRP) and Wrangell Mountain Center (WMC) summer field studies program, and leadership of the SAUNNA NRT in South Greenland. To continue growing this research theme in CCI, we have identified several goals for the next 5 years. We plan to pursue the development of an ancient DNA facility that will enable next generation paleoenvironmental research in the Arctic and fill a national gap in research infrastructure. We also plan to develop an Arctic freshwater security laboratory to identify emerging threats to drinking water safety that our team has already observed and started quantifying in the Arctic. We will build from the progress over the past 5 years in our various Arctic initiatives that work to braid Indigenous Knowledge with our research approaches and continue and expand student training in this area. We also propose to work with the UMaine Foundation to establish a CCI Postdoctoral Arctic Fellowship. In graduate education, we will explore the possibility of developing a new Interdisciplinary Arctic Studies certificate, founded on new training elements implemented over the past 5 years through the SAUNNA NRT and other programs. Lastly, we will continue to lead an initiative to operate JIRP as an accessible Polar Proving Ground & Training Program for the Polar science and education community, an effort that has already garnered significant support from NSF, NASA, Department of Defense (Army & Air Force), and private funding sources. Over the next 5 years, members of CCI working in polar regions will also begin planning initiatives and proposals to contribute to the International Polar Year (2032-33).

(14) Involvement in the New UMaine Collaborative for Novel Transdisciplinary Traineeship (CENNT). CCI has served as the hub of two NSF-funded graduate training programs over the past decade, the Adaption to Abrupt Climate Change IGERT and the Systems Approaches to Understanding and Navigating (SAUNNA) the New Arctic NRT. Over the next 5 years, we will work with the new CENNT initiative to sustain elements of CCI's IGERT and NRT and to facilitate the development of future innovation in graduate training. This dovetails with our efforts to continue to fortify UMaine's R1 status, as collectively, the IGERT and NRT supported more than 30 PhD students in CCI.

(15) Community Outreach and Education. Community outreach and education are essential to bridge the gap between scientific knowledge of climate change and public action, and to raise awareness about its causes and impacts on local-to-global scales. Effective community outreach makes the science of climate change accessible and fosters a sense of urgency and responsibility among the public. Educational opportunities designed for K-12 teachers and learners, as well as for a range of professionals, empower individuals to understand the science behind climate change and to utilize best practices to engage diverse learners at all levels. A holistic approach to community outreach and education creates more informed communities, encourages collaborative solutions, and promotes more inclusive and sustainable practices. Effective strategies also ensure that vulnerable populations are equipped with the tools and knowledge needed to adapt and mitigate risks. CCI has a history of public outreach and education activities through: (1) Public-facing experiences like community-oriented lectures, film series, expedition series, videos, and research brochures. (2) Community-oriented resources like climate education materials, access to climate data, tools, and models, and key publications like *Maine's Climate Future.* (3) Education and training, including professional development workshops for teachers, virtual fieldwork experiences for middle and high school students, K-12 learning modules, and an on-line graduate certificate in climate science and adaptation for working professionals. It is imperative to maintain these efforts and to develop new, creative strategies to ensure CCI continues to reach a broad audience, including community groups, K-12 learners and teachers, professionals, and citizens of all ages. The CCI website is a key resource for citizens to learn about climate, climate research, and strategies to mitigate and adapt to changing climate. Apart from continuing current outreach and education efforts, a priority over the next five years will be to update, restructure, and add to education and outreach materials online to increase and broaden accessibility and utility.

(16) New Faculty Hires

a. **Terrestrial Biogeochemistry of High Latitude Systems.** Biogeochemistry integrates the physical, chemical, biological, and geological processes that govern the cycles of critical Earth elements, such as carbon, nitrogen, and phosphorus. A faculty member with expertise in Arctic (e.g., permafrost), boreal, and/or temperate systems would fill several critical gaps in teaching and research, strengthen connections between CCI and the School of Forest Resources and the School of Food and Agriculture, and serve UM's Land Grant mission. This position would replace Christopher Cronan, who retired in 2020, and would fill gaps following various faculty retirements and departures in academic units over the past decade (e.g., Webster, Amirbahman, Norton, Nelson). We propose a faculty member with a joint position between the School of Biology and Ecology and the Climate Change Institute (50/50). A biogeochemist was previously identified as a priority in the last CCI 5-year Plan, and has strong support from SBE, SFR, SFA, and EES.

b. **Atmospheric Scientist/ Climate System Modeler.** This position will enhance CCI's existing expertise and would contribute significantly to CCI's Climate Futures Initiative which as noted earlier is a foundational goal in addressing future climate change and impacts for Maine and beyond. It is particularly well suited if the individual has experience in AI/ML approaches, and an Arctic focus considering CCI's legacy of Arctic research. The position would be a likely fit as a full-time, tenure track position in the Maine College of Engineering and Computing, School of Earth and Climate Sciences and/or the Department of Physics.

c. **Climate Adaptation and Resilience Specialist.** A full-time, tenure track position joint between CCI and Cooperative Extension (CE). This position would build on the momentum

in the boundary spanning work of the Maine Climate Science Information Exchange (MCSIE) in bridging science, policymaking, and management. This position also follows the successful template of a current 70/30 (CCI/CE) tenure track split for the Maine State Climatologist, and as such provides a direct linkage between University and Maine communities in coordinating climate adaptation measures and connecting stakeholders to state and federal resources. The work would include research to evaluate community climate impacts and the performance of adaptation measures to date. This position would be key in advancing the mission of promoting science informed climate solutions by engaging and informing the very latest climate change relevant research.

d. **Climate and Landscape Evolution Modeler.** A significant component of current climate research is focused on predicting climate impacts on terrestrial to marine environments (e.g., land-sea connections), and land surface evolution. This position was formerly a joint ECS/CCI position (Peter Koons), that was not replaced after he retired.

(17) New Staff Hires

a. **Mesonet Manager.** UM was recently awarded a grant to build a new statewide mesonet (weather station network) to provide enhanced environmental monitoring and weather forecasting (via integration with the National Mesonet Program) in support of agriculture and forestry. The Mesonet Manager will be a full-time professional who will oversee the construction and ongoing maintenance of the mesonet. This position will be part of the joint CCI/CE Maine Climate Office and supervised by the Maine State Climatologist (CCI/CE).

b. **Software Developer.** A full-time professional who will develop and maintain databases and climate data products and decision-support tools associated with the newly funded Maine statewide mesonet described above. This position will be part of the joint CCI/CE Maine Climate Office and supervised by the Maine State Climatologist (CCI/CE).

c. Engineering Technician. The increased use of complex field instrumentation to link in-situ observations with remote sensing and local to global numerical modeling efforts requires an engineering technician to help develop instrumentation use protocols, trainings, and maintain the geophysical, sensor, and other field instrumentation.