Stanford | Continuing Studies

Title: Climate Change in Context: What Does The Past Tell Us About The Future?
Code: SCI 68
Instructor: Michael McWilliams

Course Summary:

Course goal: To better understand the magnitude and importance of modern climate change by learning about how Earth's systems have worked in the past to regulate surface temperatures, to support life, and to respond to extreme environmental events such as glaciation, volcanism, and meteorite impacts.

Modern climate change is frequently described as an existential threat to humanity[1]. But how does this threat stack up when compared to the environmental crises Earth and its lifeforms have experienced in the past? This course targets concerned citizens who would like to better understand how the Earth system (its atmosphere, hydrosphere and lithosphere) works to regulate climate, and who would like to know more about what we can expect in the future.

This course does not require a background in science, only a desire to learn more about the Earth. Importantly, this course is not about policy; rather, it is about the science that can (and should!) inform policy.

Grade Options and Requirements[2]:

- No Grade Requested (NGR)
  - This is the default option. No work will be required, no credit shall be received, and no proof of attendance can be provided.
- Credit/No Credit (CR/NC)
  - Students should attend and participate in 75% of the class sessions *and* complete a short (less than 10 pages) research paper on a mutually agreed upon topic of interest to the student.

[1] "Today, no nation can find lasting security without addressing the climate crisis. We face all kinds of threats in our line of work, but few of them truly deserve to be called existential. The climate crisis does." – Secretary of Defense Lloyd J. Austin III (22 April 2021).

[2] If you require proof that you completed a Continuing Studies course for any reason (for example, employer reimbursement), you must choose the Credit/No Credit option. Courses taken for NGR will not appear on official transcripts or grade reports.

Class sessions will be recorded: Students will derive maximal benefit by attending the class sessions live, so that they may actively participate in discussions, pose questions, and explore topics of interest in more detail. If it is necessary to miss a class session, students are encouraged to watch the recordings to ensure continuity.

Tentative structure: Class sessions will follow the rough outline below. Individual topics may expand or contract depending on student interests and time available.

Theme	Topics
Overview	The Keeling Curve and The Pumphandle Plot Earth's energy budget-Sankey diagrams A brief history of climate change Getting a handle on geological time What do people think? - summary of survey data Life on Earth – The *Really Big Events* in context
Earth's atmosphere through time	The greenhouse effect The important greenhouse gases: their sources, sinks How long do greenhouse gases remain in the atmosphere? Geochemical box models Present day atmospheric composition - how did it get that way?
Global tectonics and climate	Subduction, rifting and interactions with atmosphere and oceans Geochemistry and temperature regulation
Solar system context	A brief history of the solar system, Venus/Mars teaser Is Earth in the 'Goldilocks zone'? Where did the (water, oxygen, CO_2, methane) come from? Variations in solar output, albedo The Faint Early Sun hypothesis Earth's orbital variations and Milankovitch cycles
Feedbacks and cycles	Positive and negative feedback-how it works (examples) Ice-albedo, long and short-term carbon cycles
How do we know what we know?	Paleoclimate indicators Isotopic tools for telling time and measuring ancient temperature
Ancient climate 1	Precambrian climate change Early life forms The Great Oxygenation Event The Cambrian explosion
Ancient climate 2	Paleozoic and Mesozoic climate 600-60 million years ago The mother of all mass extinctions 252 million years ago The dinosaur killer(s?) 65 million years ago
Ancient climate 3	The last 100 million years: Paleocene-Eocene Thermal Maximum
Recent climate 1	The last million years: Milankovitch cycles and *A Private Universe*
Recent climate 2	The last 100,000 years: Icehouse/greenhouse
Recent climate 3	The last 1000 years
The Anthropocene	Did we really do all that?
Future climate trajectories	How we model future climate change What we know and what we don't know How big are the uncertainties and what limits do they provide? How much is already 'baked in'? Policy choices-The options we have, the options we have already lost
Climate change on other planets	Our nearest neighbors, Venus and Mars
Summary	Earth will be just fine. Humans, maybe not so much. You can thank global tectonics.