Course Title: Climate Change: Chemistry, Physics, and Planetary Science

Instructors: Dr. Neil Donahue

Course Number: 09-225 Cross Listing: none

Prerequisites/Corequisites: (09-105 or 09-107) and (33-121 or 33-151 or 33-141)

Semesters Offered:

- X Fall
- ☐ Spring
- ☐ Summer-All
- ☐ Summer 1
- ☐ Summer 2

Semester Length:

- ☐ Mini 1
- ☐ Mini 2
- ☐ Mini 3
- ☐ Mini 4
- X Full Semester

Location

- X Pittsburgh
- ☐ Doha

Course Offering Frequency: uncertain whether every fall or every other fall

Suggested Days and Times: TR 9-10:20 am

Learning Format

- X In Person
- ☐ Online
- ☐ Combination

Course Evaluation type:

- X Letter Grade
- ☐ Pass/Fail

Course Unit Justification: Total Units 9

- In Class Hours: 3
- Recitation Hours: none

- Lab Hours: none
- Out of Class Hours: 6

Target Population: Interdisciplinary audience interested in climate change science

Anticipated Enrollment: 10-25 students per semester

Rationale for Course (Background): Understanding the essential features of climate and climate change is a critical tool for modern citizens and scientists. In addition, the prevalence of “climate skepticism” in modern political discourse requires of citizens that they be able to think critically about a technical subject and also be able to distinguish reliable scientific experts from advocates. In this course we shall examine the climate of terrestrial
Planets (specifically Earth and Venus) through geological time and to the present, considering geochemical methods used to determine atmospheric composition over Earth’s history (specifically the onset of oxygen in the atmosphere as well as the relationship between carbon dioxide and global temperature over geological timescales. The shorter climate history of Venus will be considered as a counter example, where the brightening “dim young sun” overwhelmed negative feedbacks in the weathering cycle, leading to a runaway greenhouse amplified by complete evaporation of the onetime Venus ocean. Throughout the course, we will consider climate change driven by human activity since the industrial revolution as a unifying theme.

**Special Facilities Needed:** none

**Textbooks and/or Other Materials:** Intergovernmental Panel on Climate Change 5th Assessment Report and articles from the primary literature.

**Assessment:** The course will be organized into four units: 1. Basic climate physics and geochemical regulation of climate. 2. Quaternary paleoclimate (glacial cycles). 3. Climate since the industrial revolution. 4. Climate solutions. The class will be split into working groups for each unit with a diversity of prior knowledge (e.g. at least one group member with prior knowledge in programming will serve as a tutor to any group members with little or no prior programming knowledge). Each unit will begin with readings from the primary literature and group discussion of issues and questions raised and conclude with a succession of modules built around pre-existing Matlab code designed to illustrate specific elements of the climate system.

To encourage a wide diversity of student backgrounds, grades for each unit will be based on individual progress. Assessment will consist of three elements: self evaluation, evaluation by peers in the group, and evaluation by the instructor. The primary evaluation standard will be evidence of improved fluency, indicated by active participation in the group and a well-crafted two-page summary paper written at the end of each unit. At the beginning of each unit all group members will complete a survey of prior knowledge on the unit topic and in the middle of each unit both the group and instructor will complete concise mid-unit evaluations to gauge progress and participation.

**Topics Covered:** Click here to enter text.

1 Introductions all around and course objectives

2 Matlab installation  Unit 1 Basic climate physics and geochemical regulation of climate.

3 Sun-Earth energy balance.

4 Greenhouse gases and atmospheric vertical structure.

5 Carbon dioxide geochemistry (ocean uptake).

6 Oxygen geochemistry and history.

7 Carbonate geochemistry and weathering / climate control.

8 9 Venus climate history.  Unit 2 Quaternary paleoclimate (glacial cycles)

10 Ice cores and chemical signatures.

11 Temperature reconstruction.
12 Milankovitch orbital perturbations.
13 Frequency analysis of glacial records.
14 Climate feedbacks and control loops.
15 16 Holocene interglacial and agricultural influence on climate.

Unit 3 Climate since the industrial revolution
17 Temperature records since 1750.
18 Atmospheric carbon balance.
19 Aerosol climate interactions.
20 Empirical climate reconstruction.
21 22

Course Catalog Description: Understanding the essential features of climate and climate change is a critical tool for modern citizens and modern scientists. In addition, the prevalence of “climate skepticism” in modern political discourse requires of citizens that they be able to think critically about a technical subject and also be able to distinguish reliable scientific experts from advocates. In this course we shall examine the climate of terrestrial planets (specifically Earth and Venus) through geological time and to the present, considering geochemical methods used to determine atmospheric composition over Earth’s history (specifically the onset of oxygen in the atmosphere as well as the relationship between carbon dioxide and global temperature over geological timescales. The shorter climate history of Venus will be considered as a counter example, where the brightening “dim young sun” overwhelmed negative feedbacks in the weathering cycle, leading to a runaway greenhouse amplified by complete evaporation of the onetime Venus ocean. Throughout the course, we will consider climate change driven by human activity since the industrial revolution as a unifying theme.

Learning Objectives: After taking this course you will

• be “climate fluent”, meaning that you will be able to follow scientific discussions of issues related to climate change and engage in reasoned conversations with non-scientists regarding the underlying science.

• understand the vexing issues underpinning climate change, most notably the extraordinary persistence of CO₂ in the atmosphere as well as the magnitude of CO₂ fluxes associated with fossil fuel combustion and the constraints these place on potential lasting solutions.

• understand basic Matlab structured programming,

• know where to find primary data related to climate

• have an enhanced understanding of the effective graphical presentation of data.

Departmental Approval Date: February 2017
CUA Recommendation Date: Click here to enter text.

College Council Approval Date: Click here to enter text.

Date Sent to Enrollment Services: Click here to enter text.

Comments: Click here to enter text.

* Please attach a copy of the proposed syllabus