Why Global Warming is Controversial
(The Scientific Uncertainties and Ethical Dilemmas)

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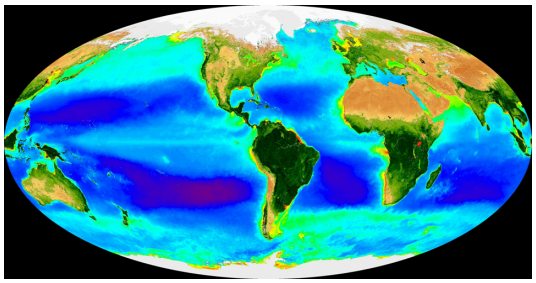

Fig.1 Climatic zones on land and in the oceans shown in terms of a vegetation index on land, and chlorophyll concentration in the ocean. Green regions are productive, dark blue and tan regions are deserts.

Description. Global warming is controversial because it involves both science and ethics. Divisive ethical issues -- to what degree should the government interfere in our daily lives to mitigate the impact of global warming? what is the appropriate balance between our responsibilities to future generations, and our obligations to those suffering today, living in abject poverty for example? -- can easily influence the interpretation of scientific results that, inevitably, have uncertainties because Earth is a complex planet. The vast majority of scientists nonetheless agree that rising CO_2 levels pose a serious threat that calls for action. Unfortunately they communicate poorly with laymen so that discussions of global warming tend not to be constructive.

This seminar explores ways to improve communications between scientists and laymen, and to promote responsible stewardship of planet Earth, by focusing, not on the risks we run -- a litany of imminent environmental disasters can become wearisome -- but on what is exceptional about our planet: it is the only one in the universe known to be habitable. Furthermore, the geological records show that the present is a precarious moment in the history of the planet, a moment for circumspection and caution. Every educated person has a rudimentary understanding of how the immensely complex human body functions -- that knowledge brings many benefits -- but most people are woefully ignorant of the planet's eventful past, and of the processes that maintain Earth's habitability. This seminar, an introduction to the earth sciences, covers the topics listed below, and has two components. One deals with strictly scientific issues, the other with the social and ethical issues that influence scientific disputes.

Outline

Week 1 *Goals and Structure of the Seminars*

The YouTube Video "Harvard A Private," in drawing attention to serious problems with science education, exacerbates the problems by giving the impression that science is a collection of facts, rather than an unending interplay between observations and theories that leads to the conclusion that "A little learning is a dangerous thing." This seminar explores ways to improve communication between scientists and laymen, and examines the limitations of science, the problems it can not solve, one of which is how to deal with global warming.

Week 2,3,4 *The Atmosphere*

The goldilocks puzzle: Why is Venus too hot, Mars too cold, while Earth is at just the "right" temperature? The answer depends on light being both a continuous train of waves, and a

discontinuous stream of photons. The story of that discovery is an introduction to the intricate interplay between light and air that causes the sky to be blue, and also causes the greenhouse effect (which on some planets – Venus – can run away.)

The Atmospheric Circulation strongly influences the pattern of Earth's great diversity of climatic zones, its deserts, jungles, forests, grasslands etc in fig.1. Each zone has a distinctive seasonal cycle with which cope because we have calendars. How did debates about the Earth's shape and location – flat or round? at the center of the universe? –contribute to an accurate calendar?

Week 5,6 The Oceans

The Oceans too have climatic zones, determined by the oceanic circulation. Microscopic plants (phytoplankton) that absorb CO_2 from the atmosphere proliferate in the green areas of fig.1. which is but a snapshot of a continually changing panorama because of the seasons, El Nino etc. How do interactions between air and sea produce these phenomena?

Week 7,8,9 Earth's Eventful Past

The Drifting of Continents was of key importance to the maintenance of habitable conditions over 4 billion years because it recycled gases in the atmosphere as the sun increased in brightness.

The Evolution of Life strongly influenced conditions on the planet, especially with the production of oxygen, even though there were several catastrophic extinctions.

Earth's climate changed continually as the continents drifted, as the atmospheric composition changed, and as life evolved. Of special interest are developments after dinosaurs disappeared shown in fig.2, that have brought us to a precarious moment in the history of the planet, poised between the start of the next Ice Age and the onset of global warming

Week 10, 11 ***Global Climate Changes and Global Warming***. Forecasts of climate changes that will accompany global warming have inevitable uncertainties. What causes them? What information about the past can help reduce them?

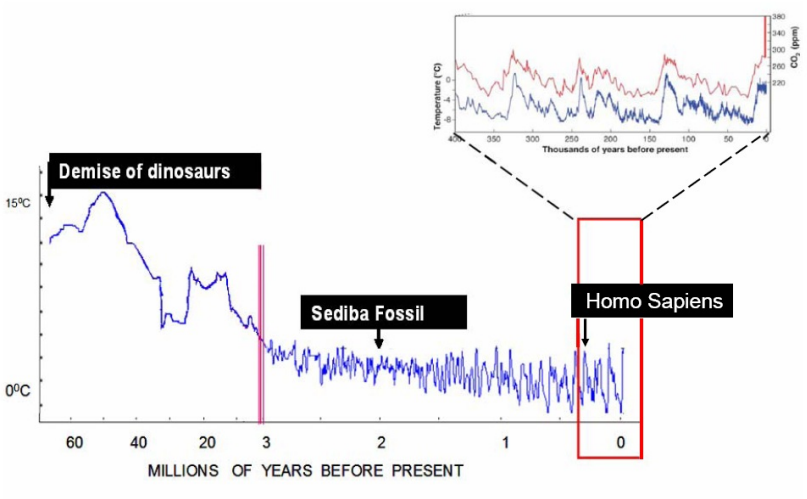

Fig.2 Variations in surface temperatures in polar regions over the past 65 million years, obtained from sea-floor cores. (Note that the time-scale changes at 3 million years.) The inset shows fluctuations in temperature (blue) and in the atmospheric concentration of carbon dioxide (red) over the past 400,000 years as inferred from Antarctic ice-core records. The vertical red bar in the inset is the man-induced increase in atmospheric carbon dioxide levels over the past century.

Readings will be designated chapters from the following books

Kump L, Kastings J, Crane R: *The Earth System*. Prentice Hall
Philander S.G: *Is the Temperature Rising?* Princeton Press.
Archer D: *Global Warming*. Blackwell Publishers
Boorstin D: *The Discoverers* Vintage
Bryson Bill: *A Short History of Nearly Everything*

Projects

Monitoring the onset of spring: Although sunlight will intensify steadily during the spring, weaken during the autumn, temperatures will fluctuate chaotically from day to day, making it difficult to determine the arrival of spring. (Even the plants can be fooled and sometimes flower prematurely.) Monitor temperature and other parameters, and compare the data with those for past years (available on the web). This exercise has relevance to deciding whether global warming has started.

Term Paper: Describe the march of the seasons over the duration of the workshop, how it differs from the march in a climatological year, and how it differs from the march in some other town with a different seasonal cycle because of a difference in weather, climate, botany, and geology. For an interested layman, write an essay of about 12 to 15 pages in length, double-spaced.