

- Final Exam:**  
Tuesday, 16 December, 1:30-3:30 in this room
- Review session for final:**  
Friday, 12 December, 5:00-6:00 pm - room TBA
- Online Evaluations - *Professors and GSIs*
- Shifting perspectives on climate change, evolution
- Summary and Course take-home messages

---

---

---

---

---

---

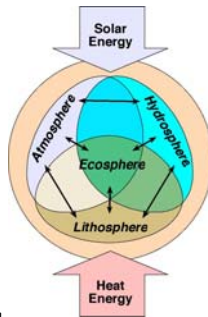
---

---

## GC1 - Course Objectives

Understand Earth as an "integrated system":

- Change and evolution** (stars, solar systems, atmosphere, soils and life evolve from precursors)
- Underlying **physical and natural processes**, how they work and how they are integrated
- Variability and uncertainty** (climate has always varied, prediction is difficult in complex systems)
- Human alteration** of Earth's physical and biological systems (rates are key)




---

---

---

---

---

---

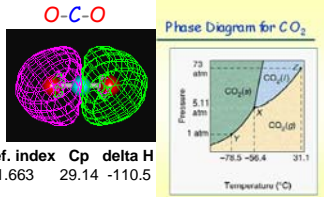
---

---

## 1. FACTS

Physical constants of CO<sub>2</sub>:

Mol. Weight	Density	mag. sus.	ref. index	Cp	delta H
44.01	1.799	-21.0	1.663	29.14	-110.5




---

---

---

---

---

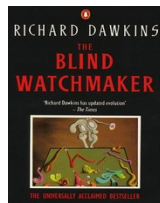
---

---

---

## 2. CONCEPTS

"Life is like a blind watchmaker"



## Scientific Concepts:

1. Standing Stock
2. Mass Balance
3. Material Flux Rate
4. Residence Time =  $\text{Stock}/\text{Flux Rate}$
5. Negative/Positive Feedback

---

---

---

---

---

---

---

## "Controls on Natural Systems"

### Physical

*Gravity, Density, Pressure*

### Chemical

*Mineral formation, Redox reactions*

### Biological

*Natural selection, Competition, Trophic efficiency*

### Interactions between controls:

*Ecosystem function, Element cycles, climate change*

---

---

---

---

---

---

---

## General method employed in science

*Combining Facts, Concepts, Controls*

1. Look for the PATTERN in the data or information
  - Are there trends over time?
  - Are there correlations between variables?
2. Find a MECHANISM that might explain the pattern
  - Does the mechanism make sense? Or not?
3. Test whether the MAGNITUDE of effect is large enough
  - Might do an experiment, make calculations, or use a model.
  - If the magnitude of effect is insufficient (e.g., sun spots and global warming), then go back to step #2 and find a new mechanism.
4. Ask if steps 1-3 are REPEATABLE
  - Is there replication? (e.g., more ice records than just for Lake Mendota)

---

---

---

---

---

---

---

## Course Take Home Messages

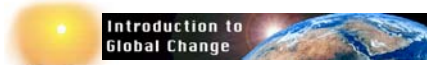
**"Everything is connected to everything else"**

*- the trick is determining the strength of the interactions*

**"Nothing occurs in a vacuum"**

**"Don't believe anything that you can calculate for yourself !"**

Your take home messages?



**Interdisciplinary, Team-taught  
Natural and Social Science Curriculum**

*"To become better equipped to contribute to the important debates concerning global environmental change, resource management and societal adaptation strategies."*

Science and understanding changes,  
we have to keep up!

8

A screenshot of the 'Global Change Minor' webpage. The page has a blue border and contains the following text:

**Global Change Minor**

**THE GLOBAL CHANGE MINOR**

*"To become better equipped to contribute to the important debates concerning global environmental change, resource management and societal adaptation strategies"*

GCMinor | Email Ben van der Pluijm, Director (vdpluim@umich.edu) | [Click here to send and/or request course information \(e-form\)](#)

**Preamble**

The three-semester, interdisciplinary course sequence "Introduction to Global Change" (<http://www.globalchange.umich.edu>) is an inquiry-based undergraduate curriculum that forms the core of the University of Michigan's Global Change minor. Development of the program has benefited from the support of the Provost, various Deans, the Vice President for Research, the Whitaker Fund and CKLT, and from external funding from the National Science Foundation and the WBF Hewlett Foundation. Recently it became part of the new Program in the Environment.

**Curriculum**

- Highly interdisciplinary, seamlessly crossing NS and SS disciplinary boundaries.
- Provide a broad understanding of the complex issues involving global change and global sustainability (Earth as a dynamic system). Enable students to use quantitative tools in approaching global change issues, including Stella (dynamic modeling), ArcView (spatial analysis), spreadsheets and interactive modules.
- Offer a "front-loaded" minor, to engage motivated students in their first years of study
  - Introduction to Global Change I (Environ109): Physical Processes (4cr) (NS)
  - Introduction to Global Change II (Environ111): Human Impacts (4cr) (SS)
  - One 200-level elective from Bio-, Geo- or Sociosphere (3-4 cr)
  - Two 300 or 400-level electives from Bio-, Geo-, Sociosphere (6-8 cr)

**Eligibility**

The GCMinor requires 17 credits (typically 5 classes, of which one may count toward both the GCMinor and the major). The Global Change minor has been approved in the following schools and colleges: the College of Literature, Science and the Arts (effective Winter 2000), the College of Engineering (effective Winter 2001), the Division of Kinesiology (effective Fall 2001), the School of Natural Resources and Environment (effective Fall 2000). Contact academic advisors for degrees in the Business School, the School of Music, and the School of Life Sciences.