

Global Change 1: Physical Processes

Environ 110, Biol 110, Geosci 171, AOSS 171, ENSCEN 171

home lectures labs syllabus reference

Global Change 1 Physical Processes

GLOBAL CHANGE
Physical Processes

Every day, millions of human and natural activities are altering the planet on which we live. Over the past century, through our ever-increasing population and mastery of technology, we have been changing the global environment at a pace unknown to natural history.

The University of Michigan's Global Change Program offers an interdisciplinary three semester introductory course sequence that investigates the causes and potential impacts of global change using a combination of traditional lecture-based and modern web-based teaching methodologies. The courses can be taken alone or in conjunction with companion courses toward completion of the Global Change Minor.

This semester course deals with issues relating to the physical, chemical and biological cycles contributing to global change. Students apply learned knowledge by using discussions and Stella systems modeling software to investigate the dynamics of natural systems.

[Meet the GCI Instructors](#)

www.globalchange.umich.edu/globalchange1

Global Change 1: Introductions

Professors

David Allan
School of Natural Resources and Environment; dallan@umich.edu

George Kling
Department of Ecology and Evolutionary Biology; Course Coordinator; gwkl@umich.edu

Ben van der Pluijm
Department of Geological Sciences, Program in the Environment; Program Director for Academic Minor in Global Change; vdpluijm@umich.edu

Chris Paulsen
Department of Geological Sciences; paulsen@umich.edu

GSi team

Sarah Barbrow, Biology sbarbrow@umich.edu

Dan Horton, Geology danehan@umich.edu

Mose Jones-Yellin, SNRE mosejy@umich.edu

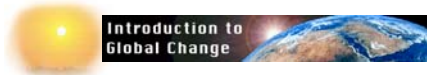
Menan Jangu, Anthro/SNRE mjangu@umich.edu

Support

Haley Cureton; globalchange@umich.edu



Email: globalchange@umich.edu



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

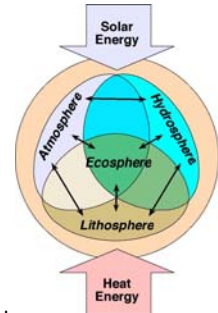
"To become better equipped to contribute to the important debates concerning global environmental change, resource management and societal adaptation strategies."

Science and understanding changes, we have to keep up!

GCI - 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)



Course Management: U-M's Ctools

<https://ctools.umich.edu/>

Lectures

Day	Date	Topic	Instructor
1	2-Sep	Introduction and Goals	all
2	5-Sep	NO LAB	all
3	8-Sep	The Sun and the Fundamental Laws of Physics	Paulsen
4	15-Sep	The Solar System and the Energy Balance of Planets	Paulsen
5	22-Sep	Chaos in Rocks, Icecaps and the Age of Earth	Paulsen
6	29-Sep	The Earth's Surface and Atmosphere	Paulsen
7	6-Oct	The Origin of Climate on Earth	Paulsen
8	13-Oct	Earth's Energy Balance Model	Paulsen
9	20-Oct	Competition and Coupling of the Atmosphere	Paulsen
10	27-Oct	Weather and Climate	Paulsen
11	3-Nov	Water and Ice - the Hydrosphere and Cryosphere	Paulsen
12	10-Nov	The Hydrological Cycle	Paulsen
13	17-Nov	WATER EXAM #1 (Cumulative through 11 Oct)	all
14	24-Nov	Equilibrium of Carbon Life, the Greenhouse and Photochemical Smog	all
15	1-Dec	The Structure of Aquifers	all
16	8-Dec	The Case of the Poisoned Milk	all

Lectures, cont.

Week	Date	Topic	Instructor
22-Oct	22-Oct	Fall Break: No Labs meet - Ecological Footprints	
23-Oct	23-Oct	The Value of Nature's Services	
24-Oct	24-Oct	Fall Break - No Labs meet - Ecological Footprints	
27-Oct	27-Oct	A Transformed Earth	
28-Oct	28-Oct	Ecotones	
29-Oct	29-Oct	Measures, Indicators of Matter and Materials	
30-Oct	30-Oct	Science and the media	
3-Nov	3-Nov	The Flow of Energy - Primary Production and Higher Trophic Levels	
4-Nov	4-Nov	The Trophic Run, Flux	
5-Nov	5-Nov	Climate Change and the Ice Age	
6-Nov	6-Nov	Climate Change Discussion and Global Warming Activity (great in class)	
7-Nov	7-Nov	MIDTERM EXAM #2 (Equivalent through 5 Nov)	
10-Nov	10-Nov	The Flow of Matter - Biogeochemical Cycles: Soil and Climate Change	
11-Nov	11-Nov	Climate Analysis and Prediction for the Future	
12-Nov	12-Nov	Analysis of Vostok Ice Core Data	
13-Nov	13-Nov	The Global Carbon Cycle - A Driver of Climate Change	
14-Nov	14-Nov	The Global Nitrogen Cycle - The Case of Acid Rain	
15-Nov	15-Nov	Climate Change in the Great Lakes Region	
16-Nov	16-Nov	The Global Carbon Cycle	
17-Nov	17-Nov	Using Science to Solve Problems: The Case of the Great Lakes of North America	
18-Nov	18-Nov	No Class	
19-Nov	19-Nov	Thanksgiving Break (No Classes from 27-28 Nov)	
20-Nov	20-Nov	Thanksgiving Break (No Labs meet - Virtual Earthquake (Data-Storm))	
21-Nov	21-Nov	Thanksgiving Break (No Labs meet - Virtual Earthquake (Data-Storm))	
22-Nov	22-Nov	Geography: Earthquakes and Volcanoes	
23-Nov	23-Nov	Geography: Surface Processes	
24-Nov	24-Nov	Geography: Coastal and Riverine	
25-Nov	25-Nov	Student Presentations - Writing IBA	
26-Nov	26-Nov	Final Class Summary, Course Evaluations	
27-Nov	27-Nov	Review for Final Exam (Exam 2)	
28-Nov	28-Nov	FINAL EXAM 2 (Nov 28-29 Nov)	

Lecture Notes and PowerPoint files

1. Your own class notes. Be here, so you learn more and won't be surprised.
2. Supporting notes on-line (but they do not replace lectures).



3. PowerPoint slides through Ctools and LectureTools (updated prior to lectures)

Information Environment (LectureTools)



Bring your wireless-enabled laptop to class for lecture notes, web access, and real-time searches



Details on Friday ...

Labs: Discussions and Analysis

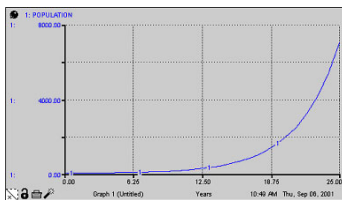
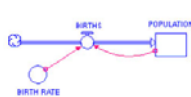
SECTION	TIME	DISC	DISCUSSION ROOM	COMPUTER ROOM
1	Wed 3-5	Manish Janga	1004 DANA	3123 DANA
2	Th 3-5	Philip James-Tyler	1004 DANA	3123 DANA
3	F 3-5	Samuel Paulson	1004 DANA	3123 DANA
4	Mo 3-5	Samuel Paulson	1004 DANA	3123 DANA
5	Tu 3-5	Manish Janga	1004 DANA	3123 DANA
6	W 3-5	Manish Janga	1004 DANA	3123 DANA
7	Th 3-5	Manish Janga	1004 DANA	3123 DANA
8	Mo 3-5	Philip James-Tyler	1004 DANA	3123 DANA
9	Tu 3-5	Samuel Paulson	1004 DANA	3123 DANA



- Before lab, read articles
- In class, discuss questions and activities related to the articles to explore our role in global change.

System Dynamics Modeling (Stella)

Population Example:
 $BIRTHS = (BIRTH\ RATE) * (POPULATION)$



- Stocks are variables of interest
- Flows change stocks. Flows go into or out of stocks
- Converters change relationships between stocks and flows
- Connectors allow information to be passed between variables

Next Week's Lab Reading

Before coming to lab, read:

The Challenges We Face - A History of our Future

2003 State of the World p. 3-13

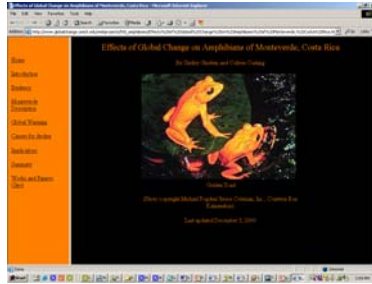


"We have only one or perhaps two generations in which to reinvent ourselves."

Group Term Project

The term project is a group research activity that will be presented in a PowerPoint class presentation and posted as a website.

Students organize into teams of 3 to develop a plan and implement the project related to the course material.



Suggestions for project topics and sample projects are offered, but the choice will be left to each team with guidance from your lab instructor.

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Grades

The class uses a **point system** for determining final grades:

- Midterms (2): 100 points each
- Final: 150 points
- Lab/Discussion: 13 points each (hand-in by next lab)
- Lecture Homework: 5 points each (hand-in by next lab)
- Term Project: 100 points total
- Surveys/Assessments: 1 point each (excluding UM's E&E)



Optional, non-graded self-tests for lectures available as a link on the CTools site.

The total points are normalized on a scale from 0-100, using a **straight scale for letter grades**. The grades are:

- 0-59 = E
- 60-62, 63-65, 66-69 = D-, D, D+
- 70-72, 73-75, 76-79 = C-, C, C+
- 80-82, 83-85, 86-89 = B-, B, B+
- 90-92, 93-95, 96 and up = A-, A, A+

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George Kling

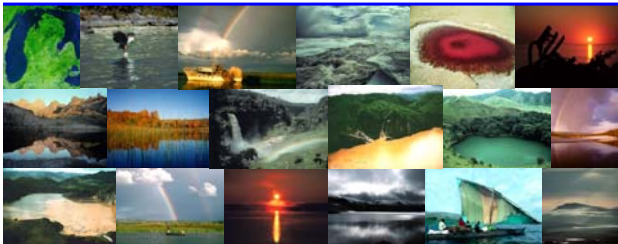
Department of Ecology & Evolutionary Biology
1041 Natural Sciences Bldg
Office hours, F 3-4
gwk@umich.edu

Teaching:

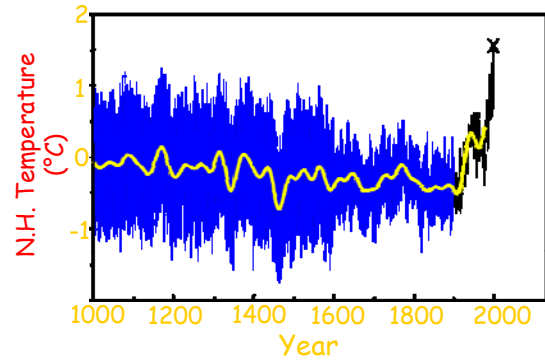
Global Change (Bio 110)
Ecosystem Ecology (EEB 476)
Limnology (study of lakes; EEB 483)

Research:

Aquatic Ecosystems
Impacts of Climate Change
Biogeochemistry
- Arctic, Africa, Michigan



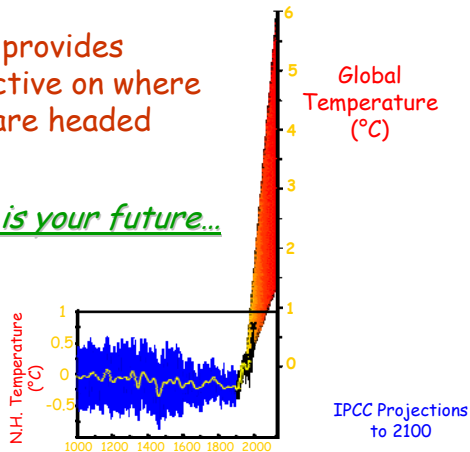
"Recent" climate change and variability...



Mann et al. (1999) GRL 26:759-762

...provides perspective on where we are headed

This is your future...



IPCC Projections to 2100

My Themes

- Global change on our planet can only be understood by combining "abiotic" and "biotic" components - *must look at the whole Ecosystem*
- A combination of facts and scientific concepts can help us understand even the most complicated problems
- Science is *NOT* hard, and everyone can and *MUST* learn enough to make rational decisions about our world's future

Possible Projects

- The "missing sink" - Where did all the CO₂ go?
- Microbes rule, Humans drool
- Does the rainforest *really* matter?
- The day the Earth turned brown and blue - The limits to food production
- Who's doing who? Climate skeptics and the use and misuse of Science facts
- Who needs more ice? Melting the Earth's glaciers (a.k.a. "Water World 2050", starring B. van der Pluijm as K. Costner...)
- WWF Climate 2008 "rage in the cage" - People vs. Nature
- Abrupt climate change - can El Nino's run wild?
- Whatcha gonna do when the rain don't come - Shifts in the Global water cycle

Me -- Chris Poulsen



• Associate Professor in Dept. of Geological Sciences and Dept. of Atmospheric, Oceanic and Space Sciences

• Paleo/climatologist

- Ancient ice ages
- Times of extreme warmth
- Climate impacts -- water resource
- South American climate and tectonics

- GS114 - Global Warming
- GS116 - Introductory Geology in the Field
- GS151 - Ice Ages Past and Present
- AOSS321 - Earth System Dynamics
- AOSS410 - Earth System Modeling

Our Place in Space

- How did 'IT' all start?
- What are the origins of our solar system and planet Earth?



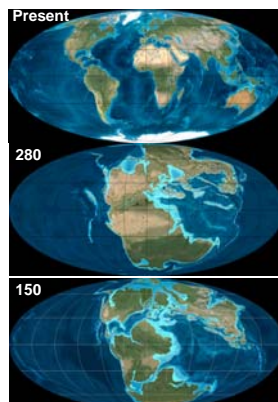
Evolution of a Habitable Earth

- Why is Earth the only habitable planet in our solar system?
- What were the steps in making a habitable Earth?



Our Solid Earth: Plate Tectonics

- What is the age of the Earth, and how do we know?
- Plate what?



Our Fluid Earth: Ice, Atmosphere & Ocean

- From fiery hell to icy rock. What controls Earth's climate?
- Why do the winds blow?
- Global warming? How, why, and so what?



Evolution and Ecology Roadmap

We wish to know:

- Where we are going
- Why we should care
- How the pieces fit together
- And, maybe... Who is this guy?



<http://tolweb.org/tree/phylogeny.html>

David Allan

dallan@umich.edu



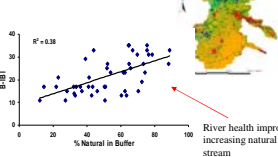
My Courses

- Environ 110 Earth and Ecosystems (fall)
- Environ 111 Human Impacts (winter)
- Environ 520 Fluvial Ecosystems (fall)



My Research

- Watersheds, Land Use, and River Ecosystems
- Environmental Flows
- River Restoration



My Interests

- Travel
- Camping
- Reading



Allan family safari, Serengeti

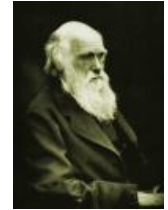
My themes

- Human-induced changes to the planet need to be understood within the context of natural processes and evolutionary change
- Not just climate change: global deforestation and desertification, over-harvested resources, global homogenization of species, altered mineral cycles
- Life diversity and life processes are at risk

Efforts to Reconcile God and Nature



Jacopo Tintoretto's Creation of the Animals (c. 1550)



Charles Darwin
1809 - 1882

Threats to Biodiversity

Human actions now threaten species and ecosystems to an extent rarely seen in earth history.



Over-harvest



Climate change



Exotic species

Why should we care about biodiversity?

- The wonder of nature
- Ecosystem goods and services
 - Clean water, productive soils, the recycling of nutrients, food and fiber, recreation, spiritual renewal
- The accelerating rate of species loss
- Emerging diseases



The March of the Penguins, narrated by Morgan Freeman



http://www.divegallery.com/Leafy_Sea_Dragon.htm



Ben van der Pluijm
 Professor of Geological Sciences
 Professor of the Environment
 Director Global Change Program
www.globalchange.umich.edu/Ben
vdpluijm@umich.edu or globalchange@umich.edu

Research: Structural Geology

field areas: the northern Appalachians, the USA continental interior, North and South America's Grenville, northern Spain's Cantabria, East African Rift, US-Canadian Rockies, San Andreas (CA) and Alpine (NZ) faults.

topical areas: brittle and ductile faults, deep-crustal architecture, fault gouge and pseudotachylite, intraplate stresses, oroclines, clay microstructures and textures, magnetic anisotropy, X-ray goniometry, paleomagnetism, geochronology, physical oceanography

Teaching

Interdisciplinary undergraduate teaching ([Global Change](#)), Environmental Geology, concentrator and graduate level specialty classes, IT-supported classroom education ([GeoPocket](#)), IT-supported field-based education ([GeoPag](#)).



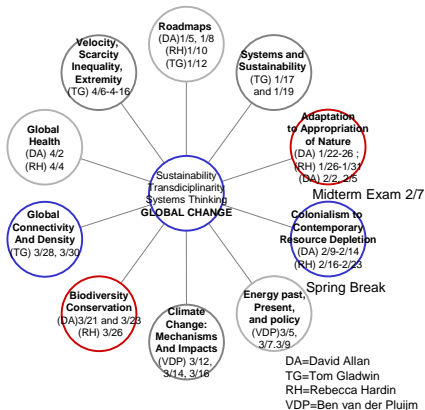
Global Change Curriculum and Minor

<http://www.globalchange.umich.edu/>

The GC2 Wheel of Lectures (Winter Semester)

How to read this slide:
 Clockwise from the "midnight" position:

- 1) First three basic Conceptual & Chronological Units preparing us to think about broad issues of past, present and future
- 2) The heart of the course is four theme-driven modules on relatively recent past and present issues: colonialism, energy, climate, and conservation
- 3) We conclude with a future-oriented series of lectures on global trends, including health



DA=David Allan
 TG=Tom Gladwin
 RH=Rebecca Hardin
 VDP=Ben van der Pluijm



**Interdisciplinary,
 Natural and Social Science Curriculum
 examining Dimensions of Global Change**

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



Wrapping up

- Global Change encompasses all the ways that our planet has been changing since its formation ~4.5 billion years ago to today, and looking toward the future.
- Humans are affecting Earth and its life support systems at an unprecedented rate, which poses new challenges to humankind and our planet.
- Decisions and good policy require good science.

... that is why you are in Global Change !