Introduction to Earth System Science

AOSC 680

Ross Salawitch: rsalawit@umd.edu

Class Web Sites:
http://www2.atmos.umd.edu/~rjs/class/fall2024
https://umd.instructure.com/courses/1367293

Photograph by NASA Astronaut Don Pettit: https://www.pinterest.com/pin/212161832415650804

Lecture 0: Introduction & Logistics

27 August 2024

Introduction to Earth System Science

AOSC 680

Ross Salawitch: **rsalawit@umd.edu**

1) Fine to address me as “Ross” in emails

2) Please, please, pretty please: try to remember to use “AOSC 680” in *the subject* of any class related email

3) I prefer email rather than messages sent via Canvas. I will do my best to reply to messages sent either way

4) The signature line of my standard email contains my personal cell phone number; please use this “judiciously” and note I prefer text messages to voice mail

5) Office hours do not make sense these days, since we can so easily meet either in person or electronically: please email me to setup meetings, which could occur either in person or on Zoom (my Zoom link is included in signature line of all my emails)

6) I will strive to successfully record each lecture

Class Website, External

AOSC 680 Introduction to Earth System Science

Instructor: Ross Salawitch

Tues-Thurs, 2:00 to 3:15 pm, Atlantic 2316

Fall 2024: 3 units

Office Hours: By arrangement, via email

Required Texts:

Chemistry in Context: Applying Chemistry to Society 7th edition
The Chemistry in Context text can be purchased, rented from me for $20 (refunded upon return of book), or downloaded here. I'll review how to open the PDF file, if downloaded, in class on 27 August 2024.

Princeton Primers in Climate:

Atmospheres, Clouds, and Climate by David Randall*

Climate and Oceans by Geoffrey Vallis*

Climate and Ecosystems by David Schimel and/or Global Carbon Cycle by David Archer

The Cryosphere by Shawn Marshall and/or Paleoclimate by Michael Bender

Introduction to Atmospheric Chemistry by Daniel Jacob and/or The Ends of the World The Ends Of The World by Peter Brannen

We will read nearly all of the first two books listed above in their entirety. Students should acquire the books by Randall and by Vallis soon, as well will read from these books prior to the exam>

Chapters from *some* of the other Princeton Primers in Climate books and the other two books listed above will also be read, based on student interest. All of these books are available in various formats including paperback for less than $30 each

Material from these readings will be the primary source for the student-led discussions.

* Students, please purchase these two books as soon as possible.

Syllabus

ELMS Course Page

Syllabus is at:
https://www2.atmos.umd.edu/~rjs/class/fall2024/syllabus/AOSC680_Fall2024_Syllabus.pdf

Canvas Course page at:
https://umd.instructure.com/courses/1367293

http://www2.atmos.umd.edu/~rjs/class/fall2024

Syllabus

AOSC 680: Introduction to Earth System Science

Instructor: Ross Salawitch (rsalawit@umd.edu)

Fall 2024: Tues – Thurs 2:00 to 3:15 pm, Atlantic 2316

Websites: http://www.atmos.umd.edu/~rjs/class/fall2024 & https://umd.instructure.com/courses/1367293

Required Text:

Chemistry in Context: Applying Chemistry to Society **7th Edition** American Chemical Society
(You can either purchase, rent a used copy from me for $20 refundable upon return of the book, or use a password protected PDF file I'll provide to registered students)

Paris Climate Agreement: Beacon of Hope by Ross J. Salawitch *et al.* (freely available via open access)

Atmospheres, Clouds, and Climate by David Randall

Climate and Oceans by Geoffrey Vallis

Climate and Ecosystems by David Schimel and/or Global Carbon Cycle by David Archer

The Cryosphere by Shawn J. Marshall and/or Paleoclimate by Michael Bender

Intro to Atmos Chem by Daniel Jacob and/or The Ends of the World by Peter Brannen

Chapters from some of these six Princeton Primers in Climate books, available in various formats including paperback for less than $30 each, will be the primary source for the student-led discussions. We may also select chapters from *Intro to Atmos Chem* (freely available via a password I shall provide) and/or *The Ends of the World* ($17 on Amazon)

Supplemental Text:

Global Warming: The Complete Briefing **5th Edition** by John Houghton (selected readings will be provided)

Course Description. An introduction to the study of the earth as a system: atmosphere, oceans, land, cryosphere, solid earth, and humans. Cycling of materials and energy in the earth system: the energy cycle, the hydrologic cycle, the carbon cycle, the nitrogen cycle. Climate processes and variability: land-atmosphere, ocean-atmosphere, biosphere-climate, and human interactions, short- and long-term variability in climate. This class will be taught at a level appropriate for first year graduate students in Atmospheric and Oceanic Science.

Prerequisites: AOSC graduate student *OR* being advised by an AOSC Faculty Member *OR* permission of instructor.

https://www2.atmos.umd.edu/~rjs/class/fall2024/syllabus/AOSC680_Fall2024_Syllabus.pdf

Syllabus

Class Philosophy: We'll begin in a traditional format consisting of 8 or 9 lectures designed to provide a broad background to Earth System Science. This portion of class will make use of equations, at a level considerably simpler than you will see in the other AOSC Core classes. We will then transition to the ***student led discussion part of class***, which will make use of four or more of the most excellent Princeton Primers in Climate series and related text. These readings, which consist of light equations, emphasize **fundamental understanding of concepts in Earth System Science**, which is the mantra of this class. Each book is available in a variety of formats, including paperback, for less than $30 each.

Grades: Grades will be based on the problems set (10%), admission tickets (30%), one in class exam (20%), the student led presentation (20%), and each student's final research-project presentation (10%) & paper (10%). Students are required to write a research paper 6 to 8 pages long (single-spaced; length does not include figures or references) on a topic of their choosing related to the material covered in class. ***All students will deliver two in class presentations***: one based on a chapter or two selected from one of the required books in the *Princeton Primers in Climate* series or related textbooks (this will be an hour-long discussion) and the second based on a research project (this will be an 18 minute presentation).

Course Topics

- How to Build a Habitable Planet: Geological Evolution of Earth's Atmosphere
- Overview of Global Warming
- The Greenhouse Effect: Radiative Transfer; Cloud and Water Vapor Feedbacks
- Climates of the Past
- Modeling of Earth's Climate
- The Global Carbon Cycle
- Biogeochemical Cycles of Methane and Nitrous Oxide
- Student led discussion of selected readings from some of the Princeton Primers in Climate (PPC) books (*Atmospheres, Clouds, and Climate* & *Climate and Oceans* almost certainly will be used) as well as some of the other PPC books and/or *Intro to Atmos Chem* or *The Ends of the World*

https://www2.atmos.umd.edu/~rjs/class/fall2024/syllabus/AOSC680_Fall2024_Syllabus.pdf

Class Website, External

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2. Schedule

Date	Lecture Topic	Required Reading	Admis. Tickets	Lecture Notes	Problem Sets	Additional Readings	Learning Outcome
08/27	Class Overview	No reading for first meeting	No AT	Lecture 0 Video			No Quiz
08/29	Geological Evolution of Earth's Atmosphere	Paris Beacon of Hope Sec 1.1, 1.2 (intro), and 1.2.1 (11.5 pages)	AT 1	Lecture 1 Video		Meckler *et al.*, *Science*, 2022 Excellent news article on Meckler *et al.* study Ivany and Salawitch, *Geology*, 1993 NOVA: The Day The Dinosaurs Died Fascinating article on extra-terrestrial life	Quiz 1
09/03	Overview of Global Warming	Climate Change Evidence and Causes, Royal Society (36 pages) IPCC 2007 FAQ (1.1, 1.2, 1.3, 2.1, & 3.1) (11 pages) Paris Beacon of Hope Sec 1.2.2 (3 pages)	AT 2	Lecture 2 Video		Kerr, *Science*, 2007 Warming Animation ENSO Video Entire IPCC 2007 FAQ News story 1, Antarctic Ice News Story 2, Antarctic Glacier	Quiz 2

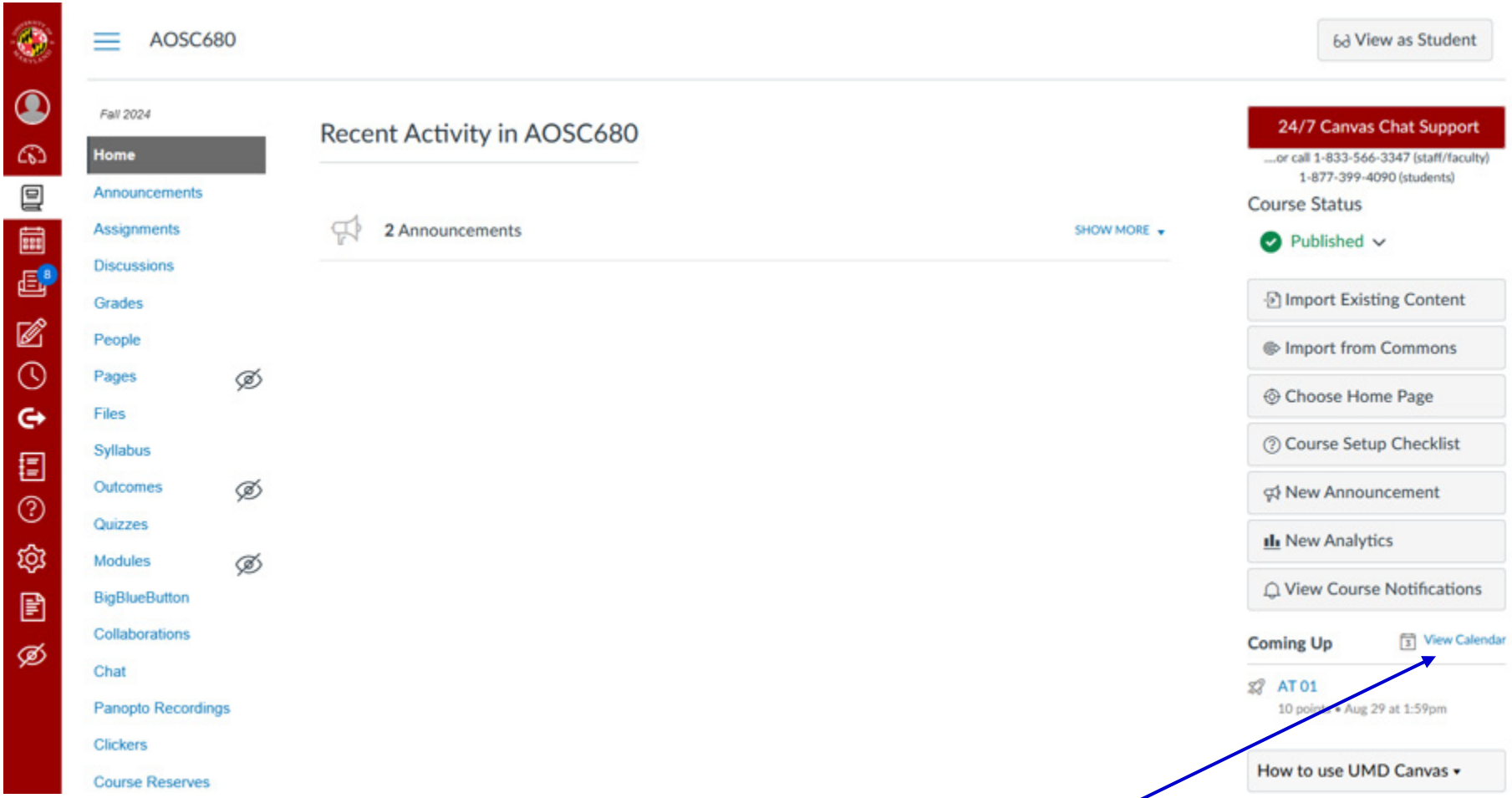
Should be "hot". To what file does this link point?

https://www2.atmos.umd.edu/~rjs/class/fall2024/lectures/AOSC680_2024_lecture00_handout.pdf
https://www2.atmos.umd.edu/~rjs/class/fall2024/lectures/AOSC680_2024_lecture00_class.pdf

AT 1: Admission Ticket Number 1
Due prior to the start of Lecture 1 (this Thurs) based on reading for Lecture 1
More about ATs to soon follow

http://www2.atmos.umd.edu/~rjs/class/fall2024

Class Website, Canvas (Calendar View)



Click here for View Calendar

https://umd.instructure.com/courses/1367293

Class Website, External

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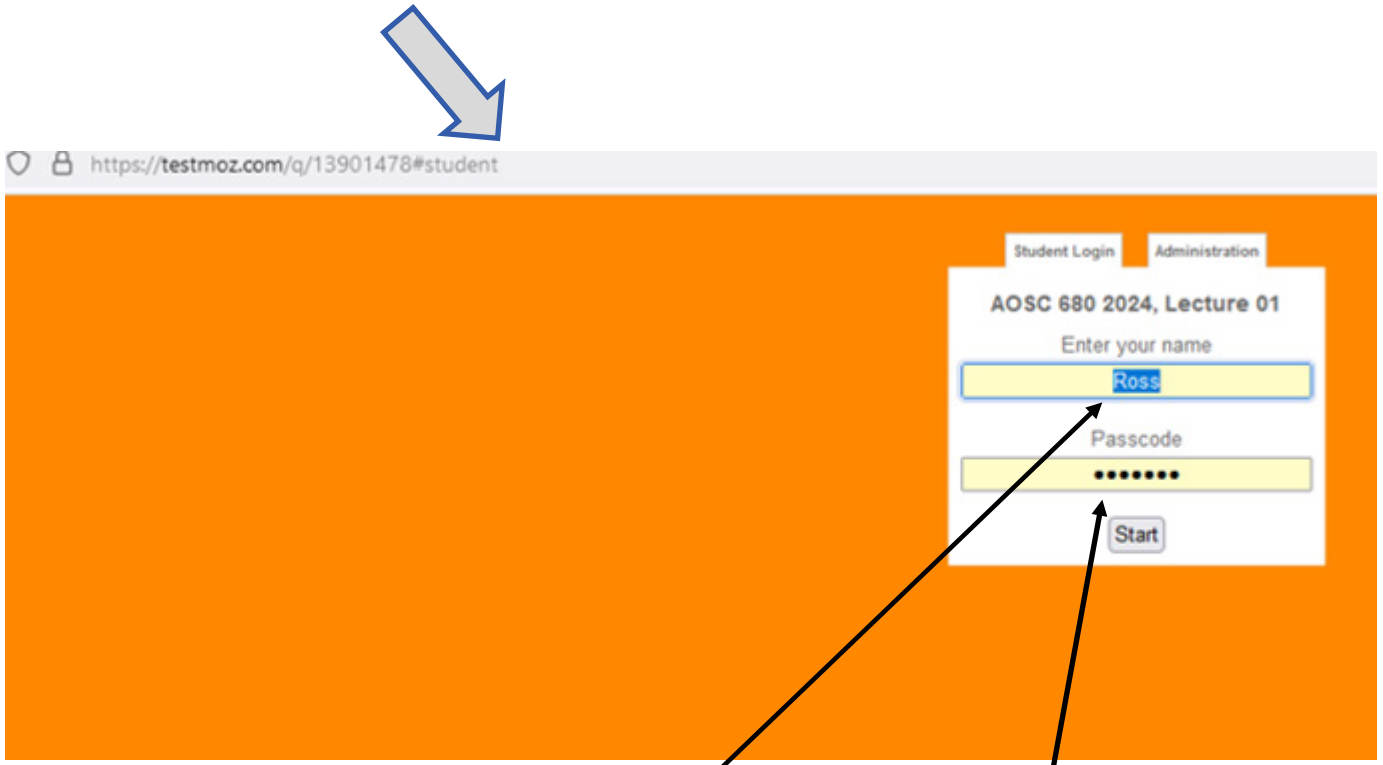
Learning outcome Quiz: https://testmoz.com/q/13901478
Note: must use passcode of ATL2316 to access

https://www2.atmos.umd.edu/~rjs/class/fall2024

Class Website, External

Learning outcome Quiz: https://testmoz.com/q/13901478



Please use your real name here.

Must use ATL2316 here.

Links to these learning outcome quizzes will be posted in the "Learning Outcome" column of https://www2.atmos.umd.edu/~rjs/class/fall2024

Organization Details

- Admission Tickets (AT) (30%)
  - short set of questions, related to lecture; *completed prior to the start of each class*
  - posted on web page; straightforward if reading has been done
  - graded on a 10 point basis; *lowest three scores will be dropped*
  - please complete on Canvas and email me if you are having a problem with Canvas
- Problem Sets (10%)
  - posted on web page and announced in class at least 1 week before due date
  - prescribed "late penalty" and final receipt date: will not be accepted after solutions have been discussed (typically within ~7 days of due date)
- Exam (20%)
  - **one in-class exams (early semester)**
  - exam will tend strongly towards understanding of concepts via essay-like answers whereas problem set will tend strongly towards quantitative understanding
- In Class Presentation (20%)
  - one in-class presentation on a topic of your interest, from one or two chapters from a **Princeton Primers in Climate** or related book
  - Will take place starting approximately 10 Oct.
- Presentation of final project (10%)
  - If we stay at 13 students, we will have either 2 or 3 class meetings (depending on whether we meet the Tues before Thanksgiving) with each student giving a 12 min presentation
- Final paper (10%)
  - 6 to 8 pages single spaced, with references and a few figures, on topic of final project
  - Paper is due midnight (11:59 pm) of the day following your presentation, which for now is 4 Dec 2024 for students 1 to 7 and 6 Dec 2024 for students 8 to 13.

Fall 2024 Calendar

Meeting Number	Date	Topic
1	8/27	Class Overview
2	8/29	Geological Evolution of Earth's Atmosphere
3	9/03	Overview of Global Warming
4	9/05	Climates of the Past
5	9/10	Global Carbon Cycle
6	9/12	Methane and Nitrous Oxide
7	9/17	Radiative Forcing
8	9/19	Climate Basics & Atmospheric Energy Flow (DR)
9	9/24	Water Vapor, Aerosol, Cloud, & Albedo Feedbacks
10	9/26	Basics of Climate and the Oceans (JV)
11	10/01	Review for Exam
12	10/03	Exam
13	10/08	Writing a Good Paper, Giving a Good Talk, Path Forward
14	10/10	Student 1

Meeting Number	Date	Topic
15	10/15	Student 2
16	10/17	Student 3
17	10/22	Student 4
18	10/24	Student 5
19	10/29	Student 6
20	10/31	Student 7
21	11/05	Student 8
22	11/07	Student 9
23	11/12	Student 10
24	11/14	Student 11
25	11/19	Student 12
26	11/21	Student 13
27	12/03	Presentation Day 1
28	12/05	Presentation Day 2

This notional calendar has us ***not meeting*** on Tues, 26 Nov the Tues before Thanksgiving. Next week, we'll talk more about whether to meet on 26 Nov.

If we stick to 13 students, and we do not meet on 26 Nov, we will need to carve out extra time the last week of class (week of 2 Dec)

Class Website, External

11/14	TBD	TBD	AT 18	**Student 11**			
11/19	TBD	TBD	AT 18	**Student 12**			
11/21	TBD	TBD	AT 18	**Student 13**			
11/26	***Tuesday Before Thanksgiving; we will discuss whether to meet this day.*** If we meet this day, the class session will be devoted to student presentations of their final project.						
12/03 **We will need to start early if we do not meet on 11/26**	Student Presentations, Day 1		No AT	Presentations students 1 to 7	Each Presentation is 12 minutes, with 3 mins for discussion. 7 x 15 = 105 minutes Paper due 4 Dec, 11:59 pm		
12/05 **We will need to start early if we do not meet on 11/26**	Student Presentations, Day 2		No AT	Presentations students 8 to 13	Each Presentation is 12 minutes, with 3 mins for discussion. 6 x 15 = 90 minutes Paper due Dec 6, 11:59 pm		

https://www2.atmos.umd.edu/~rjs/class/fall2024

Text Books

Required Textbook: *Chemistry in Context: Applying Chemistry to Society*,
American Chemical Society ⇒ **7th Edition !**

***Atmospheres, Clouds, and Climate* by David Randall**
***Climate and Oceans* by Geoffrey Vallis**
Climate and Ecosystems by David Schimel and/or *Global Carbon Cycle* by David Archer
The Cryosphere by Shawn Marshall and/or *Paleoclimate* by Michael Bender
Intro to Atmos Chem by Daniel Jacob and/or *The Ends Of The Worlds* by Peter Brannen

These six **Princeton Primers in Climate** books, available in various formats including paperback for less than $30 each, will be the primary source for the student led discussions. Based on the importance of these first two books, my knowledge of who is in this class, as well as the excellent of the content of these two books, we will certainly read all (or nearly all) of the books by Randall and Vallis. The first reading from these books will be discussed on 19 September 2024**. As such, please obtain copies of these two books (that is, the book by Randall and the book by Vallis) as soon as possible.**

We will decide which of the other books to use, based on in class discussion and polling, in plenty of time for students to obtain.

Supplemental Texts:

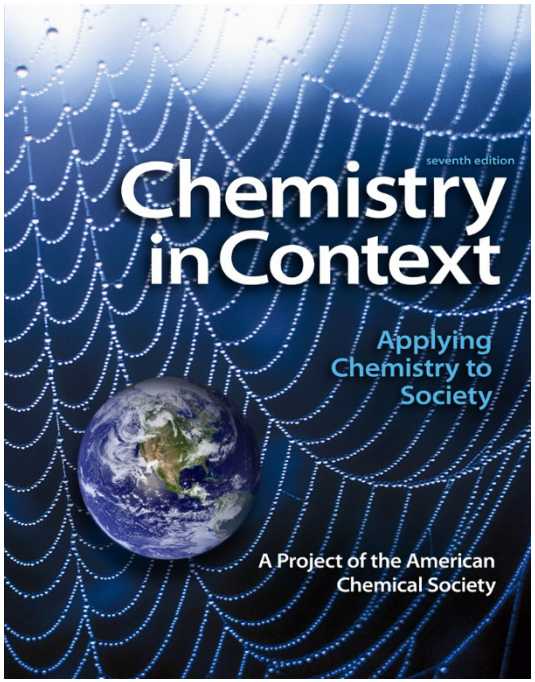
Global Warming: The Complete Briefing 5th Edition by John Houghton

Paris Climate Agreement: Beacon of Hope by Ross Salawitch, Tim Canty, Austin Hope, Walt Tribett, and Brian Bennett

https://www2.atmos.umd.edu/~rjs/class/fall2024/readings/Chem_in_Context_2011.pdf

Must use what to open? _____

Required Textbook: *Chemistry in Context: Applying Chemistry to Society*, American Chemical Society $\Rightarrow$ **7th edition !**



Chemistry in Context : Applying Chemistry to Society, 7/e

American Chemical Society (ACS)
Catherine H. Middlecamp, University of Wisconsin--Madison
Steven W. Keller, University of Missouri--Columbia
Karen L. Anderson, Madison Area Technical College
Anne K. Bentley, Lewis & Clark College
Michael C. Cann, University of Scranton
Jamie P. Ellis, The Scripps Research Institute

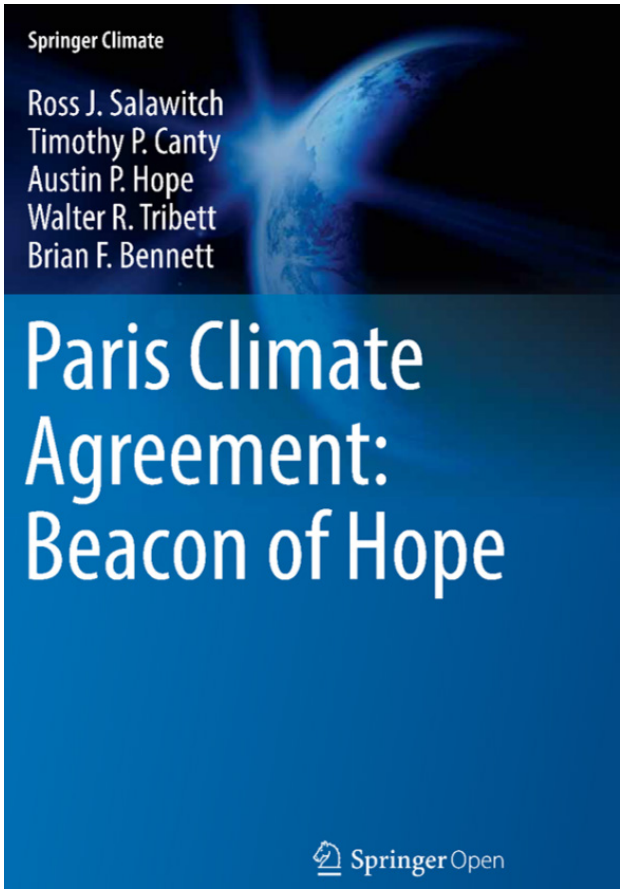
The author team truly benefitted from the expertise of a wider community. We extend our thanks to the following individuals for the technical expertise they provided to us in preparing the manuscript:

Mark E. Anderson, University of Wisconsin–Madison
David Argentar, Sun Edge, LLC
Marion O'Leary, Carnegie Institution for Science
Ross Salawitch, University of Maryland
Kenneth A. Walz, Madison Area Technical College

- Active used book market for 7th edition, since release of 8th, 9th & now 10th editions
- Changes from edition to edition are minor: we will use 7th edition to save you $$$
- If you collect text books for future reference, please note this book is more of a "tutorial" than an indispensable reference book, so probably best to check out free PDF to see if the book is worth buying
- If you feel compelled to permanently keep all of your textbooks, you are welcome to acquire your own copy of *Chemistry in Context* either from sellers such as Amazon
- Finally, I have many used hard copies of the book. Students are welcome to "rent" one of these for $20, which will be refunded upon return of the book at the end of the semester.

Numerous readings from: *Paris Climate Agreement: Beacon of Hope*

by Ross Salawitch, Tim Canty, Austin Hope, Walt Tribett, and Brian Bennett



On 11 November 2014, a remarkable event occurred. President Barack Obama of the United States and President Xi Jinping of China announced a bilateral agreement to reduce the emission of greenhouse gases (GHGs) that cause global warming by their respective nations. On 12 December 2015, a year and a month later, representatives of 195 countries attending the 21st Conference of the Parties of the United Nations Framework Convention on Climate Change meeting in Paris, France, announced the Paris Climate Agreement.

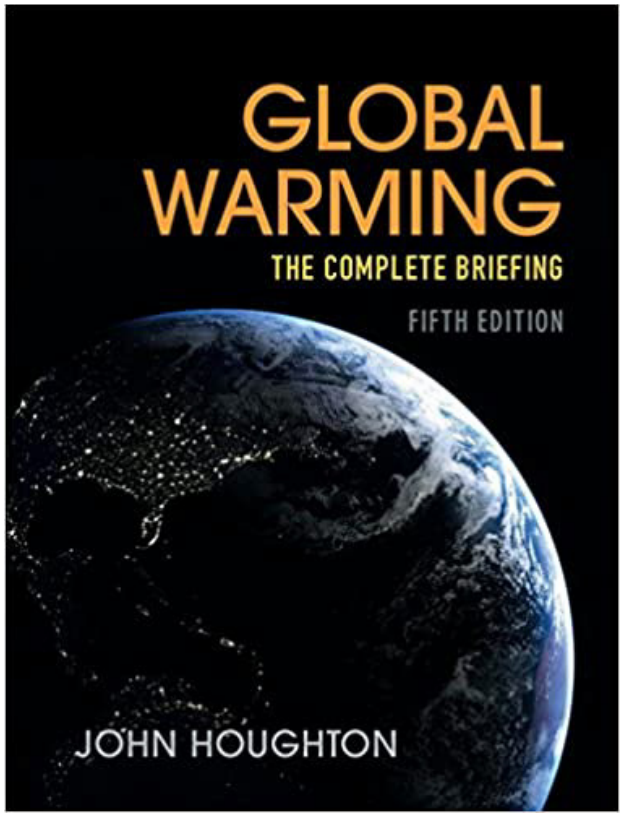
The goal of the Paris Climate Agreement is to limit the future emission of GHGs such that the rise in global mean surface temperature will be no more than 1.5 °C (target) or 2.0 °C (upper limit) above the pre-industrial level. The Paris Climate Agreement utilizes an approach for reducing the emissions of GHGs that is distinctly different than earlier efforts. The approach for Paris consists of a series of Intended Nationally Determined Contributions (INDCs), submitted by the world's nations, reflecting either a firm commitment (unconditional INDCs) or a plan contingent on financial and/or technological support (conditional INDCs).

Here we provide an analysis of the Paris Climate Agreement written for two audiences. The first audience is the bewildered public. Hardly a day goes by without some newsworthy item being reported on climate change. Often the stories are contradictory, tainted by parochialism, skepticism, and extremism by not only the conservative and liberal media but also the camps of so-called believers and deniers. Our book goes back to basics, outlining what is known and not known about climate change. If we have been successful, this book will enable readers to advance their own understanding of this topic, in a manner that will assist in the proverbial "separation of the wheat from the chaff" with regard to climate change.

Our second audience is the women and men who are charting the response of the world to the threat of global warming. As is clear from the title of this book, we believe the Paris Climate Agreement is truly a Beacon of Hope. The Agreement has been severely criticized by some scientists, even a few prominent in the field of climate change. In this book, we closely examine the behavior of the computer models commonly used to inform climate change policy. This examination will be eye opening to many. We urge policy makers to seek their own independent assessment of the veracity of the global warming projections that are being used to inform policy.

- Book published via open access, so text is freely available
- Culmination of many years' worth of research initially motivated by AOSC 652 & AOSC 633
- Can obtain from https://link.springer.com/book/10.1007/978-3-319-46939-3

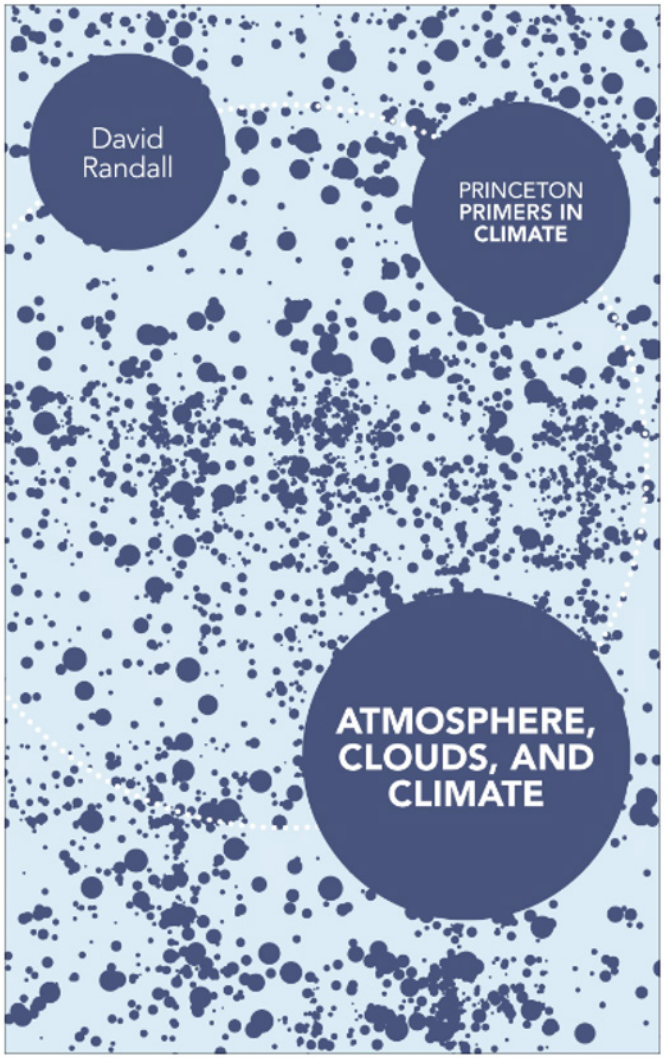
Numerous readings as well as: *Global Warming: The Complete Briefing* (Fifth Edition) by Sir John Houghton



https://twitter.com/hannahmmalcolm/status/1250778555505655808

- Selected readings will be provided in password protected files (ATL2316)
- If you like the style of this book, please consider purchasing for your library
- Can purchase from this link.

Required Textbook: *Atmosphere, Clouds, and Climate*
David Randall
Princeton Primers In Climate



The atmosphere is critical to climate change. It can amplify shifts in the climate system, and also mitigate them. This primer offers a short, reader-friendly introduction to these atmospheric processes and how they work, written by a leading expert on the subject.

Giving readers an overview of key atmospheric processes, David Randall looks at how our climate system receives energy from the sun and sheds it by emitting infrared radiation back into space. ***The atmosphere regulates these radiative energy flows and transports energy through weather systems such as thunderstorms, monsoons, hurricanes, and winter storms. Randall explains how these processes work, and also how precipitation, cloud formation, and other phase changes of water strongly influence weather and climate.*** He discusses how atmospheric feedbacks affect climate change, how the large-scale atmospheric circulation works, how predicting the weather and the climate are fundamentally different challenges, and much more.

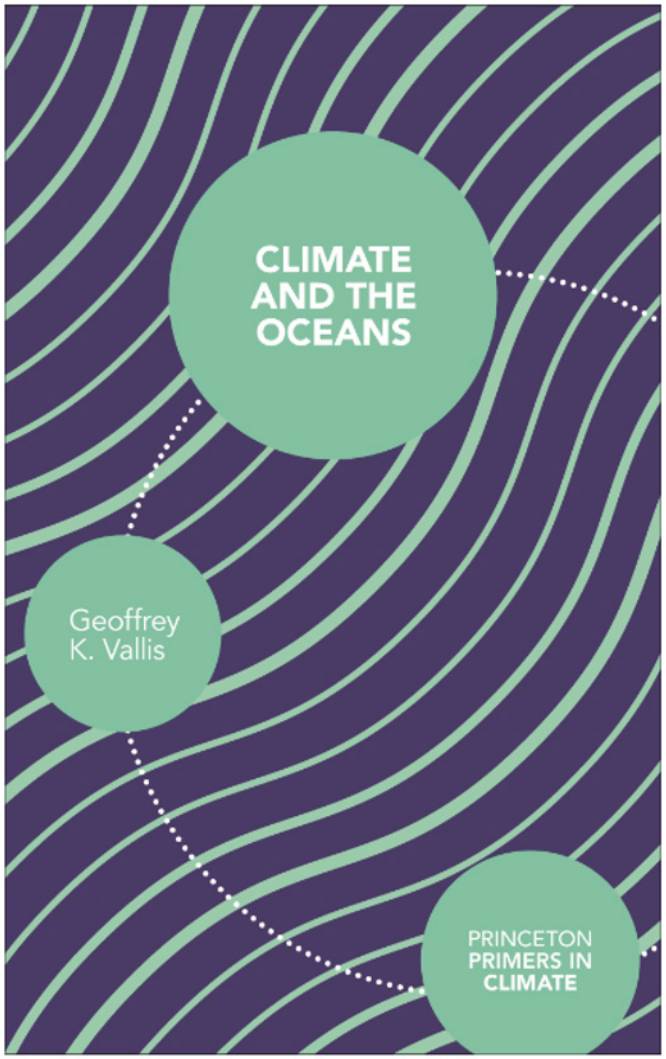
Authoritative and concise, *Atmosphere, Clouds, and Climate* features a glossary of terms, suggestions for further reading, and easy-to-follow explanations of a few key equations. This accessible primer is the essential introduction to atmospheric processes and the vital role they play in our climate system.

https://press.princeton.edu/books/paperback/9780691143750/atmosphere-clouds-and-climate

Likely Required Textbook: *Climate and The Oceans*

Geoffrey Vallis

Princeton Primers In Climate



The oceans exert a vital moderating influence on the Earth's climate system. They provide inertia to the global climate, essentially acting as the pacemaker of climate variability and change, and they provide heat to high latitudes, keeping them habitable. Climate and the Oceans offers a short, self-contained introduction to the subject. **This illustrated primer begins by briefly describing the world's climate system and ocean circulation and goes on to explain the important ways that the oceans influence climate.** Topics covered include the oceans' effects on the seasons, heat transport between equator and pole, climate variability, and global warming. The book also features a glossary of terms, suggestions for further reading, and easy-to-follow mathematical treatments.

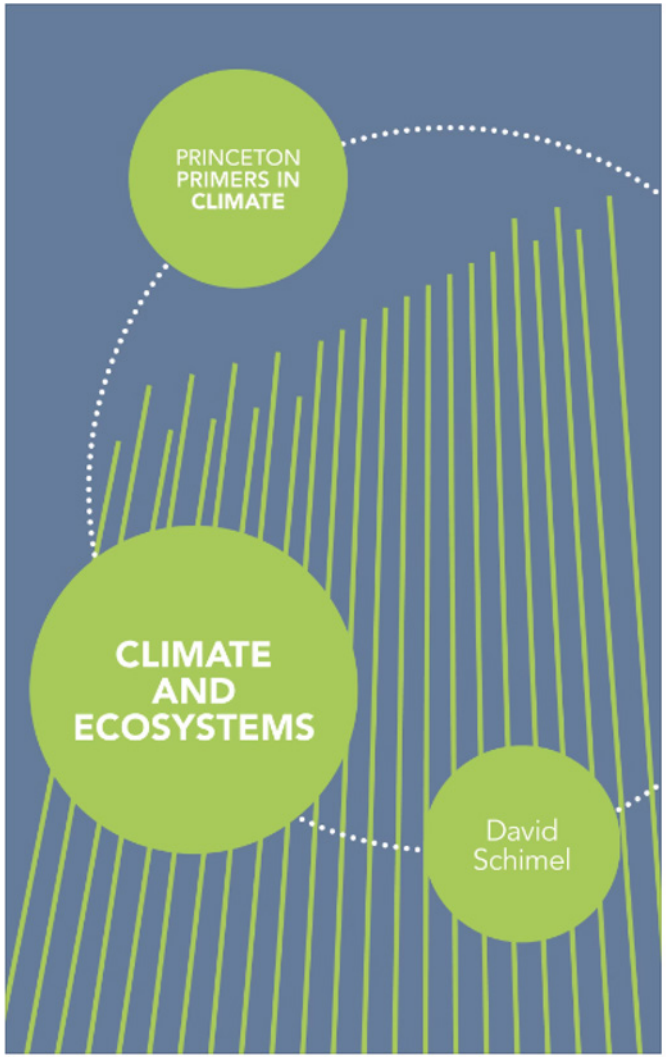
Climate and the Oceans is the first place to turn to get the essential facts about this crucial aspect of the Earth's climate system. Ideal for students and nonspecialists alike, this primer offers the most concise and up-to-date overview of the subject available.

The best primer on the oceans and climate

- Succinct and self-contained
- Accessible to students and nonspecialists
- ***Serves as a bridge to more advanced material***

https://press.princeton.edu/books/paperback/9780691150284/climate-and-the-oceans

Possible Textbook: *Climate and Ecosystems*
David Schimel
Princeton Primers In Climate

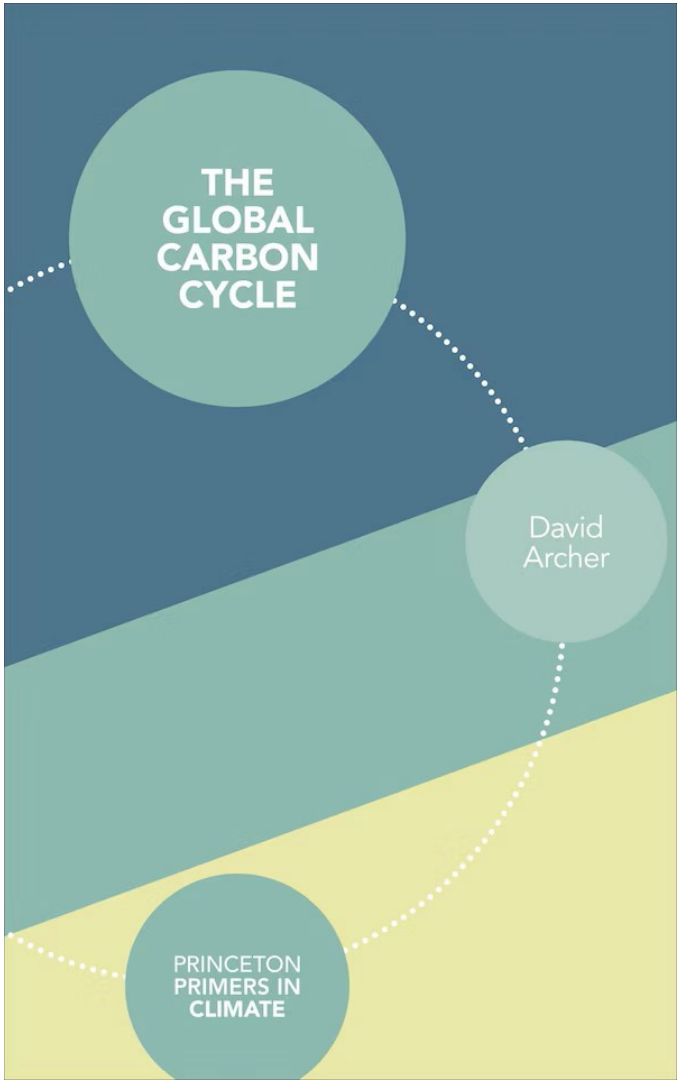


How does life on our planet respond to — and shape — climate? This question has never been more urgent than it is today, when humans are faced with the daunting task of guiding adaptation to an inexorably changing climate. This concise, accessible, and authoritative book provides an unmatched introduction to the most reliable current knowledge about the complex relationship between living things and climate.

Using an Earth System framework, David Schimel describes how organisms, communities of organisms, and the planetary biosphere itself react to and influence environmental change. While much about the biosphere and its interactions with the rest of the Earth System remains a mystery, this book explains what is known about how physical and chemical climate affect organisms, how those physical changes influence how organisms function as individuals and in communities of organisms, and ultimately how climate-triggered ecosystem changes feed back to the physical and chemical parts of the Earth System.

https://press.princeton.edu/books/paperback/9780691151960/climate-and-ecosystems

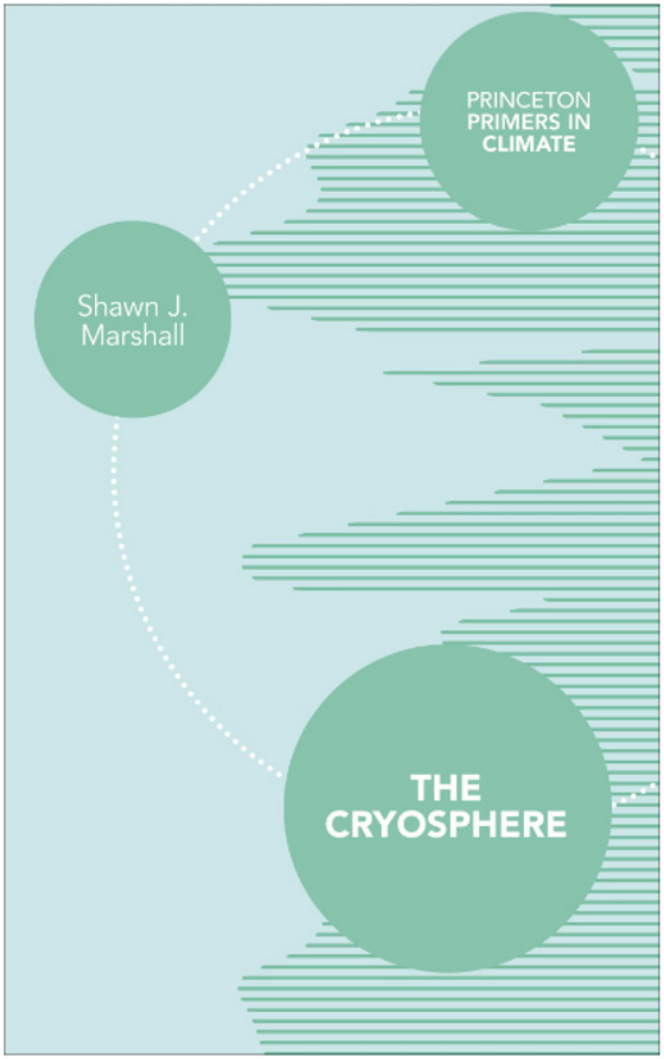
Possible Textbook: *Global Carbon Cycle*
David Archer
Princeton Primers In Climate



The Global Carbon Cycle is a short introduction to this essential geochemical driver of the Earth's climate system, written by one of the world's leading climate-science experts. In this one-of-a-kind primer, David Archer engages readers in clear and simple terms about the many ways the global carbon cycle is woven into our climate system. He begins with a concise overview of the subject, and then looks at the carbon cycle on three different time scales, describing how the cycle interacts with climate in very distinct ways in each. On million-year time scales, feedbacks in the carbon cycle stabilize Earth's climate and oxygen concentrations. Archer ***explains how on hundred-thousand-year glacial/interglacial time scales, the carbon cycle in the ocean amplifies climate change, and how, on the human time scale of decades, the carbon cycle has been dampening climate change by absorbing fossil-fuel carbon dioxide into the oceans and land biosphere***. A central question of the book is whether the carbon cycle could once again act to amplify climate change in centuries to come, for example through melting permafrost peatlands and methane hydrates.

https://press.princeton.edu/books/paperback/9780691144146/the-global-carbon-cycle

Possible Textbook: *The Cryosphere*
Shawn Marshall
Princeton Primers In Climate



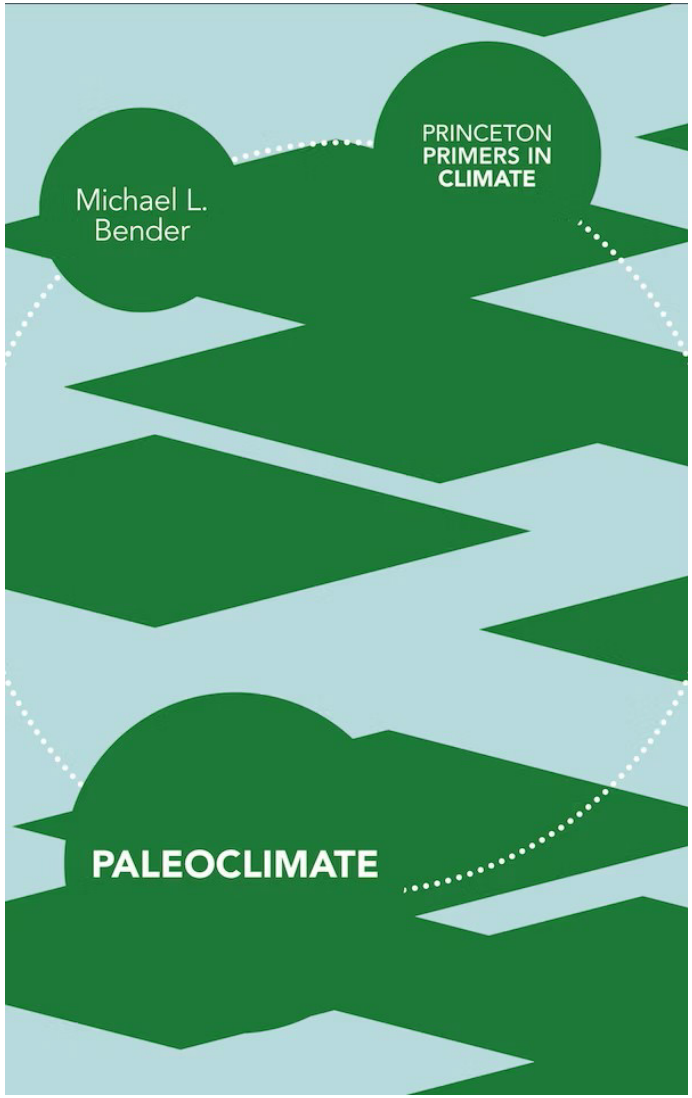
The cryosphere encompasses the Earth's snow and ice masses. It is a critical part of our planet's climate system, one that is especially at risk from climate change and global warming. *The Cryosphere* provides an essential introduction to the subject, written by one of the world's leading experts in Earth-system science.

In this primer, glaciologist Shawn Marshall introduces readers to the cryosphere and the broader role it plays in our global climate system. After giving a concise overview, he fully explains each component of the cryosphere and how it works — seasonal snow, permafrost, river and lake ice, sea ice, glaciers, ice sheets, and ice shelves. ***Marshall describes how snow and ice interact with our atmosphere and oceans and how they influence climate, sea level, and ocean circulation. He looks at the cryosphere's role in past ice ages and considers the changing cryosphere's future impact on our landscape, oceans, and climate***.

Accessible and authoritative, this primer also features a glossary of key terms, suggestions for further reading, ***explanations of equations, and a discussion of open research questions in the field***.

https://press.princeton.edu/books/paperback/9780691145266/the-cryosphere

Possible Textbook: *Paleoclimate*
Michael Bender
Princeton Primers In Climate

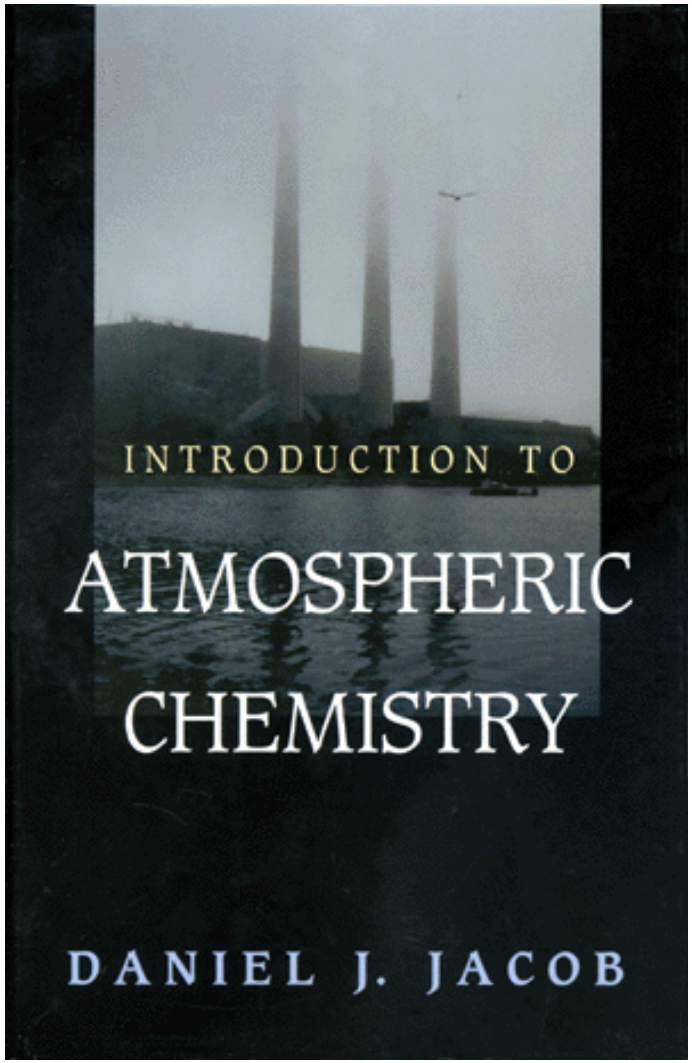


At one extreme, Earth has been glaciated from the poles to the equator for periods that may have lasted millions of years. At another, temperatures were once so warm that the Canadian Arctic was heavily forested and large dinosaurs lived on Antarctica. Paleoclimatology is the study of such changes and their causes. ***Studying Earth's long-term climate history gives scientists vital clues about anthropogenic global warming and how climate is affected by human endeavor.***

In this book, Michael Bender, an internationally recognized authority on paleoclimate, provides a concise, comprehensive, and sophisticated introduction to the subject. After briefly describing the major periods in Earth history to provide geologic context, he discusses controls on climate and how the record of past climate is determined. The heart of the book then proceeds chronologically, introducing the history of climate changes over millions of years — its patterns and major transitions, and why average global temperature has varied so much. The book ends with a discussion of the Holocene (the past 10,000 years) and by putting manmade climate change in the context of paleoclimate.

https://press.princeton.edu/books/paperback/9780691145556/paleoclimate

Possible Textbook: *Introduction to Atmospheric Chemistry, Second Edition*
Daniel Jacob
Princeton University Press



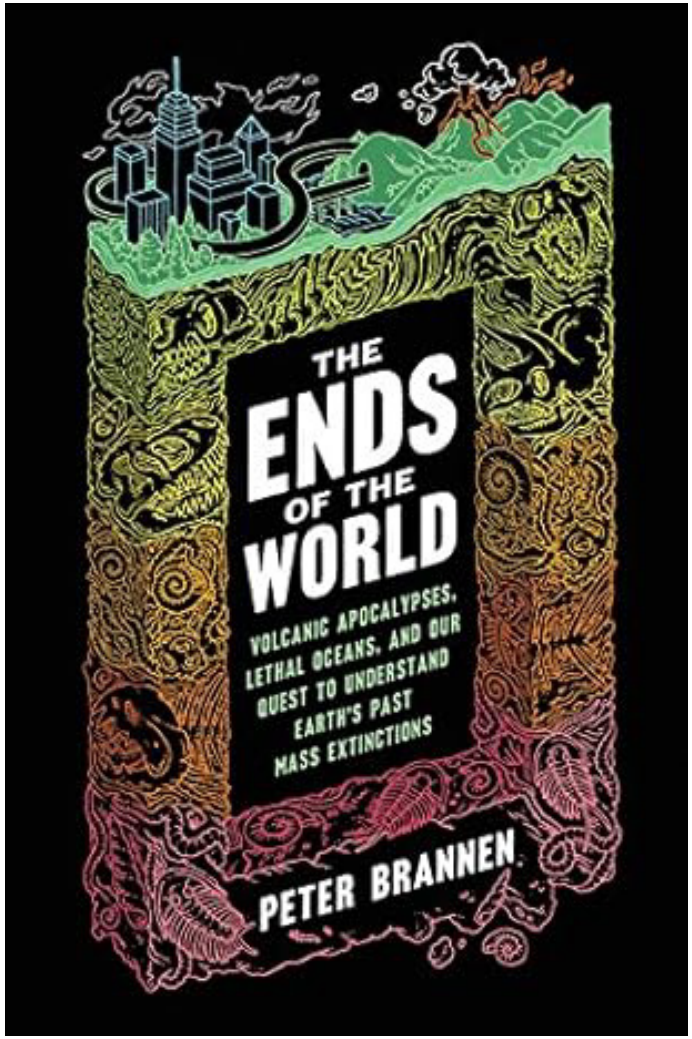
Atmospheric chemistry is one of the fastest growing fields in the earth sciences. Until now, however, there has been no book designed to help students capture the essence of the subject in a brief course of study. Daniel Jacob, a leading researcher and teacher in the field, addresses that problem by presenting the first textbook on atmospheric chemistry for a one-semester course. Based on the approach he developed in his class at Harvard, Jacob introduces students in clear and concise chapters to the fundamentals as well as the latest ideas and findings in the field.

Jacob's aim is to show students how to use basic principles of physics and chemistry to describe a complex system such as the atmosphere. He also seeks to give students an overview of the current state of research and the work that led to this point. Jacob begins with atmospheric structure, design of simple models, atmospheric transport, and the continuity equation, and continues with geochemical cycles, the greenhouse effect, aerosols, stratospheric ozone, the oxidizing power of the atmosphere, smog, and acid rain. Each chapter concludes with a problem set based on recent scientific literature. This is a novel approach to problem-set writing, and one that successfully introduces students to the prevailing issues.

https://press.princeton.edu/books/hardcover/9780691001852/introduction-to-atmospheric-chemistry

If we read from this book, we will use the recently released draft of the 2nd Edition, available on-line for free at:
https://acmg.seas.harvard.edu/education/introduction-atmospheric-chemistry

Possible Textbook: *The Ends Of The World*
Peter Brannen
Harper Collins



Want to know the future? Look to the past, the deep past. That's one of the many insights you'll glean from reading Brennen's entertaining, engaging, elegant book. The Earth has survived much worse than that people are currently throwing at it in the form of global warming, changes in nature, and even mass death. But that's not particularly good news for civilization – unless we change our ways fast

David Biello, Author of *The Unnatural World*

This is a book about rocks: a vivid, fascinating, sometimes horrifying book about rocks and the story they tell about all the past and future lives of our planet. Peter Brannen has a knack for opening new worlds under our feet – oceans half a billion years old under Cincinnati, forests hundreds of millions of years old in upstate New York, the sabre-toothed cats under Los Angeles. He follows the scientific quest to understand the five great extinctions in Earth's history that utterly changed life on this planet. A riveting and disturbing story because we can imagine a different kind of Earth, the we understand how it may be changing now, and how little it would take to bring on more "end of the world".

Michael Pye, author of *The Edge Of The World*

https://www.amazon.com/Ends-World-Apocalypses-Understand-Extinctions/dp

If we read from this book, the reading will occur at the end of the semester (sort of like a capstone) and who ever leads the discussion (or discussions) will need to consult the scientific literature for suitable illustrations.