Atmospheric Chemistry and Climate

AOSC / CHEM 433 & AOSC / CHEM 633

Ross Salawitch: rsalawit@umd.edu

Class Web Sites:
http://www2.atmos.umd.edu/~rjs/class/spr2022
https://umd.instructure.com/courses/1317772

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

Lecture 0: Introduction & Logistics

25 January 2022

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Atmospheric Chemistry and Climate

AOSC / CHEM 433 & AOSC / CHEM 633

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

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

2) Please, please, pretty please: try to remember to use “433” or “633” (i.e., “AOSC 433” or “CHEM 633” in *the subject* of any class related email

3) I prefer email rather than messages sent via ELMS. 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 in Spring 2022: please email me to setup meetings, which will occur on my personal Zoom channel (different than the class channel), that is also included in the signature line of my standard emails

6) Please note we shall meet in person until further notice, and I will strive to successfully record each lecture

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Class Website, External

https://www2.atmos.umd.edu/~rjs/class/spr2022/ 110%

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AOSC / CHEM 433 & AOSC / CHEM 633 Atmospheric Chemistry & Climate

Instructor: Ross Salawitch

Grader: Heather Fettke von Koeckritz

Tues-Thurs, 2:00 to 3:15 pm, Atlantic 2428

Spring 2022: 3 units

Required Text:

Chemistry in Context: Applying Chemistry to Society

***7th edition*, American Chemical Society**

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 25 Jan 2022.

Syllabus

Syllabus is at:
https://www2.atmos.umd.edu/~rjs/class/spr2022/syllabus/Atmospheric_Chemistry_Climate_syllabus_spring_2022.pdf

http://www2.atmos.umd.edu/~rjs/class/spr2022

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Syllabus

Atmospheric Chemistry and Climate: AOSC & CHEM 433 / AOSC & CHEM 633

Instructor:
Ross Salawitch (626-487-5643; rsalawit@umd.edu)

Spring 2022: Tues – Thurs 2:00 to 3:15 pm, Atlantic 2428

Websites: http://www.atmos.umd.edu/~rjs/class/spr2022 & https://umd.instructure.com/courses/1317772

Required Text:

Chemistry in Context: Applying Chemistry to Society **7th Edition** American Chemical Society
(You can either 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 all registered students)

Supplemental Text (selected readings will be provided):

Paris Climate Agreement: Beacon of Hope by Ross J. Salawitch *et al*. (available for free via open access)
Twenty Questions & Answers About the Ozone Layer by Ross J. Salawitch *et al*. (also freely available)
Global Warming: The Complete Briefing **5th Edition** by John Houghton (selected readings will be provided)
Green Chemistry: An Inclusive Approach, edited by Béla Török and Timothy Dransfield (ditto)
Beyond Oil and Gas: The Methanol Economy by George A. Olah *et al*. (readings will also be provided)

Course Description. The effects of human activity on atmospheric composition, focused on global warming, the carbon cycle, air pollution, and the ozone layer. Fundamentals of atmospheric chemistry (spectroscopy, kinetics, isotopic analysis, and biogeochemical cycles) are related to the modern understanding of climate change, air quality, and ozone depletion, based on resources such as satellite missions, field campaigns, and scientific assessments published by international agencies. We also examine how society's future energy needs could be met in a more environmentally friendly manner than the present heavy reliance on combustion of fossil fuels. The course is taught at a level appropriate for upper class undergraduate chemistry or physical science majors, as well as all graduate students in a physical science program.

Prerequisites: (CHEM 131 or CHEM135 or CHEM146) and (MATH241); or permission of instructor.

Any STEM major who has advanced to the Junior year or beyond with a modicum of chemistry (i.e., knows the difference between an element and a compound; knows that the integral *or* differential of an exponential is another exponential) should be able to handle the class material.

https://www2.atmos.umd.edu/~rjs/class/spr2022/syllabus/Atmospheric_Chemistry_Climate_syllabus_spring_2022.pdf

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Syllabus

Atmospheric Chemistry and Climate: AOSC & CHEM 433 / AOSC & CHEM 633

Instructor:
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Prerequisites: (CHEM 131 or CHEM135 or CHEM146) and (MATH241); or permission of instructor.

Humanities majors may struggle: if you do not satisfy these pre-requisites and the words on the prior slide regarding elements, compounds, integrals, and differentials seem foreign, please send me an email to arrange a Zoom meeting this week.

https://www2.atmos.umd.edu/~rjs/class/spr2022/syllabus/Atmospheric_Chemistry_Climate_syllabus_spring_2022.pdf

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Prerequisites: (CHEM 131 or CHEM135 or CHEM146) and (MATH241); or permission of instructor.

Grades: Grades will be determined based on daily short questions (termed *admission tickets*) due prior to the start of lecture that are based on the readings (30%), problem sets (30%), two in class exams (13.33% each), a final exam (13.34%). In addition, students enrolled in 633 will be required to write a research paper on a topic of their choosing, give a presentation on this paper, and may be assigned an extra question on problem sets. For computation of final course grade, the graduate student paper/presentation will have equal weight as each exam.

https://www2.atmos.umd.edu/~rjs/class/spr2022/syllabus/Atmospheric_Chemistry_Climate_syllabus_spring_2022.pdf

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Syllabus

Course Topics

- How to Build a Habitable Planet: Geological Evolution of Earth's Atmosphere
- Overview of Global Warming, Air Quality, and Ozone Depletion
- 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
- Pollution of Earth's Troposphere: Air Quality, Acid Rain, and Aerosols
- Pollution of Earth's Stratosphere: Ozone Depletion and Ozone Recovery
- World Energy Needs and Future Fossil Fuel Reserves
- The Kyoto Protocol and the Science of CO_2 Stabilization
- Renewable Energy I: Solar, Geothermal, Hydro, and Wind
- Renewable Energy II: Ethanol, Methanol, and Biofuels
- Hydraulic Fracturing aka Fracking
- Nuclear Energy and The Hydrogen Economy
- Geo-engineering of Climate

https://www2.atmos.umd.edu/~rjs/class/spr2022/syllabus/Atmospheric_Chemistry_Climate_syllabus_spring_2022.pdf

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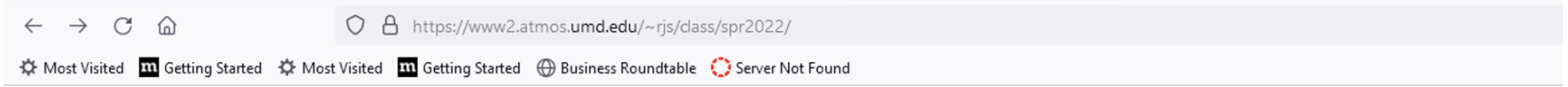
Class Website, External



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2. Schedule

Date	Lecture Topic	Required Reading	Admis. Tickets	Lecture Notes	Problem Sets*	Additional Readings	Learning Outcome
01/25	Class Overview	No reading for first meeting	No AT	Lecture 0 Video			No Quiz
01/27	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		Ivany and Salawitch, *Geology*, 1993	Quiz 1
02/01	Overview of Global Warming, Air Quality, & Ozone Depletion	IPCC 2007 FAQ (1.1, 1.2, 1.3, 2.1, & 3.1) (11 pages) EPA AQI Brochure (11 pages) 20 QAs Ozone (Q1, 2, 7, & 14) (11 pages) Paris Beacon of Hope Sec 1.2.2 (3 pages)	AT 2	Lecture 2 Video		Kerr, *Science*, 2007 * Bell *et al.*, *EHP*, 2006 * Montzka *et al.*, *Nature*, 2018 Naming Convention for CFCs & Halons Entire IPCC 2007 FAQ Entire 20 QAs Ozone Movie Clip	Quiz 2

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

https://www2.atmos.umd.edu/~rjs/class/spr2022

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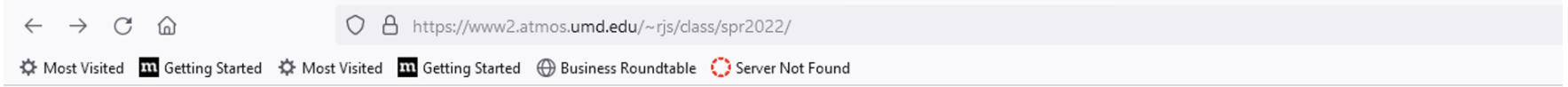

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Should be "hot". To what file does this link point?

https://www2.atmos.umd.edu/~rjs/class/spr2022

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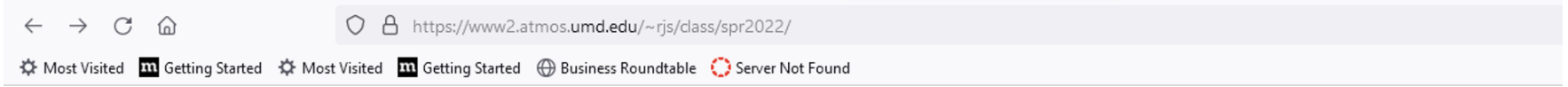

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Should be "hot". To what file does this link point?

https://www2.atmos.umd.edu/~rjs/class/spr2022/lectures/ACC_2022_lecture00_handout.pdf

https://www2.atmos.umd.edu/~rjs/class/spr2022

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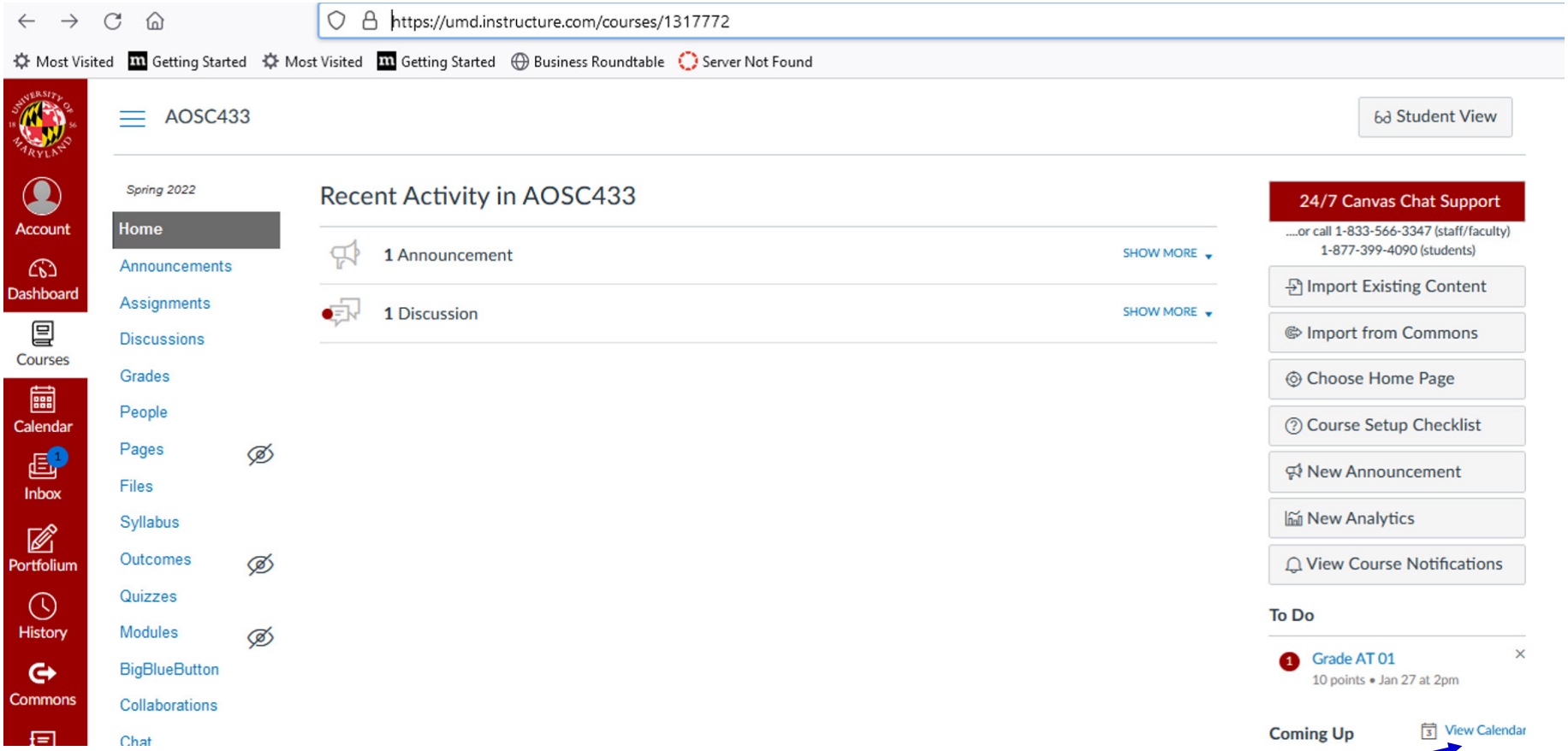
Class Website, ELMS (Calendar View)



Click here for Calendar View

https://umd.instructure.com/courses/1317772

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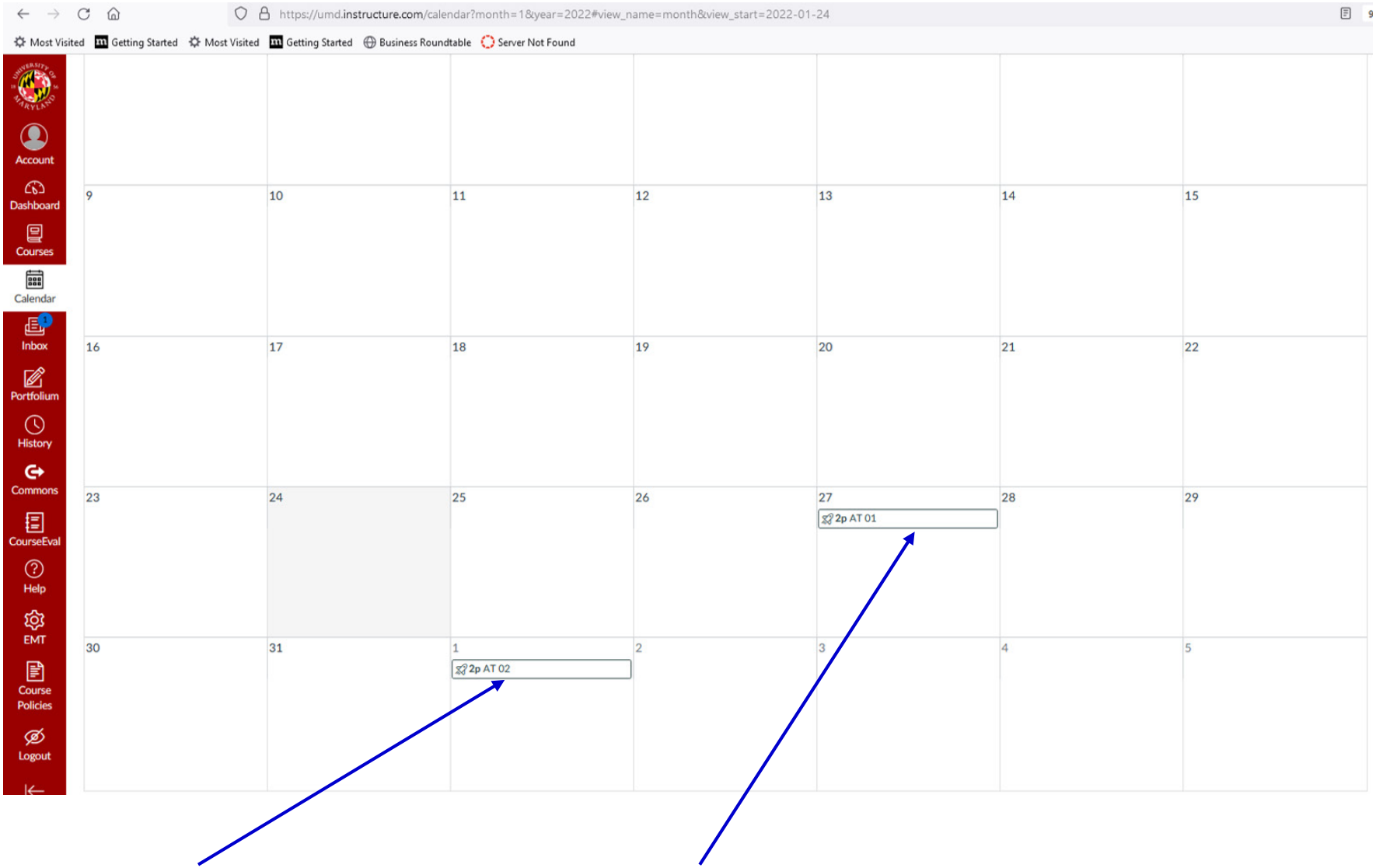
Class Website, ELMS (Calendar View)



Will see ATs; T.B.D. whether Problem Sets will be linked via Calendar View

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Class Website, External

https://www2.atmos.umd.edu/~rjs/class/spr2022/

Most Visited | Getting Started | Most Visited | Getting Started | Business Roundtable | Server Not Found

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Learning outcome Quiz: https://testmoz.com/q/11436780
Note: must use passcode of ATL2428 to access

https://www2.atmos.umd.edu/~rjs/class/spr2022

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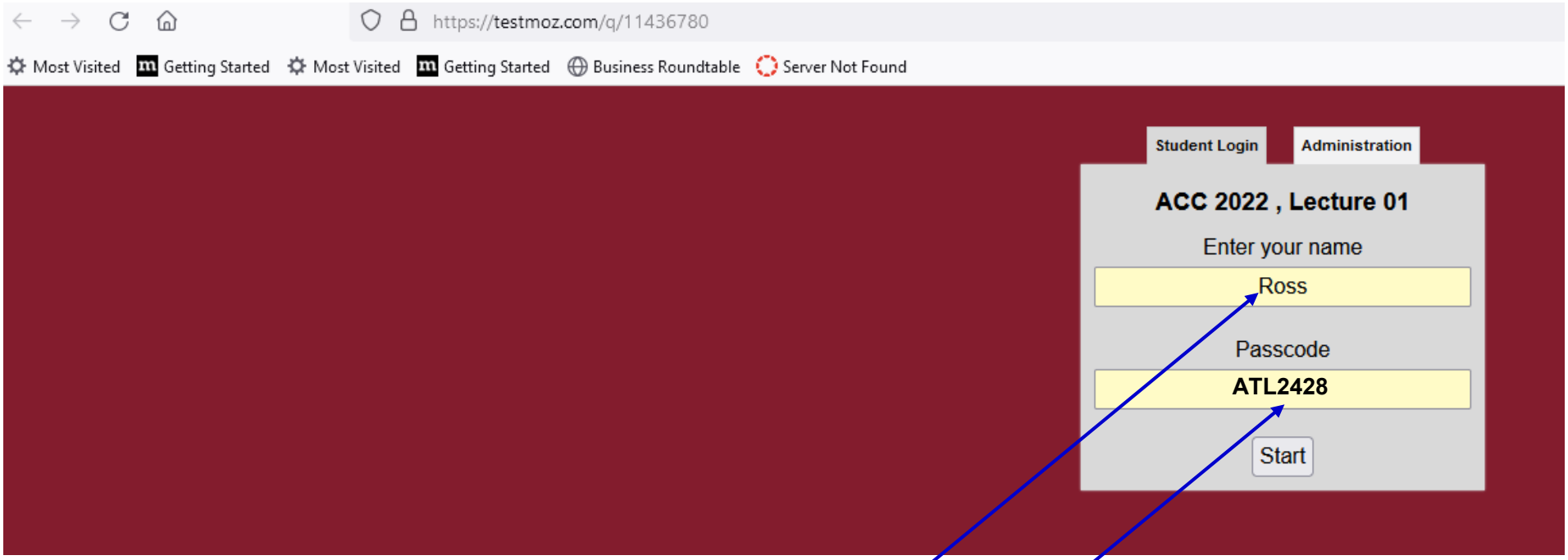
Class Website, External

Learning outcome Quiz: https://testmoz.com/q/11436780



Please use your real name here.

Must use ATL2428 here.

Links to these learning outcome quizzes will be posted in the "Learning Outcome" column of https://www2.atmos.umd.edu/~rjs/class/spr2022

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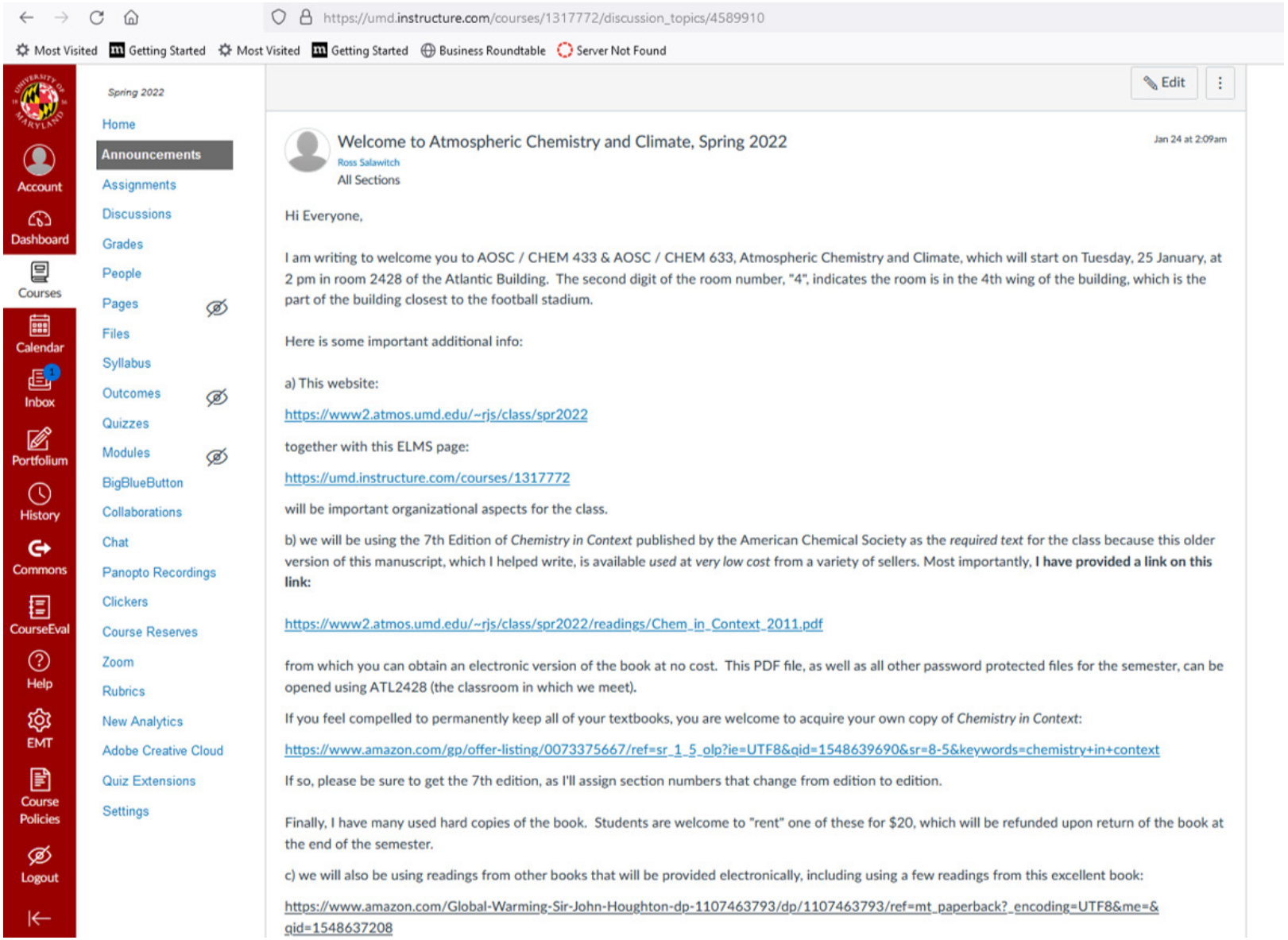
Class Organization

Who did not get this message?



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Text Books

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

Supplemental Texts:

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Twenty Questions and Answers About the Ozone Layer by Ross Salawitch, David Fahey, Michaela Hegglin, Laura McBride, Walter Tribett, and Sarah Doherty

Beyond Oil and Gas: The Methanol Economy by George A. Olah, Alain Goeppert, and G. K. Surya Prakash

Green Chemistry: An Inclusive Approach, edited by Béla Török and Timothy Dransfield

(graduate students will be assigned parts of three chapters)

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(graduate students will be assigned parts of three chapters)

https://www2.atmos.umd.edu/~rjs/class/spr2022/readings/Chem_in_Context_2011.pdf

Must use what to open?

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Why Six Books And So Many Readings?

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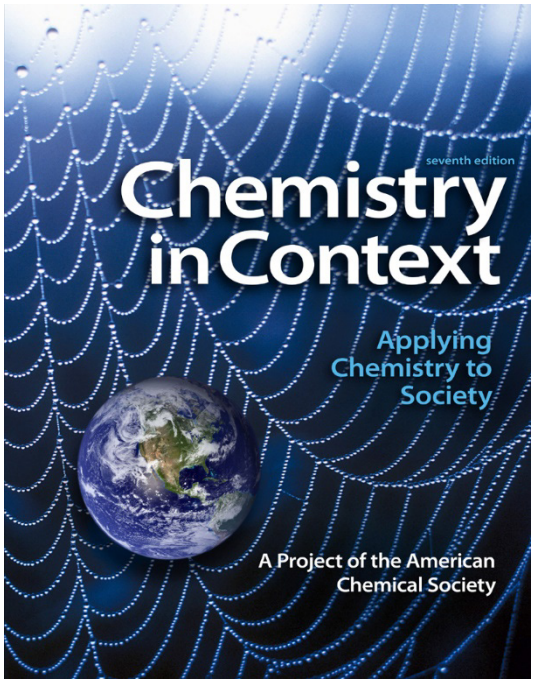

Chemistry in Context : Applying Chemistry to Society, 7/e

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.

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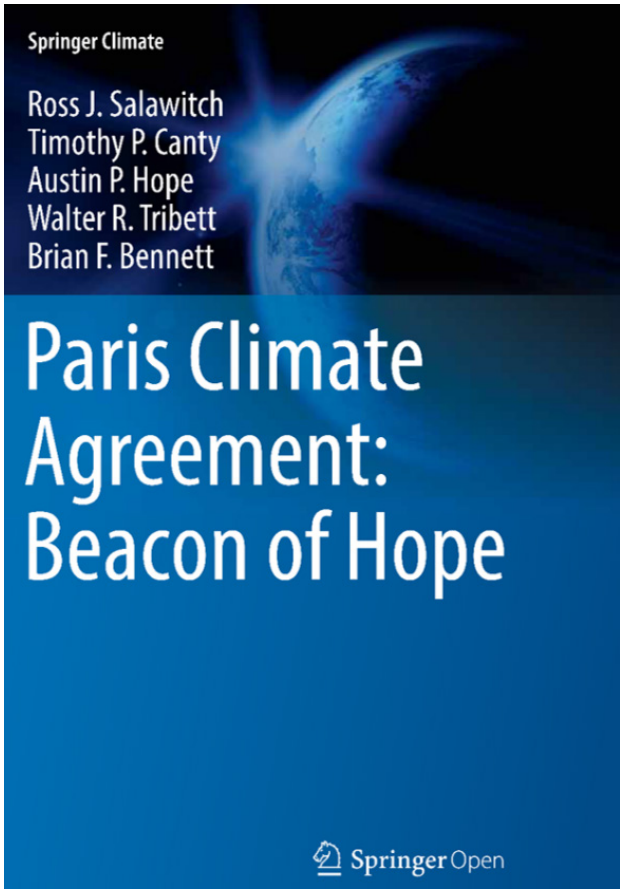
Numerous readings from: *Paris Climate Agreement: Beacon of Hope*

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 this class & AOSC 652
- Can obtain from https://link.springer.com/book/10.1007/978-3-319-46939-3

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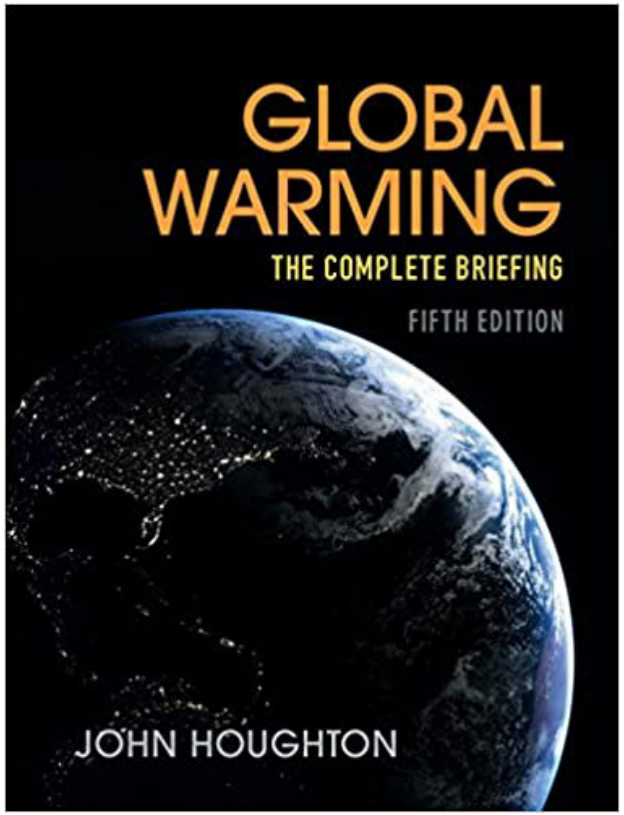
Numerous readings as well as: *Global Warming: The Complete Briefing* (Fifth Edition) by Sir John Houghton



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

- Selected readings will be provided in password protected files (ATL2428)
- If you like the style of this book, please consider purchasing for your library
- Can purchase from this link.

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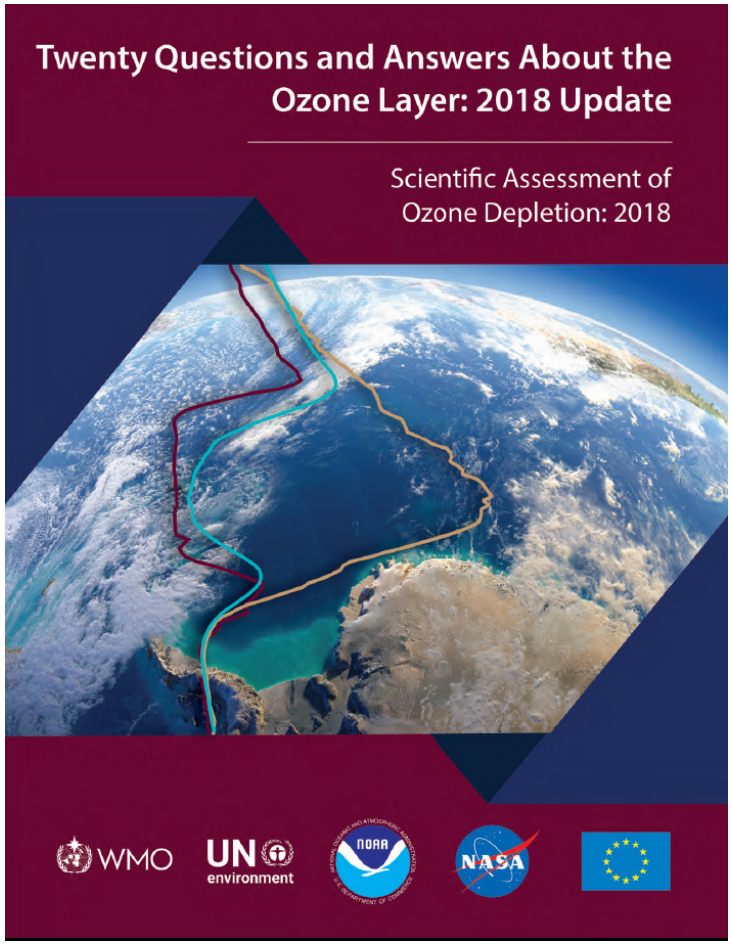
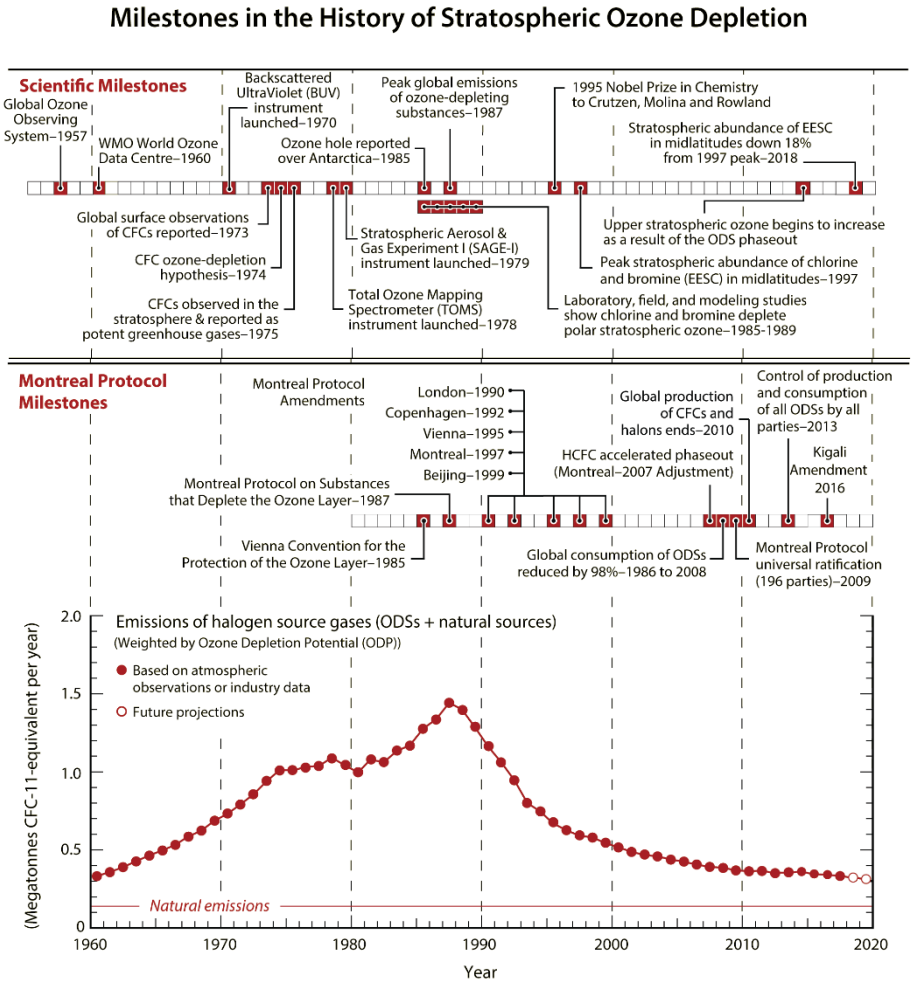
Numerous readings also from: *Twenty Questions and Answers About the Ozone Layer*

by Ross J. Salawitch, David W. Fahey, Michaela I. Hegglin, Laura A. McBride, Walter R. Tribett, and Sarah J. Doherty





- Book also published via open access, so text is freely available
- This document is updated every 4 years; I led the 2018 update and am leading the 2022 update
- Can obtain from https://www.esrl.noaa.gov/csl/assessments/ozone/2018/twentyquestions/

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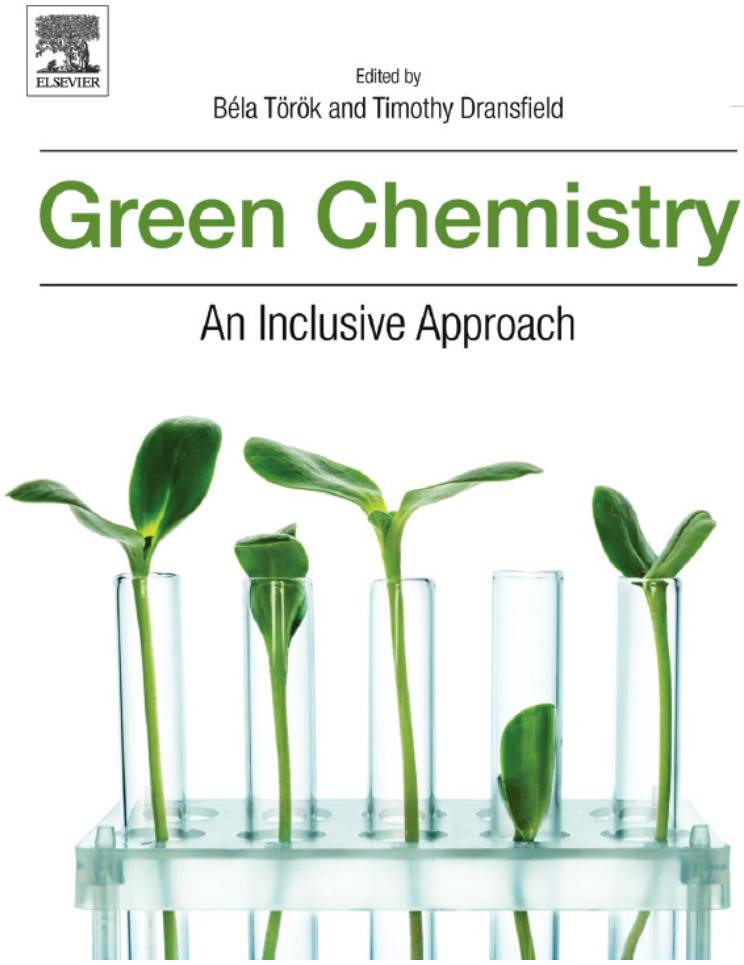
Numerous readings also from: *Green Chemistry: An Inclusive Approach*

edited by Béla Török and Timothy Dransfield



- Selected readings ***for those enrolled in 633*** will be provided in password protected files
- Can purchase from https://www.elsevier.com/books/green-chemistry/torok/978-0-12-809270-5 but this book is pricey

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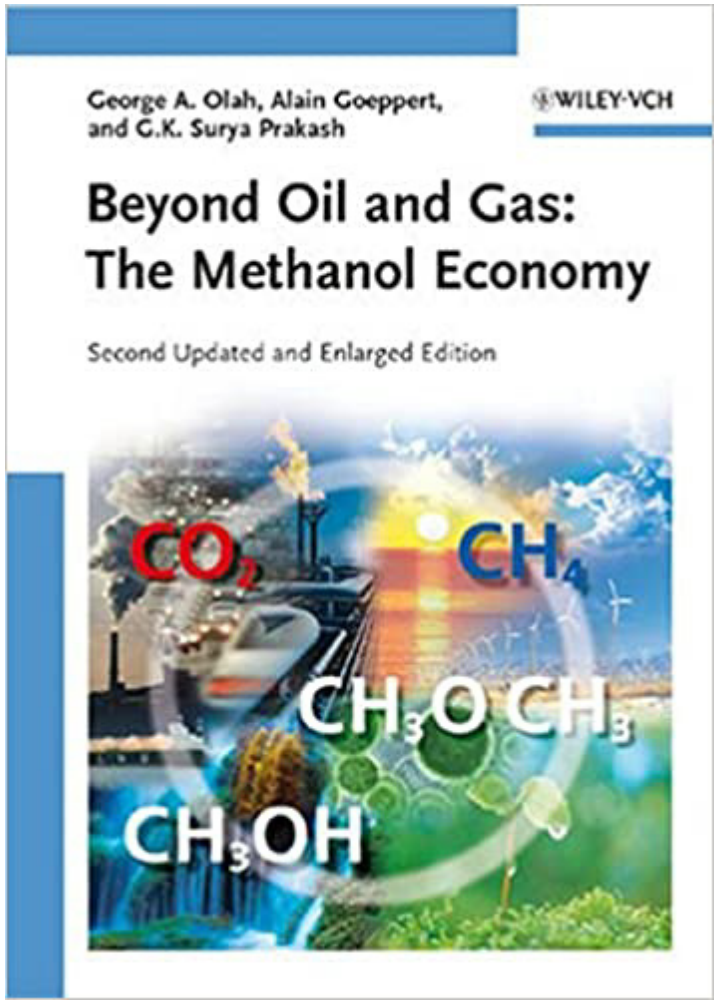
Numerous readings and finally from: *Beyond Oil and Gas:The Methanol Economy*

by George Olah, Alain Goeppert, and G. K. Surya Prakash



Dr. Olah was awarded the Nobel Prize in 1994 for his research on carbocations, positively charged hydrocarbons that form during the intermediate steps of some chemical reactions but are so fleeting (lasting only nanoseconds, in some cases) that it was thought to be virtually impossible to study them.

Dr. Olah in 2014. (Gue Ruelas/University of Southern California via AP)

The chemist realized he could use extremely harsh acids, called superacids, to stabilize the carbocations long enough to use spectroscopic methods to study their properties. The discovery led to a boom in the exploration of these elusive molecules. His work also led to new methods to convert "straight-chain" hydrocarbons into molecules with branched structures, which resulted in higher octane ratings and cleaner-burning fuel.

Later, Dr. Olah developed the idea of a methanol economy as an alternative to one based on fossil fuels. He proposed drawing down carbon dioxide (a single-carbon gas) and turning it into methanol (a single-carbon alcohol), thus creating a renewable fuel and reducing greenhouse gas in the atmosphere.

His research paved the way for a new kind of methanol-based fuel cell that produced electricity with high efficiency. More recently, he became interested in methanol found in space, exploring in papers with Prakash whether the molecule could have been one of the key molecules involved in the origin of life.

George Olah Obituary, 13 March 2017, Washington Post

- Selected readings will be provided in password protected files towards end of semester
- Can purchase from this link but the book is a bit dated (albeit, excellent, which is why we use)

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Class Communication

c) we will also be using readings from other books that will be provided electronically, including using a few readings from this excellent book:

https://www.amazon.com/Global-Warming-Sir-John-Houghton-dp-1107463793/dp/1107463793/ref=mt_paperback?_encoding=UTF8&me=&qid=1548637208

that I'll explain during our initial meeting. If this book seems appealing for your personal library, you're welcome to purchase on-line. Please be sure to get the 5th (latest) edition.

There is no reading of course for the first class meeting, which will be focused solely on class logistics. I have assigned 11.5 pages (from a book my group wrote) for the second class meeting on Thurs, 27 Jan and four items (total of 36 pages) for our third class meeting on Tues, 1 Feb as detailed at http://www.atmos.umd.edu/~rjs/class/spr2022 in case anyone wants to get started early.

d) Until further notice, we will meet live in person in room 2428 of the Atlantic Building. I will do my best to record each lecture using Panopto, including our initial class meeting. It is expected everyone who attends in person will be wearing an N95 of KN95 mask; I shall do the same. Of course, if you are not feeling well, do not come to class. Given the situation, I will be totally "chill" about in person attendance; my teaching style tends to be quite interactive so there is certainly considerable benefit for attending in person.

e) For a class of this size, communication is vital. I prefer to receive messages via email at rsalawit@umd.edu (fine to address me as "Ross" in emails), with a meaningful subject. Great appreciate if the subject starts with either "AOSC 433", "CHEM 433", "AOSC 633", or "CHEM 633" to help me spot emails from students. For me, one on one communication using email is much much better than messages sent within ELMS, despite the fact I use ELMS Announcements to broadcast message to the entire class.

Looking forward to meeting everyone on Tuesday at 2 pm.

Cheers,

Ross

All class related messages will be sent using the ELMS announcement tool, because this tool nicely logs all of the messages.

I nonetheless prefer conducting all other correspondence via email rather than ELMS, because email is easier for me to manage.

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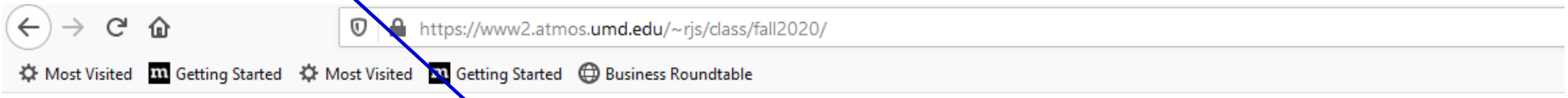
Organization Details

- 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 ELMS and email me if you are having a problem with ELMS



Date	Lecture Topic	Required Reading	Admis. Tickets	Lecture Notes	Problem Sets*	Additional Readings	Learning Outcome
09/01	Class Overview	No reading for first meeting	No AT	Lecture 0 2020 Zoom Video			No Quiz
09/03	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 2020 Zoom Video			Quiz 1
09/08	Overview of Global Warming, Air Quality, & Ozone Depletion	IPCC 2007 FAQ (1.1, 1.2, 1.3, 2.1, & 3.1) (11 pages) EPA AQI Brochure (11 pages) 20 QAs Ozone (Q1, 2, 7, & 14) (11 pages) Paris Beacon of Hope Sec 1.2.2 (3 pages)	AT 2	Lecture 2 2020 Zoom Video		Kerr, *Science*, 2007 * Bell *et al.*, *EHP*, 2006 * Montzka *et al.*, *Nature*, 2018 Naming Convention for CFCs & Halons Entire IPCC 2007 FAQ Entire 20 QAs Ozone Movie Clip	Quiz 2

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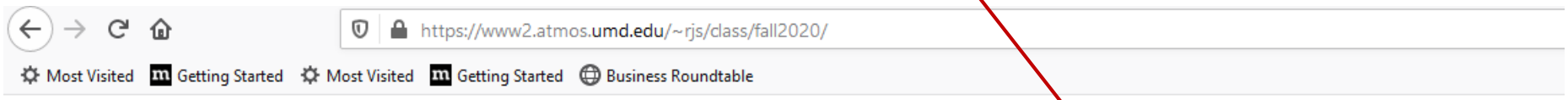
  - graded on a 10 point basis; *lowest three scores will be dropped*
  - please complete on ELMS and email me if you are having a problem with ELMS

Asterisk denotes assigned reading for students enrolled in 633



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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 ELMS and email me if you are having a problem with ELMS
- Problem Sets (30%)
  - posted on web page and announced in class at least 1 week before due date
  - assignment about every two to three weeks; 6 total
  - prescribed "late penalty" and final receipt date: will not be accepted after solutions have been handed out (typically within ~7 days of due date)
  - problem sets are new each year; access to old solutions will be of little or no benefit
- Exams (40%)
  - **two in-class exams (early semester; late semester) plus final exam, same weights**
  - exams will tend strongly towards understanding of concepts via essay-like answers whereas problem sets will tend strongly towards quantitative understanding
- Prerequisite
  - CHEM131, CHEM135, or CHEM146 plus MATH241 or permission of instructor
  - Class will be taught at a level accessible to any upper level (Jr or Sr year) physical science major (i.e., we expect students are adept at use of equations; have seen a differential, and understand the basic concept of integration)

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Organization Details

- Grading:
  - admission tickets: 30%
  - problem sets: 30%
  - in-class exam I and II: 13.33% each (likely open note, limited time)
  - final exam: 13.34% (likely open note, limited time)
  - collaboration policy posted on class website: problems sets & admission tickets should reflect your own work & understanding of the material
- Students enrolled in 633:
  - 5 to 8 page, single-spaced (not including references and figures) **research paper** plus a **verbal presentation** on same topic
  - paper/presentation will contribute to final grade in an amount equal to each exam (i.e., 10 % each)
  - extra question on some problem sets
  - a few different questions on exams (some overlap)
  - extra readings that could very well appear on an exam
- Office hours:
  - Ross: via Zoom, by email appointment
  - I strive to be accessible throughout the semester. However, *just before class is generally not a great time to meet* & the AOSC Seminar occurs 3:30 pm each Thurs

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Organization Details, Continued

- Readings
  - All readings, except those from required text, will be posted on class webpage
  - Handouts of selected readings will be provided
  - Publicly available PDF files will be "unprotected"
  - Copyright protected PDF files will be protected, using **password ATL2428**
- Additional Readings
  - Provided for many lectures for students who would like more in depth info, to enhance learning experience for motivated students
  - If noted with an asterisk additional reading is "strongly suggested" for students enrolled in 633; could be used for a question on 633 problem set or exam
- Email
  - ***Please use AOSC 433, CHEM 433, AOSC 633, or CHEM 633 at start of subject line of all class-related email***

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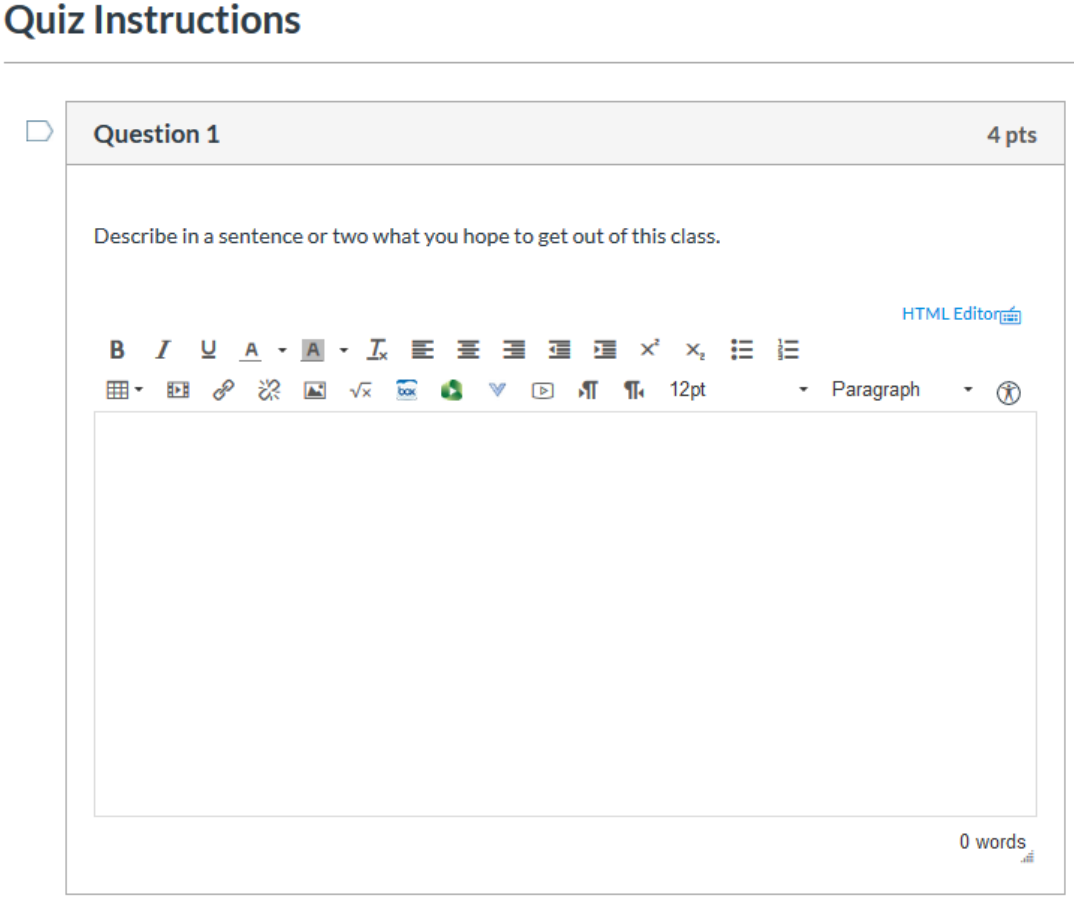
Next Lecture: Geological Evolution of Earth's Atmosphere

Reading: Sec 1.1, 1.2 (intro), and 1.2.1 (11.5 pages) of
Paris Climate Agreement: Beacon of Hope

Admission Ticket for Lecture 1 is posted on ELMS



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Next Lecture: Geological Evolution of Earth's Atmosphere

Question 2 3 pts

According to Section 1.1 of Paris Climate Agreement: Beacon of Hope:

a) what time marks the first appearance of life on Earth?

b) when did atmospheric O_2 begin to rise to a level that could sustain eukaryotic cellular forms of life, such as you and I ?

c) what other happenstance associated with the rise in atmospheric O_2 occurred that allowed life to emerge from sea to land?

d) when do scientists believe plant life first appeared on land?

- ○ a) 3.5 billion years before present (Bybp)
  b) 2.5 Bybp
  c) formation of the O_3 layer, which protects terrestrial life from harmful solar UV radiation
  d) 0.5 Bybp
- ○ a) 3.5 billion years before present (Bybp)
  b) 2.5 Bybp
  c) formation of the O_3 layer, which protects terrestrial life from harmful solar UV radiation
  d) 500 Bybp
- ○ a) 3.5 billion years before present (Bybp)
  b) 2.5 Bybp
  c) rise in atmospheric CO_2, which plants need to grow
  d) 500 Bybp
- ○ a) 3.5 billion years before present (Bybp)
  b) 2.5 Bybp
  c) rise in atmospheric CO_2, which plants need to grow
  d) 0.5 Bybp

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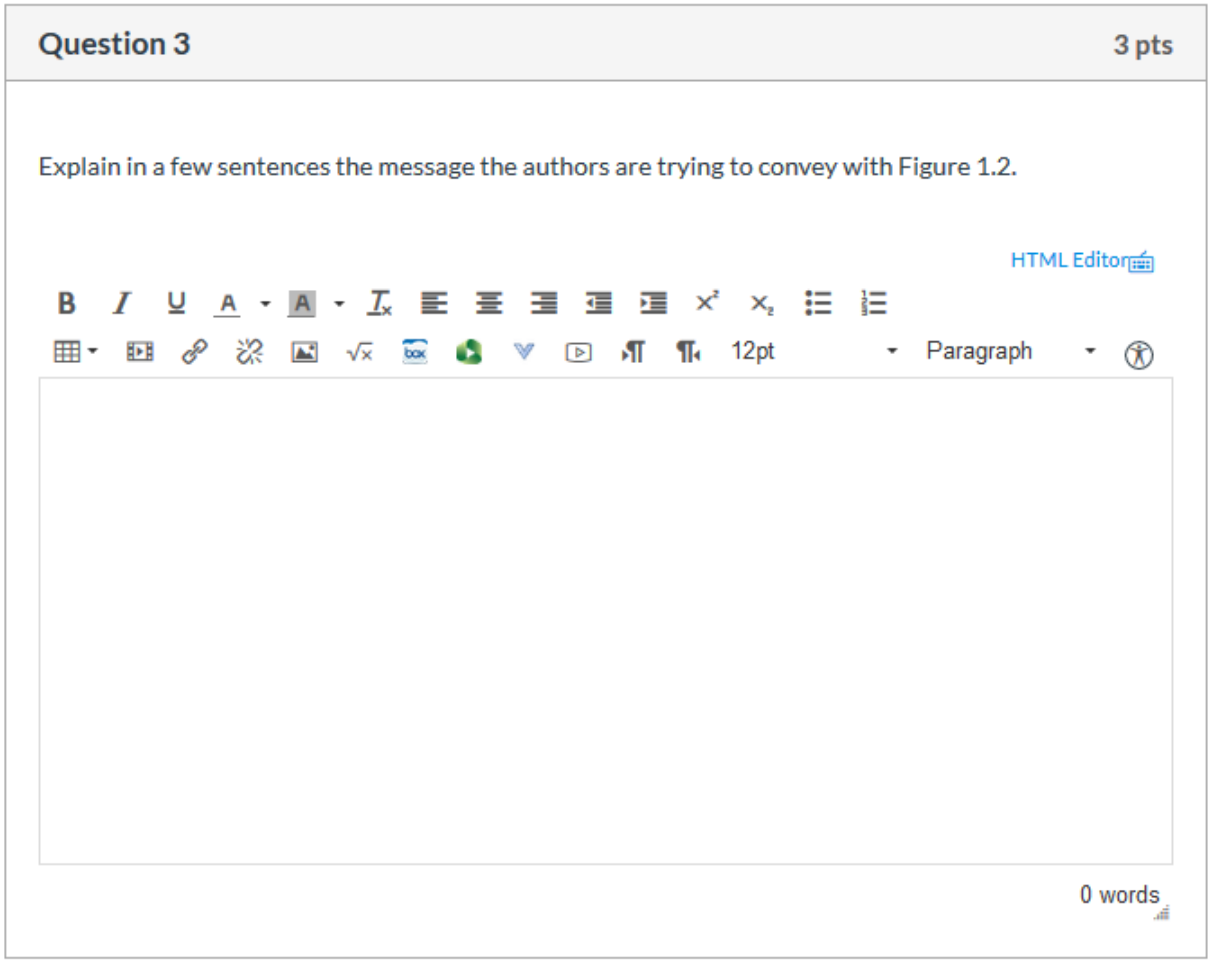
Next Lecture: Geological Evolution of Earth's Atmosphere



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Next Lecture: Geological Evolution of Earth's Atmosphere

Question 3 3 pts

Explain in a few sentences the message the authors are trying to convey with Figure 1.2.

HTML Editor

12pt Paragraph

0 words

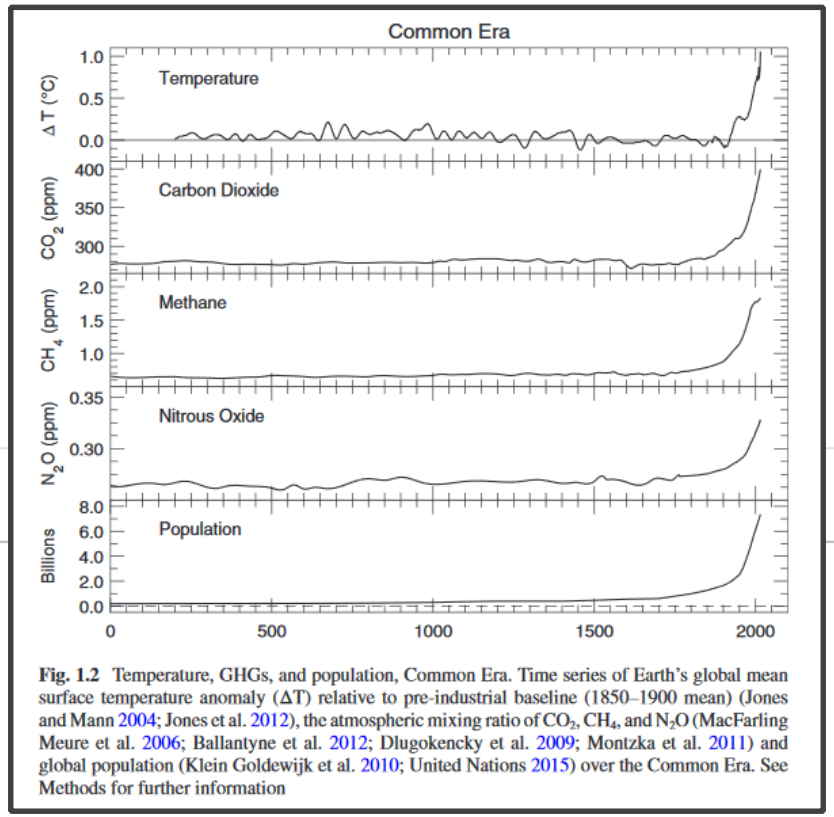

Fig. 1.2 Temperature, GHGs, and population, Common Era. Time series of Earth's global mean surface temperature anomaly (ΔT) relative to pre-industrial baseline (1850–1900 mean) (Jones and Mann 2004; Jones et al. 2012), the atmospheric mixing ratio of CO_2, CH_4, and N_2O (MacFarling Meure et al. 2006; Ballantyne et al. 2012; Dlugokencky et al. 2009; Montzka et al. 2011) and global population (Klein Goldewijk et al. 2010; United Nations 2015) over the Common Era. See Methods for further information

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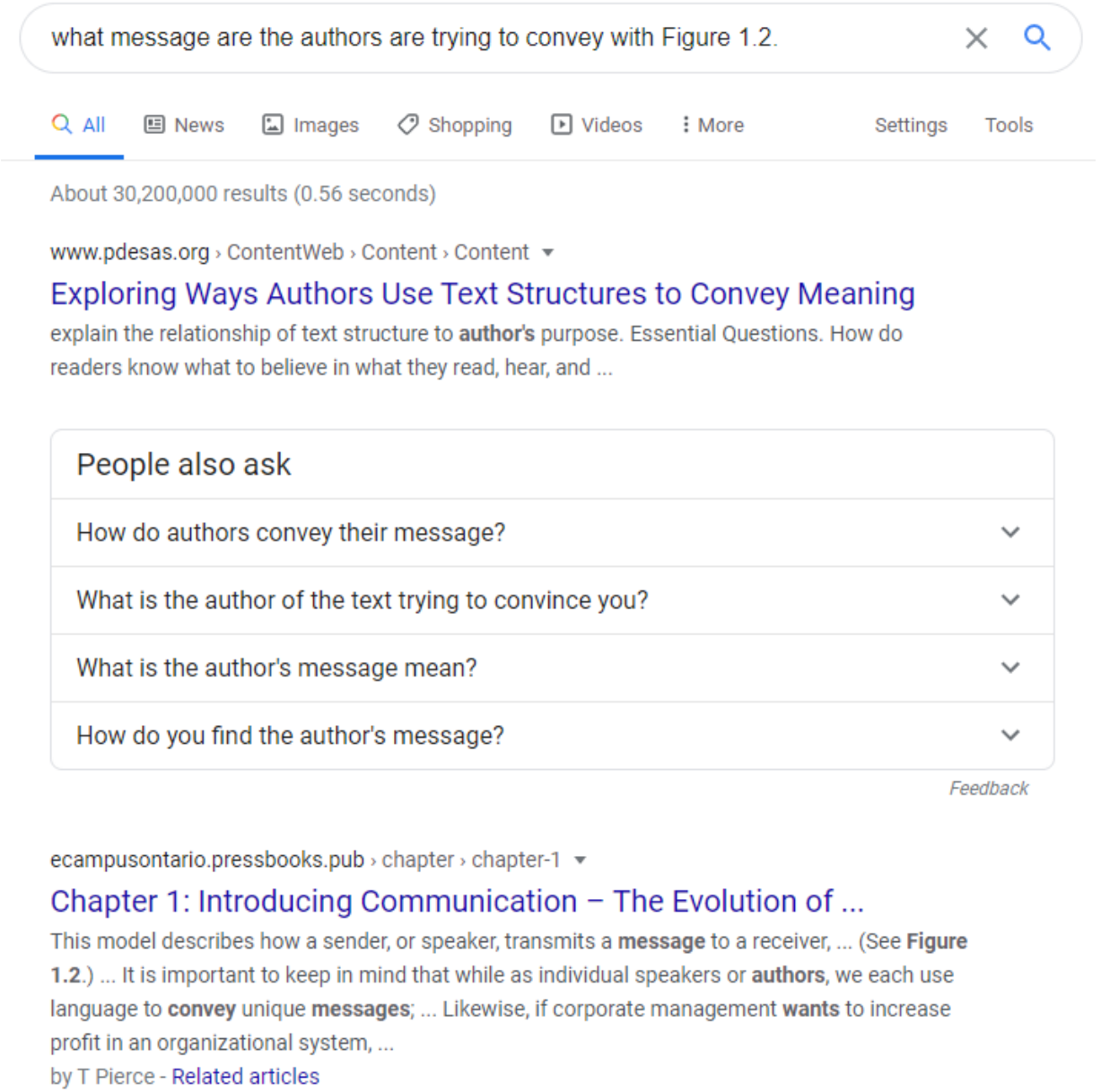
Next Lecture: Geologic Evolution of Earth's Atmosphere



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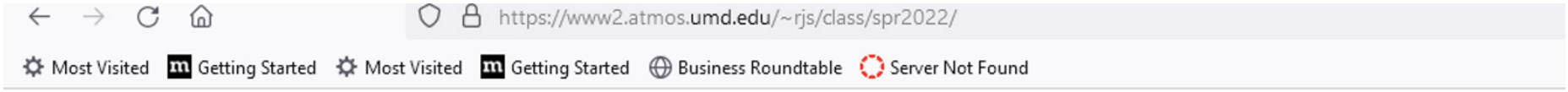
Next Two Lectures Very Important



2. Schedule

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02/01	Overview of Global Warming, Air Quality, & Ozone Depletion	IPCC 2007 FAQ (1.1, 1.2, 1.3, 2.1, & 3.1) (11 pages) EPA AQI Brochure (11 pages) 20 QAs Ozone (Q1, 2, 7, & 14) (11 pages) Paris Beacon of Hope Sec 1.2.2 (3 pages)	AT 2	Lecture 2 Video		Kerr, *Science*, 2007 * Bell *et al.*, *EHP*, 2006 * Montzka *et al.*, *Nature*, 2018 Naming Convention for CFCs & Halons Entire IPCC 2007 FAQ Entire 20 QAs Ozone Movie Clip	Quiz 2

Geology 101 rolled into 75 minutes, with emphasis on composition of Earth's atmosphere

https://www2.atmos.umd.edu/~rjs/class/spr2022

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Next Two Lectures Very Important

https://www2.atmos.umd.edu/~rjs/class/spr2022/

Most Visited | Getting Started | Most Visited | Getting Started | Business Roundtable | Server Not Found

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Road map of the material to be covered in the first 2/3 of this class

https://www2.atmos.umd.edu/~rjs/class/spr2022

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Announcement

ALPHA CHI SIGMA

Professional Chemistry Fraternity

SPRING 2022 RUSH

February 1st – 15th

Events Located in Fraternity Lounge unless otherwise specified

Zoom ID: 980 9543 1289

Password: AXSRush

For more information contact Korina at (301) 661-5061 or kvlahos@umd.edu

Those interested in joining must attend 1 info session & 2 events

☽☿♀☉♂♃♄

4 Year Plan & Skribblio Feb 1, 5 pm **Online Option*	**Bob Ross Night** Feb 3, 6 pm	**Scavenger Hunt** Feb 4, 5 pm
Board Game Night Feb 6, 5 pm	**Looney's Trivia Night** Feb 8, 7 pm	**Info Session** Feb 10, 6 pm **Online Option*
Men's Lacrosse vs. Loyola Feb 12, Time TBD	**Info Session** Feb 14, 6 pm **Online Option*	**Pizza & Study Night** Feb 15, 6 pm

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