

Imperial Valley College Course Syllabus – Geology 120: Climate Studies

Basic Course Information

Semester	Spring 2015	Instructor Name	Kevin Marty
Course Title & #	Geology 130: Climate Change	Email	<u>kevin.marty@imperial.edu</u>
CRN #	20224	Webpage (optional)	
Room	2733	Office	2776
Class Dates	February 16-June 13, 2015	Office Hours	5-6 pm, M,W,Th and Tues 12:15-1:15 pm, Room 2776
Class Days	W	Office Phone #	760-355-5761
Class Times	10:15-1:20 pm	Office contact if student will be out or emergency	Ofelia Duarte (Science Dept) at 760-355-6155
Units	3		

Course Description

This course will engage the student in learning the key concepts and scientific principles of Climate Science by analyzing interactions among and between Earth's Systems as matter and energy are continuously exchanged, and the influence from our position in the Solar System and Universe. We will examine the processes that occur in our atmosphere and hydrosphere, and how these processes create Earth's climate. We must also consider how the Earth and its inhabitants have changed through time, how humans interact with weather and climate systems, and strategies to counter negative impacts to global climate change.

(C-ID GEOL 120) (CSU, UC)

(more)

Student Learning Outcomes

Upon course completion, the successful student will have acquired new skills, knowledge, and or attitudes as demonstrated by being able to:

- 1 Analyze and use web-based resources in science learning (ILO1, ILO2, ILO4)
- 2 Utilize scientific methodology as problem-solving techniques to learn key concepts of earth science and specifically climate concepts (ILO1, ILO2)
- 3 Use the vocabulary and concepts of climate science to describe and consider local and global issues (ILO1, ILO4; ILO 5)

Course Objectives

Upon satisfactory completion of the course, students will be able to:

1. Comprehend key concepts, developments, and reasoning strategies used in studying climate such that they are able to analyze and solve problems in open-ended, inquiry environments using materials, maps, data collection tools, models and computer simulations, other class activities and discussions, and background readings.
2. Relate and evaluate the study of the climate to contemporary, historical, technological and societal issues.
3. Demonstrate the ability to analyze and use web-based resources in climate science learning.
4. Exhibit skills in utilizing scientific methodology as a problem-solving technique to learn key concepts of earth science.
5. Demonstrate knowledge of climate science vocabulary and concepts to describe local issues within a global context.
6. Reflect upon the nature and practice of climate science as a process rather than a body of disconnected facts to be memorized.
7. Demonstrate skills in analyzing the factors which might affect the climates of the future and to understand what ramifications on the lives of people these changes might have.

Textbooks & Other Resources or Links

- 1 Climate Studies Student ePackage Access Card 2014-2015 (ten-digit access code is 1935704818 and thirteen digit access code is 978-1-935704-81-2). The eText is titled “Our Changing Climate: Introduction to Climate Science”; the eInvestigations Manual is for the years 2014-2015 also. The student package includes the eText, eInvestigation Manual, RealTime Climate Portal Access and the eGlossary for the suggested price of \$139.00.

Course Requirements and Instructional Methods

Course Philosophy and Teaching Method: The subject of Climate Science is as vast and diverse as the natural world around us. Together, we will explore and visualize this dynamic world in a number of ways; in no way will it be a static collection of facts. Accordingly, we will concentrate on understanding natural processes and how we explore and learn things about our planet and its climate, rather than terms and factual trivia. We will concentrate on active, inquiry-based learning and will learn how to observe, think about, and understand our place in the natural environment. The critical inquiry and observational skills that we cultivate this semester should be useful in any profession, since they give you an appreciation of how climate processes in our natural world impact our environment and society.

Class time will not simply consist of me repeating via lecture everything that is in the book! It is your responsibility and obligation to complete the required readings prior to any quizzes. Class time may be used for working on lecture assignments, clarifying written materials, introducing new material, small-group activities, discussions, independent work projects, and/or identifying and applying principles and concepts, including in-class demonstrations.

Course Expectations: My role in this class is to provide a framework that includes theory, best practices, activities, and assignments for you to utilize in the development of your knowledge, understanding, and skills. I care very much how and what you learn in this class, but I believe that you are responsible for participating in learning from the activities provided. This class requires significant outside preparation and reading. It will be impossible to cover all issues in the textbook during class time. This is partly why we use a hybrid approach in this course.

Course Grading Based on Course Objectives

Grades: In this course, your grade will be based on points that you earn. There are approximately ??? possible points, which are written out below:

Point Distribution Summary*	Points
Course Project: Powerpoint Presentation (over COMET module)	100
Online Quizzes (1 @ 20 pts; 11 @ 10 pts)	130
Investigation A Manual Worksheets (~12 @ 10-20 pts)	~120-240 pts
Weekly Critical Thinking Questions	120
Total Points Possible	~530

Online Quizzes (outside of class time):

For every chapter, on your own time outside of lecture, you will complete an online quiz using Blackboard that covers information from the textbook and lecture. Each of the 12 online quizzes is worth approximately 10 points (first quiz is worth 20), for a total of ~130 points. Quizzes are due every Sunday night by 11:59 pm. You can use your textbook or your notes to answer these quizzes, but not another person. Each quiz has a time limit of 120 minutes. You will need to read the textbook and review lecture notes before beginning the time-limited online quiz. Some of the quiz questions might relate to assigned readings that are not discussed in lecture; you are thus expected to read all of the assigned reading (such as AMS website assignments). Quizzes close on the due dates, there are no late or make-up quizzes.

In-Class Assignments (Investigation Manual) and Website Investigations (COMET/Current Climate Studies and News):

A set of student learning investigations is coordinated, two per each textbook chapter. Here you will be led through analysis and interpretation of real-world climate. Here is also the weekly “Current Climate Studies” feature posted to the “Real Time Climate Portal” at the AMS website to reinforce work and expand on important concepts learned about through the Investigation Manual.

The “Real Time Climate Portal” delivers Weekly Climate News, current climate data and graphics, and satellite imagery throughout the year.

The “Weekly Climate News” contains links to the latest climate news items year round and is an important feature of the “Real Time Climate Portal”.

Also found at the AMS website are COMET learning modules; many of these modules have been downloaded and linked to our class Blackboard site (and syllabus) for use during the semester.

For this semester, you will have time in class to work on weekly assignments from the eInvestigation Manual (Investigation A for Chapter’s 1-12). This is your main assignment under this heading.

In-Class Participation:

It is important that you show up for class every week (unless we have discussed and agreed on your special circumstances). This class will move fast, and a significant portion of your grade will be participation and completion of investigations worked on in class (and/or as homework assignments). We will also use IVC computers in class to work on investigations and it is here you can get the help you might need to understand the investigations and AMS website. Missed classes and points earned during class meetings cannot be made up (again, I am willing to work on an alternative schedule for those who work during the day).

Course Project: Slide Presentation

The course project involves your creation of a 30 slide Powerpoint presentation over a topic related to the class subject matter (i.e., a COMET module). This project is also a significant part of your grade and will be submitted as a working draft during mid-semester (week of April 6-12; at least 15 slides so I can view your progress and provide input/help if needed) and as a final presentation at the end of the semester (I have set aside two weeks for your presentations).

Weekly Critical Thinking Questions: two questions have been picked from each chapter for your weekly homework assignment to be turned in at the beginning of each class (handwritten or typewritten). We will begin each class discussing these questions that will lead us into other topics. These assignments are worth 10 points each for a total of 120 points.

Due Dates:

The above assignments have specifically defined due dates as noted in the Course Schedule later on in this syllabus. It is your responsibility to consult the Course Schedule (if applicable) for all weekly tasks and due dates. The instructor will not assume the responsibility of reminding you that an assignment is due or that a quiz, for example, will be given.

Score/Grade Posting:

All scores will be posted on Blackboard. You have 7 days after a score has been posted to dispute an entry. After the 7-day period, the score stands as entered. Do not wait until the end of the semester to check your scores. Grades are not assigned by a “curve”, where a certain percent is assigned “A”, “B”, etc. Instead, you are competing against my expectations, not your classmates, and there is no predetermined percentage of “A”, “B”, and “C”. The exact division between letter grades will not be determined until the final points are totaled, but the grade breaks will not be raised above typical values (e.g., the A-B grade break will be 90% or lower, etc.). No items are weighted—your grade is based solely on total points received.

Dates for Withdrawals:

There is a course withdrawal deadline—check the college calendar to find the course withdrawal deadline for this semester. The course withdrawal deadline is a no-tolerance policy. When the withdrawal period ends, students only have one option – a grade of F for the course.

Incomplete Grade:

A mark of “I” is given only when a student who is otherwise doing acceptable work is unable to complete a course because of an illness or other situation beyond the student’s control. The student is required to arrange for the completion of the course requirements with the instructor. The university does not allow instructors to assign a grade of “I” simply because a student has quit attending classes and/or completing assignments.

Attendance

- A student who fails to attend the first meeting of a class or does not complete the first mandatory activity of an online class will be dropped by the instructor as of the first official meeting of that class (does not apply to special circumstances). Should readmission be desired, the student's status will be the same as that of any other student who desires to add a class. It is the student's responsibility to drop or officially withdraw from the class. See General Catalog for details.
- Regular attendance in all classes is expected of all students. A student whose continuous, unexcused absences exceed the number of hours the class is scheduled to meet per week may be dropped. For online courses, students who fail to complete required activities for two consecutive weeks may be considered to have excessive absences and may be dropped.
- Absences attributed to the representation of the college at officially approved events (conferences, contests, and field trips) will be counted as 'excused' absences.

Classroom Etiquette

Class Disruptions:

These disruptions are defined as activities that distract the instructor or other students from the course content. Such activities include talking or whispering, cell phones ringing, tardiness or whispering about another tardy student, noisily preparing to leave the class prior to the end of the period, etc. Disruptive students will be asked to leave the class. Students who disrupt or interfere with a class repeatedly may be sent out of the room and told to meet with the Campus Disciplinary Officer before returning to continue with coursework. Disciplinary procedures will be followed as outlined in the General Catalog.

Audio/Visual Recording:

Neither audio nor video recording will be permitted except under special circumstances prescribed by the DSPS. You are also not allowed to use the camera in your phone to record pictures or video, without expressed consent of the instructor.

Cellular Telephones/Text Messaging/Pagers:

Please turn off all cellular telephones and pagers during class time – this includes text messaging. If your work situation requires that you be on call, please notify the instructor prior to class. Text messaging is not permitted in this class.

Use of Laptops In the Classroom:

You are not permitted to use laptops in class during lectures or during work on lecture assignments/checkpoints/exercises from your class handbook (one exception is if you are using an electronic book for class, then you are permitted to use your laptop only during work out of the class handbook). You may use your laptop during breaks only as long as you are not disturbing your neighbors. If you use your laptop during lecture you will lose all in-class points for the day; and if you continue to use your laptop during unauthorized times or are disrupting other students you will be asked to leave the classroom. If it is essential that you use your laptop to take notes during lectures please see me about this and we can possibly work something out.

Food and Drink:

Food and drink are prohibited in all classrooms. Water bottles with lids/caps are the only exception. Additional restrictions will apply in labs. Please comply as directed.

Children in the Classroom:

Due to college rules and state laws, no one who is not enrolled in the class may attend, including children.

Academic Honesty

- Plagiarism is taking and presenting as one's own the writings or ideas of others, without citing the source. You should understand the concept of plagiarism and keep it in mind when taking exams and preparing written materials. If you do not understand how to 'cite a source' correctly, you must ask for help.
- Cheating is defined as fraud, deceit, or dishonesty in an academic assignment, or using or attempting to use materials, or assisting others in using materials that are prohibited or inappropriate in the context of the academic assignment in question.
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- Anyone caught cheating or will receive a zero (0) on the exam or assignment, and the instructor may report the incident to the Campus Disciplinary Officer, who may place related documentation in a file. Repeated acts of cheating may result in an F in the course and/or disciplinary action. Please refer to the General School Catalog for more information on academic dishonesty or other misconduct. Acts of cheating include, but are not limited to, the following: (a) plagiarism; (b) copying or attempting to copy from others during an examination or on an assignment; (c) communicating test information with another person during an examination; (d) allowing others to do an assignment or portion of an assignment; (e) using a commercial term paper service.

Additional Help – Discretionary Section and Language

Help Along The Way: Many students enter this class with a bit of anxiety. Other students may have various disabilities, including test anxiety, which may make traditional classroom environments very difficult. Don't worry, almost all such students before you have passed this course – many with very high grades! The success of many of these students, though, was in part because they attended class regularly, took advantage of my office hours, or obtained help from their peers. If you are having difficulty understanding the course work, please contact me immediately. Also, the college has learning centers, disability resource centers, and counseling centers to address the various needs of students. (see examples next):

- Blackboard support center:
<http://bbcrm.edusupportcenter.com/ics/support/default.asp?deptID=8543>
- Learning Labs: There are several 'labs' on campus to assist you through the use of computers, tutors, or a combination. Please consult your college map for the Math Lab, Reading & Writing Lab, and Study Skills Center (library). Please speak to the instructor about labs unique to your specific program.

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- **Library Services:** There is more to our library than just books. You have access to tutors in the Study Skills Center, study rooms for small groups, and online access to a wealth of resources.

Disabled Student Programs and Services (DSPS)

Any student with a documented disability who may need educational accommodations should notify the instructor or the Disabled Student Programs and Services (DSP&S) office as soon as possible. The DSP&S office is located in Building 2100, telephone 760-355-6313, if you feel you need to be evaluated for educational accommodations.

Student Counseling and Health Services

Students have counseling and health services available, provided by the pre-paid Student Health Fee. We now also have a fulltime mental health counselor. For information see <http://www.imperial.edu/students/student-health-center/>. The IVC Student Health Center is located in the Health Science building in Room 2109, telephone 760-355-6310.

Student Rights and Responsibilities

Students have the right to experience a positive learning environment and due process. For further information regarding student rights and responsibilities, please refer to the IVC General Catalog available online at http://www.imperial.edu/index.php?option=com_docman&task=doc_download&gid=4516&Itemid=762

Information Literacy

Imperial Valley College is dedicated to helping students skillfully discover, evaluate, and use information from all sources. Students can access tutorials at <http://www.imperial.edu/courses-and-programs/divisions/arts-and-letters/library-department/info-lit-tutorials/>

Anticipated Class Schedule / Calendar

Course Schedule for Geol 120: Climate Studies, Fall 2014

*All due dates and distribution of grade points is subject to change according to class needs.

Week of	Topic/Lecture/Test	Readings
Feb 16-22	Introduction to course	
Feb 23-Mar 1	Chapter 1: Earth's Climate as a Dynamic System -Investigation Manual 1A: Due Sunday EOD -Quiz 1 Chapter 1 due Sunday EOD -Critical Thinking Questions (Due Beginning of class each week) -Powerpoint Presentation: Due at end of year over Comet Module Topic	Chapter 1

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March 2-8	<p>Chapter 2: Observing Earth’s Climate System</p> <p>-Investigation Manual 2A: Due Sunday EOD</p> <p>-Quiz 2 Chapter 2 due Sunday EOD</p> <p>-Critical Thinking Questions (Due Beginning of class each week)</p>	Chapter 2
March 9-15	<p>Chapter 3: Tools for Investigating Earth’s Climate System</p> <p>-Investigation Manual 3A: Due Sunday EOD</p> <p>-Quiz 3 Chapter 3 due Sunday EOD</p> <p>-Critical Thinking Questions (Due Beginning of class each week)</p>	Chapter 3
March 16-22	<p>Chapter 4: Radiation and Heat in the Climate System</p> <p>-Investigation Manual 4A: Due Sunday EOD</p> <p>-Quiz 4 Chapter 4 due Sunday EOD</p> <p>-Critical Thinking Questions (Due Beginning of class each week)</p>	Chapter 4
March 23-29	<p>Chapter 5: Water in Earth’s Climate System</p> <p>-Investigation Manual 5A: Due Sunday EOD</p> <p>-Quiz 5 Chapter 5 due Sunday EOD</p> <p>-Critical Thinking Questions (Due Beginning of class each week)</p>	Chapter 5
March 30-April 5	<p>Chapter 6: Global Atmospheric Circulation</p> <p>-Investigation Manual 6A: Due Sunday EOD</p> <p>-Quiz 6 Chapter 6 due Sunday EOD</p> <p>-Critical Thinking Questions (Due Beginning of class each week)</p>	Chapter 6
April 6-12	Spring Break	

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<p>April 13-19</p>	<p>Chapter 7: Atmosphere-Ocean Relationships</p> <p>-Investigation Manual 7A: Due Sunday EOD</p> <p>-Quiz 7 Chapter 7 due Sunday EOD</p> <p>-Critical Thinking Questions (Due Beginning of class each week)</p> <p>-Powerpoint Presentation: Mid-year check</p>	<p>Chapter 7</p>
<p>April 20-26</p>	<p>Chapter 8: Natural and Anthropogenic Drivers of Climate Change</p> <p>-Investigation Manual 8A: Due Sunday EOD</p> <p>-Quiz 8 Chapter 8 due Sunday EOD</p> <p>-Critical Thinking Question (Due Beginning of class each week)</p>	<p>Chapter 8</p>
<p>April 27-May 3</p>	<p>Chapter 9: Paleoclimatic Investigations: Relevancy to the Present State of Climate</p> <p>-Investigation Manual 9A: Due Sunday EOD</p> <p>-Quiz 9 Chapter 9 due Sunday EOD</p> <p>-Critical Thinking Questions (Due Beginning of class each week)</p>	<p>Chapter 9</p>
<p>May 4-10</p>	<p>Chapter 10: Future Projections of Climate</p> <p>-Investigation Manual 10A: Due Sunday EOD</p> <p>-Quiz 10 Chapter 10 due Sunday EOD</p> <p>-Critical Thinking Question (Due Beginning of class each week)</p>	<p>Chapter 10</p>
<p>May 11-17</p>	<p>Chapter 11: Human and Ecosystem Vulnerabilities to Climate Change</p> <p>-Investigation Manual 11A: Due Sunday EOD</p> <p>-Quiz 11 Chapter 11 due Sunday EOD</p> <p>-Critical Thinking Question (Due Beginning of class each week)</p>	<p>Chapter 11</p>

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May 18-24	Chapter 12: Climate Change Mitigation and Energy Use -Investigation Manual 12A: Due Sunday EOD -Quiz 12 Chapter 12 due Sunday EOD -Critical Thinking Question (Due Beginning of class each week)	Chapter 12
May 25-31	-Powerpoint Presentations	
June 1-7	-Powerpoint Presentations	
June 8-12	Final's Week	Final's Week

Possible COMET module studies:

Met ED

Operated by the COMET Program

The Cooperative Program for Operational Meteorology, Education and Training (COMET) was established by the University Corporation for Atmospheric Research (UCAR) and the National Weather Service to promote the teaching of meteorological topics to professionals as well as students. Interactive educational materials dealing with meteorology and related sciences are available through COMET's MetEd website.

MetEd provides online learning materials for students, professionals, professors, and weather enthusiasts in weather, climate and unique forecasting applications. We have selected several modules to accompany each textbook chapter that can be used as a supplemental learning activity in the classroom. These modules can be incorporated into your class, or used as an additional learning opportunity for the advanced student. Many of the subjects discussed in the modules take an in-depth look at topics introduced in the text and are presented at an advanced level.

Many of the exercises include a quiz at the conclusion of the module. These quizzes offer challenging, multiple choice questions and require a passing score. Student's scores are revealed at the conclusion of the quiz, allowing them to view the questions they incorrectly answered. The score is then emailed to the email address chosen for registration. If desired, quiz scores may also be emailed to the professor. This can be arranged during registration and requires the student to have the professor's email address. Quizzes may be taken multiple times until a passing grade is received.

To view and use the COMET modules, you must first register with MetEd. Website registration is free of charge but requires the use of an email address. Please visit <http://www.meted.ucar.edu/> to register. Locate the "Resources" section on the homepage, and then choose "Accounts/Registration". Click "Register Now" to begin registration.

MetEd Website: <http://www.meted.ucar.edu/>

For more information on UCAR, please visit: <http://www.ucar.edu/>

For more information on COMET, please visit: <http://www.comet.ucar.edu/>

CHAPTER 1: *Earth's Climate as a Dynamic System*

To view and use the COMET modules, you must first register with MetEd. Registration is free at <http://www.meted.ucar.edu/> by clicking on the Sign Up button.

- “Introduction to Climatology”

<http://www.meted.ucar.edu/afwa/climo/intro/>

“Introduction to Climatology” provides information on climate, the factors that govern it, and sources and uses of climate information. Begin with the *Overview* section and work through the *Wx vs. Climate* and *Climatology* sections to review concepts covered in the *Modes by Which Climate is Defined* section of Chapter 1.

- “Climate Change and Regional Impacts”

https://www.meted.ucar.edu/training_module.php?id=972%3E

If you're interested in where we're heading this semester, here's a sneak peek. This short module is an overview of the different effects climate change produces in different regions of the United States and touches on many of the subjects we'll explore. In addition to discussing impacts already being experienced, the module presents information on how climate scientists use specialized models and statistical techniques to estimate how regional climates are likely to change in the future. Recognize, however, that some references in this module are a bit older than those in the textbook, since it was written later.

CHAPTER 2: *Observing Earth's Climate System*

To view and use the COMET modules, you must first register with MetEd. Registration is free at <http://www.meted.ucar.edu/> by clicking on the Sign Up button.

- “Climate Change: Fitting the Pieces Together”

<http://www.meted.ucar.edu/broadcastmet/climate/index.htm>

Topics in this module include causes of climate change, factors that influence climate, evidence of change, climate models and data, and the overall effects of a changing climate. Begin the module and select the *How Do We Know?* tab along the top menu. Under *The Experts*, click on *IPCC* to review information about the IPCC. This will supplement the ‘*How observations of Earth’s climate system are used and by whom*’ section of Chapter 2. Move on to the *Tools: Models* section to review climate models which are introduced toward the end of Chapter 2.

- “Introduction to Climate Models”

https://www.meted.ucar.edu/training_module.php?id=913

This module explains how climate models work. Because the modeling of both weather and climate share many similarities, the content throughout this module draws frequent comparisons and highlights the differences. Chapter 2 explains not only how, but why climate models differ from weather models. To do this, the chapter explores the difference between weather and climate and then explains how models are built to simulate climate and generate the statistics that describe the climate system. The chapter concludes with a discussion of how models are tuned and tested.

- “Jason-2: Using Satellite Altimetry to Monitor the Ocean”

https://www.meted.ucar.edu/training_module.php?id=534#.VD6BC0uRey

Remote sensing platforms are critical tools in monitoring the climate system. In Chapter 2, the Jason satellite missions are mentioned numerous times as an effective means of monitoring the ocean. This module explores how these observational data are useful in helping scientists understand the full scope of ocean processes as a part of Earth’s climate. This module also serves to augment the links for Jason-2 as listed in Topic in Depth 2.2 of the textbook.

CHAPTER 3: *Tools For Investigating Earth's Climate System*

To view and use the COMET modules, you must first register with MetEd. Registration is free at <http://www.meted.ucar.edu/> by clicking on the Sign Up button.

- “Introduction to Statistics for Climatology”

https://www.meted.ucar.edu/training_module.php?id=500

This module duplicates some of the basic statistical procedures outlined in Chapter 3. It augments the textbook content in relation to the impacts of data quality on climatology products. While the module is more focused on applications to weather forecasting, the tools described are germane to the discussion and investigation of Earth's climate system. There are many more applications with sample data provided in this module that will help illuminate the content in Chapter 3.

- “Creating a Local Climate Product Using Composite Analysis”

<https://www.meted.ucar.edu/climate/composite/>

This module is a bit more advanced than the one above. It is designed for operational forecasters who wish to create or utilize a local climate product from local and regional observations using various statistical procedures. Many of the statistical comparisons involve the use of ENSO signals. From the given ENSO signal, sampling techniques are used to generate probabilities for a local region. While the module has a relatively narrow focus, it is a sound application of the content presented in Chapter 3 of the textbook. Instructors should have students thoroughly cover textbook content and the previous module on this page before assigning content from this module.

CHAPTER 4: *Radiation and Heat in the Climate System* To view and use the COMET modules, you must first register with MetEd. Registration is free at

<http://www.meted.ucar.edu/> by clicking on the Sign Up button.

- “Basic Weather Processes”

<http://www.meted.ucar.edu/fire/s290/unit4/>

This module provides background information on basic weather processes, and most importantly for this chapter, information on the Earth-Sun radiation budget and Earth’s heat balance. Work through the *Temperature* section to touch on various topics discussed in Chapter 4. (This module was created for the Wildland Fire Behavior Course. Aspects of the module relating to fire weather do not need to be reviewed unless assigned by your instructor.)

- “Nighttime Radiation and Cooling of the Lower Atmosphere”

https://www.meted.ucar.edu/training_module.php?id=1074

This module is not as comprehensive as others, but does provide a specific application of radiation laws to a common atmospheric process. More importantly, it provides an interactive tool to elaborate on content from Chapter 4 in identifying the role radiation plays in nighttime cooling. The interactive tool allows the student to modify controls on climate like emissivity and temperature. In this manner, the student should be better able to comprehend the role of radiation in diurnal heating and cooling.

CHAPTER 5: *Water in Earth's Climate System* To view and use the COMET modules, you must first register with MetEd. Registration

is free at <http://www.meted.ucar.edu/> by clicking on the Sign Up button.

- “Understanding the Hydrologic Cycle”

<http://www.meted.ucar.edu/hydro/basic/HydrologicCycle/>

This module provides a detailed explanation of the water cycle and its components, transfer processes, and distribution of water. Select desired topics from the menu on the left hand side of the screen to take a more in-depth look at topics introduced in *The Global Water Cycle* section of Chapter 5. Interactive questions conclude each of the different sections. Printable summaries of each section are available in the *Module Summary* section of the module.

- "Snowmelt Processes: International Edition"

http://www.meted.ucar.edu/hydro/basic_int/snowmelt

Snowmelt is an integral component of the hydrologic forecasting process in many parts of the world. For flood forecasting, the spatial and temporal evolution of the snowpack, the speed at which it melts, and the impact from the water released are very important. This module examines the influences of environmental conditions on snow distribution and snowpack characteristics. It also investigates energy exchanges between the snow and atmosphere, and how those exchanges affect the rate of snowmelt. Finally, the fate of snowmelt water after it reaches the ground is discussed.

- “Preparing Hydro-climate Inputs for Climate Change in Water Resource Planning”

https://www.meted.ucar.edu/training_module.php?id=959

This module is slightly more rigorous than other introductory modules on this list, but it applies some recent climate model output specifically to hydrologic applications. Both past and future scenarios are presented, as the content herein ties in with other climate change discussions. Both pre-assessment and post-assessment activities are available in this module for the instructor to use at his/her discretion. Finally, other related (re: background) MetEd modules are referenced at multiple points in this module.

- “An Introduction to the Downscaled Climate and Hydrology Projections Website”,

https://www.meted.ucar.edu/training_module.php?id=1104

This resource is not a typical MetEd module, as it takes the student to external video sources, focusing on

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the application of NOAA hydrologic products. It is a shorter module, with slightly advanced topics relative to the topics introduced in Chapter 5. The resources provided herein might be helpful to students more interested in hydrologic issues in climate science. It also has overlapping content to the “For Further Exploration” in Chapter 5.

- “Flow Interaction with Topography”

<http://www.meted.ucar.edu/mesoprim/flowtopo>

This module takes an advanced look at the wind’s interaction with topography. Orographic lifting is introduced in Chapter 5 in the *Mechanisms of Cloud Formation* section. Having some background knowledge in physics may help students to comprehend this module.

CHAPTER 6: *Global Atmospheric Circulation* To view and use the COMET modules, you must first register with MetEd. Registration

is free at <http://www.meted.ucar.edu/> by clicking on the Sign Up button.

- “Wind Systems”

<http://www.meted.ucar.edu/fire/s290/unit7>

This module explores wind systems and is divided into five chapters. Review the first chapter, *Intro and General Winds*, to learn more about wind, wind direction, and general wind processes. Move on to other chapters if desired. (This module was created for the Wildland Fire Behavior Course. Aspects of the module relating to fire weather do not need to be reviewed unless assigned by your instructor.)

- “Topics in Dynamic Meteorology: Pressure Gradient Force”

https://www.meted.ucar.edu/training_module.php?id=1024

One of the first concepts conveyed in Chapter 6 is that of the pressure gradient force, which is a primary factor in atmospheric circulation. This module, while brief, provides specific applications of PGF with interactive tools, allowing the student to manipulate various parameters affecting PGF. More complex equations are provided to the advanced student but should not dissuade introductory students from understanding the concepts.

- “Satellite Feature Identification: Blocking Patterns”

http://www.meted.ucar.edu/norlat/sat_features/blocking_patterns/index.htm

This module defines and describes various blocking patterns and their associated weather. Questions are presented and example satellite images are shown for each blocking pattern type. This module can be used to supplement the *Blocking Patterns and their Effects* section of Chapter 6.

- “Thermally-forced Circulation II: Mountain/Valley Breezes”

<http://www.meted.ucar.edu/mesoprim/mtnval/index.htm>

Information on slope and valley winds is presented in this module. Diagrams in the module display how these winds form and dissipate. This module can be used to supplement the *Monitoring Wind Circulations* section of Chapter 6.

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- “Topics in Lake Effect Snow Forecasting”

http://www.meted.ucar.edu/norlat/snow/lake_effect/

This module reviews the conditions necessary for the formation of lake effect snow, describes the banding process, and discusses detection of lake effect snow and ocean effect snow by satellite. Work through desired sections of the module to augment on the *Monitoring Wind Circulations* section of Chapter 6 as an example of mesoscale circulations.

- "Forecasting Dust Storms v2"

<http://www.meted.ucar.edu/mesoprim/dust>

This module explains dust storm processes by analyzing examples of dust storms from around the world, focusing primarily on Southwest Asia and the Middle East. Regardless of location, though, the lessons can be applied to any region of the world given some knowledge of local climatology and dust source regions.

CHAPTER 7: *Atmosphere-Ocean Relationships* To view and use the COMET modules, you must first register with MetEd. Registration

is free at <http://www.meted.ucar.edu/> by clicking on the Sign Up button.

- “Introduction to Ocean Currents”

<http://www.meted.ucar.edu/oceans/currents/>

This module examines various aspects of ocean currents in terms of their location, origin, characteristics, role in the Earth’s heat budget, and current forecasting methods. Introduced at the end of Chapter 4 in the section entitled *Heat Transport by Ocean Circulation*, ocean currents help redistribute heat poleward and are an important player in atmospheric circulation. Measurement techniques, such as satellite, radar and buoys, and data products are also discussed. Work through the *Wind-driven Currents*, *Ekman Spiral* section to review properties of the Ekman Spiral. Continue to the *Surface Current* section where it explains characteristics of gyres and work through desired topics. Review the *Upwelling* section of the module to accompany the *Upwelling and Downwelling* section of the text.

- “Climatology for the Operational Forecaster”

https://www.meted.ucar.edu/training_module.php?id=1028

This module, while generally geared toward weather forecasters, actually has very specific climatological applications to naval operations in the open ocean. It would be an ideal module for students with military experience or training so as to better understand how climate tools and observations are useful for the U.S. Navy. There are many connections herein relating to ocean processes described in Chapter 7 of the textbook.

- “The El Niño-South Oscillation (ENSO) Cycle”

<http://www.meted.ucar.edu/climate/enso/>

This lecture provides information on the ENSO cycle, its global impacts, and ways the ENSO cycle is monitored. The impacts of El Niño and La Niña on weather and climate are discussed using maps and graphics to explain temperature and precipitation patterns. Each section is broken up into various pages, allowing you to review specific topics. This module should be used to supplement the *El Niño, La Niña, and the Southern Oscillation* section of Chapter 7.

- “Thermally-forced Circulation I: Sea Breezes”

<http://www.meted.ucar.edu/mesoprim/seabreez/index.htm>

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This module describes the formation of a sea breeze, a sea breeze front, and discusses changes that occur as a result of a sea breeze throughout the day. A case study is also presented. This module can be used as a specific supplement the *Air- Sea Interaction* section of Chapter 7.

CHAPTER 8: *Natural and Anthropogenic Drivers of Climate Change*

To view and use the COMET modules, you must first register with MetEd. Registration is free at <http://www.meted.ucar.edu/> by clicking on the Sign Up button.

- “Space Weather Basics, 2nd Edition”

<http://www.meted.ucar.edu/spaceweather/basic/>

This module discusses space weather and the processes that create space weather events. Use page 6 of the module, *Sunspots and Solar Cycles*, to learn about sunspots and sunspot activity.

- “Climate Variability and Change Lectures, July 2013”

https://www.meted.ucar.edu/training_module.php?id=1034

This is not a traditional module in the MetEd format, but is rather a series of video lectures from renowned scientists, or preeminent researchers. The topics are varied but focus on the variability and changes in the climate system. It is recommended that the instructor review the list of lectures and determine which best fits the manner by which they utilize the materials in Chapter 8.

CHAPTER 9: *Paleoclimatic Investigations: Relevancy to the Present State of Climate*

To view and use the COMET modules, you must first register with MetEd. Registration is free at <http://www.meted.ucar.edu/> by clicking on the Sign Up button.

- “Climate Change: Fitting the Pieces Together”

<http://www.meted.ucar.edu/broadcastmet/climate/index.htm>

Topics in this module include causes of climate change, factors that influence climate, evidence of change, climate models and data, and the overall effects of a changing climate. Begin the module and select the *How do we know?* tab along the top menu. Under *Tools: Data*, review the *Paleoclimate* section to accompany various sections of Chapter 9.

- “Understanding Drought”

http://www.meted.ucar.edu/climate/drought/print.htm#p2_5

While this module is focused on the climate connection to drought, there is a specific section (linked above) which provides insight on the paleoclimatic evidence for drought in the climate record. It is not an exhausting set of resources herein, but does match well with some content presented in Chapter 9.

CHAPTER 10: *Future Projections and Extremes of Climate*

To view and use the COMET modules, you must first register with MetEd. Registration is free at <http://www.meted.ucar.edu/> by clicking on the Sign Up button.

- “Mesoscale Convective Systems: Squall Lines and Bow Echoes”

<http://www.meted.ucar.edu/convectn/mcs/>

This module investigates the features and formations of Bow Echoes, Squall Lines, and Mesoscale Convective Complexes (MCCs). Click “Launch MCS” on the module homepage to begin the module. Next, choose *Conceptual Modules* in the menu on the left-hand side of the screen to explore Squall Lines, Bow Echoes, and MCCs.

- “Flash Flood Processes”

<http://www.meted.ucar.edu/hydro/basic/FlashFlood/>

In Chapter 10, flooding is mentioned most frequently in the *Hurricane Hazards* section. This module provides a proper definition of a flash flood and it identifies its broader characteristics. The module also describes the hydrologic influences on flash floods, specifically soil and basin influences. The module also introduces Flash Flood Guidance, a product used by the National Weather Service.

- “Hurricane Features” (Part of “Remote Sensing Using Satellites”)

<http://www.comet.ucar.edu/nsflab/web/hurricane/index.htm>

Properties of hurricanes such as formation, winds, storm surge, and classification are reviewed in this module. Hurricane structure is also discussed, focusing on the eye, eye wall, and spiral bands. The module concludes with a section on the use of satellites in tracking and monitoring hurricanes.

- “Climate Change and Extreme Weather”

https://www.meted.ucar.edu/training_module.php?id=973

This module discusses how a changing climate can also lead to changes in extreme weather events on the local scale. The role of natural variability is also explained. The module describes how climate change can have both positive and negative effects, depending on the situation, location, and the vulnerability of the population, as well as, what changes are likely if greenhouse gas emissions continue to rise.

CHAPTER 11: *Human and Ecosystem Vulnerabilities* To view and use the COMET modules, you must first register with MetEd. Registration

is free at <http://www.meted.ucar.edu/> by clicking on the Sign Up button.

- “Climate Change and Sea Level Rise”

https://www.meted.ucar.edu/training_module.php?id=974

This topic was introduced in Chapter 7 but in Chapter 11 the vulnerabilities tied to sea-level rise are further examined. This module not only elaborates on the processes by which sea-level rises are due to changes in the climate system but also how communities are preparing for such heightened vulnerabilities. Multiple methods of mitigation and adaptation are presented herein.

- “Sea Ice and Products and Services of the National Ice Center”

<http://www.meted.ucar.edu/oceans/seaice/>

This module explores physics of sea ice, such as how heat is lost from water, the development and crystal formation of sea ice, the stages of sea ice melting and how winds and currents along with sea ice drift. Types of ice are defined in structure, formation and melting. This module could also be used to supplement content from Chapter 7 since there are direct connections to the ocean’s role in the climate system.

- “Arctic Ecosystems”

http://www.meted.ucar.edu/oceans/arctic_ecology/index.htm

One particularly vulnerable ecosystem, as described in Chapter 11 is the Arctic. This module provides a greater depth of discussion relating marine environments in the Arctic and the potential impacts a changing climate is having and will have on a further warming climate system. While the full module is no longer supported by MetEd, the link above allows for students and instructors to still gain access to the resources provided herein.

- “Climate Change and Regional Impacts”

https://www.meted.ucar.edu/training_module.php?id=972

This module focuses on regional trends in a changing climate, specifically the U.S. Besides describing these changes by region, the module also focuses on what future impacts may occur in those same areas. As noted in Chapter 11, different areas of the world are differently vulnerable to the impacts of a changing climate. The same can be said in the U.S., as this module elucidates some of those projected vulnerabilities.

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- “The Amazon Rain Forest and Climate Change”

https://www.meted.ucar.edu/training_module.php?id=556

A main topic in Chapter 11 is the vulnerability of forest ecosystems to a changing climate. In particular, tropical rainforests serve as vast reserves of carbon and reservoirs in the carbon cycle. Their importance in the biosphere cannot be overstated. This MetEd module focuses on the impacts associated with tropical deforestation. Moreover, the UN-REDD program, mentioned in Chapter 11 is addressed in greater detail within this module.

CHAPTER 12: *Climate Change Mitigation and Energy Use*

To view and use the COMET modules, you must first register with MetEd. Registration is free at <http://www.meted.ucar.edu/> by clicking on the Sign Up button.

- “Climate Change: Fitting the Pieces Together”

<http://www.meted.ucar.edu/broadcastmet/climate/index.htm>

Topics in this module include causes of climate change, factors that influence climate, evidence of change, climate modules and data, and the overall effects of a changing climate. Begin the module by choosing the *Introduction* section on the module homepage. Work through the tabs at the top of the module to explore various questions and topics concerning climate change. It is recommended, however, that instructors focus their attention on the “*What’s Next?*” section, where many topics from Chapter 12 are addressed. Chapter 12 provides a more comprehensive discussion on energy, but this module places these issues in a more concise context.

CHAPTER 13: *Human Needs, Actions and Public Policy*

To view and use the COMET modules, you must first register with MetEd. Registration is free at <http://www.meted.ucar.edu/> by clicking on the Sign Up button.

- No modules for this chapter.

CHAPTER 14: *Climate Studies as a Scientific Endeavor in a Changing Society*

To view and use the COMET modules, you must first register with MetEd. Registration is free at <http://www.meted.ucar.edu/> by clicking on the Sign Up button.

- “Coastal Climate Change: Communicating Climate Science”

<https://www.meted.ucar.edu/climate/coastalclimate/navmenu.php?tab=6&page=1.0.0>

While there is no complete module dedicated to the topics addressed in Chapter 14 of the textbook, this one section imbedded within the Coastal Climate Change Module (also listed in Chapter 7) provides some overlap with Chapter 14. Specifically, the Chapter 14 section on *Discourse in Media* matches some specific content relating the proper communication of science. Part of this module provides specific communications strategies that serve to augment the brief description of the communications problems outlined in the textbook.

-“Welcome, Broadcast Meteorologists!”

<http://www.meted.ucar.edu/communities/broadcastmet/index.php>

Chapter 14 mentioned the important role broadcast meteorologists play in communicating climate science and climate change concepts. As mentioned above, there is no specific MetEd module for the broadcaster’s role in communicating climate science but this resource page centralizes some resources for students in helping them understand the vast set of responsibilities broadcasters have assigned to them in their role as ‘station scientist.’ The instructor is recommended to find specific links from this resource page that best fit their specific application of Chapter 14.