EMBRY-RIDDLE AERONAUTICAL UNIVERSITY
Applied Aviation Sciences Department
WX 381: Climate Dynamics
Spring 2020: 3 Credits
MWF 2–2:50 p.m.
CoA 353

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Office Hours: MWF 12–2 p.m., 4–5 p.m.; TuTh noon–2 p.m., 3:30–5 p.m.; by appt or just stop by

Prerequisites: WX 261, WX 368, WX 375

Course text (REQUIRED): Global Physical Climatology (2nd edition), D. L. Hartmann (2016)
https://www.amazon.com/Global-Physical-Climatology-Dennis-Hartmann/dp/0123285313

Course Objectives

- Achieve a qualitative and quantitative understanding of the physical and dynamic processes of the climate, climate variability, and climate change.
- Understand the atmospheric general circulation and global climatology of the climate system.
- Gain a basic understanding of the causes of and processes associated with natural climate oscillations and teleconnections such as El Nino-Southern Oscillation (ENSO), Arctic Oscillation (AO), Madden-Julian Oscillation (MJO), etc.
- Understand how atmospheric teleconnections can be applied to seasonal weather forecasting.
- Understand climate sensitivity and feedback mechanisms
- Understand how climate models work and differ from numerical weather prediction models.
- Develop a foundation of observational evidence and impacts of climate change, including a review of the most recent Intergovernmental Panel on Climate Change (IPCC) report.

Learning Outcomes:
During the course the student will, to the satisfaction of the instructor:

1. Qualitatively and quantitatively understand the general circulation and global climatology of the climate system, as well as the underlying driving mechanisms for each.
2. Apply physical and dynamical reasoning to explain the causes of internal climate variability (including teleconnections such as ENSO, MJO, NAO, etc.)
3. Describe the role of ocean-atmosphere coupling with emphasis on the theoretical basis and impacts of ENSO and the MJO.
4. Understand the utility of teleconnections to seasonal and intra-annual forecasting.
5. Conceptualize and explain climate sensitivity and feedback mechanisms.
6. Apply physical reasoning to understand the processes and mechanisms responsible for anthropogenic climate change and the associated sources of uncertainty.
7. Explain the differences between climate models and numerical weather prediction models, explain why there are uncertainties in climate predictions, and describe how climate predictions can be verified.
8. Gain quantitative and qualitative understanding of current and future climate assessments and projections using the most recent IPCC report.

Grading

- **Assignments (Article Reviews, HW, In-Class Lab Exercises):** 30%
- **Midterm Exam:** 20%
- **Teleconnections Project/Presentation:** 25%
- **Cumulative Final Exam**: 25%
- **Attendance will affect your grade in the following ways:**

0 unexcused absences	+2.0% to final grade
1 unexcused absence	+1.5% to final grade
2 unexcused absences	+1.0% to final grade
3-6 unexcused absences	+0% to final grade
> 6 unexcused absences	**Loss of full letter grade**

- **Final grades*: Strictly*** rounded to the nearest whole degree, i.e., 89.5 = "A," but an 89.4 = "B." Your attendance record is intended to be the discriminator for borderline grades.

A	**90-100**
B	**80-89**
C	**70-79**
D	**60-69**
F	**59 or below**

Assignments

- You will have a total of **6–9 assignments over the course of the semester**. A few are intended to be completed in small groups while in class.
- Assignments will consist of a combination of qualitative and quantitative questions and are intended to help prepare you for the types of questions on the exams.

Project Presentation

- **In groups of 2 (one group of 3),** select an **atmospheric teleconnection** (ENSO, AO, MJO, etc.).
- Choose a **high-impact weather/climate event or time period** (i.e., month, season) during which your teleconnection played a major role in and/or was strongly correlated with your event.
- Prepare a **12–15-minute oral presentation** on your case**.**
- Presentations will take place the **last two days of class (Mon. 4/20 and Wed. 4/22)**
- I will provide you with specific instructions and a grading rubric **just before Spring Break**.

Exams

- **Both exams** will be a combination of multiple choice, conceptual short-answer questions, and quantitative questions.
- **Study guides** will be posted on Canvas and review sessions will be held before each exam.
- The final exam will be **cumulative**, but **weighted towards material after the midterm.**

Course Website

The course website is on Canvas; to use it, go to https://erau.instructure.com/. Class announcements will be posted on this class's web site. **I will post any lecture PowerPoints and supplemental material at the latest NIGHT BEFORE each class at the latest.** I will also post exam study guides on Canvas.

Climate/Teleconnection Links

Any climate/teleconnection links you have ever wanted (and those you've never wanted!), including forecasts, are available on my website http://www.shawnmilrad.com/forecast/#climate. **Please explore!**

Class Policies

1. **Seven or more unexcused absences** will result in an automatic **loss of one full letter grade**.

2. Students must submit each excused absence in writing (email is acceptable) prior to the start of class (with the obvious exception of extreme personal or family medical emergencies). Illnesses extending more than one class period require documentation from the university health clinic or other medical professional. University-sponsored events require written documentation. Examples of valid excuses are: illness, medical emergency, university-sponsored academic, professional or ERAU athletic events. Oversleeping, personal vacations, club events are not valid excuses.

3. **Please be on time.** If you are more than 10 minutes late, it may be counted as an unexcused absence.

4. Late homework will be docked one full letter grade (10%), unless the absence is excused in advance. Unexcused homework and labs over 1 class period late will not be accepted.

5. Make-up exams will not be given except for excused absences. Obtain verified excused absences from Health Services (7917) or Student Services Office (6326).

6. Academic dishonesty will not be tolerated. Academic dishonesty could result in dismissal from the University.

7. If you have any difficulties or special needs that hinder your learning in the class, please see me about providing accommodations needed to overcome your difficulties.

9. **CELL PHONES:** During class, please turn all cell phones to vibrate or silent, and please **refrain from checking E-mail, Facebook, Instachat, Snapface, Tick Tock, etc. during class.**

10. **COMPUTER USAGE:** Computers are only to be used for labs or following along with lectures. **During class, please refrain from checking/using E-mail, text message, Facebook, Instachat, Snapface, Tick Tock, and any other chat/messaging apps that I am too old to be aware of.**

11. **PERSONAL CONVERSATIONS**: Except during labs or when directed by the instructor, personal conversations are prohibited during class, including cell phone conversations.

Course Outline:

Here is a list of course topics in the approximate order that they will be covered. **Exam and project presentation dates are in bold.** Dates are subject to change slightly, as necessary.

- Global Climatology (Textbook Chapters 1 & 5 + Notes)
  - Atmosphere, Hydrological Cycle, Cryosphere
- Global Energy Balance Part I (Textbook Chapter 2)
  - Incoming solar and outgoing longwave energy
  - Top of the atmosphere energy balance
- Radiative Processes and Heat Transfer (Textbook Chapter 3)
  - Selective emission and absorption
  - Natural greenhouse effect
  - Impacts of clouds on climate system
- Global Energy Balance Part II (Textbook Chapter 4)
  - Surface albedo
  - Sensible and latent heat fluxes
  - Surface energy balance and variations
- Atmospheric General Circulation (Textbook Chapter 6)
  - Meridional transport
  - Hadley circulation
  - Monsoon circulations
- Ocean General Circulation (Textbook Chapter 7)
  - Ocean properties
  - Mixed Layer
  - Ekman spiral and dynamics
  - Thermohaline circulation
- **Midterm Exam: Wednesday 3/4, in class**
- Natural Variability and Atmospheric Teleconnections (Textbook Chapter 8 + Notes)
  - El Nino-Southern Oscillation (ENSO)
  - Pacific-North American (PNA) Pattern
  - Arctic Oscillation (AO), North Atlantic Oscillation (NAO), and the Polar Vortex
  - Pacific Decadal Oscillation (PDO) and Atlantic Multidecadal Oscillation (AMO)
  - Madden-Julian Oscillation (MJO)
- Climate Sensitivity and Feedbacks (Textbook Chapter 10)
  - Sensitivity
  - Radiative and cloud feedbacks
  - Ice-albedo feedback
- Climate models (Textbook Chapter 11)
  - Climate models vs. numerical weather prediction (NWP) models
  - Model components
  - General Circulation Models (GCMs)
- Observations, Impacts, and Projections of Climate Change (Textbook Chapter 13 + Notes)
  - IPCC report
  - Climate change and extreme weather events
- **Project Presentations: Monday 4/20 and Wednesday 4/22, in class**
- **Final Exam: Take-home assigned Thursday 4/23, due Tuesday 4/28 by 5 pm**