ATMO 706: Tropical Climate Dynamics and Modeling

Spring 2020, Monday & Wednesday 12:30-13:45pm, HIG 310

Instructor: Tim Li, POST 409B, Phone: 956-9427, Email: timli@hawaii.edu

Student Learning Objectives (SLOs):

Upon completion of the course, the student should be able to:
1. Demonstrate a familiarity with the basic equatorial wave dynamics and simple atmospheric and oceanic model framework.
2. Understand the mechanisms of the earth's tropical climate mean state and annual variation.
3. Describe and explain the origin, structure and evolution behaviors of the MJO.
4. Understand the synoptic and climatic aspects of tropical cyclone formation.
5. Have a basic understanding of the ENSO growth, oscillation, phase locking processes and its interaction with other climate modes.
6. Understand the basic concept of the monsoon and its interannual variability.

Prerequisites:

ATMO 600, or consent of the Instructor.

Course outline:

I. Equatorial wave theory and simple tropical atmospheric and oceanic models
1. Equatorial wave dynamics
2. The Gill model
3. The Lindzen-Nigam model
4. The Cane-Zebiak model
5. A 2.5-layer atmospheric model
6. A 2.5-layer oceanic model

II. Climate mean state: ITCZ asymmetry and annual cycle
1. Observations
2. Mechanisms for ITCZ asymmetry
3. Meridional wind – SST – upwelling feedback
4. Evaporation – SST – wind feedback
5. Stratus cloud – radiation – SST feedback
6. Role of land-ocean and coastal distribution
7. Mechanisms for annual cycle at the equator

III. Madden-Julian Oscillation (MJO)

1. Planetary scale selection
2. Eastward propagation mechanism
3. Initiation mechanism
4. Boreal summer intraseasonal oscillation: northward propagation mechanism
5. Role of air-sea interaction
6. Interannual variability

IV. Tropical cyclones and synoptic-scale variability

1. Synoptic precursors of tropical cyclone (TC) genesis
2. Origins of the synoptic-scale wave train
3. Energy source of easterly waves in western Pacific
4. Dynamics of TC genesis
5. Large-scale control of TC genesis by MJO and ENSO
6. TC change under global warming
7. Interaction between synoptic-scale motion and MJO

V. El Nino – Southern Oscillation

1. Instability theories
2. Oscillation mechanisms
3. El Nino and La Nina amplitude asymmetry
4. El Nino and La Nina duration asymmetry
5. Indian Ocean dipole (IOD) theory
6. ENSO interaction with higher-frequency motions
7. Modulation of El Nino types by the interdecadal mean state
8. Future projection of ENSO under global warming

VI. Monsoon

1. Monsoon concept and climatology
2. Quasi-biennial and lower-frequency variability of the monsoon
3. Tropospheric biennial oscillation (TBO)
4. ENSO – Indian monsoon relation
5. ENSO – East Asian monsoon relation
6. ENSO inter-basin teleconnection

Main Text Book:

Li, T. and P. Hsu: Fundamentals of Tropical Climate Dynamics. Springer, 2017

Grading Policy:

Class participation of discussion: 30%, attendance: 20%, final exam: 50%.

Title XI Statement:

The University of Hawai'i is committed to providing a learning, working and living environment that promotes personal integrity, civility, and mutual respect and is free of

all forms of sex discrimination and gender-based violence, including sexual assault, sexual harassment, gender-based harassment, domestic violence, dating violence, and stalking. If you or someone you know is experiencing any of these, the University has staff and resources on your campus to support and assist you. Staff can also direct you to resources that are in the community. Here are some of your options:

As members of the University faculty, your instructors are required to immediately report any incident of potential sex discrimination or gender-based violence to the campus Title IX Coordinator. Although the Title IX Coordinator and your instructors cannot guarantee confidentiality, you will still have options about how your case will be handled. Our goal is to make sure you are aware of the range of options available to you and have access to the resources and support you need.

If you wish to remain ANONYMOUS, speak with someone CONFIDENTIALLY, or would like to receive information and support in a CONFIDENTIAL setting, use the confidential resources available here:

http://www.manoa.hawaii.edu/titleix/resources.html#confidential

If you wish to directly REPORT an incident of sex discrimination or gender-based violence including sexual assault, sexual harassment, gender-based harassment, domestic violence, dating violence or stalking as well as receive information and support,

contact: Dee Uwono Title IX Coordinator (808) 956-2299 t9uhm@hawaii.edu.