Version: Tuesday, August 22, 2023

ATS 602
Atmospheric Dynamics II
Course Syllabus for Fall 2023

Instructor:

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room: ATS 430
Office hours: Tuesday 10:00-11:00 AM or by appt.

Meeting times:

Tuesday, Thursday 9:00-9:50 AM, ATSW 121

Resources (all are available free via CSU libraries and the links below):

- Holton, J. R. and G. J. Hakim, 2013: An Introduction to Dynamic Meteorology, 5th Edition, Academic Press
https://www.sciencedirect.com/book/9780123848666/an-introduction-to-dynamic-meteorology

- Vallis, G. K., 2017: Atmospheric and Oceanic Fluid Dynamics, Cambridge University Press. 2nd edition.
http://empslocal.ex.ac.uk/people/staff/gv219/aofd/

- Hoskins, B. J. and James, I. N., 2014: Fluid Dynamics of the Mid-Latitude Atmosphere. Wiley.
https://www.wiley.com/en-us/Fluid+Dynamics+of+the+Mid+Latitude+Atmosphere-p-9780470795194

- Held, I. M., 2000: The general circulation of the atmosphere
https://www.gfdl.noaa.gov/wp-content/uploads/files/user_files/ih/lectures/woods_hole.pdf

Evaluation:

Evaluation consists of two parts: HW and developing a research paper.

The paper should include novel analyses of the dynamical processes covered in class using, for example, ERA5. The paper should be ~4-6 figures and roughly 3 pages of single spaced text. Ideally, it will integrate analyses of large-scale dynamics based on observations with your research interests.

The "midterm" assessment will be based on the introduction/motivation and proposed framework for the project.

The "final" assessment will be based on the completed research project.

Homework: 40%
Midterm project proposal:
Introduction/motivation/proposed framework for research paper: 20%
Final project:

Complete research paper: 40%

Focus:

Atmospheric dynamics constitutes a branch of the larger field of geophysical fluid dynamics which itself is embedded in the general field of fluid mechanics. Geophysical fluid dynamics is focused on understanding the underlying mechanisms of atmospheric and oceanic motion over a vast range of spatial and temporal scales. Much of the study of geophysical fluid dynamics requires simplifications to the underlying physics, but much can be gained by studying such simplified systems. In fact, many of the conclusions drawn from these simplified systems carry-over directly to the real atmosphere/ocean.

This course follows from ATS601.

General course outline:

1. Review of primitive equations / the QG approximation
2. The conventional Eulerian mean
3. The transform Eulerian mean
    - The Eliassen-Palm flux
8. Eulerian and TEM perspectives of large-scale extratropical dynamics
    - The climatological mean circulation
    - Tropospheric variability
4. Potential vorticity
    - The QG PV equation
    - PV inversion, conservation, and the height tendency equation
    - The QG omega equation
5. Baroclinic instability
    - The two-layer model; the Eady model
    - Baroclinic lifecycles
6. Frontogenesis
7. Equatorial wave theory
8. Stratospheric variability
    - Sudden stratospheric warmings
    - The QBO
9. Other topics
    - Frequency dependence and anisotropy
    - The extended Eliassen-Palm flux