ATS 601
Atmospheric Dynamics I
Course Syllabus for Fall 2024
(as of Tuesday, August 6, 2024)

Meeting times:
Tuesday, Thursday 10:00-10:50 AM, ATSW 121
(+ A few make-ups as indicated on the schedule)

Instructor:
David W. J. Thompson, davet@atmos.colostate.edu
Office hours: Tuesday 11:00-12:00 pm

TA:
Tyler Barbero, tbarbero@rams.colostate.edu
Office hours: Monday/Wednesday 1:00-2:00 pm

Programming TA:
Office hours: TBD

Resources (other than class notes)
Primary textbooks (both are available online via CSU libraries)
- Vallis, G. K., 2017: Atmospheric and Oceanic Fluid Dynamics, Cambridge University Press. 2nd edition. https://www.cambridge.org/core/books/atmospheric-and-oceanic-fluid-dynamics/41379BDDC4257CBE11143C466F6428A4
- Holton, J. R., 2004: An Introduction to Dynamic Meteorology, 4th Edition, Academic Press
  Available electronically via CSU libraries. Can be downloaded at:
  https://www.sciencedirect.com/bookseries/international-geophysics/vol/88

Evaluation:
- 3 exams: 50% (exams are equally weighted)
- Homeworks: 50% (HWs are equally weighted)

The exams will emphasize concepts covered in lectures. These include physical interpretation of the equations of motion, Lagrangian and Eulerian perspectives of fluid motions, scale analysis of the momentum equations, the Coriolis and centrifugal forces, geostrophic and hydrostatic balance, thermal wind, etc.

General 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. Many of the conclusions drawn from such simplified systems carry-over directly to the real atmosphere/ocean. The course covers the fundamentals of geophysical fluid dynamics with an emphasis on the atmospheric component.

In the class you will:
- apply vector calculus to derive the equations of motion on a fixed and rotating frame
- be able to physically interpret the equations of motion
- apply physical intuition into dynamical processes to the interpretation of observed and simulated variability

Course Web Page:
The course web site will be used for posting notes and homework assignments and providing additional resources. The course web site is available through Canvas.

General course outline:
1. General Mathematical Concepts
2. The Equations of Motion (from scratch)
   - Continuity
   - Momentum equations
   - Equation of state
   - Thermodynamic equation / Potential temperature
3. Earth's Rotation
   - Rotating framework
   - Coriolis effect; Centrifugal effect
   - Spherical coordinates
4. The Primitive Equations
5. Balanced Motion
   - Hydrostatic balance
   - Geostrophic balance
   - Thermal wind
6. Rotational Flow
   - Vorticity
   - Circulation
   - Vorticity equation
   - Local vorticity balance to thermal and orographic forcing
7. Rossby Waves
   - non-divergent, barotropic vorticity equation and its solution
   - Rossby wave dispersion relation
   - phase speed; group velocity
   - relationship between group velocity and momentum flux
   - Rossby waves and jet streams
   - Ray tracing
8. Shallow Water Models