ATMOSPHERIC DYNAMICS II (ATS 602, 2 credits)

Professor: Thomas Birner, Associate Professor, Department of Atmospheric Science

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Office Hours: quick questions right after class
for longer questions Fridays 1–3 pm, or by appointment

Graduate teaching assistants:

Louis Rivoire (louis.rivoire 'at' atmos.colostate.edu), Office: 406
TA Office Hours: Thursday 1–3 pm

Main Text: Lecture Notes

Highly Recommended Texts:

Vallis, G. K., 2006 (or later editions): Atmospheric and Oceanic Fluid Dynamics, Cambridge University Press (mainly Chapters 5-7)
Gill, A. E., 1982: Atmosphere-Ocean Dynamics, Academic Press
Cushman-Roisin, B., and J.-M. Beckers, 2011: Introduction to Geophysical Fluid Dynamics, 2nd Ed., Internation Geophysics Series, Academic Press
Pedlosky, J., 1987: Geophysical Fluid Dynamics, 2nd Edition, Springer-Verlag

Other Texts:

Salmon, R., 1998: Lectures on Geophysical Fluid Dynamics, Oxford University Press
Prof. Schubert's class notes (password protected) at http://schubert.atmos.colostate.edu/teaching/at601-2/at601-2_notes.html
Holton, J. R., 2004: An Introduction to Dynamic Meteorology, 4th Edition, Academic Press (or 5th Ed. Holton & Hakim 2012)

Classroom: ATS 101, Tue/Thu @ 10:00 am - 10:50 am

Class Website: http://birner.atmos.colostate.edu/ats602.html

Grading: Homework 80% (lowest HW problem score will be dropped)
(possibly a class project – will decide later in semester)
Final: ~30 min oral exam 20% (during Finals week)

At least 2 hours of effort are expected to complete readings and homework assignments outside of class for each hour of class time.

This course will adhere to the CSU Academic Integrity Policy as found on the Student' Responsibilities page of the CSU General Catalog and in the Student Conduct Code.

At a minimum, violations will result in a grading penalty in this course and a report to the Office of Conflict Resolution and Student Conduct Services.

Course Description

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 aims at understanding the underlying mechanisms of atmospheric and oceanic motion. This involves processes on a vast range of spatial and temporal scales. In almost all cases one has to strongly simplify the underlying physics using appropriate assumptions in order to be able to arrive at an understanding of particular types of motion. Yet, much can be gained by studying such strongly simplified systems. In fact, some of the conclusions drawn from simplified systems carry over directly to the real atmosphere/ocean. This course, part II of a two-semester sequence on atmospheric dynamics, provides fundamental theoretical insights into the dynamics of atmospheric flow patterns and their interaction with the general circulation. In most cases the treatment is general enough to be applied straightforwardly to oceanic problems.

Rough Course Outline:

✗ Observed Large-Scale Dynamics, PV-thinking & Invertibility (~2 weeks):

→ isentropic maps of potential vorticity (Hoskins et al. 1985)

→ fundamentals of PV (different coordinate systems, Ertel's PV principle)

→ invertibility, PV substance and impermeability

✗ Quasi-Geostrophic Dynamics (~4 weeks)

→ shallow water QG Rossby waves

→ scaling, Rossby number expansion

→ isentropic vs. pressure coordinates

✗ Baroclinic & Barotropic Instability (~4 weeks)

→ Phillips two-layer problem

→ Eady problem and counter-propagating Rossby waves

→ Charney problem

→ necessary conditions for baroclinic and barotropic instability

✗ Wave-Mean Flow Interactions (~3 weeks):

→ wave-mean flow interaction in the Eady & Charney problems

→ non-acceleration theorem in isentropic coordinates, diabatic overturning circulation

→ Transformed Eulerian Mean (TEM) equations

→ wave activity, Eliassen-Palm flux, group velocity property

✗ Miscellaneous Topics (~2 weeks):

→ equatorial wave theory

→ (time-permitting) semi-geostrophic dynamics

→ (time-permitting) vertically propagating Rossby waves and stratospheric dynamics