COURSE TITLE: Atmospheric Dynamics Spring, 2018
COURSE NUMBER: PHYS731, M & W, 1:00 – 2:15 pm, Rm 226 (Final day/time TBD)
INSTRUCTOR: Dr. Lynn Sparling (sparling@umbc.edu). ph: 301-741-6355
OFFICE HOURS: M-W 2:15 – 3:15 pm.

TEXTS: Holton, J. R. *Introduction to Dynamic Meteorology*, 4th ed., Academic Press, 2004 (required).
Reference texts: Vallis, G., *Atmospheric and Oceanic Fluid Dynamics*, Cambridge University Press, 2006; *Mid-Latitude Atmospheric Dynamics: A first course,* P. Martin
Other course material: papers and lecture notes

DESCRIPTION: Overview of conservation laws, principles of rotating stratified fluids, shallow water equations; basic fluid flows and approximations to the primitive equations; quasi-geostrophic dynamics of mid-latitude synoptic systems, mesoscale and local phenomena (hurricanes, sea breeze, topographic forcing), atmospheric waves, barotropic/baroclinic instability, boundary layer.

PRE-REQUISITES: PHYS621 is highly recommended. In lieu of that, either grad/undergrad course work in meteorology OR a strong mathematical background may be sufficient. Interested students who have not taken PHYS621 should come and talk to me.

Computational skills: Students should have some experience with Matlab, IDL, Python or other software that allows overplotting on global grids. I use IDL; for those interested, the free Gnu version GDL seems to have most of the required functionality. You can download GDL from http://gnudatalanguage.sourceforge.net/.

Relevant mathematics: vector & tensor calculus, geometry of a space curve, properties of vector fields, such as vorticity and divergence, partial differential equations, curvilinear coordinates, dispersion relations, index notation.

Required: Registration at the COMET MetEd site. Contains excellent tutorials.

GRADING: Homework/data analysis assignments (30%), midterm (25%), HW/lecture quizzes/Comet modules (20%); final research project & presentation (20%); class participation (e.g. Bb discussions) (5%).

Notes: Work on assignments that is sloppy/unreadable or without clear mathematical development/discussion (e.g. numbered equations) will be returned. I will require some assignments to be formatted in LaTex.

Post questions and discussion of homework problems to the Bb homework forums.

MAIN COURSE OUTLINE: (Subject to some rearrangement as necessary. Course lecture schedule will be posted on Bb).

Week 1-3: Review of relevant intro-level physics. Brief review of 621-level dynamics/thermo:
- Hydrostatic equation, scale height, geopotential, lapse rate, skew-T
- Equations for conservation of mass, energy and momentum for a rotating, stratified fluid
- Lagrangian and Eulerian reference frames
- Atmospheric stability, buoyancy.
- Geostrophic and cyclostrophic balance, thermal wind, gradient wind, adiabatic motion
- Equations of motion in pressure coordinates
- Baroclinic and barotropic stratification

Static stability and inertial stability
Potential vorticity
Gravity waves, Rossby waves, inertia-gravity waves, Kelvin waves
Geostrophic adjustment, deformation radius
Accessing and plotting data at NOAA/ESRL

Weeks 4-9:

Shallow water equations
Shallow water waves
Effect of rotation on shallow water waves
Shallow water potential vorticity
Two layer baroclinic instability
Barotropic and baroclinic instability
Energy considerations

Quasigeostrophic Dynamics
Fundamentals of synoptic meteorology
Omega equation, QG potential vorticity
Ageostrophic circulations
Polar and subtropical jet streams

Weeks 10-13:

Planetary boundary layer
Boundary layer processes: convective and shear induced turbulence, turbulent fluxes, entrainment, diurnal variations in PBL height, pollution trapping, control by synoptic scale processes, Reynolds decomposition, Ekman layer
Physical processes: that impact the atmosphere from below, soil moisture, vegetation, land-sea thermal contrasts
Selected mesoscale phenomena; low level jets, sea breezes, hurricanes
Mixing and transport

Weeks 14-end:

Brief intro to climatology; North American Oscillation (NAO), El Nino, climate change

Academic Integrity: Working together on HW is acceptable, but all submitted work should be your own. Cheating or plagirizing the work of others will not be tolerated.