2007 METR 4433 EXAM 1 Study Guide

1. Scale analysis and definition of scales

- Know the definition of mesoscale
- Be able to perform scale analysis on the atmospheric equations of motion. Know the typical magnitude and relative importance of terms in the equations for the corresponding scales.
- Know the methods for categorizing atmospheric motion into various scales, and the general characteristics of such motion.
- Know the role of mesoscale in the energy cascade processes in the atmosphere.
- Be able to give examples of atmospheric phenomena that fall into different scales.

2. Mountain waves and mountain-related phenomena

- Know the steps and procedures by which solutions of linear mountain waves in flows of constant Score parameter over a sinusoidal or bell-shaped mountain are obtained.
- When given mountain wave solutions, being able to discuss their properties and sketch the solution schematically
- Understand the role of the Score parameters, and how the environmental parameters affect the value of this parameter, and how vertical variation of the Score parameter affects gravity wave propagation
- Know how the width of a bell-shaped mountain or the wavelength (or wavenumber) of a sinusoidal mountain affects the mountain wave behavior.
- Know the condition under which low-level lee waves form
- Know how vertical change in air density affects the amplitude of mountain waves and the physical reason for such a behavior. Know wave breaking as a result of density decrease at the upper atmosphere when waves can reach those high levels.
- Know the reasons for the formation of low-level rotor circulation and sometimes rotor clouds to the lee of mountains.
- Know the Froude number as a key parameter in flow over finite amplitude 2D or 3D mountains and know how it affects the flow/mountain wave behaviors.
- Know wave breaking as a result of wave amplification and isentrope overturning, and the potential effect of wave breaking on wave activity below the breaking zone.
- Know the phenomena of severe downslope wind storm and two theories explaining its formation.
- Know the typical pattern of trapped waves to the lee of a three dimensional isolated mountain
- Know the phenomena of Karman vortex street to the lee of an isolated mountain.
- Know the phenomena of cold air damming and its hazard. Know the process by which cold air damming is established.
- Know the phenomena of gap flow and how Froude number affects gap flow.
- Know the common ingredients of heave orographic precipitation

- Know and be able to explain the conceptual models for several types of orographically induced or enhanced precipitation, including one due to the feeder-seeder mechanism.

3. PBL and related phenomena

- Know the definition and role of atmospheric PBL, and the main characteristics of and differences between PBL and the free atmosphere
- Know the typical vertical structure of both day and night time PBL, the properties of the surface layer, mixed layer, inversion layer, and residual layer, and the reason for their formation. Be able to draw the typical profiles of potential temperature, wind, mixing ratio of day and night time boundary layer.
- Know the typical diurnal evolution of PBL
- Know the definition of dryline and the primary physical processes responsible for the formation and movement of drylines
- Know the typical structures, in both horizontal and vertical, of drylines, in terms of temperature, humidity and wind.
- Know the role of drylines in convective initiation
- Know why convective cells are often initiated along specific locations along the dryline, and the role of boundary layer convective rolls, and their interaction with the mesoscale dryline convergence
- Know the definition, characteristics, climatology, and significance of boundary layer low-level jet.
- Being able to perform basic calculations/quantitative estimates associated with the above phenomena given equations.

The following will not be tested in the first exam.

- Understand the theories and be able to explain the formation of low-level jet in the nocturnal boundary layer that is associated with sloping terrain, and the role of vertical momentum transport/mixing in the process