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METR 4433 – Mesoscale Meteorology
Spring 2017

Study Guide for Exam #2

Below are listed the principal topics, concepts, and capabilities for which you will be responsible on the first exam. The absence of a topic from this sheet does NOT imply that it will be absent from the exam!

Mountain Wave Dynamics and Downslope Wind Storms

1. Know the physical characteristics and presumed mechanisms associated with the formation of downslope wind storms.
2. Understand the application of shallow water wave theory to downslope windstorms and the assumptions made.
3. Understand the physical difference between supercritical and subcritical flow in the context of downslope wind storms.
4. Understand and be able to explain and apply the two flow constraints for nonlinear theory applied to downslope wind storms for cases in which the Froude number is less than, greater than and equal to unity.

Drylines

1. Know the physical characteristics of drylines (e.g., location, duration, horizontal variations of atmospheric properties across, vertical structure).
2. Know the conditions necessary for the formation of drylines.
3. Be able to explain the mechanism by which drylines move and the reasons for the strongly diurnal cycle.
4. Understand why convection tends to be triggered near drylines and be able to explain why storms often are triggered well out ahead.

Sea and Land Breezes

1. Be able to explain the physical characteristics of sea and land breezes.
2. Know the vertical and horizontal structure of the temperature, wind and pressure fields in sea and land breezes.
3. Be able to explain the life cycle of the sea and land breezes and the associated meteorological structures in wind, pressure, and temperature.
4. Know the typical cloud distribution of sea and land breezes and the factors that give rise to them.
5. Understand how sea and land breezes are similar to density currents.Be able to explain how pressure-density solenoids are responsible for the local circulation of sea and land breezes. You should be able to do this using equations as well as diagrams.
6. Understand and be able to explain the significance of land and sea breezes from societal points of view, i.e., what is their significance in the context of convective initiation, air pollution, etc?

Horizontal Convective Rolls

1. Be able to describe the physical characteristics (including horizontal and vertical structure) of HCRs and the environmental conditions favorable for their development.
2. Know the significance of HCRs in creating fine-scale temperature and moisture variations in the planetary boundary-layer and the reasons behind them.
3. Be able to explain the significance of HCRs in convective initiation.
4. Know and be able to explain how HCRs interact with the seabreeze to initiate moist convection.

Low-Level Jet

1. Know the definition and characteristics of the low-level jet.
2. Know how the low-level jet differs from the polar front jet and the sub-tropical jet.
3. Understand the theoretical basis of the low-level jet vis-à-vis decoupling of the planetary boundary-layer from the free atmosphere.
4. Understand the terrain-based mechanism behind the low-level jet and the reasons for its diurnal variation, including the role played by the thermal wind.

Atmospheric Instability Theory

1. Understand the concept of instability and be able to give meteorological and non-meteorological examples of it.
2. Be able to explain the physical characteristics of: static/gravitational instability, centrifugal instability, inertial instability, and symmetric instability.
3. Understand the importance of conserved variables in instability theory.
4. Be able to utilize equations for the above types of instability to diagnose whether a given atmosphere (e.g., on a map or diagram) is stable, neutral, or unstable.
5. Be able to provide examples of where the instabilities listed above most commonly occur in the atmosphere.
6. Understand the concepts of absolute momentum and absolute geostrophic momentum.
7. Understand the assumptions used in deriving the basic theory of symmetric instability.
8. Be able to relate symmetric instability to static instability (parcel theory), particularly the analogous roles of gravitational and centrifugal acceleration.

Single Cell Storms

1. Know the definition of a thunderstorm!
2. Understand the classification system of thunderstorms, the characteristics of single cells, multicells, lines and supercells, and the principal differences in environmental conditions among them.
3. Understand the concept of buoyancy and how thermal and vapor buoyancy differ from one another.

4. Understand the concept of water loading and how it contributes to updraft acceleration/deceleration.
5. Understand the concept of CAPE and how it relates to updraft acceleration. Be sure you understand the approximations associated with relating the two.
6. Be able to compute the CAPE and Wmax (via integration) if given an appropriate expression for buoyancy.
7. Understand how CAPE is represented on a thermodynamic diagram.
8. Understand and be able to explain convective inhibition (CIN) and its role in promoting or inhibiting moist convection.
9. Be able to explain mechanisms by which CAPE and CIN can increase or decrease.
10. Know the principal ingredients needed for thunderstorms to form and the role of environmental wind shear.
11. Be able to define and apply the bulk Richardson number to determine storm classification.
12. Understand and be able to explain the characteristics and life cycle of single-cell storms, including the built-in self-destruct mechanism.
13. Understand the origin and forcing mechanisms (entrainment, water loading, evaporation) for storm downdrafts.

Necessary Equations Will be Provided on the Exam