MEA 214 FUNDAMENTALS OF METEOROLOGY II
Spring 2011
Course Review for Final Exam (Tu, 5/10/11, 8:30-11:00 a.m.)

Below is a list of review questions that summarize the material covered in this course. This list is not guaranteed to be completely comprehensive. *Do more than memorize* the answers to these questions! Try to anticipate what questions could be asked. The final exam will largely be based on the topics represented below. There will be some weighting towards material since the midterm exam, maybe 55-45%.

1.) Know the basics of cloud and precipitation formation.

2.) What are the primary *lifting mechanisms* in the atmosphere?

3.) How does the force balance in the atmosphere relate to vertical air motion (lifting mechanisms)? Why are meteorologists so concerned with vertical air motion?

4.) Given a cross-section of *temperature,* how can you estimate where *height* or *pressure* gradients aloft would be located? Or in other words, how does the jet stream relate to temperature contrasts beneath it?

5.) What are typical conditions and characteristics of warm, cold, occluded, and stationary fronts?

6.) What are occluded fronts, and how do they form? Know the typical evolution of fronts during the life cycle of a typical cyclone.

7.) In order for surface pressure to decrease in a cyclone center, what must occur in the overlying air column?

8.) Know where the favored regions for cyclogenesis (around North America) are located, and why they are there.

9.) Explain how waves in the jet stream lead to the formation of high and low-pressure systems at the surface. Given an upper-air map with a wavy pattern, where would cyclones or anticyclones most likely be found, and why?

10.) What are *jet streaks,* and how do they lead to divergence aloft and rising motion? Which locations near a jet streak favor rising air?

11.) What is *vorticity,* and how does it relate to cyclones, especially lee cyclones? How did the vorticity equation help us to understand lee cyclogenesis? Explain the process.

12.) Geographically, where do rapidly deepening cyclones tend to form? How does this differ from the overall pattern of cyclogenesis?

13.) What is meant by the term “Self development” for cyclogenesis? What processes are at work?

14.) Given a diagram showing a surface cyclone, be able to match given observations to the relative location in the system.

15.) Review from MEA 213: Know the definition and interpretation of adiabatic processes, lapse rates, and how these relate to stability.

16.) Given temperature and elevation data, be able to compute the environmental lapse rate.

17.) Given vertical profiles of temperature, be able to compute dry adiabatic temperature changes, and determine atmospheric stability.

18.) Physically, how does lifting a *layer* of air in which the relative humidity changes rapidly with height modify the stability of that layer?

19.) For numerical weather prediction models, know the main limitations, and have a basic understanding of the process of numerical weather forecasting.

20.) Know the basics of the thunderstorm electrification theory. What aspects are still not completely understood?

21.) Know the basic steps in a lightning stroke. Why does lightning flicker? Why does thunder rumble?

22.) Know the different thunderstorm types and the associated characteristics. For example, how do supercell thunderstorms differ from multicell storms? Which severe weather threats are most likely with each thunderstorm type?

23.) In forecasting convection, what three ingredients are needed? Given a set of observations or data, be able to assess the degree to which convection is likely.

24.) What distinguishes “severe” thunderstorms from non-severe ones (in terms of the storm impacts and characteristics)?

25.) What environmental factors differentiate severe storms from non-severe ones?

26.) In which geographical region do tornadoes tend to form?

27.) What meteorological setting is favored for tornado development? In which season are tornadoes most common? Why then?

28.) What ingredients are needed for tornado formation?

29.) What is vertical wind shear, and how does it relate to tornado formation?

30.) Anemometers cannot withstand the fierce winds of a tornado. How then can we determine what the wind speeds are in tornadoes? How was the Fujita tornado intensity scale devised? What is the "enhanced Fujita" scale, and how is it different?

31.) What tool (instrument) is most useful for short-term tornado forecasting?

32.) If you were storm chasing in Kansas, and you wanted to view a tornado safely, where would you locate yourself relative to the storm? (i.e., which way do tornadoes usually move, and in what part of the storm do they usually form?)

33.) In what ways does the tropical atmosphere, in general, differ from the midlatitude atmosphere (besides being warmer!)?

34.) In terms of structure and dynamics, how do hurricanes differ from midlatitude cyclones? Be able to identify the main features of a hurricane on a schematic.

35.) Why are hurricanes "warm core", and what significance does this have for their structure? What forces are in balance in a hurricane eyewall, and what is the name of this force balance?

36.) What is the "stadium effect", and how can it be explained in terms of force balance?

37.) What are the necessary conditions for hurricane formation?

38.) What are *easterly waves (aka African waves)*?

39.) How does the *size* of a hurricane compare to that of a tornado? What about compared to a typical midlatitude wave cyclone?

40.) What elements of hurricanes are responsible for their destructiveness? What is a *storm surge*, and how does it form?

41.) Where are the strongest winds found in relation to the eye of a landfalling hurricane, and why there?

42.) Why do hurricanes often move from east to west, opposite the usual jet stream flow?

43.) Be prepared to answer a series of true/false questions concerning the basic characteristics of hurricanes (e.g., wind speeds, dimensions, etc.)

44.) What is meant by the term *climate*, and what factors determine climate at a particular location?

45.) How do we know what past earth climates were like? Know the basic data sources and the time scales to which they apply. What is oxygen isotope analysis?

46.) What causes climate fluctuations? Know what factors must be considered, and how the Milankovitch cycles work.

48.) Understand some of the basic climate-change and feedback mechanisms at work in the earth system, and know upon what time scales they generally operate. In other words, can orbital changes explain warming over a decadal time period?

49.) What are "greenhouse gases"? What is their overall role in earth's climate?

50.) What is unique about the structure of greenhouse gases, and why do they absorb more in the IR than do other, more plentiful gases?

51.) For each of the Milankovitch orbital parameters, know what configuration would lead to the onset of an ice age.

52.) Why do cold summers favor ice ages?

53.) What are current predictions from global climate models for the next ~100 years?

54.) What is causing the global carbon dioxide increase?

55.) Have global surface temperatures increased in the past decade or so? By how much?

56.) What are the predicted *consequences* of climate change due to increased greenhouse gas emissions? Do we need to worry about sea-level increases?

57.) What are some important limitations in global climate models? Should we trust detailed forecasts of regional climate change? Are there any other tools available to project future climate?

58.) Are climate models able to predict present conditions when run from the past to present? What factors are necessary to take into account?

59.) What are the two main processes that can lead to sea-level rise? Has sea level risen in a detectable way?

60.) What is the linkage between climate change and hurricane intensity? Is there a well-defined change in hurricane activity that can be detected in observations?

61.) The warmest year on record was 1998, more than a decade ago. If the earth continues to warm, then why haven't we broken that record since?

62.) What is the difference between primary and secondary pollutants?

63.) Why is the ozone layer located between 10 and 50 km in altitude?

64.) What are CFCs, and how do they result in ozone depletion?

65.) The concentration of Cl released by CFCs in the stratosphere is *much* less than the concentration of O_3; so why is the ozone layer at risk?

66.) Has ozone depletion outside of the polar regions been observed?

67.) What is the *ozone hole*? When and where does it develop? Why then and there?

68.) Do we need to worry about an *arctic* ozone hole? If not, why not?

69.) Is there any link between the strength of hurricanes and ozone depletion?

70.) Is the ozone hole continuing to worsen each year? Why or why not?