Knowledge Expectations for METR 4303
Statistical Meteorology

Purpose: This document describes the principal concepts, technical skills, and fundamental understanding that all students are expected to possess upon completing METR 4303, Statistical Meteorology. Individual instructors may deviate somewhat from the specific topics and order listed here.

Pre-requisites: Grade of C or better in MATH 2423, CS 1313 (or CS 1323), or permission of instructor.

Upon entering this course, students should have a working knowledge of limits, differentiation, integration and experience programming in any language with an idea of the basics of how to write a computer program.

Goal of the Course: This course is designed to illustrate the interplay between statistics and meteorology. At a first glance, statistics may seem not as exciting (to many of us) as, say, chasing tornadoes. However, projects that receive national funding for chasing have considerable experimental design built in and the resulting data are almost always statistically analyzed to evaluate competing theories, among other things. In order to understand how experiments are designed and analyzed, the course will cover theory of descriptive statistics, a brief overview of probability and probability distributions, inferential statistics, and regression. The relevance to the atmosphere will be examined through use of meteorological data sets and by review of key journal articles which have relied on statistics for support and illumination. If the class is successful, you will exit with an enthusiasm for statistics and a "toolbox" of techniques to apply to data sets using Splus.

Topical Knowledge Expectations

I. Descriptive Statistics

- Understand the ideas of scale that data are measured on.
- Understand and be able to apply measures of location. Know each methods pros and cons.
- Understand and be able to apply measures of variability. Know each methods pros and cons.
- Understand skewness and kurtosis.
- Understand what resistant measures are and when to apply them.
- Understand boxplots and other graphical exploratory data analysis devices.
- Understand how to construct and fully analyze scatterplots.
- Know the formulation of Pearson's and Spearman's correlation.

II. Forecast Evaluation

- Understand how to construct a confusion matrix.
- Know the various indices that can be applied to any 2 x 2 matrix.
- Understand what skill is and how it is measured.

III. Probability

- Understand the concepts of fairness, bias, equally-likely, relative frequency and subjective probability.
- Have a working knowledge of unconditional probability for applied problem solving.
- Have a working knowledge of conditional probability for applied problem solving.
- Know how to calculate independence and what it allows for the calculation of probability.
- Know how and when to apply Bayes' Theorem.
- Understand expectation in detail.
- Know how to apply expectation to arrive at the first two moments of probability distributions.
- Understand the Central Limit Theorem.
- Understand the binomial distribution.
- Have the ability to work with a number of probability distributions used by meteorologists.

IV. Sampling , confidence intervals and hypothesis testing

- Understand the nuances in sampling meteorological data where typical assumptions are violated.
- Know how to work with random number generators.
- Know how to formulate hypotheses and calculate p-values.
- Know how to set up an experiment to control Type I and Type II error.
- Know T-tests of several forms.

V. Regression

- Understand the basic concepts behind regression.
- Know how to run simple and multiple regression, diagnose the results and explain how significant the findings are.
- Understand regression under multicollinearity.
- Know how to calculate regression diagnostics and alter the model as needed.