MET3220C Meteorological Computations

Dr. Mark Bourassa

Class Time: TR 2:00 – 2:50; Wed. 10:10 – 12:05
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Office Hours: TR 11:45 -1:45; W 12:15 – 2:15
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Course Objectives

- Students will learn the general statistics and programming (in FORTRAN 90), with application to atmospheric sciences.
  - Examples from physical meteorology, remote sensing, and climatology.
- Students will learn a wide range of data analysis techniques
  - Develop computer code to apply them.
  - Become familiar with the strengths and weaknesses of many statistical methods.
    - How to program tests of how typical errors will influence the results of the statistics.
    - Students should be able to assess the quality of statistics.

Course Web Page

- Accessible through http://campus.fsu.edu/ on the campus
  - Everyone in this class has access to the course site.
  - You must have a garnet or mailer account to use the class WWW site!
    - Get this ASAP!
- On line versions of
  - Syllabus and course outline.
  - Assignments
  - Grades
  - Reading material and lecture notes will be put online prior to the lecture
    - You are expected to read the material prior to the lecture
    - I suggest printing the pages, and taking them to class

Getting Your garnet or mailer Account

- https://cars.acns.fsu.edu/
  - If you don't already have an account you can get one.
- If you've forgotten your password you can change it.
  - https://cars.acns.fsu.edu/CARS/account_maintenance.html
- Forward your email to an account you regularly check.
  - https://cars.acns.fsu.edu/CARS/account_maintenance.html

The Basics

- TEXT BOOKS:
  - Statistical Methods in the Atmospheric Sciences, 2nd Ed. by Daniel S. Wilks
  - Introduction to FORTRAN 90 by Nyhoff, L. and S. Leestma
  - Alternative suggestions for books on programming in FORTRAN are listed under 'class library' on the class web site
- Useful resources:
  - Several references cards on computer and editor commands are available on the class web site.
- Read and follow the honor code.
- Students with disabilities needing academic accommodations
  - Register with FSU's Student Disability Resource Center
  - Let me know so that I can plan ahead accordingly

Grading

- Exams:
  - Midterm #1 Feb. 27 (on all stats material through Feb. 20)
  - Midterm #2 April 19 (on all stats material after from Feb. 20)
  - Final: None!
- Grading (MET3220C):
  - 40% Weekly Homework (Programming)
  - 30% for Midterm #1
  - 30% for Midterm #2
- Grades will be routinely updated on the blackboard site.

Scoring the Work

A	weighted average ≥ 88%
A–	88% > weighted average ≥ 850%
B+	85% > weighted average ≥ 82%
B	82% > weighted average ≥ 73%
B–	73% > weighted average ≥ 70%
C+	70% > weighted average ≥ 67%
C	67% > weighted average ≥ 58%
C–	58% > weighted average ≥ 55%
D+	55% > weighted average ≥ 53%
D	53% > weighted average ≥ 47%
D–	47% > weighted average ≥ 45%
F	weighted average < 45%

- Grading guidelines are available on the blackboard site.
- MET3320 students must have at least a "C" average on the last five homework assignments, or they will receive an overall grade of "F" for this course.

- Consistent studying of material and class attendance are generally among the factors which determine grades earned by students.
- Makeup exams are not given except as noted by University policy.
  - Extra credit is available one time – for improvements to lecture notes, and
  - Late assignments are accepted, but grades are dramatically reduced,
- All homework must be submitted electronically.
- See handout on grading for detailed expectations.

Course Outline

Jan. 9	Introductory Concepts in Statistics and Programming
Jan. 11 – 30	Empirical Distributions and Data Exploration
Feb. 1 – Feb. 22	Parametric Probability Distributions
March 1 – 13	Hypothesis Testing
March 15 – March 29	Statistical Forecasting
April 3 – 17	Forecast Verification

February 27	Midterm 1
April 19	Midterm 2

Solar 'Constant' for Other Planets

- The energy flux (F) from the sun can be estimated by multiplying the flux density (S, aka the solar constant) at a radius (R) by the surface area of a sphere at that radius. Note that this value of S_E applies only to the distance from the earth to the Sun (R_E). The solar 'constant' varies as a function of distance (R) from the Sun.

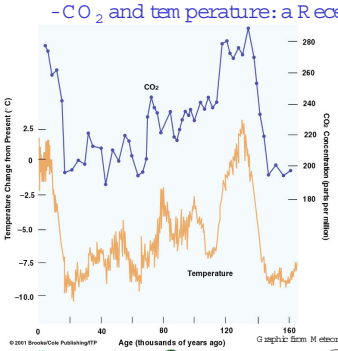
  $F = S_E\, 4\, \pi\, R_E^2$

- F is constant – it does not depend on R.
- Solve for S, applicable to any value of R.

  $S = F / (4\, \pi\, R^2)$

- Consider that R for Venus is approximately half of R for the earth, and that R for Mars is approximately double that of Earth. F is constant in this context, so the only variable is R.
  - Approximate the solar constants for Venus and Mars.
- Earth's solar constant was originally determined through statistics: a linear regression.

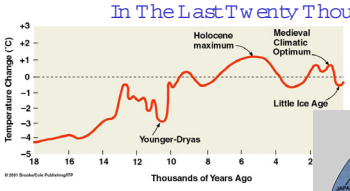
Global Change Does Happen
- CO_2 and temperature: a Recent History -

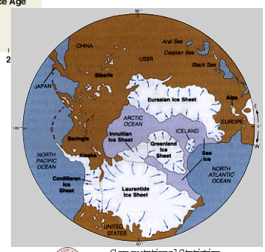


- Strong correlation between global mean surface temperatures and the concentration of CO_2
- Correlation DOES NOT imply cause and effect!

Graphic from Meteorology by Danielson, Levin and Abrams

Surface Temperature Has Varied In The Last Twenty Thousand Years





- Even relatively recent times have been warmer than now
- During colder periods, lots of current water channels were land (or ice)
- Medieval times were warm in higher latitudes.. expansion of territories

Graphics from Meteorology by Danielson, Levin and Abrams

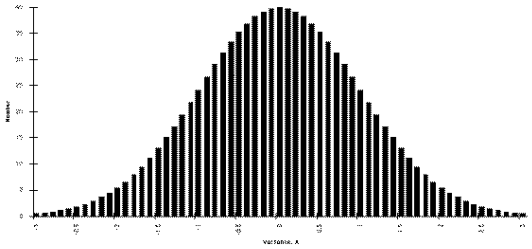
What Is Statistics?

- Traditional descriptions of Statistics are
  - Tedious,
  - Mind numbing, and
  - Time consuming.
- In most statistics classes, the above terms are painfully accurate.
  - However, applied statistics (with modern computers) can be
    - Intriguing,
    - Relevant, and
    - Fast.
- Statistics is used to quantify uncertainty
  - It can also be used to determine trends and make forecasts
  - These applications are most clearly interpreted when statistical uncertainty is mentioned.

Data vs. Information

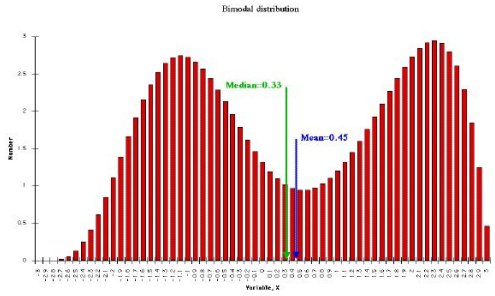
- Statistics can be used to summarize data.
  - Data can be thought of as a set of values.
    - Many meteorological data sets have huge numbers of values.
    - The forest cannot be seen due to the trees
  - For example, a single satellite can measure millions of observations in a day.
    - This is too much data for one person to absorb.
    - Statistics can be used to make the data easier to understand.
      - Statistics can tell us an average value, and some information about the distribution.

Gaussian Distribution



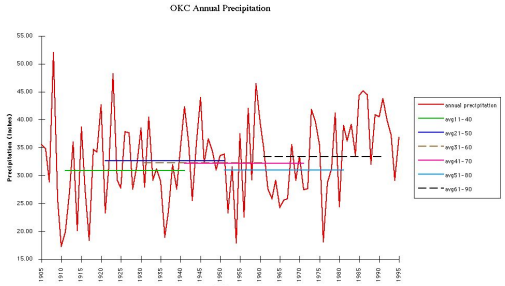
Graphic from www.cimms.ou.edu/~doswell/Normalafromalhtml

Is The Average Always the Best Bet?



Graphic from www.cimms.ou.edu/~doswell/Normalafromalhtml

Is the Average Always the Same



Always LOOK AT THE DATA!

Graphic from www.cimms.ou.edu/~doswell/Normalafromalhtml

Inferential Statistics

- Statistics can be used to predict an outcome, or to describe the likelihood of a variety of outcomes.
  - Example: gambling in a casino
    - The odds indicate that the casino will win slightly more often than the patron.
  - Example: Trends can be used to forecast conditions.
    - In the absence of a change of air masses, the trend of the recent conditions can be used to estimate future conditions.
  - Rate of change in surface (or upper air) temperatures.
    - Is the resulting rate statistically reliable?
    - Is it physically meaning full?
    - How sensitive is the result to the beginning and end times?

Uncertainty

- Statistical descriptions, comparisons, and particularly forecasts are prone to some errors
  - A typical error is a bias
    - A systematic over or under estimation.
  - Another type of error is random differences
    - Random errors are often referred to as uncertainties.
- Many statistical techniques are based on the assumption that one or more of the types of observations are free of error.
  - There are many example of horrible conclusions due to failing to consider uncertainty of comparison data.
  - There are many real world cases where there is no standard of truth.

Basics of Programming

- The operating system
  - Examples: UNIX, DOS, MAC OS, Windows, Linux
  - Know how to move around, and copy files
- Editing a file
  - Find an editor that you like, and become functional with it.
- Compiling code (and debugging)
  - FORTRAN 77: f77 program.f77 –o executable_name
  - FORTRAN 90: f90 program.f90 –o executable_name
    - Also works on F77 routines
  - C: cc program.c –o executable_name
- Running code (and debugging)
  - ./executable_name