

# SIO 221B: Analysis of Physical Oceanographic Data

Winter 2016

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- I. Ocean instruments and data
  - A. Platforms
    - 1. Ships
    - 2. Moorings
    - 3. Autonomous and Lagrangian platforms
    - 4. Satellite
  - B. Model output
- II. Why statistics?
  - A. Ocean is complex
  - B. Ocean is nonlinear
  - C. Observations are not controlled
  - D. Lorenz model
- III. Single variable statistics
  - A. Random variables and processes
  - B. Ensemble average
  - C. Distribution function
  - D. Probability density function (pdf)
  - E. Average from pdf
  - F. Moments
  - G. Example pdfs
    - 1. Uniform
    - 2. Normal
- IV. Multiple variable statistics
  - A. Joint pdf
  - B. Conditional pdf
  - C. Independence, covariance, and correlation
  - D. Linear statistical model
  - E. Principal axes
  - F. Sum of two independent uniformly distributed variables
  - G. Joint normal pdf
- V. Central limit theorem
  - A. Moment generating function
  - B. Characteristic function
  - C. Proof of central limit theorem
- VI. Random walk
  - A. Discrete random walk
  - B. Continuous random walk and diffusion
- VII. Sampling errors
  - A. Sample mean

1. Bias
2. Variance
3. Estimate of variance
  - a. Minimum bias
  - b. Minimum variance
- B. Serially correlated observations
  1. Mean-square-error of sample mean
  2. Continuous observations
- C. Confidence limits
  1. Mean
  2. Variance
- VIII. Introduction to inverse theory
  - A. Function fitting
  - B. Determination of geostrophic reference velocity
  - C. A nonlinear problem
- IX. Least-squares problems
  - A. Overdetermined
  - B. Constraints
  - C. Underdetermined
  - D. Simultaneous minimization of misfit to data and model size.
  - E. Weighted systems
  - F. Error propagation
- X. Review of linear vector spaces
- XI. Eigensystems
- XII. Singular value decomposition
- XIII. Resolution matrices
- XIV. The geostrophic reference velocity inverse problem
- XV. Linear estimation
  - A. Single variable
    1. Nonzero mean
    2. Noisy data
  - B. Multiple variables
    1. Interpolation
    2. Linear operations
- XVI. Objective mapping
  - A. Unbiased estimate of mean
  - B. Example: an oceanic front
- XVII. Empirical orthogonal functions
- XVIII. Wavelets