Geography 507

Time Series Analysis in Biogeoscience – Outline

Instructors

Sean Fleming
Email: Sean.Fleming@BCHydro.com

R.D. (Dan) Moore
Email: rdmoore@geog.ubc.ca
Phone: 604.822.3538

Place and time

The class will meet at 6 pm on Monday evening in Geography 239, beginning January 12. Sessions will run for 2 to 3 hours.

Registration

The class will be limited to 20 students. Students who wish to audit the course will need to register formally and will be expected to attend all of the sessions and participate in discussions. However, students wishing to take the course for credit will have priority of registration.

Course description

This course introduces a range of concepts and applications in time series analysis and modelling (drawn from statistics, digital signal processing, and linear and nonlinear dynamics) as applicable to the biogeosciences. Subjects reviewed include time series decomposition, stationarity, ARMA and regression models, spectral analysis, trend and change analysis, hypothesis testing, smoothing and filtering, and basic concepts in fractal and chaotic dynamics. Fundamental principles will be identified, but emphasis will be on applications to and interpretations of real data sets drawn from a variety of biogeoscience contexts, such as streamflow modelling, climate variability and change, and tree ring analysis.

Prerequisites

Two semesters of university-level calculus; one semester of statistics (including linear regression); and satisfactory standing in any UBC science or engineering graduate program (or permission of the instructors).

Learning objectives

Upon successful completion of this course, students should:

- Understand the dominant types of variability present in time series and their relations to the generating processes
- Understand a range of common approaches to analyzing time series at a level that allows the student to comprehend their applications in research articles within the biogeosciences

- Have gained hands-on experience with the management, processing and analysis of time series data within the R programming language to a level that they could use these skills in their own research
- Have gained experience in self-directed learning and research
- Have gained experience in scientific communications and debate, through participation in seminars, delivery of an oral presentation and preparation of a formal report

Format, work load and grading

Format. There will be one 3-hour session each week. In the first eight weeks, the session will comprise a lecture followed by a computer-based laboratory exercise. In the final weeks, the sessions will be used for seminars, focused on recent scientific debates related to time series analysis, and presentations of students' term projects.

Lectures. Lectures will introduce the conceptual, mathematical and statistical foundations of different approaches to time series analysis, as well as the underlying assumptions.

Laboratory exercises. Laboratory exercises will introduce the application of time series analysis to simulated and real data sets using the R programming language. This language is open-source (therefore free), powerful and flexible, with rich capability for graphical presentation. Each exercise will include a set of interpretive questions to be addressed by the students.

Seminars. Seminar sessions will examine a selection of readings drawn from recent research articles in which time series analyses play an important role in drawing conclusions. Students will be encouraged to draw upon the concepts introduced earlier in the course to assist their critical evaluation of the arguments presented in the articles. Students will be required to submit an essay presenting a critical evaluation of the papers considered in one of the seminars, drawing upon the discussion and possibly some re-analysis.

Term project. The term project will require students to select a technique or approach for time series analysis that is not covered in the lecture/laboratory component of the course, and prepare a formal report presenting a practical introduction to the technique and its application in the biogeosciences. The term project comprises three components: (1) a proposal, (2) an oral presentation, and (3) a formal written report. See the term project handout for more details.

Grading scheme. The final grade will be based on all aspects of the course, as indicated below.

Activity		**Contribution to course grade (%)**
Term project	- Proposal	5
	- Oral presentation	20
	- Written report	60
Seminars	- Participation	5
	- Final exam essay	10

Geog 507 – Time Series Analysis in Biogeoscience

Tentative Syllabus

1. Introduction to course and environmental time series (RDM/SF)
2. Linear models and applications to time series (RDM)
3. Low-order memory in time series (SF/RDM)
4. Spectral analysis and colours of noise (SF)
5. Chaos and fractal time series (SF)
6. Hypothesis testing and model selection (SF/RDM)
7. Trend analysis and effects of persistence (SF)
8. Time series smoothing and filtering (SF)
9. Seminar
10. Seminar
11. Student presentations (depending on number of students)
12. Student presentations