

Report on AMBER Workshop

“Time Series Analysis and Modelling of Environmental Data”

The BONUS+ AMBER workshop took place from September 13–17, 2009 on the island of Seili in the Finnish Archipelago Sea. 23 students (15 female and 8 male) from Finland, Germany, Lithuania, Peru, Poland, Serbia, and Spain (see list of participants on AMBER webpage) were educated by six teachers from Belgium, Finland, Germany and Spain (see list of teachers on AMBER webpage). 16 of the students were Ph.D. students in different BONUS+ projects. The workshop was sponsored by the BONUS+ EEIG Secretariat which is greatly acknowledged. In the following a short description of the course is given. Details of the complete teaching program, the slides and the excersises can be found on the AMBER webpage and ftp-server.

Joachim Dippner started the teaching program with a repetition of fundamentals in linear systems such as matrix calculation, determinants, eigenvalues and eigenvectors. Ilppo Vuorinen presented various time series from the Baltic Sea and discussed the fundamental problems of biological time series analysis such as shortness and resolution, spatial and temporal coverage, autocorrelation at many levels, trends, shifting baselines, multiple control, gaps, outliers, peaks or generation time. Jukka Corander presented an introduction to probability theory with special emphasis to Bayesian probability. He continued with two applications of forecast models an example from atmospheric chemistry and a biomedical example, the DNA copy of cancerous tissues. After a short introduction into the program WinBUGS, he presented some examples of first regression models. In the evening session, Anne-Mari Ventelä presented the restoration program of Lake Pyhäjärvi (SW Finland) which covers the management of the drainage area and the lake as well as water quality with respect to the Water Framework Directive. First results of the recently installed automatic monitoring facilities were shown.

On the second day, Amaury Lendasse introduced time series modelling and presented various linear and non-linear approaches to time series modelling. Using a time series of the temperature of the Baltic Sea, the students had the possibility to try out some of the mentioned methods to predict the development of temperature. Jari Hänninen presented a description of the development of Transfer Function modelling from ARIMA models and demonstrated some applications. Joachim Dippner gave an introduction to recurrence quantification analysis and the students applied this technique firstly to simple sine waves, white noise, or Brownian motion and later to various climatic time series such as the arctic

oscillation index, sun spot activity, and the temperature in the Baltic Sea or other time series like heart beat irregularities, gene sequences or some strange attractors. In the evening session, Joachim Dippner gave an overview on the goals of the BONUS+ project AMBER.

On the third day, Amaury Lendasse went into more detail about non-linear time series modelling such as learning vector quantization. Using again the time series of the temperature of the Baltic Sea, the students applied the newly learned techniques for predictions. Joachim Dippner presented an introduction to network analysis in marine ecosystems. In the practical part the students applied the network analysis to the output of the classical Fasham model.

On the last day, Eduardo Zorita gave an introduction into climate modelling and introduced techniques like empirical orthogonal functions (EOFs) and statistical downscaling. In the practical part, the students applied various statistical tests to different time series and improved their understanding of fundamental statistical properties. Amaury Lendasse gave a short introduction into Self-Organizing Maps (SOM) which can be understood as a projection of non-linear PCA in two dimensions. He showed the historical example of human brain, and an application to macro-economical data. He further demonstrated on the example of satellite derived sea surface temperature in Lake Tanganyika how SOM in combination with EOFs can be used to fill missing values in a data set. He closed with an example where unknown future data is considered as missing values.

At the end a student's evaluation of the workshop took place. The students were asked to answer the following questions:

1. What did you expect when you applied for the workshop?
2. Have your expectations been fulfilled? If not, please explain. What did you miss?
3. Please explain how you will profit from the workshop.
4. Do you have any suggestions for improvements of the workshop?

The answers to the first question were slightly biased due to the fact that the workshop was mandatory for Ph. D. students from the AMBER project. Most of the students expected to learn about the variety of models and their selection and to decide which model can be applied for which problem. In general, there was a positive response to the workshop in terms of getting an overview on existing modern techniques and principal knowledge of model application. For future courses, the students recommended changing the order of presentations which would fit better their existing mathematical knowledge. They also suggested to allocate more time for practical exercises and to apply the learned techniques to only one set of data or alternatively, their own data sets. Some students would have liked to get an introduction to the recommended standard software.

The workshop took place in a very friendly atmosphere during excellent weather conditions. All students and teachers wish to thank the local organizers Jari Hänninen and Ilppo Vuorinen and the staff of the research station Seili for their friendly hospitality and their perfect organisation.

Seili, September 17, 2009

Joachim Dippner