Fractal-based Analysis to Identify Trend Changes in Multiple Climate Time Series

Santiago Augusto Nunes[1], Luciana A. S. Romani[2], Ana M. H. Avila[3], Caetano Traina Jr[1], Elaine P. M. de Sousa[1], Agma J. M. Traina[1]

[1] ICMC - University of São Paulo at São Carlos - Brazil
bynael@grad.icmc.usp.br, {caetano, parros, agma}@icmc.usp.br
[2] Embrapa Agriculture Informatics at Campinas - Brazil
luciana@cnptia.embrapa.br
[3] Cepagri - State University of Campinas - Brazil
avila@cpa.unicamp.br

Abstract. In the last few decades, huge amounts of climate data have been gathered and stored by several institutions. The analysis of these data has become an important task due to worldwide climate changes and the consequent social and economic effects. In this work, we propose an approach to analyzing multiple climate time series in order to identify intrinsic temporal patterns and trend changes. By dealing with multiple time series as multidimensional data streams and combining fractal-based analysis with clustering, we can integrate different climate variables and discover general behavior changes over time.

Categories and Subject Descriptors: H. Information Systems [**H.2 Database Management**]: H.2.8 Database Applications—*Data Mining*

Keywords: anomalies, data streams, clustering

1. INTRODUCTION

In the last decades, results from Climatology have shown worldwide climate changes, mainly with rising temperatures and changing rainfall distribution. According to the World Meteorological Organization, climate change can be defined as the average description of weather conditions inferred from continuous observations during at least a 30-year period [Zhai et al. 2005]. Moreover, deviations from the average description characterizing natural variability and extreme phenomena must also be considered.

Climate research has been carried out to study the influence of climate conditions on global and regional populations and their daily lives, geographic distribution and economic activities such as agriculture. Recently, this research has been intensified due to the increasing world population [Ayoade 1996] and the huge volumes of data gathered from different sources, such as meteorological sensors, weather satellites and climate models. By analyzing such data, meteorologists aim to understand extreme conditions and climate anomalies.

Results from several scientific analyses show an increase in intensity-duration-frequency of extreme events [Alexander et al. 2006] and a consequent escalation of natural hazards. Intense rainfall in a single day as well as consecutive days of precipitation may cause floods and serious problems for both urban and rural areas. Therefore, understanding trends of extreme phenomena is crucial to prepare for adverse situations, i.e., to create conditions to mitigate some of the problems and to make strategic decisions in a feasible time.

Climate-related observations from ground-based meteorological stations, remote sensors, weather radars and other sensors have continually generated a huge volume of data. Furthermore, data from climate models have enlarged climate archives in the magnitude of terabytes per simulation of climate change scenarios. Thus, the analysis of these data has become increasingly challenging for researchers