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A Guide to Empirical Orthogonal Functions for Climate Data Analysis

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Chapter 1
Introduction

Climatology and meteorology has been basically a descriptive science without the means to perform quantitative experiments under controlled conditions. In fact, until the second half of the twentieth century, the border between climatology and geography was often blurred and the two disciplines were confused one with the other.The situation changed when the solution of the evolution equations for the climate system became possible using numerical methods. The development of numerical models allowed the application of standard scientific verification machinery for testing hypotheses, but crucial to the success of the strategy is that the model must be a good representation of the real climate system of the Earth. Assessing the quality of models regarding their capability to reproduce the climate became a cornerstone in the scientific progress of climatology. Tighter and tighter standards were required for the model simulations in comparison with the real characteristics of climate. Models were required to reproduce not only the mean properties of climate, but also its variability. In the last decades of the XX century the amount of data available was becoming very large and strong evidence of remote spatial relations between climate variability in geographically diverse regions were emerging. Quantitative techniques were developed to explore the climate variability and its relations among different geographical locations. Methods were borrowed from descriptive statistics, where they were developed to analyze variance of related observations-variable pairs, or to identify unknown relations among variables.

These methods were introduced to meteorology in the mid-1960, but they became increasingly popular in the early 1980s where their capability to identify dynamically significant modes in the climate variability was demonstrated. Since then they have been further developed and many variants and extensions have been proposed and applied. Very often these developments were taking place separately from the formal development in the mainstream statistics and reflected ad hoc solution to the particular vies that climatology was using.

There are excellent books treating these methods in a formal and rigorous way (von Storch and Zwiers 1999; Wilks 2005; Jolliffe 2002) and we refer the reader to these excellent texts for proofs and a more formal treatment. We take in this booklet a different approach, trying to introduce the reader to a practical application of the methods and to the kind of real problems that can be encountered in a practical application. We are including in the book data sets from real simulations

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