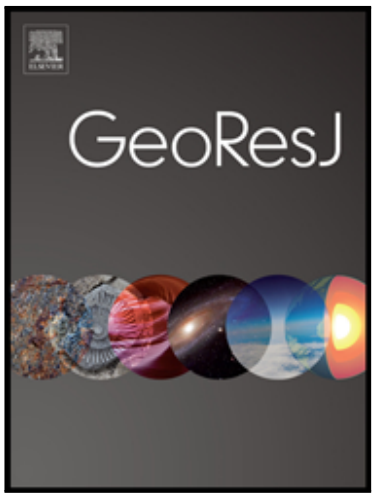

The application of machine learning for evaluating anthropogenic versus natural climate change

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The application of machine learning for evaluating anthropogenic versus natural climate change

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Abstract

Time-series profiles derived from temperature proxies such as tree rings can provide information about past climate. Signal analysis was undertaken of six such datasets, and the resulting component sine waves used as input to an artificial neural network (ANN), a form of machine learning. By optimizing spectral features of the component sine waves, such as periodicity, amplitude and phase, the original temperature profiles were approximately simulated for the late Holocene period to 1830 AD. The ANN models were then used to generate projections of temperatures through the 20th century. The largest deviation between the ANN projections and measured temperatures for six geographically distinct regions was approximately 0.2°C, and from this an Equilibrium Climate Sensitivity (ECS) of approximately 0.6°C was estimated. This is considerably less than estimates from the General Circulation Models (GCMs) used by the Intergovernmental Panel on Climate Change (IPCC), and similar to estimates from spectroscopic methods.

Introduction

The past two decades have seen an unprecedented international focus on climate change, and particularly the perceived relationships between increasing global temperatures and emissions of greenhouse gases, referred to as anthropogenic climate change. The Intergovernmental Panel on Climate Change (IPCC) is a body under the auspices of the United Nations, set up at the request of member governments, to provide scientific information on climate change and its political and economic impacts. The IPCC publishes Assessment Reports at regular intervals, with the current viewpoint, based mainly on application of physical models, particularly General Circulation Models (GCMs). These models attribute over 90% of the global warming since 1900, and virtually 100% of the global warming since 1970, to anthropogenic climatic forcings, particularly industrial emissions of carbon dioxide and methane (Stocker et al., 2013; Myhre at al., 2013).

Instrumental temperature records extend back a little over a century. To understand how climate has varied over much longer periods, over hundreds and thousands of years, various types of proxy records have been assembled. These are derived from measurements associated with biological and geological phenomena that can leave evidence of past climate, particularly temperatures. The most familiar proxy records are derived from annual rings of long-lived tree species. Other proxies include measurements from corals, stalagmites, and sediments. These types of records provide evidence for periods of time over the past several thousand years (the late Holocene) that were either colder, or experienced similar temperatures, to the present, for example the Little Ice Age and the Medieval Warm Period (Hunt, 2006; Lamb, 1965; Lamb, 1982).

Examination of many of these proxy temperature records shows they typically consist of complex oscillations or cycles about a mean value, with the amplitude and structure of the temperature signal depending on the geographical location considered. In the pre-industrial era, these oscillations