Understanding the variability of the El-Niño Southern Oscillation phenomenon

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1. Introduction

Research led by the University of Edinburgh seeks to understand how the El-Niño Southern Oscillation (ENSO) phenomenon may change over the coming decades. The research aims to shed light on why some ENSO events are much stronger than others, why some decades show much stronger ENSO activity, and how ENSO will be affected by future climate change.

The direct climatic impacts of ENSO events are felt primarily in the tropics. Hence, Scottish scientists working to better understand ENSO are collaborating with international partners to understand implications for natural resource management and to contribute to adaptation internationally. However, there are also implications for Scotland. Two key areas where ENSO can indirectly impact on Scotland are food security – e.g. mass crop failure in the tropics could cause a spike in global commodity prices – and the insurance industry – e.g. widespread storm damage on the US east coast could significantly affect the international insurance market. There could also be indirect impacts on human health if large ENSO events triggered outbreaks of diseases transferable across borders by international travel. Future policies and strategies in these areas should promote resilience to the **variability** of ENSO events.

Preliminary results suggest that:

a) The 20th C is a relatively unusual period in terms of many large ENSO events compared to the rest of the last millennium.

b) Future predictions of decadal time-scale ENSO variability remain highly uncertain, due principally to the relatively large natural fluctuations seen over the last millennium.

2. Background

The ENSO phenomenon is the largest natural mode of inter-annual climate variability in the Earth's climate system. ENSO events occur roughly every 3-5 years and involve changes to the winds, rainfall, temperature patterns and ocean currents across the whole of the tropical Pacific. These changes directly impact the lives of over a billion people living within the tropics and have global consequences in terms of commodity prices, insurance risks, ecological damage and human health issues. Although scientists now understand the basic mechanisms behind the ENSO cycle fairly well, some major questions remain, such as why some ENSO events are much stronger than others and how ENSO will be affected by future climate change.

Considerable uncertainty remains in scientific understanding of possible links between ENSO and the changing climate resulting from increased atmospheric greenhouse gas (GHG) concentrations. At the moment, any tentative predictions that can be made about the impact on ENSO of increased GHG concentrations or climate change are dwarfed by the natural year-to-year variability in ENSO's strength.

3. Summary of Research Methods

A fundamental challenge in understanding systems such as ENSO is that the directly observed record of climate is limited to the 20th century, a period insufficiently long to characterise the extent of natural variability. Consequently, researchers are indirectly reconstructing tropical Pacific climate over the past millennium using the physical and chemical properties of natural archives, such as annually-banded corals and trees. In particular, the current project is generating many centuries of new data from living and 'fossil' corals from the Galápagos Islands in the Eastern Pacific, an area highly sensitive to ENSO variability.

In order to understand the origins of changes in ENSO behaviour over the last millennium, climate model simulations are compared to the climate reconstructions. These are the same climate models as those used in the Intergovernmental Panel on Climate Change's future climate change simulations, but run over the past millennium. By comparing model simulations with different external 'forcings', such as the effect of changes in solar output, volcanoes and GHG emissions, we will better understand the sensitivity of the ENSO system to such forcings and consequently, will be better able to predict its likely future response.

4. Further Information

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