

Causation and Explanation in Our Nonlinear World

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'Causality and Explanation in Physics, Biology and Economics' Conference

18 February 2010, Barcelona

Abstract

What does a physicist mean by causation and explanation in the macroscopic world of sea gulls and circuits, carbon dioxide and computer models? Suppose that in over 99% of model-worlds in which a Brazilian sea gull flaps its wings a tornado follows in Texas and that, in addition, 97% of matching model-worlds in which that sea gull fails to flap its wings no tornado follows in Texas: what then do we conclude about actual tornados in Texas? What might climate scientists mean when they say increases in carbon dioxide cause global warming? How does this claim differ from the statement that science provided the explanation of the ozone hole and contributed to its solution? Or that our state-of-the-art (nonlinear) models can explain the climate change "trend", but not "natural variability"? The roles played by causation and explanation in the study of a simple electric circuit, a rotating bucket of heated fluid, and the Earth-System will be discussed. For none of these three systems do we have an empirically adequate model. Nevertheless, it is generally believed both that our models have high explanatory value in each case, and that the behaviour of each of these systems yields insight into causation and explanation in the other two systems.