

16th JEREMY GRANTHAM LECTURE ON CLIMATE CHANGE

Land-atmosphere exchanges of carbon, energy and water: new theory and next-generation models

Iain Colin Prentice
Chair, Biosphere and Climate Impacts
Imperial College, London

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I will present evidence that the current approach to representation of the land surface in climate and Earth System models is broken and suggest that models have entered a downward spiral whereby ever-increasing complexity is accompanied by a proliferation of poorly known parameters. I will show examples of spectacularly poor performance by current terrestrial ecosystem models in tests that were not anticipated by the models' developers. I will argue that models exist, above all, to improve scientific understanding – the role they normally play in other, less politically charged areas of science – and that their predictive power in the contemporary climate-change context will improve only in so far as they fulfil this role. I will then present a way forward in which new theory, founded on the general principles of competition and natural selection, can lead to relatively simple, novel, tractable mathematical representations of the core plant and ecosystem processes, which our new “data-rich” world permits us to test. I will show examples of the predictive power thus acquired, which often exceeds that achieved by more complex models that depend on long parameter lists. I will outline how this new approach can provide the basis for a new generation of ecosystem and land-surface models, resting on secure theoretical and empirical foundations.