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** RESUBMIT **

Maximum Entropy Production : from the Climate to the Chloroplast

RODERICK C. DEWAR[1]

[1]*Unité de Recherche EPHYSE, INRA Bordeaux-Aquitaine,*
B.P.81, 33883 Villenave d'Ornon CEDEX, France

Thirty years ago Paltridge [1-2] showed that Earth's mean annual climate closely resembles that predicted by a selection principle of maximum entropy production (MEP) associated with the turbulent transport of heat in the oceans and atmosphere. However a theoretical understanding of MEP has since remained elusive, until recently.

Building on the work of Boltzmann, Gibbs, Shannon and Jaynes, a new formulation of non-equilibrium statistical mechanics has been proposed [3-4] according to which selection of the MEP state occurs because it is the most probable non-equilibrium steady state consistent with local energy and mass conservation. This result explains the relevance of MEP not only to climate systems [5] but also to a wide range of open, non-equilibrium systems across physics and biology, for which there is a growing body of empirical evidence [6-7].

Here I begin by outlining the key physical principles leading to MEP [3-4]. Then I show why the relevant quantity for climate selection is the entropy production due to fluid turbulent dissipation, as Paltridge found, rather than the entropy production due to downgrading of solar radiation to energy at terrestrial temperatures [5]. Finally, I give an example illustrating the relevance of MEP to biological feedback processes. Stomatal regulation of leaf gas exchange appears to maximize the entropy production of the CO_2-fixating dark reactions located in leaf chloroplasts.

Keywords: Non-equilibrium; statistical mechanics; steady state; entropy production; climate; leaf gas exchange; stomata; information theory.

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