



## **Rethinking Models of the Climate with Entropy Production in Mind**

Goodwin Gibbins (1,2) and Joanna Haigh (1,3)

(1) Atmospheric Physics Group, Imperial College London, UK, (2) Mathematics of Planet Earth CDT, Imperial College London, UK, (3) Grantham Institute - Climate Change and the Environment, Imperial College London

As scientists, we explore the climate system through the lens of a collection of models and metaphors which make tractable the immense complexity of the climate system. From EBMs to GCMs, we have implicitly made decisions about which aspects of the climate system are important to faithfully reproduce and which can be neglected. Are we choosing well?

Every process within the Earth system creates entropy, the sum total of which (assuming a steady-state planet) is exported in the outgoing longwave radiation. It is not energy alone which sets the planetary climate in motion, but the movement of energy from hot to cold, from lower entropy to higher, fed by incoming solar radiation. Entropy production is at the core of the mixing processes, phase changes, heat transfers and resulting temperature distributions we study.

As a community, we do not yet have a clear picture of how to use entropy production rates for predictive purposes, but we know that entropy is a fundamental physical attribute of the climate. In this study, we examine a range of models which serve as reductions of the climate system and ask: how is entropy production represented and does it match the true climate? We define the nested entropy productions rates appropriate to subsystems within the climate, put forward an entropy-focussed reduction of the climate system, and suggest how entropy production might connect to climate sensitivity and climate change.