Geophysical Research Abstracts
Vol. 20, EGU2018-7736, 2018
EGU General Assembly 2018

Entropy Production and Coarse Graining of the Climate Fields in a General Circulation Model

Valerio Lucarini (1,2,3) and Salvatore Pascale (4)

(1) University of Reading, Department of Mathematics and Statistics, Reading, United Kingdom (v.lucarini@reading.ac.uk), (2) University of Reading, Centre for the Mathematics of Planet Earth, Reading, United Kingdom, (3) University of Hamburg, CEN, Hamburg, Germany, (4) GFDL, Princeton, USA

We extend the analysis of the thermodynamics of the climate system by investigating the role played by processes taking place at various spatial and temporal scales through a procedure of coarse graining. The coarser is the graining of the climatic fields, the lower is the resulting estimate of the material entropy production. In other terms, all the spatial and temporal scales of variability of the thermodynamic fields provide a positive contribution to the material entropy production. At all scales, the temperature fields and the heating fields resulting from the convergence of turbulent fluxes have a negative correlation, while the opposite holds between the temperature fields and the radiative heating fields. Moreover, the latter correlations are stronger, which confirms that radiation acts as primary driver for the climatic processes, while the material fluxes dampen the resulting fluctuations through dissipative processes. Using specific coarse-graining procedures, one can separate the various contributions to the material entropy production coming from the dissipation of kinetic energy, the vertical sensible and latent heat fluxes, and the large scale horizontal fluxes. Most of the entropy production is associated to irreversible exchanges occurring along the vertical direction, and neglecting the horizontal and time variability of the fields has a small impact on the estimate of the material entropy production. The approach presented here seems promising for testing climate models, for assessing the impact of changing their parametrizations and their resolution, and for investigating the atmosphere of exoplanets. Our findings deserve to be explored in a more general context, because they provide a way for understanding the relationship between forced fluctuations and dissipative processes in continuum systems.
V. Lucarini and S. Pascale, Entropy Production and Coarse Graining of the Climate Fields in a General Circulation Model, Climate Dynamics 43, 981-1000 (2014)