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Bounds on dissipation in compressible convection

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Concerning geophysical or astrophysical objects, we sometimes have measurements of the heat flux that escapes from them. For instance, the net heat flux leaving the Earth is approximately 47 TW (Davies and Davies, Solid Earth, 2010), while the luminosity ("heat flux" in astrophysics) of the Sun is $3.83 \sim 10^2 6$ W. Given that the heat flux is transported by convection, at least partly, one would like to know how much internal energy dissipation is associated with that heat flux. In mathematical terms, this question can be adressed in a simplified Rayleigh-Benard geometry. In the Boussinesq approximation, the answer is straightforward and the total (time-averaged) energy dissipated is equal to the product of the (time averaged) heat flux and the dimensionless dissipation number. In compressible convection, the answer depends on the flow configuration. We can then look for lower and upper bounds of the ratio of dissipation over heat flux. From numerical simulations, we obtain a small-scale flow configuration leading to a specific ratio when the Rayleigh number becomes sufficiently large. We will discuss whether that value can be used in general geo and astrophysical objects.

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