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On the effect of Prandtl number to subgrid-scale heat flux models

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In this work, we aim to shed light to the following research question: *can we find a subgrid-scale (SGS) heat flux model with good physical and numerical properties, such that we can obtain satisfactory predictions for buoyancy-driven turbulence at high Prandtl (Pr) numbers?* This is motivated by (i) our findings showing the reasons for the lack of accuracy of existing SGS heat flux models for LES [1, 2] (see Figure 1, left) and (ii) the fact that the flow topology in the near-wall region changes dramatically at high-Pr numbers [3]. Firstly, we plan to study *a priori* the capability of the models proposed in [2] to provide accurate approximations of the actual SGS heat flux both in the bulk and in the near-wall regions. To do so, direct numerical simulations (DNS) at high Pr will be carried out. Moreover, the availability of DNS results at $Pr = 0.7$ (air) from our previous works [1, 2] (see Figure 1, right) will allow to study the near-wall Pr-number effects. In this regard, it may be possible that some additional corrections/modifications of the model will be needed. Secondly, we plan to study *a posteriori* the performance of these models. In this case, LES simulations will be carried out with the same code and results compared with the DNS data. In a first stage, we plan to study the (*a posteriori*) modelization effects in the bulk region. This can be done by properly refining in the near-wall region. Finally, *a posteriori* tests including the modelization effects of the near-wall region will be performed.

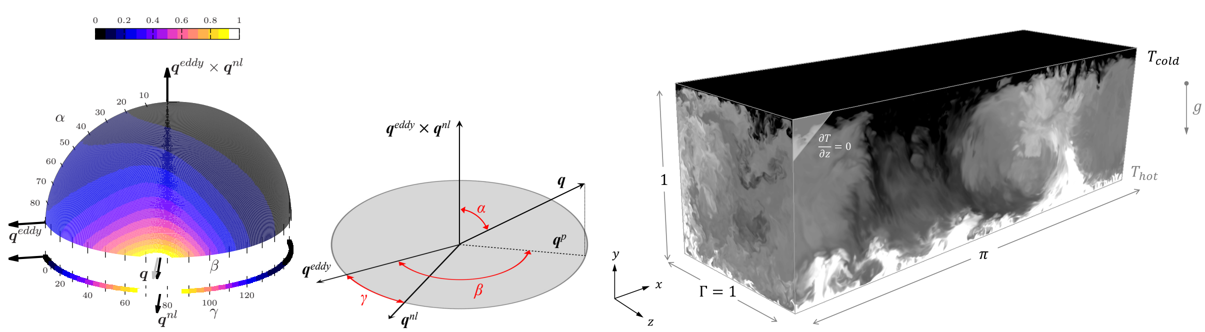

Figure 1: Left: alignment trends of the actual SGS heat flux, q. For details the reader is referred to our work [1]. Right: DNS of the air-filled RBC at $Ra = 10^{10}$ studied in Refs. [1, 2].

References

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