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On a proper tensorial subgrid heat flux model for LES

F.X. Trias[1], A. Gorobets[2], A. Oliva[1]

[1] Heat and Mass Transfer Technological Center, Technical University of Catalonia, C/Colom 11, 08222 Terrassa (Barcelona), francesc.xavier.trias@upc.edu

[2] Keldysh Institute of Applied Mathematics, 4A, Miusskaya Sq., Moscow 125047, Russia

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In this work, we aim to shed light on 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 Rayleigh numbers (Ra)?* This is motivated by our previous findings showing the reasons for the lack of accuracy of existing SGS heat flux models for LES. Namely, (i) linear eddy-diffusivity models are completely misaligned with the actual SGS heat flux, whereas (ii) non-linear models, such as the gradient model, may lead to numerical instabilities due to the presence of (eigen)directions with negative diffusivity. In this context, we first plan to study *a priori* the capability of exiting (non)linear models to provide accurate approximations of the actual SGS heat flux both in the bulk and in the near-wall regions. To do so, we will use the data of our previous DNS results of air-filled Rayleigh-Bénard convection at Ra up to 10^{11}. This analysis will include a new unconditionally stable non-linear model that can indeed be viewed as a stabilized version of the above-mentioned gradient model. In this way, we expect to combine the good *a priori* accuracy of the gradient model with the stability required in practical numerical simulations. 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 the 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.