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A comparison between eddy-viscosity models and direct numerical simulation: the response of turbulent flow to a volume force PAOLO LUCHINI, SERENA RUSSO, DIIN – Università di Salerno – Italy — Inspired by P. Luchini & F. Charru's[1] analysis of the phase lead of the wall-shear stress at a channel's perturbed bottom, we identified a benchmark problem simple enough that it can be solved both by an eddy-viscosity model, similar to those typically used in shallow-water flow calculations, and by direct numerical simulation. This is the linear response of a turbulent flow's mean-velocity profile to an external volume force. Such a force, of unspecified origin in the present context, was found in[2] to be representative of the perturbation induced by bottom topography, and its consequences were analysed by means of an eddy-viscosity model. On the other hand, a modification of Luchini, Quadrio & Zuccher's[3] method to compute the linear impulse response of a wall-bounded turbulent flow allows the response to a volume force to be computed directly. The comparison exhibits significant differences and suggests that there might be fundamental obstacles to designing an eddy-viscosity model that provides the correct result.

[1]Luchini, P., Charru, F., The phase lead of shear stress in shallow-water flow over a perturbed bottom, *J. Fluid Mech.* **665**, 516-539 (2010)
[2]Ibid.
[3]Luchini, P., Quadrio, M., Zuccher, S., The phase-locked mean impulse response of a turbulent channel flow, *Phys. Fluids* **18**, 121702 (2006).

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