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On the Reynolds number dependence of large-scale friction control in turbulent channel flow

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Abstract

The present work investigates the effectiveness of the control strategy introduced by Schoppa & Hussain [Phys Fluids 10:1049--1051 (1998)] as a function of the Reynolds number.

The skin-friction drag reduction method proposed by these authors, consisting of streamwise-invariant, counter-rotating vortices, was analysed by Canton *et al.* [Flow Turbul. Combust. doi:10.1007/s10494-016-9723-8 (2016)] in turbulent channel flows for friction Reynolds numbers (Re_τ) of 104 and 180.

Under these conditions the method proved to be successful and was capable of providing a drag reduction of up to 18%.

The objective of the present study is to analyse the effects of higher Reynolds number on this drag-reducing strategy.

Two new sets of Direct Numerical Simulations have been performed for Re_τ =360 and 550.

These simulations, along with the ones carried out for lower Re_τ, constitute an extensive database that allows an in-depth analysis of the method as a function of the control parameters (amplitude and wavelength) and the Reynolds number.

Results show that the effectiveness of the method is reduced as the Reynolds number increases above Re_τ =180 and no drag reduction can be achieved for Re_τ =550 for any combination of the parameters controlling the vortices.

An analysis of the effects of Re_τ on the mechanics of the control is presented as a function of both outer and inner (viscous) scaling.

Despite the negative outcome, the present results offer ideas upon which to improve the control strategy.

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September, the 22nd, 2016 at 11:30
Sala Consiglio, 2nd Floor, Building B12, Campus Bovisa
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