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12-mode reduced order models of Waleffe and Couette flow ANDRE CAVALIERI, Instituto Tecnologico de Aeronautica — New reduced-order models (ROMs) are derived for sinusoidal shear flow (Waleffe flow) and plane Couette flow. The derivation for Waleffe flow exploits Fourier modes that form an orthonormal basis for the problem, and a ROM is obtained by a Galerkin projection of the Navier-Stokes equation. A large basis was reduced to 12 modes that contribute significantly in maintaining chaotic, turbulent dynamics. A key difference from earlier ROMs is the inclusion of two roll-streak structures, with spanwise wavelengths equal to L_z and $L_z/2$, where L_z is the spanwise length of the computational box. The resulting system was adapted to Couette flow with the same 12 modes, modified to satisfy no-slip conditions on the walls. The resulting dynamical systems lead to turbulence with finite lifetimes, in agreement with earlier ROMs and simulations in small domains. However, the present models display lifetimes that are much longer than in earlier ROMs, with differences of more than an order of magnitude. The Couette-flow model is compared to results of direct numerical simulation (DNS), with statistics displaying fair agreement. The inclusion of the L_z and $L_z/2$ lengthscales is seen to be a key feature of the models: neglecting their interaction leads to drastic lifetime reductions.

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