Theoret. Comput. Fluid Dynamics (1996) 8: 449–450

Theoretical and Computational Fluid Dynamics

Erratum: The Effect of Modeled Drag Reduction on the Wall Region[1]

(*Theoret. Comput. Fluid Dynamics*, 1:229–248, 1990)

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The low-dimensional model described in this paper displays an intermittent phenomenon with ejection and sweep phases that strongly resemble the bursting phenomenon observed in the boundary layer. The probability distribution of interburst times has the observed shape [6]–[8], [2]. However, we now recognize that the bursting period predicted by the model is much longer than the bursting period observed in the boundary layer. Note that a factor of $[L_1 L_3]^{1/2}$ was omitted from the left-hand side of the equation in Appendix A of [1], which had the accidental result of making the bursting periods comparable with observation; this was corrected in [5], although its full implications were realized only recently. The same factor (333 for the specific case considered) was also omitted in the calculations described in this paper; hence, all of the times noted on the time history figure abscissas are in error by this factor. The amplitudes of the a's (and therefore the statistics such as the Reynolds stresses, the two-point correlations, etc., together with the phase portraits) remain quantitatively correct.

A similar slow cycle has also been observed in direct numerical simulations of a minimal flow unit [3]. We believe that this results from the fact that, in the low-dimensional model, the same coherent structure is followed; this is also true in the minimal flow unit. In the real boundary layer, a succession of statistically

[1] Nadine Aubry was supported by the U.S. National Science Foundation under the PYI Award MSS89-57462 and Grant No. CTS-9423304. John Lumley was supported in part by Contract No. F49620-92-J-0287 jointly funded by the U.S. Air Force Office of Scientific Research (Control and Aerospace Programs), and the U.S. Office of Naval Research, in part by Grant No. F49620-92-J-0038, funded by the U.S. Air Force Office of Scientific Research (Aerospace Program), and in part by the Physical Oceanography Programs of the U.S. National Science Foundation (Contract No. OCE-901 7882) and the U.S. Office of Naval Research (Grant No. N00014-92-J-1547).

independent coherent structures is observed. In effect, a single coherent structure bursts relatively infrequently, but when a succession of such is convected past the observation point, bursting is observed much more often. A simple statistical model of this situation restores the magnitude of the observed bursting period, although there is a great deal of flexibility in the various parameters involved. For a fuller discussion, see [4].

References

[1] N. Aubry, P. Holmes, J.L. Lumley, and E. Stone. The dynamics of coherent structures in the wall region of a turbulent boundary layer. *J. Fluid Mech.*, 192:115–173, 1988.

[2] P.J. Holmes and E. Stone. Heteroclinic cycles, exponential tails and intermittency in turbulence production. In T.B. Gatski, S. Sarkar, and C.G. Speziale, editors, *Studies in Turbulence*, pages 179–189. Springer-Verlag, New York, 1992.

[3] J. Jimenez and P. Moin. The minimal flow unit in near-wall turbulence. *J. Fluid Mech.*, 225:213–240, 1991.

[4] B. Podvin, J. Gibson, G. Berkooz, and J.L. Lumley. Lagrangian and Eulerian view of the bursting period. Technical Report FDA 96-01, Sibley School of Mechanical and Aerospace Engineering, Cornell University, Ithaca, NY, 1996.

[5] S. Sanghi and N. Aubry. Mode interaction models for near-wall turbulence. *J. Fluid Mech.*, 247:455–488, 1993.

[6] E. Stone and P.J. Holmes. Noise induced intermittency in a model of a turbulent boundary layer. *Phys. D*, 37:20–32, 1989.

[7] E. Stone and P.J. Holmes. Random perturbations of heteroclinic cycles. *SIAM J. Appl. Math.*, 50(3):726–743, 1990.

[8] E. Stone and P.J. Holmes. Unstable fixed points, heteroclinic cycles and exponential tails in turbulence production. *Phys. Lett. A*, 155:29–42, 1991.