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Simulating wall-bounded turbulence[1]

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In the past 20 years, direct simulations of turbulent channels have grown from $Re_\tau \approx 200$ to 2000, and the number of grid points, from about 5 Mp to 20 Gp. This has given us access to buffer layer dynamics, and now to incipient logarithmic layers and cascades. We can now do conceptual experiments on the latter (100 Mp), which should soon lead to dynamic understanding. DNS of channels has become a full partner of experiments, both in data quality and in Reynolds number. Challenges persist. A full log layer would require $Re_\tau \approx 10^4$ and a Petapoint. That should happen in 5-10 years. Other flows have progressed slower. ZPG boundary layers are only now being pushed to $Re_\tau \approx 10^3$ (5 Gp), and almost nothing is available on the APG BL. We have grown used to computer growth, but new problems are appearing. The processor count for DNSes has grown by a factor of 10 per decade (now about 1000). It is not clear whether present methods will work in $10^5 - 10^6$ processors. Even now, CPU time is becoming stochastic as different users compete for memory access. Postprocessing is a bottleneck. We now store O(10 TB) per simulation (1 KB/point). It will soon grow into PBs. Postprocessing software tends to be ad-hoc, and not well adapted to shared facilities. Managing TBs in 'personal' computers is possible, but hard. Even harder, and more important, is to share this amount of information among groups. The prospects are however good. The community has faced similar challenges before and, with the help of computer scientists and others, it has succeeded up to now.

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