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A Mathematical Framework for Linear Analysis of Large-Scale n-Periodic Systems: Applications to Spanwise Arrays of Wall Irregularities or Jets[1] ATHANASIOS T. MARGARITIS, Imperial College London, TARANEH SAYADI, Sorbonne University, OLAF MARXEN, University of Surrey, PETER J. SCHMID, Imperial College London — Boundary-layer stability and transition to turbulence is a major field of research for aerospace vehicle design. While unperturbed flow poses complexities in itself, in a variety of applications the boundary layer encounters a spanwise n-periodic array of surface irregularities, such as roughness or jet injections. In most cases, numerical simulations treat these configurations as periodic over each unit, thus neglecting cross-unit dynamics. In this work, we expand an earlier mathematical framework for the analysis of n-periodic arrays of fluid systems and apply it to large-scale simulations of flows using an operator-free approach for the linear analysis. Using a domain that spans only a triplet of units it is possible to extract the linear dynamics for arbitrary numbers of units with minimal additional cost. This formulation allows to study the stability, wake synchronization, and cross-unit dynamics of n-periodic systems from reduced-cost simulations without the assumption of fully periodic flow. We test this mathematical framework to canonical flat-plate boundary layer with roughness or jet injections; it is possible to extend the methodology to complex configurations and implement it in existing codes in a minimally intrusive way. Preliminary results will be presented.

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