Abstract Submitted
for the DFD20 Meeting of
The American Physical Society

Extraction of finite-time coherent sets in 3D Rayleigh-Benard Convection using the dynamic Laplacian GARY FROYLAND, University of New South Wales, ANNA KLUENKER, KATHRIN PADBERG-GEHLE, CHRISTIANE SCHNEIDER, Leuphana University, JOERG SCHUMACHER, Technical University Ilmenau — Turbulent convection flows in nature are often organized in regular large-scale patterns, which evolve slowly relative to to the typical convective timescale, and are arranged on spatial scales that are much larger than the layer height. Prominent examples are cloud streets in the atmosphere and granulation patterns in solar convection. This order in a fully developed turbulent flow is sometimes called turbulent superstructure in convection. Large-scale structure formation in turbulent Rayleigh-Benard convection recently became accessible in direct numerical simulations, which resolve all relevant scales of turbulence in horizontally extended domains with a large aspect ratio. Using DNS output we apply the dynamic Laplacian approach [Froyland, 2015] to identify these turbulent superstructures as finite-time coherent sets in both quasi-2D and fully three-dimensional settings. A modest number of trajectories are meshed and a finite-element based method is employed to numerically estimate the dynamic Laplacian [Froyland Junge, 2018]. The coherent sets are encoded in the leading eigenvectors of the dynamic Laplacian, and the individual coherent sets are "decoded" using the recently developed Sparse Eigenbasis Approximation (SEBA) algorithm [Froyland, Rock, Sakellariou, 2019]

Gary Froyland
University of New South Wales

Date submitted: 31 Jul 2020 Electronic form version 1.4