Abstract Submitted
for the DFD19 Meeting of
The American Physical Society

Internal Boundary Layer Induced by Dune-Field Roughness ANDREW GUNN, University of Pennsylvania, RYAN EWING, Texas A&M University, MATTHEW WANKER, DOUGLAS EDMONDS, Indiana University Bloomington, PHILLIP SCHMUTZ, University of West Florida, DOUGLAS JEROLMACK, University of Pennsylvania — Within atmospheric boundary layers(BL), internal BL (IBL) develop across sharp flow-normal topographic changes in planetary surfaces. At White Sands, New Mexico, topographic change is brought about by the BL itself in the form of wind-blown sand dunes. There is an abrupt roughness change from a smooth playa to a dune field, inducing an IBL. We have measured wind profiles of the unidirectional BL across the roughness transition with 3 meteorological towers simultaneously on an along-flow axis, and 2 Doppler lidar deployments. Our results show profiles downwind from the roughness transition have decreased surface stress and northward deflected flow w.r.t. those upwind, consistent with an equilibrium expectation from Rossby similarity theory. An IBL, however, is a non-equilibrium phenomena and is yet to be observed to include secondary flow. Using a Lagrangian 1D BL model, we show this large change in roughness can, with sufficient fetch, introduce geostrophic secondary flow and match our observations. We close this land-atmosphere feedback loop via repeat high-resolution aerial topographic surveys, finding that this IBL in-turn steers and slows the dune migration along-wind. We believe our results can generalize to other cases such as canopies and coasts.

Andrew Gunn
University of Pennsylvania

Date submitted: 02 Aug 2019

Electronic form version 1.4