GCSC & Mechanical Engineering Special Guest Seminar

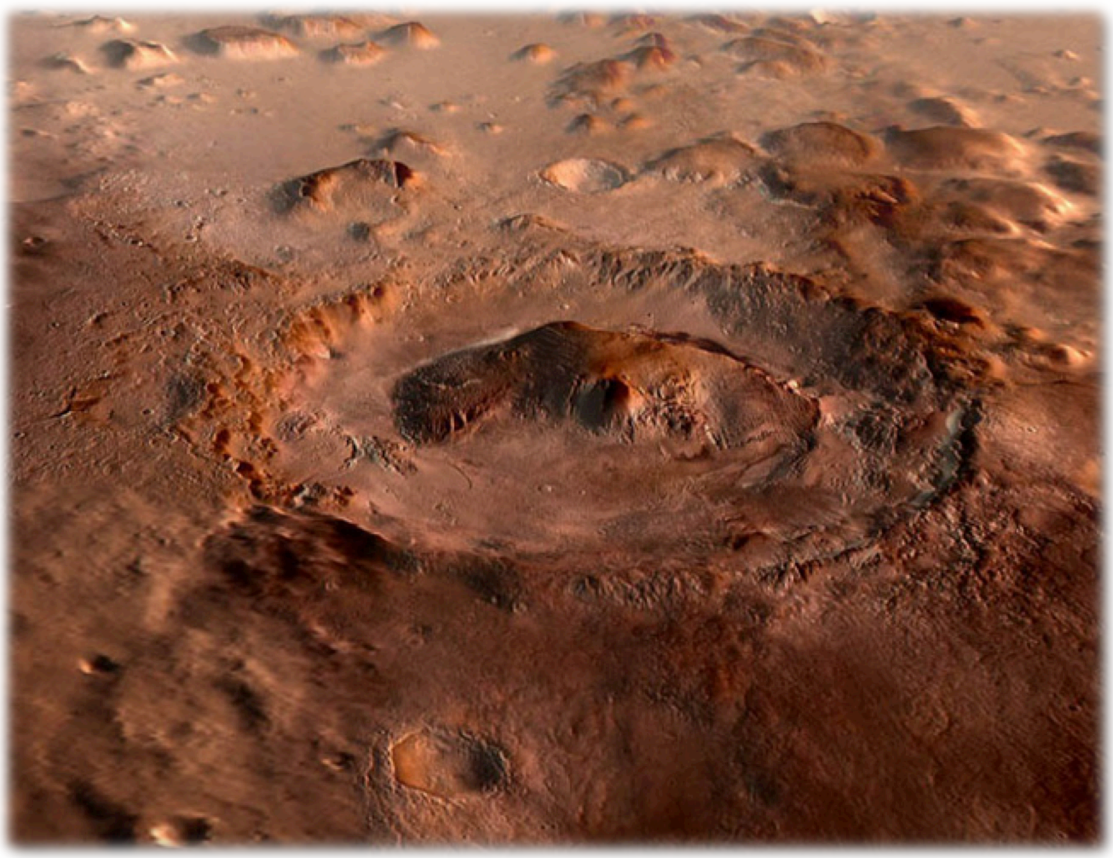
May 15, 2017
2:00-3:00 PM
210 ASB (Aline Skaggs Bldg)

ALL ARE WELCOME

William Anderson

Mechanical Engineering Department, The University of Texas at Dallas

"Large-eddy simulation of planetary boundary layer turbulence: aeolian morphodynamics on Earth and Mars"



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Abstract

High Reynolds number rough wall turbulent flows are ubiquitous in engineering and geophysical flows. Turbulence influences the aero-/hydro-dynamic signature of bluff bodies and the performance of vapor power systems; in geophysical flows, turbulence impacts urban dispersion, the hydrologic cycle, and sedimentary processes in fluvial/aeolian systems. We present results from LES of neutrally stratified atmospheric boundary layer flow over a sparsely vegetated, arid landscape, to explore the role of coherent structures in driving aeolian processes. Conceptual models for aeolian erosion typically indicate that sediment mass flux, q (via saltation or drift), scales with imposed aerodynamic stress raised to some exponent, n, where $n > 1$. Since aerodynamic stress (in fully rough, inertia-dominated flows) scales with incoming velocity squared, u^2, it follows that $q \sim u^{2n}$ (where u is some relevant component of the flow, $\boldsymbol{u}(\boldsymbol{x},t)$). Thus, even small (turbulent) deviations of u from its time-averaged value may be important in aeolian activity. We have used conditional averaging predicated on aerodynamic surface stress during LES (where threshold selection is guided by probability density functions of local surface stress). This averaging procedure provides an ensemble-mean visualization of flow structures responsible for erosion “events”. Preliminary evidence indicates that surface stress peaks are associated with the passage of inclined, high-momentum regions flanked by adjacent low-momentum regions. In addition, results are presented over crater-like geometries with attributes resembling those found on Mars. Craters are common topographic features on the surface of Mars, and many craters on Mars contain a prominent central mound (NASA’s *Curiosity* rover was landed in Gale crater). Resultant datasets suggest a deflationary mechanism wherein vortices shed from the upwind crater rim are realigned to conform to the crater profile via vortex stretching and tilting. This was accomplished using three-dimensional Reynolds-averaged datasets (momentum and vorticity) retrieved *a posteriori* from LES. As a result, helical vortices occupy the inner region of the crater and, therefore, are primarily responsible for aeolian morphodynamics in the crater. These results suggest that secondary flows – originating from flow separation at the crater – have played an important role in shaping landscape features observed in craters (including the dune fields observed on Mars, many of which are actively evolving).

Bio

Anderson received his PhD in Mechanical Engineering from The Johns Hopkins University in July 2011. He began as a tenure-track faculty in the Mechanical Engineering Department at Baylor University in Fall 2011, and moved to the University of Texas at Dallas in Fall 2014. His research interests focus on rough wall turbulent flows; this has relevance to planetary boundary layers, aerospace engineering, and mechanical engineering. The Army Research Office (ARO), Air Force Office of Scientific Research (AFOSR), the National Science Foundation (NSF), and the Texas General Land Office (TGLO) currently support his research activities. He is a 2014 recipient of the AFOSR Young Investigator Program award.