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Surface Effects on large-scale solar convection

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Abstract. The upper boundary of the solar convection zone displays vigorous fluid motions associated with the observed patterns of supergranulation, mesogranulation, and granulation, as well as a complex interplay with magnetic structures in the photosphere. These both play a large role in the turbulent transport of heat to the solar surface. The downflows associated with these effects produce downward motions that plunge from the surface into the near-surface layers of the Sun bringing cooler, low entropy material with them. These flow structures in turn modify the nature of larger scale motions, such as giant cells, that extend beyond the near-surface regions. To investigate such dynamics, we have carried out several 3-D numerical simulations of fully compressible fluids within curved, spherical segments that, at this stage, approximate conditions near the top of the rotating solar convection zone. In one set of simulations we exlpore the consequences of enhanced surface cooling in and around active regions to explore the formation of large-scale flows in the surrounding photosphere. In the second set of simulations, the upper boundary of the segment is stochastically driven with cool plumes that approximate the spatial and temporal scales of supergranular cell downflows, in essence creating a network of supergranular cells. We explore the formation and evolution of the boundary layer resulting from such stochastic driving, and discuss these dynamics in the context of the near-surface shear layer of the solar convection zone.