Abstract Submitted
for the DFD17 Meeting of
The American Physical Society

A Kàrmàn-Howarth-Monin equation for variable-density turbulence CHRIS LAI, JOHN CHARONKO, KATHY PRESTRIDGE, Los Alamos National Laboratory — We present a generalisation of the von Kàrmàn-Howarth-Monin (K-H-M) equation to include variable density (VD) effects. The derived equation: (i) reduces to the original K-H-M equation when density is a constant and (ii) leads to a VD-analogue of the 4/5-law with the same value of constant (=4/5) appearing as the prefactor of dissipation rate. The equation is employed to understand negative turbulent kinetic energy production in a SF_6 turbulent round jet with an initial density ratio of 4.2; from a Reynolds-averaged Navier-Stokes (RANS) perspective, negative production is indicative of an inverse energy cascade. We show that an inverse cascade exists in the development region of the jet and is captured by the linear scale-by-scale energy transfer term in the variable-density K-H-M equation. There is a redistribution of scale energy among turbulent eddies such that off-axis eddies lose their energies to the forward-cascading eddies oriented in the streamwise direction.The nonlinear transfer term of the VD-K-H-M equation depicts a conventional forward cascade for all eddies having a size less than the Eulerian integral length scale, regardless of their orientation. The net effect is a retarded energy cascade that has not been accounted for by existing turbulence theories.

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Date submitted: 31 Jul 2017 Electronic form version 1.4