In this paper, we present an adaptive algorithm to construct response surface approximations and to perform global sensitivity analysis for high-fidelity models using a hierarchy of lower fidelity models. The main contributions of this paper are:

- The extension of Multi-index stochastic collocation (MISC) to function approximation. The original MISC papers, upon which our work is based, focused on estimation of moments using quadrature.

- The development of an adaptive multi-index collocation approach based upon sparse grid approximation. The seminal multi-index collocation paper used *a priori* estimates of model and parameter importance to allocate samples across the model ensemble. Our algorithm adaptively balances physical discretization, response surface error, and parameter importance.

- Formulation of a multi-index method for variance based sensitivity analysis.

- Application of multi-index collocation to an engineering application of practical importance, specifically UQ of a nozzle of an unmanned aerospace vehicle.