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Statistical-geometric tools for studying vector and tensor-based parameterizations for geophysical transport processes

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When parameterizations are proposed for vector or tensorial physical quantities (such as heat and momentum fluxes), there are implicit geometric assumptions made that pertain to the vector directionality, or tensor eigen-directions. In this talk, we review a set of new statistical-geometric tools designed not only to evaluate vector-based and tensor-based models, but also to gain physical intuition to help in guiding the design of new parameterizations of complicated natural transport processes in numerical models. As a detailed example, these geometric methods are applied to the specific problem of closure models for subgrid scale (SGS) fluxes in large eddy simulations of the atmospheric boundary layer. We show, through the the analysis of field data, the usefulness and applicability the statistical geometric approach by testing models for the SGS heat flux and stress. Moreover, some plausible generalizations of this approach are proposed for possible applications to other areas including flow and transport in porous media and other mixing problems.