Abstract Submitted
for the DFD20 Meeting of
The American Physical Society

A Statistical Closure for Turbulent Zonal Jets based on the Generalized Quasilinear Approximation[1] GIRISH NIVARTI, Department of Applied Mathematics, University of Leeds, Leeds LS29JT, UK, BRAD MARSTON, Department of Physics, Brown University, Providence, Rhode Island 02912-1843, USA, STEVEN TOBIAS, Department of Applied Mathematics, University of Leeds, Leeds LS29JT, UK — The generalized quasilinear (GQL) approximation was applied recently to the simulation of zonal jets on the spherical surface and on the beta plane. GQL allows for a systematic improvement over quasilinear equations by generalizing the conventional Reynolds decomposition: rather than decomposing fields into a mean and fluctuation, GQL projects them into large- and small-scale zonal modes. In this framework, considerable accuracy can be achieved in regimes with strong driving even when few large-scale zonal modes are retained. In the present work, we derive a statistical closure based on cumulant expansions starting from the GQL approximation. The resulting generalised cumulant expansion (GCE2) equations allow for direct statistical simulation of the first and second cumulants. Thus, GCE2 retains the generalisation embodied in GQL and also precludes the need for Direct Numerical Simulation in order to collect statistics. We use GCE2 to simulate a deterministically-forced barotropic jet on the spherical surface and on the beta plane, and evaluate its performance in comparison to GQL. Plausible applications of GCE2 to other astro/geophysical problems are discussed.

[1]This work was funded by ERC under the Horizon 2020 programme (grant no. D5SDLV-786780).

Girish Nivarti
Department of Applied Mathematics, University of Leeds, Leeds LS29JT, UK

Date submitted: 31 Jul 2020 Electronic form version 1.4