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Flux-driven global gyrokinetic simulation of tokamak turbulence

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The Eulerian gyrokinetic turbulence code GENE (www.ipp.mpg.de/˜fsj/gene) has recently been extended to include full radial temperature, density, and geometry variations. Moreover, collisions between any pair of particle species and electromagnetic effects are considered, and the turbulence can be either gradient- or flux-driven. In the former case, Krook-type sources are employed across the radial domain to keep the profiles almost constant, while in the latter case, localized sources and sinks are used, and the central temperatures and densities may float. Careful benchmark tests are performed successfully. In addition to running GENE in a stand-alone fashion, the code is also coupled to the TRINITY transport solver in order to facilitate extremely long time scale simulations. This setup is applied to address three related transport issues concerning nonlocal effects. First, it is confirmed that in gradient-driven simulations, the local limit can be reproduced - provided that finite aspect ratio effects in the geometry are treated carefully. In this context, it also becomes clear that it is useful to define a modified ρ^* value, reflecting the width of the profiles (not of the device). Thereafter, extensions to flux-driven cases are presented. Second, the nature and role of heat flux avalanches are discussed in the framework of both local and global, flux- and gradient-driven simulations. Third, important aspects of transport barrier physics are studied in the context of electron internal barriers in TCV as well as edge barriers in ASDEX Upgrade.