Increase of Turbulence and Transport with Resonant Magnetic Perturbations in ELM-Suppressed Plasmas on DIII-D

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Abstract. Long wavelength turbulence increases dramatically in the outer regions of DIII-D plasmas with the application of resonant magnetic field perturbations (RMP) that suppress edge-localized modes (ELMs). Correspondingly, transport increases and global energy confinement decreases in these low collisionality RMP-ELM suppressed discharges. The core and pedestal density are sharply reduced, while ion and electron temperatures may change only slightly. Low wavenumber density turbulence ($k_\perp\rho_i<1$) in the range of 60–300 kHz, measured with beam emission spectroscopy (BES), is modified and generally increases throughout the outer region ($0.6<\rho<1.0$) of the plasma in response to RMPs over a range of q_{95} values; ELM suppression, in contrast, occurs for a narrower range in q_{95}. Radial magnetic field modulation experiments indicate that these turbulence modifications occur on a time scale of a few milliseconds or less near ρ=0.85–0.95, significantly faster than transport time-scales and faster than the local pressure gradients and shearing rates evolve at these locations. As the internal coil current is modulated in a square-wave fashion from 3.2 to 4.2 kA, the turbulence magnitude varies in phase by 30% or more, while local density changes by only a few percent. This dynamical behavior suggests that the turbulence is directly affected by the RMP, which may partially or largely explain the resulting increased transport and stabilization of the pedestal against peeling-ballooning instabilities that are thought to drive ELMs.