Temporal evolution of H-mode pedestal in DIII-D

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Abstract. The temporal evolution of pedestal parameters is examined in the initial ELM-free phase and inter-ELM phases of H-mode discharges in the DIII-D tokamak. These discharges are heated by deuterium neutral beam injection and achieve Type-I ELMing conditions. Pedestal parameters exhibit qualitatively similar behavior in both the ELM-free and inter-ELM phases. There is a trend for the widths and heights of pedestals for electron density, temperature and pressure to increase during these phases; the increase in width is most pronounced in the density. Near the separatrix, the ion temperature achieves higher values but a flatter profile as compared to the electron temperature. Higher heating powers lead to a faster evolution of the pedestal and to a shorter period until the onset of an ELM. For sufficiently long ELM-free or inter-ELM periods, some parameters, particularly gradients, approach a steady state. However, a simultaneous steady state in all parameters is not observed. The simultaneous increase of density width and pedestal density is opposite to the predictions of a simple model, which predicts that the density width is set by neutral penetration. Thus, additional physics must be added to the simple model to provide a more general description of pedestal behavior. However, the barrier growth is qualitatively consistent with time-dependent theoretical models that predict a self-consistent temporal growth of the pedestal due to $E \times B$ shearing effects. In addition, observations of a linear relation between the density width and the square root of the pedestal ion temperature are qualitatively consistent with model predictions that pedestal width depends on the ion gyroradius. These pedestal studies suggest that a complete model of the pedestal width in Type-I ELMing discharges must be time-dependent, include transport physics during inter-ELM periods and include the limits to pedestal evolution imposed by the ELM instability.

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