The dielectric properties of liquid water are determined in large part by the orientational fluctuations of dipolar water molecules. Near a liquid water-vapor interface these orientational fluctuations are constrained and anisotropic, leading to dielectric properties that differ significantly from their bulk values. These differences are fundamental to interface-selective chemical and physical processes but they are generally difficult to predict. We attempt to understand these differences by considering the statistical mechanics of hydrogen bonding at the liquid water interface. Using a mean-field model, we demonstrate that three-body hydrogen bond defects that are stabilized at the interface contribute significantly to determine the interfacial dielectric properties. We utilize this mean field model to study the properties of hydrophilic interfaces and then adapt this perspective to the development of an order parameter that can be used to mapping the dynamic hydration properties of proteins.