Magnetosphere-ionosphere coupling is responsible for storm time disturbance electric field propagation to equatorial latitudes, by processes of direct penetration and disturbance wind dynamo. New results have been forthcoming in recent years from satellite and ground based observations and modeling studies on the important characteristics of these electric fields as well their effects on the electrodynamics of the equatorial ionosphere and thermosphere, especially, in terms of their impact on the equatorial spread F (ESF) plasma bubble irregularity development conditions that is in focus here. The disturbance zonal electric fields, when superimposed on equatorial evening prereversal enhancement electric field, PRE, can drastically modify the post sunset, and night time, F layer heights, a basic control factor for the instability growth by Rayleigh-Taylor mechanism leading to plasma bubble development. Based on published results and some new data we present here a comprehensive, but brief, analysis and discussion of the processes of ESF development, suppression or disruption under different phases of a storm activity sequence. Consequences for ESF occurrence from under-shielding and over-shielding penetration electric fields as well as from the disturbance winds and wind dynamo electric field occurring in different local time sectors of the night, as also the irregularity dynamics and longitude distributions, etc., are highlighted in this presentation. Some outstanding problems for further research are also presented.