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Remote sensing of ionospheric space weather through radio waves: New insights

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Although polar ionosphere is severely affected during geomagnetic storms and magnetospheric substorms, the impact of these disturbances on the low latitude ionospheric electrodynamics can be quite significant. Several prompt electric field perturbations can affect the ionosphere over low-equatorial latitudes. While during storm times, prompt penetration (PP), overshielding (OS) and solar wind dynamic pressure induced electric field perturbations (related to changes in IMF Bz) can affect the equatorial ionosphere and generate impact leading to disruption in radio wave propagation, the other types of non-conventional prompt electric field perturbations (like substorm, IMF By) have not received due attention so far. As a consequence of this existing gap area, the impact of space weather induced electric field perturbations over low latitudes are not fully understood making the model predictions difficult and challenging. It is, therefore, increasingly becoming obvious that in order to step forward towards a comprehensive understanding of low latitude ionosphere, one has to go beyond the existing paradigm wherein one only considers the effects of IMF Bz and sharp changes in the solar wind dynamic pressure as the main drivers for the prompt electric field perturbations.

Both coherent and incoherent radars operating at HF or VHF frequencies can play very important roles in deciphering the changes in the ionospheric space weather in quiet as well as in disturbed times. These changes come in the form of variations in ionospheric height and drifts, generation of plasma irregularities, evolution of plasma plumes and uncharacteristic variations in the ionospheric drifts that lead to anomalous plasma distribution over low latitudes. On some occasions, the perturbations are anomalous and on other occasions, these perturbations are extreme. In this presentation, a few such aspects wherein radio techniques play very important roles will be highlighted based on the results obtained by our group. It will be argued that non-conventional drivers like substorm induced electric field and IMF By affect the low latitude ionosphere significantly on many occasions and it will be a gross simplification of the underlying physics if one bracket each of these prompt electric field disturbances within the conventional driver category.