Using Principal Component Analysis to Characterize the Equatorial F2 Peak During Geomagnetic Storms

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In the present study, a Principal Components Analysis (PCA) is used to determine significant patterns in ionospheric behavior from ionograms. Pattern characteristics of the pre-reversal enhancement of the equatorial F2 peak are examined for the two-year study period that spans 2001-2002. Jicamarca Digisonde data are used to determine the F2 critical frequencies, peak heights, and changes in the peak heights with respect to time. Correlations between the F2 peak characteristics and geomagnetic indices of interest, including ap, Dst, and the Polar Cap Index (PCI), will be presented in comparison with the corresponding correlations to the Principal Component(s) derived from these indices. The selection of these specific parameters was motivated by the need to provide an overall measure of the disturbance of the ionosphere on a planetary scale (ap), the strength of the ring current (Dst), and the intensity of the cross-polar cap potential (as given by a proxy through PCI). These three indices provide diagnostic information that may be useful in predicting so-called penetration electric fields, which are known to augment the vertical drifts of the F2 layer in the equatorial ionosphere.

For stormtime conditions, PCI and Dst had a relatively weak correlation of 0.25, compared with the stronger correlation between Dst and ap of 0.56 over the study period. In general, strong correlations are needed for an effective PCA. With this study, we show that the addition of even the weakly correlated PCI does contribute a small improvement to the selection of a single Principal Component. With these results, we anticipate that a single Principal Component based on ap, Dst, and PCI can be used to replace ap as a driver for the STORM module of the International Reference Ionosphere.