Analysis of Ionospheric Variations over Japan during 23rd Solar Cycle Using Wavelet Techniques

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Abstract : The characterization of spatio-temporal inhomogeneities occurring in the ionospheric F_2 layer is remarkable since these variations are direct consequences of electrodynamical coupling between magnetosphere and solar events. The temporal and spatial variations of the F_2 layer, which occur with a period of several days or even years, mainly owe to geomagnetic and meteorological activities. The hourly F_2 layer critical frequency (foF2) over 23rd solar cycle (1996-2008) of three ionosonde stations (Wakkanai, Kokunbunji, and Okinawa) in northern hemisphere, which falls within same longitudinal span, is analyzed using continuous wavelet techniques. Morlet wavelet is used to transform continuous time series data of foF2 to a two dimensional time-frequency space, quantifying the time evolution of the oscillatory modes. The presence of significant time patterns (periodicities) at a particular time period and the time location of each periodicity are detected from the two-dimensional representation of the wavelet power, in the plane of scale and period of the time series. The mean strength of each periodicity over the entire period of analysis is studied using global wavelet spectrum. The quasi biennial, annual, semiannual, 27 day, diurnal and 12 hour variations of foF2 are clearly evident in the wavelet power spectra in all the three stations. Critical frequency oscillations with multi-day periods (2-3 days and 9 days in the low latitude station, 6-7 days in all stations and 15 days in mid-high latitude station) are also superimposed over large time scaled variations.

Keywords : continuous wavelet analysis, critical frequency, ionosphere, solar cycle
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