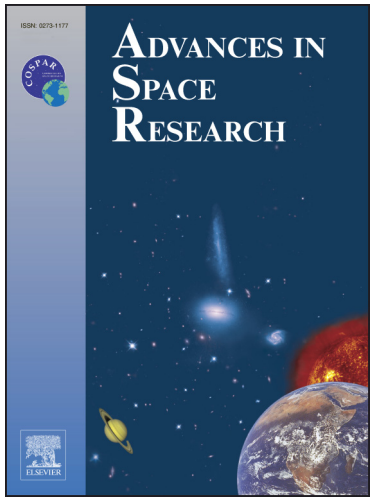

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Long-term changes in space weather effects on the Earth's ionosphere

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Abstract

Certain limitations that have been identified in existing ionospheric prediction capabilities indicate that the deeper understanding and the accurate formulation of the ionospheric response to external forcing remain always high priority tasks for the research community. In this respect, this paper attempts an investigation of the long-term behavior of the ionospheric disturbances from the solar minimum between the solar cycles 23 and 24 up to the solar maximum of solar cycle 24. The analysis is based on observations of the foF2 critical frequency and the hmF2 peak electron density height obtained in the European region, records of the Dst and AE indices, as well as measurements of energetic particle fluxes from NOAA/POES satellites fleet. The discussion of the ionospheric behavior in a wide range of geophysical conditions within the same solar cycle facilitates the determination of general trends in the ionospheric response to different faces of space weather driving. According to the evidence, the disturbances in the peak electron density reflect mainly the impact of geoeffective solar wind structures on the Earth's ionosphere. The intensity of the disturbances may be significant (greater than 20% with respect to normal conditions) in all cases, but the ionospheric response tends to have different characteristics between solar minimum and solar maximum conditions. In particular, in contrast to the situation in solar maximum, in solar minimum years the solar wind impact on the Earth's ionosphere is mainly built on the occurrence of ionization increases, which appear more frequent and intense than ionization depletions. The ionization enhancements are apparent in all local time sectors, but they peak in the afternoon hours, while a significant part of them seems not related with an F2 layer uplifting. Taking into account the main interplanetary drivers of the disturbances in each case, i.e. high speed streams (HSSs) and corotating interaction regions (CIRs) in solar minimum and coronal mass ejections (CME) in solar maximum, we argue that the identified tendency may be considered as evidence of the ionospheric response to different solar wind drivers.

1. Introduction

The transient changes imposed on the Earth's ionosphere by space weather events remain always one of the most fascinating but challenging topics for space weather purposes (e.g., Kutiev et al.,