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Helio-geomagnetic influence in cardiological cases

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Abstract

The effects of the energetic phenomena of the Sun, flares and coronal mass ejections (CMEs) on the Earth's ionosphere–magnetosphere, through the solar wind, are the sources of the geomagnetic disturbances and storms collectively known as *Space Weather*. The research on the influence of *Space Weather* on biological and physiological systems is open. In this work we study the *Space Weather* impact on Acute Coronary Syndromes (ACS) distinguishing between ST-segment elevation acute coronary syndromes (STE–ACS) and non-ST-segment elevation acute coronary syndromes (NSTE–ACS) cases. We compare detailed patient records from the 2nd Cardiologic Department of the General Hospital of Nicaea (Piraeus, Greece) with characteristics of geomagnetic storms (D_{ST}), solar wind speed and statistics of flares and CMEs which cover the entire solar cycle 23 (1997–2007). Our results indicate a relationship of ACS to helio-geomagnetic activity as the maximum of the ACS cases follows closely the maximum of the solar cycle. Furthermore, within very active periods, the ratio NSTE–ACS to STE–ACS, which is almost constant during periods of low to medium activity, changes favouring the NSTE–ACS. Most of the ACS cases exhibit a high degree of association with the recovery phase of the geomagnetic storms; a smaller, yet significant, part was found associated with periods of fast solar wind without a storm.
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Keywords: Space weather; Magnetic storms; Substorms; Sunspots

1. Introduction

The energetic events of the Sun (flares and coronal mass ejections (CMEs)) release radiation, energetic particles and plasma in the interplanetary space; when they are earth-bound, they affect the terrestrial environment. The energetic events induce rapid changes of the solar wind parameters; the Solar Wind speed can increase from its 400 Km/s quiet-period near-Earth mean value, to 800 Km/s which is typical of perturbed periods. This high-speed solar wind triggers magnetic and ionospheric storms; major triggering, however, requires also a southward oriented interplanetary magnetic field, which facilitates reconnection of the solar wind magnetic field lines with the geomagnetic field. These magnetospheric disturbances are known as *Space Weather* (see Kivelson et al., 1995 for a review). The NASA definition of Space Weather[1] is: "*The conditions and processes occurring in space which have the potential to affect the near Earth environment. Space Weather processes can include changes in the interplanetary magnetic field, coronal mass ejections from the Sun and disturbances in Earth's magnetic field. The effects of space weather can range from damage to satellites to disruption of power grids on Earth*". The magnetospheric response to *Space Weather* is quantified by geomagnetic indices. In this work, we use the D_{ST} index, which is an estimate of the magnitude of the geomagnetic disturbance based on the change of earth's ring current (e.g. Kivelson et al., 1995). For values of D_{ST} less than 50 nT we have a geomagnetic storm or substorm.

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[1] Space Weather Centre/NASA.

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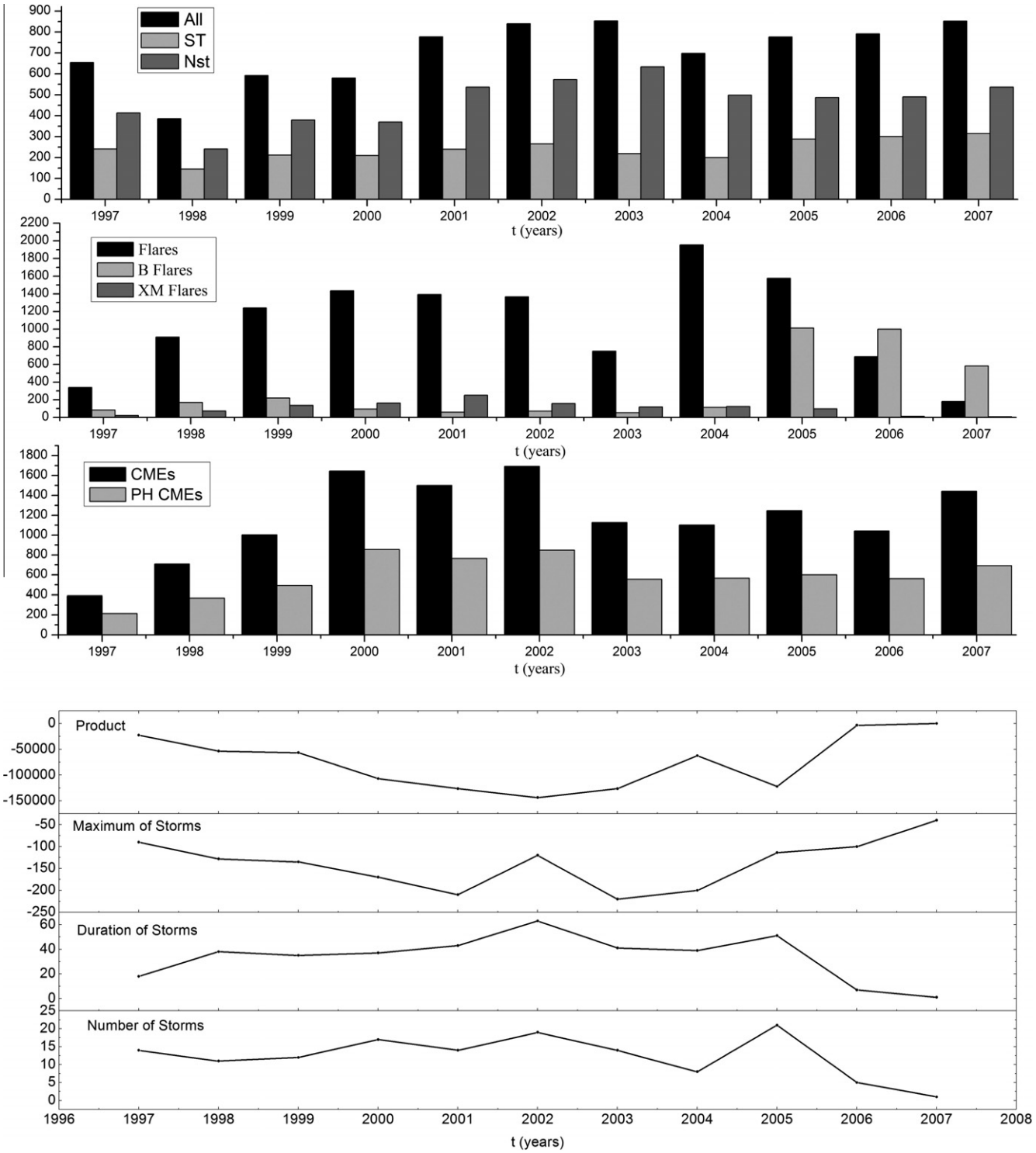

Fig. 1. Top to bottom: annual distribution of ACS (ST and NST), CMEs and partial-halo CMEs, flares and intense flares (X–M flares) as well as B flares (three upper panels). Annual number of storms, their total annual duration, the annual D_{ST} maximum value and their product (four lower panels).

The influence of *Space Weather* on biological and physiological systems is important. The geomagnetic field variations (from helio-geomagnetic disturbances) seem to affect, directly or indirectly, the human physiology and health (Palmer et al., 2006); this has been an open research objective for the last three decades. Possible mechanisms linking solar and geophysical parameters to human health have been proposed (Cherry, 2002). The study of the effects

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