THE INFLUENCE OF SOLAR ACTIVITIES AN OCCURANCE OF THE FOREST FIRES IN SOUTH EUROPE

Milan M. RADOVANOVIĆ,[a] Tomislav M. PAVLOVIĆ[b], Gorica B. STANOJEVIĆ[a], Miško M. MILANOVIĆ[c], Mila A. PAVLOVIĆ[c], Aleksandar R. RADIVOJEVIĆ[d]

[a]Geographical Institute “Jovan Cvijić”, Serbian Academy of Sciences and Arts - SASA,
[b]University of Niš, Faculty of Natural Sciences and Mathematics, Department of Physics
[c]Faculty of Geography, Belgrade, Serbia
[d]University of Niš, Faculty of Sciences and Mathematics, Department of Geography

Abstract: *In mid-July 2012, hundreds of fires spread over forest stands in the south of Europe. Considering available satellite and meteorological data we have tried to determine a method using analogy, whether these fires were preceded by the intensified solar activity. The justification of this approach lies in the belief that it is impossible by direct or indirect activity of man to set fire at the same time to the sites that are geographically separated. In this paper we have tried to test the hypothesis claiming that charged particles coming to us from the Sun may be responsible for the number of forest fires. Unlike some other situations when the potential explanation could be a sudden influx of the protons of different energy ranges, in our study, there are electrons as carriers of the potential explanation. Many previous studies results have shown that there is statistically significant relationship between the processes on the Sun and certain movements of air masses in the atmosphere our planet. The presented results in this paper of the correlation relationships between the mean hourly flows of electrons and the mean hourly air temperatures in Belgrade and Rome and the analysis of the synoptic situation as a function of the suggested model so far, indicate that the number of fires that were occurring more than a week, from July 15, 2012, in the south of Europe, were caused by electrons coming from the Sun.*

Keywords: *solar activity, electrons, forest fires, South Europe*

1. Introduction

On 15th July 2012 the public was informed that 212 fires were recorded in Serbia on that day. After examining the satellite image (Figure 1) it proved that at that time fires were registered in the wider area of the Balkan Peninsula, Sicily, northern Turkey and Ukraine. The next few days the fires occurred in Bosnia and Herzegovina to such an extent that the authorities requested military aid from Croatia in order to prevent further spreading of the fire. After 2-3 days the public was informed that fires on the border between Spain and France were out of control and there were also casualties. The Canary Islands, Madeira Island and about 5 000 ha of forests in the south of Portugal in the Algarve tourist region were also endangered [1].

Fig. 1 - Satellite image of the distribution of fire over the Balkan Peninsula and adjacent areas 07/15/2012 09:25 UTC. Retrieved July 16 2012 from http://rapidfire.sci.gsfc.nasa.gov/cgi-bin/imagery/gallery.cgi

In Croatia, near the town of Rijeka, a fire-fighter was killed. On 18th July Greek authorities declared the state of emergency in five villages near the city of Patra, in the northern part of the Peloponnese peninsula on the rough terrain due to the fires that raged for days. The suburb of Athens was also threatened by the destructive power of fire. In the coming days information on a number of sites affected by fire in Macedonia and Montenegro was continuously arriving. On 24th July, 2012 in the evening it started raining which considerably facilitated the situation in most of the Balkan Peninsula. It is important to note that many of the locations burning (hot spots), of smaller area of 1.1 km^2 are not registered on satellite images because of the limited possibilities of measuring instruments. As in many other situations studied the cause of the initial phase of the flame in this case also remains unknown. Gorte, points out that: "Research information on causative factors and on the complex circumstances surrounding wildfire is limited" [2]. The value of wildfires as case studies for building predictive models is confined because the *a priori* situation (e.g. fuel loads and distribution) and burning conditions (e.g. wind and moisture levels, patterns, and variations) are often unknown". Even if the possible role of pyromaniacs (as well as any other potential explanation regarding the direct or indirect role of man) is accepted for the occurrence of fire in specific locations, it remains unclear how there is a selective ignition of vegetation in remote places on the same day [3,4]. In Serbia the drought dominated a few weeks earlier so the assumption that electrical discharges in the atmosphere may be an explanation, has remained unsubstantiated. It is unrealistic to expect that lightning can be attributed to biomass burning at such remote locations without being rainfall in any of them [5,6]. It is founded that from 1990 to 1998 over 17000 naturally ignited wildfires were observed in Arizona and New Mexico on US federal land during the fire season of April through October. Lightning strikes associated with these fires accounted for less than 0.35 % of all recorded cloud-to-ground lightning strikes that occurred during the fire season during that time [7]. In addition, the role of the wind in the spread of the fire is not clear, especially if one takes into account the 'skip' of certain vegetation complexes horizontally as well as vertically, i.e. altitude [8]. The studies conducted by Csiszar et al., (2005) bring additional concerns about the coupling of climate and fires [9]. According to them, the most numerous fires detected by satellites in the period 2001-2002 took place from November to February in the belt of 7.5 to 22.5° N. The problem of collecting data using uniform methodology greatly burdens not only any serious statistical spatial-temporal analysis but also the work on any kind of projection models [10]. That is why the following statement does not come on surprise: "Thus, research on fire protection and control is considering challenging and predictive tools for fire protection and control are often based substantially on the expert opinion and anecdotes rather than on the documented research evidence" [11].

When the region of the south Europe it has been noticed that with the increase in average annual temperatures it comes to an increase in the number of fires in the past few decades. Regarding the region of the Mediterranean it is particularly necessary to point on that a recent regional situation analysis published in the frame of the FAO Global Forest Fire Assessment 1990-2000 reveal that the average annual number of forest fires throughout the Mediterranean basin is close to 50 000, i.e. twice as many as during the 1970s. [12]. According to Nikolov (2006) it can be concluded that, in average, 58.8 % from the total number of forest fires in the country of the Balkan Peninsula for the period 1988-2004 has human origin, 3.3 % has natural origin and 37.9 % has unknown origin [13]. Given the geographic spread of fires in the mentioned period we have tried in the paper to test the hypothesis according to which the forest fires, for which there are no determined causes, are connected with the processes on the Sun, that is, charged particles [14]. According to these authors, charged particles are able in certain circumstances to penetrate the ground and burn plant mass which actually represents the initial phase of flame phenomenon. Under certain conditions it is primarily meant on the critical level of density of particles per unit volume which diffuse to the lower layers of the atmosphere. Protons and electrons (with a very strong eruptions, nucleons, too), ejected from the coronal holes and/or energy sources towards the Earth are moving in the form of an electric jet. A simplified representation of the penetration of the solar wind (SW) through the atmosphere is given in Figure 2. Increased cloudiness is also a limiting factor because the water vapour in the atmosphere acts as absorbent of the charged particles [15]. In the polar areas due to the SW burst a process known as reconnection takes place. If the *Bz* component of the interplanetary magnetic field (IMF) has a negative sign it comes to merging with the geomagnetic field, i.e. reconnection in the areas above the North Pole. In contrast, it comes to reconnection over the Antarctic if *Bz* component has a positive sign [16]. Thus, the process is going on in the area where the Earth's magnetic field is the strongest. Otherwise, the IMF goes around the Earth. "We found that the events occurring during closed geomagnetic conditions do not show common peaks at all high latitude stations and tend to be coherent only among the Antarctic stations, while there is a lack of coherence between high latitude opposite the hemispheres. Conversely, during open geomagnetic conditions the pulsation events are characterized by discrete frequencies, the same at all stations, and are generally highly coherent between high and low latitudes and between opposite the hemispheres" [17].

Fig. 2 - Schematic survey of the way of SW penetration towards topographic surface [13].

In the equatorial regions the penetration occurs due to the orientation of the IMF towards the part of the geomagnetic field which is the weakest. Theoretical model according to which the charged particles penetrate the ground through geomagnetic anomaly and after scattering on the ground could cause burning of biomass, for the first time, to our knowledge, was presented by Gomes and Radovanović [18]. At the same time there is an impression that these processes are accompanied with certain patterns of disorders in the movement of air masses [19]. Idea on the dominant influence of the processes on the Sun (including cosmic rays) on the movement of air masses in the atmosphere is not new [20-24]. According to Troshichev, Janzhura (2004), Troshichev et al., (2005) the disturbance in the fluctuation of the SW causes the changes in the atmospheric electric field resulting in the alterations of the cloudiness of troposphere and the atmospheric radiation budget and dynamics [25]. Georgieva et al., (2007) have come to the conclusion that long-periodic correlation between the solar activity and the atmospheric circulation changes in the consecutive solar secular cycles and it depends on the north-south asymmetry [26]. McKenzie, Hessl et al, (2004) showed that certain quantitative connection between fires and drought periods do exist in eastern Washington, as well as quasi-periodical connection with ENSO (3-7 years periodicity) and PDO (20-30 years periodicity) [27].

On the basis of the available data applying complex linear regression for the period 1891-2004, Milovanović, Radovanović, (2009) tested the connection between the solar activity and atmospheric circulation [28]. The values for adjusted R^2 were calculated from 0,572-0,825. According to Tinsley, Yu, (2004) "there has not been any decisive result which would discern how many of the monitored decade variations were formed because of the entry of the flux of particles, comparing to the total or spectral changes of radiation [29]. However, there is not such ambiguity concerning the correlation of the atmospheric dynamics with particle flows on the weather scale day after day." The report by Baldwin and Dunkerton (2001) shows that stratospheric mean-flow variations induce circulations that penetrate into the lower troposphere [30]. To investigate these results more in detail, Boberg (2003) have used GPH data on 16 pressure levels covering both hemispheres to see if the proposed correlation exists in the terrestrial stratosphere and troposphere [31]. The results show a statistical E-GPH connection extending from the lower stratosphere down to the surface.

2. Causality of Processes on the Sun and Forest Fires in South-East Europe on the 15th of July 2012

Based on the theoretical considerations as well as the analysis of processes in the interplanetary space and in the atmosphere, we will attempt to test the hypothesis by which the forest fires are preceded by scattering of charged particles through the lower layers of the troposphere. According to data taken from NASA (Figure 3, left) a strong transmission of energy from the Sun occurred on 12th July 2012. In the immediate vicinity of the active region 1520 there were regions 1519 and 1521 (http://www.nasa.gov/mission_pages/sunearth/news/News071212-X1.4flare.html). On the same day, in the afternoon, in the interplanetary space, a sudden increase in the flow of charged particles occurred in all energy ranges (Figure 3, right).

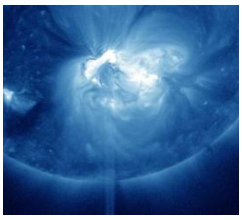
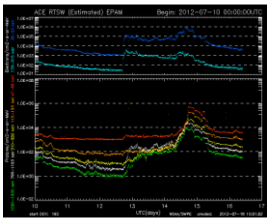

Fig. 3 - An X1.4 class flare erupted from the center of the sun, peaking on July 12, 2012 at 12:52 PM EDT. It erupted from Active Region 1520 which rotated into view on July 6. Retrieved July 16 2012 from (http://www.nasa.gov/mission_pages/sunearth/news/News071212-X1.4flare.html) (left) and a sudden rise of electron (upper sketch) and proton (bottom sketch) flows in all energy ranges on 12th July 2012 reached a peak late in the evening on 14th July 2012. Retrieved July 17 2012 from (http://www.swpc.noaa.gov/ace/EPAM_7d.html) (right)

The Figures 4, 5 confirm visually that there is a potential connection between the sudden influx of the energy from the Sun and the geomagnetic anomaly. Following the images that were taken from the same source in the coming hours it was observed that there was also a reconnection.

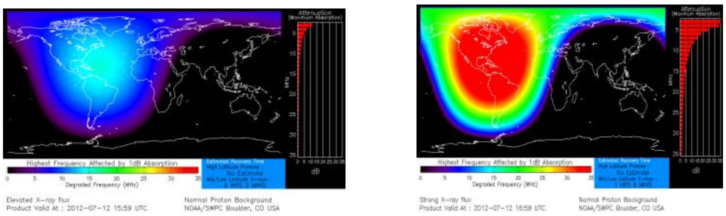

Fig. 4, 5 - Ionospheric conditions on 12th July 2012 over the geomagnetic anomaly of the western Atlantic and eastern Pacific. Left image is related to 15:59 and right to 16:59 UTC. Retrieved July 17 2012 from (http://www.ngdc.noaa.gov/stp/drap/data/2012/07/12/SWX_DRAP20_C_SWPC_20120712165900_GLOBAL.png)

When it comes to reconnection it appears that at the beginning the stronger flow of energy to the Earth has mainly been directed towards the southern hemisphere. The first serious intrusion on the northern hemisphere over the polar region occurred in 2012 07 15 at 0023 UT when the measured energy flow of 93.1 GW was measured (Retrieved July 16, 2012 from http://www.swpc.noaa.gov/pmap/Plots.html). On the same day at 1536 UT, the flow rate of 384.3 GW was measured (taken from the same source). Following the idea according to which a sudden influx of charged particles has the possibility of penetration into the lower layers of the troposphere an analysis of the movement of air masses was carried out on the day when numerous fires occurred in Serbia (Figure 6). Yellow isolines in the Figure show an average wind speed both horizontally and vertically.

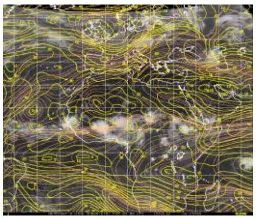

Fig. 6 - Wind Shear in the 150-300 mb layer mean minus 700-925 mb layer mean. Retrieved July 16 2012 from http://tropic.ssec.wisc.edu/real

In the previous Figure we can see clearly how the wind speeds reached the highest value northwest of Portugal and Spain to the Pyrenees, the Alps, the northern Adriatic Sea and the north-western and northern Balkan Peninsula. The maximum values were reaching over 80 knt (~ 40 m/s) and it should not be disregarded that this has been a curved movement of air masses of the approximate west-east direction, but also from above to downward. Jet Stream over Europe on 250 hPa (July 15, 2012) and Synoptic situation over Europe on 15th July 2012, 00 UTC are given in Figure 7.

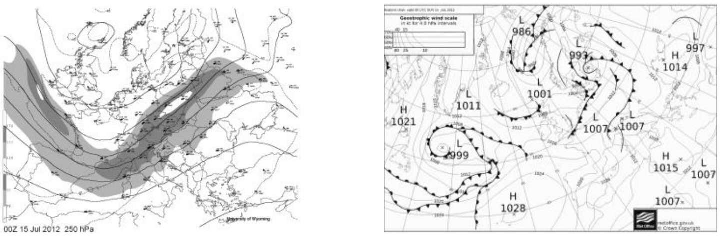

Fig. 7 - Jet Stream over Europe on 250 hPa. Retrieved July 15, 2012 from http://weather.uwyo.edu/cgi-bin/uamap (left) and Synoptic situation over Europe on 15th July 2012, 00 UTC Retrieved July 16, 2012 from (http://meteonet.nl/aktueel/brackall.htm) (right)

Based on Figure 7 (left) we can also see a similar direction of movement of air masses (jet stream) except that, unlike the previous image, in this we can see 2d representation which confirms that there has been a strong movement of air masses over the same geographical area. In the days that followed an increased number of fires coincided with these atmospheric disturbances. According to Gabis, Troshichev (2000), fluctuations of baric field within periods of 5±10 days are typical of the meridional and zonal transfer in the troposphere (500 mb-level) [32].

Based on the synoptic map (Figure 7, right) we can see that there is a relatively high air pressure from 1014 – 1015 mb over almost the whole of the Mediterranean and the Balkan Peninsula (including the areas to the Black Sea), while up to 1020 mb was measured over the Iberian Peninsula. In contrast, left of the main direction of the jet stream shown in Figures 7 and 8, in central and north Europe, there is a relatively low air pressure - below 1007 mb. Analysis which would aim to connect the atmospheric pressure with the scattering of charged particles in the northern part of Africa and north Europe would imply much more complex approach, which was not the goal of this research.

According to Black (2002) the results are in keeping with the view where the potential anomalies of vortex in the lower part of the stratosphere, associated with changes in strength of the stratospheric polar whirlpool (vortex) are causing zonal symmetric wind disturbances, spreading down toward the surface [33]. The position of the opening of the magnetospheric door greatly depends on the moving of the geomagnetic poles for it is clear the magnetosphere coordinates (including also geomagnetic anomalies) link magnetic poles, and not the geographic ones. This is an essential factor which should represent the integral part of the forcasting models [4]. Radovanović (2012 b) emphasizes the fundamental importance of the south magnetic pole moving (which is located in the northern hemisphere) [34]. The moving of the poles is directly connected with the movement of the entire network of geomagnetic lines, including the positions of anomalies. Therefore, if there is a hydrodynamic intake of air masses within these processes, then their influence on the meteorological conditions should be followed by the movement of magnetospheric coordinate network. In order to come to more real conclusions it is clear that the temperature data must be examined in much greater database and the links with some other indicators of the solar activity. Nikolić et al., (2010) give arguments that connect the daily mean values of proton flux with the average daily values of air temperatures in Torino (Italy) [35]. A drop in temperature, at the field of low atmospheric pressure, is the consequence of the downward vertical advection of cold air masses under the effect of the dynamic pressure of proton particles of corpuscular solar radiation, that is, shock wave protons. In contrast, areas that come under the influence of electrons, on the basis of presented considerations, should be characterized by relatively stable weather conditions and increased air pressure [36].

Based on this approach, in general, it is possible on the basis of detection of a sudden influx of charged particles to expect the occurrence of forest fires for up to several days in advance. However, for precise determination of location where the fires will occur, the research of experts from various fields is necessary. Such a team research should provide the answer to the question of how it comes to a propagation of charged particles to the ground, i.e. burning of bio mass.

3. The Theoretical and Mathematical Considerations of the Charged Particles Moving Through the Troposphere

Let us suppose that with a deeper penetration of the current field to the ground, the power of the electric field becomes weaker and thus the power of its magnetic layer, too. After opening, the charged particles begin to scatter from the current field on the principle of the left coil: protons to the left and electrons to the right in relation to the dominant direction of current field [37]. In fact the intensity and the direction of the electromagnetic force $\vec{F}$ is determined by the vector product:

$$d\vec{F} = I\,d\vec{l} \times \vec{B} \qquad (1)$$

where **I** is the electric convection current generated by particles in motion, $d\vec{l}$ is a vector of length of the current element and $\vec{B}$ is the magnetic induction strength vector eq. (1).

Upper relation connects electrical and mechanical values with the magnetic ones. When we apply this relation to the free electric loads of the SW, ranging in geomagnetic field, then we can say that the electromagnetic force is essentially a physical force, acting on the free electrical loads:

$$\vec{F} = q\vec{v} \times \vec{B} \qquad (2)$$

where q is the electrical load of particles, and $\vec{v}$ is particle velocity eq. (2).

When a SW charged particle, which has a velocity **v**, electrical load **q** and mass **m**, penetrates into the geomagnetic field of the induction **B** after opening the current field, then it is affected by the electromagnetic force, that is, the force of electric and magnetic fields.

Bearing in mind that the particle velocity v covers an angle θ with the vector of the magnetic induction B, the velocity can be decomposed into two components: component $v\cos\theta$, which is in the direction of the field and component $v\sin\theta$, which is perpendicular to the direction of the magnetic field. The first longitudinal component of the particle velocity v cosθ indicates that the movement of particle will be even and in the direction of the magnetic field. Another transversal component of the particle velocity $v\sin\theta$ will cause circular movement in the level which is perpendicular to the magnetic field (Figure 8). By mutual action of these components one gets that the resultant particle trajectory is coil with a cylinder-shaped tube, with a radius

$$r = mv\sin\theta/qB \qquad (3)$$

$$d = (2\pi r/v\sin\theta)\,v\cos\theta = 2\pi\,rmv\cos\theta/qB \qquad (4)$$

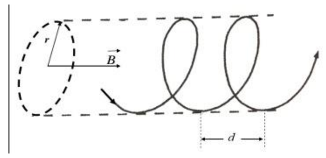

Fig. 8 - Schematic representation of the resultant trajectory of the corpuscular radiation particle

This means that with deeper penetration into the lower layers of the atmosphere, the influence of geomagnetic field increases, that is, geomagnetic induction B increases, which results in a decrease in the radius of the current field. Magnetic layer of the current field does not allow the scattering of particles and with decreasing radius particle density increases, that is, momentum.

Wind speed outside the equatorial belt can be described by the equation (5)

$$v = c \frac{rqB}{m \sin\theta} \quad \text{where c is the sliding factor.}$$

Momentum is a vector value, which intensity is defined by product of vector $\vec{v}$ and scalar *m*, where $\vec{v}$ is the velocity, and m is mass of particles eq. (6).

$$\vec{p} = \mathrm{m}\vec{v} \tag{6}$$

The speed of change of momentum in time is equal to the force acting and has the same direction as the force (Figure 9).

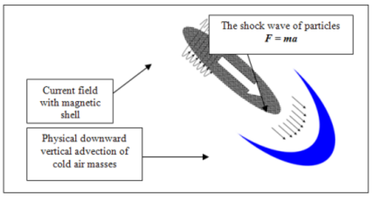

Fig. 9 - Schematic representation of the downward vertical advection

Distribution of particles through the lower layers of the troposphere will depend on the altitude and the angle at which scattering of particles occurs. At the moment of loss of circulation kinetic energy the gravity and electric field force will act upon electrons. If the loss of kinetic energy of electrons occurs at relatively higher altitudes, the impact of electric field force will prevail. Otherwise, the electrons will be directed towards the ground.

4. Analysis of the Flux of Protons and Electrons with Series of Air Temperature and Humidity in Belgrade and Rome in the Period 9th - 24th July 2012

Considering the previous results we have tried to establish a quantitative relationship between hourly flow rates of electrons and protons and hourly values of air temperature and relative humidity in Belgrade and Rome for a period 09-24 July 2012 (Data for hourly flow rates of protons and electrons are taken from: http://www.swpc.noaa.gov/ftpdir/lists/ace2/201207_ace_epam_1h.txt Data for daily flow rates of protons and electrons are taken from: http://www.swpc.noaa.gov/weekly/index.html. Data for hourly values of air temperature and relative humidity in Belgrade were obtained from the Republic Hydro meteorological Service of Serbia. The daily average temeratures in Rome were kindly send by AIR FORCE, C.N.M.C.A, National Centre of Meteorology, Air and Clima, 3° Service „Climatology“, Rome, Italy). We analyzed the period from the beginning of the rapid flow of charged particles to 24th July when the rain subsided the situation with the fires in the Balkan Peninsula. Data for the station of Belgrade were measured according to the local time hence it was necessary to be complied with the Coordinated Universal Time (UTC). In the analysis, 2-hour time lag of time series in Belgrade was taken into account, compared to the measurements of protons and electrons. We assumed that it takes a certain period of time while charged particles reach the lower elevations and eventually are reflected on the down-to-earth measurements. Looking strictly mathematically it is found that the calculated values are relatively low: the strongest correlation was obtained for the flow of electrons in the range of 38-53 particles/cm^2-s-ster-MeV and an air temperature of r = 0.29. In view of a possible link between the flow of charged particles and relative air humidity the strongest relationship was obtained for the flux of electrons in the same range but the negative correlation of r = -0.32 (Table 1).

Table 1. Pearson correlation coefficients for hourly and daily values of electrons and protons and temperature (T) and relative humidity (R) in Belgrade, period 9-24 July 2012

Hourly values	**T**	**R**	**Daily values**	**T**	**R**
Electrons 38-53/cm²-s-ster-MeV	0.29*	-0.32*	Electrons 38-53/cm²-s-ster-MeV	0.34	-0.16
Electrons 175-315/cm²-s-ster-MeV	0.10**	-0.17*	Electrons 175-315/cm²-s-ster-MeV	0.14	0.17
Protons 47-68/cm²-s-ster-MeV	0.20*	-0.22*	Protons 47-68/cm²-s-ster-MeV	0.19	-0.20
Protons 115-195/cm²-s-ster-MeV	0.23*	-0.23*	Protons 115-195/cm²-s-ster-MeV	0.22	-0.20
Protons 310-580/cm²-s-ster-MeV	0.25*	-0.25*	Protons 310-580/cm²-s-ster-MeV	0.24	-0.19
Protons 795-1193/cm²-s-ster-MeV	0.25*	-0.26*	Protons 795-1193/cm²-s-ster-MeV	0.23	-0.14
Protons1060-1900/cm²-s-ster-MeV	0.26*	-0.26*	Protons 1060-1900/cm²-s-ster-MeV	0.24	-0.13

* Significant at 0.05 level
**Significant at 0.10 level

At the start of the study it was clear that strong correlations cannot be expected, primarily due to the large range of charged particles flow in a relatively short time compared to the values of air temperature and relative humidity. Despite the fact that this is a statistically small sample, testing is done on correlation links at daily averaged values. The obtained results are slightly better for the flux of electrons in the range of 38-53 particles/cm^2-s-ster-MeV and air temperature r = 0.34 (with data for the station of Belgrade (Table 1) and the flux of protons p> 100 MeV and relative air humidity r = 0.56 (Table 2). In the analysis for Rome (weather station AM Rome Ciampino Airport), we had daily mean values of air temperature (Table 3). It turned out that almost identical values were obtained for the flux of electrons in the range of 38-53 particles/cm^2-s-ster-MeV and air temperature as for Belgrade r = 0.37, while for the flux of protons p> 100 MeV and the air temperature somewhat different values of r = -0.58 were obtained.

Table 2. Pearson correlation coefficients for daily values of electrons and protons (different scale for flux) and temperature (T) and relative humidity (R) in Belgrade, period 9-24 July 2012

	T	R
Electrons >2/cm²-s-ster-MeV	0.17	-0.23
Protons >1/cm²-s-ster-MeV	0.21	-0.21
Protons >10/cm²-s-ster-MeV	0.21	-0.22
Protons >100/cm²-s-ster-MeV	0.05	0.56*

*Significant at 0.05 level

Table 3. Pearson correlation coefficients for daily values of electrons and protons and temperature (T) in Rome, period 9-24 July 2012 and Pearson correlation coefficients for daily values of electrons and protons (different scale for flux) and temperature (T) in Rome, period 9-24 July 2012

Correlation coefficients for daily values of electrons and protons and temeparture (T) in Rome, period 9-24 July 2012		**Correlation coefficients for daily values of electrons and protons (different scale for flux) and temeparture (T) in Rome, period 9-24 July 2012**	
	T		T
Electrons 38-53/cm²-s-ster-MeV	0.37	Electrons >2/cm²-s-ster-MeV	0.28
Electrons 175-315/cm²-s-ster-MeV	-0.07	Protons >1/cm²-s-ster-MeV	0.38
Protons 47-68/cm²-s-ster-MeV	0.37	Protons >10/cm²-s-ster-MeV	0.29
Protons 115-195/cm²-s-ster-MeV	0.38	Protons >100/cm²-s-ster-MeV	-0.58*
Protons 310-580/cm²-s-ster-MeV	0.38	-	-
Protons 795-1193/cm²-s-ster-MeV	0.35	-	-
Protons1060-1900/cm²-s-ster-MeV	0.35	-	-

* Significant at level 0.05

For a more detailed consideration of the causal connection between the propagation of protons and electrons to the ground and the occurrence of forest fires it is necessary to bear in mind that penetration of the current field through the troposphere is not uniform. Therefore, the effect that charged particles would cause on the ground requires more complex modelling. Figure 10 we can see that there are certain ‘matches’ in the example of hourly mean values of air temperature in Belgrade and the flow of electrons in the range 175-315/cm^2-s-ster-MeV.

According to Weng (2012), it should be kept in mind that once a solar preferred atmospheric circulation patterns and related weather/climate events occur, the nonlinear wave-mean interaction will be in effect, resulting in zonal index cycle, which may or may not synchronize with solar activity [38].

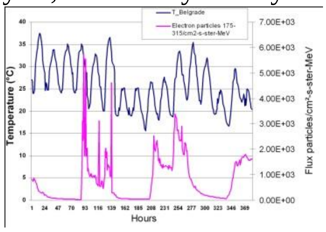

Fig. 10. Hourly values of air temperature in Belgrade and electrons 175-315/cm2-s-ster-MeV in the period 9-24 July 2012

In this regard Ogurtsov et al, (2010) point out that it can be very difficult to reveal these variations because the character of the originating cause–effect relation is extremely complex, and this problem can hardly be solved using the traditional methods of statistical analysis [39].

5. Conclusion

In this paper using the method of analogy, and on the basis of the available satellite and meteorological material we have tried to determine whether the increased solar activity was preceded by the numerous forest fires in South Europe in mid-July 2012. In the period from 15th July most countries around the Balkan Peninsula issued a statement about the fires in their territories the situation was only claimed with the absence of rain on 24th July. The starting hypothesis is that the charged particles from the Sun are in certain circumstances able to penetrate the ground and burn plant mass, that is, initiate a flame. A strong emission of energy from the Sun occurred on 12th July, which was manifested in a sharp increase in the charged particles in all energy ranges in interplanetary space, in order that a maximum followed on 14th July, in the evening. Analysis of synoptic conditions on 15th July indicates increased wind speed (over 40 m/s) in the area above the northern part of the Iberian Peninsula, the Alps, the northern Adriatic Sea and the north-western and northern part of the Balkan Peninsula (curved moving of approximate west-east direction, and from above to downward), which coincides with an increased number of forest fires in the coming days. At the same time, across the Mediterranean and the Balkan Peninsula there is relatively high air pressure (1014-1015 mb), which is consistent with the hypothesis that these areas were under the dominant influence of the electrons (right side of the jet stream main direction), that is, low pressure over northern and central Europe indicates the propagation of protons in these areas (left of the jet stream main direction).

Analysis of the quantitative agreement (in the period 09-24 July 2012) between the proton and electron flow and hourly values of the temperature and relative humidity in Belgrade, that is, mean daily temperatures in Rome, from a strictly mathematical point of view show relatively poor values.

However, strong correlations cannot be expected given the large range of the charged particles flow in a relatively short time compared to the values of air temperature and relative humidity. Also, penetration of the current field through the troposphere is not uniform, and the effect of the charged particles on the ground requires much complex modelling. The obtained results can be a starting point for future forecasting models which for the announcement of fire elementals must contain in it the propagation of protons and electrons through the lower layers of the atmosphere.

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