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ENDARGEMENT OF UNDEVELOPED AREAS OF SERBIA BY FOREST FIRES

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Abstract: Considering the significance of discovering the causes of forest fires, the hypothesis on the solar activity is presented (i.e. physical–chemical characteristics of the solar wind) as the possible cause of these natural disasters. The empirical confirmation of the mentioned hypothesis was disabled by the non existence of an adequate data base on the (regional) distribution of the number of fires and burned areas on the level of Serbia. Therefore an emphasis is put on theoretical explanations, but also on the characteristic situations in which there is an agreement between the processes occurring on the Sun and fire phenomena in the area of Serbia and the Balkans. The formations of the corresponding data base would enable the systematic explanation of endangerment of undeveloped areas of Serbia, but also the confirmation of the solar wind–forest fires hypothesis. The directions of the future multidisciplinary research should be directed towards the models for better prevention.

Key words: solar wind, forest fires, heliocentric hypothesis, undeveloped areas, Serbia.

Introduction

Forest fires represent one of the most significant disasters which endanger modern humanity. The explanation of this problem is still burdened with numerous open questions and often the decision making process does not give satisfying results in the sense of preventing the destructive power of fires. There is not enough data series both for the frequency of fires and area spread by fires for rarely inhabited, i.e. uninhabited parts of Serbia that also represent the undeveloped areas of the country. Relatively small locations under fire cannot be detected by satellites either. It especially stands for cases that have relatively short time limit of duration.

Establishing the causes of disasters has been a specific problem. Some official representatives of ecological and forest institutions consider humans as responsible for 95% of the cases, disregarding whether it was the intentional or

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unintentional ignition of fire about[2]. The indications of the connection between global warming and frequency of forest fires can often be found in literature. However, in the last few years we are the witnesses of severely opposed attitudes in the scientific literature on the question whether global warming exists at all (Radovanović et al, 2006). Based on the analysis of voluminous literature, Radovanović and Gomes (2009) consider there is not direct connection, scientifically established, between the regional climate changes and meteorological conditions and fires. It turned out that electric discharges from the atmosphere cannot considerably be the potential cause for such events. "From 1990 to 1998, over 17 000 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. Natural wildfire ignitions in this region are often attributed to what is referred to as 'dry' lightning, or lightning with little or no precipitation" (Hall, 2007).

Taking the presented limitations into consideration, the attempt will be to highlight the possibilities offered by the idea on the charged particles influence upon the phenomenon of the initial phase of fire.

Available Data

The use of statistical methods in studying the mentioned problems was greatly made difficult due to the lack of information on the regional and global level "Fire data are compiled for industralized countries and published by UNECE/FAO as Forest Fire Statistics every two years. However, as global data are not available, FAO member countries were requested to complete a standard questionnaire on forest fire data. Unfortunately this met with little success, so a standardized fire profile was developed which enabled countries to complete thematic information even in the absence of numeric data. These profiles, completed by 47 countries, describe how fires affect people and natural resources and how the countries are organized to manage fires" (http://www.fao.org/docrep/004/y1997e/y1997e0d.htm). Concerning the area of the Balkans, the data on the number of forest fires are presented in Tables 1 and 2, as well as areas seized by fires in the period from 1988 to 2004.

[2] J. S. Miguel, coordinator of the EFFIS told Press Service 16th Aug, 2003

Table 1 Number of fires in the Balkan countries in the period 1988–2004 (Nikolov, 2006)

Year	Albania	Bulgaria	Croatia	Greece	R. of Macedonia	Slovenia	Serbia and Montenegro -Serbia-	Turkey	Total	Average
1988	121	101	/	1 898	126	/	25	1 372	3 643	455
1989	132	578	/	1 284	95	/	48	1 633	3 770	471
1900	269	208	/	1 322	241	/	98	1 750	3 888	486
1991	147	73	/	941	38	30	55	1 481	2 765	346
1992	659	602	/	2 042	235	40	44	2 117	5 739	717
1993	560	1 196	/	2 406	390	108	157	2 545	7 362	920
1994	585	667	/	1 763	195	66	70	3 239	6 585	823
1995	110	114	/	1 438	24	25	15	7 676	9 402	1 175
1996	490	246	/	1 508	90	50	45	1 645	4 074	509
1997	735	200	/	2 271	174	59	28	1 339	4 806	601
1998	601	578	/	1 842	151	151	78	1 932	5 333	667
1999	623	320	/	1 480	452	53	11	2 075	5 019	627
2000	915	1 710	7 797	2 581	1 187	98	281	2 353	16 922	2 115
2001	327	825	4 024	2 658	165	65	42	2 631	10 737	1 338
2002	140	402	4 692	1 400	59	60	112	1 471	8 336	1 042
2003	771	452	6 924	1 452	96	224	57	2 177	12 153	1 519
2004	143	294	2 855	/	73	/	5	1 762	5 132	642
Total per country	/ 333	8 566	26 292	28 286	3 /91	1 029	1 1/1	39 198	115 666	850
Average per country	*431*	*504*	*1 547*	*1 664*	*223*	*61*	*69*	*2 306*		

Serbia (and Montenegro) and Slovenia are noticed to have the least number of fires on average basis in relation to other countries of the Balkan Peninsula in the mentioned period. The same might be concluded for burned areas concerned.

Table 2 Areas spread over by fires in the Balkan countries for the period 1988–2004 (Nikolov, 2006)

Year	Albania	Bulgaria	Croatia	Greece	R. of Macedonia	Slovenia	Serbia and Montenegro -Serbia-	Turkey	Total	Average
1988	256	462	/	/	/	/	76	18 210	19 004	4 751
1989	320	223	/	/	1 633	/	165	13 099	15 440	3 088
1900	417	1 041	/	/	5 760	/	646	13 742	21 606	4 321
1991	250	511	/	/	444	677	211	8 081	10 174	1 696
1992	1 011	5 243	/	/	9 390	426	215	12 232	28 517	4 753
1993	522	18 164	/	/	14 423	1 660	2 036	15 393	52 198	8 700
1994	705	18 100	/	/	5 802	912	435	38 128	64 082	10 680
1995	153	550	/	/	105	260	117	7 676	8 861	1 477
1996	410	2 150	/	/	986	288	209	14 922	18 965	3 161
1997	1 847	595	/	/	3 574	493	126	6 316	12 951	2 158
1998	680	6 967	/	/	1 889	1 353	919	6 764	18 572	3 095
1999	689	8 291	/	/	1 992	433	36	5 804	17 245	2 874
2000	3 675	57 406	129 883	/	37 928	265	7 476	26 352	262 985	37 569
2001	1 434	20 152	27 251	/	6 667	340	273	7 394	63 511	9 073
2002	690	6 513	74 945	/	659	160	1 373	8 413	92 753	13 250
2003	6 359	5 072	77 359	/	3 936	2 100	430	6 644	101 900	14 557
2004	1 473	1 137	8 988	/	1 584	/	12	4 876	18 070	3 012
Total	20 891	152 577	318 426	/	96 772	9 367	14 755	214 046	826 834	103 354
Average	1 229	8 975	63 685	/	6 048	720	868	12 591		

According to the author of the previous two tables, “it can be concluded that an average of 58.8% of the total number of forest fires originated from human factor, 3.3% is of natural origin, while 37.9% of unknown origin. The highest percentage of forest fires caused by people was recorded in Croatia (75.3%), whereas the lowest one in Bulgaria (30.4%). On the other side, Bulgaria had the

highest percentage of fires with unknown cause (67.9%). Generally, one should be concerned with the fact that the causes of fires are very often unknown.

FAO (2002) gave different data for Serbia and Montenegro for the period from 1999 to 2001 in relation to the Table 1. Namely, there were 889 fires in that period by their report, and the cause was unknown in 435 cases (48.9%).

The source Figure 1 was taken from, gave data which can be of an extreme significance for working out the heliocentric hypothesis on the solar activity influence on the phenomenon of fires. By a hasty survey of Chart 1, it becomes clear that the meteorological conditions cannot be the factor in the origin of the initial phase of biomass ignition. Moreover, in this case, it is hard to imagine any kind of intentional or unintentional ignition of stands done by humans as the potential explanation.

Figure 1. Distribution of Forest Fires in South–eastern Europe on March 19th 2007 (http://firefly.geog.umd.edu/firemap/)

Heliocentric Hypothesis on the Origin of Forest Fires

The authors who analysed some cases of the Sun–forest fires connection (Gomes, Radovanović, 2008, Gomes et al, 2009, Todorović et al, 2007), pointed out the causative link between the position of coronary holes and/or energetic sources in geo–effective position on the Sun and forest fires.

However, the use of statistical methods is simply impracticable for checking the heliocentric hypothesis for undeveloped areas of Serbia. The lack of daily values on the origin of destructive power of fires also disables the testing of the connection on the level of temporal sequence of the phenomena for longer time intervals. Physical–chemical characteristics of the SW (speed, temperature, chemical structure, concentration of protons and electrons, etc.) have never been the same, by which the trajectory of the penetration towards the ground is always different. That practically means that if it would be tried with the calculation on the basis of repeating, for example the coronary holes on the Sun in geo–effective position, it is disputable whether fires would appear at approximately each 27 days on the same locations. For Palamara, Bryant (2004), there will not be any questions on the existence of the interactive connection. The key issue is how the solar/geomagnetic activity is being manifested in the lower part of the atmosphere.

The heliocentric hypothesis is based on the assumption that protons and electrons coming to us from the Sun and out of the Cosmos can reach the ground at certain conditions and cause the biomass to burn in the form of forest fires. However, the crucial weakness refers to the lack of laboratory and experimental testing. Contrary to that, arguments that would speak in favour of the mentioned hypothesis would be pointed out.

Many fires occurred in the area of the Mediterranean from July 22nd 2007. They spread out on the area of the Balkan Peninsula until July 25th 2007 (Figure 2).

They were preceded by the coronary hole and energetic sources in geo–effective position on the Sun. Immediately after the ejection of the solar wind (SW) stream, there were intensive disturbances in the atmosphere (Stevančević et al, 2006). In Figure 3, several relatively small locations can be seen in the area of the Mediterranean, which are characterized be lower air pressure. The analysis of meteorological conditions points out to the possibility of the SW penetration over the middle part of the Atlantic, i.e. above the geomagnetic anomaly. By the further penetration towards the Mediterranean, it results in the reduction of the kinetic energy, i.e. the speed of the SW due to friction between much denser

layers of air. Therefore, the weakening of the magnetic shell occurs, winding the SW stream. In the next step, the separate streams appear at smaller diameter, moving towards the topographic surface under different angles.

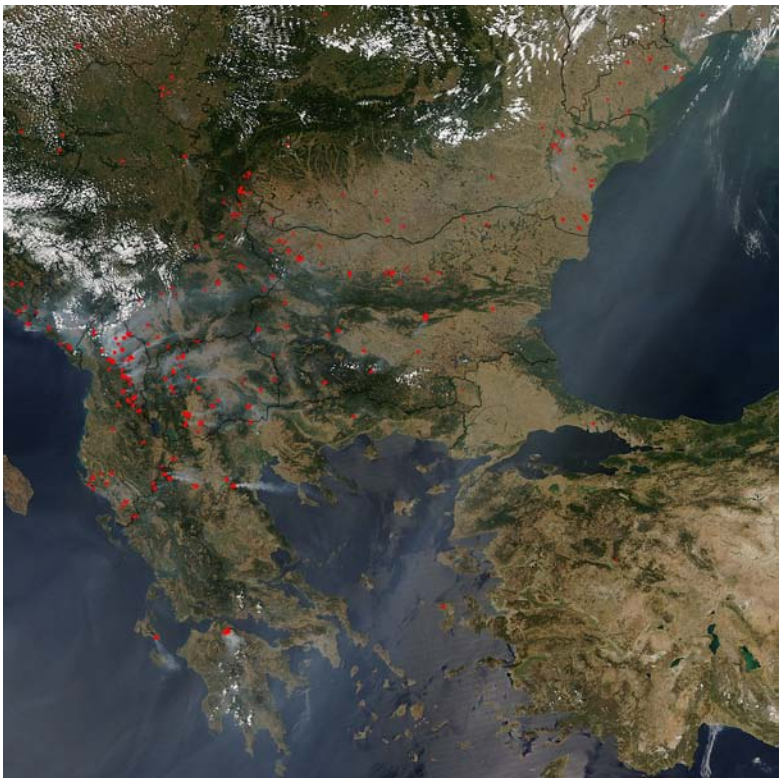

Figure 2 Distribution of forest fires on July 25th 2007 in South–eastern Europe (Radovanovic et al, 2007)

According to the hypothesis of Stevančević (2006), the protons which are not recombined, make fields of low pressure and, in case that current field is taking along more separate proton streams, more small fields of low air pressure are being made.

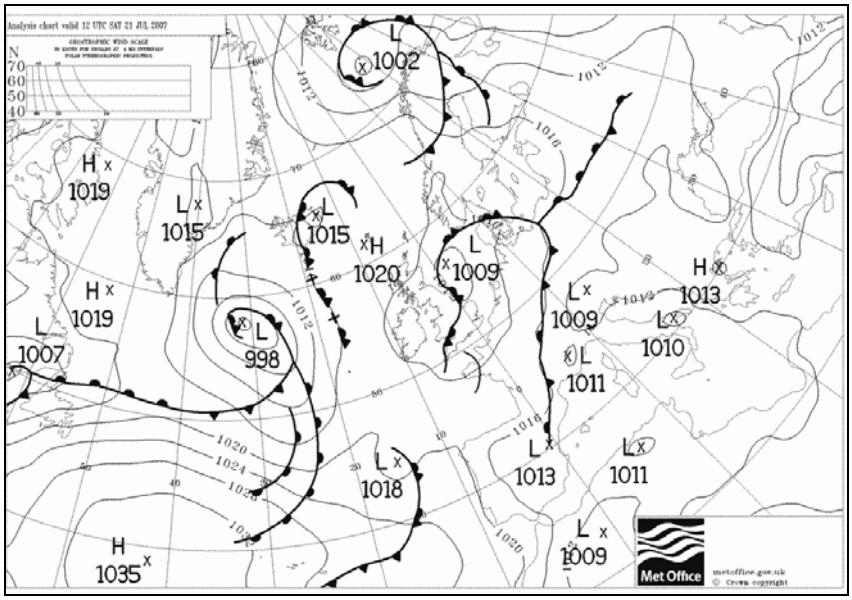

Figure 3 Synoptic situation above the Atlantic and western Europe on July 21st 2007 (Radovanovic et al, 2007)

Another group of fires originated by the dominant influence of electrons on biomass. The similarity with the previous group of fires is shown in the temporal sequence of events. Namely, a CH373 coronary hole (Figure 5) had been on the Sun the day before "hot spots" were registered by satellites (Figure 4). The influx of protons and electrons is shown in Table 3, several days before and after the phenomenon of fires in the Mediterranean and Balkans.

Table 3 Influx of protons and electrons towards the Earth several days before and after the phenomenon of fires on Sicily and the Balkans (http://www.swpc.noaa.gov/ftpmenu/warehouse.html)

	GOES–11 Proton Fluence			GOES–11 Electron Fluence	
#	--- Protons/cm2-day-sr ---			-- Electrons/cm2-day-sr --	
# Date	>1 MeV	>10 MeV	>100 MeV	>0.6 MeV	>2 MeV
2009 07 11	6.8e+05	2.0e+04	4.5e+03	2.0e+09	4.8e+05
2009 07 12	7.2e+05	2.0e+04	4.6e+03	2.2e+09	7.1e+05
2009 07 13	1.3e+06	2.0e+04	4.8e+03	1.5e+09	5.8e+05
2009 07 14	6.6e+05	2.0e+04	4.5e+03	6.0e+09	3.7e+05
2009 07 15	5.1e+05	2.0e+04	4.5e+03	1.8e+10	2.8e+06
2009 07 16	5.2e+05	2.0e+04	4.7e+03	2.2e+10	5.6e+06
2009 07 17	6.5e+05	2.0e+04	4.4e+03	2.3e+10	8.8e+06
2009 07 18	8.9e+05	2.1e+04	4.5e+03	2.3e+10	1.2e+07

From the previous table, it can clearly be noticed that from July 14th 2009, an increase in the influx of protons in the energetic range of >1MeV took place. However, the same day the influx of electrons considerably increased in the range of >0.6MeV, whereas a day later it was in the range of >2MeV. The following days, in contrast to protons, the influx of electrons continued to increase more significantly in both energetic ranges up to July 17th 2009.

Figure 4 Fires on Sicily and the Balkan Peninsula on July 15th 2009
(http://rapidfire.sci.gsfc.nasa.gov/realtime/single.php?T091961015)

In the case when the Bz component of the interplanetary magnetic front has the direction which is the opposite to the geomagnetic field, i.e. when it has negative sign, it reaches the opening of the magnetosphere (magnetic reconnection). The SW particles then get into the atmosphere of the Earth (magneto–spherical door in polar areas) in the form of jet–stream and move along the geomagnetic lines towards the magneto–spherical equator. Therefore, the process occurs in the area where the Earth's magnetic field is the strongest. Otherwise, the SW does not penetrate into the magnetosphere of the Earth but it goes around, i.e. repulses it. "We found that the events occurring during closed geomagnetic conditions do not show common peaks at all the high latitude stations and tend to be coherent only among Antarctic stations, while there is a lack of coherence between high latitude opposite 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 hemispheres" (Lepidi et al, 2005). The strengthen circulation of the atmosphere above the Atlantic can clearly be seen in the following chart, which points out to the connection between the SW penetration over the polar areas and the air mass movements.

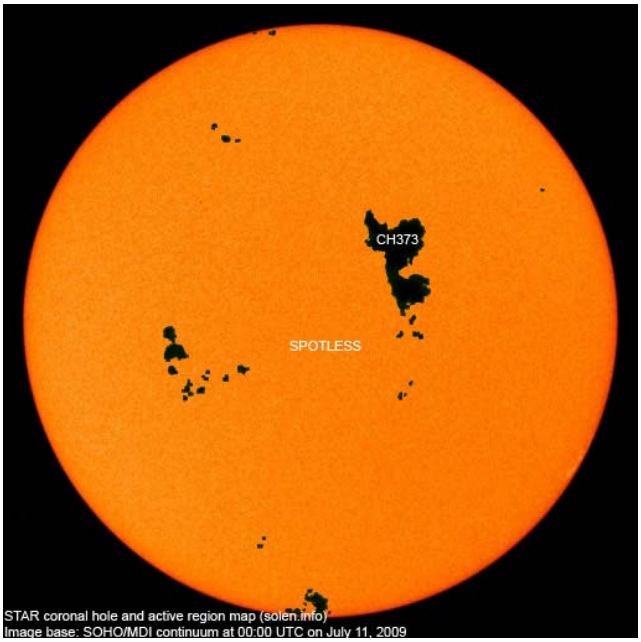

Figure 5 Position of coronal hole on the Sun on July 11th 2009
(http://www.dxlc.com/solar/index.html)

Immediately before the satellite detection of fires, i.e. their development to the stage in which they cannot be registered by satellites, high air pressure had been over the Apennine and Balkan Peninsula (Figure 6). Therefore, it was the opposite situation in relation to the previous type of fire. According to the heliocentric hypothesis, when it comes to the dispersion of the main stream of the SW, the protons principally turn left, while the electrons turn right in relation to the main direction of the SW penetration (Figure 7). Basically, the grouping of protons is caused by low air pressure, while the grouping of electrons is caused by high air pressure.

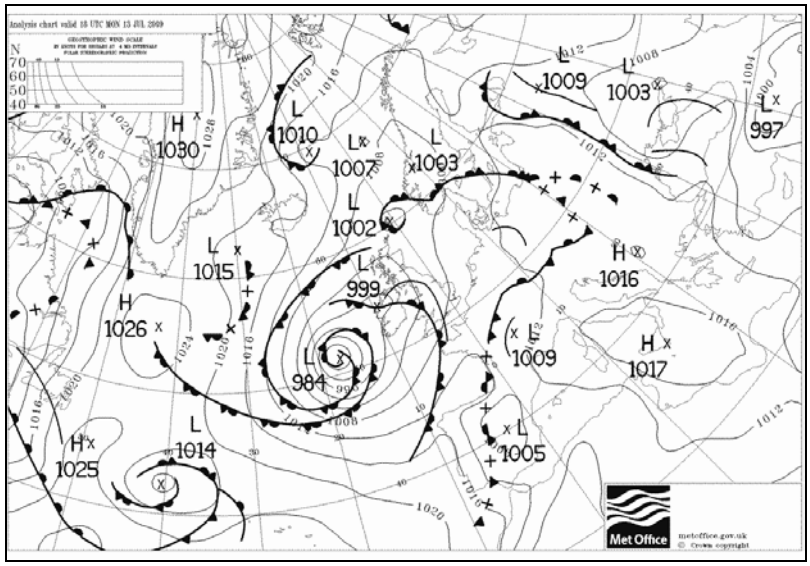

Figure 6 Synoptic situation over the Atlantic and Western Europe on July 13th, 2009 (http://meteonet.nl/aktueel/brackall.htm)

At strong current fields, during the strengthen activity of the Sun, the electrons move in the form of streams. The radius of the rotation ranges up to several tenths of metres. Besides that, the direction of the rotation is opposite in relation to the circulation movements caused by proton streams. Consequently, each image of the circulation of air masses locations with fires on Figure 4 could serve as the evidence for accepting or rejecting the presented hypothesis. In case of the July 15th 2009, the spinning movements of air masses must have the direction of movement to the right.

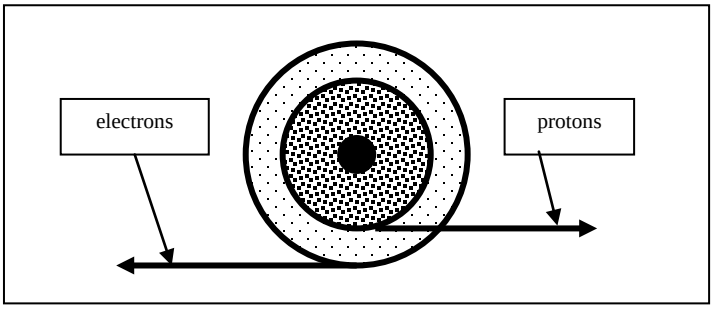

Figure 7 Schematic representation of the dispersion of protons and electrons after the weakening of the magnetic shell of the solar wind stream

It was noticed that the critical reduction in the radial speed of the current field and opening of the magnetic shell occurs most often on the area of 250 mb in winter period. Throughout summer, the critical level of dispersion occurs approximately at 300mb (Figure 8)

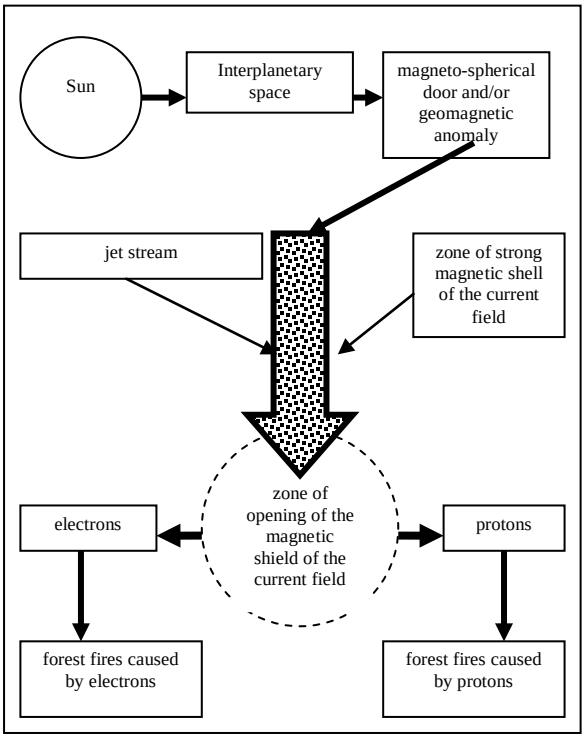

Figure 8 Schematic representation of dispersion of protons and electrons

From the figure 9, it can be noticed that the position of jet streams considerably coincides with the line, i.e. zone of the restriction of dominant geographical deposition of protons and electrons. An almost ideal sequence of the position of clouds and jet streams over Europe can be seen in Figure 10.

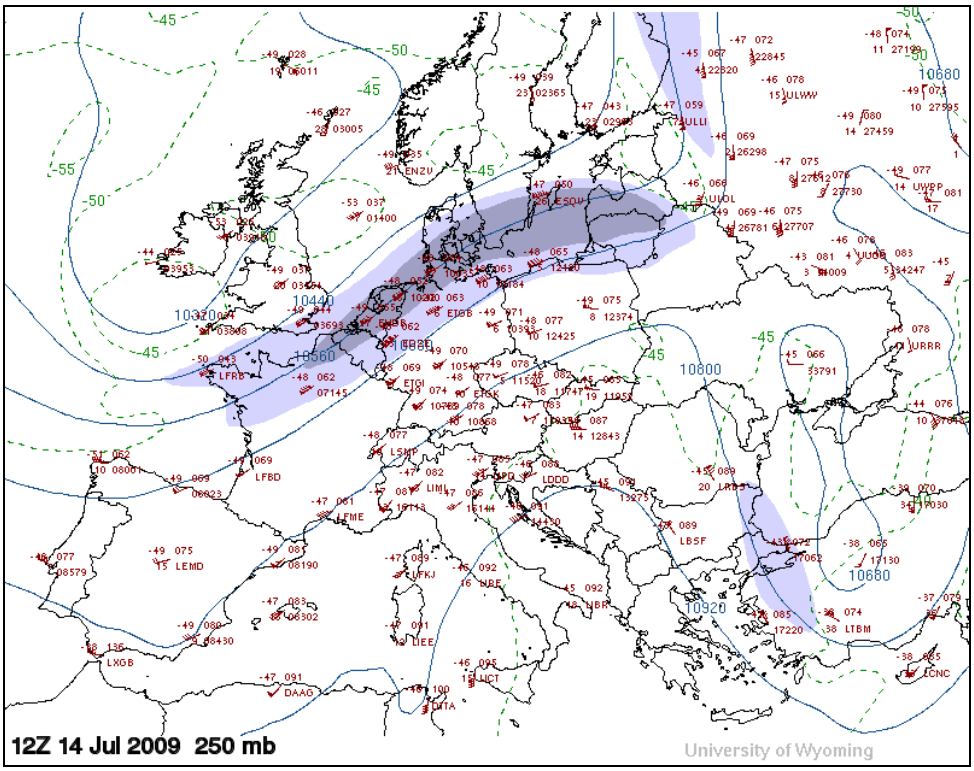

Figure 9 Jet–streams over Europe on July 14th 2009 at 250mb
(http://weather.uwyo.edu/upperair/uamap.html)

It is necessary to emphasize that the fires registered on July15th 2009 most probably had the initial phase of origin the day before (Figure 4). However, the satellite sensors had not been able to notice them until they came into certain stadium of development. From the previous chart, it can be noticed that the area of the Balkans and Apennines was without cloudiness, whereas over Scotland and southwest of Ireland, the cyclone activity was already developed. Spread over by hydrodynamic pressure of the SW, air masses are moving from above to below. After the decreasing of the kinetic energy, the jet–stream of the SW particles, upon the influence of gravitational force and law of the magnetic field, descends towards the Earth's surface. The trajectory of descending is

represented by a funnel–shaped spiral, the wider end of which is turned upwards. The presented facts are in accordance with the mechanism of the movement of protons and electrons towards the topographic surface, which is contained in the given hypothesis (Stevančević, 2006).

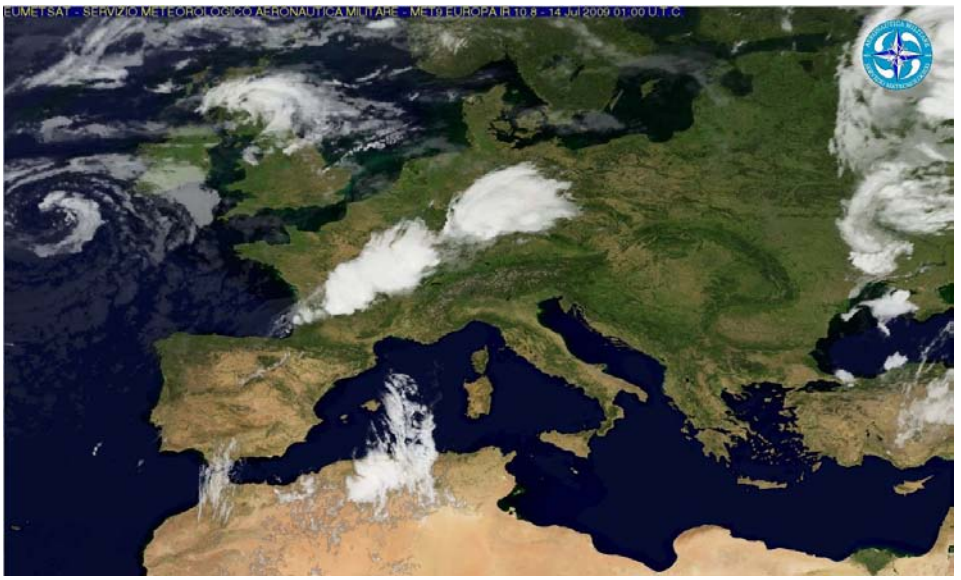

Figure 10 Cloud formations on July 14th 2009 over Europe (http://www.meteoam.it/modules.php?name=meteosat7&fileNameView=satellit/WWW/vapore7_2006–06–23%2017:45:00.jpg)

Analysing the further development of weather conditions, it was noticed that in this concrete case, the protons can again be brought into the connection with forest fires, but not with the area of Serbia. The measuring showed it had come to a sudden increase in the speed of protons on July 13th and July 14th 2009 (Figure 11 and 12).

Other scientists also noticed some unclear details concerning the mechanism of the SW penetration, as well as the parameterisation of losses in speed, temperature and chemical structure of particles. “The associated changes in the Brewer–Dobson circulation have a non–local effect on the thermal structure in the lower tropical stratosphere leading to significant solar signals in e.g. temperature, cloud cover, precipitation in the tropical troposphere. …It must however be noted that many questions concerning the impact of solar variability on the atmosphere are still open. E.g. the observed solar signal in stratospheric

ozone can so far not be reproduced by models. The contribution of energetic particles to the solar signal is not yet well understood" (Langematz et al, 2005).

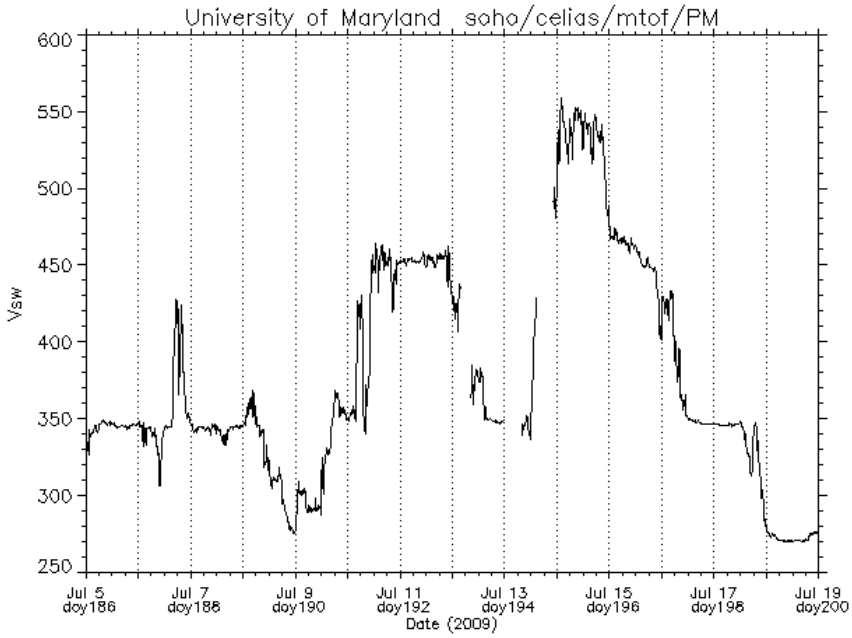

Figure 11 Speeds of protons reached 550 km/sec on July 14th 2009 (http://umtof.umd.edu/pm/crn/)

By the analysis of the satellite images which referred to the Sun, atmosphere and fires, as well as corresponding numerical (table) values, the causative–effective link can be noticed in many cases. Based on the previous results, there is an impression that, in dependence on the SW parameters, the distribution of the locations spread over by fire is also dependant. McKenzie et al, (2004) made the following conclusion: "Although associations between fire and quasi–periodic patterns (PDO[3] and ENSO[4]) have been identified, we have little understanding of how these indices will respond to climate warming. Thus, our ability to extrapolate these latter associations into the future is poor. ...The 10–yr running means of PDSI[5] and percentage scarred are correlated ($r = -0.375$, $p < 0.001$) during the period of record (1684–1978). Prior to 1901, the 10–yr running means of PDSI and percentage scarred are more strongly correlated ($r = -0.577$, $p <$

[3] Pacific Decadal Oscillation
[4] El Nino Southern Oscillation
[5] Palmer Drought Severity Index

0.001), indicating that the relationship between fire and climate in the 20th century is weaker than in the previous two centuries."

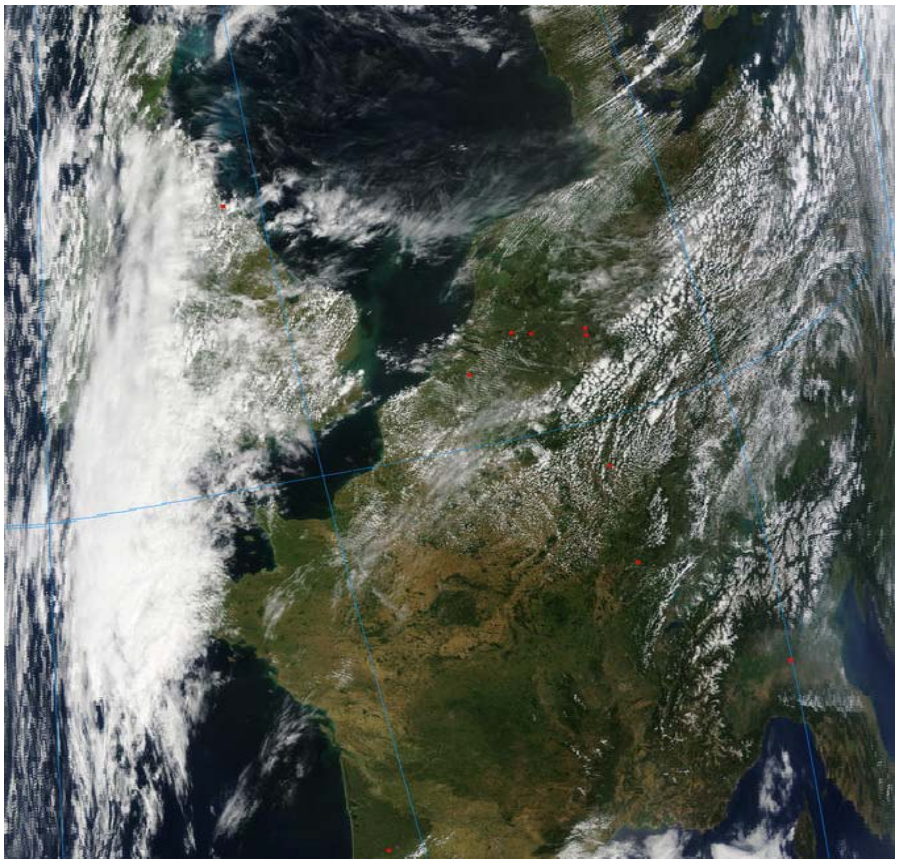

Figure 12 Forest fires in Europe on July 16th 2009
(http://rapidfire.sci.gsfc.nasa.gov/realtime/single.php?T091971055)

Conclusion

It can be concluded that there is a strong conviction that successful measures of prevention can be realized only on the basis of better knowledge of what is happening on the Sun, the processes that occur in the magnetosphere and atmosphere, as well as the manifestations being realized by charged particles in the contact with biomass. The condition we are now is generally characterized by incapability of making the successful models of prediction and, by itself, the prevention, too (Radovanović et al., 2008). "Even though the basic theme of this

paper has been the historical survey of the pioneer efforts, which leads us towards our present stadium of knowledge, the common link of this paper is the wish of each generation in development to achieve the "purely analytical system" (Hardy, Hardy, 2007). Moore et al, (2002) thought similarly: "Many aspects of fires in the landscape remain obscure and more reliable data on fire causes, impacts and research on fire is required to effectively understand and then address the fire issue."

Lynch et al, (2004) understood the domain of the key question, but obviously without a vision clear enough, in which way the further measures of prevention are to be developed: "Our results therefore support other recent studies demonstrating that warmer/drier climatic conditions do not necessarily induce greater fire importance. …These results contradict the current understanding of modern fire–climate relationships. It is also inconsistent with model predictions that a drier and warmer climate, as a result of glasshouse warming, will lead to increased fire activity in boreal system." Gorte (2006) was also categorical: "Research information on causative factors and on the complex circumstances surrounding wildfire is limited. 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."

Based on the previous researches it can be concluded that:

–coronary holes and/or energetic regions in geo–effective position on the Sun had preceded the forest fires in Serbia up to several days earlier in all cases for which the data were gathered. The emission of strong electromagnetic and thermal corpuscular energy had preceded fires from these sources at each concrete situation;

–the basic ways of the SW penetration through the magnetosphere are a) reconnection (in the area of geomagnetic poles) and b) direct penetration of the solar wind under the dominant effect of the kinetic energy (near geomagnetic anomalies) (Stevančević et al, 2006, Stevančević et al, 2006);

–solar wind, directed towards the Earth, gets weaker with deeper and deeper penetration towards the topographic surface. The modifications of the main stream, which occur above the Atlantic anomaly and above the magneto–spherical tropics, also represent the maximum modern science has come to (Radovanović et al, 2005);

–air masses, caught by a jet–stream of particles of the SW, will be subject to the laws of magnetic field and their motion will be on the account of energy of particles of a jet stream (Radovanović et al, 2003);

–geomagnetic coordinates can represent the basis for the use of mathematical equations, which describe the trajectories of the motion of air masses;

–the direction of the motion of air masses is determined by the polarization of charged particles of the SW. In the northern hemisphere, the motion of winds, created on the account of energies of particles of the proton SW, has the left direction. The speed of the wind increases with the height increase and it is directly proportional to the increase of kinetic energy of particles of the SW;
–cloudiness represents one of the most important factors which determine whether the charged particles are going to be deposited to the topographic surface;

–based on the preliminary results, there are indications that cosmic radiation (specifically in the period of reduced solar activity), can also cause fires. In some situations, cosmic radiation can be by much higher temperatures, speeds, densities of particles, i.e. much stronger electromagnetic waves than ever measured for the SW. "However, the physical mechanism of the influence of the solar activity on weather phenomena remains unclear. It is supposed that the significant part in the transfer of the solar variability to the lower part of the atmosphere can be carried out by charged particles of the solar and galactic origin, protons mainly, with energies of ~100 MeV up to several GeV" (Veretenenko, Thejll, 2004)

–the research of the conditions in which the dispersal of charged particles over vegetation can cause the initial phase of ignition, demands experimental testing. Due to the impossibility of the precise prediction on which locations it might concretely happen, the simulation of the similar conditions in laboratories seems to be the first step (Radovanović, Gomes, 2009).

Theoretical–mathematical researches in 2009, suggest that electrons of relativistic speeds can also represent the cause of forest fires in certain conditions.

Considering the presented explanations, it can be concluded that the heliocentric hypothesis is in the initial phase with relatively limiting possibilities. In order that the development of this idea have practical usage, it is necessary to study the whole problem on considerably larger number of cases than it has been done

until now. Therefore, the possibility of explaining the endangerment of undeveloped areas of Serbia from forest fires demands a project research of multidisciplinary character.

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