

Application of the ANFIS Models and Parallel Calculations for Establishing Potential Causal Link Sun-hurricanes

Vyklyuk Y., Radovanovic M., Milovanovic B., Leko T.,
Milenkovic M., Yamashkin A.A., Milanovic Pesic A.,
Jakovljevic D., Malinovic-Milicevic S.

Milan Radovanović

Geographical Institute "Jovan Cvijić"
Serbian Academy of Sciences and Arts
Belgrade
Serbia

In this paper we examined the potential causative link between the flow of charged particles that are coming from the Sun and hurricanes. For establishing eventual link, the methods of Big Data, such as Adaptive neuro fuzzy inference system (ANFIS), Parallel Calculations, Fractal analysis etc., are applied. There are nine parameters which are observed as an input, and daily values of the hurricane phenomenon are observed as an output in the period May-October 1999-2013. The nonlinear R/S analysis was conducted to determine the degree of randomness for time series of input and output parameters. The phase shift of 0-10 days was taken into account in the research. It led to growing input parameters up to 99. The problem of finding hidden dependencies in large databases refers to problems of Data Mining. The ANFIS with Sugeno function of zero order was selected as a method of output fuzzy system. The "brute-force attack" method was used to find the most significant factors from all data. To do this about 500 000 ANFIS models were tested on Computer Cluster using Parallel Calculation. Within the experiments, eight input factors were calculated which became the basis for building the final ANFIS models. These models can predict up to 39% of the hurricanes. This means that, if causal link exists, approximately every third penetration of charged particles from coronary hole(s) or/and from the energetic region(s) toward surface can generate hurricanes.

There are many conventional theories that seek to explain the development of a tornado. Without exception they cannot explain the complex internal structure and energy flows in a simple and logical manner.

Peter Thomson

http://peter-thomson.com/tornado/the_structure_of_the_tornado.html

The parallel calculation was used in order to find the key factors. Accordingly to it array of separate datasets (that included all combinations from 4 input files each) was formed for each testing ANFIS model. After that this array was distributed between cores of computer cluster.

Results of the search of the key factors

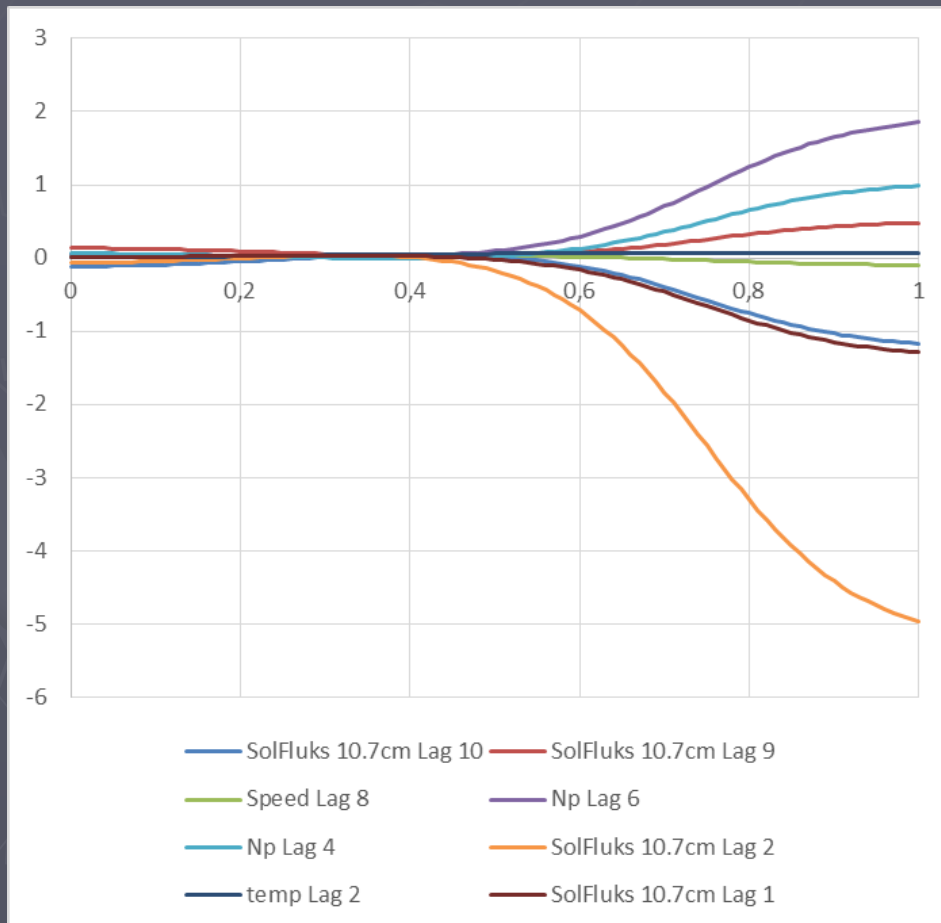
All		Atlantic		East Pac		West pac	
Speed	Lag 10	Speed	Lag 10	Np	Lag 10	SolFluks 10.7cm	Lag 10
Solar Flux	Lag 9	Solar Flux	Lag 9	Np	Lag 6	SolFluks 10.7cm	Lag 9
Solar Flux	Lag 5	Solar Flux	Lag 5	Np	Lag 5	Speed	Lag 8
Solar Flux	Lag 3	Solar Flux	Lag 3	temp	Lag 5	Np	Lag 6
Speed	Lag 3	Speed	Lag 3	Speed	Lag 4	Np	Lag 4
Temp	Lag 2	Temp	Lag 2	Speed	Lag 3	SolFluks 10.7cm	Lag 2
Solar Flux	Lag 1	Solar Flux	Lag 1	temp	Lag 3	temp	Lag 2
Solar Flux	Lag 0	Solar Flux	Lag 0	temp		SolFluks 10.7cm	Lag 1

Accuracy analysis of hurricanes prediction for ANFIS models under experiment

Atlantic (Ha), East Pacific (He), West Pacific (Hw) and total hurricanes (Ht)

Types of hurricanes	Dimension of time series	Number of coincidences with calculated by model (including days without hurricanes)		Total number of observed hurricanes	Number of calculated hurricane	Number of true calculated hurricane	Number of false calculated hurricane	Number of hurricanes that cannot be calculated	Mean-square error in amplitude			
1	2	3	4	5	6	7	8	9	10	11	12	13
<i>Ha</i>	2610	2548	98%	100	39	39	39%	-	0%	61	61%	0,1566
<i>He</i>	2610	2545	98%	102	37	37	36%	-	0%	65	64%	0,1614
<i>Hw</i>	2610	2537	97%	102	30	30	29%	-	0%	72	71%	0,1706
<i>Ht</i>	2610	2357	90%	363	126	122	34%	4	1%	241	66%	0,3275

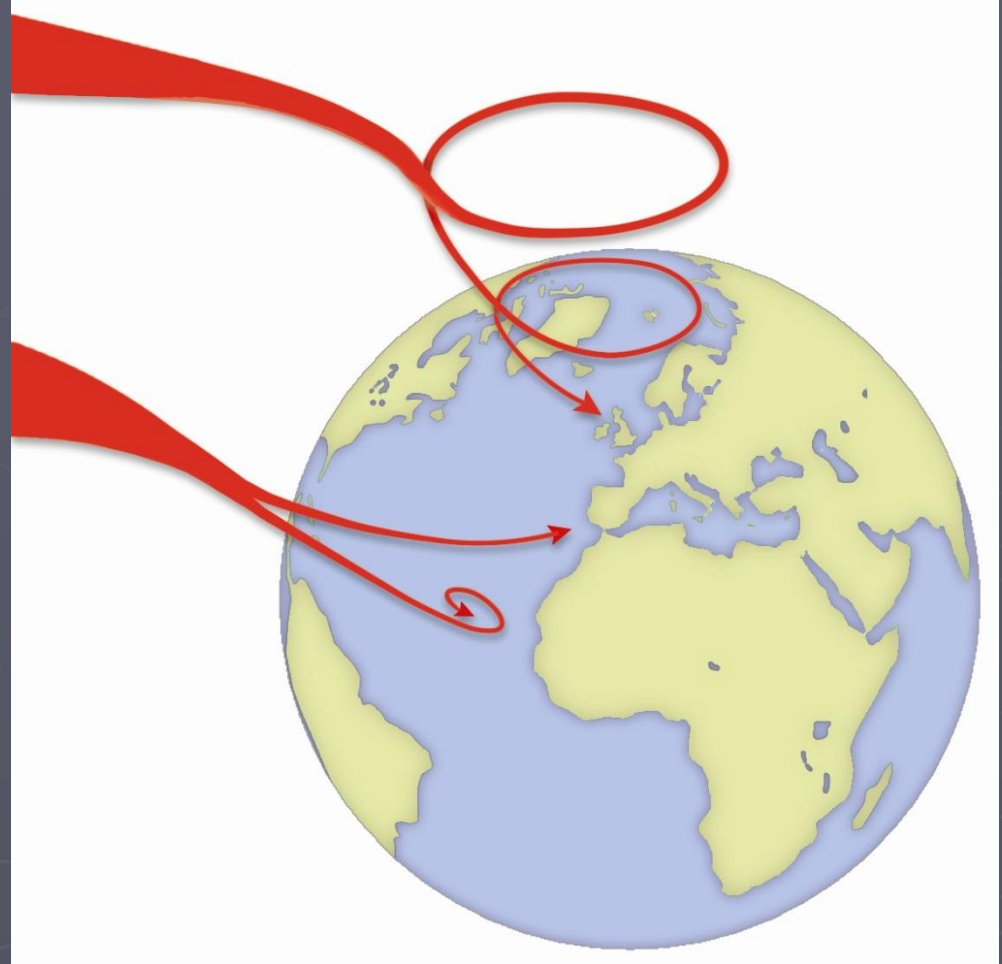
Number of hurricanes dependent on key factors



X - normalized values of key factors,
Y - number of hurricanes

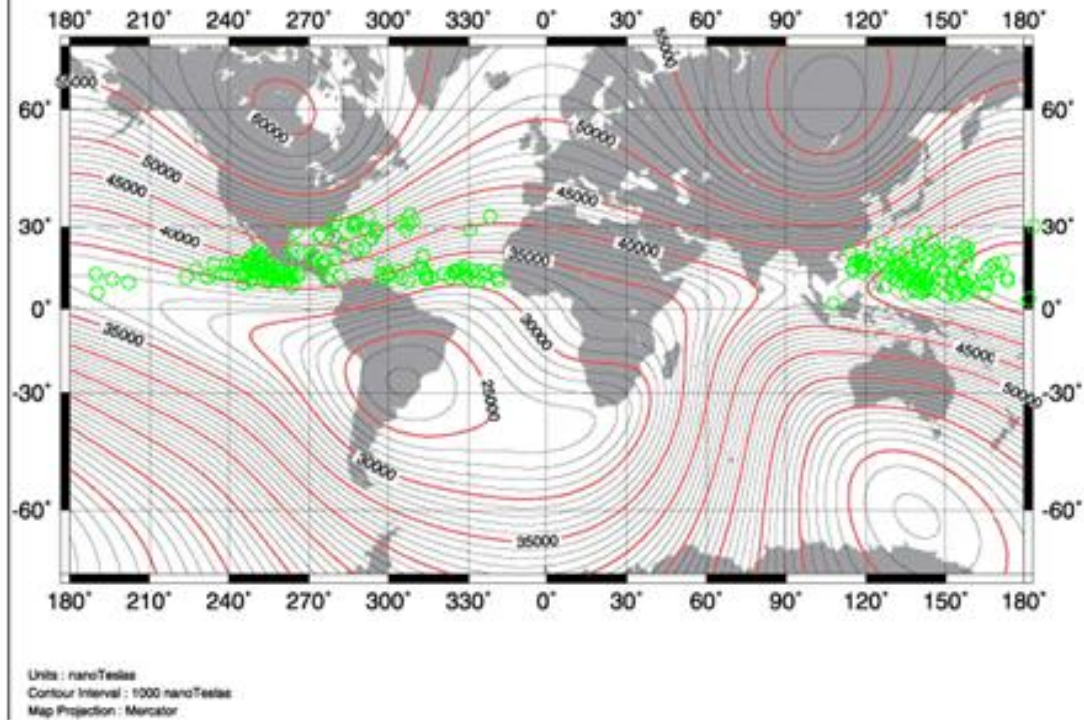
From plot HW - clearly see that number of hurricanes strongly dependence on NP lag6, Np lag4 and SolFlux lag 9

Schematic survey of the way of SW penetration towards topographic surface



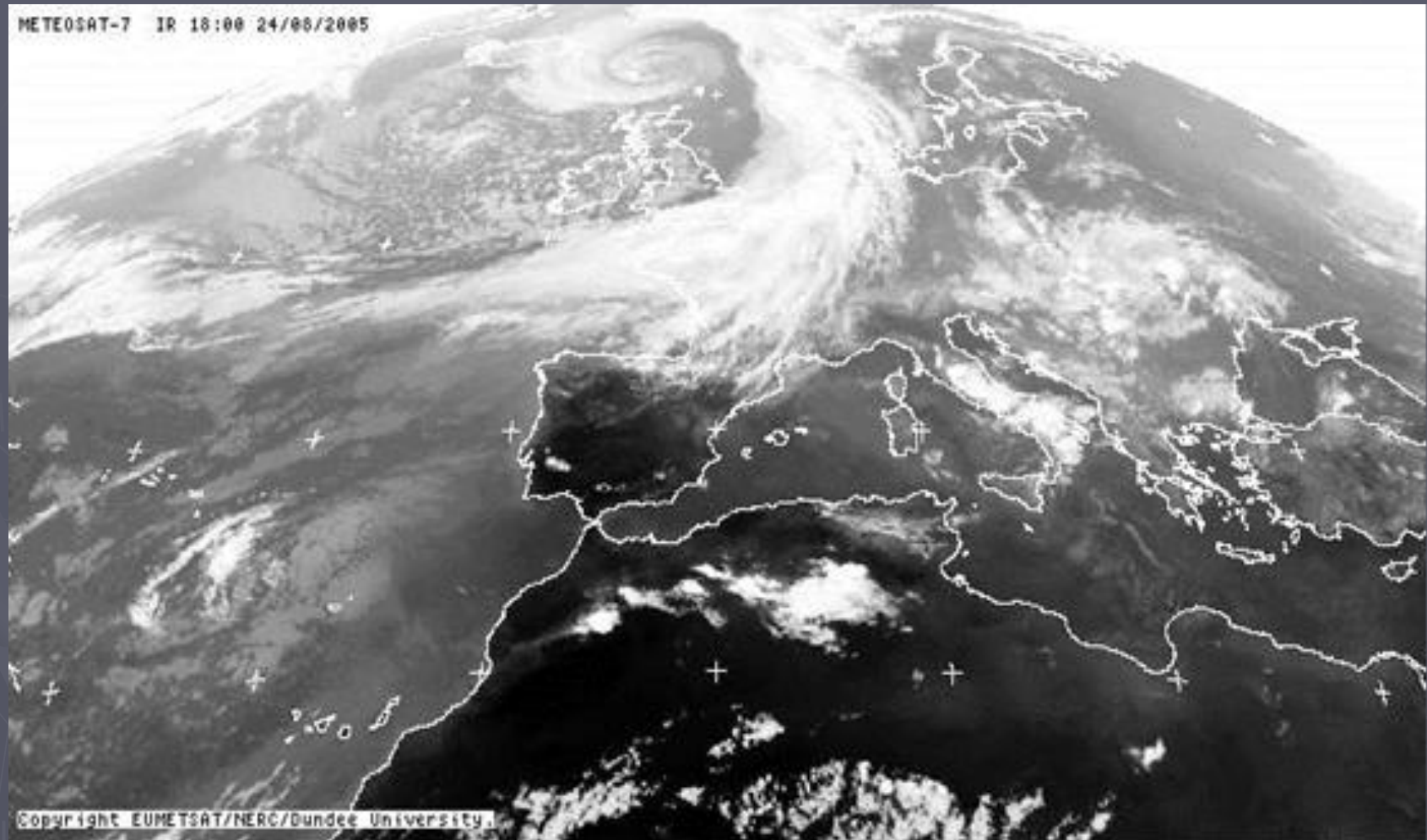
(Gomes, J.F.P, Radovanovic, M, Ducic, V, Milenkovic, M, Stevancevic, M.:
Wildfire in Deliblatska Pescara (Serbia) - Case Analysis on July 24th 2007. In Book: Handbook on Solar
Wind: Effects, Dynamics and Interaction, Nova Science Publishers, New York, 2009, 89-140.)

US/UK World Magnetic Chart -- Epoch 2000 Total Intensity - Main Field (F)



World magnetic chart for Epoch 2000. Magnetic field total intensity distribution, represented by iso intensity lines, over the globe (credit National Geophysical Data Center <http://www.ngdc.noaa.gov>). The green points show the places of hurricanes in the period 1997-2005.

Satellite image of air mass motion over Western Europe on August 24th 2005
(Gomes, Radovanovic, 2008)



Considering the mentioned idea, the angle of incidence of the SW towards the ground was considerably higher at hurricane Katrina than at the stream that moved towards Europe. However, it seems that individual separations from the main stream were not just connected with these two cases. "A total of 43 reported tornadoes were spawned by Katrina. One tornado was reported in the Florida Keys on the morning of 26 August. On 29-30 August, 20 tornadoes were reported in Georgia, 11 in Alabama, and 11 in Mississippi. The Georgia tornadoes were the most on record in that state for any single day in the month of August, and one of them caused the only August tornado fatality on record in Georgia" (Knabb et al, 2006).

- ▶ The temporal difference in appearance of TC Katrina and regenerated TC Rita was 26.5 days. The assumption that separate cyclonic movements of air masses were to appear in this case was confirmed again. At least 90 tornadoes were reported in association with Rita, mainly to the north and east of the circulation center in portions of Alabama, Mississippi, Louisiana, and Arkansas. In the next rotation of the Sun, after approximately the same temporal distance, hurricane Wilma appeared. According to our hypothesis, the number of tornadoes shows of how many separate jet streams the grouped stream of the SW particles which created hurricane was composed. The breakdown of the primary jet stream was the consequence of transition of hurricane from ocean to land when it came to the sudden increase in geomagnetic induction above the land. Water areas are diamagnetic at which the magnetic permeability is 0.90×10^{-5} . The magnetic permeability of land is much larger and belongs to ferromagnetic.

If we look at the Earth with the atmosphere as a system, which brings power from the Sun by an electric field K , then its energy balance relation can be described

$$KJdV = J^2/\sigma dV + dA/dtJdV + \text{grad}\phi JdV \quad (1)$$

Term on the left side represents the force that is brought to Earth through the electric field on the Sun. Terms on the right show how the power is distributed on Earth. The first term of the right side of the equation is the power of joule's losses, the second - the power absorbed by the magnetic field, while the third term is the power absorbed by the electric field.

If the $\text{div}(\phi J) = \text{grad } \phi J + \phi \text{ div } J$ then

$$\text{div}J = -d\Delta/dt$$

- where Δ is the density of electrical loads, and ϕ is the electric scalar potential, then

$$\text{grad } \phi J = \text{div}(\phi J) + \phi d\Delta/dt.$$

In this way, the third term of the right side of the equation (1) can be written as

$$\text{grad } \phi JdV = \text{div}(\phi J) dV + \phi d\Delta/dt dV.$$

The first volume integral on the right side of the equation can be transformed into a surface integral over the surface of the current field in which the electric convection currents flow, carried by the solar wind. In this case, the normal component of the density of electric convection current vector J on the surface of the current field is equal to zero, and therefore, the surface integral must be zero. In this way we obtain that the electric field energy is

$$\text{grad } \phi JdV = \phi d\Delta/dt dV.$$

By conversion of electric field energy given by this equation, a quantitative value is obtained for the heat on the Earth that comes from the Sun. In this way we come to the conclusion that heat on Earth is obtained by double conversion of immaterial energy.

In moderate latitude SW penetrates the Earth's atmosphere always at some angle θ_{sw} , which is the angle that the speed v makes with the vector of the magnetic induction B . We can separate the speed v into one component, $v \cos \theta_{sw}$, in the direction of the magnetic field, and the other component, $v \sin \theta_{sw}$, perpendicular to the direction of the magnetic field. Then the result will be that the trajectory of SW (the trajectory of the SW particles) is a spiral (helix), where the momentary diameter of the cylinder around which the SW is spiraling, is

$$r = mv \sin \theta_{sw} / qB,$$

while the step of the trajectory SW is:

$$d = 2\pi r / v \sin \theta_{sw} \times v \cos \theta_{sw} = 2\pi m v \cos \theta_{sw} / qB$$

However, when a cloud of SW particles is moving through the atmosphere, the speed v is gradually reduced (which means: the particles are slowing down), and, consequently, the radius r becomes smaller. For this reason, the trajectory of SW, the speed being less and less, is not a cylinder, but rather a funnel, and the SW is winding itself around this funnel, which wider end is turned towards the Sun.

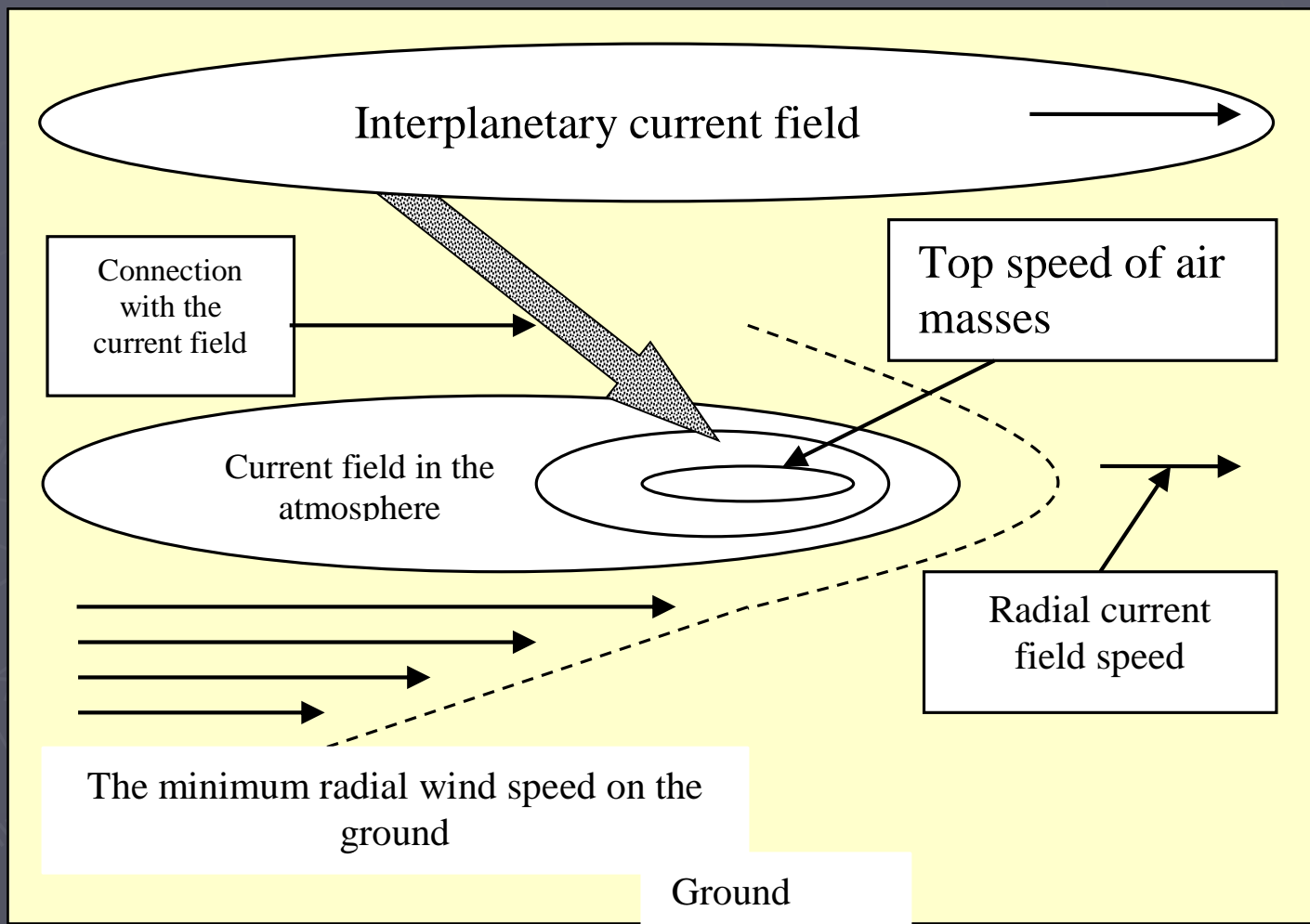
The speed of spinning motion of air masses is calculated by starting from relation that describes time for which particle makes a circle:

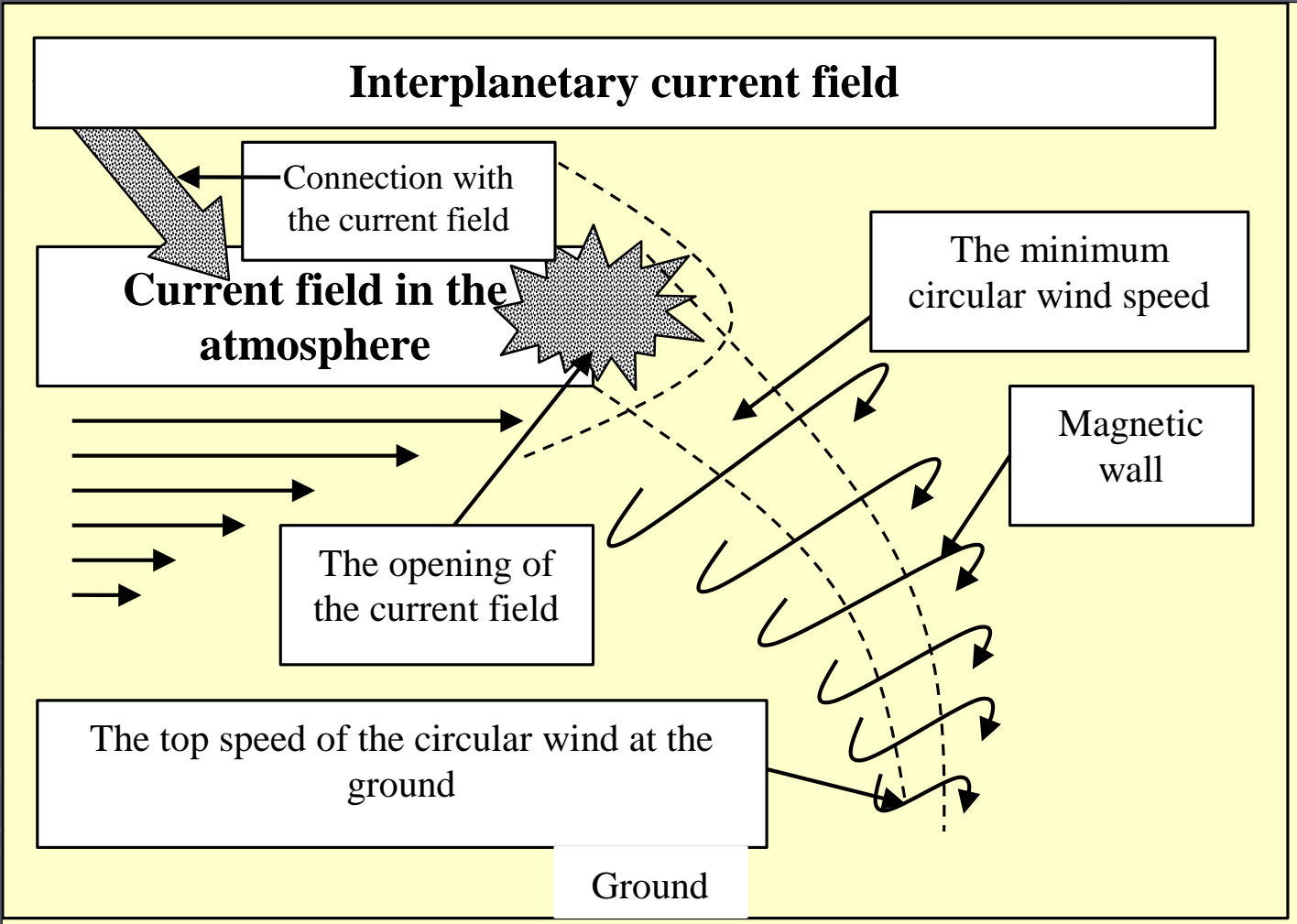
$$t = 2\pi r / v = 2\pi m / qB$$

namely,

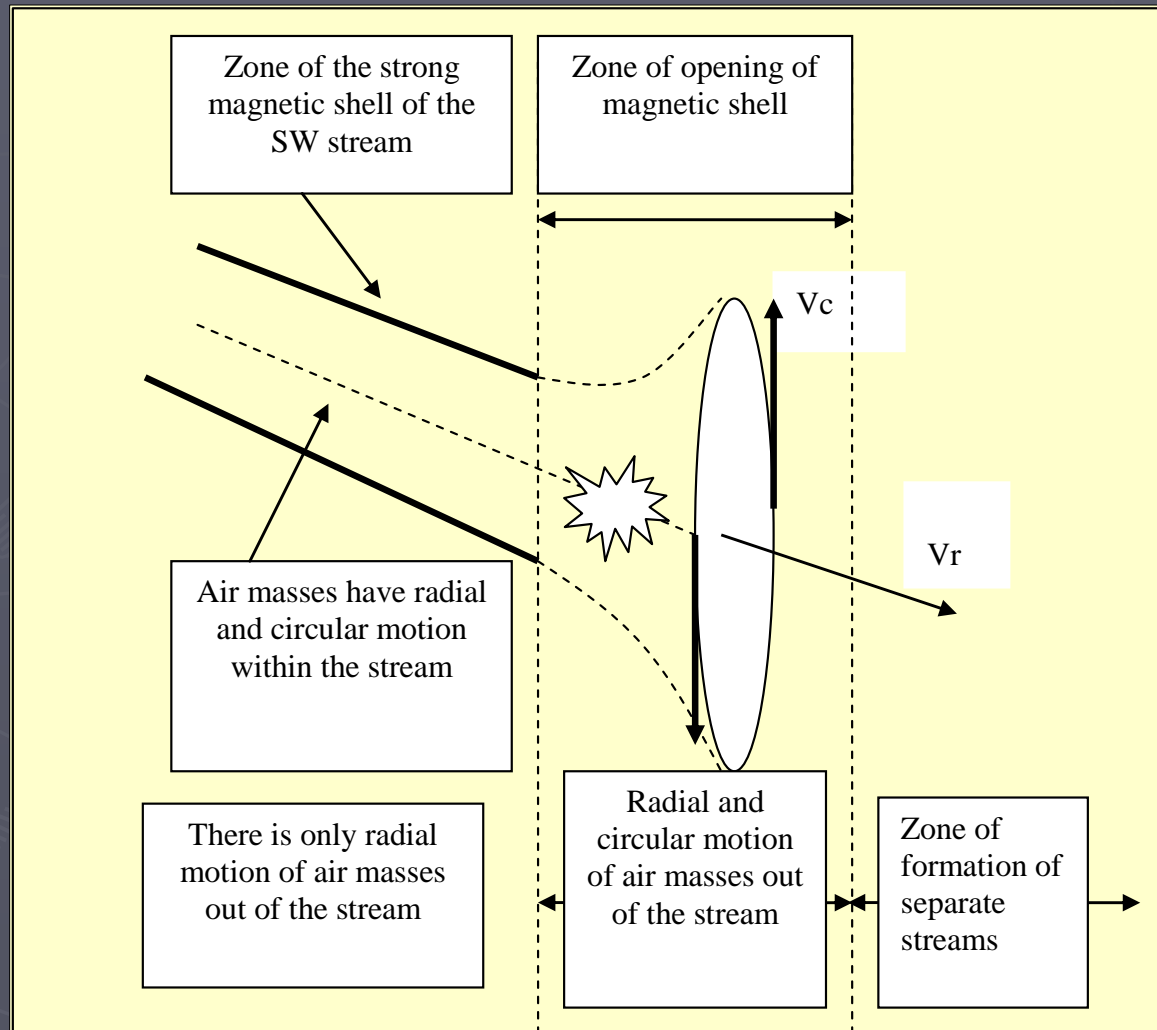
$$v = (rqB/m)k$$

where k is the sliding factor (Mukherjee, S, Radovanović, M.: Influence of the Sun in the Genesis of Tornadoes. The IUP Journal of Earth Sciences, Vol. 5, No. 1, 2011, pp. 7-21).

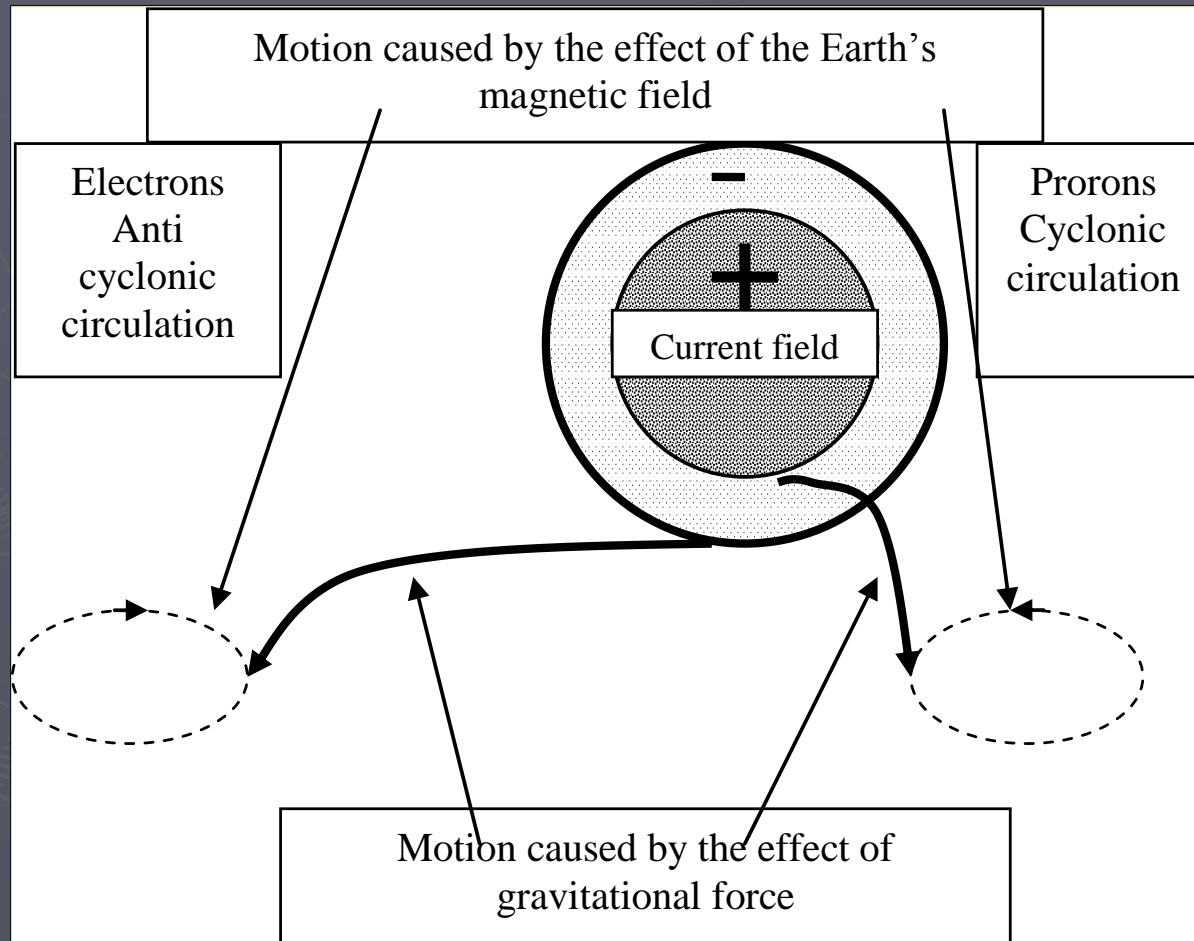


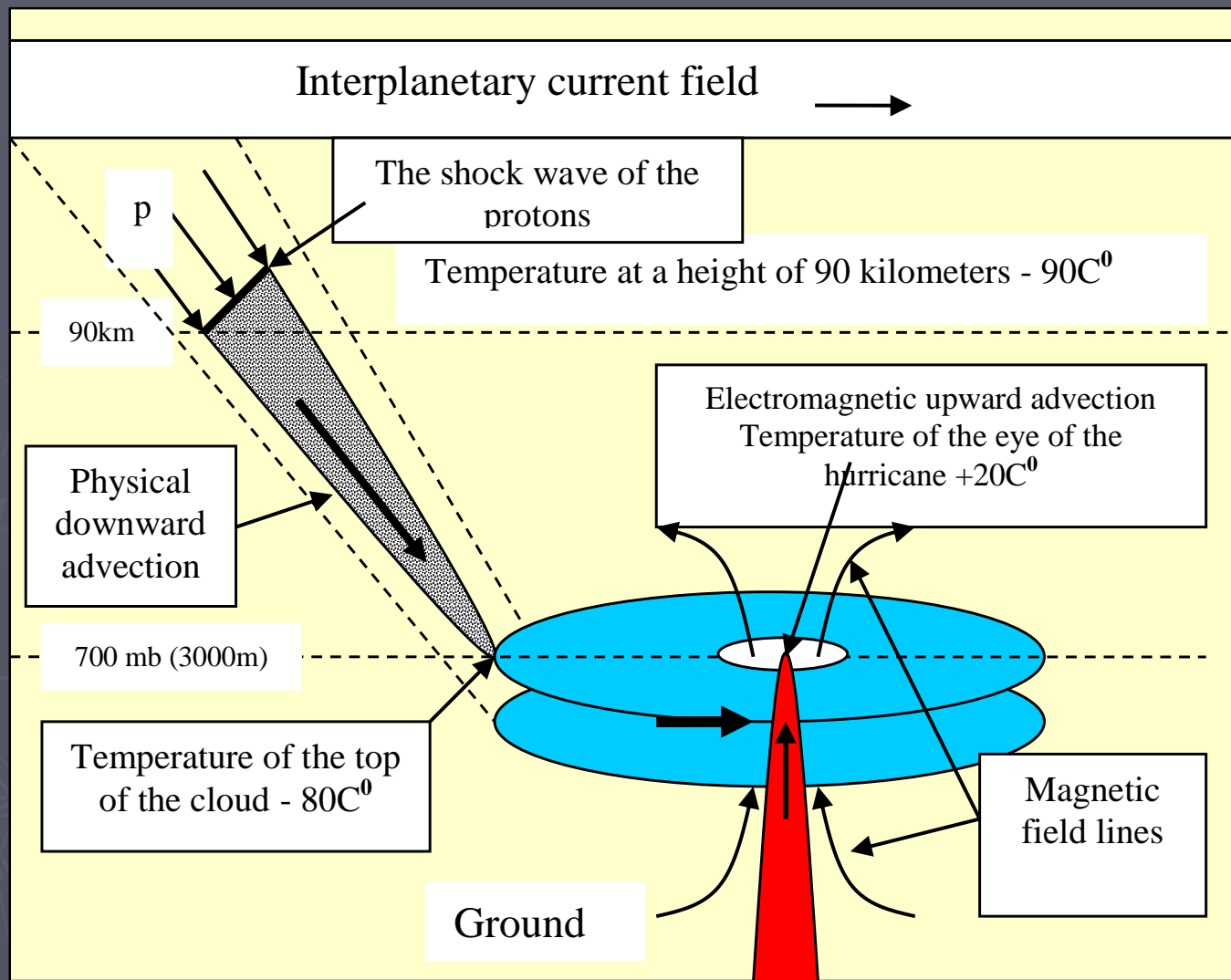


Schematic representation of the opening of magnetic shell of the main SW stream



Schematic representation of the separation of protons and electrons from the main stream of the SW



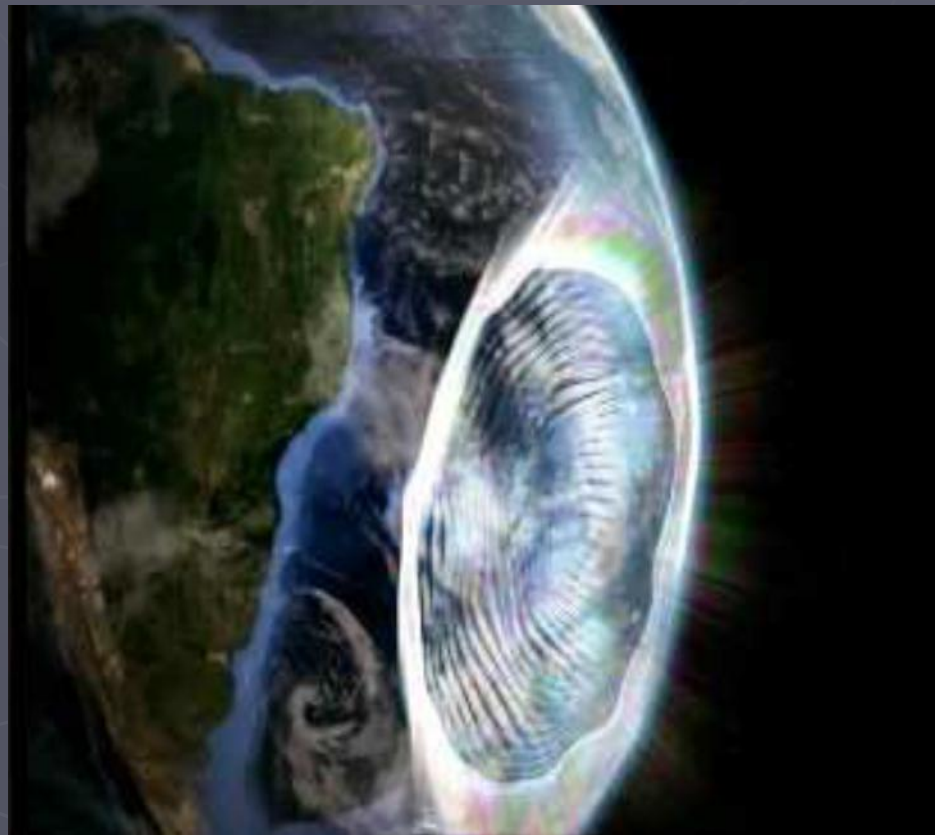


- ▶ Extremely low temperatures were recorded at all three hurricanes on surface of 700 mb in zone of clouds. In the case of hurricane Katrina GOES-12 10.7 μm IR images revealed cloud top brightness temperatures as cold as -87°C (<http://cimss.ssec.wisc.edu/goes/blog/archives/date/2005/10>).
- ▶ Electrical power from space is partially dissipated in the mechanical energy of the encircling winds. Instead of generating the electrical effects, the tornadic winds are driven by the charge sheath vortex and its connection to the electric currents of the solar system (<https://www.thunderbolts.info/tpod/2005/arch05/050330tornado-electric-discharge.htm>).

Sketch of the geomagnetic hole in the South Atlantic area. The magnetic field intensity in this area is about three times lower than the intensity of the magnetic field at the SAA boundary (Augusto et al, 2013).

Augusto CRA, Kopenkin V, Navia CE, Tsui KH, Feliciano AC, Pinto AC, De Oliveira MN, Pimentel B, Freitas F, Vianna J, Fauth AC, Sinzi T. (2013).

The first GLE in the solar cycle 24 (May 17, 2012) detected by the Tupi muon telescopes. 3ND International Cosmic Ray Conference, Rio de Janeiro 2013, <http://www.cbpf.br/~icrc2013/papers/icrc2013-1121.pdf>.



These results could be proof that tropical cyclogenesis is more affected by disturbances in the Earth's magnetic field as caused by solar activity. Finally, the relationship found between vertical wind shear and the Dst Index might suggest that the effect of geomagnetic activity on TCs activity is due to an effect that geomagnetic activity has on the vertical wind shear, which is fundamental for TCs development

(Pazos M, Mendoza B, Gimeno L. 2015. Analysis of precursors of tropical cyclogenesis during different phases of the solar cycle and their correlation with the Dst geomagnetic index. *Journal of Atmospheric and Solar-Terrestrial Physics*, 133, 54–61).

As it has already been seen, the previous investigations on the origin of cyclones are characterised by numerous unclearness. However, there are several indications which are in favour that the beginning of violent cyclonic motions in Earth's atmosphere may be caused by charged particles from the solar wind. In any case, the experiments have shown that in this way 29% to 39% of the hurricanes can be calculated. The mentioned results should be taken conditionally, primarily because of the limitations in the Software and Hardware. The phase shift which was reduced to the maximum of three days was exactly caused by the mentioned limitations. Gabis and Troshichev (2000) have pointed out that the critical days on this issue are in the range of 5 - 10. A report by Baldwin and Dunkerton (2001) shows that stratospheric mean-flow variations induce circulations that penetrate into the lower troposphere. This downward propagation takes between 15 and 50 days and is most pronounced during winter months. As we mentioned previously, our research was focused on warmer period of the year.

- ▶ Also, it is necessary to have in mind that we didn't calculate data about tornadoes. According to this hypothesis, the origin of all violent atmospheric circulations is same.
- ▶ Input data are calculated only from the sun, without any calculation of the cosmic influx.
- ▶ It is obvious that not all sudden influxes from the sun produce strong atmospheric vortex circulation. For this part of the hypothesis a much detailed research is necessary in the field of the theoretical explanation of the possible mechanism of propagation of the SW towards lower layer of the atmosphere.

Thank you

Milan Radovanović

Geographical institute "Jovan Cvijić"
Serbian Academy of Sciences and Arts
Belgrade
Serbia

Phone:

+381 11 26-37-597
26-36-594

www.gi.sanu.ac.rs

E-mail: m.radovanovicl@gi.sanu.ac.rs