GLOBAL HURRICANE ACTIVITY INTERCONNECTION WITH COSMIC RAY INENSITY CHANGES.

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1. Introduction.

In late summer and early autumn high velocity circular winds are born over the hot equatorial waters of the oceans. Traditionally those winds over the Pacific Ocean are called typhoons and those over the Atlantic – hurricanes. Powered by the solar intensive heating, producing fast evaporation and large upward hot air streams, the circular winds gradually gain velocity of 65 nods (120 km/h)., accepted traditionally to separate the upper limit of a thunder storm from the lower of a hurricane. With the further increase of the circular velocity, reaching sometimes up to 160 nodes (280 km/h), the whole vortex spread out to a giggantic ring with a diameter of several hundred kilometers **[Fig. 1.].** In the center of this ring there is a relatively calm zone called Eye of the Hurricane. Typical hurricane characteristics are systematized on **Table 1**.

Fig. 1. Hurricanes near Florida.

Table 1.

Storm diameter:	200- 1300 km	**Eye diameter:**	16 - 70 km
Energy Source:	Latent heat release	**Lifespan**	1 - 30 days
Kinetic energy:	4-8 TWh	**Surface winds:**	> 33 m/sec

Moving generally to the West, **North Atlantic hurricanes** frequently strike the Caribbean islands, Mexico, and the United States. The **Pacific Typhoons** devastate large areas from South China, Taiwan, Japan, India and Philippine Islands. During the summers in the South hemisphere storms often hit the North Australia, the Pacific Islands, and Madagascar **[Fig. 2.].**

The energy accumulated during these processes is enormous. One single hurricane dissipates energy, which could be compared with that released in an explosion of more than **thousand Hiroshima type atomic bombs**. That explains the disasters produced by a hurricane, when it touches a populated area **[Fig. 3. and 3A.]**.

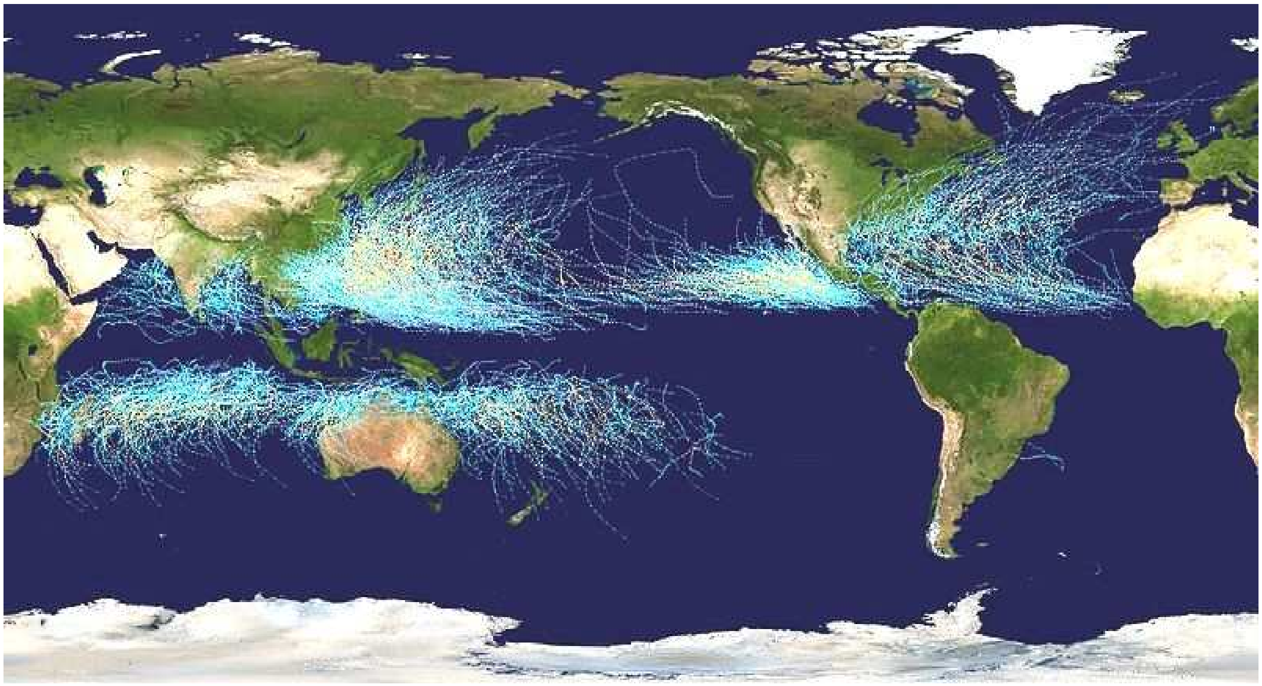

Fig. 2. Trajectories of all recorded hurricanes over the world oceans.

Fig. 3. After the hurricane… **Fig. 3A. …what remains…**

Only in the USA the total cost of hurricane devastations is estimated for **2 billion US$** per year. The new developed industrial area in China and Taiwan suffer probably more. The total counted amount of known lives lost in hurricane blows only around the Mexican gulf is over **300 000**…The same estimations around China East coast is over **500000**... Could we stop the hurricanes? Not now… Probably in the future, when we dispose and could easily redirect enormous amounts of energies…

But it is not less important to understand all the processes, participating in the hurricane formation and so to be able to forecast well in advance their appearances and trajectories and so, at least, to reduce significantly the loss of human lives. The Cosmic Ray (CR) flux, as one of the major cause of high altitude atmospheric ionization was supposed to be a contributing factor in storms and hurricane appearance and intensification. In our previous works we compared separately the behavior of many single hurricane developments with CR intensity changes in a comparatively small interval of time. Then a slight statistical interconnection with CR intensity changes was first demonstrated.

Now a new type of data appeared [4]. They present the averaged values of all parameters of all observed Thunder Storms (TS) and Hurricanes (H) over all parts of the Globe for the chosen day. In this work we took data in a 30 years period **(January 1, 1979 – December 31 2008)** to compare some of hurricane parameter daily values with of simultaneously measured data sets, describing the CR intensity, the geomagnetic changes and the solar activity. We obtained results, showing a well expressed interconnection between them. Obviously the ionization of the upper atmospheric layers due to the CR particles is connected with the hurricane vortexes.

2. Data.

2.1. Hurricane Data.

We used the following daily hurricane parameter values, averaged over **all** hurricanes, recorded over the **whole** global surface in a calendar day. These data refer to the corresponding points of the trajectories on **[Fig. 2.]:**

W -- the daily rotational velocities of all recorded hurricanes. Traditionally **W** is measured in nautical mile per hour, or knots.
P -- the daily barometric pressure averaged from minimal pressures recorded in all hurricanes centers, measured in millibars
dW/dt -- the daily average from all hourly changes of the rotational velocities averaged over all recorded hurricanes.
dP/dt – the daily average from all hourly changes of the barometric pressure
LAT -- the daily geographical latitudes averaged over all hurricanes centers.
LON -- the daily geographical longitudes averaged over these hurricanes centers.

2.2. *Cosmic Ray Data.*

From the available large amount of stations, measuring continuously CR, we chose one near the geographical North Pole, one near the geographical South Pole and one situated at middle latitudes **[Table 2.].** Their data cover the whole 30 years period more than 99.9%. Only the records on Climax station are till December 30, 2007.

Table 2.

	LAT degrees N	LONG degrees E	ALT m.	aver.coun c/min	Cut Off GeV
McMurdo	-77.85	166.72	48	9130	0.00
Climax	39.37	-106.18	3400	7300	2.99
Oulu	65.05	25.47	15	6055	0.78

2.3. *Solar and geomagnetic data.*

For our work we used:

Kp - planetary geomagnetic index for the day expressed as a sum of 8 continuous 3-hourly measured Kp indexes of that day.
Cp - or planetary daily character figure - of overall level of magnetic activity for the day determined from the sum of the eight AP amplitudes.
SS – international Sun Spot number. Records contain the Zurich numbers.
F -- Ottawa 10.7-cm. radio flux adjusted to 1 AU--measured at 1700 UT daily and expressed in units of 10^{-22} Watts/ meter sq/hertz.

3. Data processing.

All the daily data (**LAT; LON; W; P; dW/dt; dP/dt; KP**; **CP; SS; F; McMurdo; Climax; Oulu**) were carefully analyzed for errors. Two additional sets were calculated: POLAR (**McMurdo+Oulu average**) and All (**McMurdo+Oulu+Climax average**) arranged together they formed a large matrix **{15 columns x 10950 rows}.**

Then an "**averaged year set**" from every one of these 30 years sets of data for every one parameter was calculated. So, the new matrix became {17 x 365}. These "**averaged year set**" data were smoothed with "running average" method. Some of these parameters yearly changes are shown on the **Figures 4-14**.

Fig. 4. The yearly change of the averaged global hurricane center.

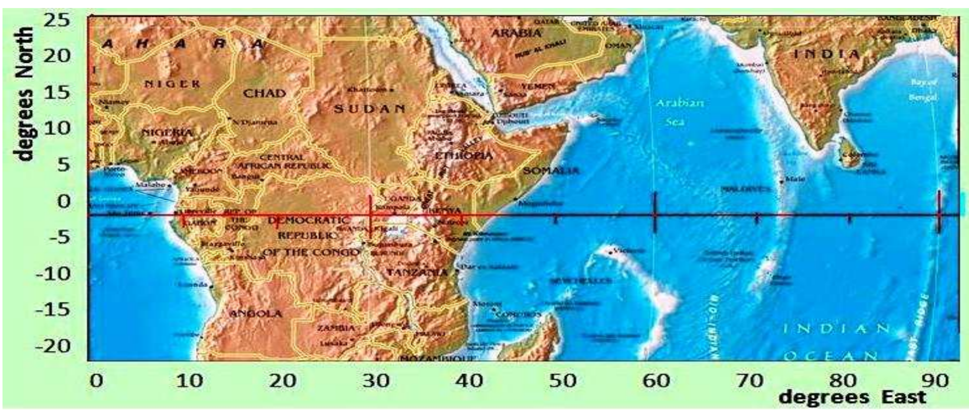

Fig. 4.1. The geographical area where the upper changes are projected.

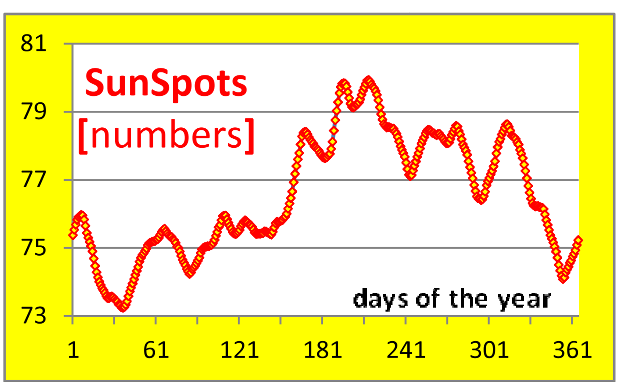

Fig. 5.

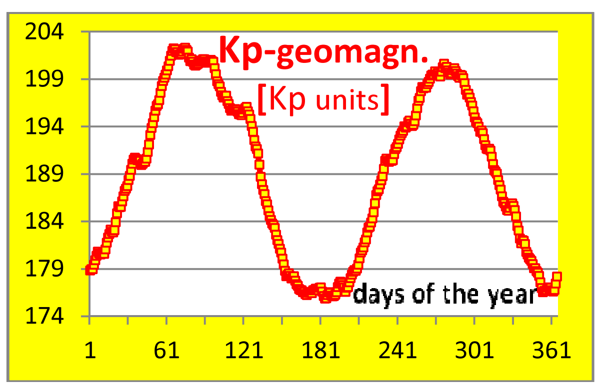

Fig. 6.

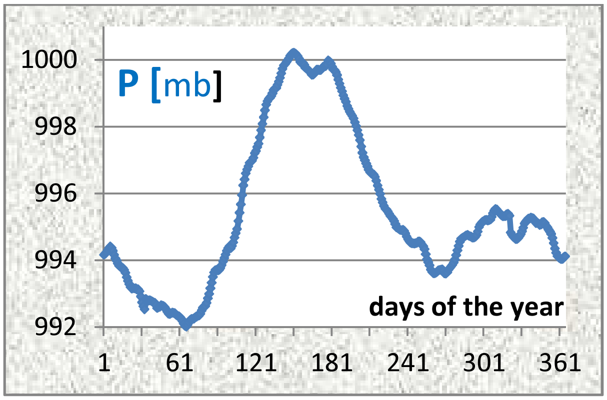

Fig. 7.

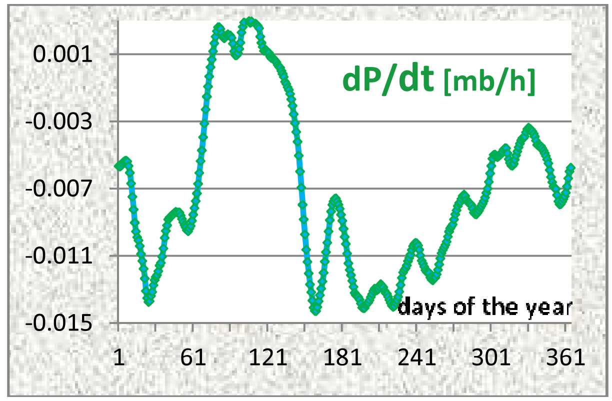

Fig. 8.

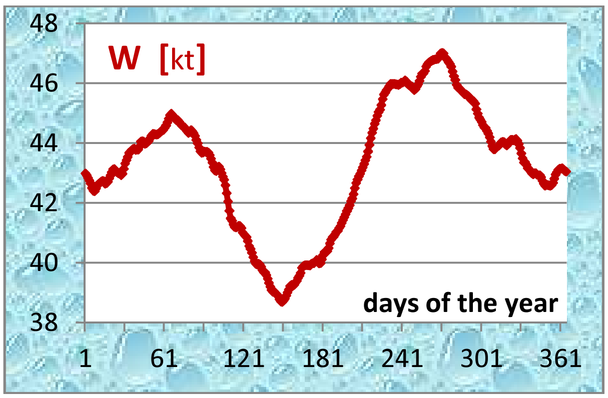

Fig. 9.

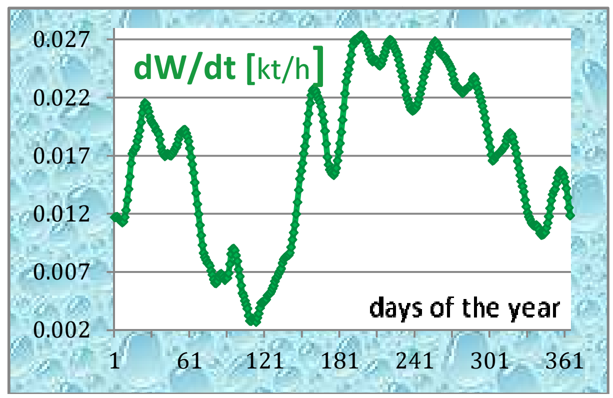

Fig. 10.

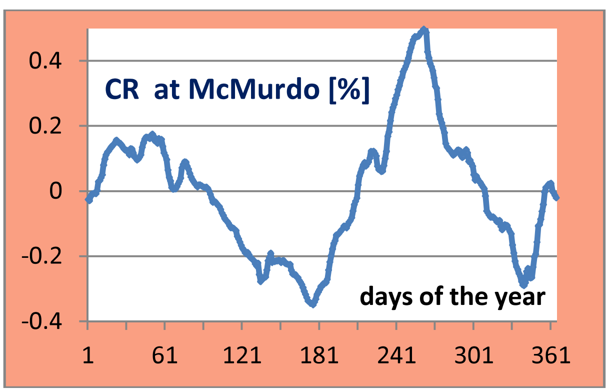

Fig. 11,

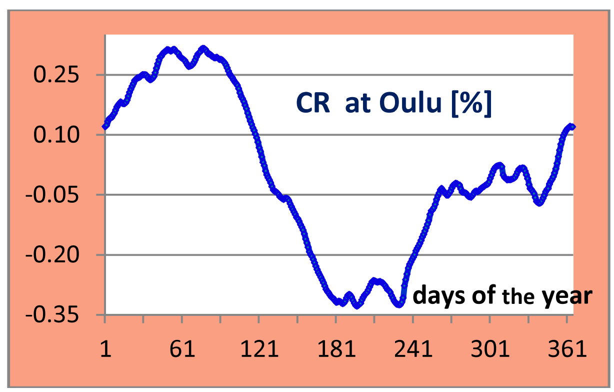

Fig. 12.

The graphs **[Fig. 11. and Fig. 12.],** presenting the averaged yearly changes of CR intensity on two stations: the far Southern McMurdo and very Northern Oulu. They seem to be very similar. They have two maximums. The higher one is during the corresponding winter time.

Table 4 All

All	P	dW/dt	dP/dt	KP	CP	flux	SS	McM	Climx	Oulu	M+O	M+C+O
W	-0.79	0.36	-0.14	0.61	0.64	0.63	0.17	0.84	0.42	0.18	0.648	0.61
P		0.03	-0.11	-0.60	-0.64	-0.7	0.39	-0.70	-0.82	-0.70	-0.893	-0.91
dW/dt			-0.92	-0.22	-0.22	0.1	0.64	0.43	-0.33	-0.57	-0.099	-0.20
dP/dt				0.45	0.45	-0.1	-0.4	-0.29	0.33	0.54	0.1684	0.25

From the graphs on these figures it could be clearly deduced that a statistical interconnection between many of them exist. More convincingly that is exhibited on the **Table 4 All**., where the calculated correlation coefficients are presented.
Depending on the sign of the LATITUDE of the average hurricane center the whole matrix was divided in North and South parts. As it could be seen on **Fig. 4,** on the Northern hemisphere this center remains 221 days (from April 29 till December 5). On the Southern – only 144 days (from December 6 till April 28).
The correlation coefficients calculated separately for the North and South parts are presented correspondingly on **Table 4(N) and Table 4(S).** The statistical error of these coefficients is less than 0.01.

Table 4 N. and 4 S.

N	P	dW/dt	dP/dt	KP	CP	flux	SS	McM	Climx	Oulu	M+O	M+C+O
W	-0.97	0.51	-0.21	0.73	0.75	0.71	0.41	0.88	0.55	0.20	0.82	0.76
P		-0.34	0.02	-0.77	-0.79	-0.81	-0.28	-0.82	-0.70	-0.38	-0.85	-0.86
dW/dt			-0.91	-0.01	0.00	0.17	0.81	0.56	-0.19	-0.54	0.22	0.03
dP/dt				0.32	0.32	0.12	-0.70	-0.32	0.50	0.75	0.06	0.29

S	P	dW/dt	dP/dt	KP	CP	flux	SS	McM	Climx	Oulu	M+O	M+C+O
W	-0.91	0.27	-0.11	0.53	0.55	0.19	-0.21	0.51	0.50	0.67	0.6205	0.60
P		-0.55	0.41	-0.36	-0.38	-0.34	0.43	-0.78	-0.74	-0.73	-0.80	-0.86
dW/dt			-0.97	-0.39	-0.37	0.64	-0.60	0.64	0.83	0.12	0.4156	0.73
dP/dt				0.53	0.52	-0.71	0.53	-0.51	-0.79	0.06	-0.251	-0.61

4. Conclusions.

Here the results are based on elaboration of a large amount of continuous measured data in a long period of 30 years. It could be accepted that these data control practically all possible influences over hurricane appearance and development.

Obviously the main influential meteorological parameter over the hurricane rotational speed (W) is the atmospheric pressure (P). The correlation coefficient between W and P is -0.79. It is even higher if calculated separately for the Northern (-0.97) and for the Southern (-0.91) hemisphere.

A similar strong connection was found between the first derivatives dW/dt and dP/dt. For them the correlation coefficients were correspondingly: -0.92 [for both hemispheres], -0.91 [for the North one] and -0.97 [for the South one].

For the first time on the basis of these Global Data we received a strong interconnection between the main hurricane characteristics W and Cosmic Ray intensity measured on high latitudes.

The first derivative dW/dt correlates also very well with the CR intensity, measured in the South hemisphere.

The geomagnetic field presented with the averaged daily values of KP and CP indexes correlate positively with W. [0.61], [0.65.].

The hurricane rotational wind (W) appeared to be more actively connected with Solar Flux (F) than with the Solar Sun Spots (SS). And just the opposite: the first derivative (dW/dt) is influenced more from the Sun Spots (SS) than from the Solar Flux (F) [In the Southern hemisphere that is not well pronounced].

The result obtained on the basis of these globally averaged data could confirm that the hurricane rotational wind velocity changes are closely connected with:

1. **CR intensity.**
2. **The Geomagnetic activity.**
3. **The solar radio frequency flux.**

Intensive efforts for quantitative evaluation of these interconnections are in progress.

Acknowledgments

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