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Keywords: GDELT project, earthquakes, solar flux units, human conflict behaviour.

I. Introduction

Although the direct impact of releases of large magnitudes of seismic energy upon human behaviour have been obvious historically and cross-culturally, the influences of more subtle releases of seismic energy upon human cognition have not been systematically explored. Persinger (1999) employed techniques of multiple regression to show an intermediate strength association between yearly estimates of global mortality from "social expenditures" (wars and armed conflicts) and the lagged values for variations in the global release of seismic energy in conjunction with geomagnetic indices. The research was inspired by the original thinking by A. L. Tchijevky from the early 20th century (Mikulecky, 2007) who reported the strong association between peaks in solar activity and major conflicts and the persistent yet infrequently investigated moderate strength between solar activity and global seismicity (Jakubcova and Pick, 1986; Odinstov et al, 2007). Recently, Anagnostopolous et al (2013) reported a positive correlation between *daily* numbers of admissions to psychiatric facilities and the numbers of small (M<3) earthquakes within the region of Crete, Greece. More specifically abrupt increases in the numbers of small earthquakes were followed within two days by increased admissions.

A direct real-time coupling between the physical substrates within the human brain that support and generate cognition and environmental events, particularly very low magnitude earthquakes and solar flux density has not been fully considered. Yet the physical potential is feasible. For example the energy associated with the smallest magnitude of earthquakes, 0.01 to 1 M, is in the order of 10^6 to 10^7 J (Joules) per day. For comparison the energy available from the metabolism of 1 Mole of glucose is about 2 x 10^6 J and the average human being utilizes about 2 to 3 M of glucose per day. The brain, as an organ, utilizes about 20 $J \cdot s^{-1}$ (Watts) or 1.7 x 10^5 J per day. However the total amount of energy associated with one estimate of the *electromagnetic* substrate of cognition (rather than the supportive cell metabolism) is more likely to be in the order of 10^{-13} J per second. This is based upon the assumption that an action potential involves units of energy of ~10^{-20} J (Persinger, 2010) and that approximately 10^7 neurons are involved with networks associated with "cognition" and awareness.

When 10^{-13} J per second is divided by the average cross-sectional area of the human cerebral cortices (~10^{-2} m^2) the radiant flux density would be about 10^{-11} $W \cdot m^{-2}$ which has been measured as photon emissions in several experimental sittings (Dotta et al, 2012). Similar flux densities of photons have been

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measured from hippocampal slices (Isojima et al, 1995) and were correlated with the strength of theta (4-7 Hz) activity. During years 2009 and 2013 the daily average numbers of M 0.01 to 1.0 quakes was ~108 per day with a total release of $\sim 8 \cdot 10^{7}$ J per day. This is equivalent to 10^{5} J·s^{-1} (on average). If the power was distributed equally over the surface of the earth the flux density would be 10^{-10} W·m^{-2} which is well within the range of the value associated with photon emission coupled with cognition. Although this does not prove coupling exists between cerebral energies of all human beings and the temporally and spatially heterogeneous release of seismic energies actually occurs, the coincidence requires at least cursory empirical assessment.

Our research group has found that relatively subtle changes in environmental stimuli, such as geomagnetic activity, are positively correlated with discrete and intensity-dependent $\mu V^{2} \cdot Hz^{-1}$ shifts in quantitative electroencephalographic activity for more than 250 subjects sampled over three years (Saroka et al, 2014). Similar intensity-dependent shifts above a threshold of ~20 nT for global geomagnetic activity as measured by the aa (average antipodal) index for subjective experiences in a controlled, quiet experimental setting was reported almost two decades ago (Persinger and Richards, 1995). The magnetic energy induced within the cerebral volume from these global geomagnetic fluctuations (0.6 x 10^{-12} J) approached the quantities associated with cognition. The effect primarily involves the right hemisphere of the human cerebrum and can facilitate the intercalation between the two hemispheres at the level of the temporal lobes (Mulligan et al, 2010). The "geomagnetic" effect has been reproduced experimentally in the laboratory by whole body exposure of volunteers to magnetic field configurations whose intensities and frequencies simulate natural conditions (Mulligan and Persinger, 2013).

We reasoned that if the human brain is sensitive to the environmental energies even crude or indirect estimates of group human behaviour over the planet should be associated with global incidence of the small magnitude earthquakes that approach energies generated by the human brain and body. At this level there should be a contribution from solar activity within the GHz range. For example the average daily solar output is $\sim 10^{-20}$ W·m^{-2}·Hz^{-1} (kg·s^{-2}). When multiplied by the potential range of 10^{9} Hz (s^{-1}) the potential flux density near the earth's surface could approach 10^{-11} W·m^{-2}. Although accommodations for impedance must still be verified, this is within the range associated with photon emission from the right hemisphere while subjects sat in hyper-dark settings and imagined white light rather than mundane events (Dotta et al, 2012). The variations in flux density were strongly correlated (0.9) with beta activity within the left prefrontal region. This region of the brain when activated is associated with self-monitoring and organization behaviors. During period of hypometabolism, the most frequent correlate is severe clinical depression.

We (Vares and Persinger, 2014) have recently shown a clear inverse correlation between daily solar flux units and the radiated energy for an earthquake of 0.01 to 1 M for the five years 2009 through 2013. We found that for every SFU unit decrease the average energy increase *per event* between 0.01 and 1 M quake over the surface of the planet would have been about 3.1 x 10^{-12} J·m^{-2}. The change in energy per event within this range rather than the numbers of events was the critical variable. The energy within the soma of a neuron with a cross sectional area of 10^{-10} m^{2} discharging at an intermediate frequency of about 40 Hz (the primary frequency range associated with consciousness, Llinas and Ribary, 1993) would have been ~1 x 10^{-20} J·s^{-1}, the energy equivalent to a single action potential (Persinger, 2010). Recently two separate groups of researchers have shown experimentally that stimulation of a *single neuron* affects behavioural responses (Houwelling and Brecht, 2007) and can shift the activity of the entire cerebral cortices (Li et al, 2009). Here we present evidence for the supposition that daily changes in global human behaviours according to a new integrated WEB-based system, small magnitude seismic events and solar activity are correlated and may reveal some degree of temporal connection with implications for future causal connection.

II. Data Bases

Access to one of the world's largest event dataset was made publicly available on May 29th, 2014. The Global Database of Events, Language, and Tone (GDELT) Project website (http://gdeltproject.org/) monitors world news media and compiles hundreds of categories of "events" as used by the DARPA-funded Integrated Conflict Early Warning System (ICEWS) project. Events including riots, protests, and diplomatic exchanges have been utilized for comparative study of political violence (Hammond & Weidmann, 2014). The events are recorded with details, including the physical location, direction of political intention and comprise the more than a quarter-billion events database, dating back to 1979. As confirmed by the avowal of the database creator (Leetaru & Schrodt, 2013), the data are considered as a global 'signal' providing insights into changes on the ground. The GDELT Event Database is available in Google's Big Query Developers Console. The cloud-based analytical database service is designed for large datasets. Fast SQL queries against multi-terabyte datasets can be accomplished in seconds, and real-time insights about global human society is accessible. Conflict and Mediation Event Observation (CAMEO) Event Root Codes label events with a key word, (i.e. 'Event Root Code 02' = 'Appeal)

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and are accessible from the GDELT website http://data.gdeltproject.org/documentation/CAMEO.Manual.1.1b3.pdf. GDELT was accessed by Big Query for six (6) Event Root Codes and extracted for dates from January 1, 2009 until December 31, 2013 for a total number of days N = 1826. To normalize and to compensate for the exponential increase in the availability of global news material over time, the percentage of CAMEO Event Root Codes were calculated from the total number of events reported in the GDELT Event Database, across all event types, and broken down by day. The following table displays the Event Root Codes average daily percentages and standard deviations.

Table 1 : Means and standard deviations (SD) per day for various codes of behaviour classification as measured by the GDELT Event Database

Code	Description	Mean	SD
15	Exhibit Force Posture (alert/mobilize/police/military)	.33	.10
16	Reduce Relations (halt/withdraw/assistance/aid)	.87	.23
17	Coerce (confiscate/impose/freedoms)	4.96	.56
18	Assault (abduct/kill/bombing/assassinate)	1.65	.30
19	Fight (occupy/fight/territory/arms/aerial)	6.73	1.09
20	Conventional Mass Violence (mass/ethnic/chemical/bio/nuclear)	.03	.02

Earthquakes were queried from the Advanced National Seismic System (ANSS) global composite earthquake catalogue of the U.S. Geological Survey (USGS) for the same N = 1826 dates from 2009 – 2013. The total number of recorded Earthquakes and average Earthquake radiated energy were calculated per day for each order of magnitude (0.01-1M, 1.01-2M, etc.). The following table (Table 2) depicts the average daily seismic activity with standard deviations in parentheses.

Table 2 : Total numbers of events per day for each interval of magnitude of global earthquake events, the numbers of days involving these events, and the average energy in Joules per event

Magnitude	Days	Total Number	Average Energy (J)
0.01 – 1.00	1826	108.73 (33.24)	7.04E5 (9.01E4)
1.01 – 2.00	1826	100.07 (41.69)	1.44E7 (2.05E6)
2.01 – 3.00	1826	35.65 (33.50)	4.38E8 (1.12E8)
3.01 – 4.00	1819	8.70 (10.04)	2.21E10 (1.14E10)
4.01 – 5.00	1826	26.72 (22.22)	5.57E11 (1.30E11)
5.01 – 6.00	1725	3.85 (6.01)	1.05E13 (8.00E12)
≥ 6.01	487	0.36 (1.02)	2.50E15 (1.33E16)

Daily solar flux units (10^{-22} W·m^{-2}·Hz^{-1}) were queried from the NOAA Penticton F10.7cm index as measured at local noon (2000 UT). The peak measurement was 2.8 GHz with a 100 MHz band width. For the analysis period the mean and standard deviation were 101.4 and 27.4, respectively. All statistical analyses involved SPSS PC 16 and 17. Spearman rho (non-parametric) and Pearson product moment (parametric) coefficients were obtained and compared to minimize the probability that any effect was due to outliers.

III. Results

The analyses of the correlations between each of the integer magnitude levels of global earthquakes and the different classes of reports of human behaviour demonstrated that only the strength of the association with the average earthquake energy for the magnitude

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0.01 to 1.0 seismic events were statistically significant ($p < .002$) and consistent. The results of the correlational analyses between solar and the low magnitude seismic activity with the different classes of reports of social behaviour as defined by the GDELT CAMEO Event Root codes are shown in Figure 1.

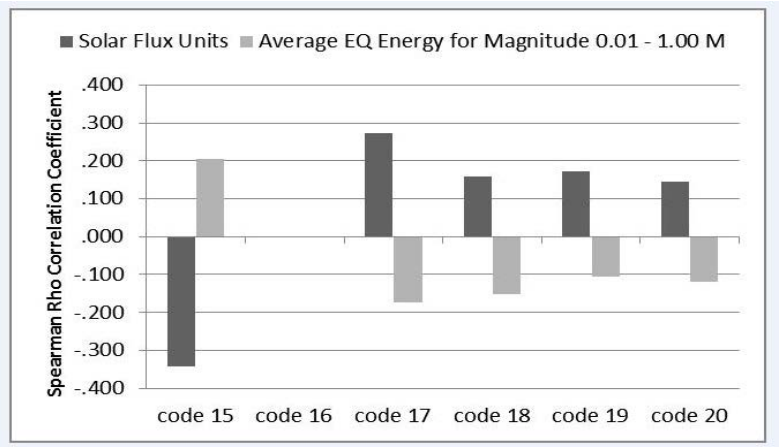

Figure 1 : Spearman Rho correlations between the daily incidence of each of the behavioural categories and the average energy from 0.01 to 1 M earthquakes and solar activity SFU.

All of the classes actually associated with active behaviour, particularly aggressive behaviour were positively and significantly correlated with the inference of solar power (SFU) for the same day. The class (code15) associated with intention, such as mobilization, was associated with increased average energy for the seismic events but decreased association with solar activity. The relationship between the daily incidence of code17 through code20, all involving actual behaviours and earthquake energy or solar flux units was opposite to that associated with intention. It is relevant that episodes of reports of simply policy changes were not significantly correlated with either solar flux units or seismic energy within the 0.01 to 1 M interval.

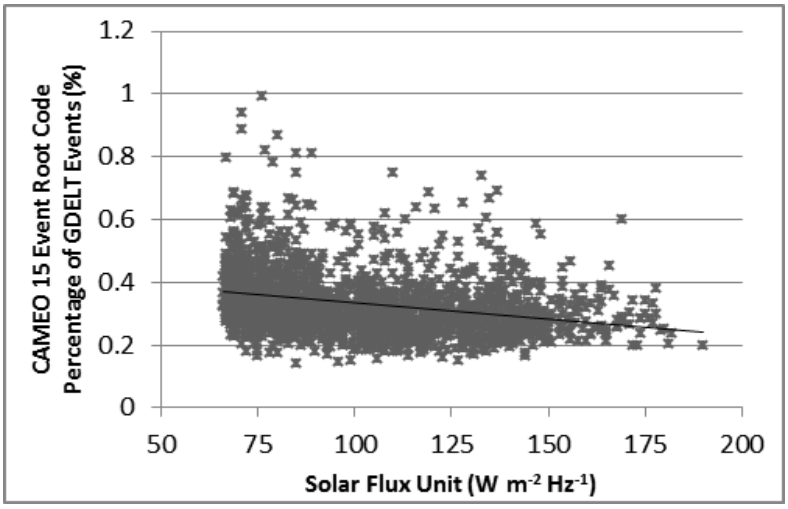

Figure 2 : Scattergram between the indices for CAMEO Event Root Code 15 class of events (exhibitions of force or posturing) and the daily SFU values

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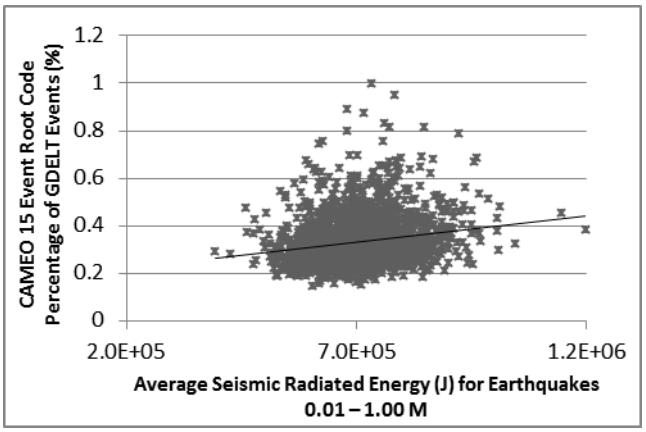

Figure 3 : Scattergram of the association between daily radiated seismic energy per event of very small magnitude earthquakes and the indices for exhibitions of force or posturing

In order to discern if there was shared variance between the three key variables, partial correlation analyses were completed with the parametric (Pearson r) values. The results are shown in Table 3 for the strongest association (Code15, intent and mobilization).

The elimination of the statistically significant association between the seismic energies and this category of reports of human behavior once the shared variance with daily SFUs was removed indicates that the original association was due to their shared variance with SFUs.

Table 3 : Zero-order and partial correlation analyses for pairs of variables after the shared variance (with the remaining variable) was removed for solar activity (SFU), average energy per earthquake within the 0.01 to 1 M range and category of reports associated with intent, e.g., alerts, mobilizations of police or military)

Correlation Variables	R	Control Variable	Partial	ΔR
SFU + EQ	-.472	Code15	-.443	.029
EQ + Code15	.194	SFU	.074	.120
SFU + Code15	-.279	EQ	-.217	.062

Lag, lead analyses were completed for the SFU and average energy per seismic event for each of the five days before and after the key day (day of report) for the various CAMEO Code categories. The most conspicuous pattern is shown in Figure 4 for CAMEO Code 15 reports and our seismic index. The average energy for individual events within the "intent" category increased about 3 days before the behavioral (or reported) occurrence. However a direct test of the difference between the two correlation coefficients if they were treated as parametric values was $z = 1.5$ ($z < 1.96$) and was not significant statistically ($p < .05$). In order to be statistically significant, the sample size (assuming the same effect size) would require a collection of about 10 years of daily data.

The "temporal distribution" of the major category associated with SFU fluctuations per day are shown in Figure 5. In this instance the slow increase in strength of association, although very minute, occurred about 2 days after the day of the reports of coerced episodes. Again the apparent difference between -1 and +2 days for this attractive pattern was not statistically significant, that is there are no significant differences between the correlation coefficients (difference about 1% of the variance). However the shared variance between this category per day and SFUs was about 7%.

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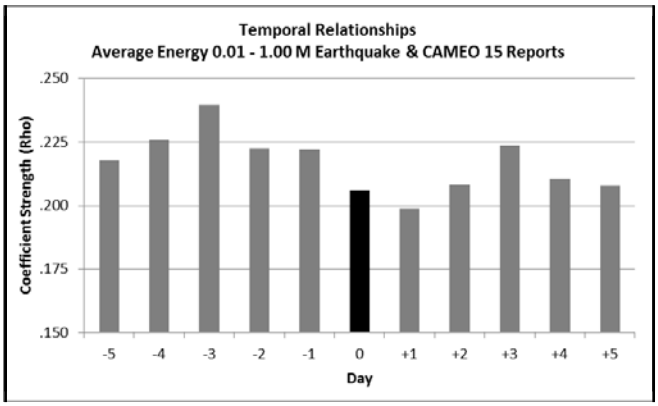

Figure 4 : Strength of association (rho) between numbers of CAMEO Code 15 reports (intentions) and average energy per unit seismic event in the 0.01 to 1.0 M range as a function of lag/lead or days energy release for each of 5 days before and after the days of the reports (0)

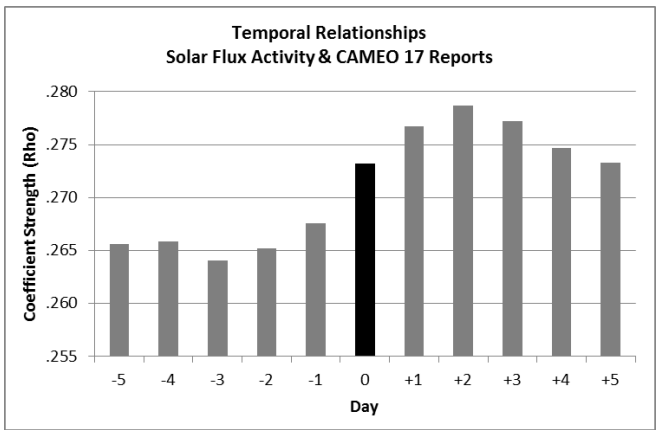

Figure 5 : Strength of association between solar flux units (SFU) and numbers of CAMEO Code 17 Reports (aggression) and for daily SFU values lagged for each of 5 days before and 5 days the days of the reports

IV. Discussion

Most biological scientists would concur with the concept that living systems developed interactively on this planet and that ultimately the majority of the energy from which these systems were constructed originated from the Sun. Some researchers who have developed the concept of quantum biology (Popp, 1979) have suggested that the photon emissions between cells within living systems may actually involve direct communication of information (Dotta et al, 2014) and that these photons are still virtual representations of the original solar source. If even partially accurate, the implications concerning the direct influence of fluctuations in minute power densities on the earth's surface from the sun may require careful reconsideration.

A shared variance of between 4% and 10% between the geophysical variables and the behavioural categories may appear minuscule. However, even when controlling for the qualitative nature of the data base and the issues of sampling and ordinal scaling, such shared variance could have significant implications for large populations. Many relevant sociological effects accommodate less than 10% of the effect size for group or "treatment" differences. The effect sizes (amount of variance explained) for changes in weather (Persinger, 1987) are in the order of 10% with respect to fluctuation in daily estimates of mood. When applied to populations of millions of people, this effect can potentially determine the direction of popular opinion, such as votes, and affect economic productivity. The latter phenomenon, including the multiplier effects noted in many large economic systems, often operates for proportions of variability that are less than 10% of the central tendency. The strength of the periodic 10 year cycle in the correlation between cerebral indicators of hemispheric dominance and birth year coupled to solar activity (Volcheck, 1995) is within this range.

The caveat to any interpretation from these data is that it may reflect the factors responsible for the reporting of the different categories rather than the behaviours themselves. However if this were totally responsible for the correlations one would not have expected the reversal of directions with respect to solar activity and seismic energy for the different categories that effectively differ by intent vs action. In addition, the numbers of CAMEO Code 16 reports which were related

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to neither intent nor behaviour at the time but a simple report of changes in policy were not significantly correlated in any direction with either the solar or seismic fluctuations.

The contribution from changes in GHz output from solar activity upon brain function does not appear to have been considered as a direct influence even though the quantitative solutions are congruent. During the five year period involved with this study the average daily SFU units was 101 SFU with a standard deviation of about 27 units, equivalent to 10^{-20} $W \cdot m^{-2} \cdot Hz^{-1}$. If the central band frequency, 2.8 x 10^9 Hz, were applied, the effective flux density is approximately 2.8 x 10^{-11} $W \cdot m^{-2}$. Although there is no evidence, primarily because of absence of systematic experiments, to discern the neutral hydrogen frequency in the human cerebrum and its coupling to physical processes, demonstration of this effect would diminish the argument that such small solar variations cannot be cerebrally effective.

The association between the increased SFU and increased numbers of reports of human actions associated with intent or planning whereas the actual execution of aggressive behaviors were negatively correlated with increased solar activity suggests that cognitions or some aspect of aggregate of anticipatory (social) behaviour is related to solar perturbations. The mechanisms are clearly not evident at this time and could involve a third factor through which both are related rather than direct causality. From the context of the emerging discipline of quantum biology and the seminal concepts of Popp (1979) and the very original thinkers Hu and Wu (2006), the presence of excess correlation between photon interactions within the human brain and the entangled photons originating from the sun would require the consideration of non-locality. That this can occur experimentally at macroscopic and non-traditional distances had been shown by Dotta and Persinger (2012).

The potential for energies associated with seismic energy release within the 0.01 to 1 M range is consistent with the concept that systems that exhibit similar magnitudes of unit energy can potential interact directly or by resonance. For example in computer systems voltages within ±5 V are potentially influential and can alter the type of information or its direction within the system. Voltages that are lower or higher are either not effective or destructive to the system's constituents. The total energy from the seismic events per day within the 0.01 to 1 M value would have been in the range of 7 x 10^7 J per day or about 8 x 10^2 $J \cdot s^{-1}$ and when distributed over the earth (assuming some distribution around homogeneity) would be 1.6 x 10^{-12} $W \cdot m^{-2}$.

This is the same order of magnitude as our measurements of background photon emissions from the earth (Persinger et al, 2012) and the magnitudes of changes from the right hemisphere of human volunteers sitting in hyper-dark settings and engaging in imagination (Dotta et al, 2012). That the latter are not artefacts of metabolism is indicated by the strong positive (0.9) correlation with the photon flux density variations of the photon output from the right hemisphere and the power density of electroencephalographic activity within the beta range over the left prefrontal regions. This region of the human brain is a major locus of neurocognitive processes associated with self-monitoring, planning, and the feeling of intent.

Previously we (Vares and Persinger, 2014) found a quantitative relationship between daily SFU variations during the same five year period and energy release from 0.01 to 1 M seismic events. The slope for the application of the energy over the earth's surface was such that for every 1 unit decrease in SFU, the seismic energy from this magnitude interval increased by 3.1 x 10^{-12} $J \cdot m^{-2}$. This is an important value because when applied to the cross-sectional area of an average neuronal soma (10^{-10} m^2) the energy is 3 x 10^{-22} J. If this fluctuation was around 40 Hz (s^{-1}), the band of cerebral cortical activity associated with consciousness and cognition, the power would be about 1.2 x 10^{-20} $J \cdot s^{-1}$. This equivalent to energy associated with one action potential per second. That a single neuron can affect the state of the entire cerebral cortices has been shown experimentally (Li et al, 2009).

There is still the possibility that the actual stimuli, similar to that found by Anagnostopolous et al (2014), were connected to increased seismic events occurring during the days preceding the aggressive events. Those researchers included a wider range (M < 3) of seismic events. The decrease in average seismic event energy on days associated with day of reports of increased actual expressions of aggressive events, if both are partially caused by solar variations in the GHz range, would suggest that the energy is distributed to the processes that ultimately result in either the smallest earthquakes or the cerebral conditions that contribute to aggressive behaviors as measured by the global index. In other words as one class of phenomenon becomes more frequent the incidence of the other diminishes. The observation that the strong correlations occurred with the average energy per seismic event rather than the numbers of events, per se, suggest that there may be an analogue of a "vesicular" or "quantum" of energy coupled so the solar-terrestrial influence that is common to both seismic and cognitive processes.

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