Journal of Agriculture and Forest Meteorology Research

JAFMR, 1(1): 11-12
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Original Short Communication: Open Access

Forecasting of Strong Earthquakes M>6According to Energy Approach

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Received April 2, 2018; Accepted April 30, 2018; Published September 22, 2018

THERMAL ANOMALIES OF OUTGOING LONG WAVE RADIATION (OLR) SIGNALS

In this study is presented information on the thermal anomalies (OLR) collected by the satellites during the earthquakes and from the past two years without earthquakes for the relevant geographic locations. It is known that the masses of the tectonic plates are subjected to enormous pressure and critical stresses are generated whereby positively charged particles "p-holes" are emitted. When these reach the ground, they ionize the molecules of the air and infrared rays are emitted. It is known as OLR. The satellite sensors at tens of kilometers catch the infrared radiation and keep track of it as a reflection from the Earth's surface with wavelength of 10-13 μm.

NOMENCLATURE

$W_a(t)$ – The average OLR value per day for the two years without collision is $\left[\frac{W}{m^2}\right]$; $W_M^d(t)$ – The momentary OLR value in the course of the year with an earthquake is $\left[\frac{W}{m^2}\right]$; $W_{amax}W_{amin}$ - Maximum and minimum value of the variation $W_a(t)$ in $\left[\frac{W}{m^2}\right]$; W_{AI} - Average integral value of the $W_a(t)$ over the period considered in $\left[\frac{W}{m^2}\right]$; W_{AA} - Average algebraic value of the $W_a(t)$ in$\left[\frac{W}{m^2}\right]$; W_{AI}^d- Average integral value of the $W_M^d(t)$ over the years with earthquakes in $\left[\frac{W}{m^2}\right]$; $W_{Mmax}^d W_{Mmin}^d$ - Average algebraic value of the $W_M^d(t)$ in $\left[\frac{W}{m^2}\right]$; $\boldsymbol{t_1 t_2}$ **-** Times in which $W_{AI} \equiv W_M^d(t)$ in [s]; $\boldsymbol{t_3}$ **-** The time in which the earthquake occurs in [days]; $\Delta\, E_{max}$- Maximum energy limit of the OLR in $\left[\frac{kWh}{m^2}\right]$; $\boldsymbol{\Delta t = (t_3 - t_2)}$The time after which the earthquake occurs in [days].

ENERGY ASSESSMENT OF THE OLR SIGNALS

On the Figures1a and 1b are shown examples of variations of OLR signals. One of the figures represents variations of OLR signal without any seismic phenomena for a two- year long period for the specific place on Earth with geographical coordinates – Latitude and Longitude. The other figure represents the OLR signal for the same place of the Earth with the same geographical coordinates, but for a time period of one yearwith occurrence of big seismic phenomena. The minimum and maximum values are as follows:W_{amin}, W_{amax}, W_{Mmin}^d, W_{Mmax}^d and the average integral values are:

$$W_{AI} = \frac{1}{T}\int_0^T W_a(t)\, dt \quad and \quad W_{AI}^d = \frac{1}{T}\int_0^T W_M^d(t)\, dt \qquad (1)$$

These are exhibited in the two figures. Extensive analysis (hundred occurred earthquakes with M>6) shows that the difference between the average integral OLR signal values and the arithmetical average values is less than 5%. For this reason could be assumed that:

$$W_{AI} \approx \frac{1}{2}(W_{amin} + W_{amax}) \quad and \quad W_{AI}^d \approx \frac{1}{2}(W_{Mmin}^d + W_{Mmax}^d) \qquad (2)$$

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Citation: Jivkov V, Natarajan V, Paneva A & Philipoff P. (2018) Forecasting of Strong Earthquakes M>6According to Energy Approach. J Agric Forest Meteorol Res, 1(1): 11-12.

The variation of the energy of the OLR signal in the time interval $h = t_1 - t_2$ is shown in the Figure 1c, where the variation ΔE_{max} is most significant. The points A and B match aligned values of:

$$W_M^d(t_1) \equiv W_{AI} \; hence \;\; W_M^d(t_1) \equiv W_M^d(t_2) \equiv W_{AI} \quad (3)$$

The largest amount of change of energy ΔE_{max}in a year with an earthquake is determined by the expression:

$$\Delta E_{max} = \int_{t_1}^{t_2} W_M^d(t)\, dt - W_{AI}(t_2 - t_1) \left[\frac{kWh}{m^2}\right] \quad (4)$$

The extent of variation of the radiation during the period of two years without any cataclysms is$\delta_N[-]$:

$$\delta_N = \frac{W_{amax} - W_{amin}}{W_{AI}} \approx 2\frac{W_{amax} - W_{amin}}{W_{amax} + W_{amin}} \quad (5)$$

and the extent of variation of the radiation during the period with cataclysms is$\delta_d[-]$:

$$\delta_d = \frac{W_{Mmax}^d - W_{Mmin}^d}{W_{AI}^d} \approx 2\frac{W_{Mmax}^d - W_{Mmin}^d}{W_{Mmax}^d + W_{Mmin}^d} \quad (6)$$

which are additional criteria for earthquake forecast. On the Figures1b and 1c, with star is marked the earthquake occurrence at time point t_3.

RESULTS

TheTable 1 shows the proposed by the authors numerical energy indicators for forecasting of strong earthquakes – main results of the study presented by the maximum values of energy change $\Delta E_{max}\left[\frac{\mathrm{kWh}}{\mathrm{m}^2}\right]$and time in days after ΔE_{max} occurrence as well as the variation δ_N before and the variationδ_d during the disasters [1-3].

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