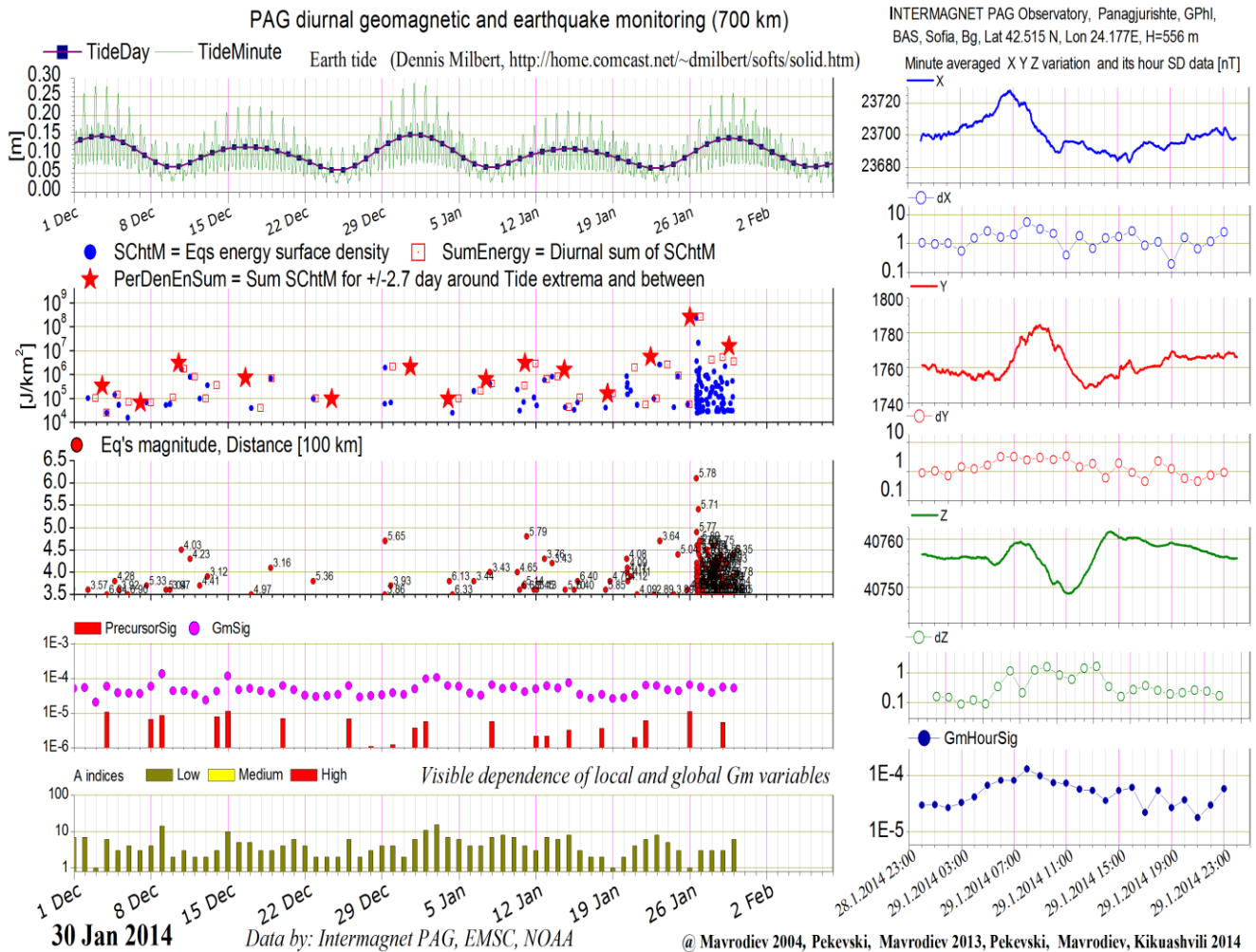


FINAL PUBLISHABLE SUMMARY REPORT 2011- 2013 BlackSeaHazNet

The aims of the project are in the project's title: Complex Research of Earthquake's Forecasting Possibilities, Seismicity and Climate Change Correlations

The main results achieved are as follows:

1. Creating a group which is able to fulfill a Complex Research of Earthquake's Forecasting Possibilities. The result is imminent forecasting for seismic regional activity on the basis of the geomagnetic monitoring in the framework of special created data acquisition system for archiving, visualization and analysis.
2. The reliability of regional imminent forecasting on the basis of Geomagnetic quake approach were tested statistically for Intermagnet PAG (Panagurichte, Bulgaria), SUA (Surlari, Romania), GCK (Grocka, Serbia), L'Aquila (AQU, Italy) geomagnetic stations, BlackSeaHazNet Skopje, Macedonia, Dusheti, Georgia (fluxgate magnetometers with minutes and second samples) as well as MES NSSP Network, Armenia, Stepanavan geomagnetic station (Proton magnetometer, hour samples). For Kiev and Lvov (Ukraine) data is not possible to do such conclusion, because of irregularly analysis.
3. Big world earthquakes and Intermagnet data. During our investigation of relation between regional geomagnetic and seismic activity in areas of interest, close to particular Intermagnet geomagnetic observatories (GMO), it was found that in case of strong earthquake occurred on epicenter distances less than 600 - 1000km from geomagnetic observatory, clear precursor signal was evident.
4. The data acquisition system (<http://theo.inrne.bas.bg/~mavrodi>), applied for **BlackSeaHazNet** every day geomagnetic and earthquake monitoring use:
 - the Balkan Intermagnet (<http://www.intermagnet.org/>) geomagnetic stations minute data,
 - software for calculation of the daily and minute Earth tide behavior (Dennis Milbert, NASA, <http://home.comcast.net/~dmilbert/softs/solid.htm>),
 - the Earth tide extremes (daily average maximum, minimum and inflexed point) as trigger of earthquakes,
 - the data for World A- indices (<http://www.swpc.noaa.gov/alerts/a-index.html>) and
 - simple mathematics for calculation of the Precursor signal and software for illustration the reliability of forecasting and its statistic estimation.

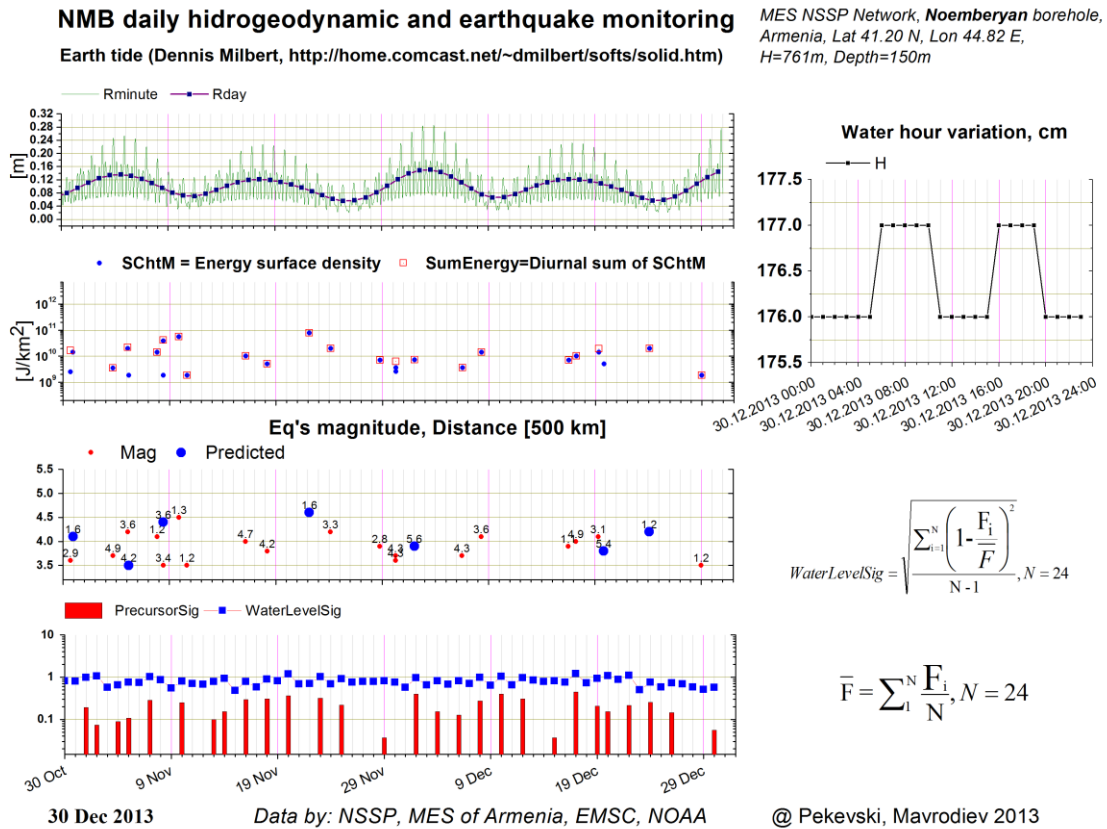


5. Regional confirmation of forecasting based on the geomagnetic quake (positive jump of PrecursorSig_{day}) approach:

- Dusheti, Georgia flux gate second magnetometer - Mw 7.1, depth 7.2 km, 2011, 23 Oct, 36.63N. 43.49E, Van, Turkey earthquake;
- Skopje, Macedonia (second) and Panagurichte (minute) flux gate magnetometers – Mw 5.6, Depth 9.4 km, 42.66 N, 23.01 E, 00.00 hour, 22 May, 2012;
- Grocka, Serbia and Panagurichte (minute) flux gate magnetometers – Mw 6.1, Depth 18km, 26 Jan 2014, 13:55, 38.19 N, 20.41 E; Mw 6.0, depth 2km, 3 Feb, 2014, 03:08, 38,25 N, 20.32 E, Mw5.6, Depth 9.4km.

6. Another geophysical network was tested in Ukraine and Antarctica: seismic, meteorological, electromagnetic (VLF), geomagnetic, infrasound, radon monitoring. Estimated probability for earthquakes with $M > 5$ was 0.8, Vrancha, Romania and earthquakes with $M > 6.5$ was 0.6 for the Scotia Sea region, Antarctica.

7. The acquisition system for archiving, visualization and analysis of the water level variations in boreholes as earthquake precursor was created for Georgia and Armenia data (<http://theo.inrne.bas.bg/~mavrodi/> , <http://dspace.nplg.gov.ge/handle/1234/9101/>):



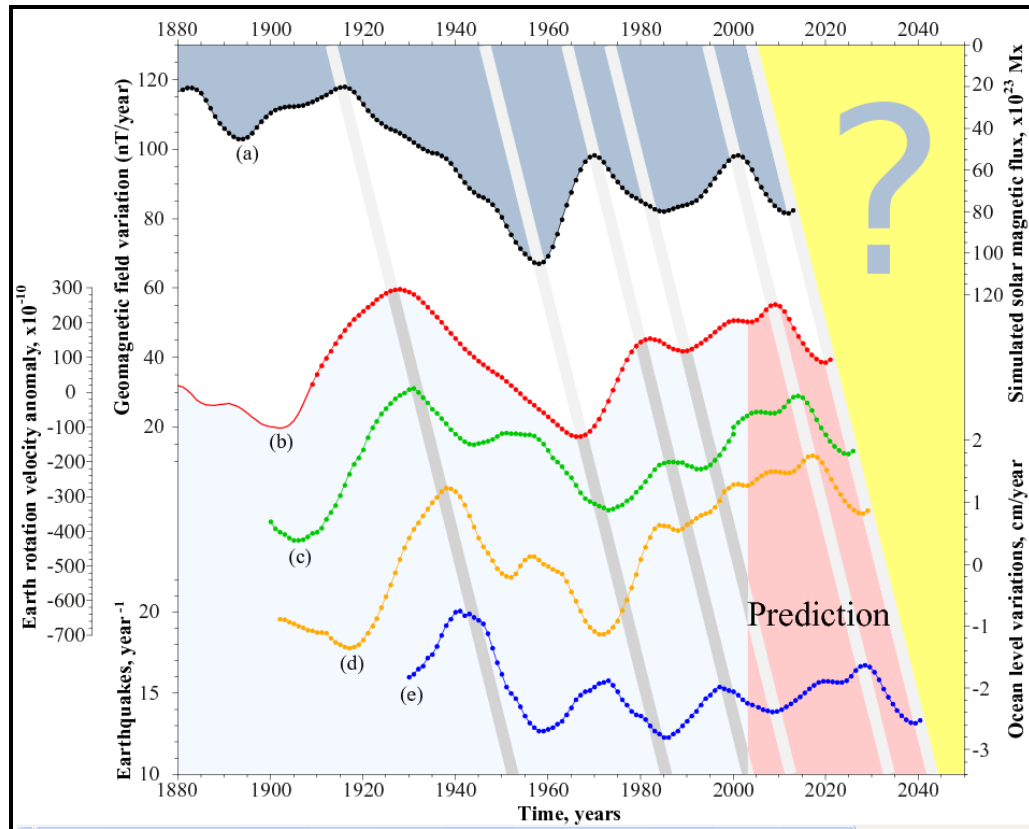
8. The reality of Climate Seismicity correlation and axion- geo -nuclear -reactors hypothesis for Climate changes reasons

In the Rusov's talk in Ohrid, Macedonia 2011 workshop was presented the hypothesis and some experimentally argumentations that Solar processes are the host power pacemaker of Earth climate behavior and its seismicity.

The causality link processes are as follows:

- the burn of one Sun axion from two gamma quanta in the field of iron nuclei (the strait Primakoff effect);
- the burn of two gamma quanta (the inverse Primakoff effect) in the field of iron nuclei in the Earth's nuclei and the increasing of temperature, which leads to the activation of geo nuclear set of reactors (Feoktistov type ^{238}U , ^{232}Th reactors with fast neutrons) in the canyons on the nuclei's surface;
- as a result there is more heat, more intensive lifting of magma, more activity in the oceans rift zones, more intensive Wegener's plates movement, and, consequently, more seismic and volcanic activity as well as change of climate behavior.

- as well as the discovery of neutrino was based on the conservation laws, we can hope that some estimations for the axions existence, its mass, the spatial distribution and characteristics of geo – reactors will be achieved after creation of the more accurate Earth’s heat balance models and the experimental measuring of neutrino’s type and energy distribution.



Time evolution: (a) of the variations of magnetic flux in the bottom of the Sun convective zone (tachocline zone); (b) of the geomagnetic field secular variations (Y -component, nT/year), the values of which are obtained at the Eskdalemuir Observatory (England), where the variations ($\delta Y/\delta t$) are directly proportional to the westward drift of magnetic features; (c) of the variation of the Earth rotation velocity; (d) of the variations of the average global ocean level (PDO+AMO, cm/year); (e) the number of large earthquakes (with magnitude $M > 7.0$). All curves are smoothed by sliding intervals in 5 and 11 years. The pink area is the prediction region. Note: formation of the second peaks on curves (c) – (e) is mainly predetermined by nuclear tests in 1945–1990.

9. Geo electromagnetic measurements: for the first time in Bulgaria territory were measured in the same point the Earth electric currents and geomagnetic field component using the station GEOMAG-02 and magnetometers GEOMAG-02M: Main technical characteristics of MTS GEOMAG-02 are: measuring range of full MF±65000nT; measuring range of MF variations ± 3200nT; resolution of MF variation registration to FLASH-card 0.01nT; temperature drift <0.2nT/°C; tolerance of component non-orthogonally of MF sensor <30ang. min; automatic compensation range of contact MF in each component ±65000nT; EF variation measuring range ±200mV; ±2000mV; resolution of EF variation registration to FLASH-card 1μV; measuring

channel frequency band DC - 1 (3, 10)Hz; measuring channel information sampling numbers 10-15 in sec; data averaging during recording to FLASH-card 0.1...60s; capacity of FLASH-card «CompactFlash» (FAT-16, FAT-32) 64MB...64GB; operating temperature range 10°-40°; connecting cable length between MF sensor and electronic unit up to 50m; power consumption 12V; 0.1A.

10. Radon mapping was carrying out on the territory Georgia and Slovenia for fixed active fault system and gas concentration monitoring was starting, including in the cave system. But there was not enough long time series for receiving the estimation of Radon concentration variations as regional earthquake's precursor.

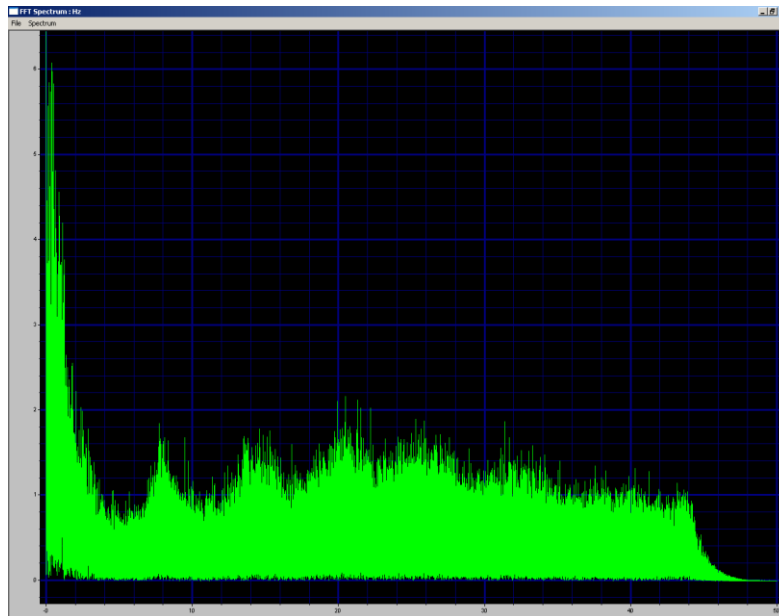
11. Meteorology and seismicity correlations: Investigation of the possible correlation between meteorology variables and regional seismic activity was started.

12. Ozone and temperature spatial distributions and its possible correlations with regional seismic activity: There is a good correspondence between geomagnetic field, near surface air temperature and pressure spatial distributions in Northern hemisphere during XX century. The alteration of the near tropopause temperature (by O₃ variations at these levels) changes the amount of the water vapor in the driest part of the upper troposphere/lower stratosphere. Application of non-linear statistical methods for analysis of climatic and magnetic field data reveals the important role of energetic particles and lower stratospheric ozone in climate variations.

13. Electromagnetic scanning: The research of deep Earth's crust structure and upper mantle study using the inverse problem analysis of the Earth electromagnetic radiation in radio diapason, measured with Astrogon device was performed in Greece and Bulgaria in different profiles. The device is a passive sensor type sensitive to the three components of the magnetic field within a wide range of frequencies (5 – 100 kHz). The comparison with geological knowledge for the Crust in the profiles and the inverse problem results give a hope for perspectives of such kind of studies and that the method has to be included in the permanent regional monitoring. Really, during the project fulfilling, the method of the electromagnetic tomography of the Earth crust and upper mantle was developed, which gives the possibility to determine the location of the future earthquake hypocenters as the most stressed volume of the crust (or mantle). Moreover, the stationary EM measurements by the same device (or new one DS-4, designed and produced during the project fulfilling) show the existence of electromagnetic precursor in a wide frequency diapason, which coincide with that of low frequency signal in Intermagnet data. So the base of the project task solution – where and when – is grounded.

14. Other precursors research are as follows: The first is TM 71 extensometer monitoring, which is carried out to observe micro-displacements along fault movements (or landslide movements connected with active tectonics) in karst caves, fault scarps or in trenches where was found anomaly in velocities 3-4 months before regional strong earthquake. The second represents 2D displacements of static vertical pendulum in 25m deep karst shaft that are registered each 10 seconds. Changes in stress direction are detected. The studies were oriented towards the aim to connect the periods of micro-displacements with local and worldwide seismicity. The third represents the temperature monitoring of two sulphidic waters, which are situated near important regional faults. The fourth includes microbiological monitoring site on the fault planes in the Postojna Cave (Slovenia) to find the possible connection between microbial biomass and tectonic displacements.

15. Schuman resonance measurement device: it was developed and the construction design and software for measuring device were tested.



16. The website of the Project was created:
<http://theo.inrne.bas.bg/~mavrodi/blackseahaznet/>

During the project many young scientists visited research centers of the Black Sea region, which facilitated their contacts with colleagues. They take part in project conferences, seminars, joint field works and processing data in hosting countries. As a result, joint publications were published in journals and conference proceedings.

In the case of project prolongation until the end of 2014 in the frame of the remaining budget (around 34% or approximately 160000EUR) **the main expected results which are based on the project current achievements will be:**

A. Preparation of the project proposal for regional electromagnetic monitoring under, on and above Earth's surface and near space and as well meteorological data for creating of complex data acquisition system on the basis of which to start solving the inverse problem for regional imminent forecasting of time, coordinates, depth, magnitude and intensity of incoming earthquakes.

B. Creation of project proposal/s for Sun – Earth interaction balances models which describe its influences on climate change, seismicity, volcanism and continental plate's movement.

C. Development of long term collaboration for complex research in the framework of bilateral, regional and other European 2020 programs.