BAKU STATE UNIVERSITY:
achievements and perspectives for cooperation in science, education and innovation

Elchin Babayev
Baku State University,
Azerbaijan

Outline

- Space Weather activities and collaborative investigations in Azerbaijan
- Studies on Solar and Solar-Terrestrial Physics
- Recent SW related events
- International collaboration: current state and perspectives

2 Observatories including:

- 3 high-mountain astronomical stations
- 2 city departments in Baku and Nakhchyvan

Shamakhy Astrophysical Observatory (ShAO)

Azerbaijan

BAKU

Baku State University

Nakhchyvan

Batabat Astrophysical Observatory (BatAO)

Main organizations dealing with Astronomical and Space Researches/Applications and Space Weather studies in Azerbaijan

- Baku State University (BSU), Including Dpt of Astrophysics
- Shamakhy Astrophysical Observatory (ShAO), Azerbaijan National Academy of Sciences (ANAS)
- Batabat Astrophysical Observatory (BatAO), ANAS
- AzerCosmos OJSC
- National Aviation Academy (NAA)
- National Aero-Space Agency (NatASA)
- Research Institutes of the Azerbaijan National Academy of Sciences - Physics, Radiation Problems, Control Systems, etc.
- Some departments of the Azerbaijan Technical University, Azerbaijan State Pedagogical University, etc.
- Other related small organizations

Baku State University (BSU)

bsu.edu.az

MAIN BUILDING

100th Anniversary Celebration of BSU at UNESCO Headquarters in Paris
12 June 2019

100th Anniversary Celebration of BSU at Azerbaijani Cultural Center in Vienna 09 September 2019

Azerbaijan National Academy of Sciences

science.gov.az

MAIN BUILDING

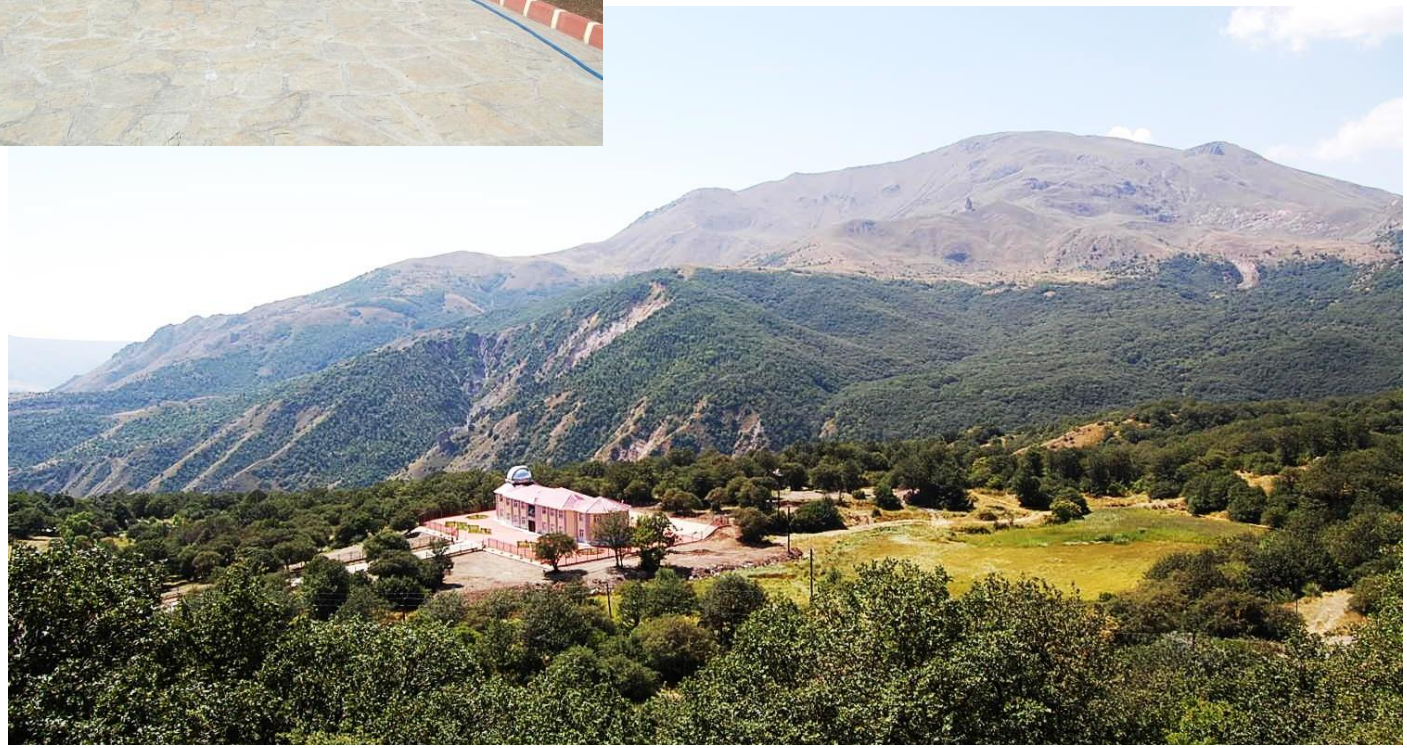
Shamakhy Astrophysical Observatory (ShAO)

Shamakhy Astrophysical Observatory (ShAO)

MAIN BUILDING

Carl Zeiss Jena 2-meter telescope

Batabat Astrophysical Observatory (BatAO)



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customized excellence

3 SATELLITES
ON ORBIT

NATIONAL AVIATION ACADEMY

NATIONAL AEROSPACE AGENCY

Solar and Solar-terrestrial physics studies in Baku State University and ShAO

Among modern problems of astronomy and astrophysics we conduct studies on:

- Solar physics (theoretical and experimental);
- Helioseismology (theoretical), global solar oscillations;
- Solar-terrestrial physics – interplanetary magnetic field, solar wind, large-scale magnetic fields on the Sun, etc.;
- Space weather effects' studies.

Space Weather Effects' Studies particularly cover some tasks of international programmes and projects, like:

- Impact on technologies (space-borne and on Earth);
- Public health problems;
- Environmental problems.

Studies on Space Weather effects and Solar-Terrestrial Relations

- These studies mainly were/are conducted in the:

- **Department of Astrophysics, Baku State University;**
- **Department of Cosmic Plasma and Heliogeophysical Problems, Shamakhy Astrophysical Observatory;**
- **Other organisations.**

  - Scientists and specialists from different fields of science and technology – astrophysicists, geophysicists, physiologists, engineers, etc.;
  - Contacts, collaboration at regional as well as at international levels.

Activities:

- monitoring and analysis;
- theoretical and experimental studies of space weather effects;
- application of obtained results (industry, public health and security, etc.);
- preparation of young specialists (Ph.D. students, lectures);
- public awareness (mass-media, TV, radio, newspapers, web site).

Space Weather effects' on geosphere and related studies

Potential influence of space weather factors are studied in the following research areas:

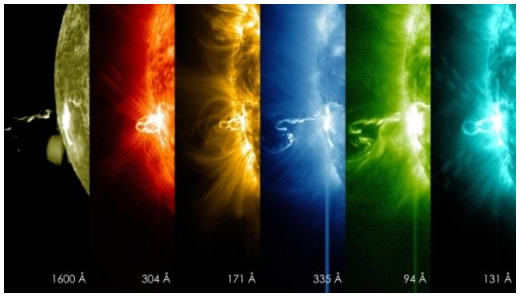
- space weather influence on technical and engineering systems (electric power supply grids, oil production activity, functioning of long pipelines, etc.);
- space weather effects on human life and health (bioelectrical activity of human brain and its functional state, cardiovascular parameters, diseases, biologically active points of human body, traffic accidents, virus-epidemic diseases, etc.);
- ecological systems (Caspian Sea level variations, climate changes, etc.);
- Distant investigation of propagation of very low frequency (VLF) electromagnetic waves in the Earth's ionosphere;
- Investigation of solar wind magnetic field distribution near the Earth;
- Study of relationship between the contrast of coronal holes on the Sun and parameters of the solar wind streams;
- other tasks, such as solar activity and comet's brightness, etc.

Collaboration

with several “clusters”:

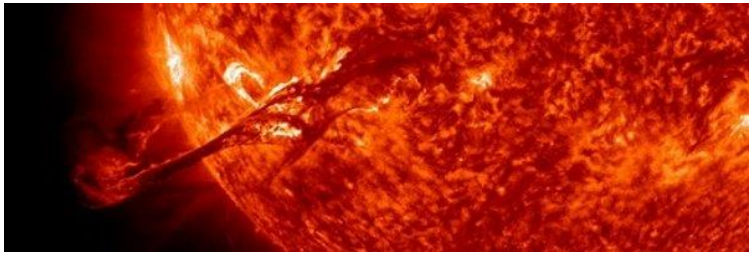
- Solar-terrestrial relations (*H.Mavromichalaki and others in Greece*)
- Heliobiological and Helioecological studies - IZMIRAN Team (*V.Obridko, O.Khabarova, M.Ragulskaya and others*)
- Heliobiological studies - Bulgarian Team (*Svetla Dimitrova and others in Bulgaria*)
- Cosmobiology (*Eliyahu Stoupel and others in Israel*)
- Space weather studies - Belgium (*Norma B.Crosby*)
- Solar-terrestrial relations (*Michael Rycroft in UK*)
- Chronobiology (*Germaine Cornelissen in USA*)
- Biorhythmology (*R.Baevsky, T.Breus, S.Rapoport, S.Chibisov, others in IKI, MSU, et al*)
- Low frequency solar eigen-oscillations and long-term climate changes - Potsdam, Germany (J. Staude, et al)

Solar studies



- The theory of propagation and transformation of linear MHD waves in a strongly inhomogeneous plasma is developed taking into account the interaction of oscillations and radiation.
- The theory of eigen-acoustic p-modes of the Sun is developed taking into account the influence of tunneling effect. It is shown that the inclusion of tunneling leakage of wave energy through the atmosphere could resolve the "frequency" problem of helioseismology.

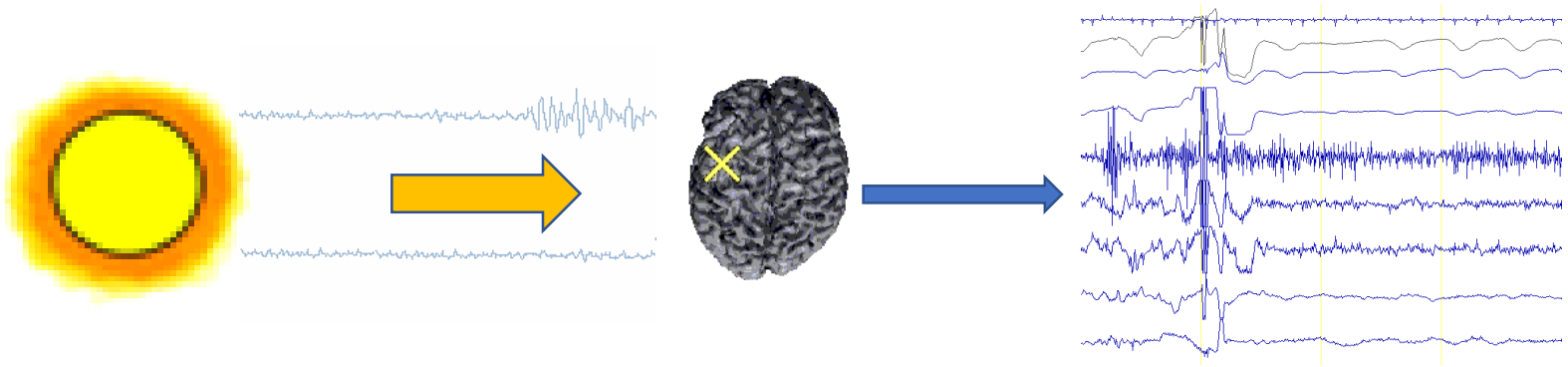
Solar studies



- Within recent theoretical studies **the general theory of propagation and linear transformation of non-adiabatic MHD waves in the non-uniform radiating plasma is developed**. The obtained wave solutions allow solving correctly a boundary-value problem of solar helioseismology. The theory of eigen acoustic p-modes of the Sun taking into account of influence of tunnel effect is developed. It is shown that the account of tunnel infiltration of wave energy through an atmosphere acoustic barrier can resolve a "frequency" problem of helioseismology.
- For the first time it was advanced and mathematically elaborated the **new idea about generation near to the center of the Sun of wave noise with the necessary characteristics which can essentially affect the process of neutrino oscillations**. This model enables using data of solar neutrino to determine a physical situation (size and configurations of a magnetic field, speed of rotation) in the core of the Sun; that creates theoretical basis for the solar neutrino tomography.
- **The theory of global vortical oscillations** of the Sun is developed. It is shown that on the Sun the wave modes with very greater periods of 1-3, 18-30, 100 and 1500-20000 years may be generated which can influence on integrated luminosity of the Sun. For the first time the idea that these fluctuations can become an original cause of global change of a climate on the Earth is put forward.
- **The fluid MHD theory of anisotropic collisionless space plasma** is developed. The full spectrum of stable and unstable turbulent wave modes is found. It is shown that the obtained hydrodynamic instability criterions of plasma are in the good agreement with the kinetic approach in the plasma physics.

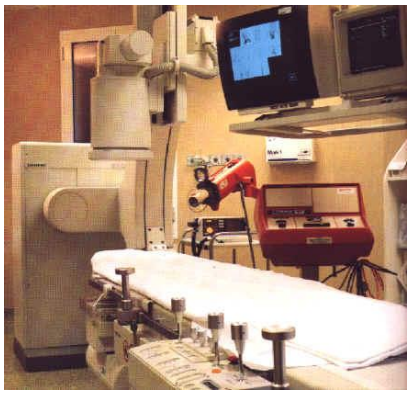
Space Weather and its Potential Influence on Functional State/ Bioelectrical Activity of the Human Brain

(experimental electroencephalographic studies of geomagnetic storm effects on the human brain's bioelectrical activity)

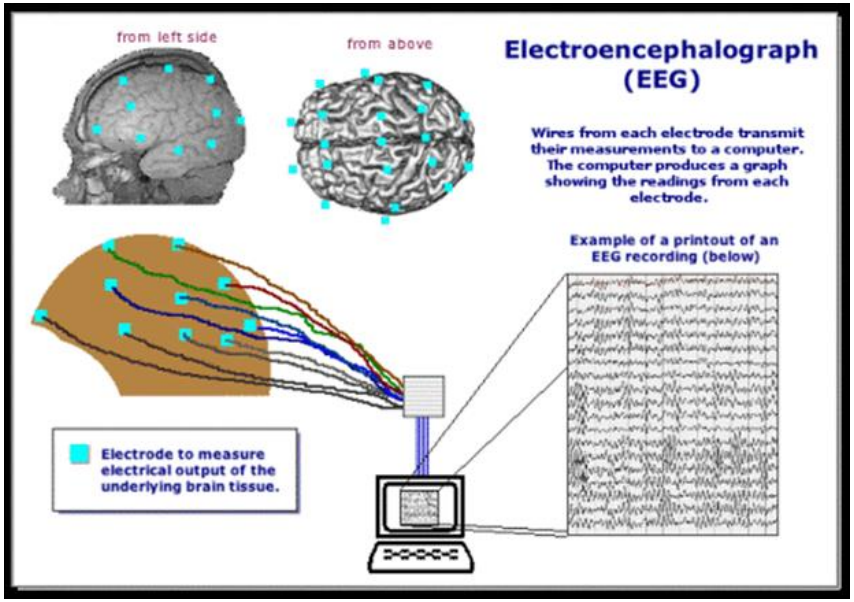


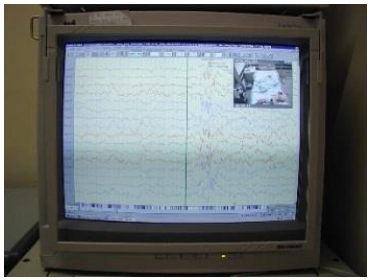
classic

portable

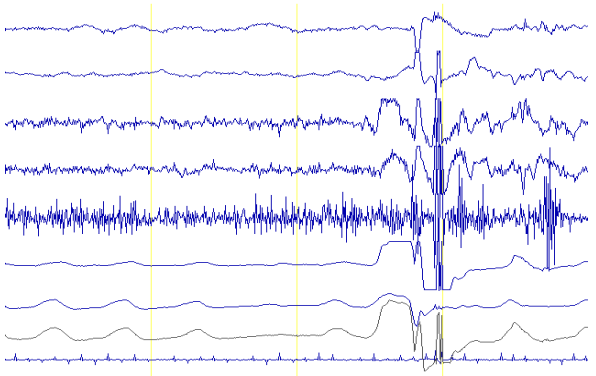


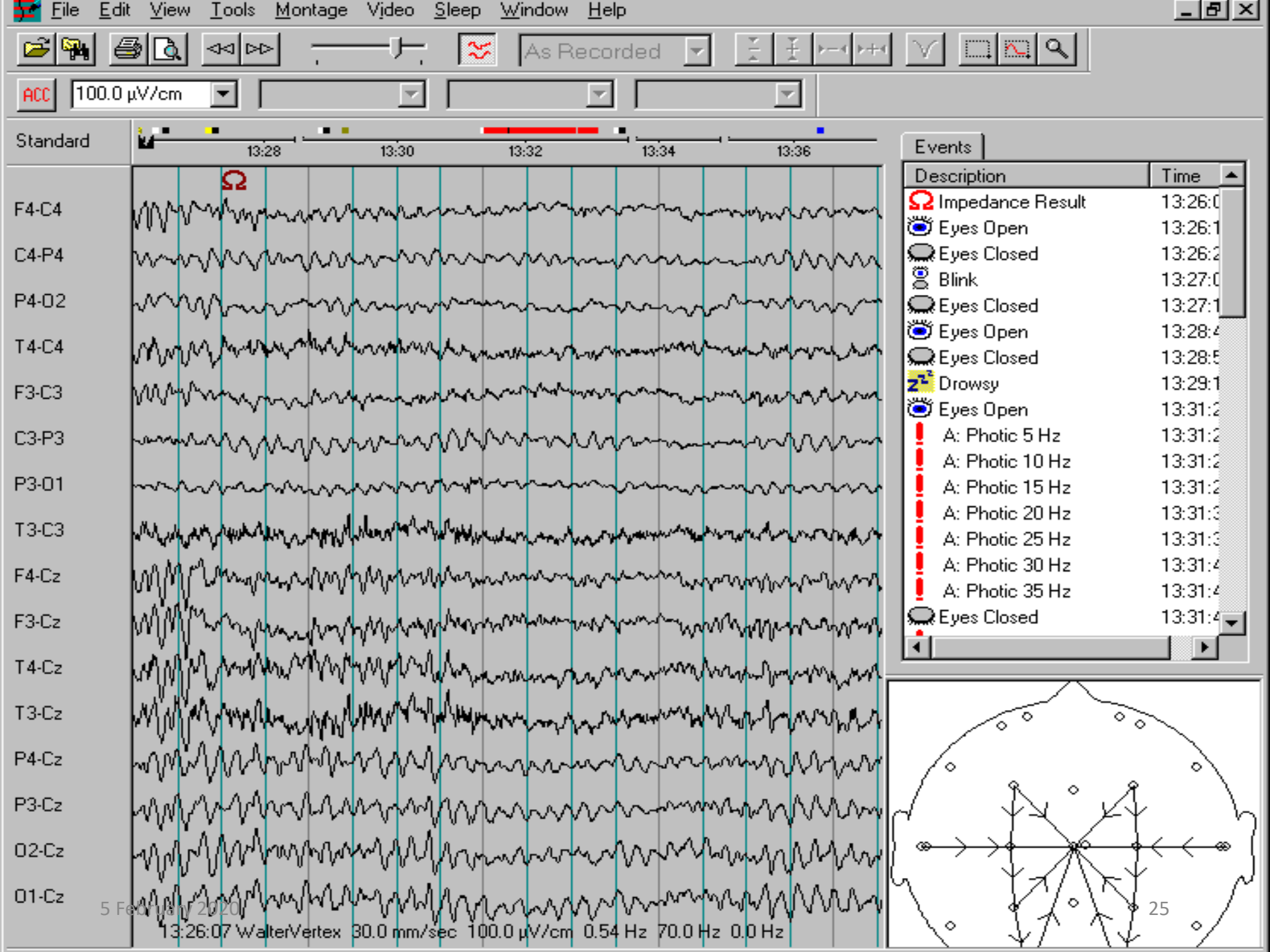
complex





digital

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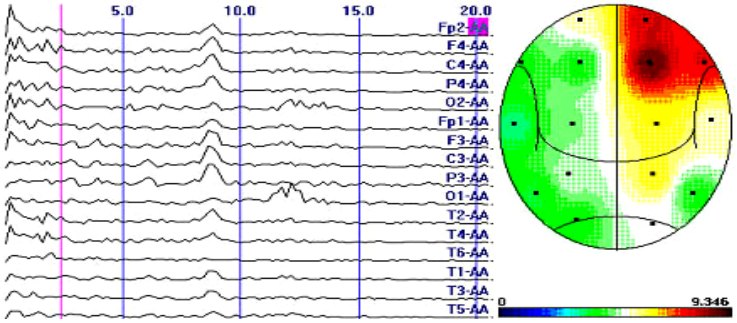
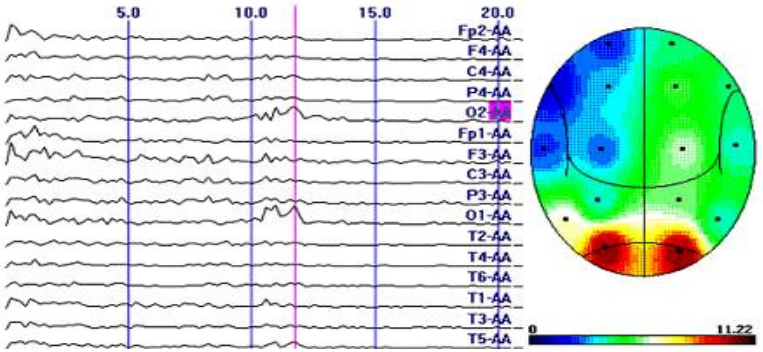
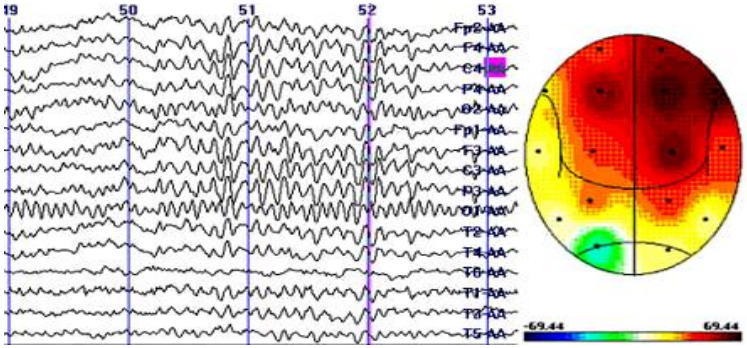


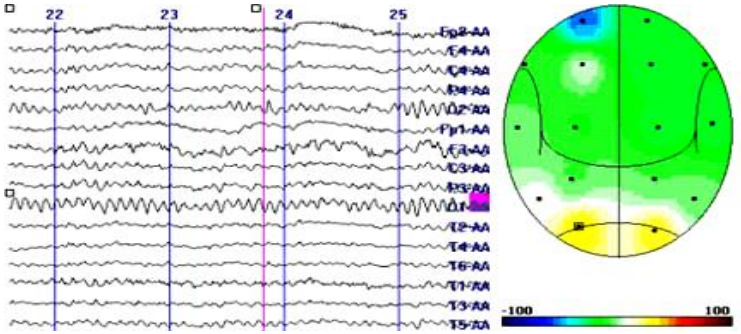
Frequency histogram and frequency cartogram during the major geomagnetic storms



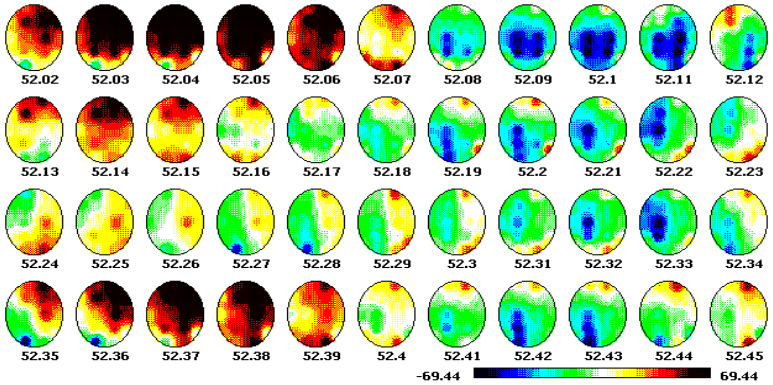
Frequency histogram and frequency cartogram at the comparatively geomagnetically quiet conditions



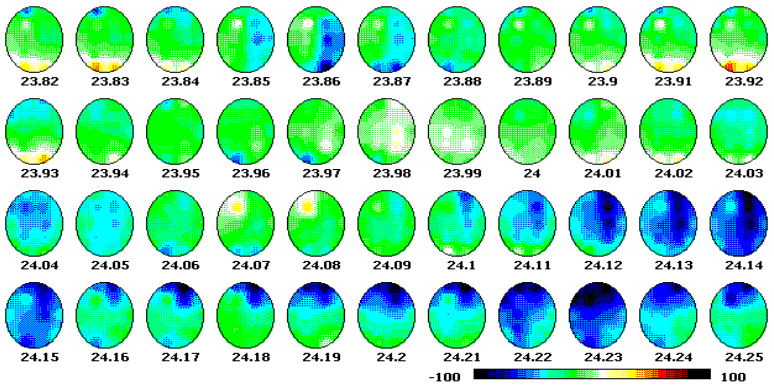
EEG and total (summary) amplitude cartogram during the severe geomagnetic storms



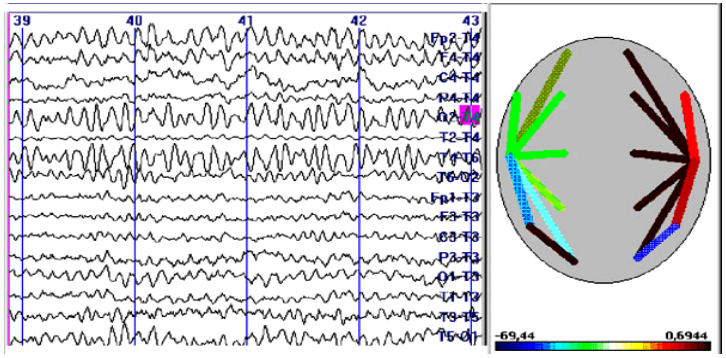
EEG and total (summary) amplitude cartogram at the comparatively geomagnetically quiet conditions



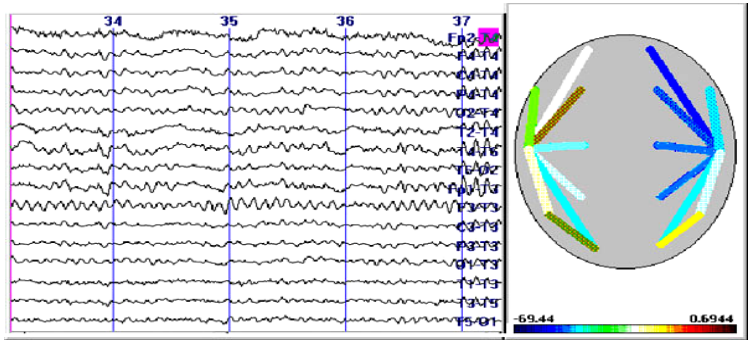
Total (summary) amplitude cartograms during the major geomagnetic storms along the whole length of hyperventilation



Total (summary) amplitude cartograms at the geomagnetically quiet conditions along the whole length of hyperventilation



EEG and correlogram during the major geomagnetic storms



EEG and correlogram at the comparatively geomagnetically quiet conditions

SPACE WEATHER CHANGES
and
HUMAN CARDIO-VASCULAR HEALTH STATE
in different locations on Earth

- cardiovascular diseases
- sudden cardiac death
- acute myocardial infarction mortality
- acute myocardial infarction morbidity
- RR intervals
- heart rate variations
- blood pressure

Data handling

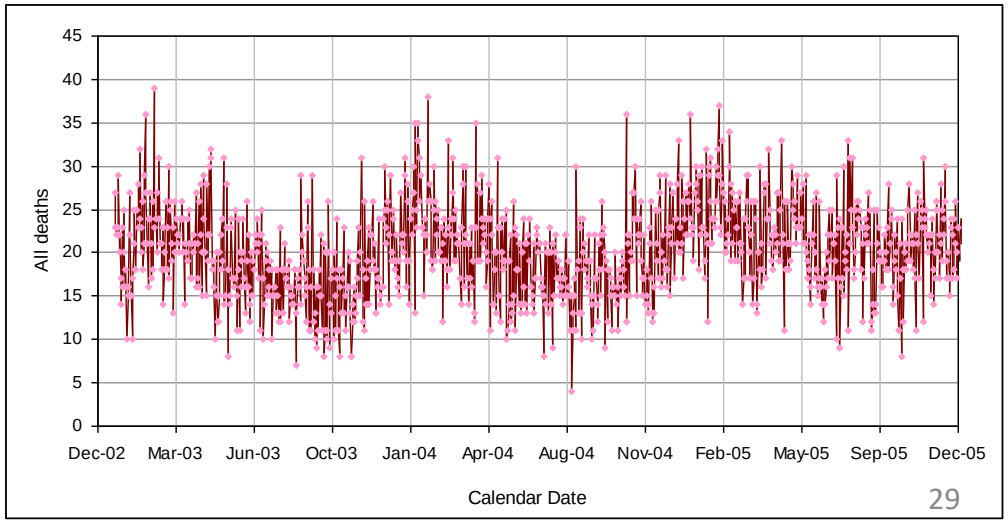
- Emergency and First Medical Aid calls – outpatients
  - Cardio-vascular related morbidity and mortality
    - SCD, AMI, etc.

"Indirect indicators"

They are essentially epidemiological data showing the temporal and spatial distribution of defined events or health disturbances involving considerable numbers of test subjects over several years.

These indirect indicators are: ***temporal distribution of emergency calls and hospital admissions***, *dynamics of industrial (work) and traffic accidents, etc.*

Temporal distribution of cardio-vascular related deaths



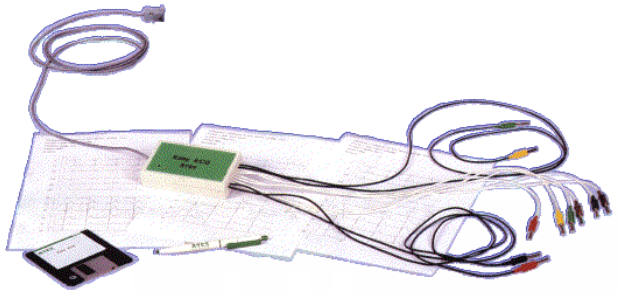
Data handling

"Direct indicators"

They are **physiological parameters**, which can be objectively verified and which are acquired either in vivo, directly on the subject (***heart rate and its variability, blood pressure,*** *microcirculation parameters, reaction time*), or in vitro by **laboratory diagnostics** or tissue investigations.

DAILY (!)

CARDIO-EXPERIMENTS



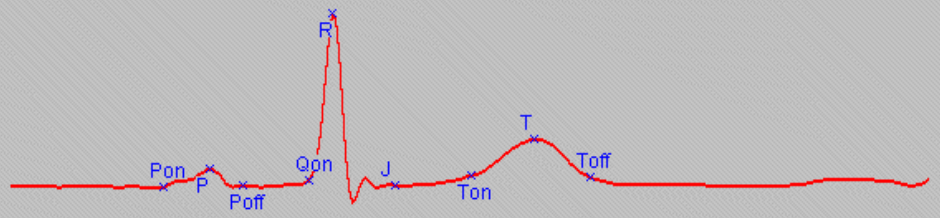
Experiments

- Digitized electrocardiograms (ECGs) registration in the **permanent group** consisting of healthy persons on working days and Saturdays
- **RR intervals** (time series of beat-to-beat heart rate intervals or heart rate period in msec) (minimal RRmin, maximal RRmax and average RRavg) and **HR values** are derived from digital ECGs.
- The obtained digital recordings are subjected to analysis.
- The experiments are conducted in a special room, which are designed for medical examinations, isolated and providing the possibility for full relaxation of the persons examined.
- This room is also free as much as possible from electrical cables and devices with electromagnetic radiation.
- In order to avoid inducing possible psychological effects prior to the experiments, the test subjects are not familiarized with the space weather conditions before and during the experiments.
- Personality and individual physiological characteristics as well as daily problems of the examined persons are taken into account. In some cases when the examined persons reported strongly express disturbances in their psycho-psychological state (stress, emotional experiences, an additional pathology – influenza, cold, etc.) then their measurements are neither conducted nor considered.

ECG Data | Countour Report | Rhythm Report

Heartrate:	82 bpm
P Axis:	36.03 °
QRS Axis:	59.54 °
T Axis:	29.9 °

Cycle Control
Lead: I
Points | Show Grid | Lines

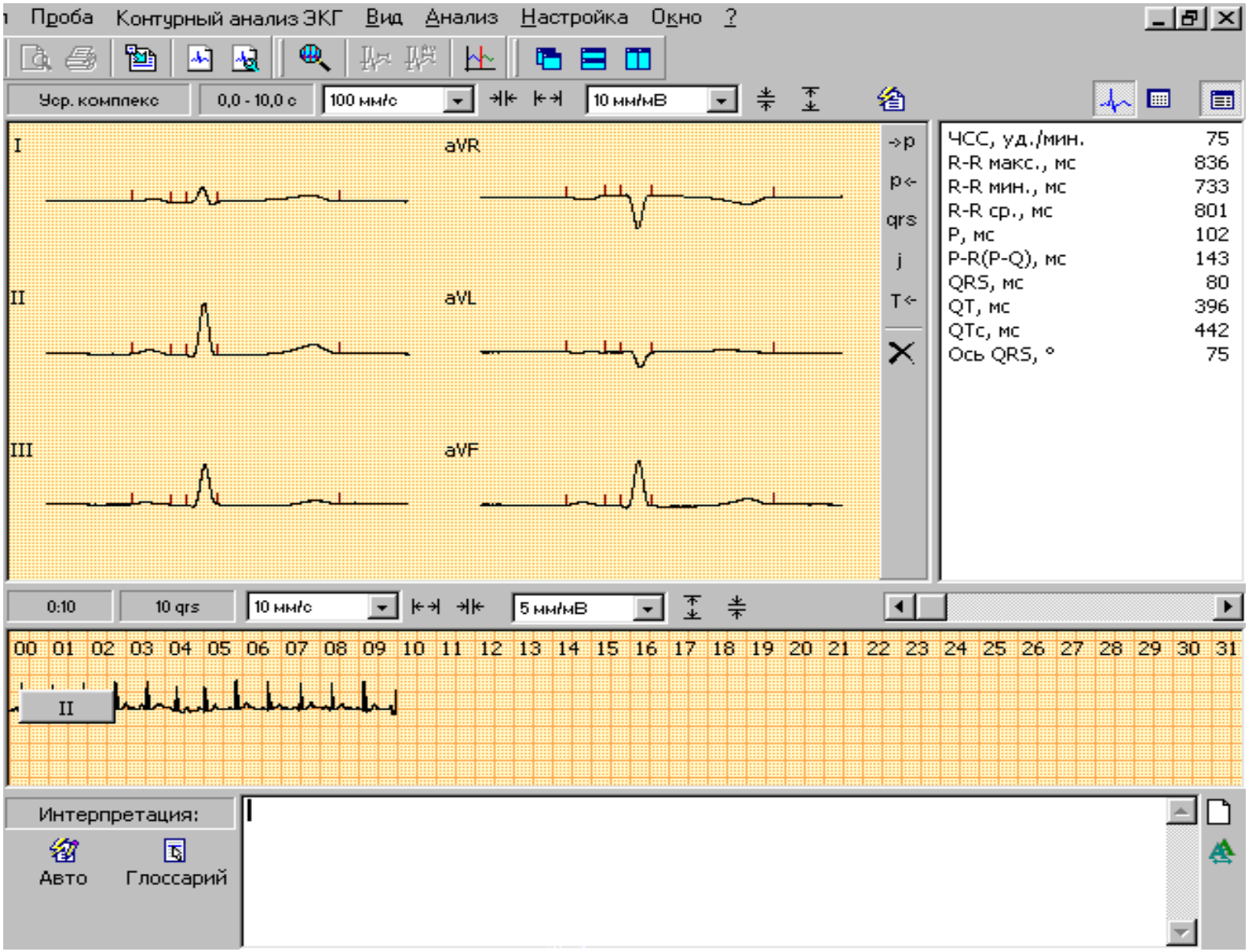


Amplitudes, µV

lead	PA1	PA2	QA	RA1	RA2	SA	STA	STA40	STA80	STA120	TA1	TA2
I	90.7	0	0	870.7	0	-86.7	0.2	4.7	31.5	118	232.3	0
II	159.2	0	0	769.5	0	-41.4	-4.2	5.8	29	92.2	175.9	0
III	88.7	0	0	103.8	0	0	-37	-2	3.9	2.7	0	0
aVR	-132	0	0	856.9	0	61.6	3.9	-3.8	-30	-108	-212.4	0
aVL	0	0	0	468.6	0	-81.6	-3.7	-4.5	9.8	61.7	131.2	0
aVF	122.3	0	0	375.7	0	-26.9	-2.3	5.6	16.7	40.6	69.4	0
V1	-71.4	0	0	535	0	0	21.5	9.5	-14.3	-59.5	-132.8	0
V2	0	0	231.3	320.5	0	0	43.6	42.5	53.8	81	146.6	0
V3	76.8	0	0	539.3	0	-261.1	12.1	40.1	61.5	136.8	191.9	0
V4	55.2	0	0	884.1	0	-60.5	-15.3	-9.1	12.7	68.2	159.1	0
V5	72.5	0	0	927.4	0	0	0.4	8	35.1	89.4	166.6	0
V6	69.9	0	0	1,174.8	0	0	-6	-1.2	25.9	96	207.6	0

Durations, ms

lead	PD	QD	RD1	RD2	SD	QRSD	PQ	QT	JT	QTc	JTc
I	96	0	60	0	60	0	176	340	92	16.5	4.5
II	104	0	44	0	48	0	136	380	108	18.4	5.2
III	104	0	20	0	0	0	180	0	0	0	0
aVR	104	0	64	0	52	0	184	332	96	16.1	4.7
aVL	0	0	48	0	60	0	0	328	116	15.9	5.6
aVF	104	0	44	0	40	0	188	324	148	15.7	7.2
V1	76	0	48	0	0	0	160	320	120	15.5	5.8
V2	0	72	40	0	0	0	0	388	140	18.8	6.8
V3	96	0	40	0	68	0	180	352	100	17.1	4.9
V4	92	0	44	0	56	0	176	336	116	16.3	5.6
V5	92	0	44	0	0	0	128	380	108	18.4	5.2
V6	92	0	48	0	0	0	128	384	100	18.6	4.9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Контурный анализ ЭКГ
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Анализ
Настройка
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I
aVR
II
aVL
III
aVF
->p
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qrs
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T<-
ЧСС, уд./мин. 75
R-R макс., мс 836
R-R мин., мс 733
R-R ср., мс 801
P, мс 102
P-R(P-Q), мс 143
QRS, мс 80
QT, мс 396
QTc, мс 442
Ось QRS, ° 75
0:10
10 qrs
10 мм/с
5 мм/мВ
00 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31
II
Интерпретация:
Авто
Глоссарий

Study of effects of different types of solar activity caused geomagnetic storms on AMI and SCD

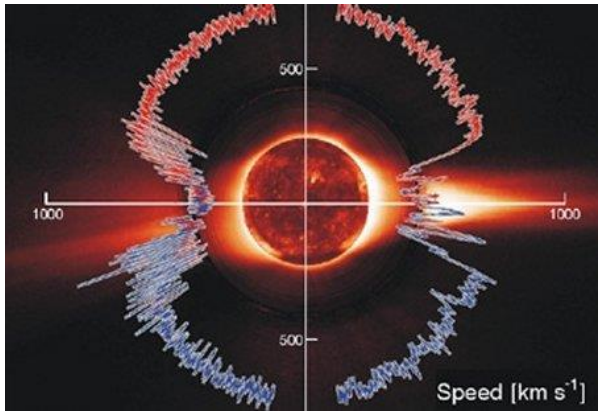
- Acute myocardial infarctions **(AMI) morbidity [number of non-deaths];**
- AMI mortality [number of deaths];
- sudden cardiac deaths

Study in two geographical regions (Sofia, Bulgaria and Baku, Azerbaijan), situated at middle latitudes but at different longitudes

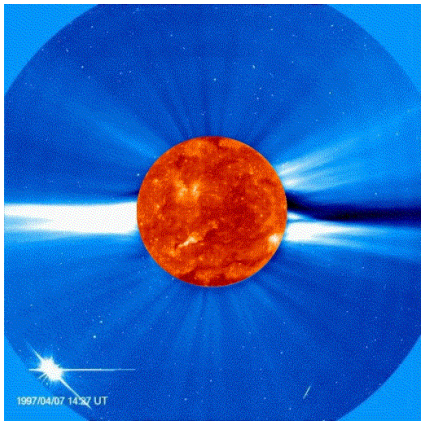
- **“Direct indicators”**
- **“Indirect indicators”**

Magnetic Storms

Temporary disturbance of the Earth's magnetosphere caused by a disturbance in space weather.

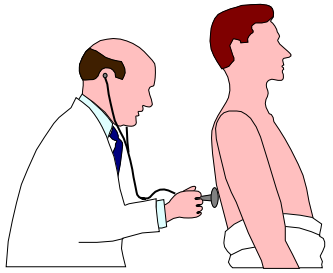


High Speed Solar Wind Streams (**HSSWS**) and low speed streams interact with each other and alternately pass by the Earth as the Sun rotates.



Magnetic Clouds (**MC**) are produced in the solar wind when solar eruptions (flares and coronal mass ejections) carry material off of the Sun along with embedded magnetic fields.

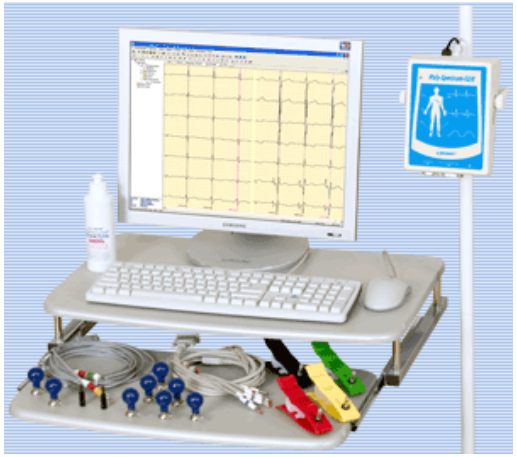
Materials and methods



Studies are based on medical data from Sofia, Bulgaria (42°43' N; 23°20' E) and Baku, Azerbaijan (40°23' N; 49°51' E)

(different longitudes!)

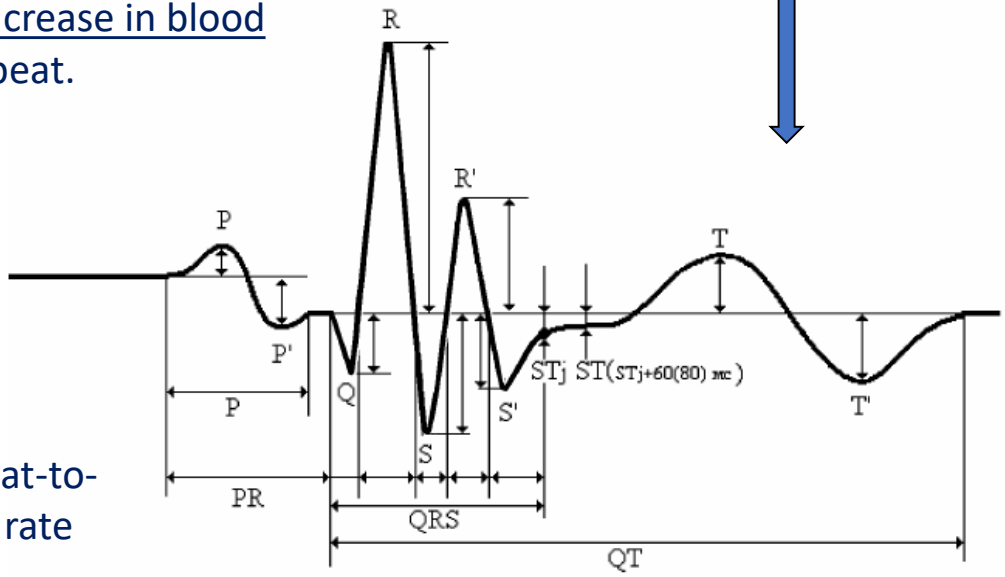
- **BULGARIAN** medical data concerned the daily distribution of patients admitted in the hospital with acute myocardial infarction (AMI) diagnose
- **AZERBAIJANI** data concerned pre-hospital incidences and contained AMI incidences, AMI mortality cases and sudden cardiac deaths (SCD) cases Data were collected from emergency and first medical aid stations in the Grand Baku Area (including Absheron Economical Region with several millions of inhabitants).

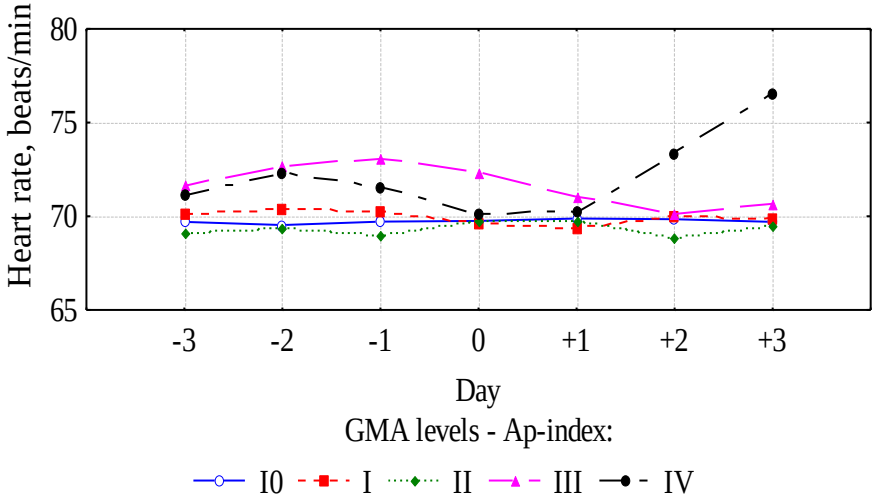


The rate of heart contractions is equal to the pulse, which is how many times a minute that our arteries expand because of the increase in blood pressure originated by our heartbeat.

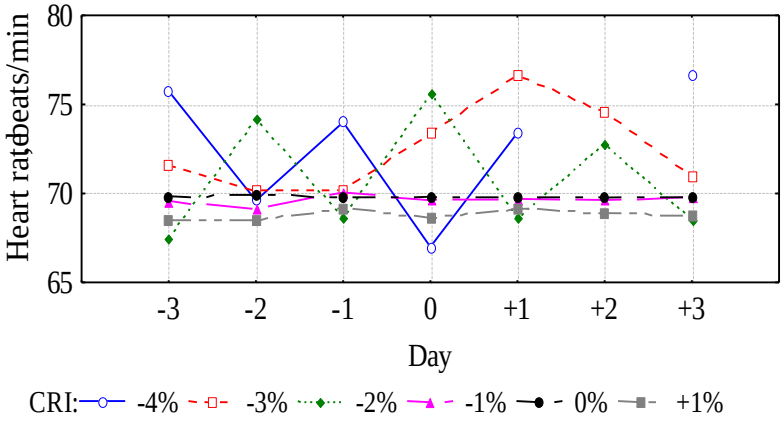
Heart rate is the speed of the heartbeat, specifically the number of heartbeats per unit of time. The **heart rate** is typically expressed as beats per minute (bpm).

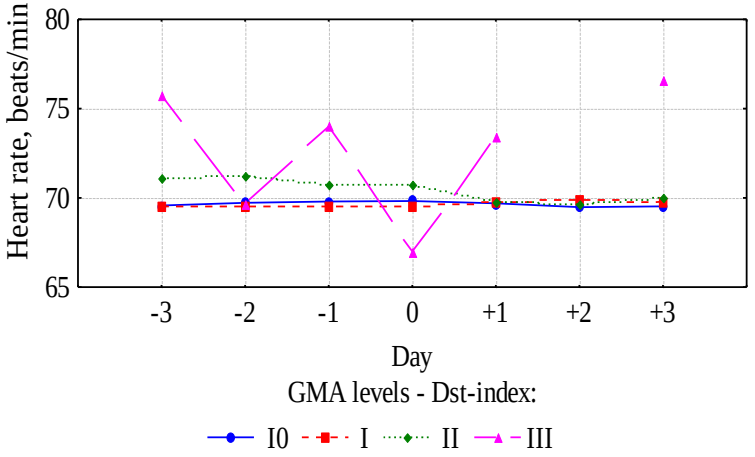
RR intervals are time series of beat-to-beat heart rate intervals or heart rate period (in *msec*)



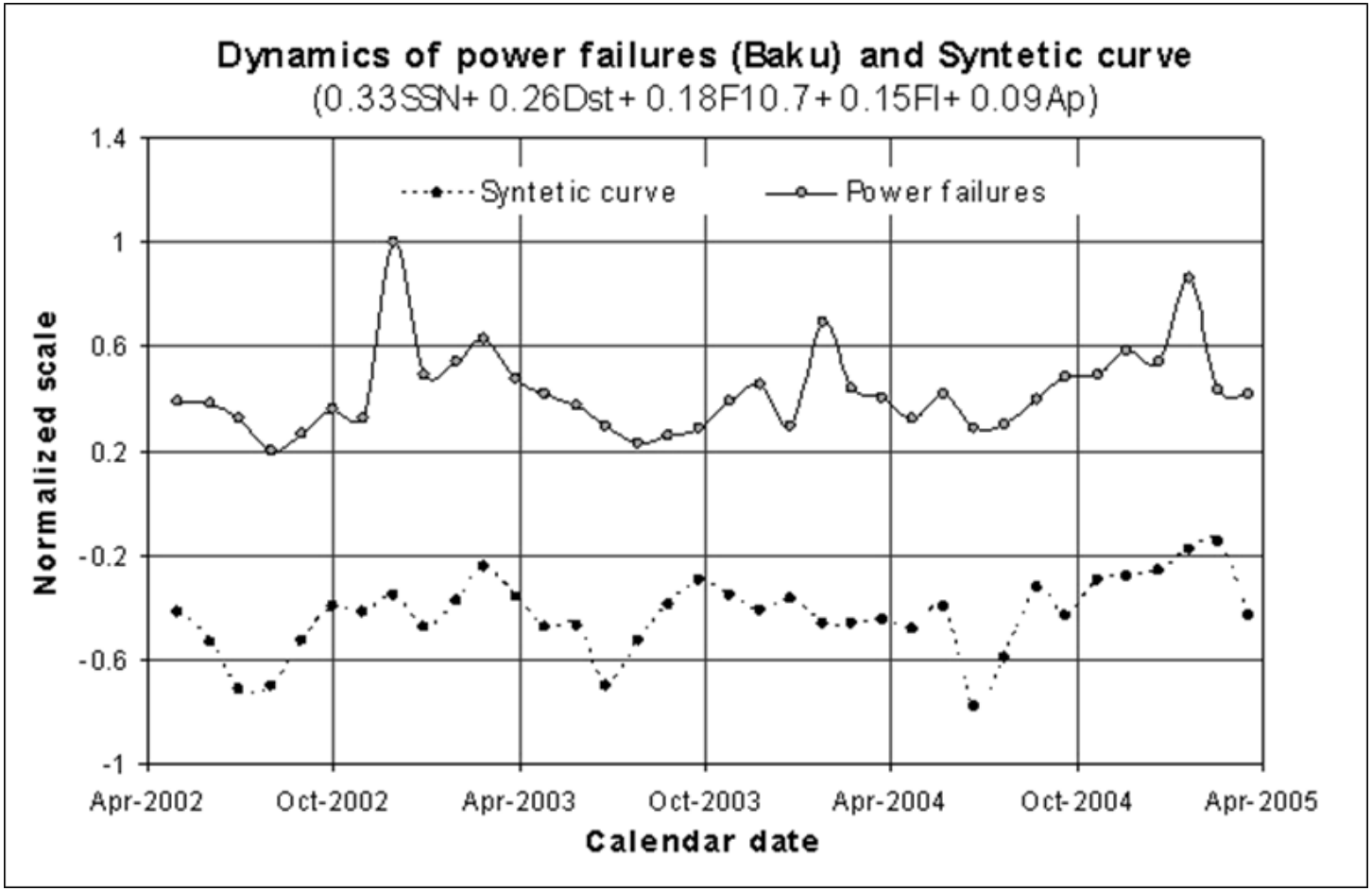


GMA effect estimated by Ap-index (upper panel), Dst-index (middle panel) and CRI effect (bottom panel) on heart rate of the whole group for the days before (-), during (0) and after (+) the corresponding variations.





Synthetic spectrum for power distribution system failures



Main characteristics of the middle-latitude ionospheric scintillations

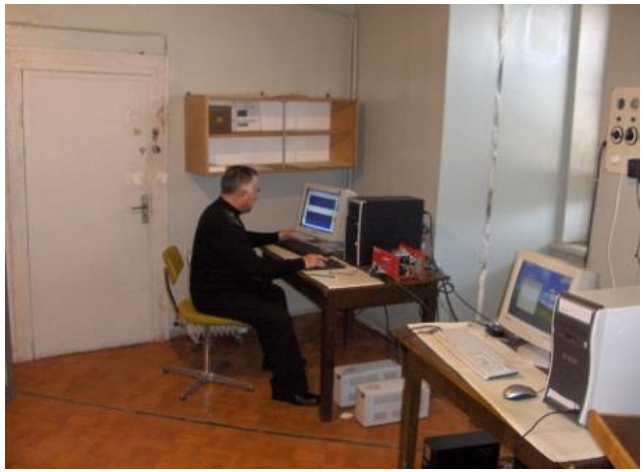
Scintillation activity level	Generally very quiet to moderately active. The probability of occurrence of scintillations as well as their intensity is very low at middle latitudes
Cause of scintillation	The daytime random scintillations occur because of the sporadic-*E*. The nighttime random scintillations are caused by the spread-*F*. Quasi-periodic scintillations originate from traveling ionospheric disturbances (*TIDs*) mainly in the *F* region on from sporadic-*E* disturbances
Frequency dependence	Usually scintillation index $S_4 \propto f^{-n}$, where n=1.38 for nighttime, and n= 1.52 for daytime. The percentage of occurrence decreases with the frequency
Diurnal Dependence	The occurrence peaks between 20.00 LT and 21.00 LT in summer. In other seasons they occur between 24.00 LT and 04.00 LT. According to the solar cycle, they are also observed rarely during daytime, between 09.00 LT and 15.00 LT. Maximum – nighttime; Sporadic – daytime.
Seasonal dependence	Random scintillations occur mainly in the summer and seldom during the other seasons. Quasi-periodic scintillations occur mainly in summer. Maximum: winter; Minimum: equinox and early summer (May-July)
Solar activity dependence	The probability of scintillations occurrence and their intensity increases with the solar activity
Magnetic activity dependence	Generally independent of *K*p

Space Weather Center

- Currently there is functioning Space weather center with several instruments for continuous space weather monitoring.
- Branch of Astrophysics Dpt of the Baku State University

- There is conducted a daily monitoring of ionosphere state by the help of AWESOME VLF receiver and Sudden-Ionospheric-Disturbance (SuperSID) monitor recently installed in ShAO were delivered as a part of the United Nations Basic Space Science Initiative (UNBSSI).

VLF remote sensing of the lower ionosphere in middle latitude site of the Azerbaijan using AWESOME receiver

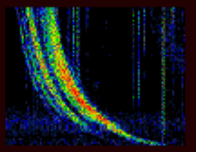


VLF receiver control room

GPS receiver antenna

STANFORD VLF GROUP

Very Low Frequency Magnetospheric and Ionospheric Research



Space Weather Monitors

Stanford SOLAR Center

The AWESOME Monitor

Englis

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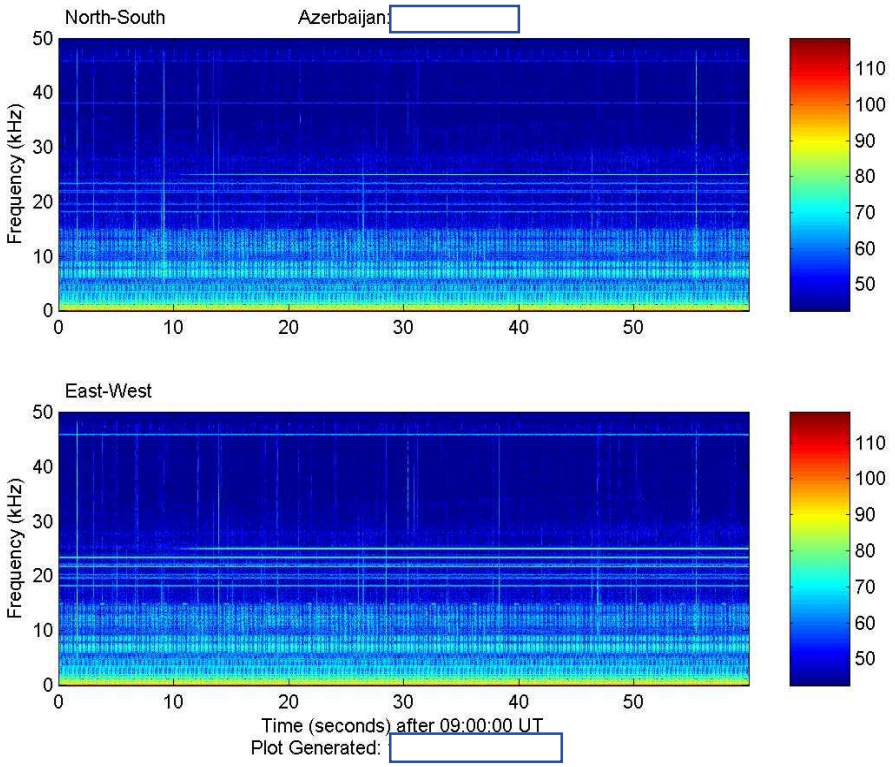
E ducation

SID MONITORS
AWESOME MONITORS
SCIENCE
DATA
OBTAINING A MONITOR
DISTRIBUTION



STANFORD SOLAR CENTER

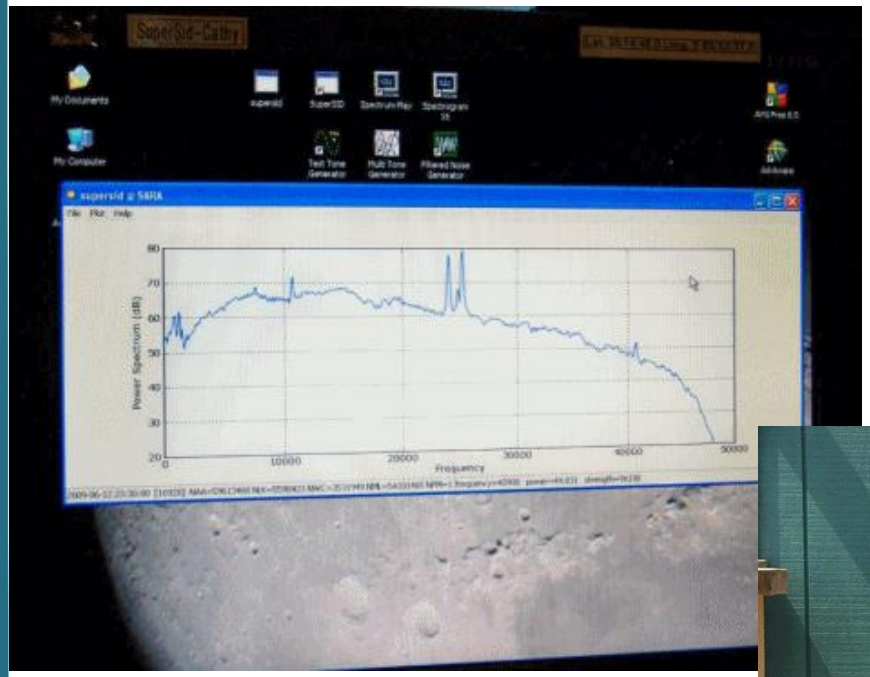
SuperSID

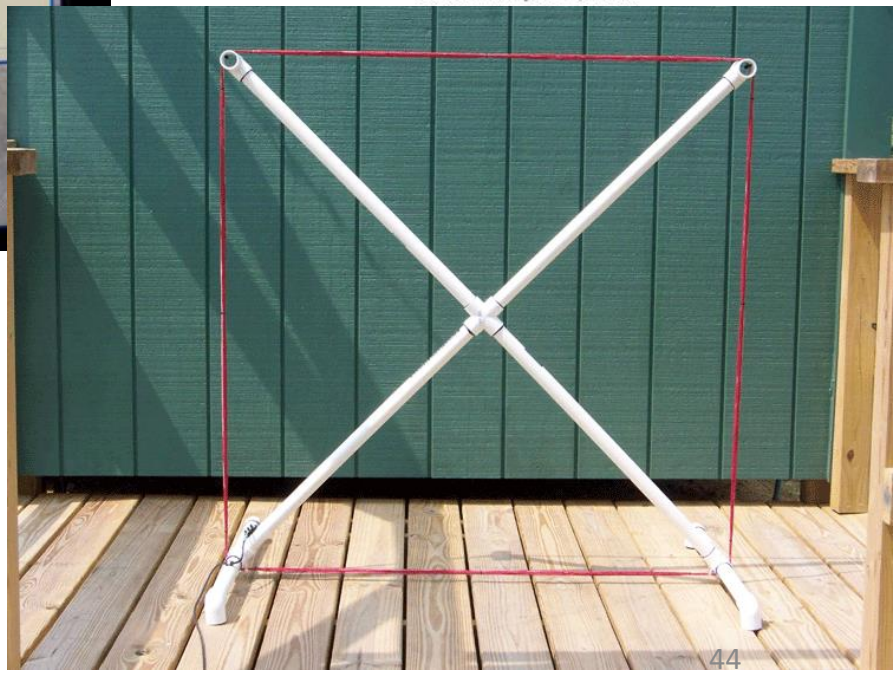
Sudden Ionospheric Disturbance Space Weather Monitor
http://solar-center.stanford.edu/SID

Society of Amateur Radio Astronomers
http://Radio-astronomy.org

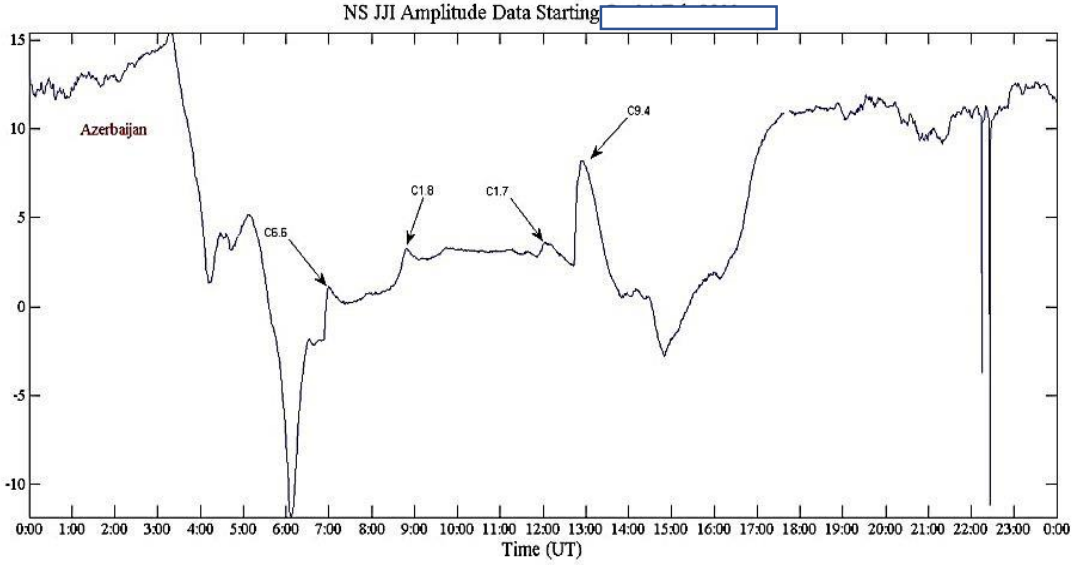
A participating project of the United Nations International Heliophysical Year and the International Space Weather Initiative

Version 1.0 Latest change: 6 January 2010 DKS

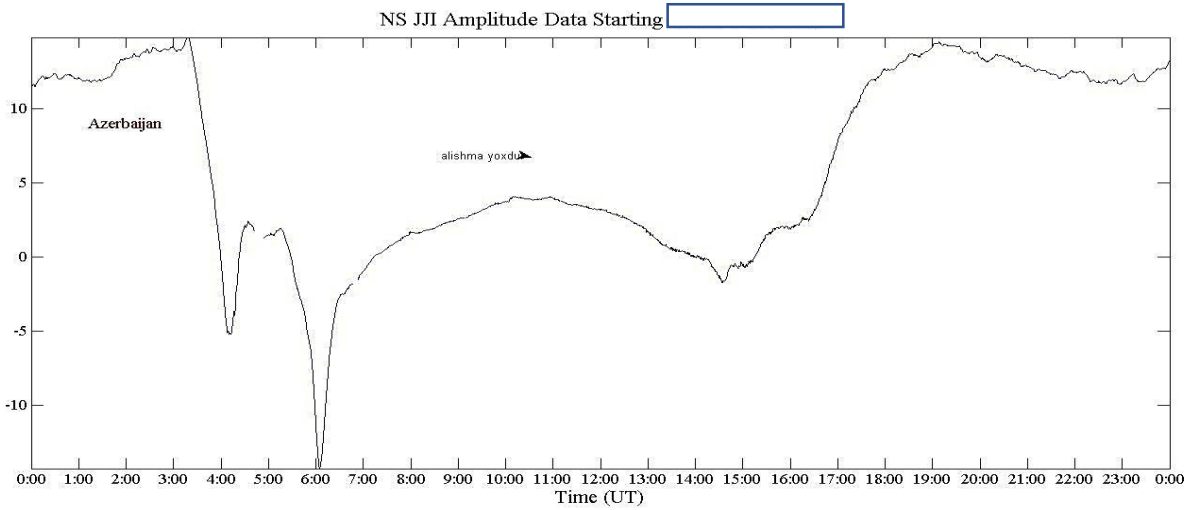




Days with solar flare



No flares



Space Weather Centre

- Induction magnetometer: Induction coil magnetometer LEMI-121 is manufactured by Lviv Centre of Institute for Space Research (National Space Agency of Ukraine, National Academy of Sciences of Ukraine) and is intended for the study of magnetic field fluctuations in the frequency band 0.0001-500 Hz in land conditions.

- It is intended for use both autonomously with any analogy registration unit and as a part of any geophysical equipment, e.g., magnetotelluric station. Extremely high sensitivity ensures excellent signal-to-noise ratio for exact measurements. Low power consumption and wide frequency range allow long term measurements at remote sites. Strengthened rugged housing and output connector prolong sensor active lifetime and increase overall reliability.

Horizontal solar telescope

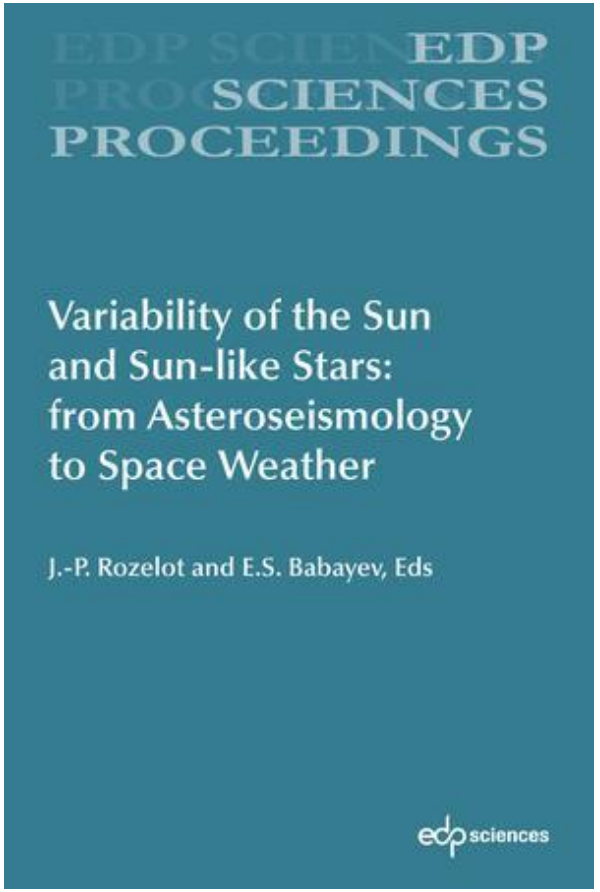
- Horizontal solar telescope "ATsU-5": was installed in 1963. This telescope is used for the solar spectral researches and photometric investigations of the Sun.
- The diameter of its heliostat, secondary and primary mirrors is 440 mm, the diameter of the Newtonian mirror is 200 mm, the Newtonian focal length is 17500 mm and equivalent focus distance in the Cassegrain system is 60540 mm. The Newtonian focus is used for spectral and magnetic observations.
- The one-camera auto-collimated spectrograph ASP-20 (with the grating of 150x120 square mm ruled area and 600 lines/mm, with the focal length of 7000 mm, dispersion in the second working order is 1.12 Ao/mm and ranges of the spectral field is 360 Ao, diameter of the image is 160 (mm) is used for the obtaining of spectrograms of solar flares, for visual observations of the magnetic fields of sunspots, studies on the development and dynamics of coronal prominences and spicules, fine structure of the solar spectral lines.

Scientific events

- The International Conference "Variability of the Sun and Sun-like stars: from Asteroseismology to Space Weather" was organized in 06-08 July 2015, Baku, Azerbaijan (Baku Solar Conference-2015)
- It aimed to highlight all aspects of modern solar physics research, including observation and theory that span from the interior of the Sun out into the wider heliosphere, as well as solar-terrestrial physics and particularly, sun-like stars. This Conference provided a broad, yet stimulating, environment for domestic and international scientists to share the findings of their research in solar and solar-terrestrial physics.

Scientific events

- The International Conference «Variability of the Sun and Sun-like stars: from Asteroseismology to Space Weather» - 06-08 July 2015, Baku, Azerbaijan



Scientific events

- The International Space Weather Initiative (ISWI) School on Space Weather (SW) and Global Navigation Satellite Systems (GNSS) was organized in Baku, Azerbaijan, on 8 – 12 October 2018.
- The School was an excellent learning and enrichment opportunity for scientists and graduate students from Asia and Eastern Europe. The purpose of the School was to advance the topics of Space Weather and Global Navigation Satellite Systems to scientists, engineers and graduate level students, who are pursuing doctorate (PhD) in solar physics, space science and engineering.

Scientific events

- The School was hosted by SDF and ShAO and sponsored by the International Committee on GNSS (ICG) through the United Nations Office for Outer Space Affairs (UNOOSA), ISWI and the Scientific Committee on Solar Terrestrial Physics (SCOSTEP). Scientific-technical support: "Azercosmos" JSCo and National Aviation Academy (Azerbaijan).
- School directors were: Dr. Natchimuk Gopalswamy, Goddard Spaceflight Center, NASA, USA, Dr. Patricia H. Doherty, Institute for Scientific Research, Boston College, USA, Dr. Sharafat Gadimova, United Nations Office for Outer Space Affairs and Mr. Elchin Babayev, Azerbaijan.

Scientific events

- The International Space Weather Initiative (ISWI) School on Space Weather (SW) and Global Navigation Satellite Systems (GNSS) - 8 – 12 October 2018, Baku, Azerbaijan

Scientific events

- The International Space Weather Initiative (ISWI) School on Space Weather (SW) and Global Navigation Satellite Systems (GNSS) - 8 – 12 October 2018, Baku, Azerbaijan

Scientific events

- International Workshop "Actual Problems of Solar-Terrestrial Physics" was organized on April 4th – 7th, 2019, at Pirgulu, Shamakhy, Azerbaijan. The event brought together representatives of the Pushkov Institute of Terrestrial Magnetism, Ionosphere and Radio Wave Propagation (IZMIRAN,) Russian Academy of Sciences (RAS) and BSU, ShAO.
- Main purpose of the workshop was the cooperation in the field of Solar-Terrestrial Physics, further expansion of bilateral ties between the two countries. The format of the workshop combined working group sessions, with oral contributions.

Scientific events

- The International Workshop **"Actual Problems of Solar-Terrestrial Physics"**
  4th – 7th, 2019, Pirgulu, Shamakhy, Azerbaijan









Public awareness

- Azerbaijani group pays an attention to the public awareness and publication of scientific information about Space Weather, impending hazards from space, especially the prediction of solar and geomagnetic storms, etc. It is carried out, in particular, in domestic media, newspapers, television and radio broadcasts, as daily space weather information, weekly interviews, monthly newspaper columns, which are addressed mainly to public, medical and technical specialists. Scientific-popular articles are usually published in special journals, such as “Science and Life”.

Public awareness – TUSI-BOHM planetarium, Astrofestivals, Olympiads

Certificate of Membership

The International Institute of Space Law

presents this Certificate of Membership to

Baku State University

in recognition of its institutional membership

of the International Institute of Space Law

Signed this 21st day of October 2019

IISL

Elina Morozova, Director

Collaboration perspectives

- UNIVERSITY-5.0. – development strategy (education, science, innovations, internationality, sociality)
- 16 faculties, 122 departments
- 2 research institutes (physics and mathematics)
- 3 research centers (including nano-research-center)
- 24 000 students
- 1500 academic staff
- The only university in Azerbaijan included in all rankings
- Establishment of Excellence Center in University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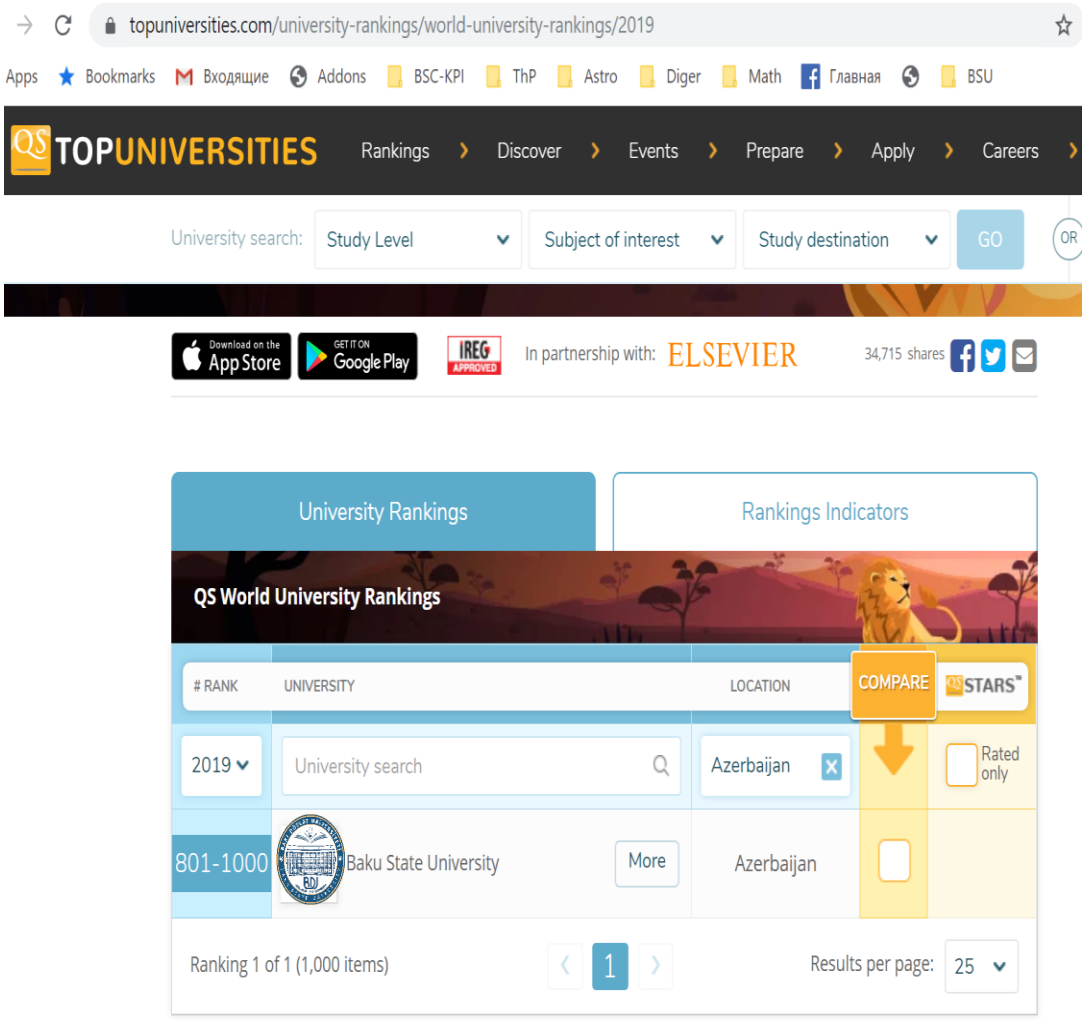
QS World University Rankings – 801



Collaboration perspectives

Becoming an active member of Azerbaijani group of Space Weather Community and device and instrument deployment allows:

- intensifying of conducted research works through step-by step involving this team in the European and other projects,
- installation of scientific and tutorial instruments,
- exchanging ideas, discussion of results,
- initiating bilateral and multilateral collaborative investigations within SW Community members,
- preparing or training of specialists for Azerbaijan, using Azerbaijani ground-based facilities (i.e., observatories) for filling of gaps in latitude or longitude.

Baku State University campus

Center of Excellence

Recent result of ISWI Collaboration

- SOFIE (SOlar Flares detected by Ionospheric Effects) is an extraordinary project of the German Aerospace Center (DLR) for students.
- **SOFIE-receiver installation**
- **Further collaboration**

INTERNATIONAL ASTRONAUTICAL FEDERATION

Connecting @ll Space People

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