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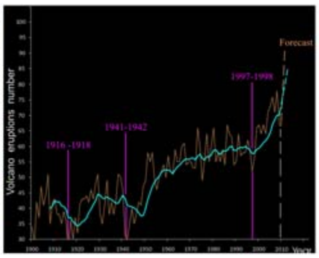
CONTENTS



Forecast
1997-1998
1941-1942
1916-1918
Volcano eruptions number





INTRODUCTION

The international scientific journal "GEOCHANGE: Problems of Global Changes of the Geological Environment" is an official scientific and informational publication of the International Committee on issues of Global Changes of the Geological Environment GEOCHANGE (IC GCGE).

***The main purpose of the journal's first issue** is to present the most complete information about the Communiqué on issues of Global Changes of the Environment GEOCHANGE and the International Committee IC GCGE. This publication also contains the first report of the IC GCGE Chairman, showing the results of research on global environmental change.*

We are planning to continue publishing in the next issues of the journal regular IC GCGE reports on the problems not covered in the first report: desertification, melting of Arctic glaciers, depletion of the ozone layer, land degradation, global changes of the Earth's ecosystem, the impact of global cataclysms on the loss of biodiversity, etc .

The journal will be publishing scientific articles of IC GCGE members, participants of the initiative group of the Communiqué GEOCHANGE and other scientists and experts, on the following issues:

Global Changes of the Environment:

- Core, mantle and lithosphere of the Earth;
- Hydrosphere;
- Atmosphere;
- Near-earth space;
- Solar-terrestrial relations;
- Effect of cosmic processes on the Earth;
- Problems of global desertification;
- Land degradation;
- Melting of glaciers;
- Natural causes of ozone layer depletion;
- Global changes of the geological environment contributing to disturbance of the natural ecosystem.

The journal is published once in six months in English.

*Electronic versions of this international scientific journal are available on the journal's website with free access (**www.geochangemag.org**).*

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List of countries whose scientists have signed the "GEOCHANGE" Communiqué

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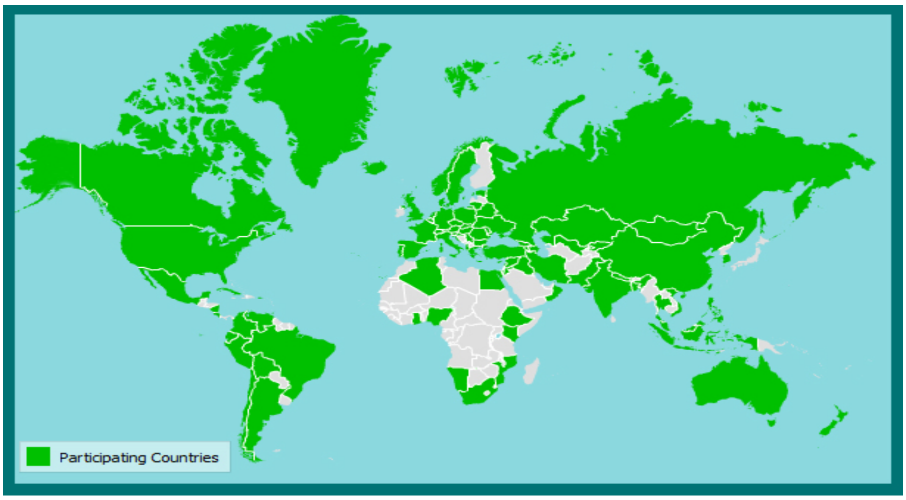

Map of countries represented in Communiqué "GEOCHANGE"

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OUR MOTTOS:

- SCIENCE IS FREE
- SCIENCE WITHOUT BORDERS
- SCIENCE WITHOUT POLITICS
- SCIENCE MUST SERVE PEOPLE

We, scientists from different countries, have teamed up to bring to the attention of leaders of the UN, EU and other international organizations, heads of states, social activists and the international community some objective information about global environmental changes, including global climate change.

We are beyond politics, beyond state borders, beyond religion.

Our mission is to improve human security in an era of natural disasters.

Our objectives are as follows:

- to identify the true causes, possible extent and implications of global environmental changes;
- to impartially assess the actual role and proportion of natural and anthropogenic factors in global climate change;
- to create equal conditions for scientists from different countries to express their opinion and present scientific results;
- to provide a platform for any alternative views of world scientists.

We invite scientists from all over the world to join our initiative.

Elchin Khalilov
Chairman of IC GCGE GEOCHANGE

An Open Letter to His Excellency Ban Ki-moon, The Secretary-General of the United Nations

Your Excellency,

During the last few years, scientists around the world have been witnessing alarming changes in the environment; these changes are of global significance for the entire planet. Global changes can now be observed throughout all of the Earth, including its core, mantle, lithosphere, hydrosphere, atmosphere, ionosphere, and magnetosphere.

In recent years, these processes have actively manifested themselves in the form of natural cataclysms causing great loss of life, destruction and huge economic damage in many countries.

The International Committee on issues of Global Changes of the Geological Environment (IC GCGE) "Geochange" has prepared a special report on this issue. Based on earthquake, volcanic eruption, tsunami and other geological and geophysical process-related data analysis, it demonstrates that the Earth's geodynamical activity has been continuously increasing over the last 100 years; the tendency has even significantly intensified during the recent decades. This is reflected in the number of fatalities and extent of economic damage caused by natural disasters. A similar situation can be observed in the atmospheric processes, a fact that has been repeatedly indicated in the UN IPCC (Intergovernmental Panel on Climate Change) reports. When combined, global environmental changes caused by anthropogenic and natural factors amplify the resulting negative effect on the progress of civilization.

It has to be acknowledged that humankind is not prepared to enter the global natural cataclysms era, either technologically, economically, legally, or psychologically. A joint effort by scientists, international organizations and governments of different countries under the aegis of the UN is needed in order to take effective measures to counter natural disasters and to minimize the casualties and damage they cause to humanity.

Being guided by the highest ideals of humanity and pursuing the desire to minimize the fatalities and damage caused by natural disasters, over 300 scientists from more than 85 countries have signed the GEOCHANGE Communiqué. We hope that the UN will support this initiative of scientists and take appropriate decisions for the sake of further stable development of human civilization and for reducing casualties and damage caused by natural disasters.

Annex: *1. GEOCHANGE Communiqué;*
2. A report by the Chairman of the International Committee on issues of Global Changes of the Geological Environment "GEOCHANGE", June 2010 (Int. Mag. GEOCHANGE: Problems of Global Changes of the Geological Environment, Vol.1, London, June 2010, ISSN-2218-5798)

Yours respectfully,
International Committee on issues
of Global Changes of the Geological Environment
GEOCHANGE

Communiqué "GEOCHANGE"

COMMUNIQUÉ "GEOCHANGE" on issues of global changes of the environment, for presentation to the UN, European Union, International Organizations and Governments of States.

This communiqué is presented on behalf of heads of international organizations, scientific institutes and centers, scientific–technical companies and scientists of different countries.

"GEOCHANGE" as used in this communiqué refers to natural changes of the environment resulting from endogenous, exogenous and cosmic factors and having negative consequences for the stable development of humanity.

Presently, multiple scientific facts indicative of the increasing environmental changes and their global nature have been collected. These changes indicate an acceleration of the growth rate of the geodynamic activity, which is expressed, in particular, as earthquakes and volcanic eruptions. There is a high risk that the scale of impact of geologic factors on global climate change will be underestimated. The periodical intensification of the Earth's endogenous activity leads to increased degassing of the mantle and emission of the greenhouse gases of geological origin into the atmosphere, causing global warming.

Alarming facts about a drastic (by more than 500%) acceleration of the drift of the Earth's North Magnetic Pole since 1990 not only have catastrophic consequences for global climatic change but also bear witness to significant changes in energetic processes in the Earth's inner and outer cores responsible for the formation of the geomagnetic field and endogenous activity of our planet.

The role of the magnetosphere in shaping the Earth's climate has been scientifically proven. The changes in the parameters of the geomagnetic field and magnetosphere may lead to redistribution of the areas of formation of cyclones and anticyclones, thus affecting global climate change.

Natural cataclysms may, in a short space of time, cause catastrophic consequences for entire regions of our planet: a lot of people will die, the populations of large territories will be deprived of shelter and livelihood, economies of states will be destroyed, and large scale epidemics of serious infectious diseases will occur. Presently, the world community is not ready to face such a development of events which is quite likely. Meanwhile, periods of significant increase of endogenous activity have been observed many times during the geologic life of our planet and, according to many geologic indicators, the next such period is already starting.

Natural cataclysms leading to large numbers of victims and massive destruction in one country or another are usually accompanied by wide international assistance of different international humanitarian organizations and individual states. However, during the period of large scale natural cataclysms, a special international, legal, administrative and financial mechanism will be required for the management and coordination of rescue, restoration and other international actions carried out in natural disaster areas.

Many countries can boast the scientific knowledge accumulated and experience in forecasting of different natural cataclysms. At the same time, in most cases there aren't definite rules for making decisions and specifying particular acts by state agencies when a need is indicated by forecasts of possible natural cataclysms. Incorrect decisions and uncoordinated actions of governmental and international structures upon receipt of such forecasts can bring panic to the population and disorganization of actions by state agencies and rescue services. It not only decreases effectiveness of preparation for natural cataclysms, but also can cause complication of the social and moral-psychological situation in the regions of the expected cataclysms.

Yet development of standards and precise rules for making decisions by the governments following reception of forecasts will help increase the effectiveness of rescue operations and restoration work and reduce the number of casualties and damage caused by natural disasters.

TAKING INTO ACCOUNT THE AFOREMENTIONED, THE INITIATIVE GROUP ON ISSUES OF GLOBAL CHANGES OF THE ENVIRONMENT "GEOCHANGE" PROPOSES:

- To adopt a UN Framework Convention on Global Changes of the Environment.
- To expand the duties and membership of the IPCC (Intergovernmental Panel on Climate Change) and change its name to IPEC (Intergovernmental Panel on Environmental Change), with additional inclusion of volcanologists, seismologists, geophysicists, geologists, space climate and international law experts. To instruct the IPEC to:

- Develop a UN International Program for studying and forecasting global environmental changes.

- Develop international legal norms and mechanisms for effective management and coordination of actions of governments of countries and international humanitarian organizations upon receipt of forecasts of natural cataclysms.

- Establish a UN International Center for Forecasting and Monitoring of Natural Cataclysms (IC FMNC).

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VisioTek Quality Control Systems *(Turkey, Istanbul)*

SETAC *(Turkey, Istanbul)*

Inta Space Turk *(Turkey, Ankara)*

FIP INDUSTRIALE *(Turkey, Istanbul)*

University of Kashan *(Iran, Kashan)*

Iraqi Meteorological Organization and Seismology *(Iraq, Baghdad)*

Department of Emergency Situations of Almaty city *(Kazakhstan, Almaty)*

Scientific Research Institute of Ecology and Climate *(Kazakhstan, Astana)*

University of Ibadan, Department of Geology *(Nigeria, Ibadan)*

Geology Department, Faculty of Science, Alexandria University *(Egypt, Alexandria)*

Council for Geoscience *(South Africa, Pretoria)*

Seismology, Geotechnician *(South Africa, Pretoria)*

University of Nairobi, Geology Department *(Kenya, Nairobi)*

Lower Canada College (LCC) *(Canada, Montreal)*

Weizmann Institute of Science *(Israel, Rehovot)*

The Geophysical Institute of Israel *(Israel, Lod)*

Tel Aviv University, Geophysics *(Israel, Tel Aviv)*

Center For Earthquakes Studies *(Pakistan Islamabad)*

Government of Yogyakarta Province Indonesia, Department of Public Works, Housing, Energy and Mineral Resources *(Indonesia, Yogyakarta)*

Islamic Indonesian University *(Indonesia, Yogyakarta)*

Gadjah Mada University *(Indonesia, Yogyakarta)*

Department of Public Works, Housing, Energy and Mineral Resources, (MT PUP ESDM) *(Indonesia, Yogyakarta)*

Tribhuvan University, Trichandra Campus *(Nepal, Kathmandu)*

Technical University of Darmstadt *(Jordan)*

Jordan Seismological Observatory *(Jordan, Amman)*

Cyprus Geological Survey *(Cyprus, Nicosia)*

JV Vietsovpetro *(Vietnam, Vung tau)*

University of Canterbury *(New Zealand, Christchruch)*

World Fish CGIAR (Consultative Group on International Agricultural Research *(Malaysia, Penang)*

Research Institute Senior *(Cuba, Havana)*

Institute of Ecology and Geography, Academy of Sciences of Moldova *(Chisinau, Republic of Moldova)*

Geological Department, Kwame Nkrumah University Of Science and Technology *(Kumasi, Republic of Ghana)*

A View from the Bottom, A Foundation for the Elimination of Generational Abuse, and Poverty. Founder & Program Developer *(USA, Seymour)*

Ltd. ESTIDA *(Ukraine, Kharkiv)*

"Dneprspetskomplektgaz" *(Ukraine, Dnepropetrovsk)*

Loepittayakom School *(Thailand, Loei)*

Rusal Armenal *(Armenia, Erevan)*

University of Vlora *(Albania, Vlora)*

Geoscience Institute, Polytechnic University of Tirana *(Albania, Tirana)*

Aristotle University Thessaloniki *(Greece, Thessaloniki)*

Nicaraguan Institute of Terrestrial Studies *(Nicaragua, Managua)*

High School Teacher *(Iceland, Reykjavík)*

University of Namibia *(Namibia, Windhoek)*

NACOMA – Namibian Coast Conservation and Management Project *(Namibia, Swakopmund)*

Geological Survey of Slovenia *(Slovenia)*

Institute of Hydrometeorology of the Academy of Sciences of Georgia *(Georgia, Tbilisi)*

University of Rajshahi *(Bangladesh, Rajshahi)*

Ibra College of Technology *(Oman)*

Al Musanna College of Technology *(Muscat, Oman)*

University of Fribourg *(Switzerland, Neuchatel)*

Forman Christian College (*Pakistan, Lahore*)

Geological Survey of Namibia (*Namibia, Windhoek)*

Central Asian Institute for Applied Geosciences (*Kyrgyzstan, Bishkek)*

Institute of Earth Sciences, Academia Sinica *(Taiwan, Taipei)*

Journals "The World of Animals", "Ecologist and Me" *(Belarus, Gomel)*

Seismological Survey of Serbia *(Serbia, Belgrade)*

National Council for Scientific Research *(Beirut, Lebanon)*

The Centre of Geophysical Monitoring of the NAS Belarus *(Belarus, Minsk)*

Geological Survey of Bangladesh *(Bangladesh, Dhaka)*

Metrokombank *(Kazakhstan, Almaty)*

Dagestan branch of the Institution of the Russian Academy of Sciences Geophysical Service *(Russia, Makhachkala)*

University of Calgary *(Canada, Calgary)*

Lecom Birotica Ardeal *(Romania, Bucharest)*

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Ministry of Public Works and Settlement *(Turkey, Ankara)*

Yeditepe University *(Turkey, Istanbul)*

Disaster Affairs of Afyon province *(Turkey, Afyonkarahisar)*

Istanbul University, Department of Geophysical Engineering *(Turkey)*

Directorate General of Coastal Safety *(Turkey, Ankara)*

Albaath University ***(Syria, Homs)***

Natural Resources Authority ***(Jordan, Amman)***

Azerbaijan Pedagogical University ***(Azerbaijan, Baku)***

Azerbaijan National Academy of Sciences (ANAS) ***(Azerbaijan, Baku)***

Azerbaijan Medical University ***(Azerbaijan, Baku)***

Azerbaijan State Advanced Training Institute ***(Azerbaijan, Baku)***

International Academy of Sciences Azerbaijan Section ***(Azerbaijan, Baku)***

National Academy of Aviation ***(Azerbaijan, Baku)***

Radioactive Researches Laboratory ***(Azerbaijan, Baku)***

Founders:

World Organization for Scientific Cooperation (WOSCO)

Official Website:* *www.wosco.org

Global Network for the Forecasting of Earthquakes (GNFE)

Official Website:* *www.seismonet.org

Approving the International Communiqué GEOCHANGE and Establishing the International Committee on issues of Global Changes of the Geological Environment GEOCHANGE

The decision to initiate preparation and signing of the International Communiqué GEOCHANGE on issues of Global Changes of the Geological Environment was adopted 12 March 2009 by the World Organization for Scientific Cooperation (WOSCO) and the Global Network for the Forecasting of Earthquakes (GNFE), following an initiative by Victor Efimovich Khain, a distinguished geologist, academician of the Russian Academy of Sciences, professor emeritus at the M. V. Lomonosov Moscow State University, doctor of geological and mineralogical sciences, Honorary President of the World Organization for Scientific Cooperation WOSCO (www.wosco.org) and Elchin Khalilov, President of the Global Network for the Forecasting of Earthquakes GNFE (www.seismonet.org), geophysicist, professor, doctor of geological and mineralogical sciences, Director General of the Scientific Research Institute for Prognosis and Study of Earthquakes (Baku, Azerbaijan).

Victor Efimovich Khain

Academician of USSR AS and Russian Academy of Sciences, Professor Emeritus at the M. V. Lomonosov Moscow State University, Doctor of geological and mineralogical sciences, Honorary President of the World Organization for Scientific Cooperation WOSCO (London, UK), Honorary President of the International Academy of Sciences H&E (Austria, Innsbruck).

Official website:* *www.victor-khain.wosco.org

Elchin N. Khalilov

IAS Academician, Professor, Doctor of geological and mineralogical sciences, Vice-president of the International Academy of Sciences H&E (Austria), President of the Global Network for the Forecasting of Earthquakes (London, UK), Director General of the Scientific Research Institute for Prognosis and Study of Earthquakes (SRIPSE, Baku, Azerbaijan)

Official website: ***www.khalilov.biz***

The Communiqué GEOCHANGE was adopted and its latest version approved after being signed by scientists from 16 countries: the US, Russia, Germany, the UK, Italy, China, Bulgaria, Czech Republic, Georgia, Kazakhstan, Uzbekistan, Turkey, Azerbaijan, Pakistan, Indonesia, India, at a joint GNFE and WOSCO Board meeting of the founders on December 5, 2009 in Baku.

The meeting of the founders decided to send the International Communiqué GEOCHANGE to:

- *Secretary-General of the United Nations*
- *President of the European Union*
- *Heads of states*
- *International organizations*

The meeting of the founders agreed to proceed with inviting new participants to join the International Communiqué GEOCHANGE.

June, 2010

GLOBAL CHANGES OF THE ENVIRONMENT: THREATENING THE PROGRESS OF CIVILIZATION

[First report of the Chairman of the International Committee GEOCHANGE on issues of Global Changes of the Geological Environment 30.06.2010]

E.N.Khalilov

"GEOCHANGE" IC GCGE

Summary

Below are given some results of studies of global environmental changes expressed by the statistics and the scale of various natural disasters, both atmospheric and geological in nature. On the basis of statistical data analysis for earthquakes, volcanic eruptions, tsunamis, drift of the magnetic poles and other geological processes it has been demonstrated that the Earth's geodynamic activity has been continuously increasing over the past 100 years, with this tendency substantially growing in recent decades. This is reflected in the number of casualties and the extent of economic damage caused by natural disasters. The global "energy spike" in endogenous and exogenous processes of the Earth started in the late 1990's.

A similar trend can be observed in atmospheric processes, specifically the increased number of tornados, hurricanes, tropical storms, floods, etc. The global environmental changes caused by anthropogenic and natural factors combine to amplify the negative effect on humanity.

It has to be acknowledged that humankind is not prepared to enter the era of global natural cataclysms, either technologically, economically, legally, or psychologically. A joint effort by scientists, international organizations and governments of different countries under the aegis of the UN is needed to take effective measures to counter natural disasters and to minimize the casualties and damage they cause to humanity.

June, 2010

CONTENTS

Introduction

The time has come when accumulated earth science data make it possible to take a deeper look into the nature's global changes, and reconsider their extent and their role in the sustainable development of civilization. Many world scientists realize that not only do these changes affect the climate, but they have an impact on virtually the entire volume of the Earth, from its core to the atmosphere and magnetosphere.

Global Changes of the Environment, "GEOCHANGE", means natural, planet-wide changes in nature, influenced by endogenous, exogenous and cosmic factors occurring within the solar system and having negative implications for the sustainable development of humankind.

This summarizing scientific work by IC GCGE, "GEOCHANGE", is our attempt to demonstrate the extent of these processes and how they influence the development of humankind. Those processes may destabilize the progress of civilization unless some preemptive and effective joint action is taken by the international community to ensure the maximum possible reduction in the number of casualties and economic damage caused by natural disasters.

The first report by the Chairman of IC GCGE is a fundamental initial document justifying the International Communiqué on issues of Global Changes of the Geological Environment, "GEOCHANGE". In the next IC GCGE reports, greater involvement of scientists from different countries as well as consideration of aspects and issues not covered in the first report is planned.

All IC GCGE reports will be published in an international scientific journal titled **"GEOCHANGE: Problems of Global Changes of the Geological Environment".**

When preparing this report, the following basic principles have been observed:

- All data provided in the report are verifiable based on references to literary sources or databases available on the Internet.
- The report primarily uses databases of various countries' public bodies or authoritative international organizations.
- To avoid subjectivity, the report provides raw data without any special mathematical treatment. In some cases, for visualization purposes, minimal mathematical processing is employed, for instance, when drafting various trends or averaging data.
- The text has been written in a popular science style so as to be understood by non-specialists.
- The report contains a lot of illustrative material to maximize the reader's perception of the information.
- Because the report addresses some issues covering various fields of science and issues at the interface between different disciplines, the text provides basic concepts of the most important terms used.

We observe that, along with the rise of our planet's average temperature, there is a simultaneous increase not only in the activity of extreme weather events such as tornadoes, hurricanes, storms, etc., but also of the number of strong earthquakes, volcanic eruptions, and tsunamis, with the movement of the magnetic poles accelerating and the Earth's shape and rotation rate changing. Therefore, it is evident that global climate change is only a part of global environmental changes.

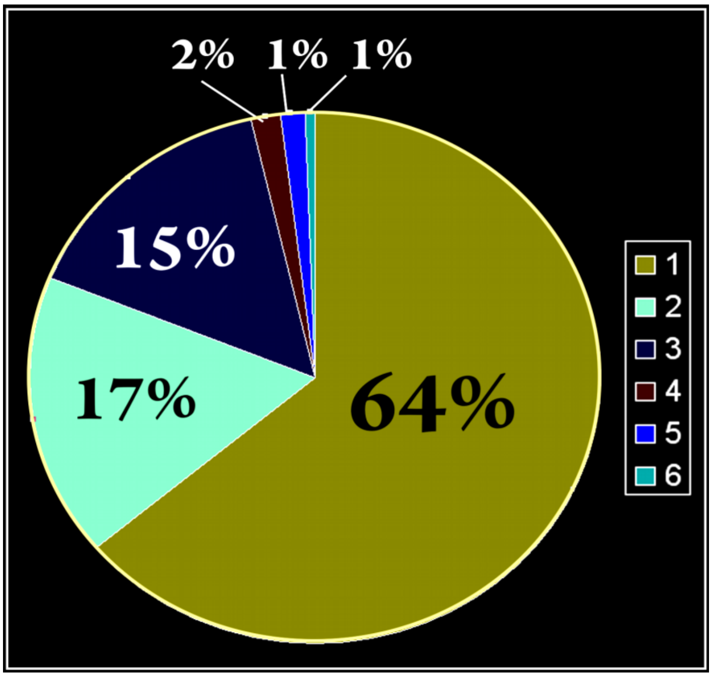


Fig. 1. Casualty breakdown by natural disaster types for the period between 1947 and 1997 (According to data by K. Y. Kondratiev et al, 2005)
http://www.viems.ru/asnti/ntb/ntb502/oboc5.html

1 – Tornadoes, typhoons, storms (1,500,000 dead);
2 – Earthquakes (400,000 dead);
3 – Floods (360,000 dead);
4 – Thunderstorms (40,000 dead);
5 – Tsunamis (30,000 dead);
6 – Volcanic eruptions (15,000 dead)

Natural disasters cause enormous economic damage to many countries, but the most tragic consequence of their manifestation is numerous casualties. According to research by K. Y. Kondratiev (Kondratiev, 2005), the majority of human lives worldwide are claimed by tornadoes, typhoons (hurricanes) and storms (64%). Earthquakes, in terms of casualty toll, rank second (17%), followed by floods (15%), thunderstorms (2%), tsunamis (1%), and volcanic eruptions (1%).

Nevertheless, in our opinion, these statistics do not so much represent a stable persistent pattern as they are a particular case associated with the specific time period being considered. Alternatively, during the period from 1999 to 2010, earthquakes would be in the lead, followed by tornadoes, typhoons, and storms ranking second, and tsunamis being third.

Below are given some actual data and their brief analysis, the conclusions of which are disappointing and articulate humankind's entering an era of global cataclysms for which people are not ready yet, either technologically, economically, legally or psychologically.

While writing this first IC GCGE report, we tried to minimize subjective approaches and opinions, relying solely on the facts and primary conclusions that are evident or the most well-grounded. That is why the last section of this report, **"Possible forecasts of some natural cataclysms and cosmic processes"** is placed beyond this report as Appendix 1. That section is attached as additional information for discussion.

This report has been published in the international scientific journal "GEOCHANGE: Problems of Global Changes of the Geological Environment" (№ 1, 2010) and is available for open discussion on www.geochange-report.org website. All proposals, recommendations, and comments will be considered and posted on IC GCGE website.

It is also planned to discuss the report during IC GCGE General Assembly and at the International Conference on Global Changes of the Environment (2011).

In the next IC GCGE reports, we plan to address the following issues not covered in the first report:
- Near-earth space;
- Impact of cosmic processes on the Earth;
- Problems of global desertification;
- Land degradation;
- Melting of glaciers;
- Natural causes of ozone layer depletion;
- Global changes of the geological environment contributing to disturbance of the natural ecosystem.

Horrifying statistics!

For the last 10 years, the number of people killed during large earthquakes across the world has increased 8.6-fold compared with the average per decade figures during the preceding 50 years.

Below is a graph showing numbers of casualties during major earthquakes, covering the period from August 1999 to January 2010. As one can see from the graph, the straight-line trend indicates the tendency to a sharp increase in fatalities over the past decade.

Meanwhile, a kind of cyclicity associated with specific events that have significantly influenced the statistics can be observed. For instance, the sharp increase in the number of casualties since 2003 was caused by the disastrous magnitude 9.1 earthquake with an epicenter north of Sumatra Island on Dec. 26, 2004, which resulted in a very powerful tsunami affecting the coasts of 14 countries. Some 230,000 people died as a result of the earthquake and tsunami.

The second maximum occurred in January 2010 and is associated with the catastrophic Haiti magnitude 7,1 earthquake (12.01.2010), claiming lives of 222,570 people.

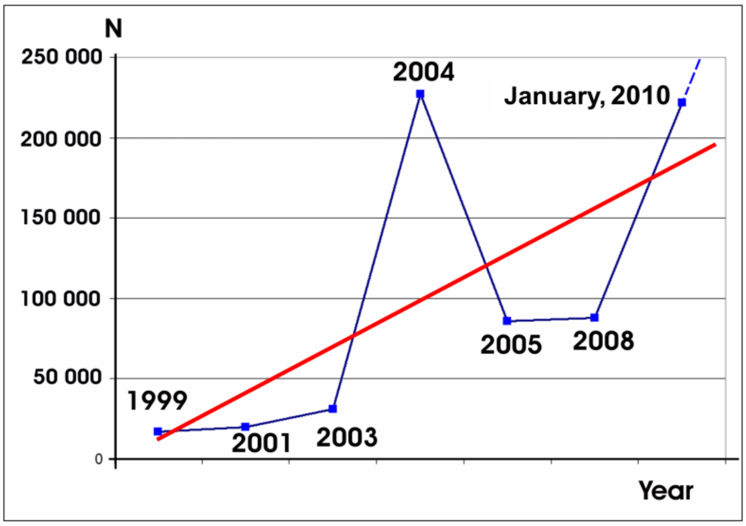


Fig. 2. Graph showing numbers of victims of major earthquakes for the period between January 1999 and January 2010 (by E. Khalilov, 2010, according to USGS data)

Graph for numbers of fatalities during major earthquakes for certain years is marked in blue. Straight-line trend reflecting tendency of fatalities to grow in numbers over last decade is marked in red.

So, certain natural disasters can make a significant contribution to the overall statistics, and such events have a special place in the history of the world civilization. Below is a table indicating the number of people killed during large earthquakes from August 1999 to February 2010. Table 1 mentions only the earthquakes with over 10,000 fatalities.

Number of casualties during major earthquakes for the period between August 1999 and February 2010

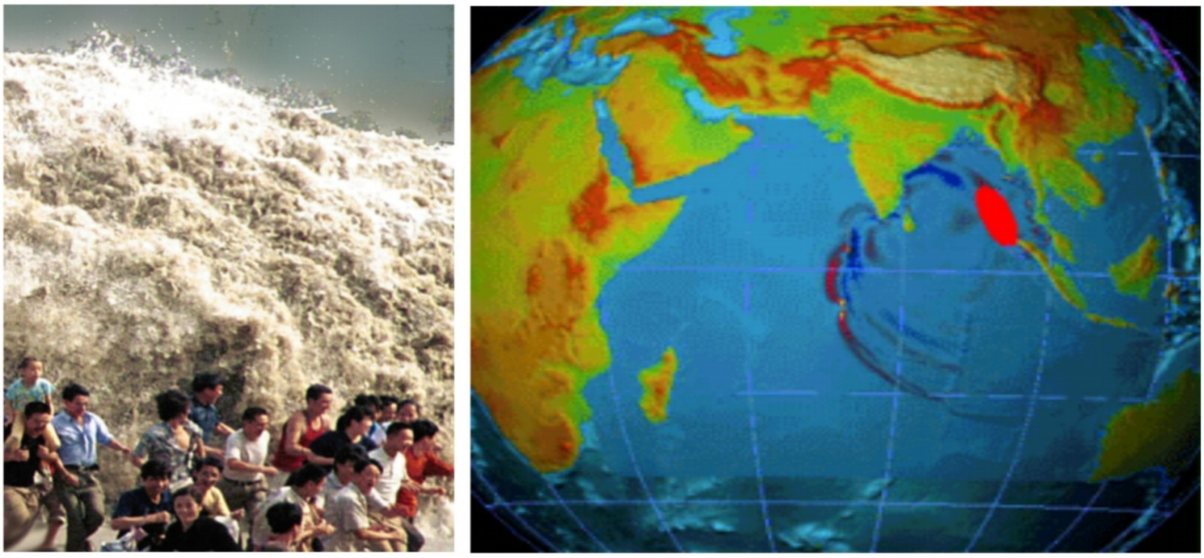
Table 1

#	Earthquake date	Location	Magnitude	Number of Dead
1	1999/08/17	Turkey 40.7N 30.0E	7.6	17,118
2	2001/01/26	Gujarat, India 23.3N 70.3E	7.6	20,085
3	2003/12/26	South eastern Iran (Bam) 28.99N 58.31E	6.6	31,000
4	2004/12 /26	Sumatra 3.30N 95.87E	9.1	227,898
5	2005/10/08	Pakistan 34.53N 73.58E	7.6	86,000
6	2008/05/12	Eastern Sichuan, China 31.002 N 103.322 E	7.9	87,587
7	2010/01/12	Haiti region 18.445 N 72.571W	7.1	222,570

The table demonstrates that the number of casualties caused by strong earthquakes is growing year by year, this tendency being distinctly displayed by the fatality graph (Fig. 2) and the straight-line trend showing the general tendency.

Meanwhile, the pernicious effects of natural disasters are not limited to human victims only. Major natural disasters may, in a short time, make a substantial impact on the Earth's global characteristics: its shape, angular velocity of rotation, and variations of the spatial position of its axis. These factors, in their turn, can cause global climate change.

For instance, the catastrophic magnitude 9.1 earthquake of December 26, 2004 near northern Sumatra generated a very large tsunami and became a cause of death of about 300 thousand people, entering into the history of humankind as one of the most immense natural disasters ever. It is not merely about the monstrous number of people fallen victim to the earthquake and the tsunami it caused. It is, above all, about an amazing geological event with a scope so large that it influenced planet-wide processes. The catastrophic earthquake in the Southeast Asia changed the Earth's geophysical characteristics. As the Spaceflight Now website reports, NASA scientists have established that the underground shocks have affected the planet's rotation rate, lengthened the day, and slightly altered the planet's shape. Moreover, the earthquake changed the position of the Geographic North Pole. It shifted by 2.5 cm towards 145° east longitude. The alteration of the planet's rotation rate caused lengthening of the 24-hour day by 2.68 microseconds, and the movement of masses led to a change in the planet's shape.



http://www.eos.ubc.ca/courses/Dist-Ed/DE114.html http://en.wikipedia.org/wiki/2004_Indian_Ocean_earthquake

The catastrophic Indonesian tsunami of December 26, 2004

The catastrophic earthquake of December 26, 2004 occurred as an upthrust at the convergent boundary between the Indo-Australian and Eurasian plates in the northern Sumatra region. Within about 2 minutes, the rupture activated elastic deformation that had been accumulating in that focal area for centuries as a result of the continuing subduction (sliding) of the Indo-Australian plate under the Eurasian plate. The aftershock zone on December 26 had a length of about 1300 km. Even if we assume that only some of the aftershocks reflected the rupture plane of the main shock, then, according to a number of researchers, its length is considerably more than 500 km. As Chen Ji indicates in his work (2005), geodetic observations and computer simulations enabled scientists to conclude that the maximum underthrust during the earthquake was about 20 m at the depth of 18 km. It was accompanied by seabed shift – about 5 m vertically and 11 m horizontally.

For the last 10 years, 42% more people have been killed as a result of catastrophic earthquakes than during the preceding 50 years

Chapter 1.

NATURAL CATACLYSMS AS A POSSIBLE DESTABILIZING FACTOR FOR WORLD ECONOMY

1.1. STATISTICS OF ECONOMIC INDICATORS

The economic damage from U.S. floods for the past 5 years has exceeded the total economic damage sustained during the preceding 20 years

It is quite evident that natural disasters have a devastating impact on the stable development of the world economy, causing enormous economic damage to countries in which they occur.

Not every country is able to cope with economic losses from natural catastrophes independently. Therefore, the international community provides such countries with large-scale humanitarian relief, including financial aid. Damage caused by strong earthquakes, volcanic eruptions, tornadoes, floods, tsunamis and other natural disasters can amount from tens of millions to hundreds of billions of dollars.

Here are several examples in order to illustrate the potential economic damage from strong earthquakes.

Early in the morning of April 18, 1906, a series of underground shocks measuring over 8 on the Richter scale turned the city of San Francisco and its environs into a heap of ruins within a minute. Calculations have showed that the economic damage from the earthquake was nearly half a billion dollars (equivalent to about $8 billion in 2010 dollars). http://www.forbesrussia.ru/mneniya/opyty/26841-zdes-byl-gorod

A powerful magnitude 6.7 earthquake occurred in the Northridge area of Los Angeles, California, U.S.A. on January 17, 1994. The damage inflicted by the earthquake was nearly 20 billion dollars. http://en.wikipedia.org/wiki/1994_Northridge_earthquake

On 26 December 2004, a catastrophic magnitude 9.1-9.3 earthquake struck the Indonesian island of Sumatra. The earthquake brought about a series of devastating tsunamis along the Indian Ocean coastline, claiming the lives of nearly 230,000 people in 14 countries. The sum allocated as humanitarian relief to affected countries alone amounted to 7 billion U.S. dollars. http://en.wikipedia.org/wiki/2004_Indian_Ocean_earthquake

One of the strongest earthquakes ever in human history occurred on Feb. 27, 2010 off the coast of Chile causing human casualties, destruction, and the formation of a tsunami. The Biobio and Maule regions were the areas most affected by the magnitude 8.8 earthquake. According to a U.S.-based international group for earthquake consequence assessment, EQECAT, the estimated losses from the Chile earthquake vary from 15 to 30 billion dollars. The disaster left about 2 million people homeless; 1.5 million houses were damaged, with 500 thousand of them suffering irreversible damage.

Fig 3. shows a graph for total economic damage caused by natural disasters worldwide between 1950 and 2009. As seen from the diagram, the total economic loss from all natural disasters from 2000 to 2009 approached one trillion U.S. dollars.

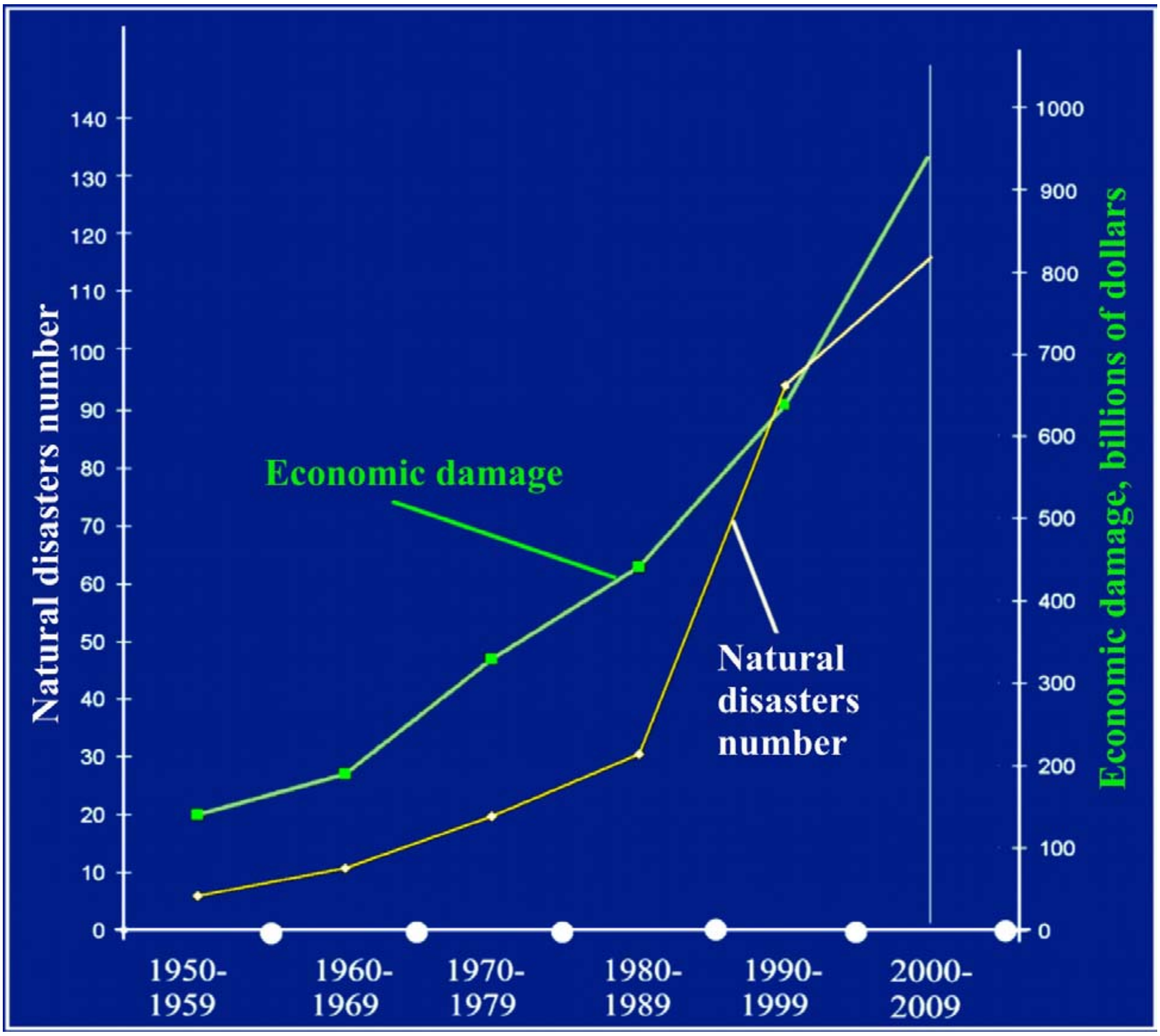


Fig. 3. Graphs showing numbers of natural disasters and economic damage inflicted by them for the period between 1950 and 2009 (According to data by K. Y. Kondratiev et. al., 2005, with additions by E. N. Khalilov, 2010 http://www.viems.ru/asnti/ntb/ntb502/oboc5.html)

Damage from floods, tornadoes, hurricanes, storms and volcanic eruptions may vary in different time periods. However, in all cases the general trend of economic damage from natural disasters rises from year to year, even taking into account global economic inflation (Fig. 4 and Fig. 5).

For instance, the total damage from floods that occurred in the United States in 1993 amounted to 26 billion dollars, reaching $125 billion in 2005 (mostly due to the damage caused by Hurricane Katrina and the accompanying flood) http://www.weather.gov/oh/hic/flood_stats/Flood_loss_time_series.shtml

The most destructive large-scale hurricane in the U.S. history – Hurricane Katrina – occurred in August 2005 off the coast of Florida and caused 110 to 150 billion U.S. dollars in damage, according to different estimates; 125 billion dollars is thought to be the most plausible figure. The U.S. President declared the states of Louisiana, Mississippi, Alabama, and Florida a disaster zone. http://www.ncdc.noaa.gov/oa/reports/tech-report-200501z.pdf, http://www.nhc.noaa.gov/pdf/TCR-AL122005_Katrina.pdf

In the Gulf of Mexico, Hurricane Katrina destroyed the offshore energy infrastructure and led to evacuation of more than 75 percent of the Gulf's 819 manned oil platforms. Two days before the hurricane approached the coast, American energy companies estimated that the nearing storm had already reduced oil production in the Gulf of Mexico by more than one-third.

Hurricane Katrina caused power failures affecting vast areas. A great number of animals and birds died; livestock and poultry farms located in the disaster zone were suffering from the damage caused to roads and communication links; the technical infrastructure was completely destroyed virtually throughout the entire disaster area. Conventional vehicles were not effective for evacuation and relocation of people and goods. Along with rescue services, military units were involved in fighting the disaster.

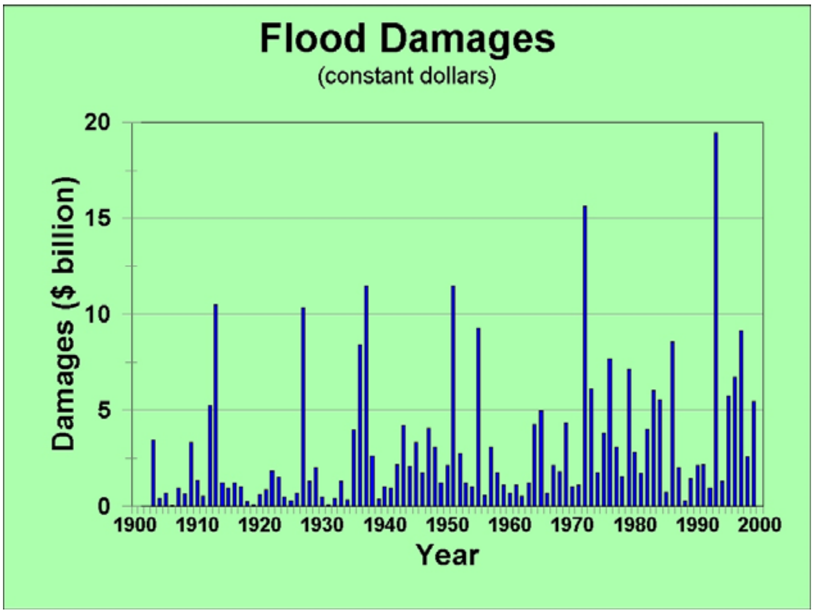


Fig. 4. Economic damage from U.S. floods from 1900 to 2000
http://www.weather.gov/oh/hic/flood_stats/flood_trends.JPG

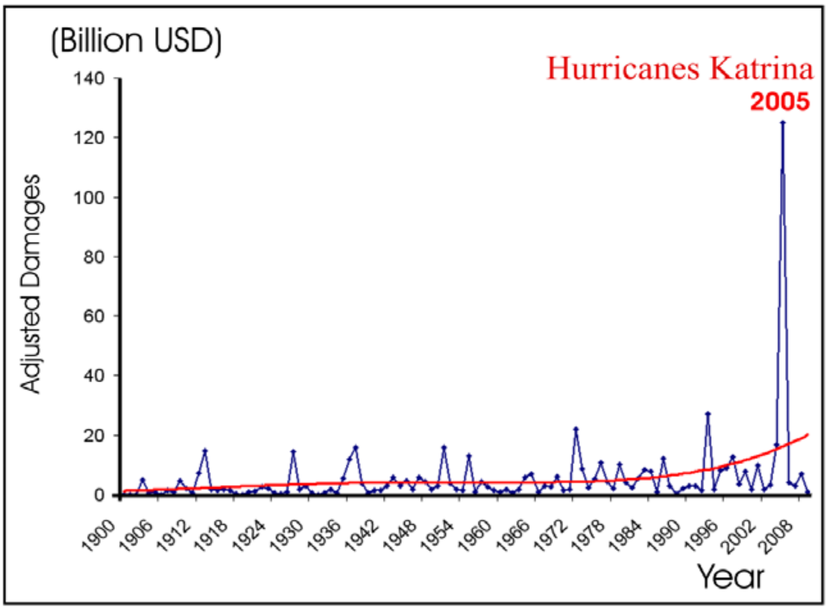


Fig. 5. Economic damage from U.S. floods from 1903 to 2009 (in billions of 2007 dollars) (by E. Khalilov, 2010, according to HIC NOAA data)
http://www.weather.gov/oh/hic/flood_stats/Flood_loss_time_series.shtml

1.2. HOW DO GLOBAL CATACLYSMS INFLUENCE THE ECONOMIC SITUATION?

The data given in the previous section are based on the assessment of direct economic damage caused by natural disasters in the period of their manifestation. Meanwhile, it should be noted that the real economic damage caused by natural disasters is much larger in scale and manifests itself over a long period of time after the catastrophe. Let us consider, by the example of Hurricane Katrina and the resulting flood, which economic and social consequences global natural disasters may lead to.

Katrina's impact on the economy and social sphere of the flooded areas was devastating and long-lasting. Between August and September 2005, the unemployment rate in the disaster areas doubled from 6% to 12%, mostly affecting the states of Louisiana and Mississippi (http://en.wikipedia.org/wiki/Hurricane_Katrina). Wages in Louisiana, Mississippi, and Alabama dropped approximately by 1.2 billion dollars in the third quarter of 2005. A sharp nationwide increase in gasoline prices dealt a special blow to living standards in the distressed communities and in the U.S. in general. The hurricane led to temporary closure of most crude oil and natural gas production in the Gulf of Mexico. The oil production between August 26, 2005 and January 11, 2006 was some 114 million barrels less than usual, accounting for one-fifth of the annual oil production in the Gulf of Mexico.

The hurricane devastated the regional administrative infrastructure. Approximately 2.5 million customers in Louisiana, Mississippi, and Alabama lost electrical power (http://en.wikipedia.org/wiki/Hurricane_Katrina). A lot of communication lines across the disaster areas sustained great damage. Over 3 million phone lines were damaged in

Louisiana, Mississippi, and Alabama, along with radio communication systems since about 50% of the radio stations and 44% of the TV stations in the affected regions were destroyed.

Initially, widespread destruction and numerous fatalities inflict serious financial damage on insurance companies that are unable to pay insurance indemnities simultaneously to large numbers of people and businesses affected by natural disasters.

A second blow is delivered to banks that are bound to ensure payments for insurance liabilities to large numbers of people and organizations at the same time. But that is not the only factor to cause problems for banks. All at once, huge numbers of people bereft of shelter and livelihood try to retrieve their bank deposits. The banks delay returning of deposits and payments to insurance companies, causing panic among depositors. The panic mood is then communicated even to those who do not need additional funds but then try to retrieve their deposits from the banks in order to save their money in case the banks go bankrupt. Economists are well aware of this chain reaction. As a rule, if this process is localized within one or several countries, then international financial support makes it possible to rectify the situation and prevent the distressed countries from falling into a full-scale financial crisis.

But if we imagine that natural disasters become widespread in many countries, the global financial system may be unable to cover the formed shortage of funds, which will definitely lead to the necessity of putting new funds into circulation, causing global inflation and a resulting global economic crisis. The newly emerging crisis may prove to be deeper and more widespread than ordinary crises as large-scale natural disasters can cause financial problems for many countries simultaneously.

Let us consider the 2010 eruption of the Icelandic volcano Eyjafjallajökull.

The eruption began on the night of 20/21 March 2010 and went through several stages. Eruptions and powerful atmospheric emissions of volcanic ash interrupted the volcano's temporary lulls. The main negative consequence of the eruption was the ejection of volcanic ash clouds that disrupted air traffic across Europe.

http://en.wikipedia.org/wiki/2010_eruptions_of_Eyjafjallaj%C3%B6kull

The financial damage from air traffic disruption in Europe as of April 25, 2010 has been estimated as ranging from 1.5 to 2.5 billion Euros, according to a report by European Commissioner for Transport Siim Kallas. The crisis affected 29% of world aviation, with some 1.2-1.5 million passengers suffering from it every day. According to estimates by the International Air Transport Association, the airlines' daily losses from

canceled flights amounted to at least $200 million.
http://www.vesti.ru/doc.html?id=353994

Losses suffered by European tourism are estimated at about 2.5 billion Euros. It is hard to calculate the losses of numerous companies whose commercial shipments were not delivered to destinations in time. The total damage from the Eyjafjallajökull eruption may exceed 10 billion Euros.

Meanwhile, Eyjafjallajökull is not even in the list of the most dangerous volcanoes. According to some calculations, the damage that the Mount Vesuvius eruption may cause to Europe is estimated at $24 billion.

CONCLUSIONS AND SUGGESTIONS:

- This brief analysis of natural disasters' statistics and impact on the economic situation of countries and regions has demonstrated that economic damage from natural disasters increases in proportion to their number and scale. Thus, further increase in the number and scale of natural disasters may lead to world-wide economic destabilization and a new, deeper global economic crisis.

- Appropriate action must be taken to stabilize the economic situation in case global planet-wide natural cataclysms occur. For that purpose, UN-sanctioned development and adoption of international legal norms and laws is proposed to effectively manage and coordinate the provision of financial support and humanitarian aid to countries and regions affected by natural disasters.

Chapter 2.
LITHOSPHERE

2.1. GLOBAL CHANGES OF EARTH'S SEISMIC ACTIVITY

31.5 % of all deaths caused by strong earthquakes over the last 110 years have taken place in the past decade

EARTHQUAKE VICTIMS

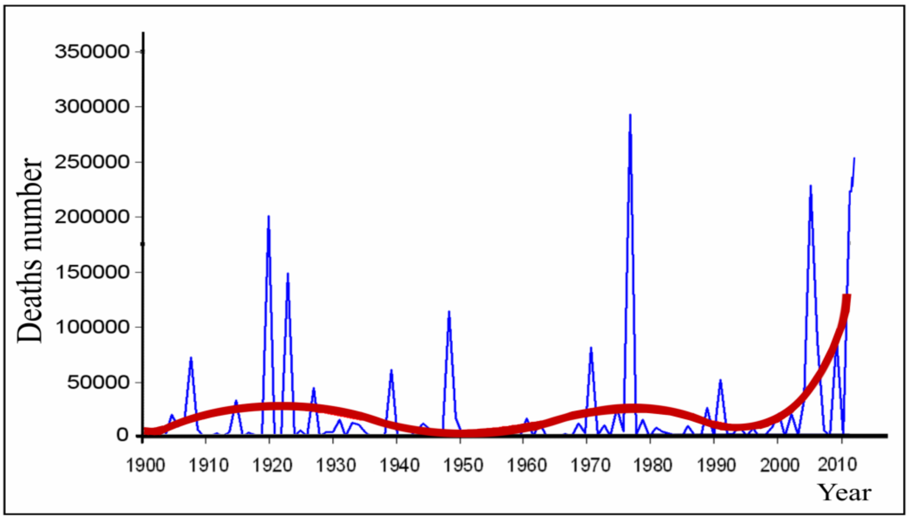


Fig. 6. Number of earthquake victims from 1900 to June 2010 (by E. N. Khalilov, 2010, according to USGS data)
http://earthquake.usgs.gov/earthquakes/world/world_deaths_sort.php)
Annual number of earthquakes graph is marked in blue
Polynomial trend of sixth degree is marked in red

The Indonesian earthquake and tsunami of 26/12/2004 claimed the lives of 230,000 people, shifted the Earth's axis and changed the length of the 24-hour day.

Fig.6 contains a graph showing the alarming dynamics of deaths caused by strong earthquakes.

Indonesian earthquake and tsunami, Sumatra island, 26 December 2004
http://www.virginmedia.com/images/earthquakes7-4x3.jpg

http://www.thejakartaglobe.com/media/images/large/20091221195843069.jpg
http://s.ngeo.com/wpf/media-live/photos/000/004/cache/thai-tsunami-boat_404_600x450.jpg

Thus, the substantial increase in the number of victims of strong earthquakes in the last decade has become evident and this tendency continues to grow.

Neftegorsk, Russia, devastated by an earthquake, 27.05.1995
(Photo by Igor Mikhalev, STF, http://visualrian.ru/images/item/8769)

Earthquakes are among the most dangerous natural disasters on our planet. This is due primarily to the fact that they occur suddenly and cause massive destruction within tens of seconds, resulting in huge death tolls. The destruction of buildings and other structures created by people is the main cause of fatalities during earthquakes.

Over 90% of the world's earthquakes take place at the boundaries of large and medium lithospheric plates and microplates. The most powerful earthquakes occur at the edges of plates subjected to subduction, active collision, or transform faults. A classic transform fault example is San Andreas, a gigantic fissure about 1300 kilometers (810 miles) long running across the western part of California in the United States and forming the tectonic boundary between the Pacific and North American plates.

Fig. 7 has a world map showing the epicenters of earthquakes that occurred from 1963 to 1998.

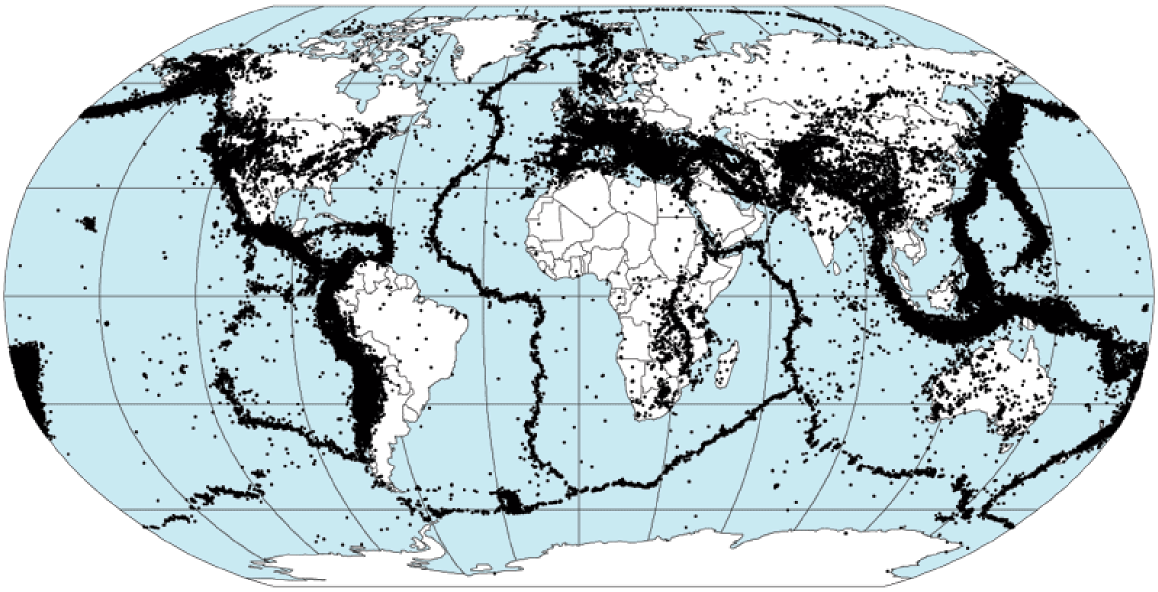


Fig. 7. Epicenter map for world earthquakes from 1963 to 1998
http://upload.wikimedia.org/wikipedia/commons/d/db/Quake_epicenters_1963-98.png

In fact, the global earthquake epicenter map reflects the lithospheric plate boundaries and is taken as a basis when mapping the tectonics of lithospheric plates.

Fig. 8 contains a graph showing the dynamics of the numbers of catastrophic earthquakes with magnitude greater than 8.

The graph clearly demonstrates that for 110 years, two periods of an abnormally high occurrence rate of catastrophic earthquakes stand out, the first of which covers the period from 1945 to 1948, and the second of which covers 2003 to 2010, with the second peak being higher than the first one by 33%. The trend characterizing the general tendency of dynamics of catastrophic earthquakes also indicates their significant intensification in the last decade.

Note, however, that devastating earthquakes with magnitude greater than 8 are rare enough, while 6.5 to 8 magnitude earthquakes hit the Earth quite frequently.

The number of people killed during strong earthquakes often amounts to tens and even hundreds of thousands of people. Here are examples of some major earthquakes in recent years: Eastern Iran (Bam), 2003 – 31,000 dead; Sumatra island, 2004 – 227,898 dead; Pakistan, 2005 – 86,000 dead; China (Sichuan), 2008 – 87,587 dead; Haiti, 2010 - 222,570 dead.

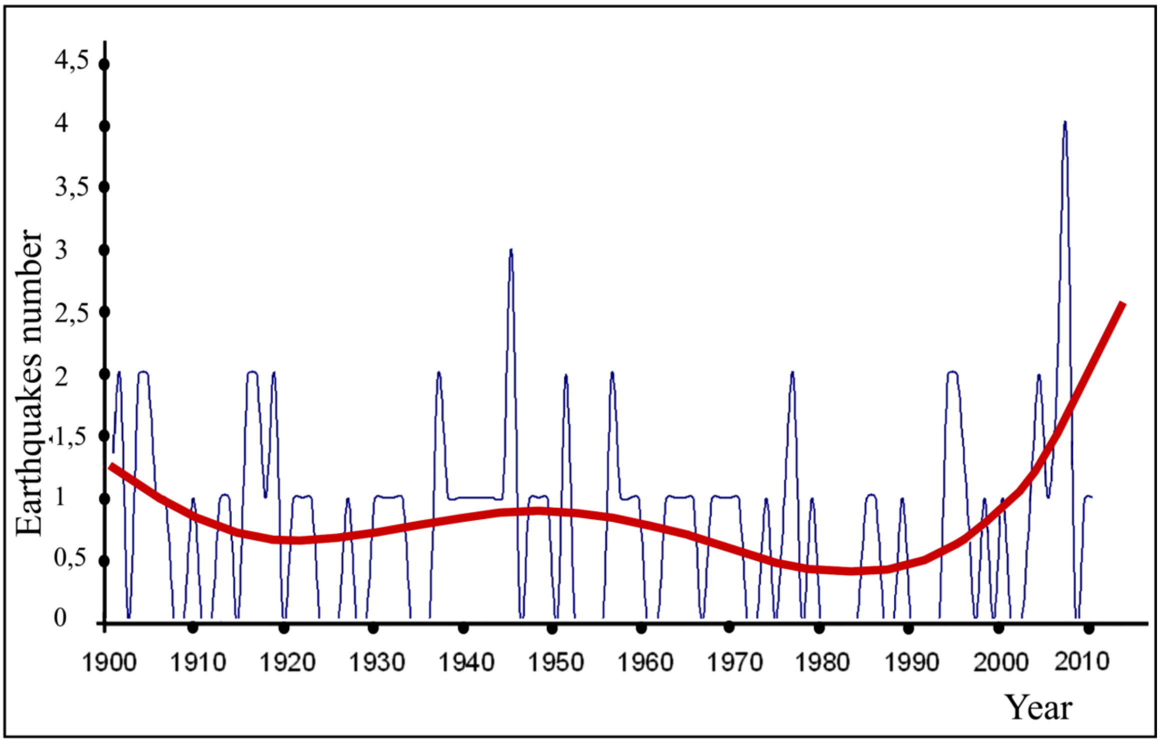


Fig. 8. Graph for M>8 earthquakes
(by E. Khalilov, 2010, according to USGS data)
Annual number of earthquakes graph is marked in blue
Polynomial trend of sixth degree is marked in red

Experts identify two primary factors responsible for the high casualty rate:

- Seismically unstable buildings and structures that collapse causing numerous casualties; and

- Lack of predictive information about potential strong earthquakes, catching public services and people unaware when an earthquake strikes, leading to them being unable to make quick, correct decisions to reduce the number of casualties and economic damage.

Generally, it is the high cost of earthquake resistant construction technologies that hampers earthquake engineering. In many densely populated countries located in seismically hazardous regions, most people do not have enough funds to build or buy expensive seismic-resistant houses. The governments, in their turn, are too short of economic resources to construct seismic-resistant buildings for social, medical, educational, and administrative institutions.

The growing number of earthquake casualties directly correlates to the increased number of strong earthquakes with a magnitude greater than 6.5. A magnitude 6.5–7 earthquake in underdeveloped countries could cause much more damage and more casualties than a similar one hitting industrialized countries. For instance, the 2003 Eastern Iran magnitude 6.6 earthquake claimed the lives of 31,000 people.

Strong earthquake, Beichuan, Sichuan Province, China, 10 June 2008
http://pics.livejournal.com/chernovv/pic/007sbx3k

However, a magnitude 7.2 earthquake struck the northern part of the Japanese island of Honshu on 13.06.2008, resulting in two people being killed and 100 injured. The consequences of these two earthquakes are incomparable. So, what is the reason why there were so many victims in Iran and only a small number of casualties in Japan? It is the difference in the construction technologies. In Japan, they use seismic resistant building construction technologies while in Iran, the vast majority of houses are built of bricks or building blocks made of a mixture of natural clay and hay, and are easily destroyed by earthquakes with a magnitude over 6.0.

Of course, catastrophic earthquakes with a magnitude over 8 may entail a huge death toll even in industrialized countries like the U.S., Japan, Canada, etc.

One of the worst natural disasters in the history of humankind is a catastrophic earthquake of enormous energy with a magnitude 9.1-9.3 that occurred 26 December 2004, with an epicenter off the west coast of Sumatra (the Sumatra-Andaman earthquake).

The subduction-caused earthquake triggered a series of devastating tsunamis along the entire Indian Ocean coast. The earthquake and tsunamis killed more than 230,000 people in 14 countries. The height of the waves in the coastal areas reached 15 meters (50 feet). This earthquake’s duration was longer than any other ever witnessed by man, lasting between 8.3 and 10 minutes.

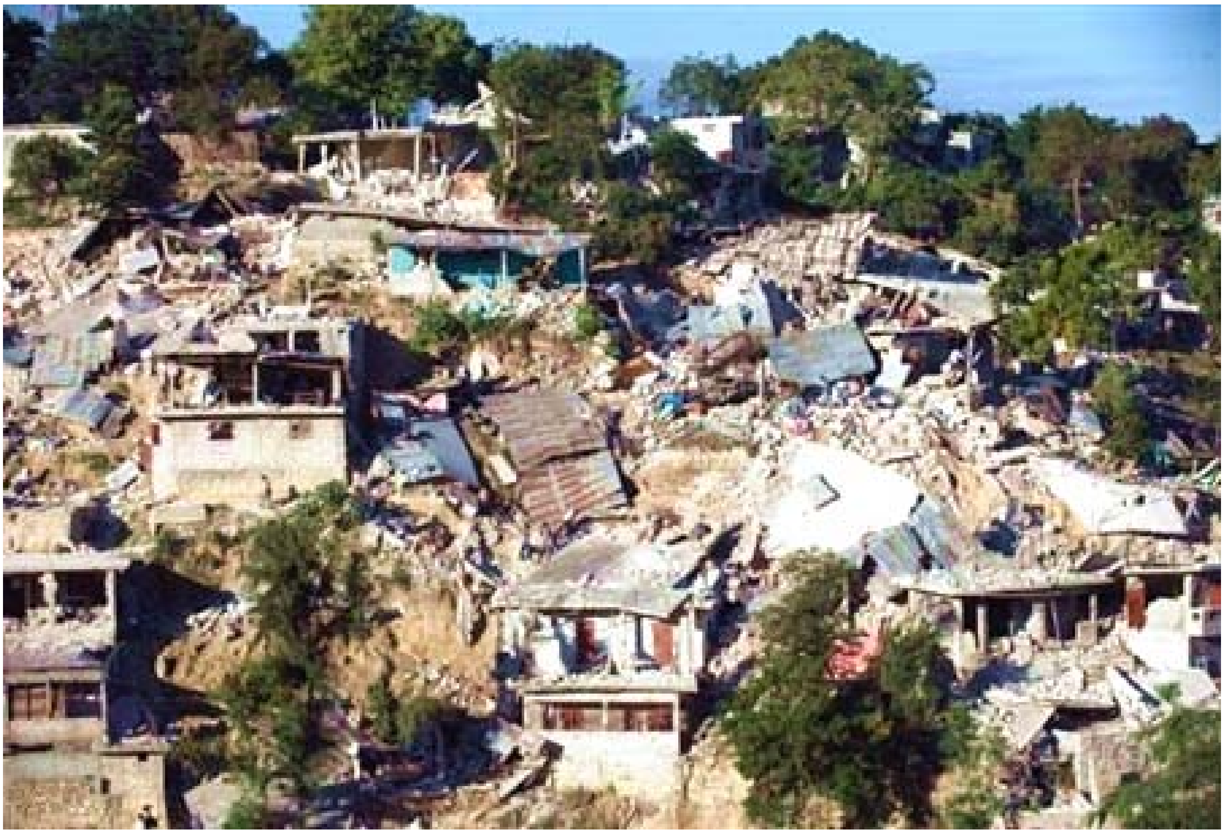
Earthquake and tsunami aftermath, Sumatra, Indonesia, 26 December 2004
http://www.nomad4ever.com/2007/11/23/psychic-predicts-devastating-sumatra-earthquake-for-23122007/

The main earthquake's hypocenter was located in the Indian Ocean, about 160 km (100 miles) north of the Simeulue Island, off the western coast of northern Sumatra, at a depth of 30 km (19 miles) below the mean sea level. The Sumatra-Andaman earthquake was the largest earthquake since 1964, and the second strongest since the Kamchatka earthquake of October 16, 1737. Since 1900, only one other earthquake has had greater energy, the 1960 Great Chilean Earthquake (magnitude 9.5).

The major magnitude 7.1 earthquake that hit Haiti on 12 January 2010 was one of the most devastating in the history of humankind. The earthquake resulted in an enormous death toll, killing 222,570 and injuring 311,000 people. The estimated material damage suffered is 5.6 billion Euros (http://en.wikipedia.org/wiki/Haiti_earthquake_2010). On the day of the earthquake, Haiti's capital Port-au-Prince saw destruction of thousands of residences and almost all of the hospitals. About 3 million people became homeless.

The major reason for the huge number of victims is seismically unstable, mostly brick, houses.

The Haiti earthquake of 12/01/2010 claimed the lives of 222,570 people.



Aftermath of Haiti earthquake of Jan. 12, 2010
Photo © AFP from Vesti.kz archive (http://vesti.kz/crash/37197/)

The catastrophic Haiti earthquake indicates a direct dependence of the number of earthquake casualties on the quality and seismic resistance of buildings and structures. Once again, the vivid example described above comes to mind; that is, a similar magnitude (M7.2) earthquake in the northern part of the Japanese island of Honshu in June 2008, which killed only 2 people.

A very powerful magnitude 8.8 earthquake occurred on 27 February 2010 off the coast of Maule (Chile). Six regions of Chile that are home to 80% of the country's population felt tremors from the earthquake. Although this earthquake's energy was much higher than that of the Haitian earthquake, it killed far fewer people.

Fig. 9 shows a graph reflecting the dynamics of the monthly number of earthquakes with a magnitude over 6.5.

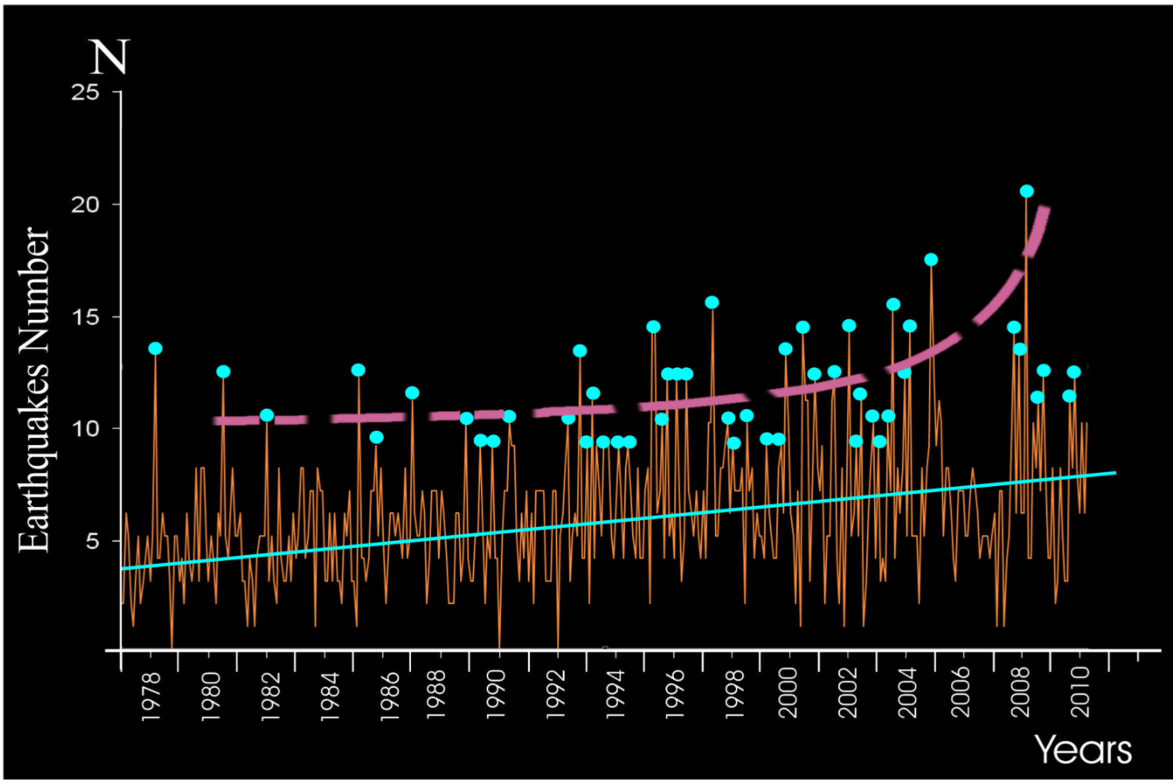


Fig.9. Graph showing monthly number of M>6.5 earthquakes from January 01, 1977 to April 30, 2010 (by E. Khalilov, 2010, according to USGS data)
Monthly number of earthquakes graph is marked in yellow;
Straight-line trend is marked in blue;
Trend enveloping extreme values of earthquake numbers is marked in lilac;
Blue dots designate peak values of earthquake numbers in cycles, starting from value 10.

The straight-line trend clearly indicates the increase in the number of earthquakes from 1977 to 30 April 2010. Meanwhile, the trend enveloping the extreme values of numbers of earthquakes for different months points to the exponential nature of the tendency observed, thereby greatly aggravating the situation.

Thus, the statistical analysis of the dynamics of the monthly number of earthquakes with a magnitude over 6.5 indicates a persistent tendency of growth in the number of strong earthquakes from 1977 to May 2010.

2.2. GLOBAL CHANGES OF EARTH'S VOLCANIC ACTIVITY

The number of eruptions of world volcanoes during the first five months of 2010 exceeded the average annual volcanic eruption rate for the previous 110 years.

Sarychev Volcano eruption (Kuril Islands) of 12 June 2009
http://techvesti.ru/node/1153

Volcanoes are one of the most formidable, yet most interesting and mysterious formations on our planet. The word "Volcano" was derived from Vulcan, the name of a "god of fire." Volcanic eruptions and earthquakes are different forms of manifestation of the same process, which is the Earth's geodynamics. They are unique indicators of rises and falls in our planet's tectonic activity.

Similar to earthquake dynamics, the dynamics of volcanic eruptions is subject to certain cyclicity. Analysis of the volcanic eruption rate evolution shows that from 1900 to June 2010, a tendency for the number of volcanic eruptions to grow has been observed. This is explicitly seen in the graph of the annual volcano eruption rate, shown in Fig. 10. Three deep minimums stand out in the volcanic activity: 1916-1918, 1941-1942, and 1997-1998. These minimums are limiters for volcanic activity cycles. The current cycle of volcanic activity began in 1999.

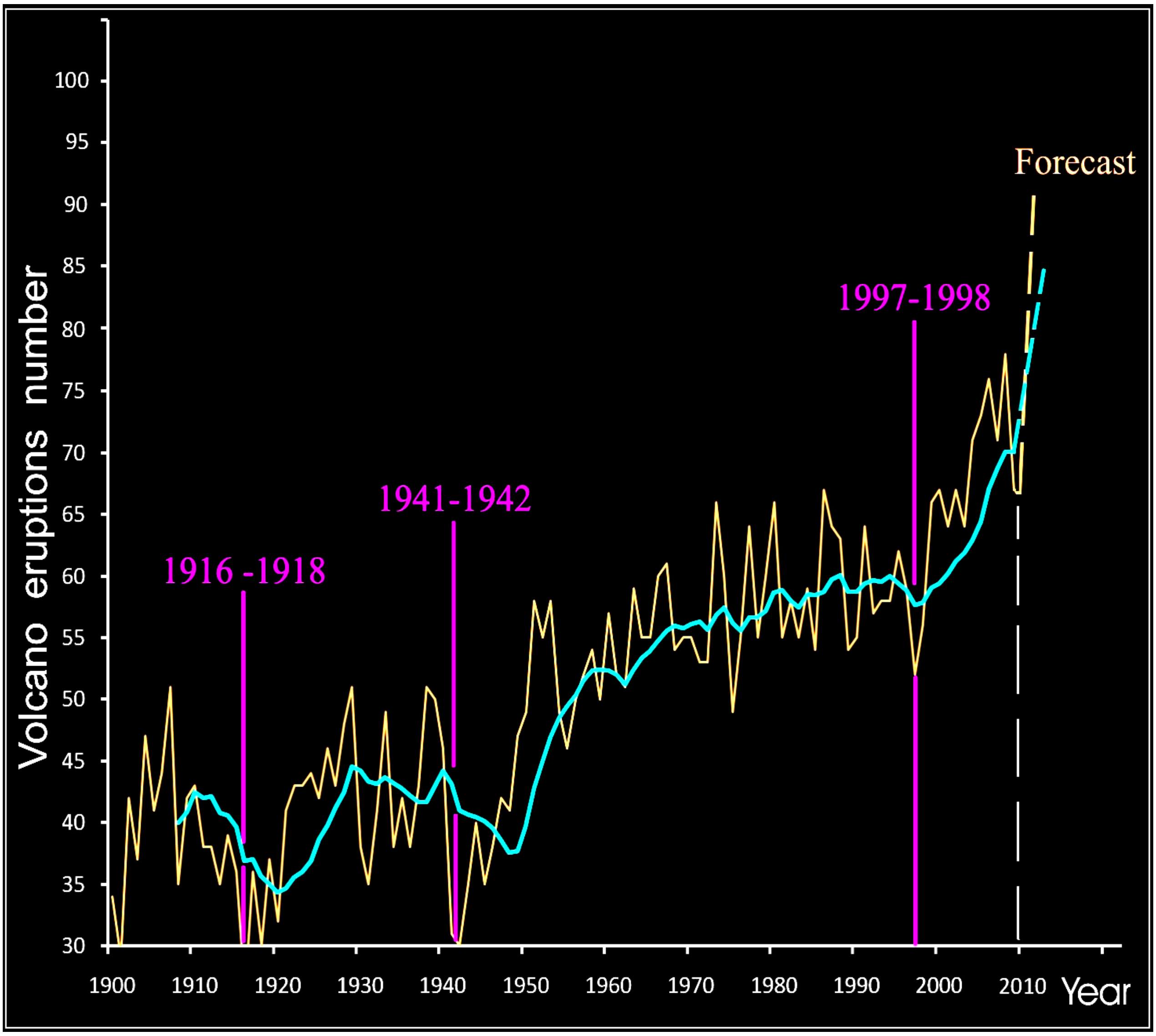


Fig. 10. Graph of the world's volcano eruptions from 1900 to June 2010 (by E. Khalilov, 2010, according to Global Volcanism Program data)
http://www.volcano.si.edu/world/find_eruptions.cfm
Annual number of volcanic eruptions is marked in yellow;
Trend based on 7-year running averages is marked in blue.

At the same time, as shown in Fig. 11, the straight-line trend characterizing the general tendency of the evolution of volcanic eruption numbers also indicates an increase in the number of volcanic eruptions from year to year.

Analysis of the distribution of world volcanoes shows that they are situated mainly in the Earth's narrow, tectonically active zones, as shown on the map in Fig. 12. The vast majority of the world's volcanoes, as well as earthquakes, are located along tectonic plate boundaries. Accordingly, volcanoes are divided into two basic types: subduction zone volcanoes and rift zone volcanoes.

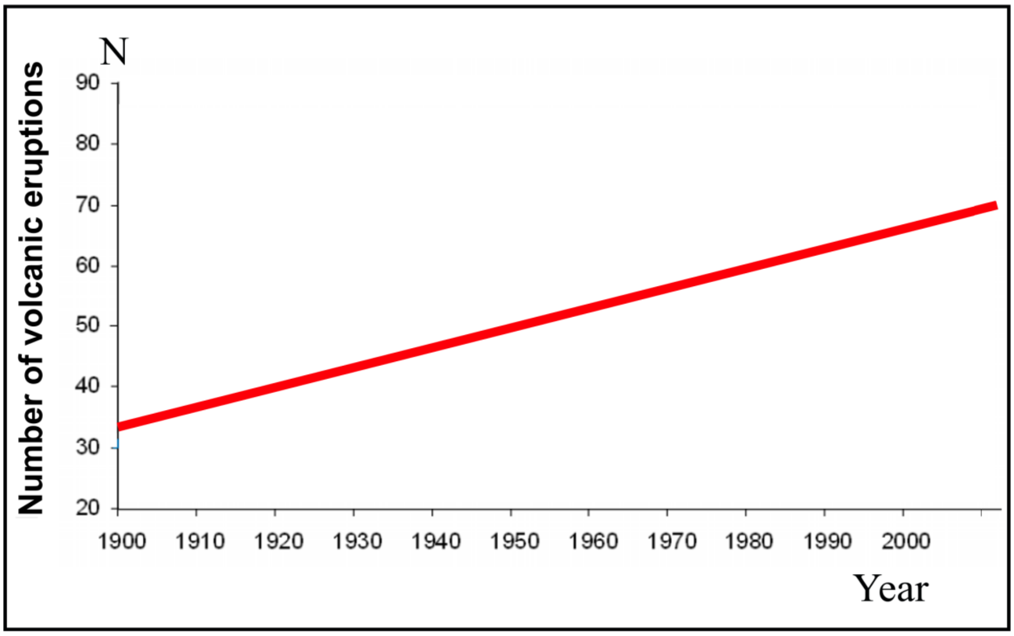


Fig. 11. Straight-line trend of the world's volcanic eruptions from 1900 to June 2010 (by E. Khalilov, 2010, from Global Volcanism Program data)
http://www.volcano.si.edu/world/find_eruptions.cfm

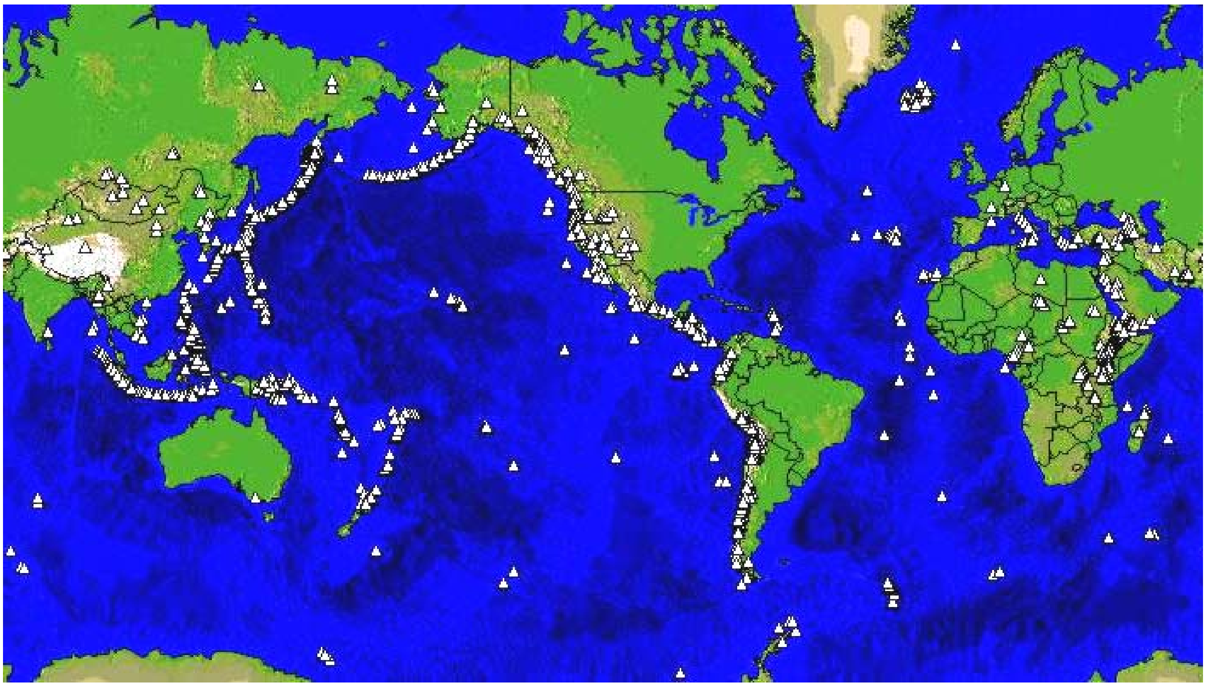


Fig. 12. Map of global volcano distribution
http://www.globalchange.umich.edu/globalchange1/current/lectures/nat_hazards/nat_hazards.html

Subduction zone volcanism is a mixed explosive-effusive volcanism, of basic to acidic but mainly of neutral composition. All volcanoes of the western edge of the American continent and of the eastern edge of the Asian continent, as well as those in adjacent island arcs, the Mediterranean Sea region, Indonesia, Aleutian Islands, Japan, Kamchatka, etc. are all examples of this type of volcanism.

The second type comprises volcanoes of mid-ocean ridges and continental rift zones. For the most part, it is tholeiitic effusive submarine volcanism of mid-ocean ridges and volcanic islands seated upon them, such as Iceland or the Azores. Continental volcanoes located, for example, in the Red Sea, East Africa, etc. are also rift zone volcanoes.

In addition to those mentioned above, there is another type of magma volcano that is an oceanic intraplate volcano. These are located in the interior parts of plates, for example, the volcanoes of Comoros and Hawaii.

There is another, though less common, type of volcano that is a mud volcano with breccia as the eruption product. This type of volcano is discussed in the next section.

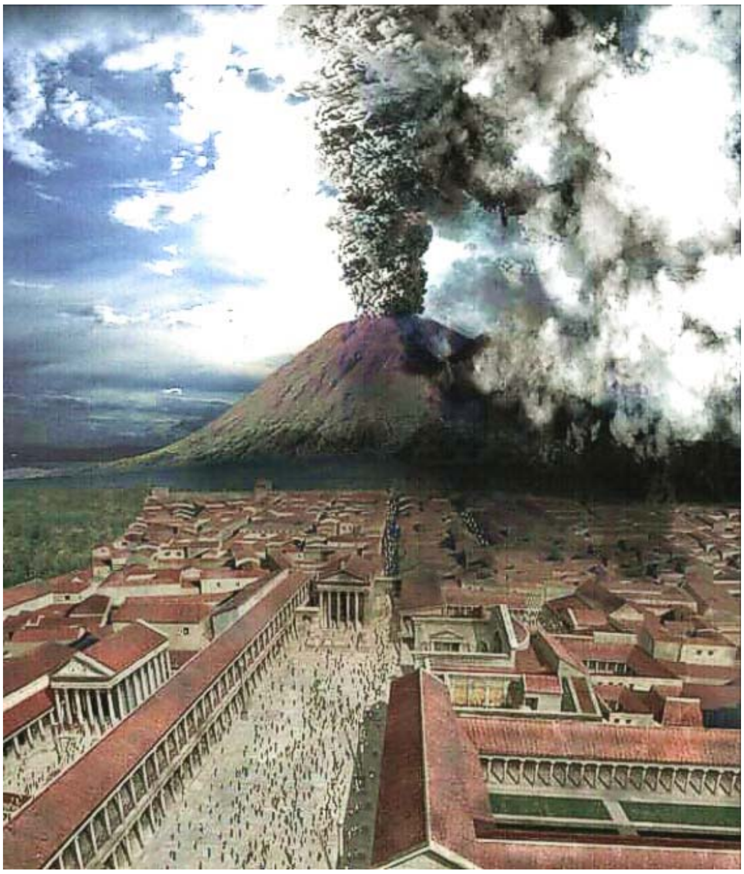
Volcanoes are active, dormant, or extinct. Extinct volcanoes are those that have retained their shape but there is just no information as to their ability to erupt. However, local earthquakes continue to occur beneath them, indicating thereby that they may awaken any time.

Many modern volcanism areas coincide with high seismic activity zones, which is quite natural. A volcanic earthquake can be identified by the concurrence of the earthquake's focus with the volcano's location, and a relatively low magnitude.

The earthquake that accompanied the 1988 Bandai-San eruption in Japan is an example of a volcanic earthquake. After the earthquake, a powerful volcanic gas explosion shattered a whole andesite mountain 670 meters high. Another volcanic earthquake accompanied the 1914 Saku Yama volcano eruption, also in Japan.

The same year's volcanic earthquake at the Italian volcano of Ipomoea ruined a small town of Casamicciola. There are numerous volcanic earthquakes in Kamchatka related to the volcanic activity of Klyuchevskaya Sopka, Shiveluch and other volcanoes. Manifestations of volcanic earthquakes are almost indistinguishable from the phenomena observed during tectonic earthquakes, but their scope and energy are much smaller.

As a rule, magma volcano eruptions are preceded by a series of small earthquakes with power increasing as the eruption approaches. Preparations for a volcanic eruption and its duration can last for a few years to centuries. The movement of high-temperature magma during eruptions causes numerous strokes and fissures in the crust, manifesting themselves in the form of medium-size and sometimes strong earthquakes.



The history of humankind has seen many strong volcanic eruptions that have claimed thousands of lives. But perhaps the most tragic of them is the eruption of Mount Vesuvius on Aug. 24, 79 AD, which lasted for about one and a half days. The eruption was accompanied by a vast ejection of rock and ash through the volcano vent, which rose several kilometers into the air, subsequently covering huge areas. Violent tremors accompanied the event and air ionization reached its critical value, causing powerful lightning discharges and thunderclaps. Many took it for the end of the world.

Most affected was the beautiful nearby seaport of Pompeii, a major trading center. Within just one day the city of Pompeii was buried under 6-7 meters of volcanic ash and huge pieces of pumice, together with thousands of locals who were trying to escape in their residences and basements. The city fell into complete oblivion and rested under a huge layer of ash for one and a half thousand years until discovered during archaeological excavations.

Unlike earthquakes, catastrophic volcanic eruptions are capable of causing planet-wide climate change. This is exemplified by the monstrous eruption of Krakatoa.

A very powerful volcanic earthquake accompanied the Indonesian Krakatoa volcano eruption of Aug. 26, 1883. A colossal explosion blasted the volcanic cones – the Danan and Perboewatan mountains – to pieces. The sound of the explosion was heard in Australia, at a distance of some 3,600 km, and even on the remote Indian Ocean island of Rodrigues almost 5,000 km away. It is estimated that over 18 cubic kilometers of rock was raised into the air. Ash fell on 827,000 square km. In Jakarta, the major city of the island of Java, volcanic ash completely eclipsed the sun, causing pitch darkness. The finest dust reached the stratosphere where it spread across the entire planet, causing unusually bright sunsets and twilights in all countries. It took years before the fine dust from the upper layers of the atmosphere settled on the land once again. As a result of the partial screening of solar radiation, average annual temperature over large areas of the Earth dropped by several degrees.

Krakatoa eruption, Indonesia

The tremendous explosion caused not just a huge air shock wave but also a gigantic tidal wave – a tsunami up to 40 meters high that devastated many islands and coasts within its reach.

The explosion destroyed half of the volcano itself, and the subsequent tremors caused fierce earthquakes that ruined towns located on the islands of Sumatra, Java, and Borneo. The entire island's population was killed, and the resulting tsunami swept away every living thing from the low-lying islands of the Sunda Strait. In total, more than 36,000 people died during that eruption.

One of the parameters for monitoring volcanic areas' conditions is seismic observations. In addition to all other manifestations of volcanic activity, micro-earthquakes make it possible, on the computer screen, to track and model magma movement in the volcano interior, and to establish its structure. Catastrophic earthquakes are often accompanied by increased volcano activity (as in Chile and Japan), but the beginning of major eruptions can also be accompanied by strong earthquakes (for example, Pompeii during the Mount Vesuvius eruption).

Icelandic volcanic syndrome or global international training

The beginning of 2010 coincided with a series of very powerful earthquakes and volcanic eruptions. The most symbolic events were devastating earthquakes in Haiti on January 12, 2010 and in Chile on February 27, 2010, as well as the eruption of the Icelandic volcano of Eyjafjallajokull on March 20, 2010.

Geologically, the island of Iceland is very young. Having emerged in the Tertiary period, it is of volcanic origin and located on the Mid-Atlantic Ridge.

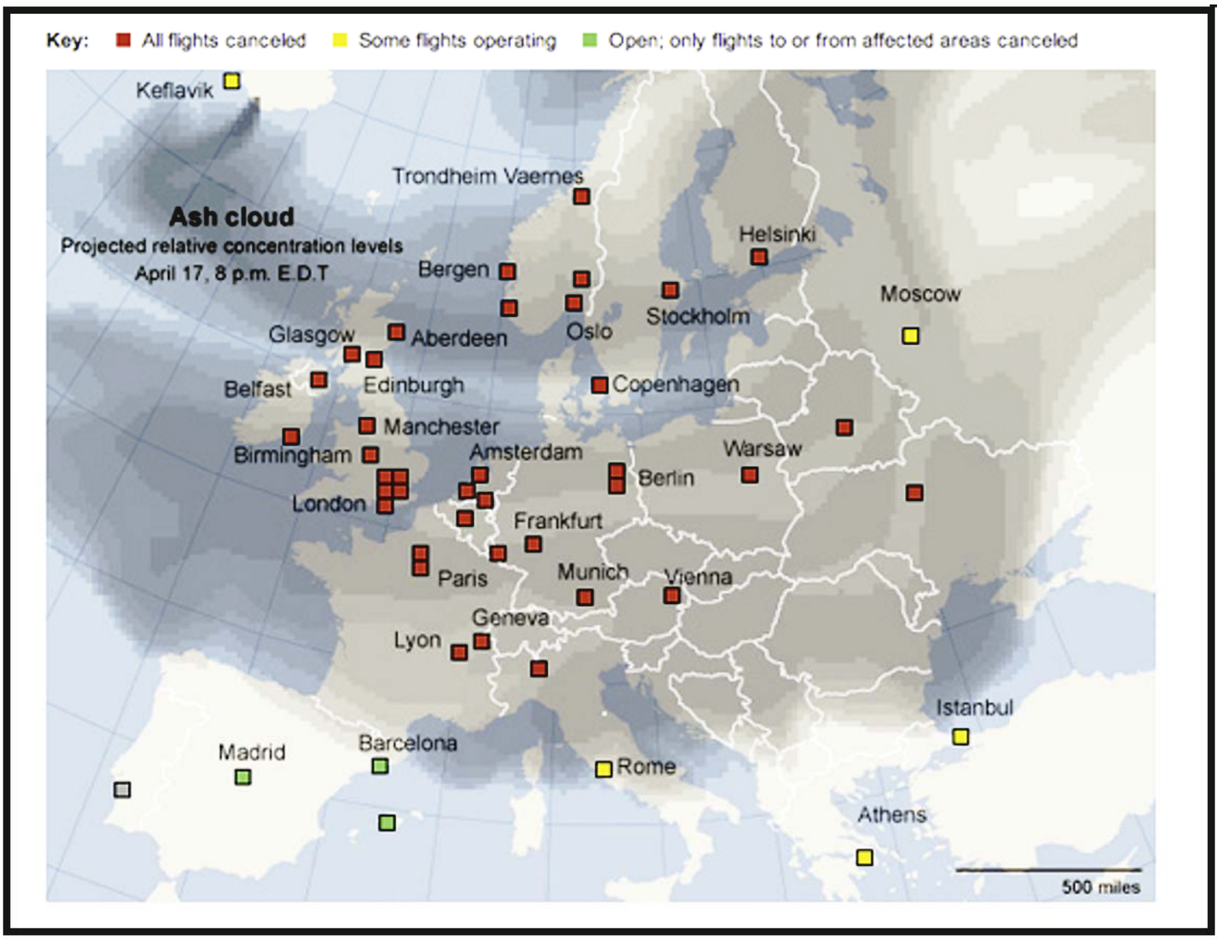
The eruption began on the night of March 20, 2010 and went through several stages. This eruption cannot be called a common eruption, for it marked the beginning of activation of the spreading process along the boundary between the North American and Eurasian lithospheric plates. This is evidenced by the fact that after the volcano had become active again on 1 to 4 April 2010, a strong magnitude 7.2 earthquake occurred on 4 April 2010 at the point where the southern coast of California meets the northern coast of Mexico.

Eruption of Eyjafjallajokull in Iceland, 13 April 2010

On March 25, due to melted glacier water that had found its way to the volcanic crater, there was a steam explosion in the crater, after which the eruption entered a more stable phase. On March 31, around 19:00 pm (Icelandic time), a new, 0.3 km long crack opened approximately 200 meters to the north-east of the first one.

On April 13, a new eruption started at the south edge of the central caldera. A column of ash went as high as 8 km into the air. About 700 people were evacuated. During the day, the meltwater flooded a highway and some destruction followed.

According to experts, the emission of massive amounts of volcanic ash to immense heights in the atmosphere threatened air traffic and caused suspension of airports' activity in many European countries. All of that caused a large amount of damage to transport companies, airports, tourist companies, etc.



Map showing spread of volcanic dust cloud from the eruption of Icelandic volcano Eyjafjallajokull over Europe at the end of April 2010
http://www.riskmanagementmonitor.com/volcanic-ash-not-dissipating-airports-still-closing/

Meanwhile, according to several authoritative organizations, the actions of many European countries' governments were uncoordinated and inadequate to the situation, indicative of disarray both at the national level in different countries and at the EU level as a whole.

According to Director General of the EU Transport Organization Matthias Ruth, untested computer software that simulates volcanic ash distribution caused the ban on flights. He called on EU leaders to consider adopting safety regulations similar to those in force in the U.S.

As ICAO head Giovanni Bisignani stated, "European governments made a decision without asking anyone for advice or adequately assessing the risk level. It is based on theoretical calculations and not on facts." According to Alexander Neradko, head of the Russian Federal Air Transport Agency, there was an element of panic during the Icelandic volcano eruption related to the suspension of flights (http://en.wikipedia.org/wiki/Air_travel_disruption_after_the_2010_Eyjafjallaj%C3%B6kull_eruption).

Thus, the world gained its first experience as to possible development of events in case of a global natural disaster by the example of the Icelandic volcano eruption. However, humanity can hardly be deemed to have successfully passed the test which nature has put to it. It has become evident that lack of necessary international laws and coordinating centers in case of global-scale emergencies may lead to making inadequate and uncoordinated decisions, as well as to panic and chaos.

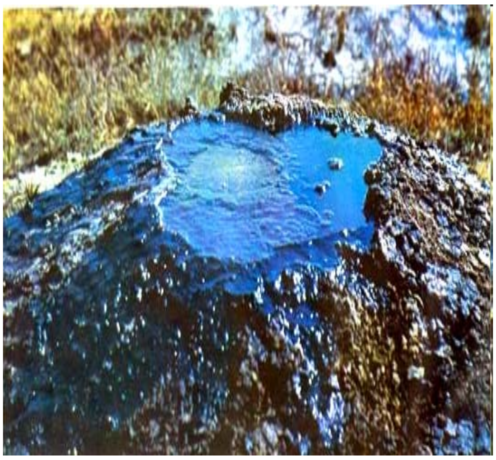
Given that the world that humankind inhabits is entering a high geodynamic and climatic activity phase, it is necessary to deeply analyze the development of the situation related to the emission of ashes by the Icelandic volcano, and to learn lessons from this experience.

2.3. MUD VOLCANOES

In terms of size and eruption energy, mud volcanoes are considerably inferior to magma volcanoes. This type of volcanism has attracted scientists' attention for a long time. Mud volcanoes are located in tectonically active regions of our planet. It is noteworthy that Azerbaijan is home to over 300 mud volcanoes, about half of all the world's mud volcanoes. Many of these volcanoes are genetically associated with hydrocarbon gases of Azerbaijan oil deposits.

As described by eyewitnesses, their eruption begins suddenly, with a subterranean rumble or thunderous roar. After a while, there is a release of mud volcanic breccia consisting of clayish mass with fragments of rocks of different stratigraphic ages. In most cases, hydrocarbon gas accompanying the eruption ignites spontaneously to form a pillar of flame a few hundred meters high (from 200-300 to 1000 m).

Ayrantekyan mud volcano (Azerbaijan)



Madrasa mud volcano (Azerbaijan)

Studies conducted by Sh. F. Mehdiyev and E. N. Khalilov (1990) found that more than 90% of the Earth's mud volcanoes are situated in subduction zones. This is seen on the map in Fig. 13.

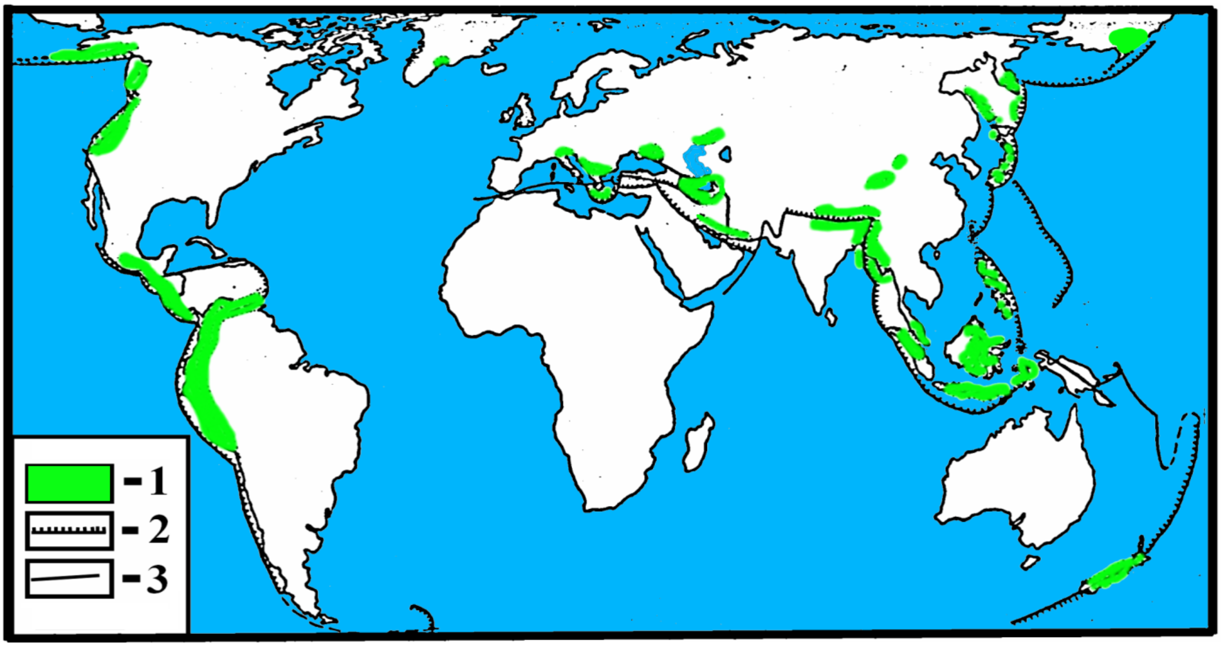


Fig. 13. Location map of the world's mud volcano zones and subduction zones (by Sh. F. Mehdiyev and E.N. Khalilov, 1987)

1 – mud volcanoes location zones; 2 – subduction zones ; 3 – transform faults.

Mud volcano in Indonesia

http://img.timeinc.net/time/2007/top_10_photos/ntrl_disaster_mud_volcano.jpg

The study of eruption dynamics of the world's mud volcanoes has shown that over the last two hundred years the eruption activity of mud volcanoes has increased (Sh. F. Mehdiyev, E. N. Khalilov, 1984; Sh. F. Mehdiyev, V. E. Khain, T. A. Ismayil-zadeh, E. N. Khalilov, 1987; V. E. Khain, E. N. Khalilov, 2008, 2009)

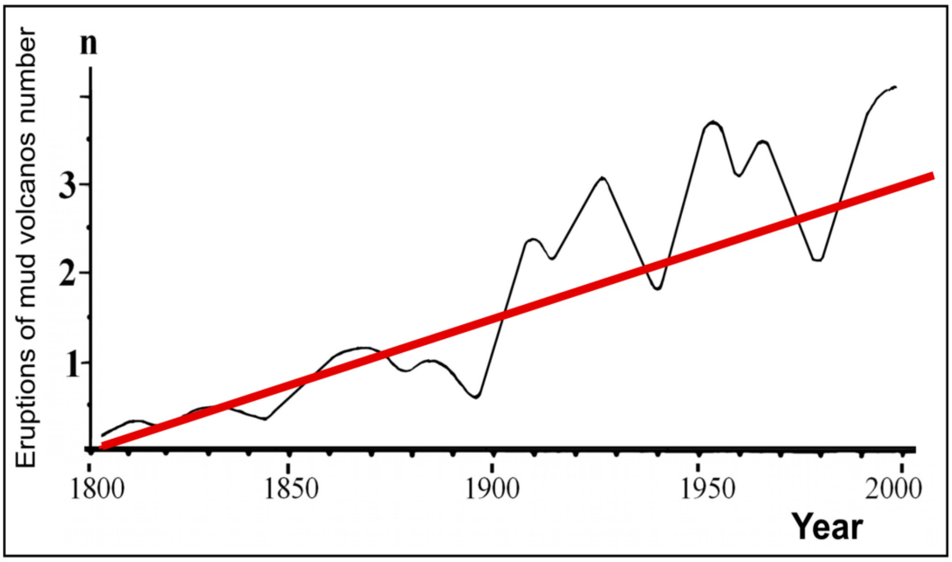


Fig. 14. World's mud volcanoes activity diagram
(by V. E. Khain, E. N. Khalilov, 2002)
Annual mud volcano eruption rate graph smoothed with 11-year averages is marked in black; Straight-line trend is marked in red.

Along with the annual volcanic eruption rates curve reflecting the existence of cyclicity, a straight-line trend is shown on the diagram to characterize a stable increase in the activity of mud volcanoes from1800 to 2000 (Fig.14).

Conclusions:

Brief overview and statistical analysis of a number of key indicators of the Earth's geodynamic activity and its impact on humankind lead to a conclusion that there has been a significant increase in seismic and volcanic activity across the world, especially in the last decade. Analysis of trends in the numbers of strong earthquakes, volcanic eruptions, and fatalities during strong earthquakes allows us to conclude that all these indicators have soared since 2000.

At the same time, statistics for the first five months of 2010 show that this year marks the beginning of another unusually high volcanic and seismic activity cycle whose negative effects for humanity may be catastrophic.

Humankind has already gained its first experience in dealing with global consequences of a moderate-scale volcanic eruption in Iceland. Meanwhile, disproportionately large economic losses, and moral-psychological and social damage suffered by many countries are indicative of poor coordination of actions and lack of international laws and mechanisms ensuring effective governance during global emergencies of international significance.

Chapter 3.
HYDROSPHERE

3.1. TSUNAMI STATISTICS

In the last decade (1999-2009), tsunamis have killed tens of times more people than over the preceding 100 years

Sumatra island tsunami of 26 December 2004
http://science.compulenta.ru/495996/

Tsunami examples

On December 26, 2004 monstrous tsunami waves struck the coasts of Sumatra island, Bangladesh, India, Malaysia, Myanmar, Thailand, Singapore, Maldives, and other territories bordering the Indian Ocean, affecting 14 countries in total. The tsunami was triggered by a very powerful magnitude 9.1-9.3 earthquake with an epicenter off the west coast of Sumatra, Indonesia. The tsunami and earthquake caused the deaths of 230,000 people. This event was one of the most terrible catastrophes in human history.

Tsunami aftermath on Sumatra Island, 24 December 2004
(Photo by U.S. Department of Defense)
http://www.defense.gov/home/photoessays/2005-01/p20050103b1.html

January 1, 2004

December 26, 2004

Sumatra island tsunami, 26 December 2004

http://earthobservatory.nasa.gov/Newsroom/NasaNews/ReleaseImages/20050110/01_srilanka.jpg

The Severo-Kurilsk tsunami took place on November 5, 1952 around 5:00 a.m. It caused the destruction of several settlements in the Sakhalin and Kamchatka regions. The tsunami was triggered by a powerful earthquake with a magnitude up to 9, which occurred in the Pacific Ocean an hour earlier, some 130 kilometers off the coast of Kamchatka. Three waves 15-18 meters high (according to different sources) devastated the town of Severo-Kurilsk and damaged a number of other settlements. According to official figures, 2,336 people were killed. The Severo-Kurilsk population before the tragedy was about six thousand people.

Other very large, tsunami-triggering earthquakes occurred in 1964 (Alaska, M 9.2), 1868 (Peru, Nazca Plate, and South American Plate), 1827 (Colombia, Nazca Plate, and South American Plate), 1812 (Venezuela, Caribbean Basin of La-Plata, and South American Plate), and 1700 (Cascadia Earthquake, western U.S. and Canada, Juan de Fuca Plate, and North American Plate).

Tsunami *is a Japanese word meaning a harbor wave. Tsunamis occur primarily as a result of strong earthquakes or other tectonic processes such as landslides or explosions of volcanic islands. Tsunamis can also be generated by nuclear explosions in the water.*

The most tsunami prone areas include: Japan; Kamchatka; Sakhalin; Kuril Islands; Aleutian Islands; Alaska; Hawaii; west coast of South America, U.S. and Canada; east coast of Canada; New Zealand; Australia; French Polynesia; Puerto Rico; Virgin Islands; Dominican Republic; Costa Rica; Azores; Portugal; Italy; Sicily; Aegean, Adriatic and Ionian coasts; Greece; African coast of eastern Mediterranean; Indonesia and Philippines. The scope of damage caused by tsunamis varies for different locations (T. S. Murty, 1981).

According to the general classification, tsunamis are long waves. Their length ranges from a few hundred meters to 600-700 meters, typically with 1 meter amplitude over the deep part of the ocean. The waves propagate in proportion to the square root of water depth. In the ocean, this rate can vary from a few hundred km to 700-800 km per hour. Upon reaching the continental shelf, tsunami wave decelerates and becomes higher. The ebb tide often preceded by short-period low amplitude water level fluctuations called precursors sometimes accompanies tsunamis as they approach the coast.

To ensure reliability of the statistical research, we used two independent catalogues, namely the International Tsunami Information Center (ITIC) catalogue (http://ioc3.unesco.org/itic/categories.php?category_no=77) and the database directory of the Intergovernmental Oceanographic Commission and the Russian Academy of Sciences (Historical Tsunami Database for World Ocean, HTDB/WLD, http://tsun.sscc.ru/htdbwld/heights/main.asp).

The International Tsunami Information Center (ITIC) data-based statistical analysis of tsunami dynamics has made it possible to investigate the tsunami activity evolution during the last hundred years. The most comprehensive tsunami statistics given in that catalogue is that starting from 1990. The earlier data is incomplete. Therefore, when analyzing ITIC directory data, the research period was divided into two parts: a statistically more reliable period (1990-2009) and a less reliable period (1910-1990).

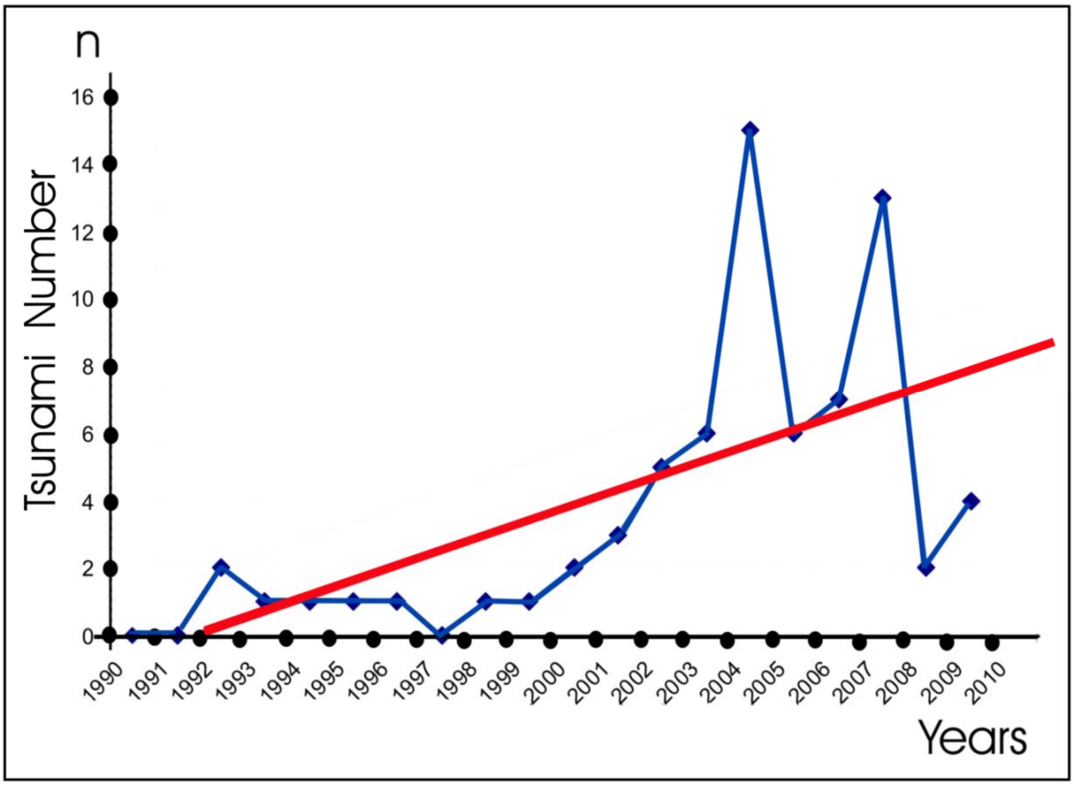


Fig. 15. Graph showing number of large tsunamis from 1990 to 2009
(by E. Khalilov, 2010, according to International Tsunami Information Center data)
http://ioc3.unesco.org/itic/categories.php?category_no=77
Annual number of tsunami graph is marked in blue;
Straight-line trend is marked in red.

Fig.15 contains a graph for tsunami rate dynamics between 1990 and 2009. Two tsunami activity cycles stand out in the graph, with peaks in 2004 and 2007. Each cycle's period is three years. The straight-line trend indicates a persistent tendency of significant increase in the number of tsunamis in the last decade.

Fig. 16 provides a graph for tsunami dynamics over the historical period of time between 1900 and 2009, according to the ITIC data. The polynomial trend of the fifth degree indicates the tendency for significant increase in the tsunami activity from 1990, and also the existence of three major cycles of increased activity of large tsunamis: 1920-1940, 1941-1980, 1981-present. At the same time, the straight-line trend displayed in Fig. 17 points to a steady increase in the annual numbers of catastrophic tsunamis.

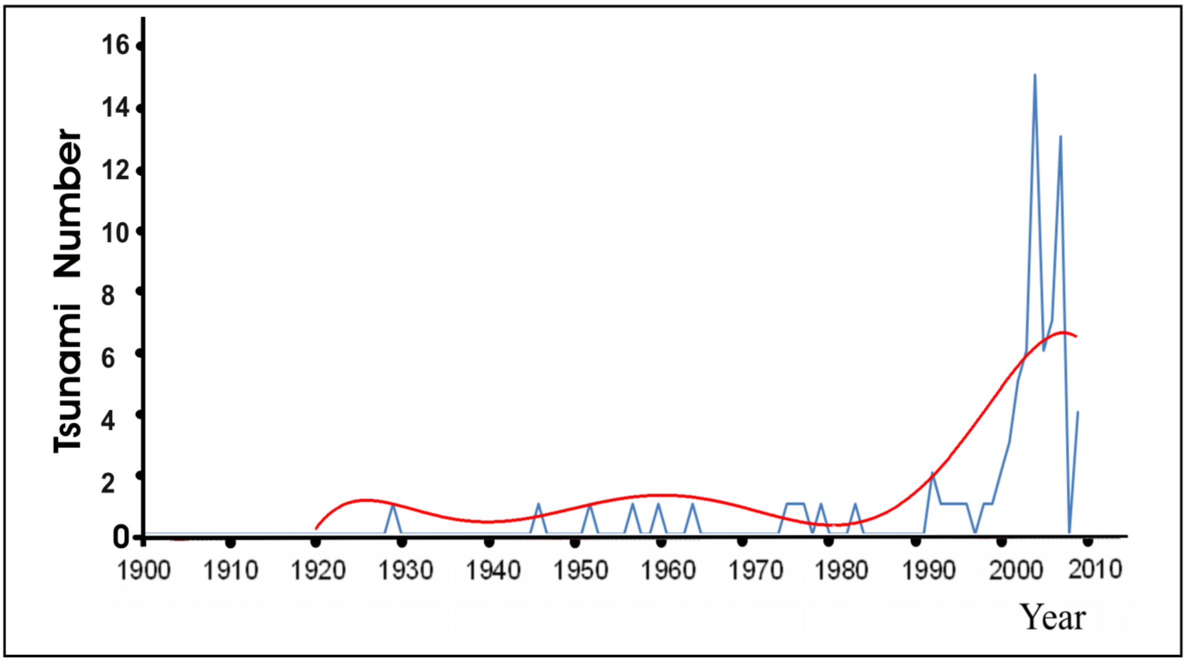


Fig. 16. Graph and polynomial trend for numbers of large tsunamis from 1900 to 2009 (by E. Khalilov, 2010, according to International Tsunami Information Center data)
http://ioc3.unesco.org/itic/categories.php?category_no=77
Annual number of tsunami graph is marked in blue;
Polynomial trend of sixth degree is marked in red.

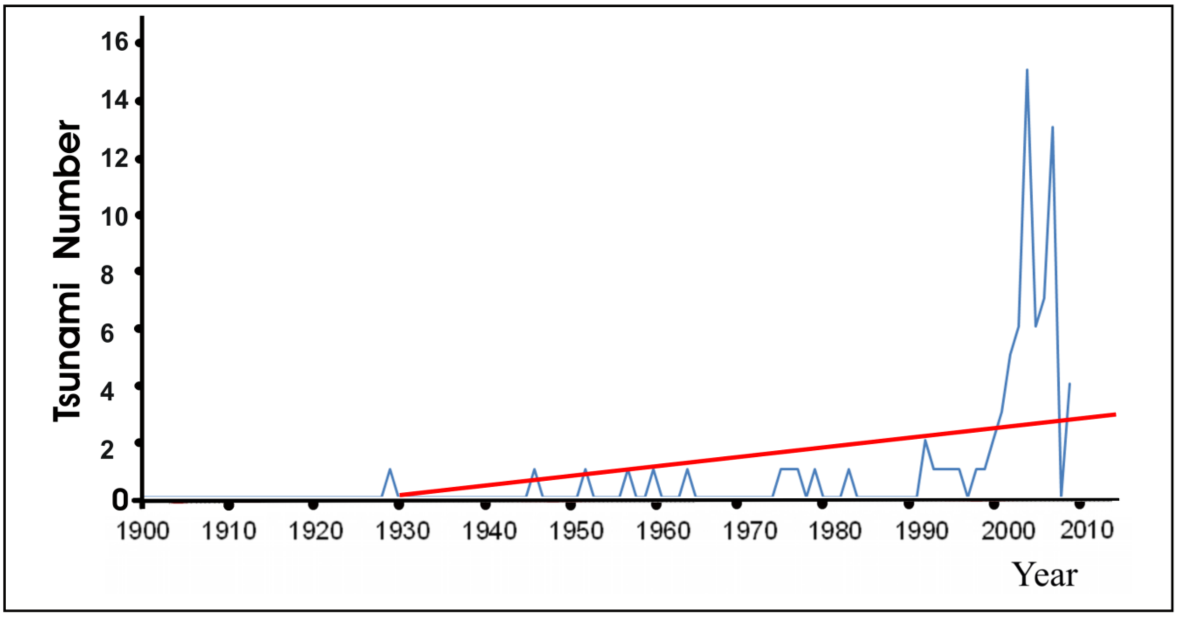


Fig. 17. Graph and straight-line trend for numbers of large tsunamis from 1900 to *2009* (by E. Khalilov, 2010, according to International Tsunami Information Center data)
http://ioc3.unesco.org/itic/categories.php?category_no=77
Annual number of tsunami graph is marked in blue;
Straight-line trend is marked in red.

Despite the fact that the tsunami statistics for the period from 1900 to 1990 may be incomplete, it nevertheless represents information about the most significant tsunamis that has survived in historical and scientific sources.

The most complete tsunami data can be found in the databases of the Intergovernmental Oceanographic Commission and the Russian Academy of Sciences (Historical Tsunami Database for World Ocean; the HTDB/WLD is maintained by the Novosibirsk Tsunami Laboratory (NTL), which is part of the Institute of Computational Mathematics and Mathematical Geophysics of the Siberian Division of the Russian Academy of Sciences, http://tsun.sscc.ru/htdbwld/heights/main.asp). This catalogue contains data pertaining not only to catastrophic tsunamis, but also to medium-sized and weak tsunamis ever documented in various national and international scientific and historical sources.

The extremely large number of tsunamis is explained by the fact that a tsunami wave triggered by a strong earthquake can be registered in different countries with each entry taken for an individual tsunami. This is an absolutely correct attitude since the concept of tsunami wave implies emergence of coastal waves in specific areas. At the same time, there are occasions when a wave caused even by a strong earthquake takes the form of tsunami in one country only. In other cases, a strong earthquake-triggered wave can cause tsunamis in several countries as it happened during the powerful Indonesian earthquake of December 26, 2004, when the tsunami caused by the earthquake-triggered wave struck the coasts of dozens of countries, resulting in a huge death toll in 14 countries.

Of great interest are the results of a statistical data analysis of dynamics of all documented tsunamis (strong, medium-sized, and weak) from 1800 to 2007. Such a long time span is selected in order to study possible cyclicity of tsunami manifestations.

To process the data correctly, we examined various time intervals with different scopes of tsunami-related information. It is clear that the more ancient the period we deal with, the more devastating are the tsunamis mentioned within it. Since, for the earlier period of history, only information about very large-scale events described in historical chronicles and recorded in various documents could have managed to reach us, graphs were drawn for the periods from 1800 to 2007 and from 1900 to 2007. Fig.18 contains a graph for the number of all tsunamis including medium-sized and weak tsunamis from 1800 to 2007, with a straight-line trend indicating a steady increase in the annual numbers of medium-sized and weak tsunamis. Fig.19 shows the same graph with a polynomial trend of the fifth degree. The polynomial trend allows identification of three cycles in tsunami manifestations: 1830 – 1890, 1900 – 1985, and 1986 to the present.

Comparing the graph for the dynamics of annual numbers of catastrophic tsunamis with the similar graph for all tsunamis including medium-sized and weak tsunamis allows a certain correlation between them to be established, Fig.20. The weak correlation refers to the period of high activity of medium-sized and weak tsunamis (1941-1970), whereas the high level of correlation covers the last tsunami activity cycle from 1995 to the present.

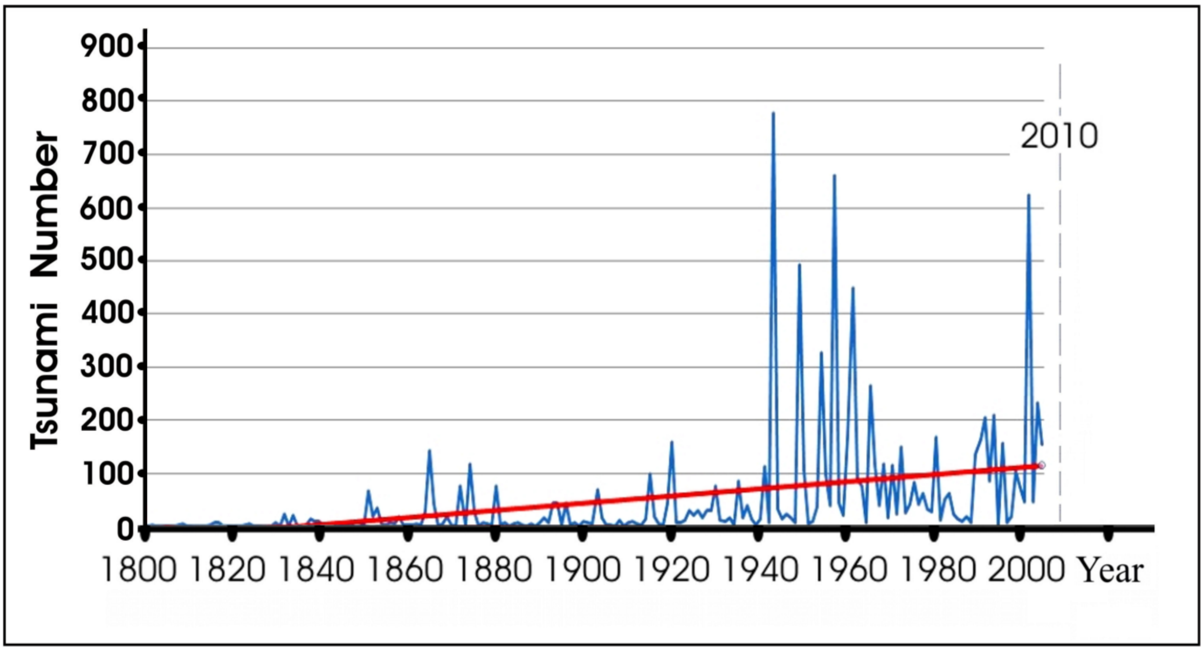


Fig. 18. Graph and straight-line trend for all tsunami numbers between 1800 and 2007 (by E. Khalilov, 2010, according to Historical Tsunami Database for World Ocean HTDB/WLD data, http://tsun.sscc.ru/htdbwld/heights/main.asp)

Annual tsunami numbers graph is marked in blue;

Straight-line trend is marked in red.

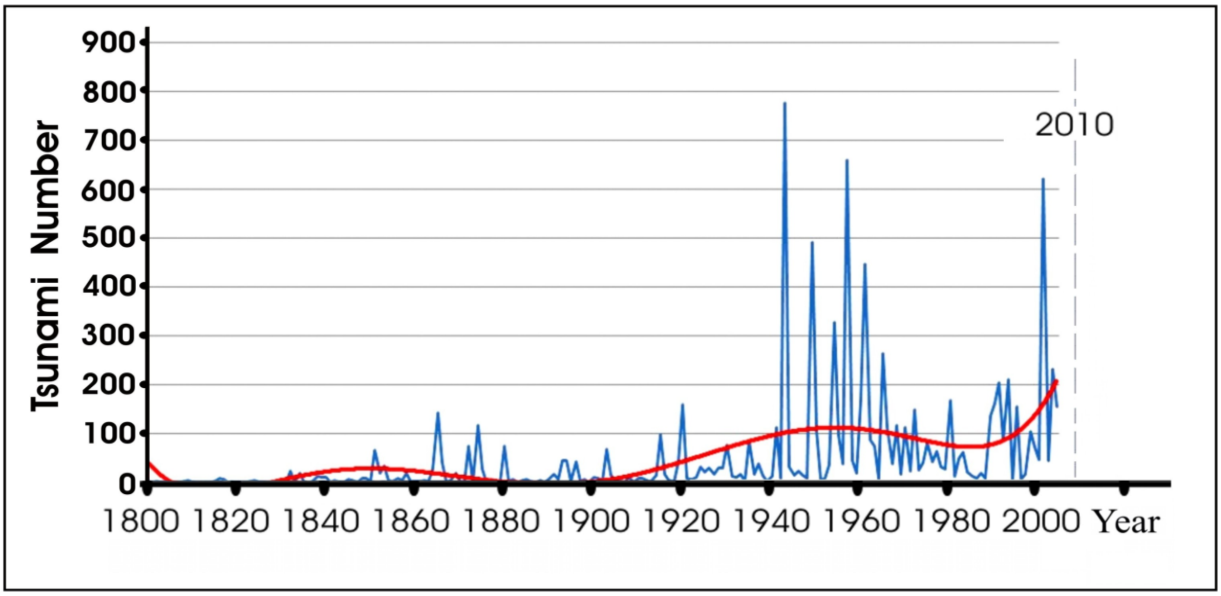


Fig. 19. Graph and polynomial trend for all tsunami numbers between 1800 and 2007 (by E. Khalilov, 2010, according to Historical Tsunami Database for World Ocean HTDB/WLD data, http://tsun.sscc.ru/htdbwld/heights/main.asp)

Annual tsunami numbers graph is marked in blue;

Polynomial trend of sixth degree is marked in red.

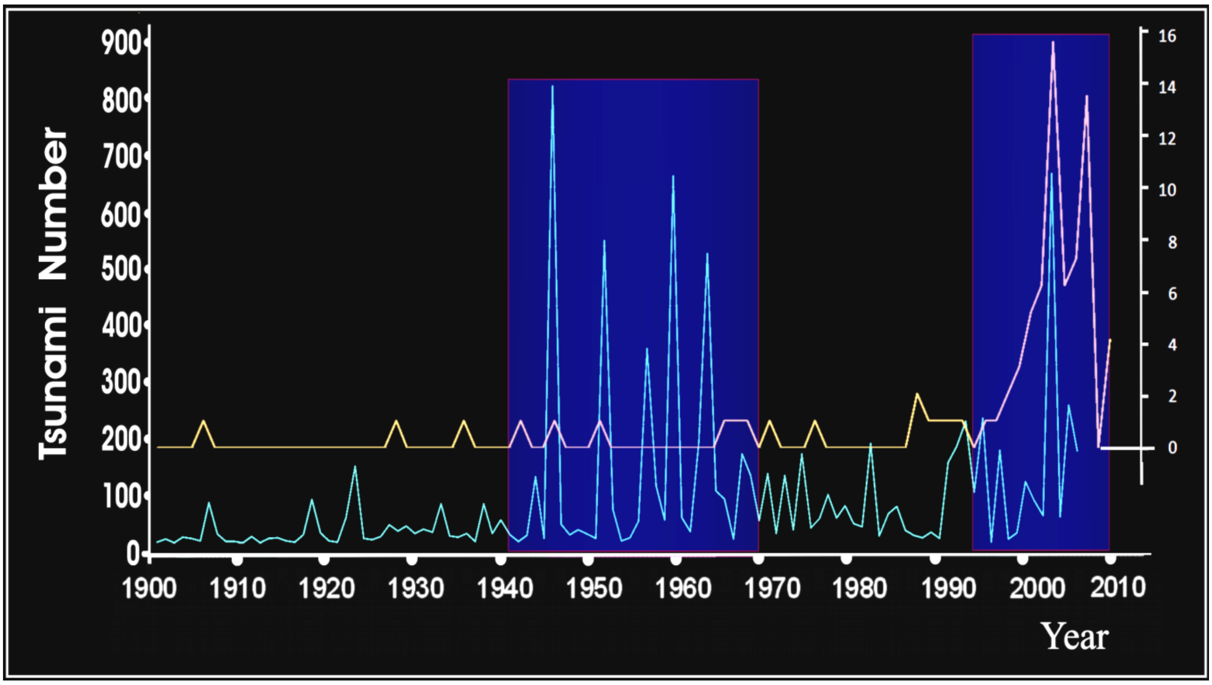


Fig. 20. Comparison of graphs for numbers of large tsunamis and of all tsunamis from 1900 to 2007 (by E. Khalilov, 2010)
Annual numbers of large tsunamis graph is marked in yellow;
Annual numbers of all tsunamis graph is marked in azure;
High tsunami activity areas are marked in dark blue;

New Zealand tsunami, 15 July 2009
http://science.compulenta.ru/upload/iblock/8e3/tsunami_420.jpg

Thus, statistical study of the tsunami dynamics from ancient times to the present based on two independent databases enables us to conclude that there has been a substantial increase in the number of tsunamis in the last two decades. This tendency persists today as well.

3.2. FLOOD STATISTICS

Flooding in New Orleans after Hurricane Katrina, August 2005
http://www.swamppolitics.com/news/politics/blog/katrina-new-orleans-flooding3-2005.jpg

Flooding in Nashville, Tennessee, U.S., 02 May 2010

http://www.youtube.com/watch?v=pFjaQoOdJvI

Floods are one of the most severe natural disasters, usually affecting large areas. Unlike earthquakes, volcanic eruptions, and tsunamis, floods are not so instantaneous and have a longer period of manifestation.

Floods have a number of features that make it harder for rescue agencies and state bodies to act properly during rescue operations and removal of the consequences. Typically, major floods lead to inundation of huge areas and total inaccessibility of the territory's infrastructure including power lines, communications, means of conveyance, etc. Conventional ground vehicles cannot be used in affected areas, the fact which complicates the evacuation of people and the providing of disaster victims with emergency aid.

In addition, the damage in flooded areas cannot be promptly assessed before the water level drops completely. All over the place, movement of people becomes limited and localized within small spaces such as rooftops, small hills, and other elevations. Unlike earthquakes and volcanic eruptions, major fires rarely accompany floods. What really represent a significant danger to people are power lines remaining underwater.

Statistics for United States flood dynamics for the period between 1980 and 2008 reveals a significant increase in their numbers, with a faster growth of the number of floods from 1999 and from 2005 as shown in Fig. 21.

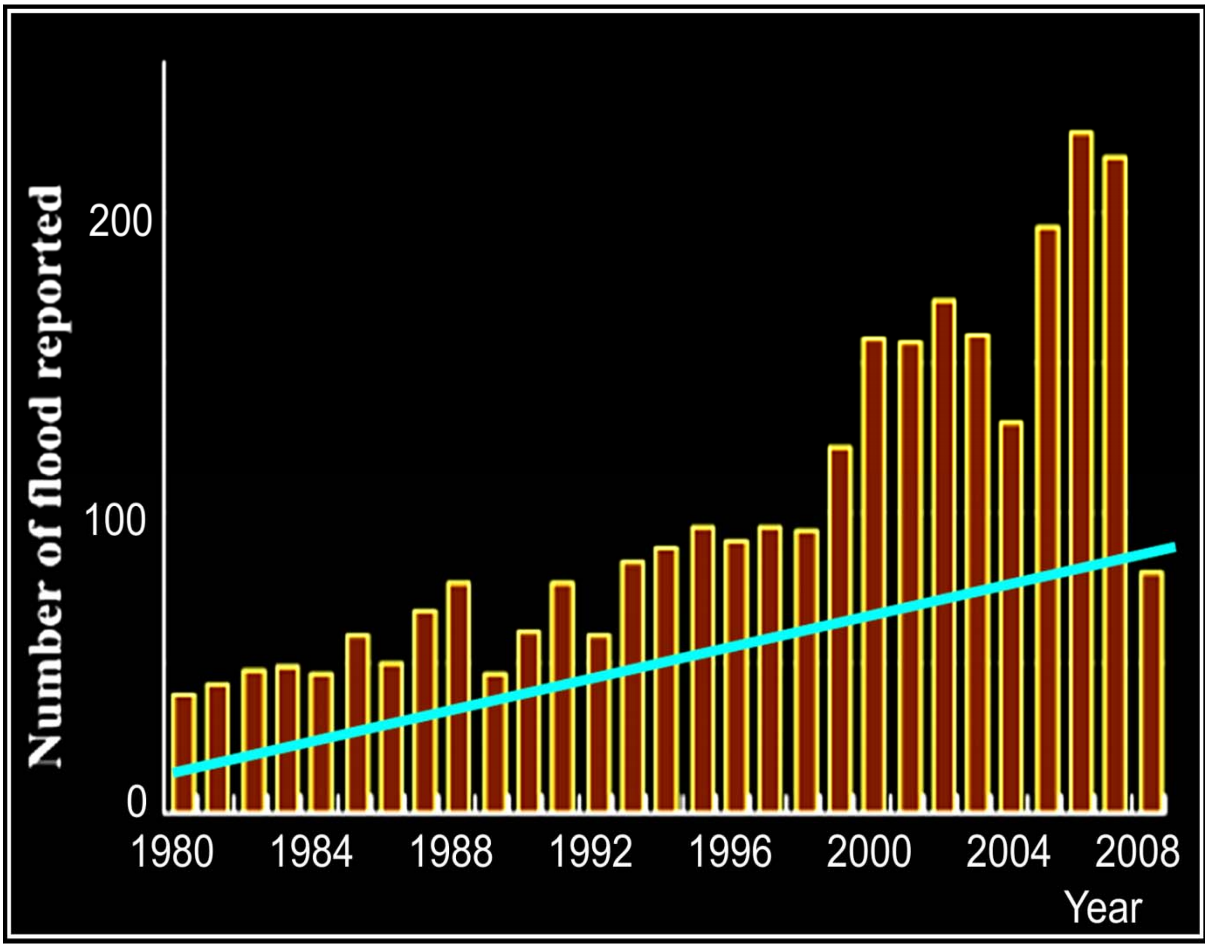


Fig. 21. 1980-2008 U.S. floods statistics
http://www.atmo.arizona.edu/students/courselinks/fall04/atmo336/lectures/sec2/fig2.gif

The general flood number trend points to a steady increase in the statistical values. The number of flood-related deaths depends directly on the scale of flooding.

Statistical analysis of the dynamics of U.S. flood-related deaths from 1913 to 2009 indicates the presence of a certain cyclicity in fatality numbers, which, in its turn, reflects the cyclicity in the number of floods (Fig. 22).

The large cycles typically represent one or several catastrophic floods that have killed large numbers of people. Two types of cycles can be identified for the time span being considered: first-order cycles of very high amplitude with peaks in 1913, 1928, 1955, 1973, 2005, and 2009-2010, and second-order cycles with lower amplitude in 1922, 1935, and 1970.

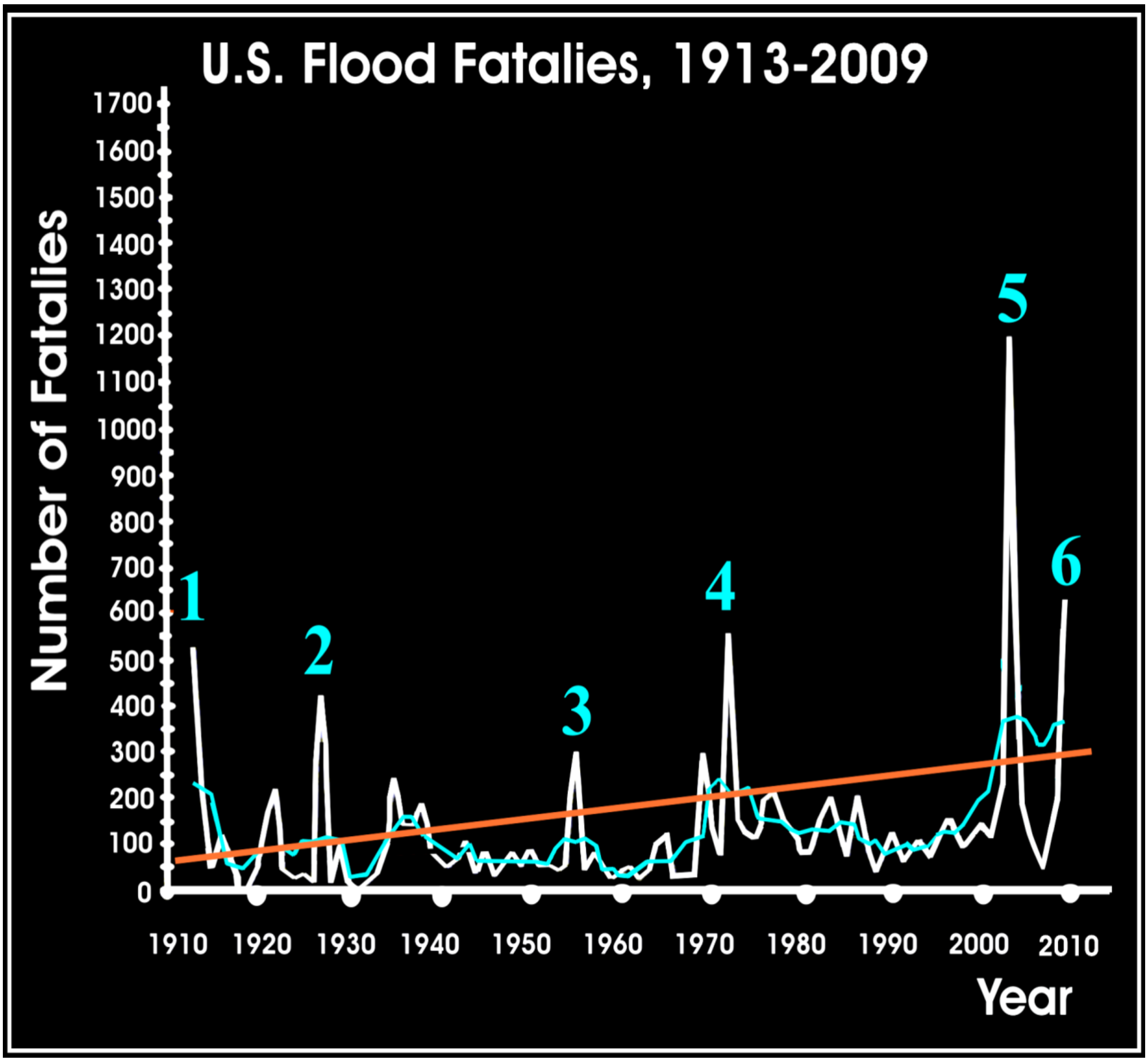


Fig. 22. Diagram showing numbers of deaths during U.S. floods from 1910 to 2010.
*(**According to data from** http://www.weather.gov/oh/hic/flood_stats/flood_trends.JPG*, **with additions by E. Khalilov***)*
Annual numbers are marked in white; 5-year average numbers are marked in green; straight-line trend is marked in orange.

The largest number of flood-related deaths (about 1200 people) was witnessed in 2005. Note that people killed by the flooding during and after Hurricane Katrina in 2005 account for the majority of fatalities. In total, more than 1800 people died during the hurricane, most of them flood victims. The years of 2009 and early 2010, prior to late May inclusive, are characterized by a large number of major floods and related casualties.

Examples of major floods, 2010

May 2010 Flood in Azerbaijan

Early in May 2010, as a result of the Kura River overflowing its banks and incessant rains, 40 Azerbaijan rayons (administrative units) suffered inundation. The disaster led to the flooding of about 20,000 residences; more than 300 of them were destroyed and 2,000 were in hazardous condition; and 50,000 hectares of cultivated land went under water.

Flood in Sabirabad Rayon, Azerbaijan, May 2010
http://eco.rian.ru/natural/20100512/233427994.html

The unusually high activity level of natural disasters as a result of heavy rains started to manifest itself across Azerbaijan from as early as the beginning of April 2010. April 5, 2010 saw a massive landslide on the Agsu Pass of the Shamakhy rayon, Azerbaijan. The ground sank along a nearly 30 meter long section of the Baku-Shamakhy-Yevlakh highway, significantly hindering road traffic. On April 10, 2010, large-scale landslides occurred in the mountain villages Urwa and Gulazi of the Gusar rayon of Azerbaijan, resulting in destruction of homes and extensive damage. http://azeri.ru/papers/news-azerbaijan/65680/

A massive landslide triggered by torrential rains took place in the Tovuz rayon of Azerbaijan on 27 April 2010; an entire private house sank underground, leaving five family members dead. Immediately thereafter, information about landslides and land subsidence started to arrive from different regions of Azerbaijan.

A study of the development of landslide processes in Azerbaijan showed that on May 3, 2010 Azerbaijan witnessed one of the world's unique events, that is, simultaneous occurrence of large-scale landslides in seven rayons of Azerbaijan: the Balakan, Quba, Dashkesan, Goygol, Astara, Ismailly, and Lankaran rayons. These landslides destroyed many private houses and roads, causing great material damage.

The situation's peculiarity owes to the fact that these areas are situated at the opposite ends of Azerbaijan, that is, in the north, south, west and north-east. Such a simultaneous large-scale manifestation of landslide phenomena within a vast territory that stretches across the whole of Azerbaijan can hardly be explained by only the heavy precipitation that falls there in large amounts every spring. Rather, intense large-scale tectonic processes in the Caucasus triggered the landslides. On 6 May 2010, a very large landslide took place in the Muganli village of the Shamakhy rayon of Azerbaijan (approximately 110 kilometers west of Baku) as a result of the continuing precipitation, leaving 15 of the village's 180 houses in hazardous condition and forcing residents of five houses to be resettled. The roads leading to the village were blocked, and sown areas and orchards suffered great damage.

In recent years, the number of atmospheric phenomena-related natural cataclysms in Azerbaijan has increased dramatically. Again in 2009, heavy rainfall caused considerable damage to a number of Azerbaijani settlements. September 2009 saw the Dashkesan rayon in the country's west affected by the disaster. The rainfall lasted for 45 minutes and was followed by hail that, according to witnesses, was as big as a chicken's egg. On 23 May 2010, a similar phenomenon occurred during 40 minutes in the Goychay rayon of Azerbaijan.

Flooding in the U.S.

April 2010

On April 1, 2010 the U.S. northeast was hit by the largest flood in 200 years. Torrents of water washed away bridges and flooded the streets of many settlements. The state of Rhode Island suffered most of all. Due to the torrential rains that lasted for a whole month, the Pawtucket River overflowed its banks and flooded several districts in the town of Coventry. Many industrial plants were brought to a halt. U.S. President Barack Obama declared a state of emergency in Rhode Island. A section of the U.S. main east coast highway linking multiple states was closed. The Amtrak Company canceled several trains on the North-Eastern Railway.

May 2010

As a result of heavy rains on 01-02 May 2010, the state of Tennessee witnessed one of the largest floods in the region in the past 1000 years. Intense rains led to inundation of large areas in Arkansas, northern Mississippi, and southern Kentucky. Twenty deaths were reported in Tennessee. The flooding killed six people in northern Mississippi and another four in Kentucky.

Tennessee floods, U.S., May 2010
http://en.wikipedia.org/wiki/May_2010_Tennessee_floods

On 7 May 2010, 30 Tennessee counties were declared major disaster areas by the federal government, with another 52 awaiting to receive that status. Combined, they cover approximately 31% of Tennessee which was the main disaster area. The damage from the floods is estimated at 1.5 billion dollars.

Flooding in Poland, May 2010

Warsaw, Poland, 22 May 2010
http://eco.rian.ru/natural/20090626/175460322.html

In the second half of May, large-scale floods spread all over Eastern Europe including Hungary, Czech Republic, Slovakia, and Poland. The situation in Poland was the most dangerous. An 8 thousand hectare territory was left under water and nearly 5 thousand local residents were evacuated. As of 25 May, 15 people had been killed by floods.

The Vistula's level in Warsaw exceeded its critical value by more than a meter. Several thousand residents were evacuated from eastern Czech Republic. According to the local authorities, people were evacuated from settlements located along the banks of the Odra, Olza, Ostravice, and Morava. Karviná, one of the largest cities in the region, was completely cut off from the outside world.

The Vistula's level in Cracow exceeded the critical point. The authorities used helicopters and boats to relocate people from the natural disaster area. Residents of suburbs of the western Polish city of Wroclaw were hastily evacuated. According to tentative estimates, the Polish floods inflicted a loss of 2.5 billion Euros, as of 25 May 2010.
http://www.rbc.ru/rbcfreenews/20100522221915.shtml

Poland, 24 May 2010
http://static2.aif.ru/public/news/714/56fb56f3d43d8419bee35b3c1959342d_big.jpg

Flood statistics

A U.S. National Weather Service information-based analysis of statistical data on the damage inflicted by U.S. floods shows that between 1900 and 2000, there has been a steady increase in flood-caused loss, considering the inflation rate for 2007, Fig.23.

Of great interest is the study of flood number statistics for the period between 2000 and 2010. It is this past decade that is notable for substantially increased geodynamic activity. One may wonder to what extent this pattern remains true for floods.

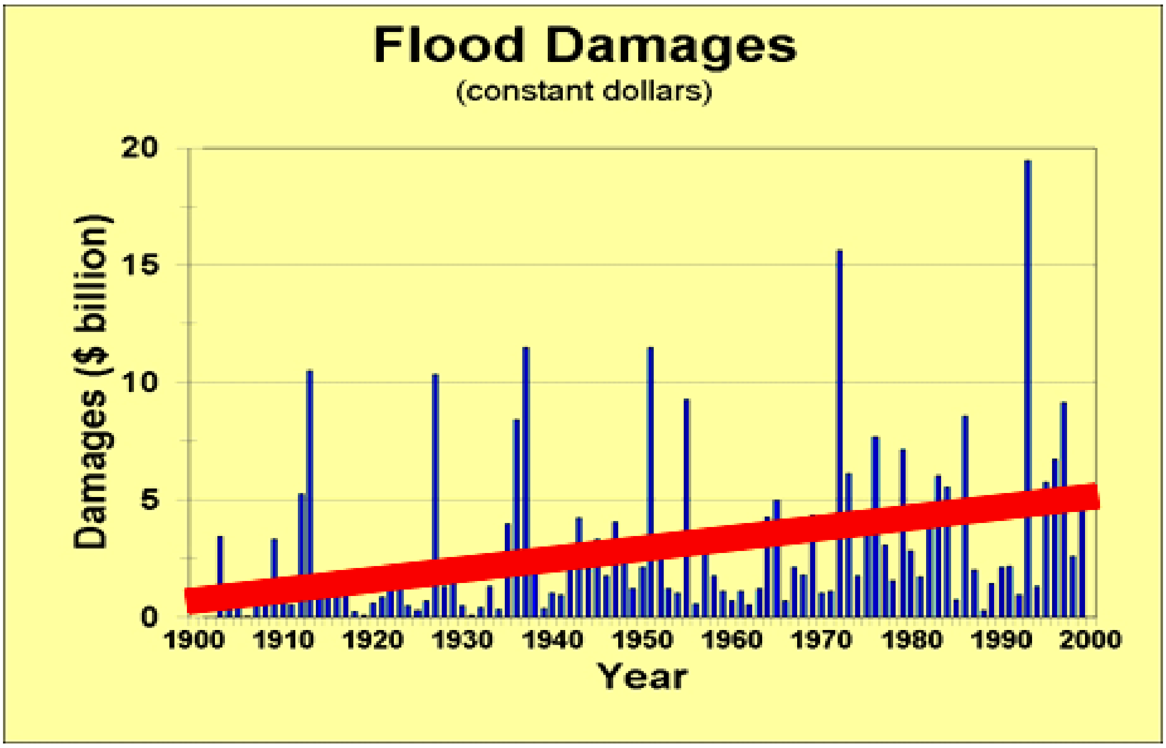
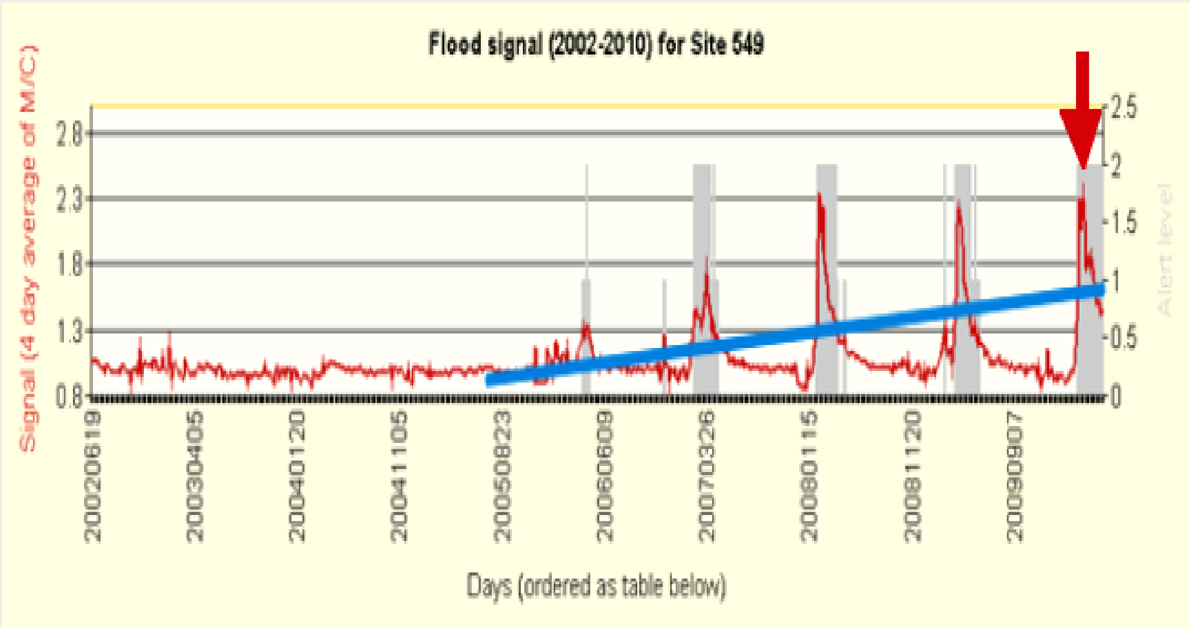


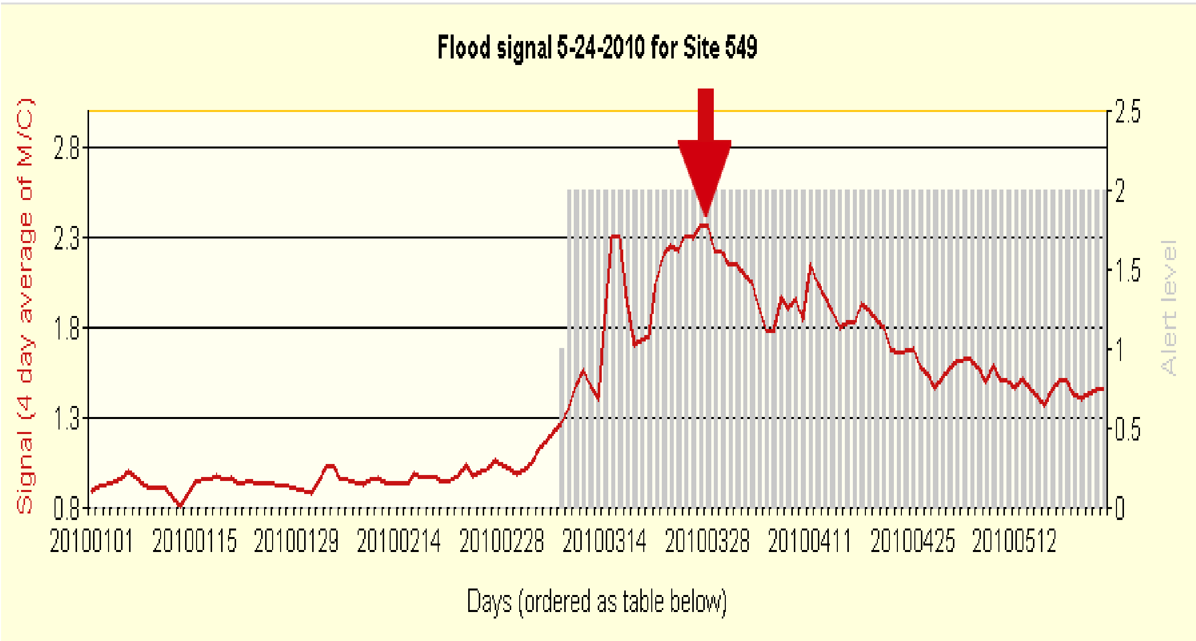
Fig.23. Economic damage from U.S. floods from 1900 to 2000
http://www.weather.gov/oh/hic/flood_stats/flood_trends.JPG
Annual values of damage from flooding are marked in blue;
Straight-line trend of damage from flooding is marked in red.

Fig. 24A contains a graph for the dynamics of numbers of flood notifications received worldwide from 2002 to May 12, 2010, according to the Global Flood Detection System, an experimental system aimed at providing flood disaster alerts (http://www.gdacs.org/floods/site.asp?SiteID=549). A flood statistics analysis shows that since 2005, the number of floods has increased steadily, and this tendency has continued up to May 2010. The straight-line trend also indicates that.

Fig. 24B shows a detailed graph for the dynamics of worldwide-received flood alert numbers from 1 January 2010 to 12 May 2010. The graph is very specific about the sharply increased number of floods from February 2010 due to the seasonal growth of flood events. This can be clearly seen on the graph in Fig. 24A as well. Meanwhile, a comparison of numbers of seasonal floods (from February to June) for the same period in previous years reveals some constant dynamics of increase in the number of seasonal floods every year from 2005 to May 2010 inclusive.



(A)



(B)

Fig. 24. Dynamics of numbers of worldwide-detected flood reports
http://www.gdacs.org/floods/site.asp?SiteID=549
(A) *- is number of received reports between 2002 and 2010;*
(B) *- is number of received reports between 01.01.2010 and 12.05.2010;*

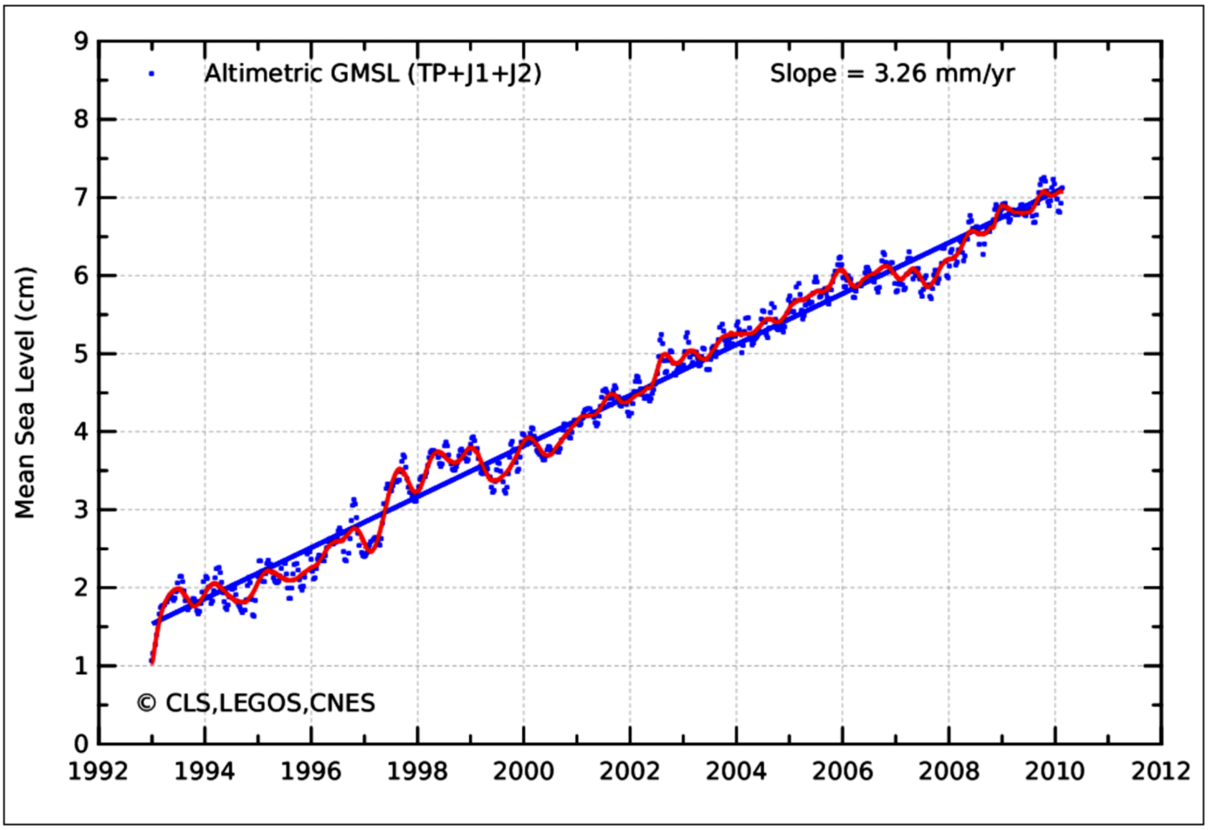


Fig. 25. Graph for global sea level fluctuations from 1992 to 2010
http://www.aviso.oceanobs.com/fileadmin/images/news/indic/msl/MSL_Serie_MERGED_Global_IB_RWT_GIA_Adjust.png

CONCLUSIONS:

Analysis of the statistical indicators of natural disasters in the hydrosphere, exemplified by tsunamis and floods, proves the existence of a stable tendency for natural disasters in the planet's aquatic environment to increase in number and scale. The straight-line trends of tsunamis and floods indicate this in particular.

Meanwhile, there is a sharp increase in statistical indicators and scale of manifestation of both tsunamis and floods over the last decade. The polynomial trends indicate a "surge" in the number of tsunamis and floods since 2000. This tendency persists today.

Chapter 4. ATMOSPHERE

INTRODUCTION

The rise in the occurrence rate and energy of extreme atmospheric events observed in recent decades is a matter of great concern due to the sharp increase in the number of casualties and the amount of economic damage.

When combined, global environmental changes caused by anthropogenic and natural factors amplify the negative effect on humanity

For many years, the Intergovernmental Panel on Climate Change (IPCC), functioning as part of the U.N., has investigated the issues of global climate change deeply. Given that the "Atmosphere" section frequently refers to IPCC research results, we consider it necessary to provide brief information about it.

The Intergovernmental Panel on Climate Change (IPCC) is an intergovernmental scientific body tasked with assessing the risk of climate change caused by human activity. The World Meteorological Organization (WMO) and the United Nations Environment Programme (UNEP) established the Panel in 1988.

The United Nations Framework Convention on Climate Change (UNFCCC) was signed in 1992 as a response to the emergence of increasing scientific evidence of global climate change being determined by anthropogenic alteration of greenhouse gas concentration in the atmosphere. Some global warming consequences, particularly the increased frequency of extreme weather events, melting of mountain glaciers, sea level rise, etc. have quite a negative impact on the natural environment and development of society. The declared long-term goal of the Convention was to stabilize the greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the planet's climate system. Reducing the anthropogenic emissions of greenhouse gases (the term "mitigation measures" will be used hereinafter in relation to the activity associated with reducing greenhouse gas emissions and increasing their absorption, e.g., planting forests) was named the key type of activity to mitigate climate change. Since emissions are generally caused by burning fossil fuel, the main source of energy in the modern world, such a long-term objective's formulation by UNFCCC was inevitably bound to have an effect on the development of the global economic system.

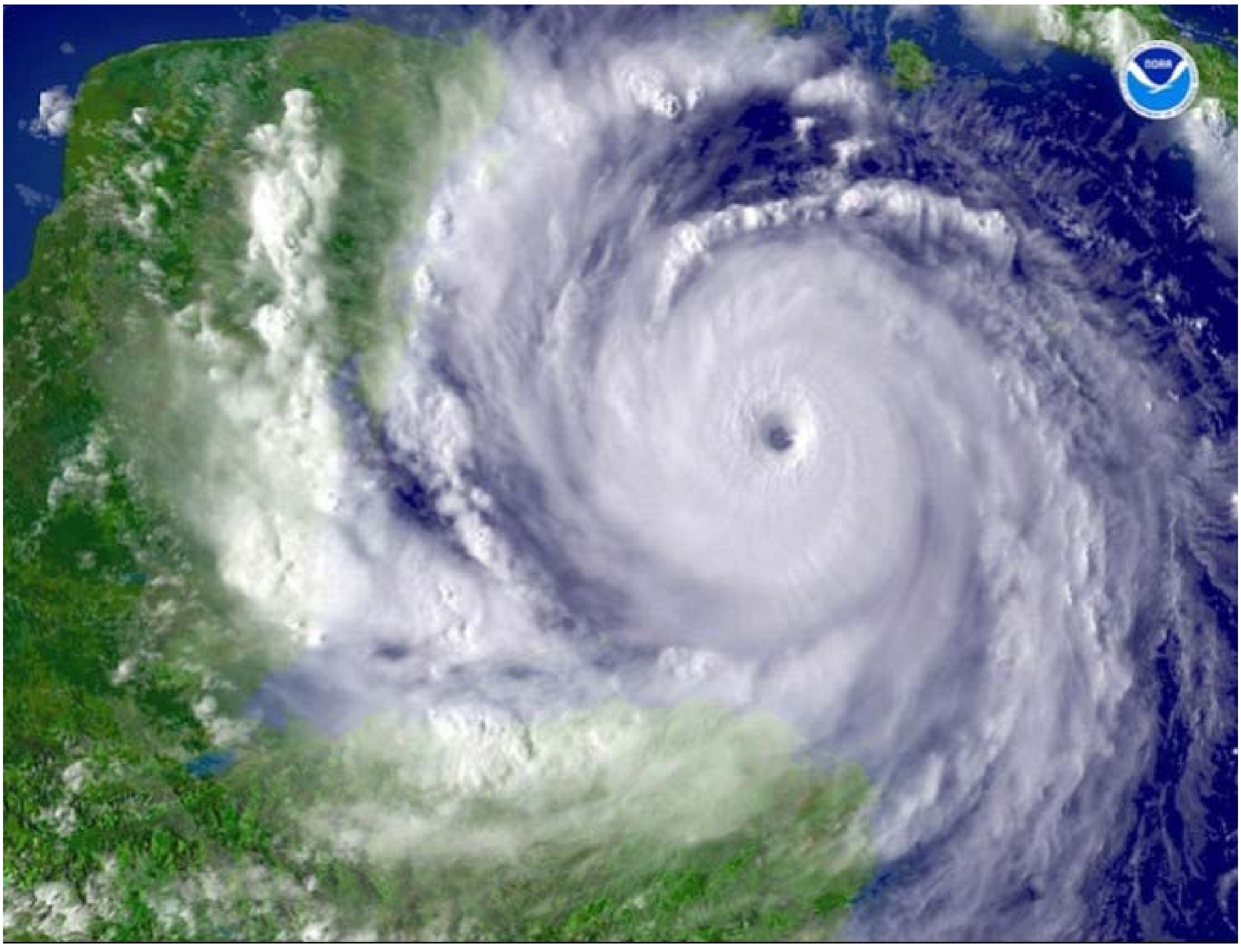
The Kyoto Protocol to the UNFCCC was adopted in 1997 in order to deepen the developed countries' commitments. The Protocol has a limited term of validity (2008-2012) and assigns each country a strictly defined emission level to be observed at end of this period. Thus, emission level in 2012 must be, as compared to 1990, not more than 93% in the U.S., 92% in the European Union, and 100% in Russia. The Kyoto Protocol introduced financial mechanisms such as emissions trading, joint implementation, and clean development to facilitate developed countries' fulfillment of their commitments.

4.1. HURRICANES, STORMS, TORNADOES: DYNAMICS ANALYSIS:

4.1.1. HURRICANES AND STORMS

Hurricane Katrina was one of the worst natural disasters in our Nation's history and has caused unimaginable devastation and heartbreak throughout the Gulf Coast Region.

(U.S. President George W. Bush, September 8, 2005)



http://news.bbc.co.uk/hi/russian/spl/pop_ups/07/russia_enl_1187710795/img/1.jpg

According to IPCC data, the number of hurricanes across the world has risen substantially over the last two decades. As follows from NOAA data, U.S. hurricane statistics also points to an increase in their numbers. Below is a graph for Atlantic Basin hurricane statistics from 1944 to 2008.

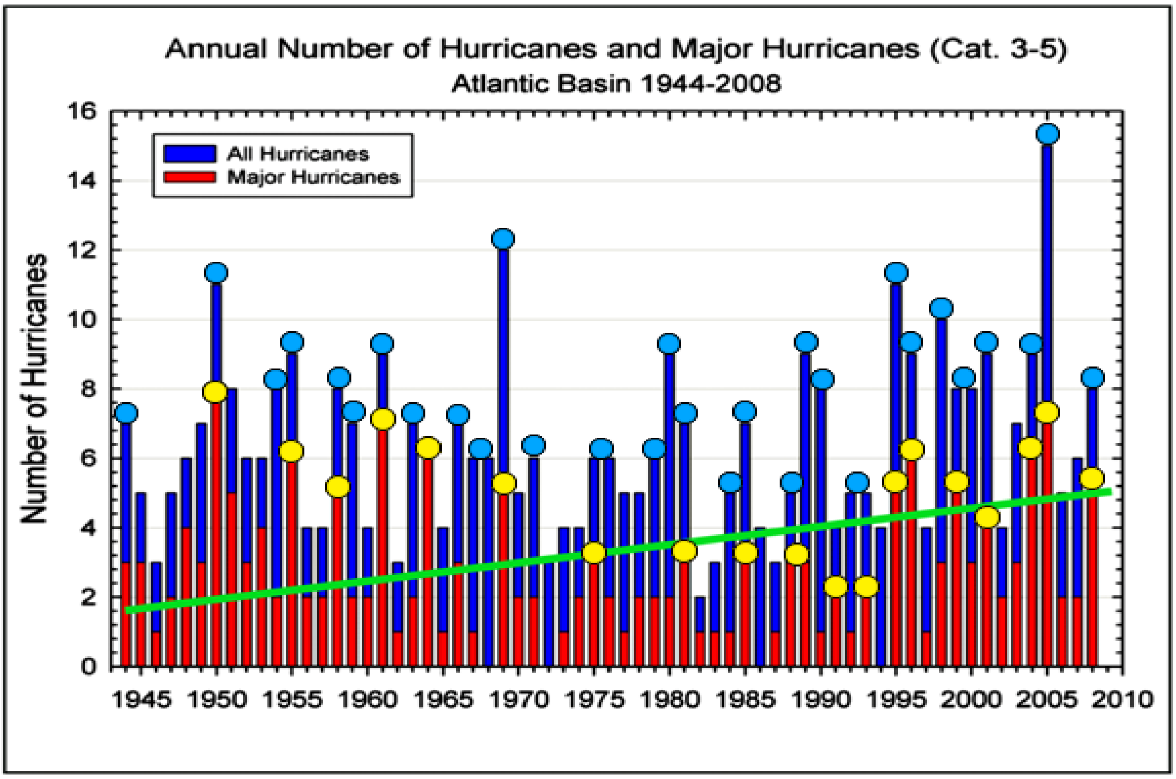


Fig. 26. Graph for numbers of hurricanes in Atlantic Basin between 1944 and 2008

(According to data http://www.climate.org/topics/extreme-weather/images/north-atlantic-tropical-storms.gif)

Total number of hurricanes graph is marked in blue;

Major hurricanes graph is marked in red;

Straight-line trend of total number of hurricanes is marked in green.

It is remarkable that the increase in the number of hurricanes applies to both the most powerful ones and the total number altogether. The straight-line trend shown on the graph in Fig.26 also points to a steadily continuing tendency for the total number of Atlantic Basin hurricanes to increase annually.

Sand Storm in Khartoum, Sudan
http://www.infranews.ru/?object=news&id=2302&catid=4

Storm in Sevastopol, 11.11.2007
http://www.infranews.ru/?object=news&id=2302&catid=4

The statistical analysis of the numbers of major Atlantic Basin hurricanes and their total number reveals a certain 4-5 year cyclicity. This cyclicity persists during the entire considered time span.

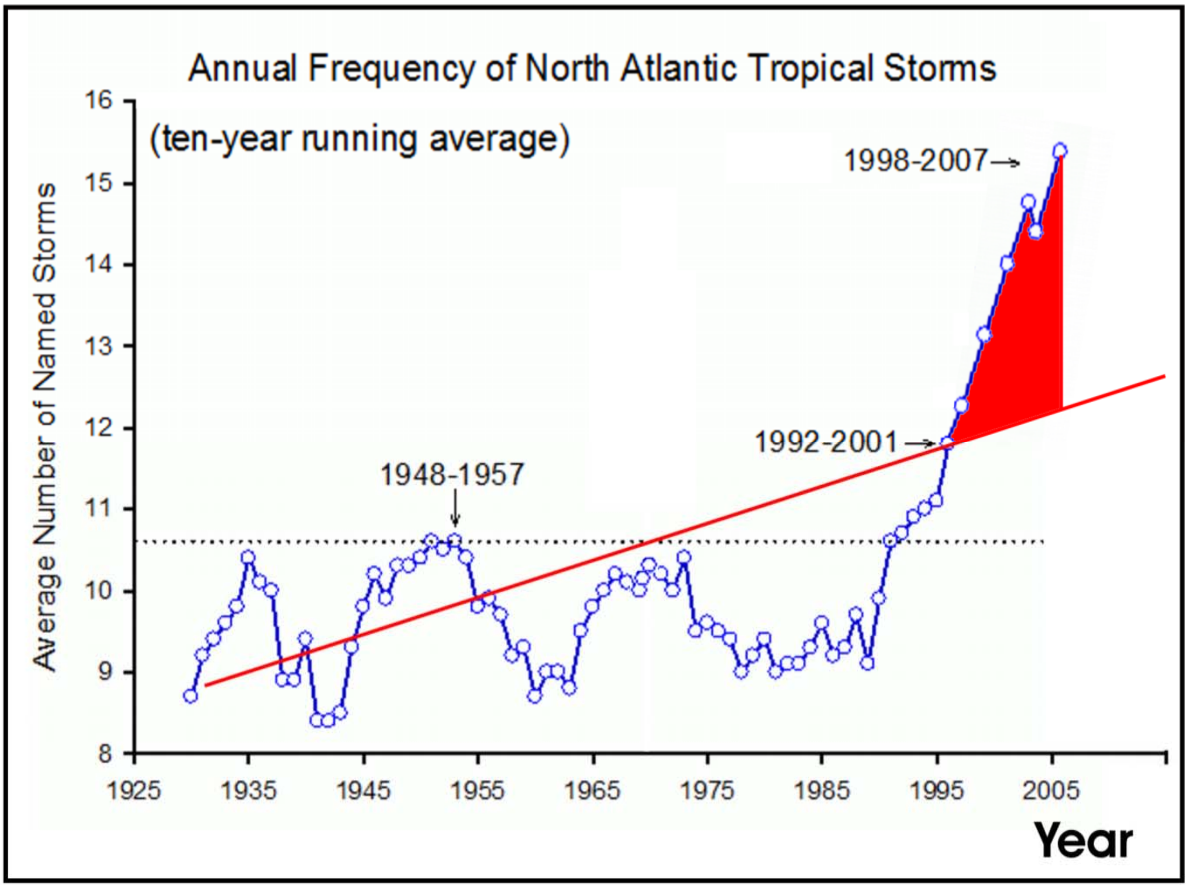


Fig. 27. North-Atlantic tropical storms frequency variations
by Pew Center on Global Climate Change
http://www.pewclimate.org/global-warming-basics/facts_and_figures/impacts/storms.cfm

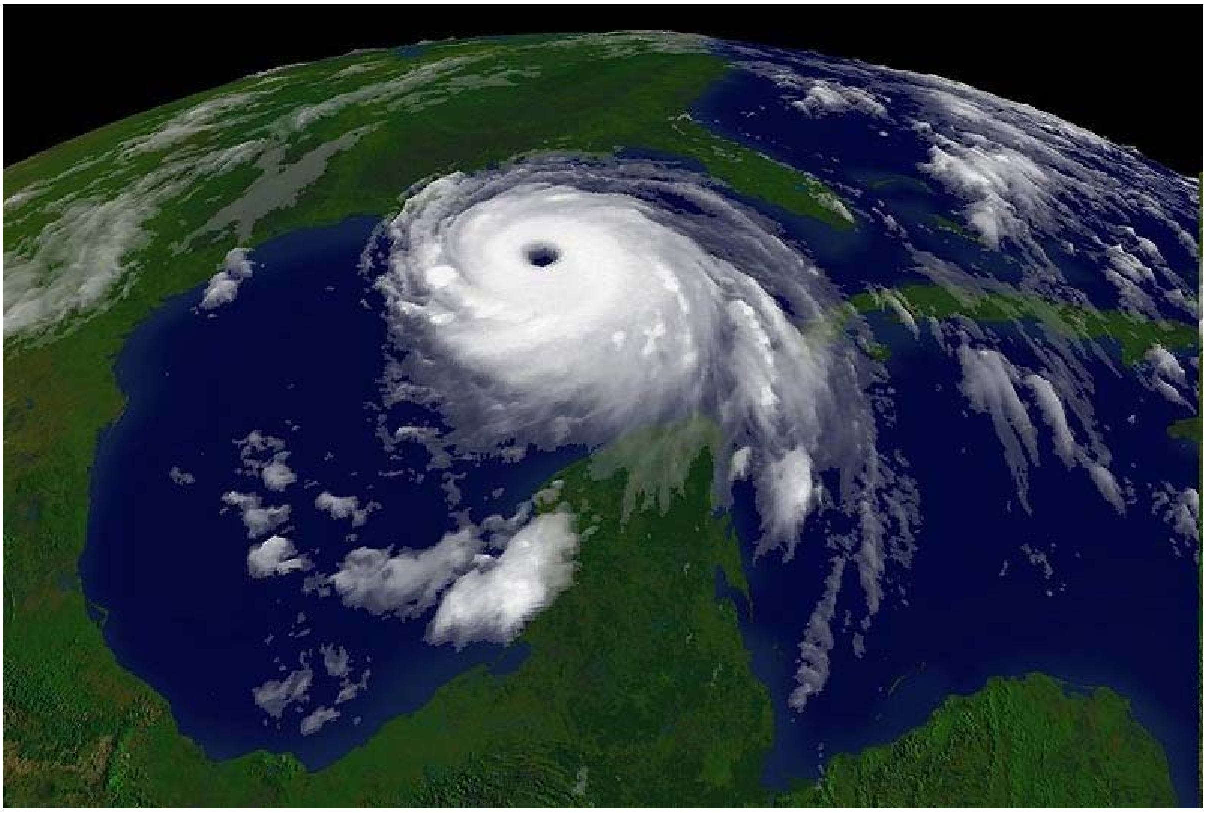
Fig.27 contains a diagram by the Pew Center on Global Climate Change, which demonstrates the dynamics of named North Atlantic Basin tropical storms. The graph shows annual numbers smoothed out over a 10-year running average to minimize the noise in year-to-year variation. Since 1996, the tropical storm frequency has exceeded by 40% the old historic maximum of the mid-1950's previously thought to be an extreme value.

This graph shows the climatic changes of recent decades. The straight-line trend points to a persistent tendency for the tropical storm frequency to grow. From the 1990's to 2007, there have been an extremely high number of North Atlantic tropical storms. (http://www.pewclimate.org/global-warming-basics/facts_and_figures/impacts/storms.cfm)

Examples of major hurricanes in recent years

2005 Hurricane Katrina and the subsequent flooding claimed the lives of 1836 people, caused U.S. economic losses amounting to 125 billon dollars, destroyed over 300,000 homes, and damaged more than 80,000 buildings. 1,200,000 people were evacuated.

Hurricane Katrina



Hurricane Katrina was the most devastating natural disaster in American history. The complete destruction caused by Hurricane Katrina and the accompanying catastrophic flood has significantly exceeded the consequences of any other large-scale disaster in the U.S.

Hurricane Katrina destroyed much more private property than any other recent hurricane, completely ruining or otherwise making uninhabitable approximately 300,000 homes (http://en.wikipedia.org/wiki/Hurricane_Katrina).

Many times since 1851 hurricane Katrina has struck the United States mainland, the last one being the most powerful and destructive.

Katrina's hurricane winds and 27 feet high rolling storm wave dealt a fierce blow to homes, farms, and property along the coast and for many miles into the country. This storm wave smashed the dams along the Mississippi River and the edges of Lake Pontchartrain. Its consequences for New Orleans, most of which lies below sea level, were terrible. The flood destroyed New Orleans almost completely. Even beyond New Orleans, the destruction from Hurricane Katrina was enormous. Cities and towns were in ruins or heavily damaged up and down the Gulf coast and for many miles into the country. As Mississippi Governor Haley Barbour stated, "The 80 miles across the Mississippi Gulf Coast is largely destroyed."

4.1.2. TORNADO

Tornado (synonyms – whirlwind, thrombus, mesohurricane) is a very powerful spinning vortex sized less than 50 km horizontally and less than 10 km vertically with wind speeds of over 33 m/sec.

Tornadoes can be diverse in form, but mostly are shaped like a spinning trunk, pipe, or funnel hanging down from the parent cloud, hence the names: French "tromb" meaning a pipe and Spanish "tornado" meaning "rotating".

Most tornadoes have wind speeds between 40 mph (64 km/h) and 110 mph (177 km/h), are about 250 feet (75 meters) across and move several miles before dissipating.

The strongest winds can reach speeds of more than 300 mph (480 km/h), be over a mile (1.6 km) across, and travel further than 100 km.

References:

[Wurman, Joshua (2008-08-29). "Doppler On Wheels". Center for Severe Weather Research. http://cswr.org/dow/DOW.htm. Retrieved 2009-12-13.]; [Hallam Nebraska Tornado". *National Weather Service*. National Oceanic and Atmospheric Administration. 2005-10-02. http://www.crh.noaa.gov/oax/archive/hallam/hallam.php. Retrieved 2009-11-15.]; [Roger Edwards (2006-04-04). "The Online Tornado FAQ". *National Weather Service*. National Oceanic and Atmospheric Administration. http://www.spc.ncep.noaa.gov/faq/tornado/. Retrieved 2006-09-08.]

Iowa Tornado
http://atticus-flinch.livejournal.com/2008/04/02/

http://www.qlabsisd.com/assets/tornado.jpg

A tornado's rotation direction, like that of cyclones of the Earth's northern hemisphere, is counterclockwise. The time record for a tornado to exist was set by the Mattoon tornado, which on May 26, 1917 swept 500 km across the U.S. territory for 7 hours and 20 minutes, killing 110 people. The width of the tornado's loose funnel was 0.4-1 km, with a whip-like funnel visible inside it. Another famous tornado outbreak was the Tri-State Tornado, which on March 18, 1925 crossed the states of Missouri, Illinois, and Indiana, covering the distance of 350 km in 3.5 hours. Its loose funnel's diameter ranged from 800 m to 1.6 km.

Air rotation inside a northern hemisphere tornado is usually counterclockwise. The reason is related to the directions of mutual movement of air masses around the atmospheric front within which a tornado is formed. Yet there are some cases of inverse rotation.

A phenomenon named *cascade* – a cloud or column of dust, debris, objects picked from ground, or splashes can occur in the area where the funnel's base touches the ground or water surface. When a tornado is forming, a cascade goes upwards to meet the funnel descending from the sky and envelop the bottom of the funnel. The term comes from the fact that debris rising to a certain minor height can no longer be held by the airflow and falls to the ground. The funnel can be wrapped by a *case* without touching the ground. The cascade, case, and mother cloud merging creates an illusion of a funnel wider than it actually is.

A whirlwind over the sea is sometimes called a waterspout, whereas overland it is called a tornado. An atmospheric vortex similar to a tornado but formed in Europe is called a thrombus. Most often, these three terms are considered synonyms.

Tornadoes have been witnessed on all continents except Antarctica. Nevertheless, the vast majority of world tornadoes occur in the U.S. area known as "Tornado Alley", although they can be found almost anywhere in North America [Sid Perkins (2002-05-11). "Tornado Alley, USA". Science News. pp. 296–298. Archived from the original on 2006-08-25. http://web.archive.org/web/20060825011156/http://www.sciencenews.org/articles/20020511/bob9.asp. Retrieved 2006-09-20.]

From time to time tornadoes occur in south-central and eastern Asia, the Philippines, the eastern part of central South America, South Africa, north-western and south-eastern Europe, western and south-eastern Australia and New Zealand. ["Tornado: Global occurrence". Encyclopædia Britannica Online. 2009. http://www.britannica.com/eb/article-218357/tornado. Retrieved 2009-12-13].

Fire tornado
http://c2.api.ning.com/files/7C3Fv1EuCqBG-gr1CPe8ki3J0hvk37eDE72Wq3M1IHiPAjDhSZZx8JLagulQe34bigSmlGgMExJWYoSRbEmg8YjGg4n3-dFa/FireTornado.JPG

Tornadoes can be detected before or after they are formed, with the help of pulsed Doppler radar and additional special equipment.

In respect to their scope and energy, tornadoes are classified according to special scales. The Fujita scale rating tornadoes by the damage caused, similar to the seismic scale of earthquake intensity (MSK64), has been replaced in some countries with the updated enhanced Fujita scale. For example, F0 or EF0 class tornados, weak categories, cause damage to trees but no major destruction. F5 or EF5 class tornadoes refer to strong tornadoes, damaging brick-made and prefabricated buildings with their foundations alike and capable of deforming large skyscrapers.

A similar TORRO scale ranges from T0 class for extremely weak tornadoes to T11 class for the most powerful tornadoes [Meaden, Terrance (2004). "Wind Scales: Beaufort, T — Scale, and Fujita's Scale". Tornado and Storm Research Organisation. http://www.torro.org.uk/TORRO/ECSS_Slide_Show/2004%20SPAIN%20ECSS%20Post-FINAL%20slide%20show.html. Retrieved 2009-09-11.]

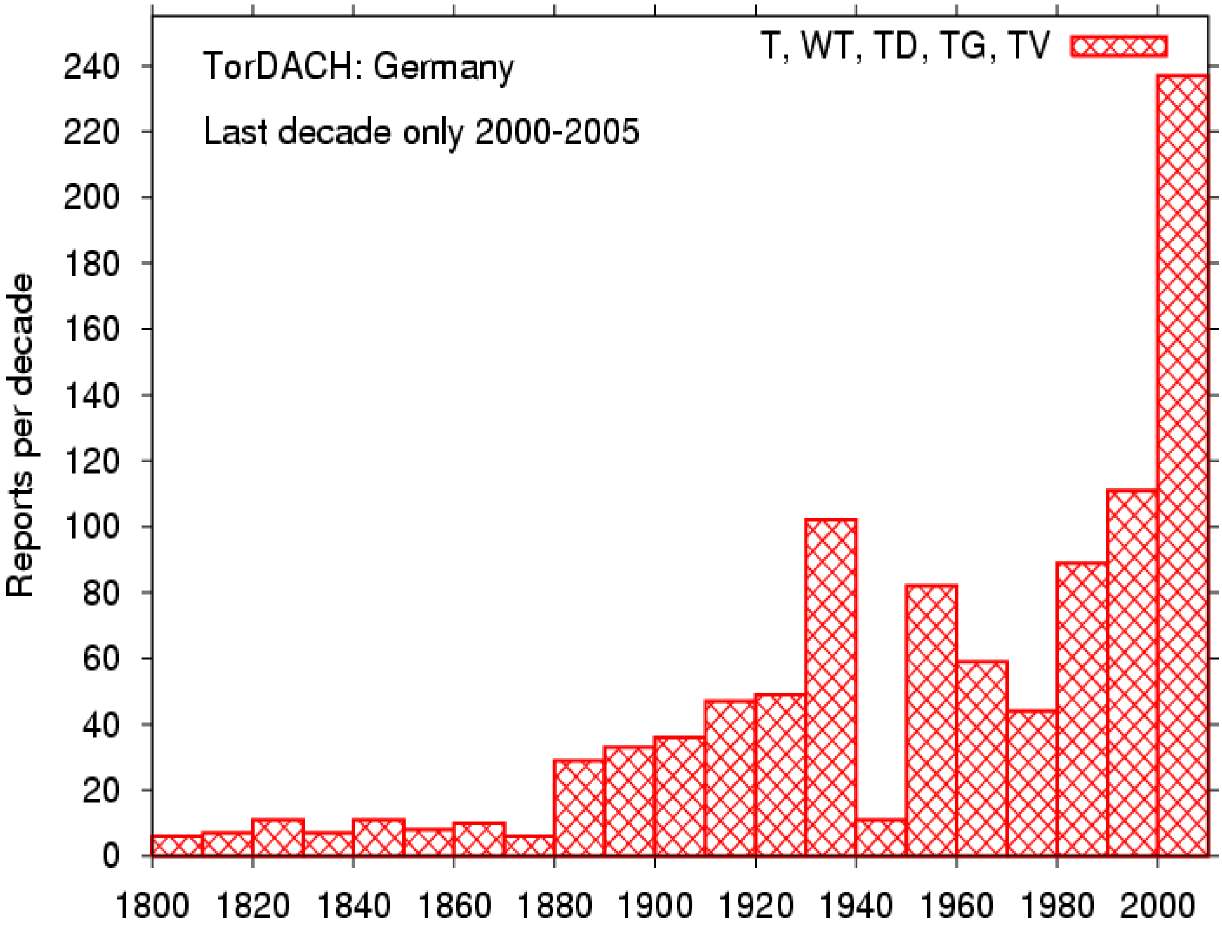


Fig. 28. Graph for tornado statistics in Germany since 1800.
Height of columns indicates per decade tornado numbers.
Last column represents tornado numbers for five years (2000-2005)
http://www.tordach.org/de/gif/cent_T.gif

Fig. 28 provides a graph to demonstrate the dynamics of per-decade tornado numbers in Germany. The last decade only covers a 5-year period (2000-2005). Meanwhile, as is seen in the graph, there were 2.5 times more tornadoes in Germany between 2000 and 2005 (for 5 years) than over the preceding ten years.

http://www.oceanographers.ru/mypict/art/bond20.jpg

A similar situation with the increased tornado rate can be observed for the territory of the United States as well. Fig. 29 shows graphs for tornado numbers from 1950 to 2007 for different tornado classes. The graphs also reflect a steady increase in the number of tornadoes of all classes in the U.S. over the last two decades.

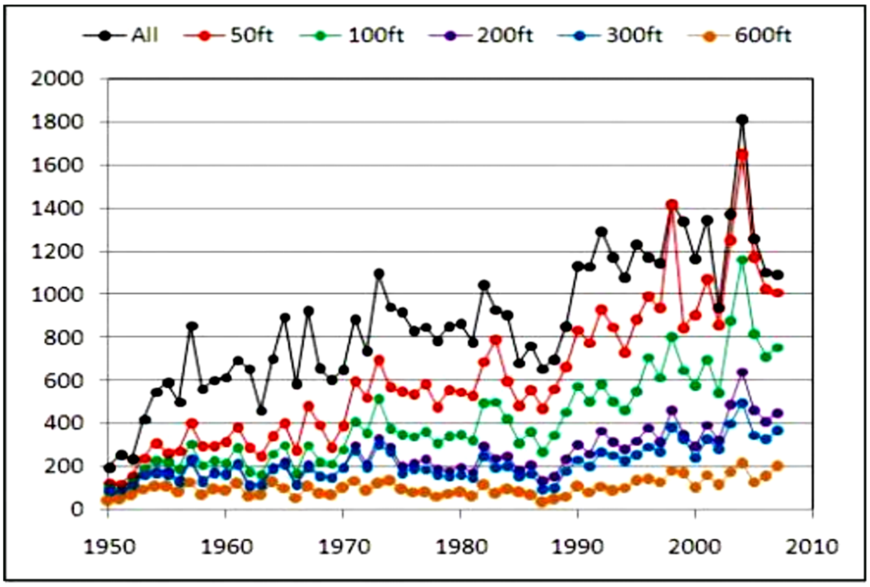


Fig. 29. Graphs for U.S. all-class tornado activity between 1950 and 2007
http://tamino.wordpress.com/2008/05/13/attack-of-the-50-foot-tornado/

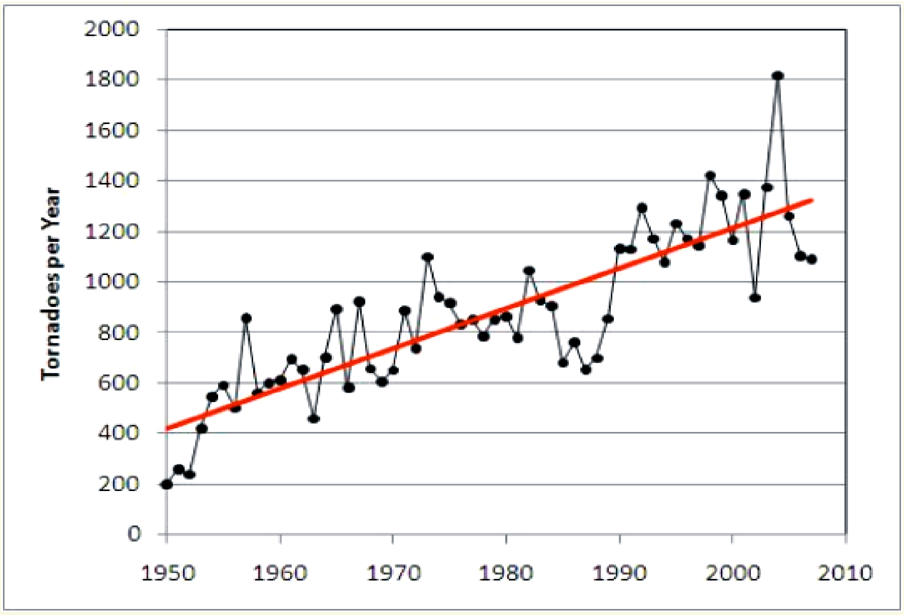


Fig. 30. US tornado numbers from 1950 to 2007
http://tamino.wordpress.com/2008/05/13/attack-of-the-50-foot-tornado/

Fig. 30 shows a graph for the annual changes in the number of U.S. tornadoes together with a straight-line trend that demonstrates the general nature of the annual increase in tornado numbers from 1950 to 2007.

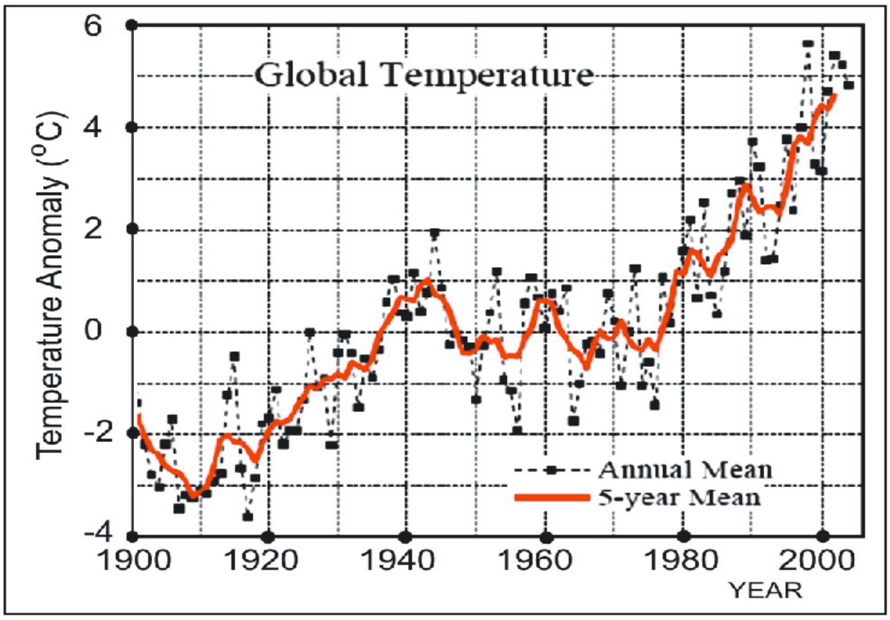


Fig.31. Graph for Earth's global temperature change

Fig. 31 demonstrates the global change of the Earth's temperature from 1900 to 2005, according to data by IPCC.

4.2. FOREST FIRE STATISTICS

Forest fires are in the list of our planet's global natural disasters that cause enormous damage to the environment and ecology as well as great economic damage every year. They often kill people and large numbers of animals. In addition to destruction of huge areas of forest, irreversible damage is done to the flora and fauna. Statistics for forest fires all over the world shows that their number and area are expanding from year to year.

http://www.segodnya.ua/img/forall/a/120553/81.jpg

According to the U.S. National Interagency Fire Center, forest fires spread over the area of 9.7 million acres in 2006 and 9.3 million acres in 2007. In each of these years, the burned area rate is the worst for the last 50 years. The number and extent of US forest fires are substantially increasing from year to year (http://www.nifc.gov/fire_info/fire_stats.htm).

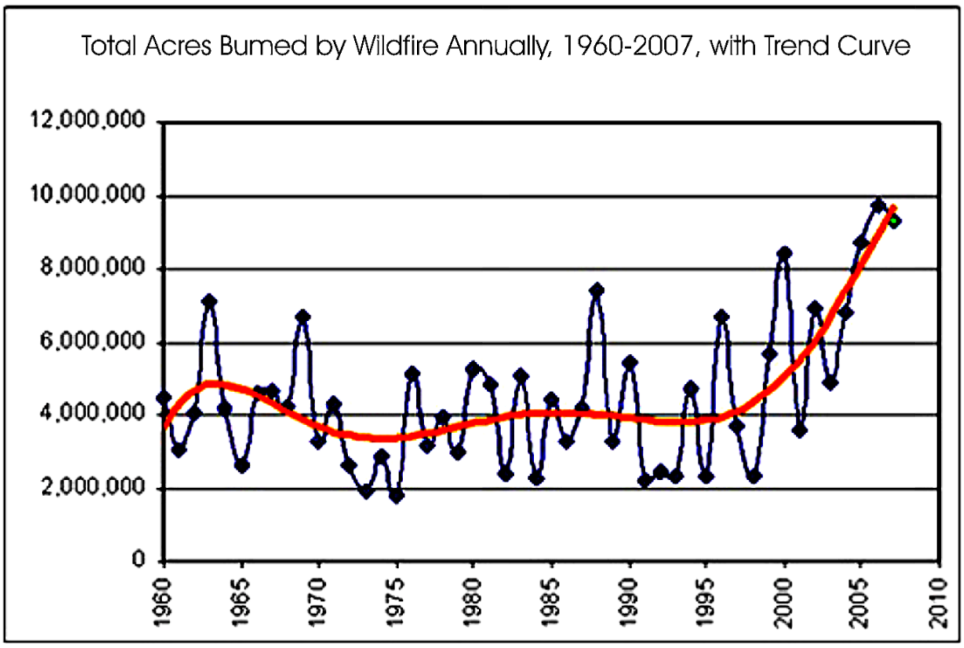


Fig. 32. Annual rates of total area affected by U.S. fires between 1960 and 2007, with trend indicating tendency for significant increase in values.
(*According to U.S. National Interagency Fire Center, http://www.nifc.gov/fire_info/fire_stats.htm*)

http://www.noaa.gov/features/resources_0109/images/fire1.jpg

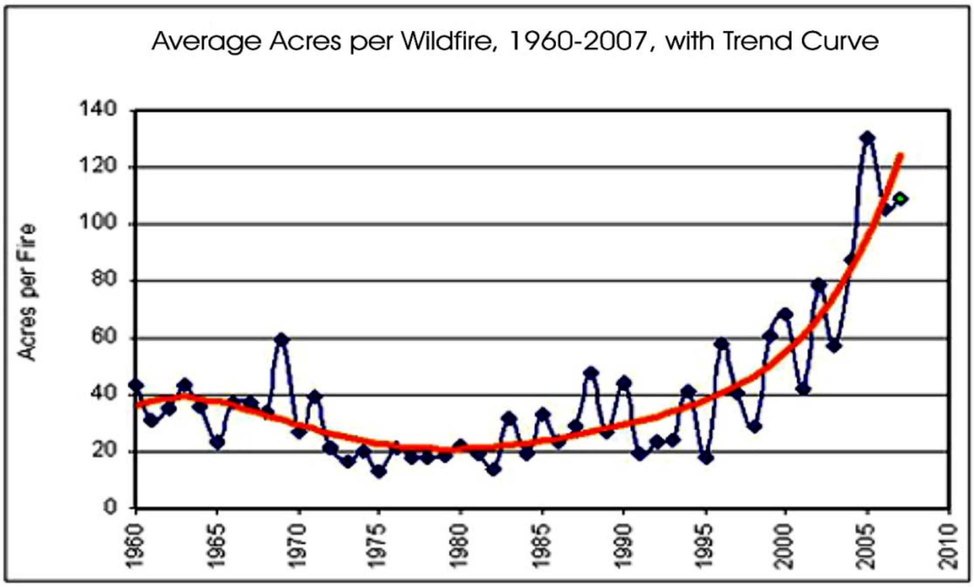


Fig.33. Annual rates of average fire-affected area in U.S. between 1960 and 2007
(According to U.S. National Interagency Fire Center, http://www.nifc.gov/fire_info/fire_stats.htm)

Fig. 32 and Fig. 33 contain graphs showing the annual rates of the total and average area affected by forest fires in the United States from 1960 to 2007. The graphs clearly demonstrate that since 1995, there has been a tendency for a sharp increase in the U.S. fire rates, which were virtually invariable for the prior 35 years.

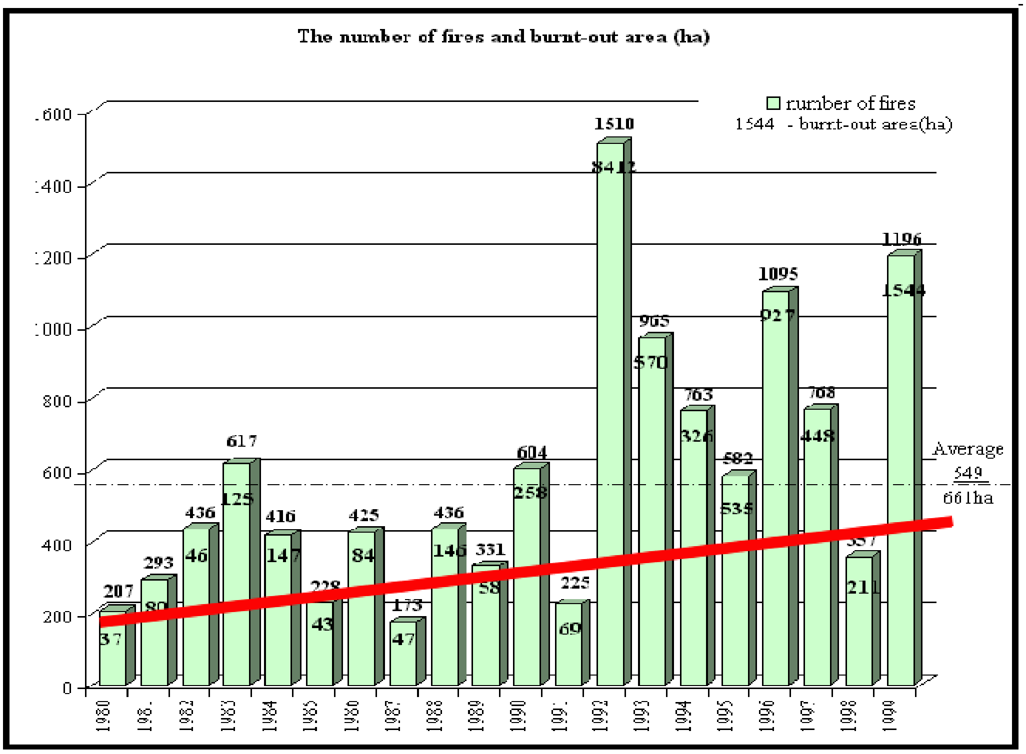


Fig. 34. Forest fire statistics in Latvia, 1980-1999
(According to http://www.fao.org/docrep/006/AD653E/ad653e75.htm)

Dynamics of forest fires in Latvia from 1980 to 1999 demonstrate a steady growth as well (Fig. 34). In 1992, Latvia witnessed a surge in the number of forest fires.

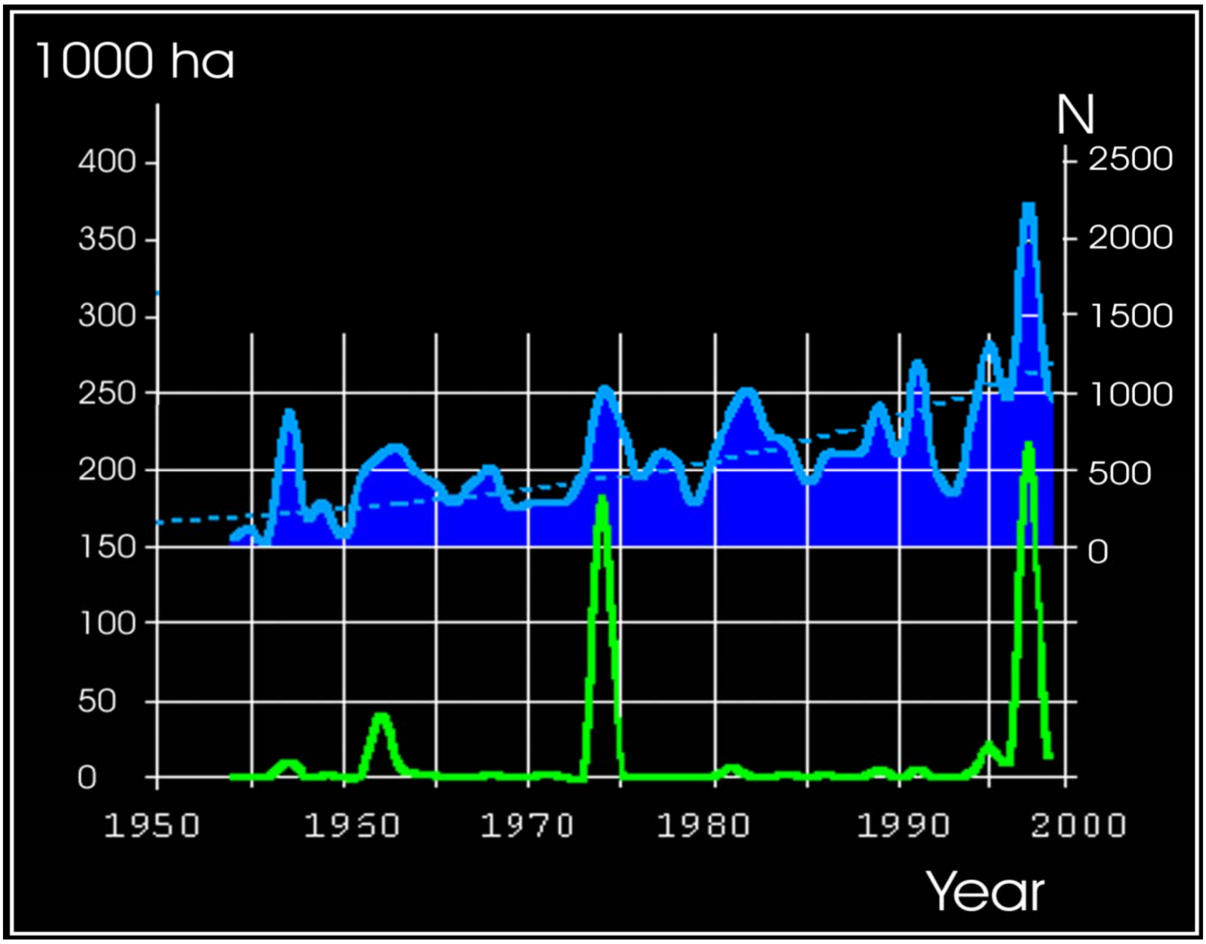


Fig. 35. Forest fire dynamics in Kazakhstan
Diagram reflects annual rates of forest fire affected areas;
Curve reflecting dynamics of annual numbers of forest fires (N) is marked in blue;
Curve reflecting fire affected areas is marked in green.

A very interesting regularity is found in relation to the dynamics of forest fires in Kazakhstan. In addition to the trend demonstrating a general tendency for the rates to grow, two distinct cycles of sharply increased forest fire statistics in 1973-1975 and 1996-1999 can be observed in the diagram for the annual numbers of forest fires and areas affected by them (Fig. 35). The last cycle with its peak in 1997 is the biggest in the last 50 years.

http://www.dpk.com.ua/files/pics/fire.jpg

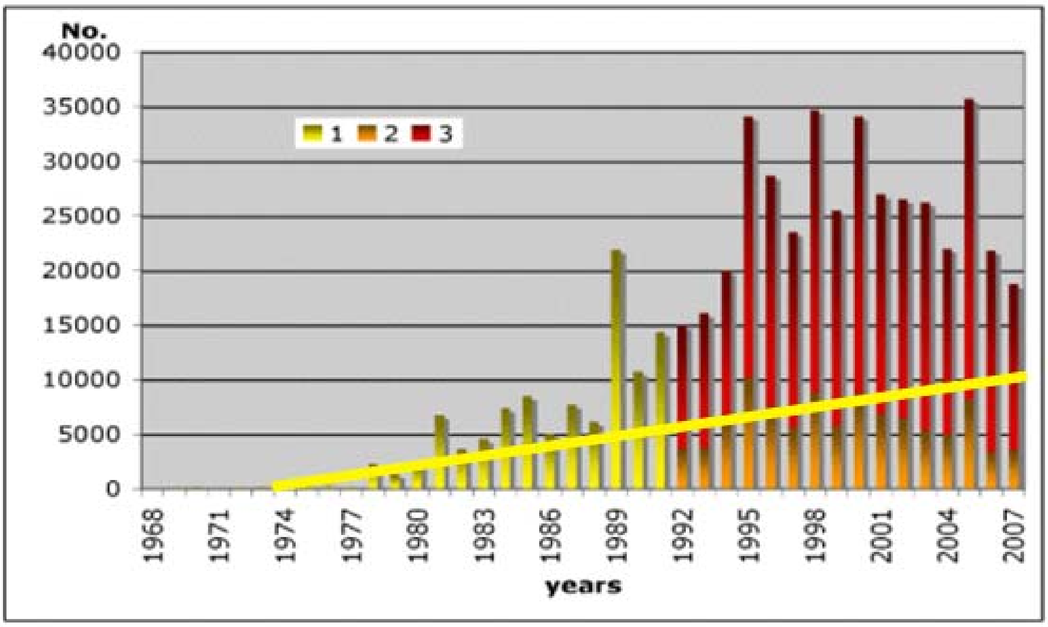


Fig. 36. Dynamics of annual rates of forest fires in mainland Portugal
According to statistical data by DGRF
1 – fire incidents; 2 – fires covering areas of ≥ 1 ha; 3 - fires covering areas of <1 ha
http://www.massey.ac.nz/~trauma/issues/2008-2/lourenco.htm

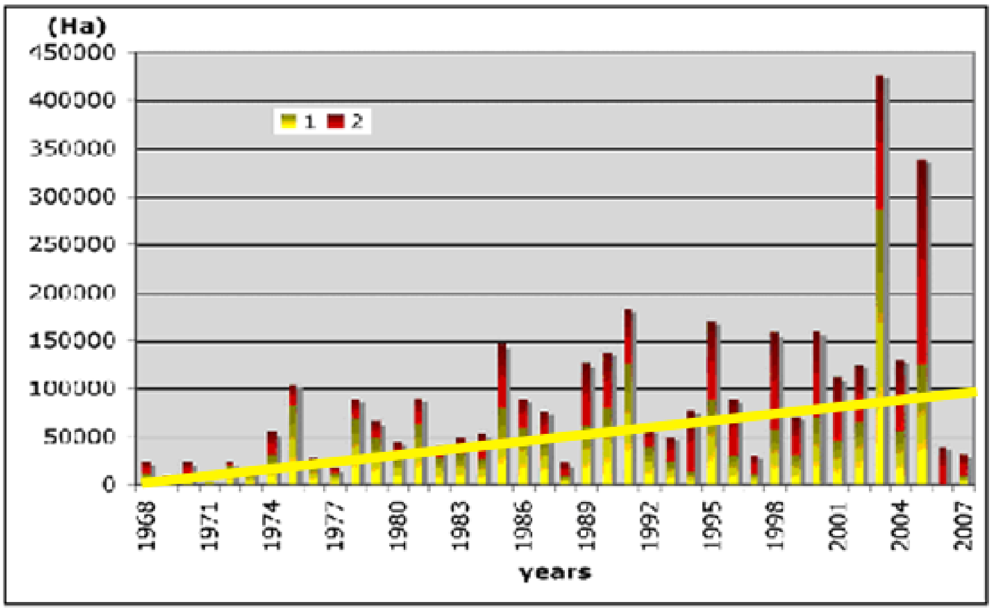


Fig. 37. Dynamics of annual rates of forest fire affected areas in mainland Portugal

According to statistical data by DGRF

1 - burned woodland areas; 2 – burned undergrowth areas

http://www.massey.ac.nz/~trauma/issues/2008-2/lourenco.htm

Fig.36 and Fig.37 contain graphs showing the dynamics of forest fire statistics in mainland Portugal for 40 years, from 1968 to 2007. Along with the fact that the graphs indicate a steady annual growth of statistical indicators, we can see that the number of forest fires in Portugal has risen sharply since 1995 and this that trend continued until 2005, followed by some decline in 2006-2007. Some increase with a surge in 2003 and 2005 can also be observed in the dynamics of annual rates of forest fire-affected areas.

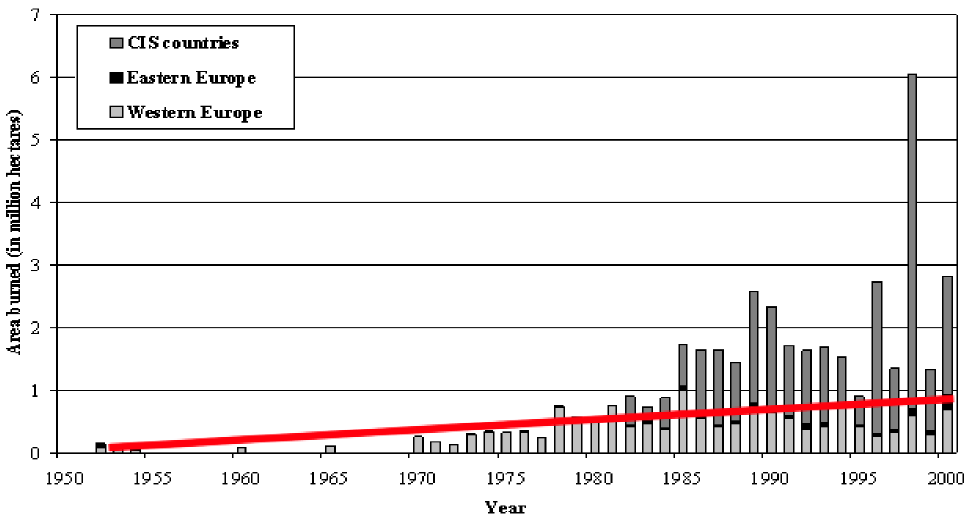


Fig. 38. Graph for dynamics of areas affected by forest fire in Eastern and Western Europe and CIS countries

http://www.fao.org/docrep/008/ae428e/ae428e02.htm

The dynamics of areas affected by forest fires in Eastern and Western Europe and the CIS countries between 1970 and 2000 demonstrates steady growth for the CIS countries, with a surge in 1998.

Chapter 5.
GEOPHYSICAL AND COSMIC FACTORS

Introduction

There are some significant changes observed during recent decades in certain geophysical and space parameters. How closely are these changes related to natural disasters, thereby jeopardizing the stable development of civilization? This chapter shows how deep and large-scale the changes taking place across the Earth and Solar System are. In its following reports, IC GCGE will address different aspects of the problem not covered in this paper.

Taking into account that the report is intended for a wide range of scientists, specialists, and people interested in the problem, definitions for some terms and considered aspects are provided. In addition to reviewing available research findings of other scientists, the report cites the latest studies illustrated with graphs and furnished with brief comments.

5.1. GLOBAL CHANGES IN EARTH'S GEOMAGNETIC FIELD

Earth's magnetic field, which reflects the complex energy processes in its inner and outer cores, is an essential physical characteristic of our planet. It is believed that Earth's magnetic field is formed mostly due to a flow of huge masses of liquid iron, which constitute Earth's outer core, around its inner solid core.

It was William Gilbert, an English physician and natural philosopher, who first assumed the existence of Earth's magnetic field in his book "De Magnete" in 1600. Observations by the English astronomer Henry Gellibrand proved that the geomagnetic field is not constant, but slowly changes. Carl Friedrich Gauss put forward a theory about the origin of Earth's magnetic field and proved in 1839 that most of it originates from within Earth and that the cause of minor short deviations of its rate should be sought in the external environment. Let us have a brief look at the structure of Earth's magnetosphere. At the distance of approximately three radii from Earth, magnetic lines of force have a dipolar orientation. This region is called the plasmasphere.

From 1983 to 2003, the North Magnetic Pole's drift velocity increased by 500% whereas for the preceding years it varied between 40 and 50% against the background level

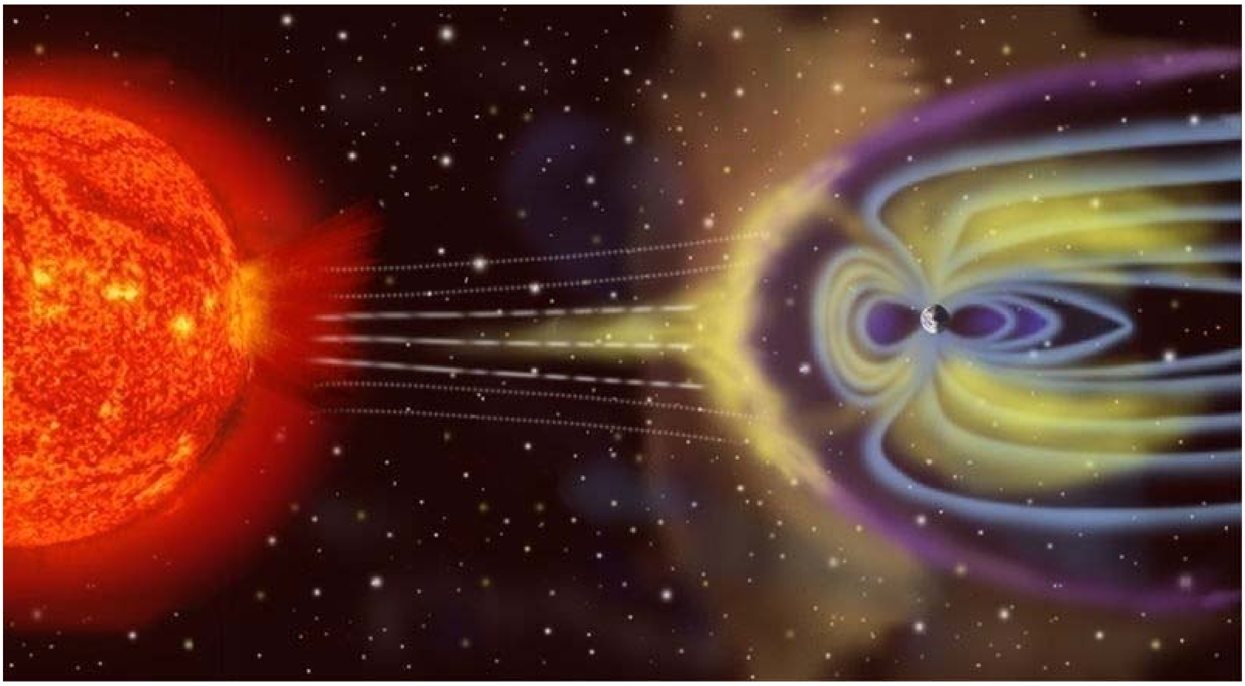


Fig. 39. Structure of Earth's magnetosphere
http://en.wikipedia.org/wiki/Earth%27s_magnetic_field

The solar wind's strength grows with the distance from Earth's surface, with the geomagnetic field shrinking on the sun side and stretching out in a long trail on the opposite side. Currents in the ionosphere have a significant impact on the magnetic field at Earth's surface. The upper region of the atmosphere (plasmasphere), about 100 km and higher, contains plenty of ions. The condition of plasma retained by Earth's magnetic field is determined by the interaction of Earth's magnetic field with the solar wind, which explains the relationship between terrestrial magnetic storms and solar flares (K. P. Belov, N. G. Bochkarev, 1983).

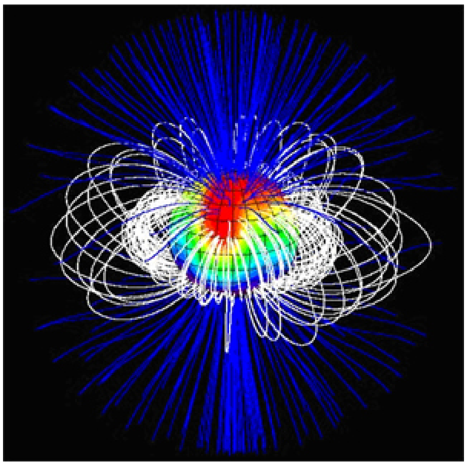


Fig.40. Earth's magnetic field
http://www.ast.obs-mip.fr/users/donati//press/images/moira.gif

The magnetic field intensity at Earth's surface highly depends on the geographical location, being about 0.5 Oe (50 microT) on average, about 0.34 Oe at the magnetic equator, and 0.66 Oe at the magnetic poles.

This intensity rises sharply near magnetic anomalies, reaching, for example, 2 Oe inside the Kursk Magnetic Anomaly. Periodically, Earth's magnetic field experiences disturbances called magnetic pulsations resulting from the excitation of hydromagnetic waves in Earth's magnetosphere. The pulsation frequency ranges from several millihertz to one kilohertz (V. A. Troitskaya, A. V. Guglielmi, 1969).

The geomagnetic field is not so constant and varies from time to time. For instance, some 2500 years ago the strength of the magnetic field was 50% higher than it is today.

The so-called inversions of the geomagnetic field, or geomagnetic reversals, when the positions of the north and south magnetic poles become interchanged, have occurred over and over throughout Earth's history. Along with inversions of the geomagnetic poles, there are less dramatic shifts of the geomagnetic field, the so-called "excursions," when the geomagnetic poles migrate rapidly to rather great distances but no geomagnetic reversal takes place. Earth's history has seen repeated occurrences of "excursions" of the geomagnetic poles when the North geomagnetic pole traveled towards the equator and reversed upon reaching it, returning to its former location.

It is hard to overestimate the importance of the geomagnetic field for the existence and evolution of life on Earth, for the lines of force of the magnetic field create a kind of a magnetic shield around the planet that protects Earth's surface from cosmic rays pernicious to all living things, and from the influx of charged particles of high energies.

The North geomagnetic pole is now located in the Canadian Arctic and continues to drift northwestwards, while the South geomagnetic pole is located off the coast of Antarctica, south of Australia.

Mandea and Dormy (2003), summarizing their ground observations and discussing the movement of the North geomagnetic pole, stated that its velocity "has more than doubled in the last 30 years, reaching the huge velocity of about 40 km per year in 2001". A subsequent model of time change of Earth's magnetic field (Olsen, et al., 2006) showed that the North Magnetic Pole's movement accelerated further, reaching 50 kilometers per year in 2000 and 60 kilometers per year in 2003. However, the North Magnetic Pole has decelerated slightly since 2003 and currently moves with a velocity slightly exceeding 50 km per year. Meanwhile, during the same time period, the South geomagnetic pole was moving with a constant speed of about 5-10 kilometers per year. The positions of the North and South geomagnetic poles are shown in the updated version of the CHAOS model (Olsen, et al., 2006), which includes more recent satellite data with ground observations (Newitt, et al., 2002).

According to a forecast by N. Olsen and M. Mandea (2007), the North geomagnetic pole will be closest to the North Geographic Pole (at a distance of 400 kilometers) in 2018, and will continue to move towards Siberia.

Studying the geomagnetic reversals and sea level fluctuations in the Phanerozoic Era has enabled a number of researchers to conclude that there is a certain correlation between those processes (E. E. Milanovskiy, A. G. Gamburtsev, 1998). The intensity of Earth's magnetic field in the past has also been subject to significant fluctuations. For instance, a study by G. N. Petrova and A. G. Gamburtsev established the existence of rhythms in the paleointensity of the geomagnetic field, predominated by rhythms with periods of 20-25 ka, 70 ka, 160-170 ka and other, though less distinct, periods (G. N. Petrova, A. G. Gamburtsev, 1998).

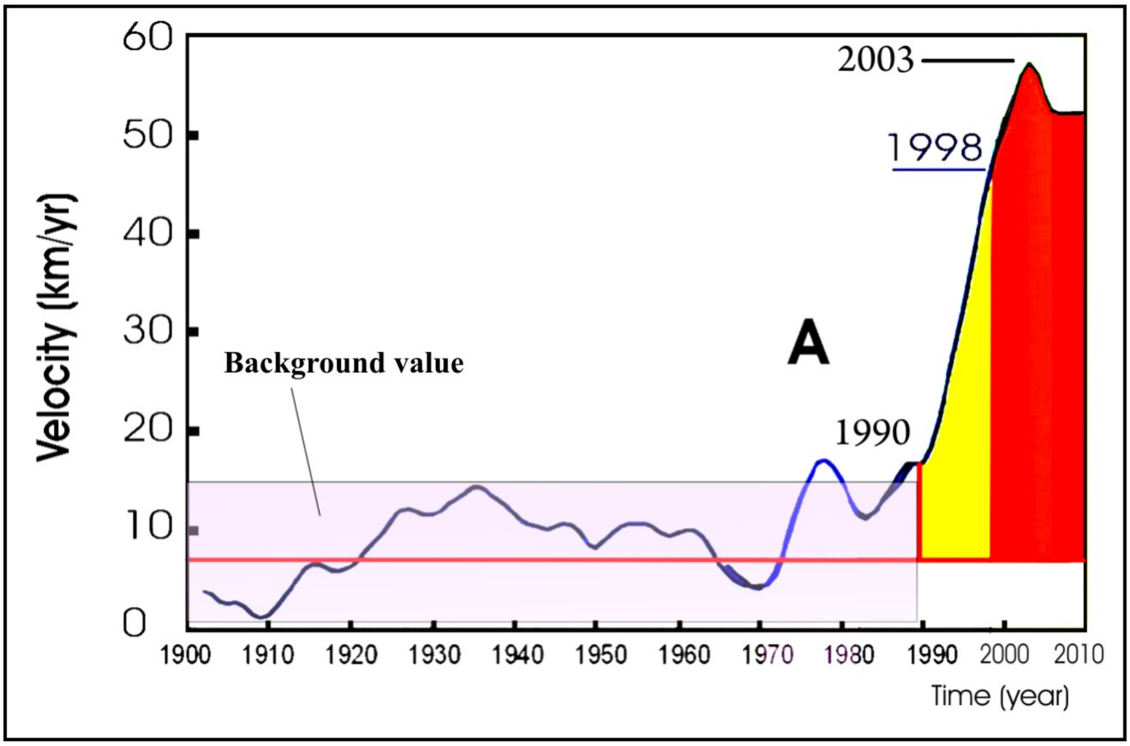


Fig. 41. Graph of velocity of North Geomagnetic Pole movement
(N. Olsen and M. Mandea, 2007)
http://geo-change.org/Pdf/Will_the_Magnetic_North_Pole.pdf

Fig. 41 contains a graph showing the movement of the North geomagnetic pole. As can be seen from the graph, the North geomagnetic pole's drift rate had increased almost fivefold by the late 1990s as compared to 1980. This fact might point to a substantial change in energy processes within Earth's core, which form the geomagnetic field of our planet. No doubt the observed phenomenon may be indicative of the beginning of another cycle of surge in Earth's endogenous activity.

To what further consequences may the vastly accelerated displacement of the North Magnetic Pole lead? Given that a decrease in Earth's magnetic field intensity accompanies this process, it can be assumed that global climate change will be influenced as well. There are so-called "cusps" in the polar ice cap areas – polar gaps that have increased in size in recent years. Radiation particles from the solar wind and interplanetary space enter Earth's atmosphere and hit its surface through those cusps, which means that huge amounts of extra matter and energy get into the polar areas resulting in "heating" of polar caps. Naturally, changing of the positions of the geomagnetic poles also causes shifting of the cusps and, consequently, displacement of the areas of high flux of solar energy into Earth's atmosphere and towards its surface. This process is followed by a redistribution of cyclones and anticyclones across the planet, leading to serious global climate change (V. E. Khain, E. N. Khalilov, 2008, 2009).

5.2. VARIATIONS OF ANGULAR VELOCITY OF EARTH'S ROTATION

Irregularity of Earth's diurnal rotation rate was found as early as in the beginning of the twentieth century. According to V. M. Kiselev (1980), these variations are mostly expressed in three ways: 1. the rotation axis changes its spatial orientation; 2. the rotation axis changes its position relative to Earth's surface; 3. the angular velocity of Earth's rotation is variable relative to the instantaneous axis.

Changes in the spatial position of Earth's axis are mainly caused by the gravitational influence of the Moon, Sun and Solar system's planets on Earth. This value can be calculated quite accurately. Much more difficult is the case with the second and third aspects, which manifest themselves in the form of, respectively, movement of the poles relative to Earth's surface and variations of Earth's angular velocity (Fig 42). All movements of the poles can be classified into three categories: a motion with a period of 14 months and variable amplitude of 0.1", discovered by Chandler; a motion with a period of one year and amplitude of 0.08" which corresponds to 2.5 m at Earth's surface; and the third one, a very slow and irregular secular motion of about 0.003", or 10 cm, per year on average (A. A. Mikhailov, 1984).

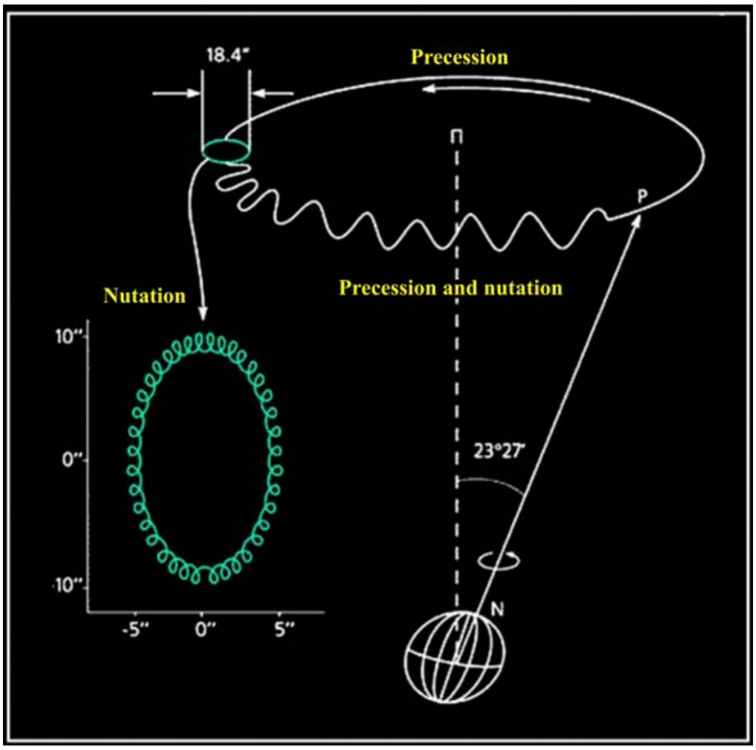


Fig. 42. Earth's precession and nutation diagram
http://vivovoco.ibmh.msk.su/VV/JOURNAL/NATURE/08_04/UNSTABLE.H

The Chandler motion reflects the free movement of the poles. Today, there is no definite answer explaining the causes of such fluctuations; however, there are various hypotheses including those connecting these fluctuations to large earthquakes and volcanic eruptions. Annual fluctuations are associated with meteorological phenomena: deposition and melting of snow, winter clustering of air masses over Northeast Asia, when the atmospheric pressure becomes above normal. A pole's secular motion does not follow strict patterns and has, to date, no unequivocal explanation (A. A. Mikhailov, 1984).

However, these movement types are not dealt with in this paper; therefore, attention will be focused on the irregularity of Earth's diurnal rotation rate. There are three main aspects usually singled out as to variations of the length of the 24-hour day: 1) Secular changes of 1-2 ms per 100 years, 2) Seasonal variations with an amplitude of about 0.5 ms, and 3) Irregular yearly changes whose magnitude exceeds secular changes by more than a factor of ten.

Secular changes in the day length are mostly associated with the effect of tide-raising forces resulting from Earth's gravitational interaction with the Moon and the Sun. Seasonal variations of Earth's angular velocity are due to the changes in zonal atmospheric circulation during the year and partly due to lunar tides.

Isaac Newton first noticed irregular variations of Earth's rotation rate in 1875 when he was studying the motion of the Moon. The existence of the irregular changes of Earth's rotation became evident after the works of de Sitter and Spencer Jones, who found simultaneous changes in the mean motion of the Moon, Sun, Mercury, Venus, Mars, and the satellites of Jupiter, proportional to their mean motions. However, to date there is no general consensus as to what causes the irregular changes of Earth's angular velocity (V.M. Kiselev, 1980).

Fig. 43 contains a graph of irregular variations of Earth's day length from 1850 to 2000, smoothed out via 5-year running averages. There have been attempts by various researchers to put forward some concepts to explain the mechanism of irregular changes of Earth's diurnal rotation. W. Munk (1964) and S. Chapman (1960) reviewed studies on the interaction between the geomagnetic field and the interplanetary medium, and examined the possibility for this interaction to influence the variations of Earth's angular velocity. As Y. A. Bilde showed in his work (1976), noticeable changes of Earth's rotation speed can occur when the variation rate of an external magnetic field (for example, of ionospheric origin) is as close as possible to Earth's rotation rate. A work by J. Ginsberg (1972) provides some estimates for the torque resulting from the solar wind's interaction with the geomagnetic field, showing at the same time that this torque is not enough to explain the observed changes in Earth's day length. According to a hypothesis proposed in 1965, impulsive changes of Earth's diurnal rotation rate can be caused by electromagnetic interaction between Earth and solar plasma streams having force-free configuration of magnetic fields, called M-elements (V. I. Afanasiev, 1965). The concept was later elaborated upon in the paper of N. P. Benkov (1976), where he demonstrated that if the solar wind contains plasma formations with M-element features, then they can explain the sudden changes in Earth's diurnal rotation rate.

P. N. Kropotkin, N. N. Pariysky and other researchers attribute the observed variations of Earth's diurnal rotation rate to possible changes in its radius and shape: P. N. Kropotkin (1984), N. N. Pariysky (1984), V. E. Khain, Sh. F. Mehdiyev, E. N. Khalilov (1984, 1986, 1987, 1988, 1989).

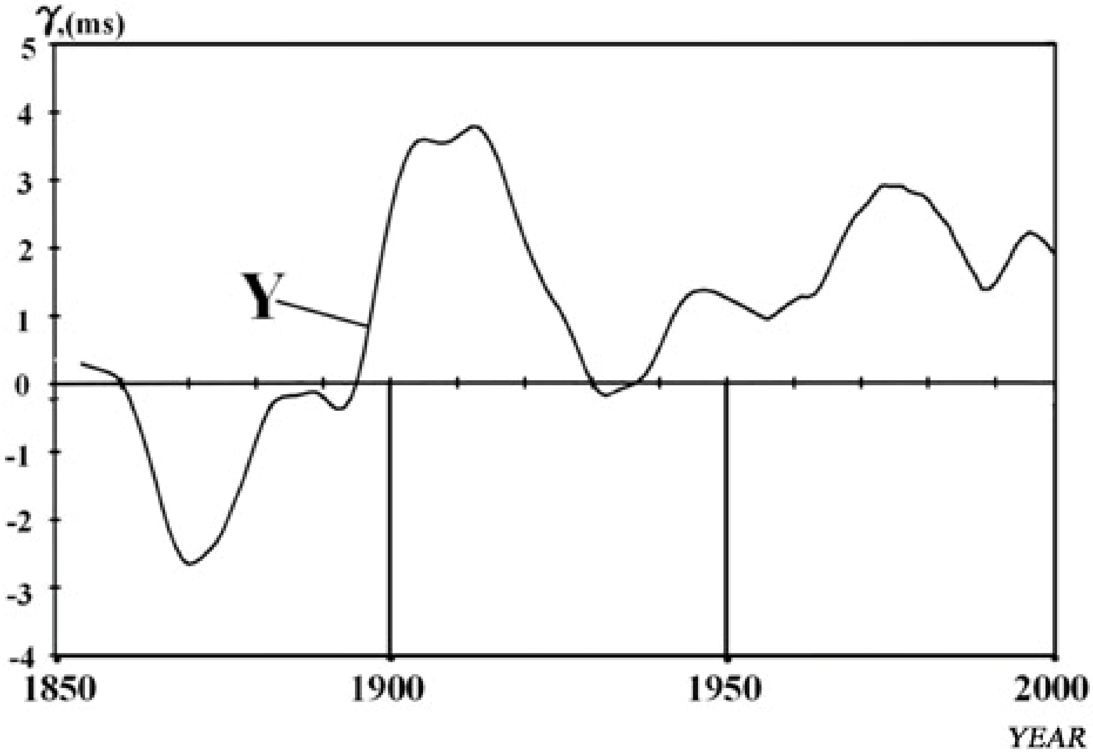


Fig. 43. Graph for day length variations between 1850 and 2000, according to data by V. M. Kiselev (1980)
Y is day length variations graph;
γ (ms) axis is changes in day length.

As P. N. Kropotkin pointed out in his work (1984), the periodic changes in Earth's radius are the original cause of both the cyclicity of tectonic processes' manifestation and the variations of Earth's angular velocity (Kropotkin, 1984). The same idea was simultaneously proposed by V. E. Khain, Sh. F. Mehdiyev and E. N. Khalilov (1984) who, similar to P. N. Kropotkin in 1984, drew a conclusion about the periodic changes in Earth's radius, which is reduced due to intensification of the subduction process and slowing down of the spreading process during the times when Earth is getting compressed, with the opposite process taking place during the periods of Earth's expansion.

It is noteworthy that P. N. Kropotkin in his work (1984) established a good correlation between the Chandler motions, Earth's angular velocity, and seismic activity that makes it possible to integrate all these processes into a single and logically valid system.

The theoretical calculations of Earth's elastic deformation and of respective changes in its moment of inertia, rotation, and surface gravity were made by N. N. Pariysky as early as 1954. Based on his calculations, N. N. Pariysky concluded that neither solar activity effects nor atmospheric phenomena could cause the observed changes in Earth's angular velocity. In his view, those variations might be the result of Earth's global deformation processes leading not only to the periodic changes of its radius, but also to the complex change of its shape. Judging from his description of this process, it must be quadrupole in nature, that is, Earth must "change its shape, expanding in the middle and polar regions and shrinking ten times more in the equatorial areas" (N. N. Pariysky, 1984).

Research findings on irregular changes of gravity, cited in a work by D. D. Ivanenko (1984), refer to the situation where the shrinking of Earth at the measuring point would be in line with the overall increase in Earth's moment of inertia, which is only possible if another part of the globe is expanding. According to V. M. Fedorov, there are some specifics regarding the distribution of catastrophic earthquakes in the diurnal cycle of Earth's rotation. Those specifics are explained by the cause-and-effect relationship between the distribution of earthquakes and the dynamics of constituent tide-rising forces of the Moon and Sun in connection with Earth's diurnal rotation.

While studying the correlation between Earth's global seismic activity and its rotation speed, a group of scientists (Friedmann, Klimenko, Polyachenko, 2005) came to interesting conclusions: 1) the correlation between the frequency of near-surface earthquakes and Earth's angular acceleration grows monotonically with increasing magnitude, and 2) correlations between the seismic activity and variations of Earth's angular velocity in subduction zones drawn along the latitude and the meridian are qualitatively different. At the end of their research, the authors conclude: "It is the processes of crustal compression and extension in the direction transverse to the rotation axis that are responsible for the changes in the annual seismic activity and angular velocity of Earth's rotation."

The most recent works by N. S. Sidorenkov, a well-known researcher of Earth's rotation irregularity, contain some interesting conclusions about the relation of Earth's rotation instability to hydrometeorological processes. Those studies formed the basis for the method of forecasting hydrometeorological characteristics, patented by scientists (N. S. Sidorenkov, P. N. Sidorenkov, 2002). N. S. Sidorenkov mentions the existence of a statistically significant correspondence between the tidal fluctuations of Earth's rotation speed and changes of weather processes in the atmosphere. Natural synoptic periods coincide with Earth's rotation modes. Lunar-solar zonal tides cause tidal fluctuations of Earth's rotation rate. According to those researchers, the evolution of synoptic processes in the atmosphere occurs not only because of the climate system's internal dynamics, but also under the control of the lunar-solar zonal tides (Sidorenkov, 2004).

The research conducted by a number of scientists (Zharkov, Pasynok, 2004) allowed them to conclude that the variations of Earth's angular velocity are very complex in nature, with completely different harmonics. When superimposed on each other, those harmonics create a very complex pattern of variation in Earth's day length. Based on that, V. N. Zharkov and S. L. Pasynok attempted to develop a theory of Earth's rotation, calling it a new theory of nutation. According to that theory, nutation of Earth's rotation is conceived as a quite complex though harmonious system that has a specific hierarchy of many superimposing nutational movements of the rotation axis of different degrees.

In our view, the variations of Earth's diurnal rotation are undoubtedly connected to the deformation processes and mass changes in the core-lithosphere - hydrosphere – atmosphere system. The aforesaid can be confirmed by the changes in the angular velocity of Earth's rotation and displacement of its axis following the catastrophic earthquakes in Indonesia (Sumatra, 26 December 2004) and Chile (27 February 2010), to name a few. The Indonesian earthquake of Dec. 26, 2004 shifted the position of the Geographic North Pole by 2.5 centimeters in the direction of 145 degrees east longitude. The change in the planet's rotation speed brought about a 2.68 microsecond increase in the day length, and the movement of the masses caused the planet's shape to alter. As a result of the earthquake, the planet's proportions changed by one ten-billionth, that is, Earth has become less flattened and more compact.

To exemplify the deviations of Earth's angular velocity from the predicted values, a graph drawn by N. V. Sidorenkov (2009) is given in Fig. 44.

Meanwhile, our comparison of the day length variations graph and solar activity (solar constant) graph yielded interesting results (Fig. 45). From the very start, the observer's attention is drawn to the presence of common trends in the nature of day length variations and the curve enveloping the peak values of solar constant variations.

The existence of a correlation between solar constant variations and changes in the day length might have a physical explanation. Let us build a logical chain. If solar activity affects geodynamic processes as well as processes in the hydrosphere (e.g. melting of ice, changes in water level in oceans and seas) and the atmosphere, this should lead to the redistribution of masses in these strata of Earth, changing Earth's moment of inertia and angular velocity. No doubt this issue requires more thorough research.

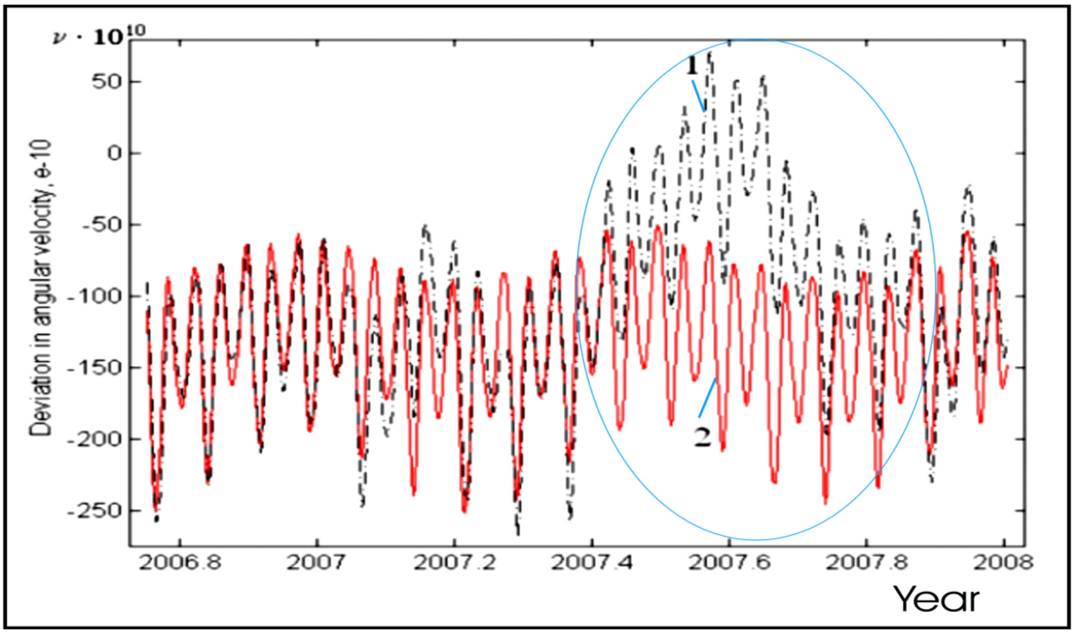


Fig. 44. Measured (dotted line) and forecast (red line) tidal fluctuations of Earth's rotation speed from 01 October 2006 to 31 December 2007 (N. S. Sidorenkov, 2009)

On the Y-axis are shown 10^-10 variations of angular velocity of rotation.
*To match both scales, a constant 150*10^-10 is added to all measured values.*
(http://geophyslab.srcc.msu.ru/article.php?story=20090505132607712)

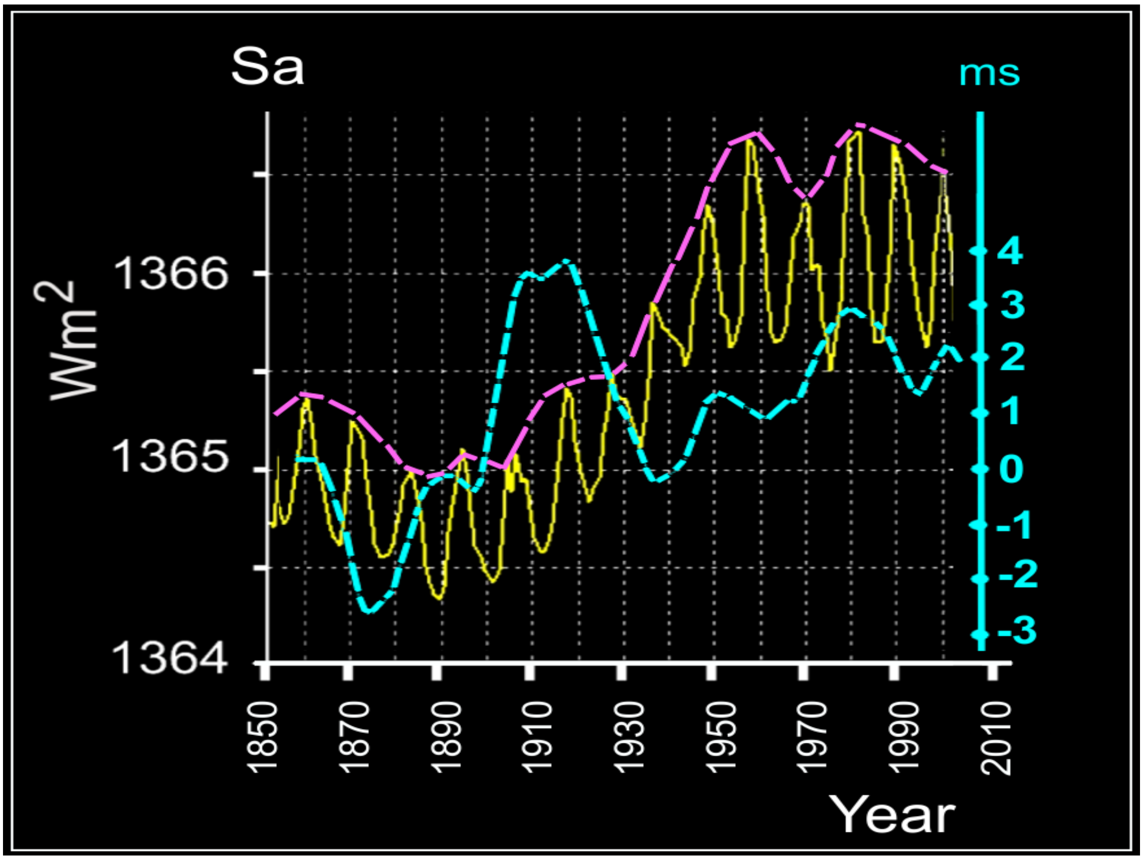


Fig. 45. Comparison of graphs of changes in Earth's day length and solar activity (solar constant), by E. N. Khalilov (2010)

Sa axis is solar constant values;

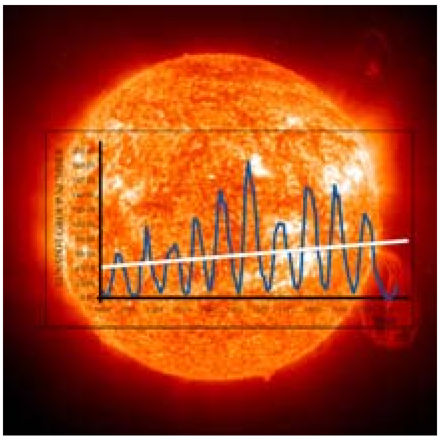
ms axis is day length variation values (in ms);

Graphs: solar constant variations graph is marked in yellow;

Earth's day length variations graph is marked in blue;

Graph passing through peak values of solar constant variations is marked in lilac.

5.3. SOLAR-TERRESTRIAL RELATIONS



The sun is the source of the most energetic outer space impact on our planet. Even rough estimates demonstrate that the thermonuclear fuel reserves inside the sun are enough to keep its physical condition unchanged for 10^{11} years. The sun annually radiates energy equal to $3x10^{33}$ cal and is a source of total electromagnetic radiation, an interplanetary plasma cloud, fast electrons, solar cosmic rays, etc. It loses most of its energy in the form of wave radiation (Y. I. Vitinsky, 1972, 1973, 1983; O. G. Shamina, 1981). The total amount of energy emitted into space by the sun can be determined experimentally based on the energy flow per unit area of Earth's surface; it is called the solar constant and averages 1.95 $cal/cm^2 \cdot min$, or about 1360 W/m^2 (E. A. Makarova, 1972); the total flux of radiant energy is $3.8x10^{26}$ J/sec.

The appearance of sunspots on the sun's surface is an indicator of increasing solar activity. In 1908, Hale discovered that sunspots have a magnetic field whose intensity reaches 2000 - 4000 gauss, whereas the strength of the sun's overall magnetic field is one gauss or less. At the beginning of a solar cycle, the spots appear at latitudes of 30^0 - 40^0, then shift towards the equator from the south and north and reaching their maximum at about 10^0 - 20^0 latitude, following which the number of spots decreases (V. M. Kiselev, 1980). Research findings indicate that the duration of sunspot drift towards the equator is about 11 years. At the end of each 11-year cycle, the magnetic field near the poles changes its polarity. Thus, the magnetic cycle of the sun is 22 years.

In the middle of the nineteenth century, S. H. Schwabe and R. Wolf established the fact that the number of sunspots changes with a mean periodicity of 11 years.

H. Babcock and R. Leighton (1961) (1969) proposed a model explaining the existence of the 22-year magnetic solar cycle. According to them, the rise of a magnetic flux tube to the photosphere's surface is accompanied by the appearance of an initial leading sunspot followed by a second one. In adjacent 11-year cycles, the leading sunspots have different polarity.

The relative sunspot number is one of the most common indices of solar activity. R. Wolf suggested that the solar activity index be determined according to the following formula:

$$W = k\,(10g + f) \tag{1}$$

where **W** is the Wolf number, **g** is the number of sunspot groups on the visible solar disk, and **f** is the number of sunspots (including nuclei and pores) in all groups. The value of the coefficient **k** depends on many factors: the particular methods of observations, visibility conditions at the time of observation, and the observer's personal characteristics, to name a few.

Another index of solar activity is the total sunspot area corrected for foreshortening, according to the formula:

$$S = \sum_i S_i S_{ec} \theta_i \tag{2}$$

where S is the area of the first sunspot, θ is arc sin (r_i/R), R is the radius of the visible solar disk, and r_i is the distance between its center and the sunspot being observed.

There is a statistical relationship between S and W with a correlation coefficient of +0.85 (V. M. Kiselev, 1980). The regression equation of S and W is as follows in equation (3) (Y. I. Vitinskii, 1976):

$$S = 16.7\ W \tag{3}$$

There are several more solar activity indices examined by Y. I. Vitinskii in his work (1973).

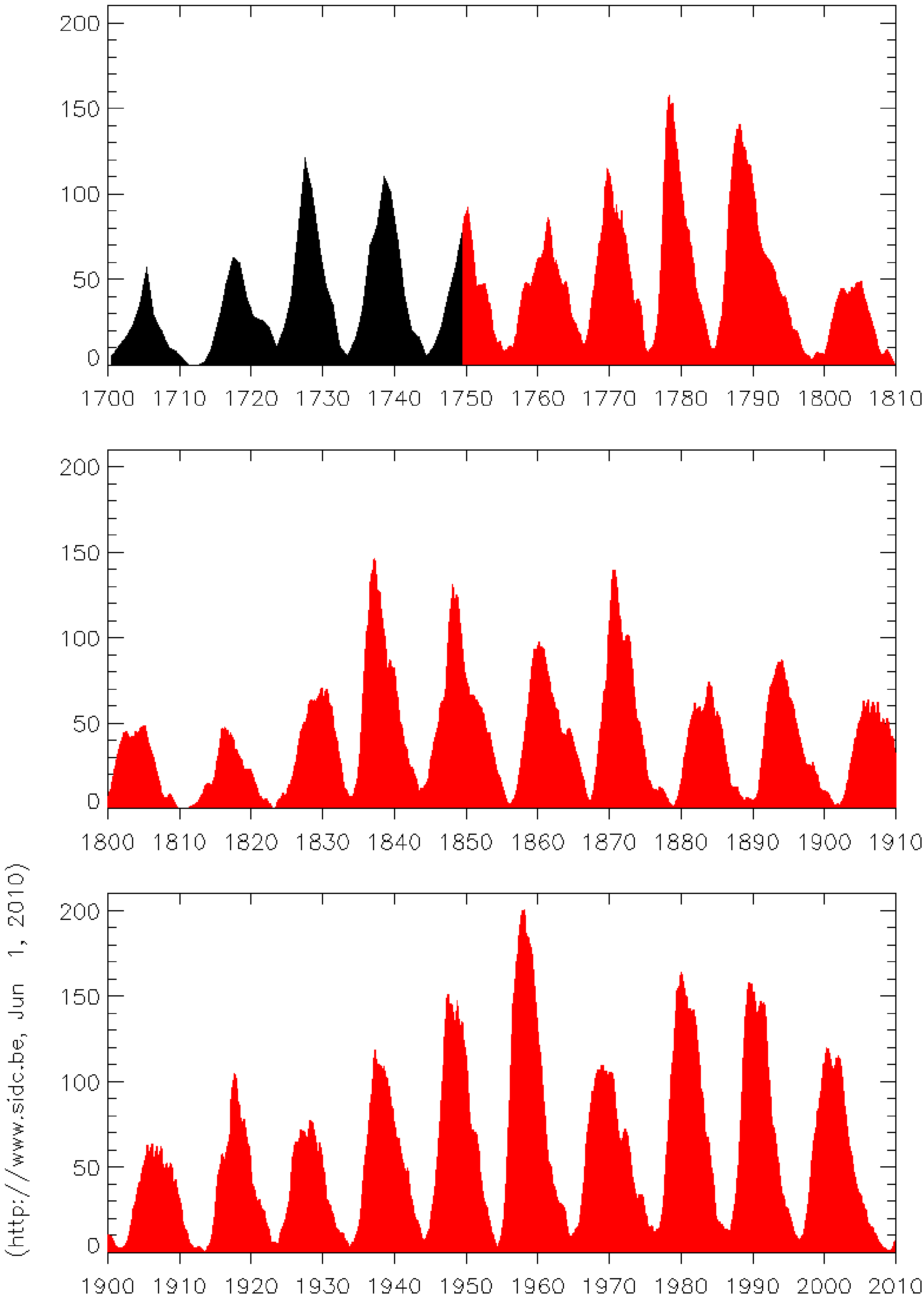


Fig. 46. Graph for Wolf numbers variations (W)
According to Data Analysis Center (SIDC),
Royal Observatory of Belgium

Fig. 46 contains a graph for Wolf number variations from 1700 to 2010.

The generally accepted numbering pattern for 11-year solar activity cycles is that the number zero is assigned to the 11-year cycle whose maximum value occurred in 1750. The average length of a 11-year cycle is considered to be 11.1 years. However, the actual duration of an 11-year cycle varies considerably; if determined by the epochs of minimum, the cycle period ranges from 9.0 to 13.6 years, and it is between 7.3 to 17.1 years when determined by the epochs of maximum (Y. I. Vitinskii, 1976).

While many researchers acknowledge the existence of 11-year and 22-year cycles of solar activity, cycles with longer periods are a matter of much debate. This is due to the unreliability of solar activity observation data earlier than 200 years ago.

Based on analysis of the historical records of observations of sunspots and polar auroras, D. Schove provides some data that makes it possible to estimate the changes of solar activity qualitatively over the last 2000 years (Y. I. Vitinskii, 1973). The data by D. Schove prove the reality of the existence of a cycle with a period of 80-90 years in the Wolf numbers variations and allows us to single out a cycle with an average duration of 554 years (Y. I. Vitinskii, 1976).

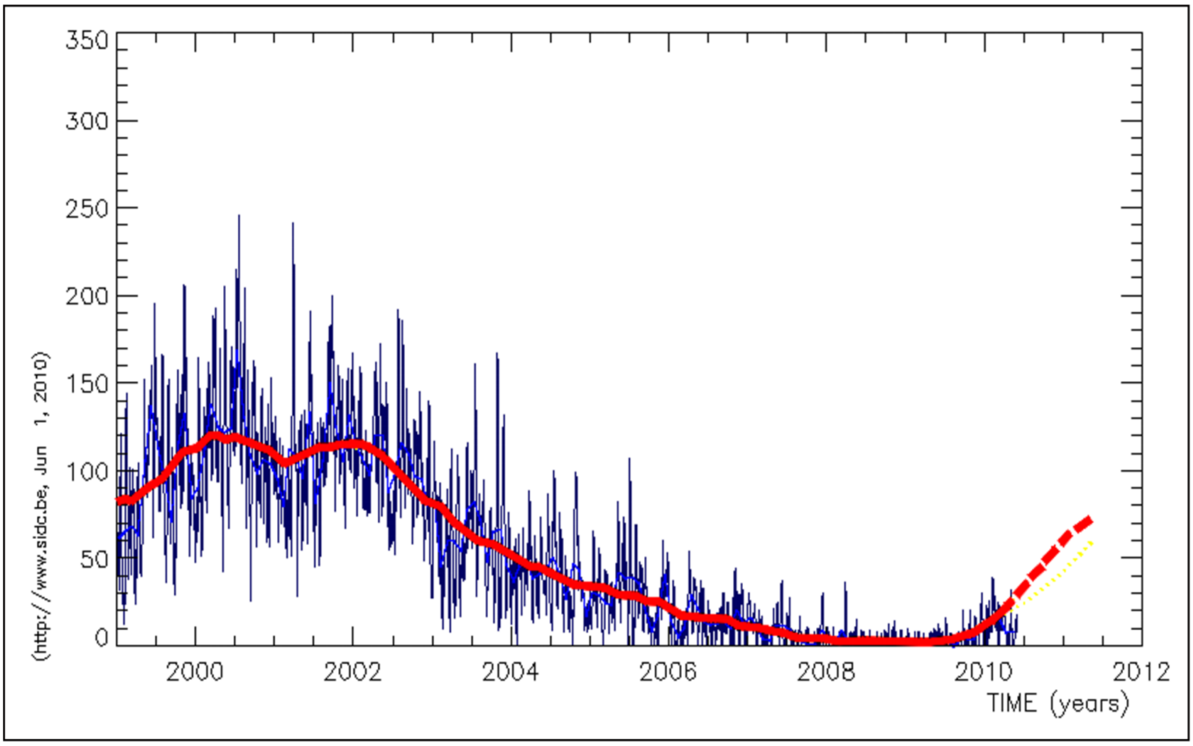


Fig. 47. Graph for Wolf numbers variations (W) from 2000 to May 2010
According to Data Analysis Center (SIDC),
Royal Observatory of Belgium
(http://sidc.oma.be/html/wolfjmms.html)

An attempt to characterize solar activity in a way not predominated by the 11-year cyclicity was made by A. Stojko and N. Stojko (1969). For that, they used the values of short-lived sunspots' areas W_1, variations between 1900 and 1963 of which were compared with Earth's diurnal rotation variations. These two phenomena correlate with

$$К = (+08); (+09).$$

Fig. 47 shows the solar activity change from 2000 to May 2010.

5.4. INTERRELATION BETWEEN SOLAR ACTIVITY AND GEODYNAMIC PROCESSES

It has become evident in recent decades that the significance of the solar activity's impact on terrestrial processes is much broader and deeper than previously thought. In our view, B. M. Vladimirsky in his work (2002) is quite right in his attempt to attribute many highly sensitive physical and chemical processes taking place on Earth to the influence of various components of solar activity. There are given some interesting examples of heliospheric parameters affecting anthropogenic processes.

Volcanic activity

Efforts to identify the statistical relationship between solar activity and volcanic manifestations have been made by a number of scientists: A. I. Abdurakhmanov (1976); N. K. Bulin (1982); Y. A. Hajiyev (1985); Sh. F. Mehdiyev, E. N. Khalilov (1984, 1985); S. V. Tsirel (2002); and V. E. Khain, E. N. Khalilov (2008, 2009), among others.

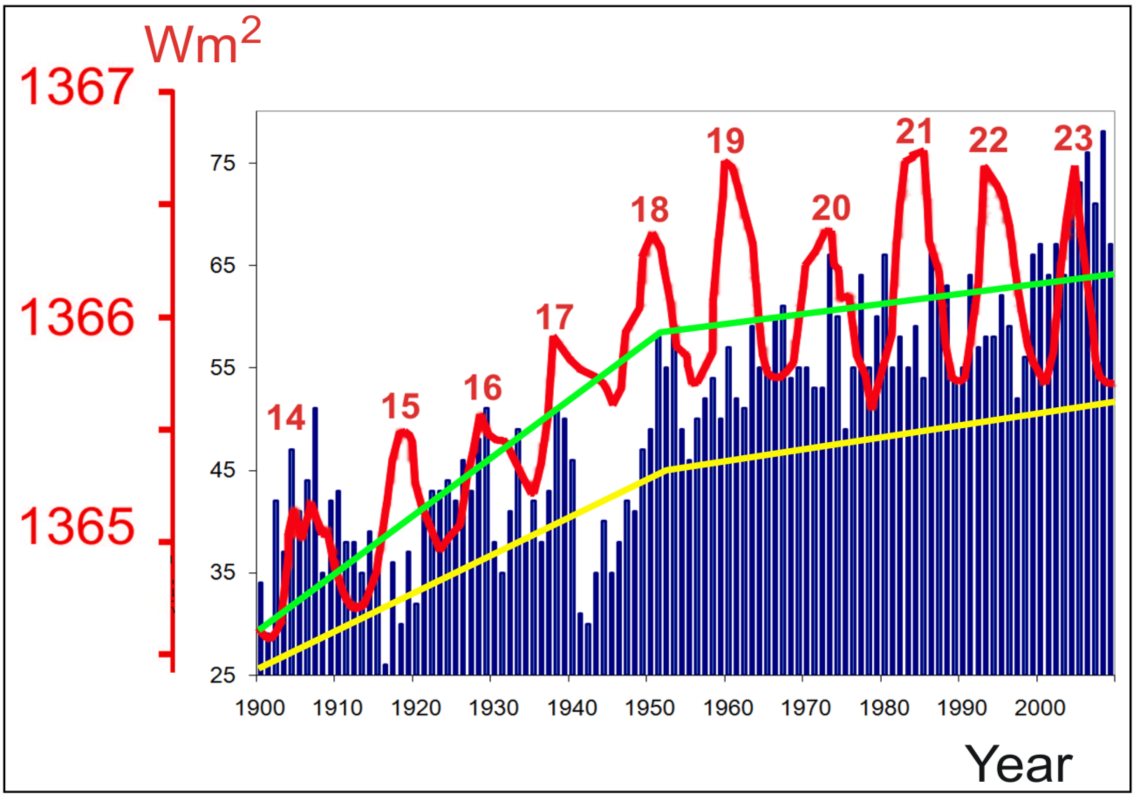
For instance, A. I. Abdurakhmanov, P. P. Firstov and V. A. Shirokov suggested a link between volcanic eruptions and the 11-year cyclicity of solar activity. According to the authors, years in the vicinity of maximum solar activity are unfavorable for volcanic eruptions, whereas the years most favorable for eruptions lie near the minimum of solar activity, mostly in the middle and end of solar cycle decline (A. I. Abdurakhmanov, 1976).

A number of researchers (Sh. F. Mehdiyev, E. N. Khalilov, 1987; V. E. Khain, E. N. Khalilov, 2008, 2009) indicate in their works that the effect of solar activity on earthquakes and volcano eruptions occurring in different geodynamic zones (in Earth's compression and extension zones) is not equal. They have divided all earthquakes and volcanoes according to their association with Earth's zones of compression (lithospheric plates' subduction and collision zones) and extension (rift zones). The research findings show that during increased solar activity periods there is generally a rise in the activity of Earth's compression zone earthquakes and a drop in the activity of Earth's extension zones. The authors conclude that due to non-simultaneity of the extension and compression processes, Earth experiences periodic deformations and changes in radius, which are reflected in Earth's angular velocity variations and global sea level fluctuations (V. E. Khain, E. N. Khalilov, 2008, 2009).

Of interest is the initial analysis of a possible correlation between solar activity and Earth's volcanic activity. We took the solar constant graph as a basic parameter of solar activity. It is this parameter that, in our view, most perfectly reflects the actual influx of solar energy into outer space, including towards Earth.

Fig. 48 provides a comparison of graphs for the solar constant and volcanic eruption numbers, smoothed out over 5-year running averages. Both images are identical, differing only in the graphical style for better perception. One can see a certain correlation between the 11-year solar activity cycles and volcanic activity cycles. The greatest overlap is observed in solar activity cycles #14, 16, 17, 18, 20, 22, and 23.

However, the most interesting correlation is, in our opinion, full coincidence in the general type of the straight-line solar and volcanic activity trends. Around 1950, the angle of the straight-line trends in both processes decreased sharply, meaning volcanic activity growth became less intense. This fact may be yet another indication of a possible solar activity impact on Earth's geodynamic activity.



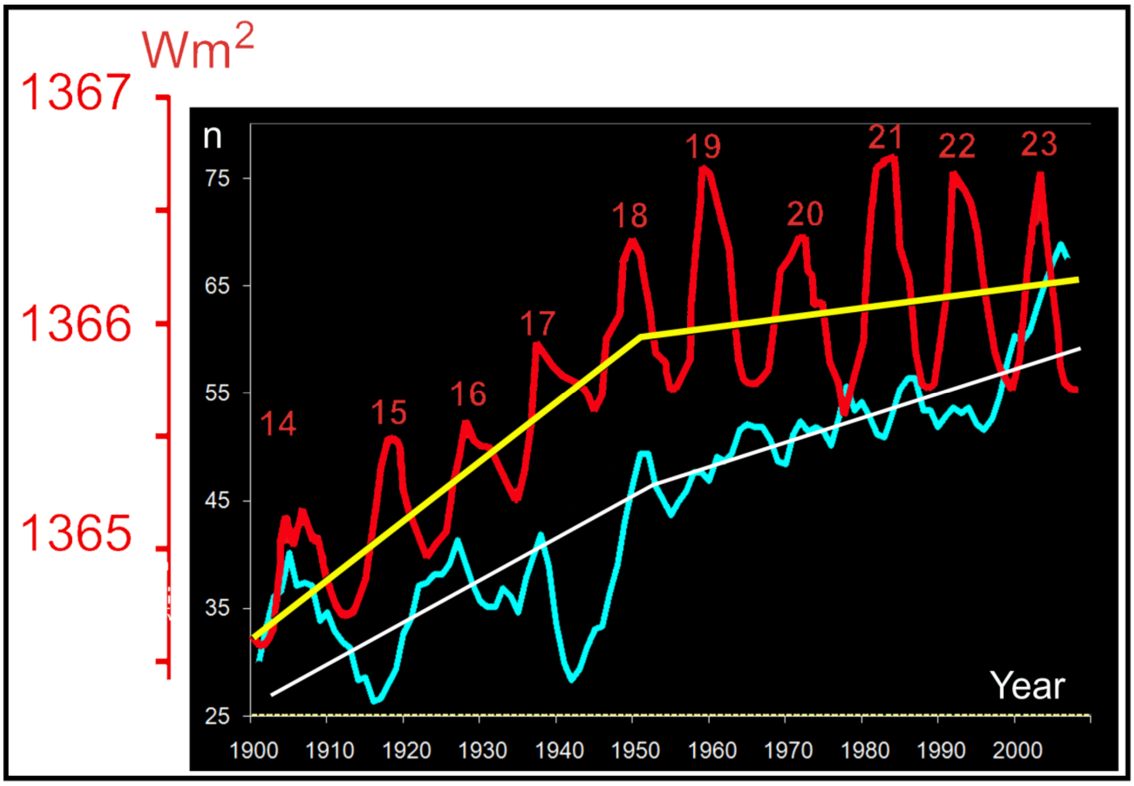


Fig. 48. Comparison of solar activity (solar constant) graph and volcanic eruption numbers smoothed out over 5-year running averages (by E. N. Khalilov, 2010)
Solar activity (solar constant) graph is marked in red;
Volcanic eruption numbers graph smoothed with 5-year averages is marked in dark blue and azure;
Lines reflecting general nature of parameter variations in all graphs are marked in green, yellow and white

Determination of a statistical relationship between the timelines of volcanic activity and solar activity suggests the existence of a similar link between solar activity and Earth's seismicity as well. The precondition for this supposition is the commonly known existence of geodynamic and correlated relations between volcanism and seismicity.

Seismic activity

A number of works have been dedicated to studying the statistical relations between the solar and seismic activity parameters: A. D. Sytinskii (1963-1998); P. M. Sychev (1964); John F. Simpson (1968); O. V. Lusmanashvili (1972, 1973); F. A. Makadov (1973); Y. D. Kalinin (1973, 1974); Gribin (1974); G. Y. Vasilyeva (1975); P. Velinov (1975); H. Kanamori (1977); V. D. Talalayev (1980); N. V. Kulanin (1984); Y. D. Boulanger (1984); Sh. F. Mehdiyev, E. N. Khalilov (1984, 1985); Jakubcova and M. Pick (1987); A. D. Sytinskii (1989); R. M. C. Lopes, S. R. C. Malin, A. Mazzarella (1990); O. A. Khachay (1994); L. N. Makarova, Gui-Qing Zhang (1998); A. V. Shirochkov (1999); X. Wu, W. Mao, Y. Huang (2001); I. V. Ananyin, A. O. Fadeev (2002); K. Schulenberg (2006); S. D. Odintsov, G. S. Ivanov-Kholodnyi and K. Georgieva (2007); and V. E. Khain, E. N. Khalilov (2008, 2009), among others.

Based on the study of about 2000 earthquakes in Earth's different regions for one solar activity cycle period between 1962 and 1973, G. Y. Vasilieva and V. I. Kozhanchikov concluded that the number of near-surface earthquakes increases with intensification of solar activity whereas the number of deep-focus earthquakes drops during the epoch of maximum solar activity. For all earthquakes, seismic activity in the years of both maximum and minimum solar activity is 10-30% higher when the planet crosses the galactic magnetic field's projection onto the ecliptic plane. It is claimed that earthquakes are electromagnetic in nature and related to the structure of the magnetosphere (G. Y. Vasilyeva, 1975). In a work by Y. D. Boulanger (1984), the number of earthquakes in USSR seismically active zones is compared with solar activity, based on which there is assumed to be a link between these phenomena as well. On comparing earthquake data for the periods between 1897-1958 and 1963-1968 with solar activity, Y. D. Kalinin points out that the high seismic activity areas appear consistently within the 11-year solar cycle at geographical latitudes more and more distant from the North Pole. Seismic activity is thought to be influenced by the solar wind (Y. D. Kalinin, 1973).

Elaborating the proposed hypothesis, Y. D. Kalinin in his subsequent work (1974) states that changes in solar activity bring about irregular fluctuations of Earth's angular velocity, affecting thereby seismic activity.

O. V. Lusmanashvili in his study (1972) mentions the possibility of solar activity impact on the distribution of Caucasian earthquakes. Reviewing earthquakes of the Caucasus between 1900 and 1970, O. V. Lusmanashvili concludes that there is a close link between the seismic activity of the Caucasus and Caspian Sea level fluctuation on the one hand and between sea level changes and solar activity on the other. When compared, a solar activity spectrum and a large Caucasian earthquakes recurrence spectrum showed high similarity (O. V. Lusmanashvili, 1972, 1973).

Other attempts to find a relation between Earth's seismicity and solar activity were made in a number of works by A. D. Sytinskii (1963 - 1998), as well as by P.M. Sychev (1964) and V. D. Talalayev (1980). They state in particular that Earth's overall seismicity represented by the total energy of earthquakes and the annual number of catastrophic earthquakes depends on the phases of the 11-year solar cycle. The highest seismic activity coincides with the epochs of maximum and minimum of the 11-year solar cycle. It is also pointed out that most earthquakes occur 2-3 days after the active region crosses the central solar meridian.

A study by A. D. Sytinskii (1973) suggests that the relation between seismicity and solar activity is realized via planetary atmospheric processes. The mechanism of dependence is as follows: due to increased solar activity there is a perturbation of the atmosphere's quasi-stationary state, leading to global redistribution of the atmospheric mass, i.e. to shifting of the Earth - atmosphere system's center of gravity and consequently, to distortion of Earth's figure.

As A. D. Sytinskii (1998) points out, seismicity's dependence on the 11-year cycle, discovered by him earlier was verified and confirmed by experimental forecasting of Earth's overall seismicity and that of its specific regions. Earth's seismic activity maxima were predicted for the period from 1963 to 1995. I. V. Ananyin and A. O. Fadeev in their works (2002) come to the conclusion about the existence of correlation between seismic activity variations, average annual temperatures at Earth's surface and solar activity. They see this correlation as a possible basis for the solar activity impact on both average annual temperatures and seismic activity.

I. K. Gribin in his work (1974) examines the causes of the devastating 1982 California earthquake in the San Andreas Fault area. He considers opposition of the Solar system's key planets and solar activity growth with an 11-year period as the main forces triggering the earthquake. The impact of the 11-year solar activity cycle on Earth's seismicity is also mentioned in F. A. Makadov's work (1973). In a study by I. F. Simpson (1968), solar activity is seen as a trigger mechanism to defuse tensions in Earth's interior.

V. M. Lyatkher's study indicates that the course of changes of the average interval between large earthquakes corresponds to solar cycle length variations. It is pointed out in particular that a quasi-periodic component with a period of about 60-100 years is observed in solar activity variations. The discovered correlation between solar activity and the frequency of large earthquakes suggests that local seismicity characteristics identified on the basis of time-limited statistical material can also vary in time with about the same periodicity as the smoothed solar cycle lengths.

John F. Simpson (1968) considers solar flares to be a trigger for large earthquakes in areas where the mechanical stresses have reached the critical values. However, he points out that solar flares should not be seen as an earthquake-causing factor.

It should be noted that there are also studies that have found no clear relationship between Earth's seismicity and solar activity. For instance, Van Gils who has analyzed more than 20000 weak earthquakes between 1910 and 1945 declared the absence of any relation between solar activity and low seismicity.

Chinese scientist Gui-Qing Zhang (1998) concluded that earthquakes often occur around the minimum years of solar activity. In the peak years of solar activity, the number of earthquakes is relatively lower than around the peaks.

A study by a group of scientists (S. D. Odintsov, G. S. Ivanov-Kholodnyi and K. Georgieva, 2007) showed that the maximum seismic energy released by earthquakes within the 11-year solar activity cycle is observed during the cycle's decline phase and before its solar maximum. They found that the maximum in the number of earthquakes directly correlates to the moment of sudden increase in the solar wind velocity.

Of certain interest is, in our view, a work by K. Schulenberg (2006, http://theraproject.com/sitebuildercontent/sitebuilderfiles/WPGMpresentation.pdf) taking a non-standard approach to the sun's possible effect on earthquakes. It reveals quite a convincing statistical relationship between the periods preceding sunrise and following sunset, and large earthquakes in China. According to the author, the physical mechanism of the sun's influence on the ionosphere and lithosphere is different before sunrise and after sunset. It is sort of a trigger mechanism set off by the sun to discharge the crustal stress in the form of earthquakes.

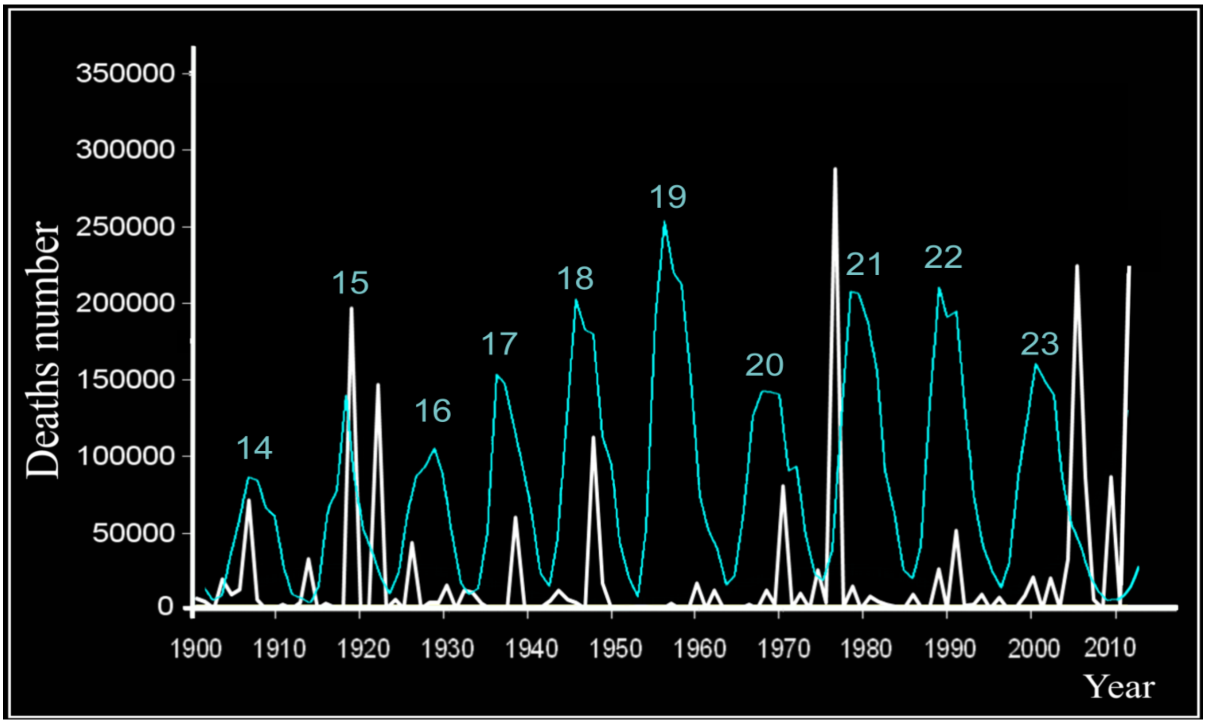


Fig. 49. Comparison of large earthquake caused fatality numbers graph (white) with solar activity graph (blue). By E. N. Khalilov, 2010

Fig. 49 shows a comparison of graphs for solar activity (Wolf numbers) and for the number of killed during strong earthquakes from 1900 to May 2010. Even a cursory glance at the graphs reveals a high correlation. The more detailed analysis allows us to notice that, except for solar activity cycles #21 and 23, the remaining cycles correspond to the higher numbers of dead. A very high maximum of 1977 fatality numbers occurred at the beginning of the 21st cycle whose maximum was in 1980 while the maximum number of 2004 deaths falls on the end of 23rd solar activity cycle.

Obviously, the correlation between numbers of dead during large earthquakes and solar activity implies the existence of a similar link between large earthquakes and solar activity.

Fig. 50 contains a comparison of graphs for numbers of large magnitude (M>8) earthquakes and solar activity for the period from 1900 to May 2010. The large earthquakes graph is drawn with 5-year running averages. The high correlation between the two graphs can be seen even at primary visual analysis. Of 10 reviewed 11-year solar activity cycles, only two (16th and 17th solar activity cycles) do not coincide with the cycles of increased numbers of large earthquakes.

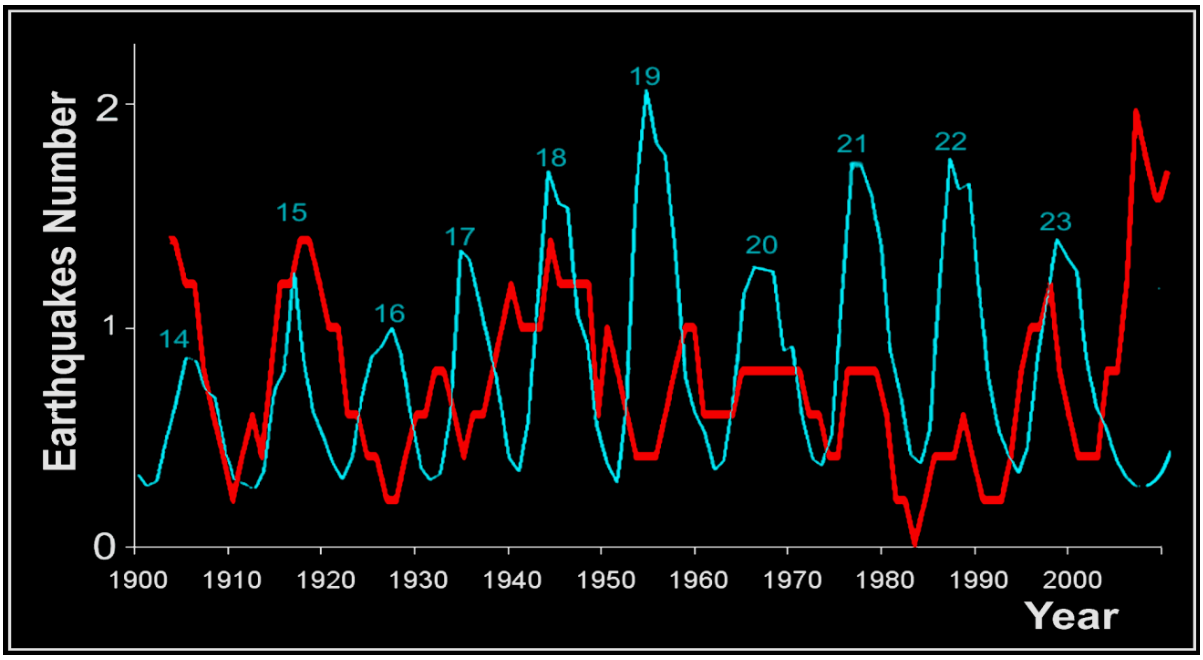


Fig. 50. Comparison of large (M>8) earthquake numbers graph (red) with solar activity graph (blue). By E. N. Khalilov, 2010

In some cases, there is a slight misalignment between the solar and seismic activity cycles. For instance, the seismic activity cycle is shifted by 2 years towards the end of the 19th solar activity cycle. Nevertheless, in general, the picture of the high correlation between these two processes is quite impressive.

Tsunami

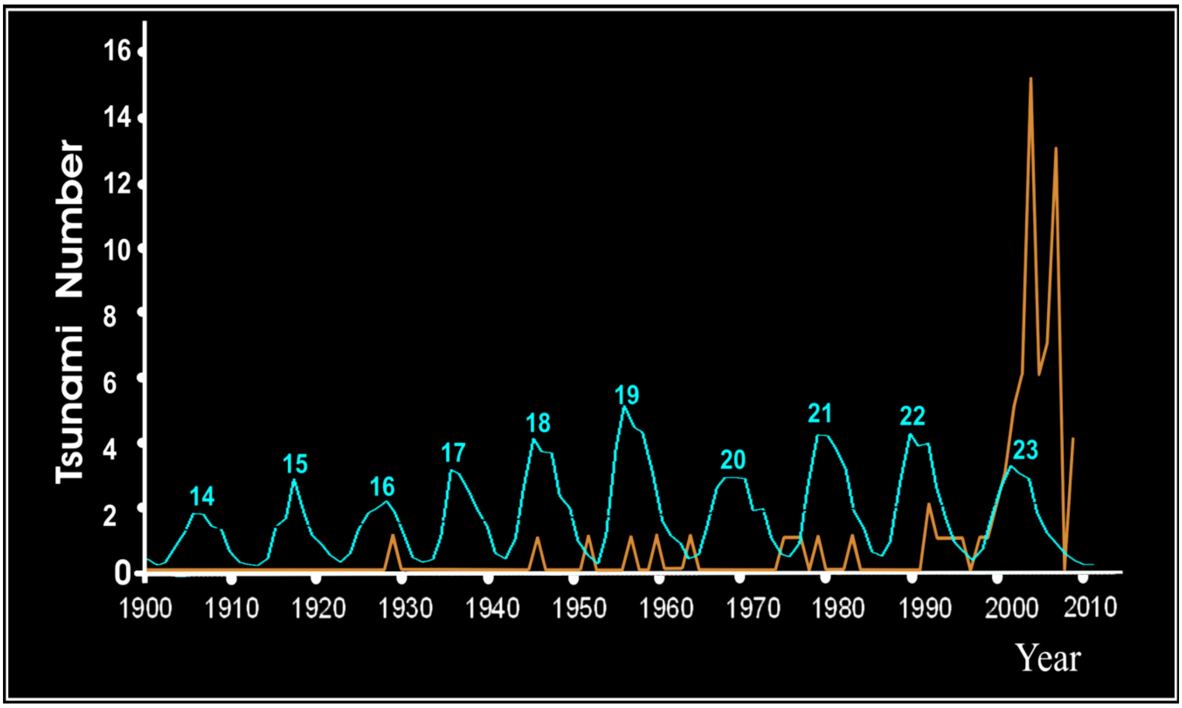


Fig. 51. Comparison of large tsunami numbers graph (yellow) with solar activity graph (blue). By E. N. Khalilov, 2010

Large earthquakes are known to be closely associated with tsunamis, which usually result from strong earthquakes in the aquatic environment. Fig. 51 contains a comparison graph for solar activity and large tsunamis. As can be seen from the comparison, most powerful tsunamis have occurred during high solar activity times, that is, during solar activity cycles #16, 18, 19, 21, 22, and 23.

CONCLUSIONS

- From 1980 to present, the North Magnetic Pole's drift velocity has increased by more than 500%. This might indicate the beginning of an increase in Earth's geodynamic activity since Earth's magnetic field is formed as a result of complex energy processes in its inner and outer core.

- It has been established that variations of the angular velocity of Earth's rotation are correlated with the solar constant trend.

- A correlation between the solar and volcanic activity trends has been found.

- A direct correlation has been discovered between solar activity (11-year cycles) and the numbers of large earthquakes, of fatalities during large earthquakes, and of tsunami.

These conclusions are provisional and intended for better understanding of the research findings presented in the following sections.

CHAPTER 6.
GLOBAL "ENERGY SPIKE"

6.1. INTERRELATION BETWEEN DYNAMICS OF DRIFT RATE OF EARTH'S MAGNETIC POLES AND NATURAL DISASTER STATISTICS

It is known that Earth's endogenous activity in the form of earthquakes and volcanic eruptions is merely an external manifestation of our planet's internal energy, the bulk of which comes from its core and adjacent layers. Today, science has yet to obtain accurate and definitive information on release mechanisms of the Earth's internal energy that causes convection in the mantle and, consequently, movement of lithospheric plates. Meanwhile, it is known for certain that Earth's magnetic field has been formed by the processes occurring in the inner and outer core of our planet. The Earth's magnetic field formation model generally recognized to date was reviewed in previous sections.

One of the most distinct indicators of energetic processes in Earth's core is the speed of movement of its geomagnetic poles. There are different theoretical models that explain the drift of the geomagnetic poles; however, regardless of the model considered, it is obvious that a significant "leap" in the velocity of the North geomagnetic pole points to an energy increase at the level of Earth's core and surrounding layers. The leap in the velocity of the North Magnetic Pole by more than 500% might be related to significant changes in the energy processes in its inner and outer core. In that case, the release of Earth's internal energy must lead to increased planetary endogenous activity in the form of large earthquakes and volcanic eruptions.

On the other hand, a sharp change in the speed of Earth's North Magnetic Pole movement must also have an impact on global climate change. It is known that Earth's magnetic field influences plasma motion, electric currents, and general electrical properties of the upper region of the ionosphere. In addition, Earth's geomagnetic field captures high-energy charged particles and has a significant effect on magnetospheric processes.

The fivefold acceleration of the North Magnetic Pole's drift and opening of cusp angles alters the energy potential of the ionosphere and upper atmosphere, with a possible impact on the redistribution of cyclones and anticyclones. This idea requires further thorough study and is put forward in order to show a probable physical mechanism of Earth's geomagnetic field redistribution influencing global climatic processes.

Numerous studies by various authors (Campbell, 2003; Newitt, et al., 2002; Barton, 2002; Alldridge 1987; Kuznetsov, 1990, 1997) were dedicated to the development of a mathematical model describing the formation of Earth's magnetic field.

As V. V. Kuznetsov points out in his works, the magnetic poles' drift (its direction and speed) is one of the most important characteristics of geomagnetism.

Meanwhile, many questions can be answered by studying the possible correlation between changes in the velocity of Earth's North Magnetic Pole and the dynamics of numbers of large earthquakes, volcanic eruptions, and tsunamis.

Fig. 52 shows a comparison of graphs for the North Magnetic Pole's drift rate variations, numbers of large earthquakes, tsunamis, and volcanic eruptions between 1900 and 2010.

A comparative analysis makes it possible to identify two characteristic cycles, designated A and B, of increased statistical values for each graph's parameters. Cycle A covers the period from 1970 to 1983 and cycle B from 1998 to the present. Within cycle A, an acceleration of the North Magnetic Pole's drift is observed, from approximately 8 to 18 km per year.

In the same period of time, there was a surge in the number of people killed during large earthquakes, along with an increase in the numbers of large earthquakes, catastrophic tsunamis, and volcanic eruptions. Although the most pronounced increase is in the numbers of large earthquakes, of earthquake victims, and of volcanic eruptions, the presence of an increased activity cycle for large tsunamis is also clearly visible for that period.

Let us take the second and most pronounced cycle of a sharp rise in all the statistical indicators, which is cycle B. This cycle covers the period from 1998 to the present. During this period, there was a surge in all the statistical indicators of the reviewed disasters. For instance, the increase in the drift rate of the North Magnetic Pole by 1998 had approached its maximum, that is, about 50 km per year.

The graphs clearly show that 1998, a turning point for all the reviewed disasters, saw a sharp growth in the numbers of large earthquakes and earthquake fatalities, as well as in the numbers of major tsunamis and volcanic eruptions. It is noteworthy that the statistical parameters for this period had been rising at an exponential rate and now all the statistical indicators are at a stage of steadily continuing growth, as evidenced by the deeper investigation of the nature of these processes' dynamics using trend analysis in Appendix 1.

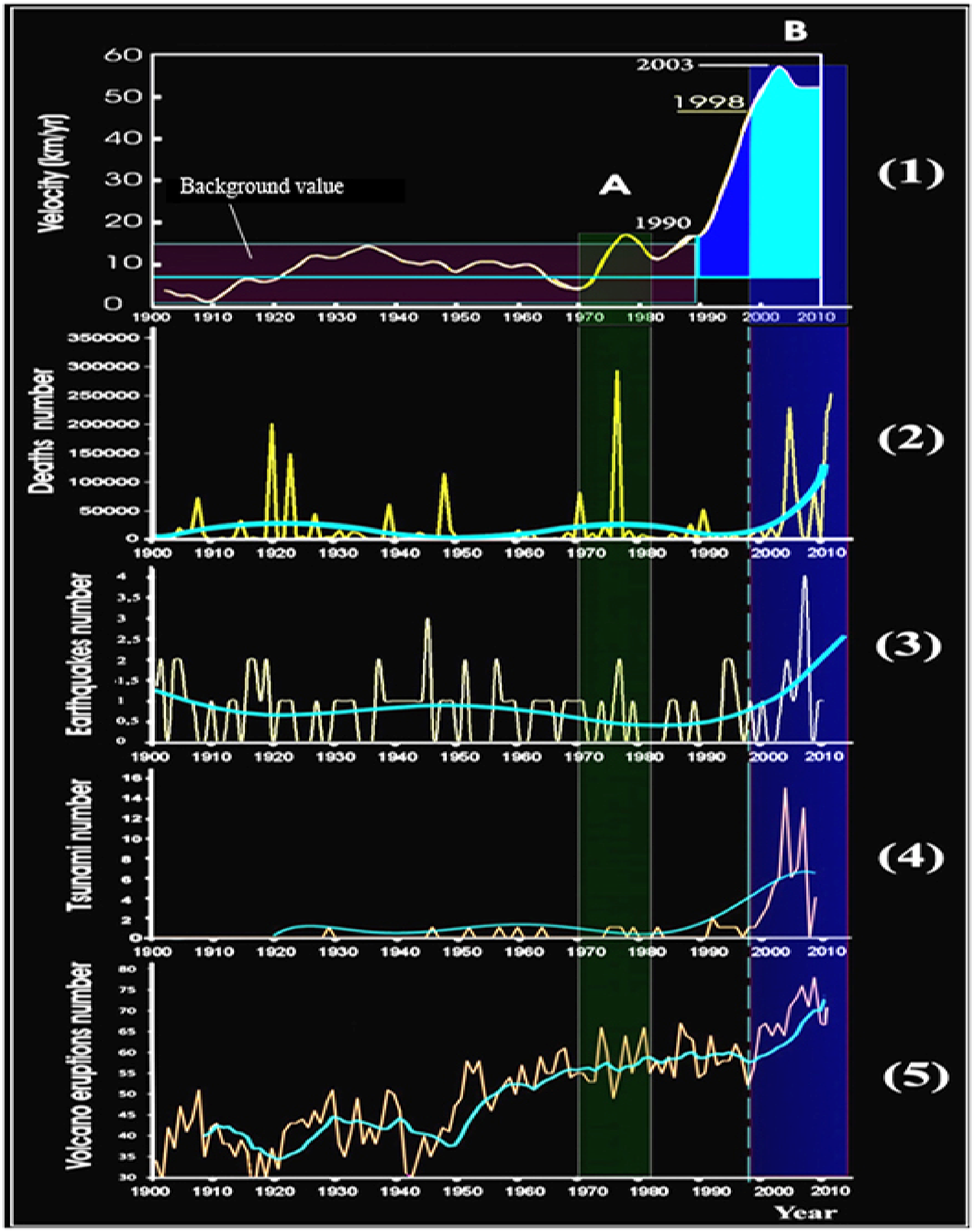


Fig. 52. Comparison of graphs for change of North Magnetic Pole's drift rate and parameters reflecting dynamics of natural disasters between 1900 and 2010 (by E. N. Khalilov, 2010)

(1) – graph for drift rate of Earth's North Magnetic Pole;
(2) – graph for number of dead during large earthquakes;
(3) – graph for dynamics of large (M>8) earthquake numbers;
(4) – graph for dynamics of catastrophic tsunami numbers;
(5) – graph for dynamics of volcanic eruption numbers.

6.2. DYNAMICS AND INTERRELATION BETWEEN THE J_2 COEFFICIENT AND NATURAL DISASTER STATISTICS

Traditional natural disaster research does not include study of some geophysical parameters one of which is the J_2 coefficient. This coefficient is determined by measuring with the help of the satellite laser ranging systems.

In satellite laser ranging (SLR), a global network of stations gauges the instantaneous time of propagation of ultrashort pulses of light going from ground stations to satellites equipped with special reflectors, and reflected back. It ensures millimeter accuracy during instant measurement of distance. This data is stored for precise determination of the satellites' orbits as well as for various researches. SLR is the most accurate method available today for dealing with the geocentric satellite-Earth system, making it possible to carry out precise calibration of radar measurements and distinguish long-term equipment bias from secular changes in ocean topography. The capability to measure temporal variations in Earth's gravitational field and monitor the movement of a network of stations with due regard for the geocenter, along with its ability to control the vertical motion in an absolute system, makes SLR unique for modeling and estimating long-term climate change by providing a reference system for the post-glacial surge, changes in sea level, and volume of ice. SLR makes it possible to identify temporal redistributions of masses of the solid Earth, the ocean, and the atmospheric system. 25 years of obtaining data using SLR have helped create a reference model for Earth's standard, high-precision, long-wave gravitational field and for studying its temporal variations due to the redistribution of mass (http://ilrs.gsfc.nasa.gov).

To measure temporal changes in the gravitational field, SLR gauges mass redistribution effects within Earth's overall system. Decades of monthly values determined by satellite laser ranging of the second zonal harmonic of Earth's gravity provide an independent verification of the mass redistribution implied by the global atmospheric circulation models used to predict global climate change.

1998 witnessed the beginning of abnormal changes in some of Earth's geophysical parameters – a leap in J_2 coefficient values in particular. An article by Christopher Cox and Benjamin Chao published in the Science magazine has reported on new and completely unexpected findings about Earth's gravitational field variations. The authors used satellite laser ranging data over the last 25 years to determine long-term variations in the zonal coefficient of Earth's spherical harmonic of the second degree, the so-called J_2 coefficient. The J_2 coefficient reflects the dynamics of the ratio between Earth's equatorial and polar radii. It was decreasing for many years, supposedly due to the release of meltwater from the mantle since the ice age. Meanwhile, the latest data show that since 1998, J_2, has started to grow (B. Chao and C. Cox, 2002).

The satellite laser ranging (SLR) data shown in Fig. 53 indicate shifts in Earth's oblateness variations along the timescale. However, while the J_2 coefficient remained roughly constant at $-2.8 \bullet 10^{-11}$ per year from 1980 until 1997, the opposite $J_2(t)$ change has accelerated since 1998 in line with some unknown mechanism.

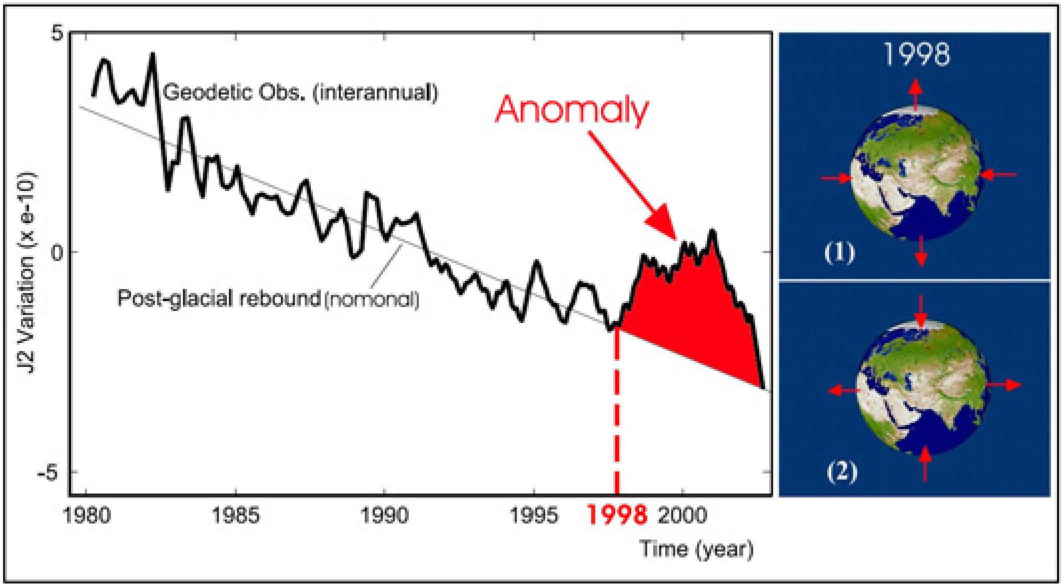


Fig. 53. Variations of J_2 coefficient values according to C. Cox and B. F. Chao, 2002

According to NASA, this process reflects Earth's expansion along the equator and its flattening at the poles, as shown in Fig. 53. NASA experts link the SLR data based deviations of the orbits of Earth's artificial satellites to global changes of Earth's gravitational field. Thus, as can be seen from the graph, a certain global-scale event occurred in 1998, causing a dramatic change of Earth's shape.

B. F. Chao (B. F. Chao, 2003) points out that, according to the model generally accepted today, the straight-line trend of the J_2 coefficient shown in Fig. 53 may indicate an increase in Earth's radius at the poles and, consequently, its reduction along the equator resulting from deceleration of Earth's rotation, which leads to the approximation of Earth's shape to spherical. At the same time, the leap in J_2 values observed in 1998 may signify a reverse trend in changing of Earth's shape, that is, a reduction of its radius at the poles and expansion in the equatorial areas. B. F. Chao's study (B. F. Chao, 2003) also contains a graph for earthquakes that occurred within the same period. He points out that earthquakes have a cumulative effect on Earth. During the past 25 years, earthquake-caused changes of J_2 may be a factor of 100 less than the observed anomalous value.

There have been a number of subsequent works attempting to attribute the soaring J_2 coefficient to melting of Antarctic ice and redistribution of water in the oceans.

As suggested in a study by Frank G. Lemoine and others (Frank G. Lemoine, et al., 2009), the J_2 leap may be a deviation belonging to a category periodically recurring in certain years. According to the authors, to observe these changes in the J_2 coefficient, an extra 2 mm difference between the equatorial and polar radii is needed.

Meanwhile, B. F. Chao in his work states that those factors are insufficient for such deviations of the J_2 coefficient to happen. Some studies examine the possibility of influence by some ultra-long-period gravitational-wave pulse which, having passed through Earth, quadrupolely altered its shape and the space-time continuum of near-earth space (E. N. Khalilov, 2004).

6.3. WHEN DID THE GLOBAL "ENERGY SPIKE" BEGIN?

Following a research by F. Deleflie, et al., 2003, it was concluded that the 1998 leap in the J_2 coefficient values could not be explained by the post-glacial rebound or the known cyclicity with a period of 18.6 years as the scale of those changes is much less than the effects observed. The authors believe that studying the relationship between the J_2 coefficient and geodynamic processes may shed some light on this problem.

Fig. 54 demonstrates a comparison of graphs for sea level fluctuations of the Indian Ocean and Western & Central Pacific Ocean with those of the Eastern Pacific and Atlantic oceans, as well as the overall graph for global sea level fluctuations.

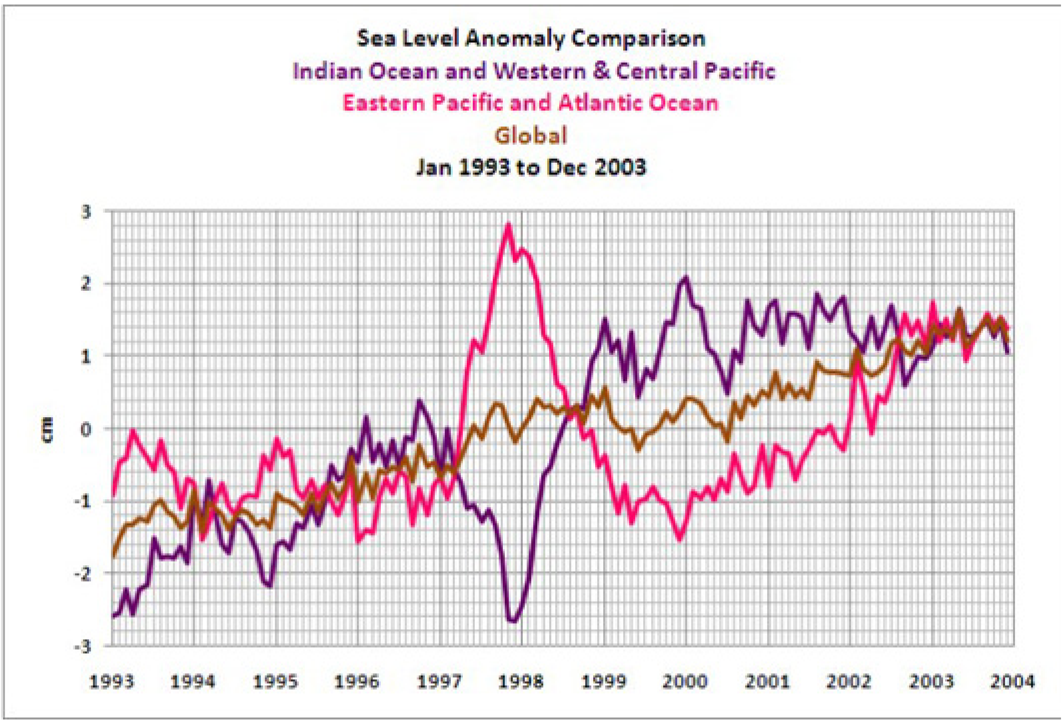


Fig. 54. Comparison of graphs for sea level fluctuations of Indian Ocean and Western & Central Pacific with those of Eastern Pacific and Atlantic Ocean, as well as overall graph for global sea level fluctuations
http://i29.tinypic.com/71oa6q.png

The comparison result obtained by the Climate Observations (Notes From Bob Tisdale on Climate Change and Global Warming http://bobtisdale.blogspot.com/2009/08/enso-is-major-component-of-sea-level.html) showed that between 1997 and 1999, sea level fluctuations of the Indian Ocean and Western & Central Pacific were out of phase with fluctuations of the Eastern Pacific and Atlantic oceans. While the level of the Eastern Pacific and Atlantic oceans began to rise sharply in 1997 with a peak in 1998 (about 3 cm), the level of the Indian Ocean and Western and Central Pacific Ocean was falling with a minimum in 1998 (about 3 cm).

This very surprising tendency requires a special study. It is the specifics of El Niño that explain those unusual variations in the levels of different oceans.

El Niño is a global oceanic-atmospheric phenomenon. As characteristic features of the Pacific, El Niño and La Niña are temperature fluctuations in surface waters of the tropical eastern Pacific Ocean. The circulation named thus by Gilbert Thomas Walker in 1923 is an essential aspect of the ENSO (El Niño Southern Oscillation) phenomenon of the Pacific.

ENSO is a set of interacting parts of a global system of ocean-atmospheric climate fluctuations occurring as a sequence of oceanic and atmospheric circulations. ENSO is the world's most famous source of interannual weather and climate variations (from 3 to 8 years). When there is a significant temperature rise in the Pacific, El Niño heats up and expands into the most of the tropical Pacific, as it is directly related to the intensity of the SOI (Southern Oscillation Index). While the majority of ENSO events occur between the Pacific and Indian Oceans, ENSO events in the Atlantic lag behind them by 12-18 months.

Fig. 55 shows a comparison of J_2 coefficient variations (top) with ocean level evolution graphs (bottom). As can be seen from the image, the timing of maximum values of ocean level variations coincides (1998) with the beginning of a sharp leap in the J_2 coefficient. So, a natural question arises: to what extent can the observed ocean level changes and El Niño processes cause the registered J_2 variations?

The "Climate Observations" study directly links the 1998 J_2 coefficient anomaly to El Niño processes. Meanwhile, as B. F. Chao and others (B. F. Chao, et al., 2003) point out in their article, studies of the J_2 coefficient have revealed correlations with northern and southern Pacific basin sea level changes.

However, even taking into account the pattern of the possible impact of water mass redistribution in the World Ocean, the actually observed effect of the J_2 coefficient is 3 times greater than that impact. Therefore, El Niño and other processes in the atmosphere and hydrosphere cannot explain the 1998 variations of the J_2 coefficient.

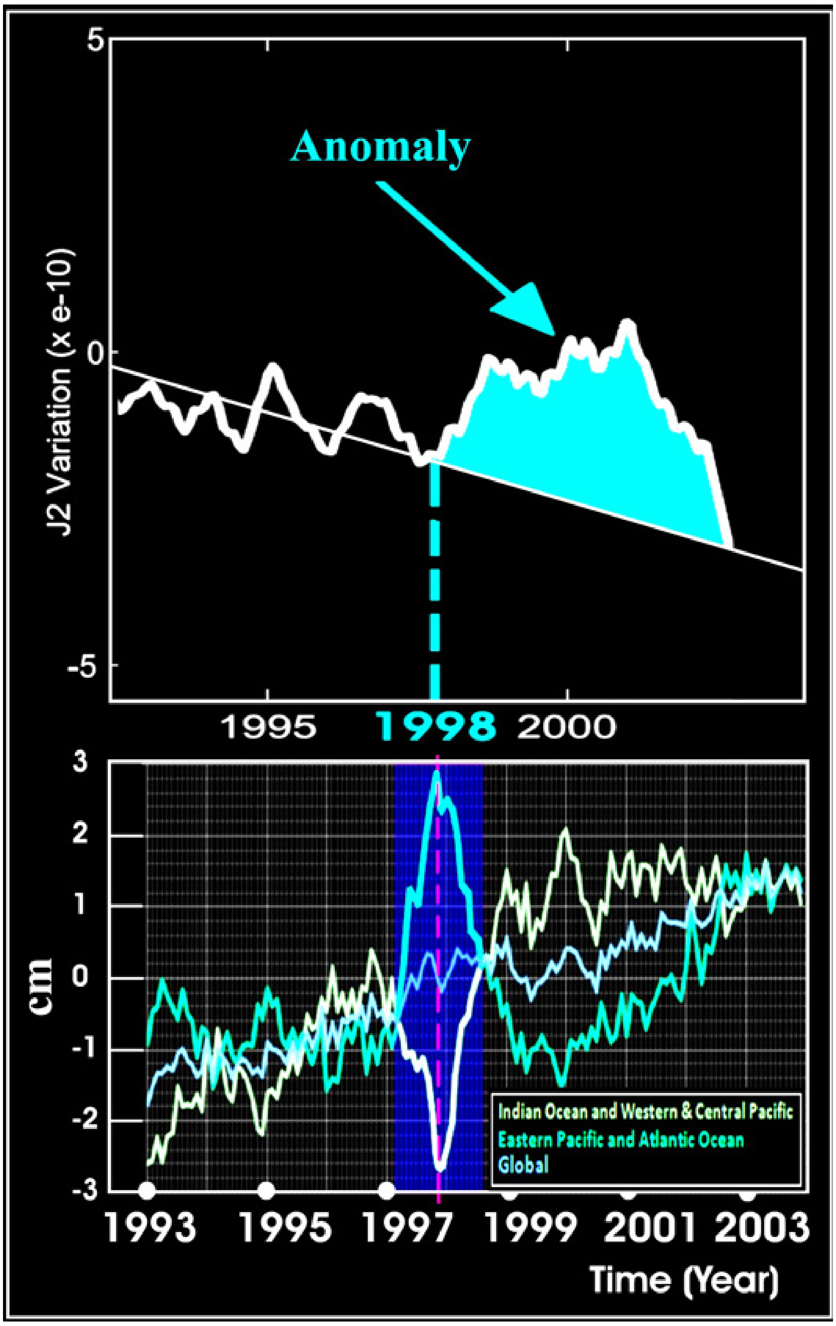


Fig. 55. Comparison of J_2 coefficient variations (top) with sea level evolution graphs for Indian Ocean, Western & Central Pacific Ocean, Eastern Pacific, and Atlantic Ocean, and with overall graph for global sea level fluctuations (bottom)

Comparing the J_2 coefficient variations with global temperature changes in the troposphere has also helped discover some correlation with the 1998 J_2 anomaly, Fig. 56. It is remarkable that in 1998, abnormally high changes of the troposphere's global temperature were observed as well. Thus, we are finding a correlation between the 1998 anomalous J_2 leap and processes in the hydrosphere and atmosphere.

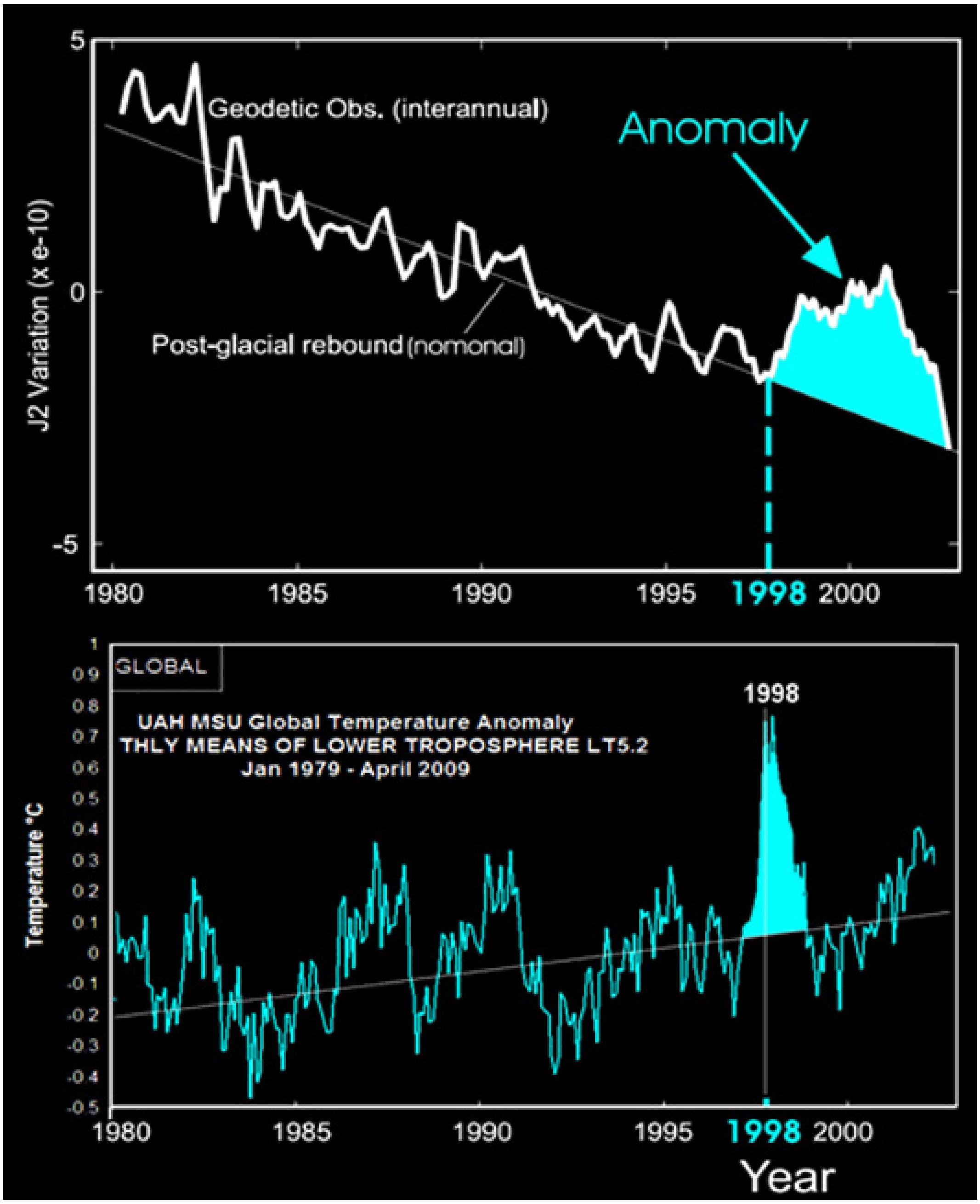


Fig.56. Comparison of J_2 coefficient variations (top) with global temperature changes in troposphere

(The source of the global tropospheric temperature variations graph: http://wattsupwiththat.files.wordpress.com/2009/05/uah_april_2009.png)

It is of interest to compare the J_2 coefficient variations with the evolution of geodynamic processes, the variations of large M>8 earthquake numbers between 1980 and May 2010 in particular. As can be seen from the comparison in Fig. 57, there has been a sharp increase in the numbers of large earthquakes and their victims according to an exponential law since 1997-1999.

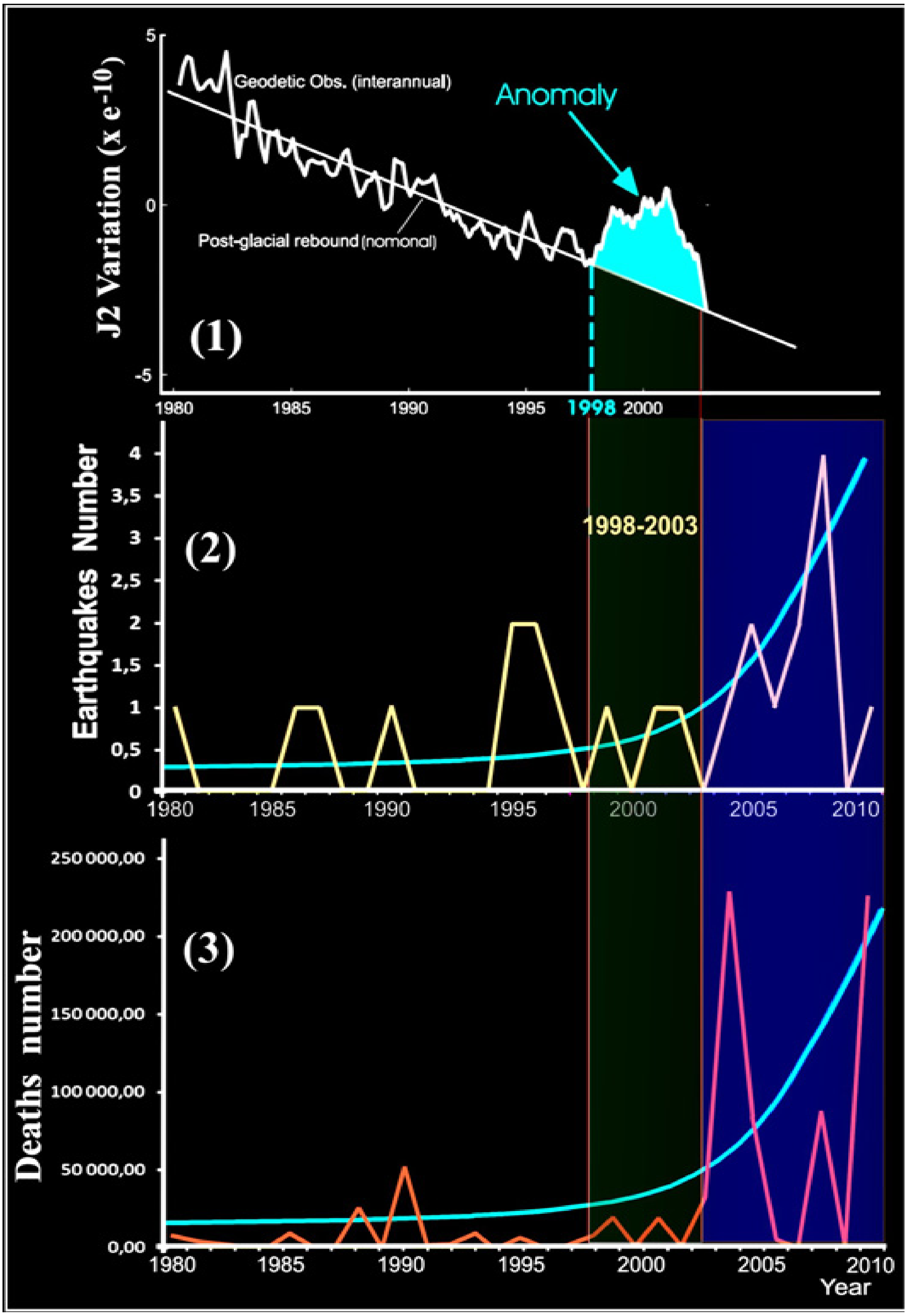


Fig. 57. Comparison of graphs for J_2 coefficient variations (1),dynamics of numbers of large earthquakes (2) and numbers of earthquake fatalities (3) from 1980 to May 2010
Exponential trends are marked in blue.

The time period between 1998 and 2003 encompassing the J_2 coefficient anomaly is actually a turning point and marks the beginning of the "leap" in the statistics for large earthquakes and earthquake victims from 1980 to May 2010.

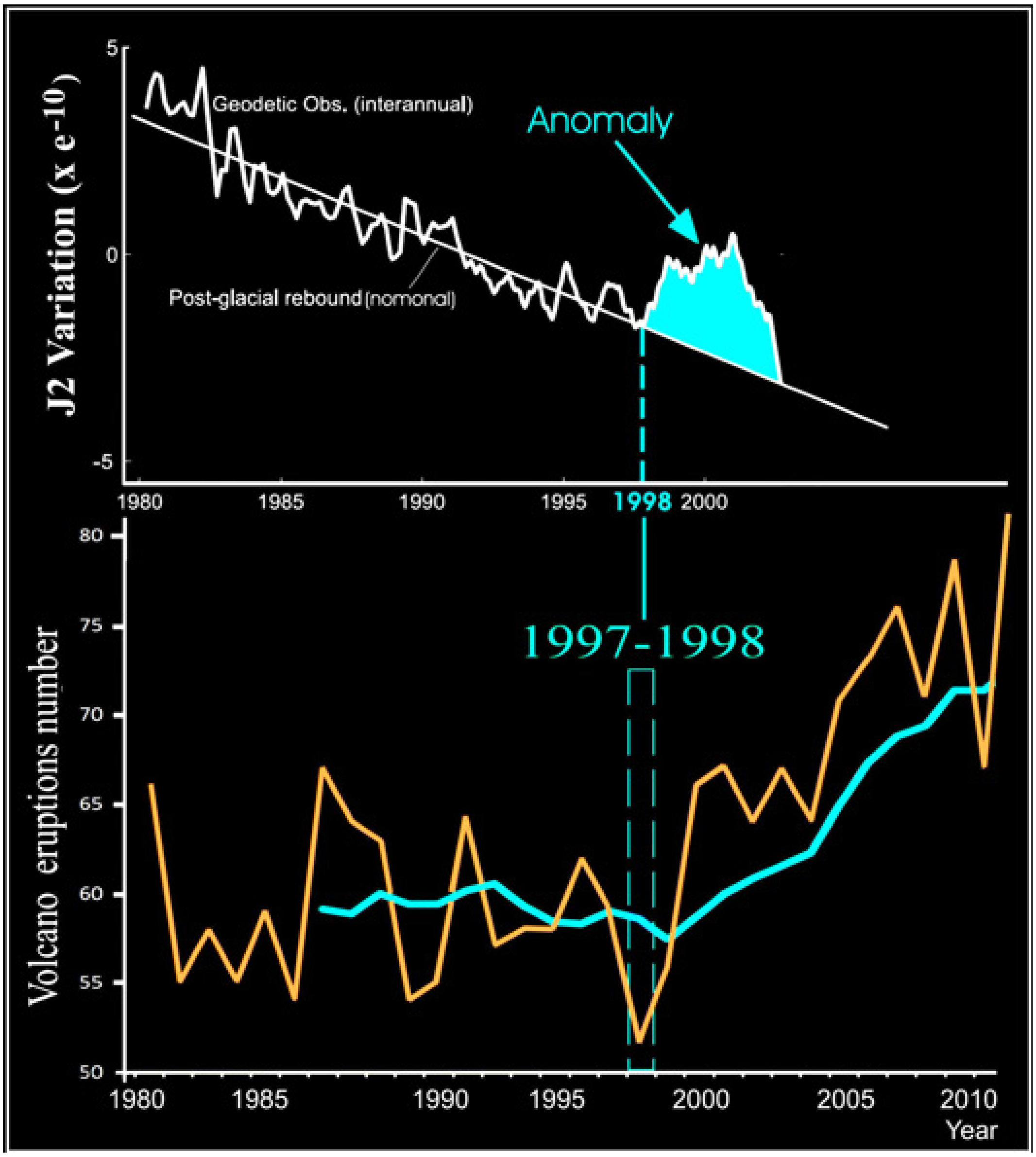


Fig. 58. Comparison of graphs for J_2 coefficient variations (top) and numbers of volcanic eruptions from 1980 to 2010.

Graph for volcanic eruption numbers from 1980 to May 2010 is marked in yellow;
Volcanic eruption numbers trend smoothed with 11-year running averages is marked in blue.

Comparing the volcanic eruptions graph with the J_2 coefficient variations graph also demonstrates that the years of 1997-1998 mark the deep minimum in volcanic activity and are a watershed followed by a sharp increase in volcanic activity still observed today, Fig. 58.

Fig. 59 (A) contains graphs for the dynamics of tsunami numbers between 1965 and May 2010. It clearly shows that there has been a dramatic change in the trend for the statistical distribution of annual rates for catastrophic, medium-sized, and weak tsunamis since 1998. The “leap” in the statistics for annual tsunami numbers observed since 1998 is depicted by the exponential trends shown in Fig. 59 (B).

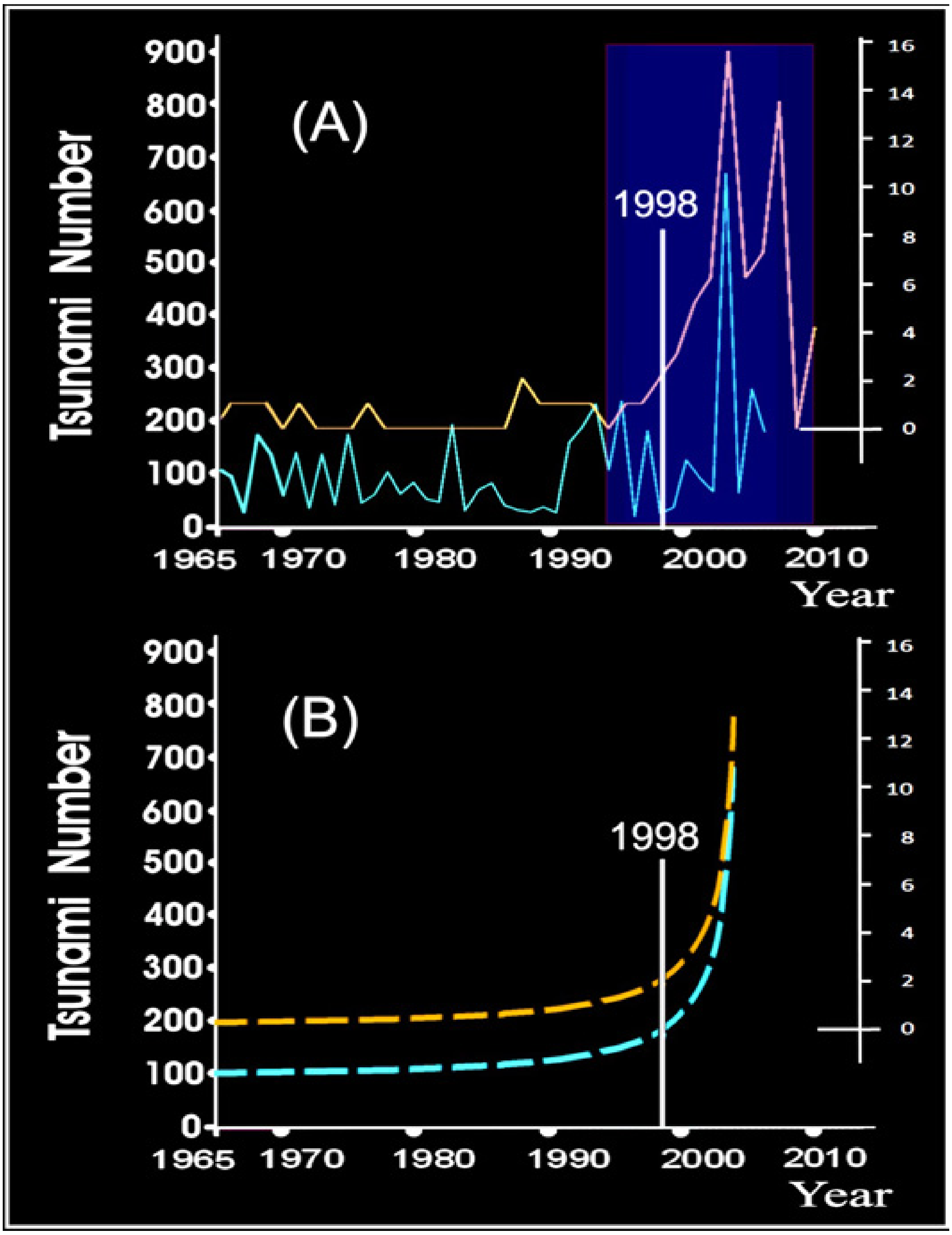


Fig. 59. Graphs showing evolution of tsunami numbers between 1965 and 2010.
Y-axis: on the left - the number of medium-sized and weak tsunamis, on the right – the number of catastrophic tsunamis.
(A) graphs show evolution of annual tsunami numbers;
Catastrophic tsunamis graph is marked in yellow; weak and medium-sized tsunamis graph is marked in blue;
(B) graphs show exponential trends of evolution of annual tsunami numbers.
Catastrophic tsunamis trend is marked in yellow;
medium-sized and weak tsunamis trend is marked in blue.

Analysis of U.S. flood statistics from 1980 to 2008 also indicates that since 1998 there has been a dramatic increase in the number of floods that is still present today (May 2010), Fig. 60.

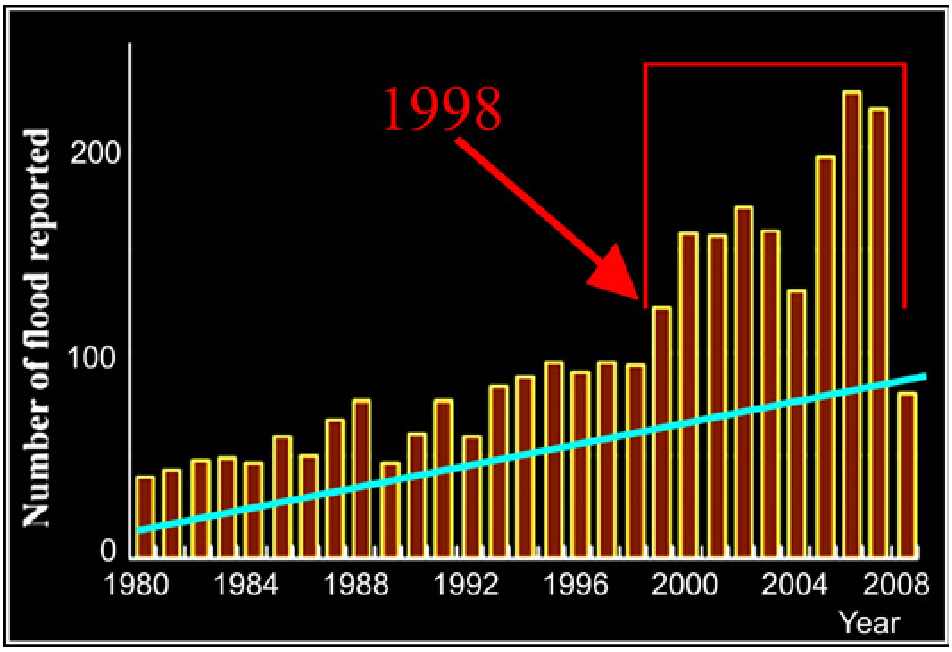


Fig. 60. U.S. flood statistics from 1980 to 2008
http://www.atmo.arizona.edu/students/courselinks/fall04/atmo336/lectures/sec2/fig2.gif

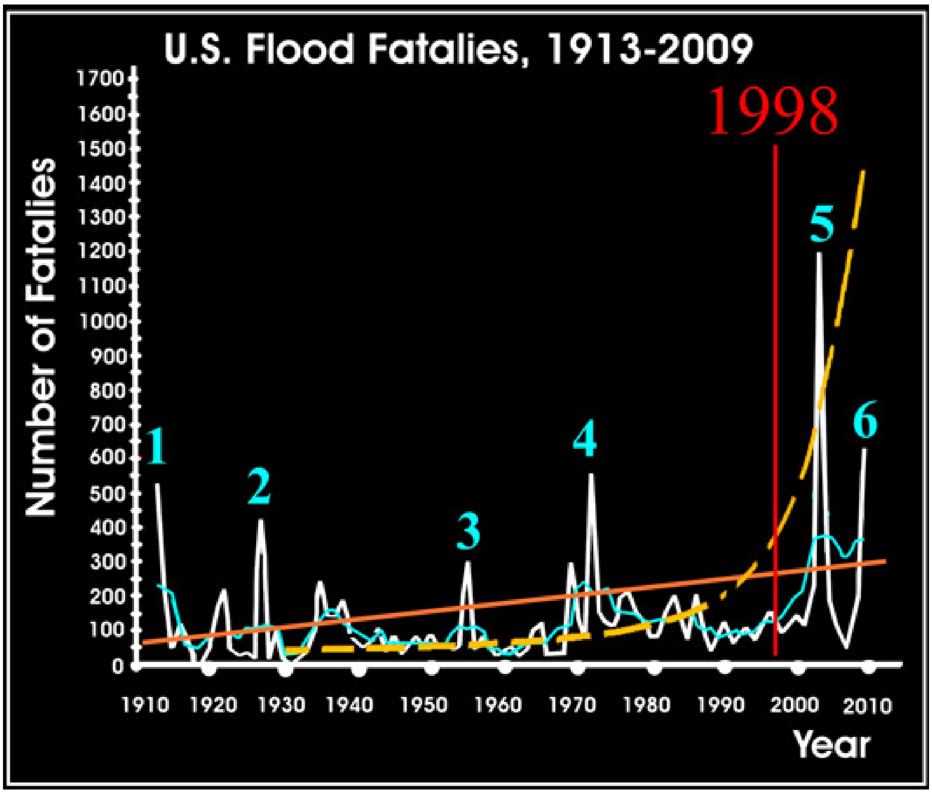


Fig. 61. Graph for U.S. flood fatality figures between 1910 and 2010
Based on data from the website: http://www.weather.gov/oh/hic/flood_stats/flood_trends.JPG
with additions by E. N. Khalilov (2010).
Annual figures are marked in white;
5-year average figures are marked in blue;
straight-line trend is marked in orange; exponential trend is marked in yellow.

The graph for the fatality rate during U.S. floods also highlights the aforementioned tendency. The growing number of flood-caused deaths in the United States between 1910 and May 2010 is most effectively depicted by an exponential trend, Fig. 61.

However, the observed "leap" in the statistical indicators within the specified time period is not limited only to catastrophic processes encompassing the lithosphere and hydrosphere. Let us have a look at the distribution of tornado dynamics in different regions of the world. Fig. 62 contains a graph for Germany's tornado dynamics by decades.

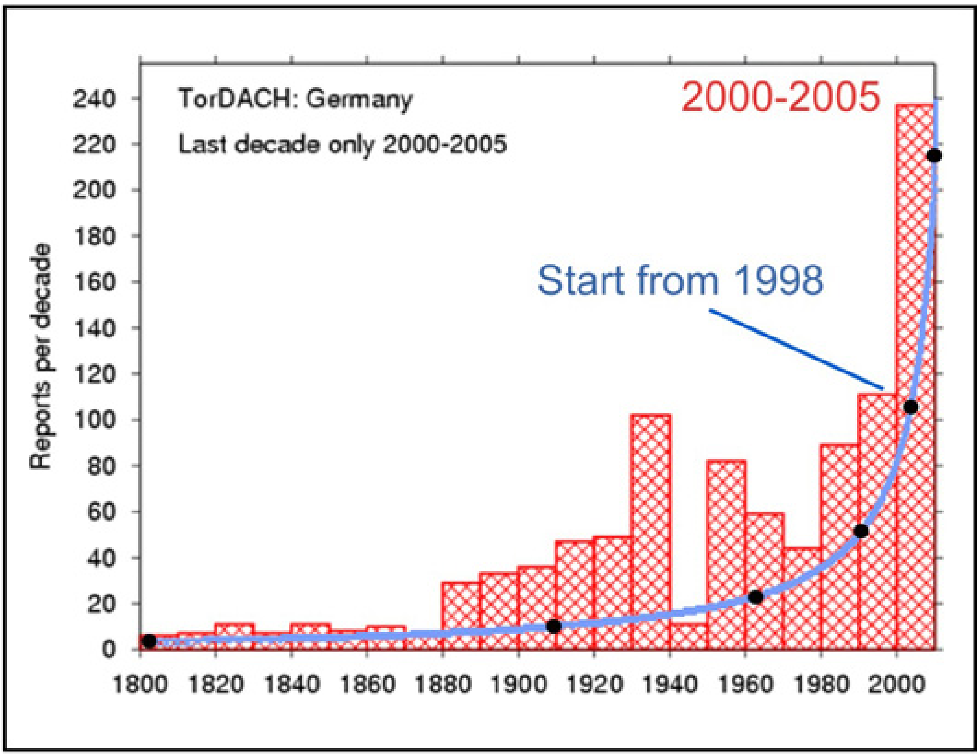


Fig. 62. Graph for tornado dynamics in Germany between 1800 and 2000.
Diagram showing tornado numbers for ten-year time intervals (last period covering 5 years) is marked in red; Exponential trend is marked in blue.

In Fig. 62, one can observe a distinct tendency for the number of German tornadoes to grow. In order to avoid significant loss of information over some historical time while examining the tendency, let us take the period from 1900 as a basis for our study. A sharp increase in the number of tornadoes since the late 1990's is seen quite clearly.

The observed "leap" cannot be regarded as accidental since the five year (2000-2005) number of tornadoes in Germany is 2.5 times higher than the number of tornadoes for the preceding 10 years.

Studying the dynamics of North Atlantic tropical storms from 1925 to 2005 reveals its consistency with the tendencies found in the dynamics of other natural disasters, and a surge in the number of storms has also been observed since 1998. The exponential trend reflects the general tendency of evolution of North Atlantic tropical storm statistics, Fig. 63.

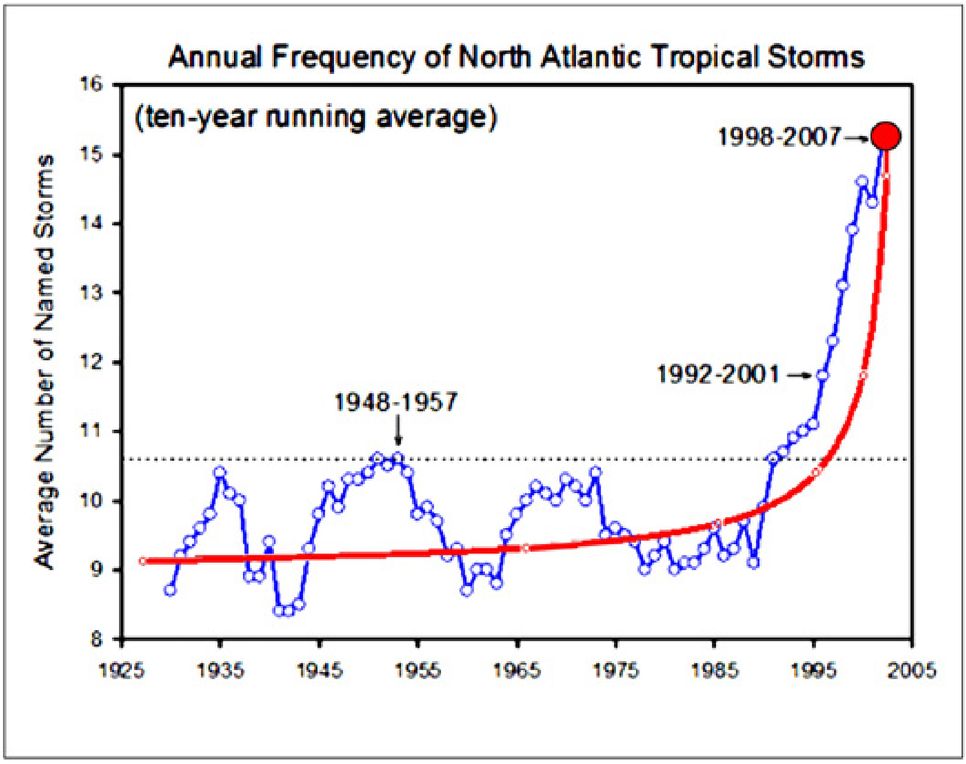


Fig. 63. Graph for numbers of North Atlantic tropical storms between 1925 and 2007
North Atlantic storms graph is marked in blue;
Exponential trend is marked in red.

A no less significant indicator of climate change dynamics are forest fires causing enormous environmental damage and leading to huge economic losses and human casualties.

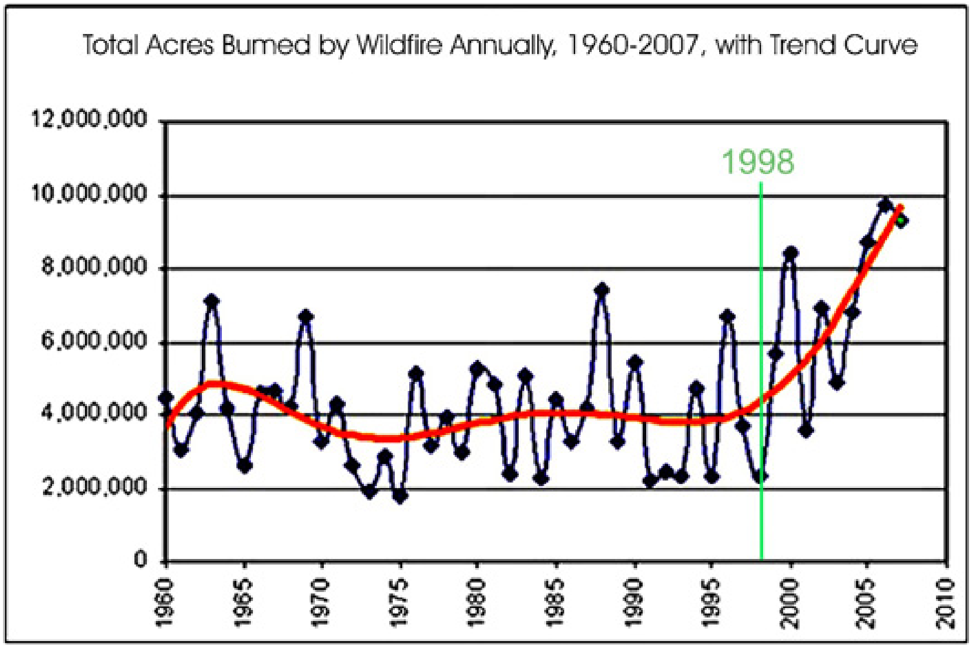


Fig. 64. Graph for annual numbers of U.S. forest fires between 1960 and 2007
Polynomial trend of fifth degree is marked in red.

The graph for evolution of the annual numbers of U.S. forest fires from 1960 to 2007 (Fig. 64) demonstrates a growing tendency for forest fires, with the beginning of the "leap" in 1998 as well. This is reflected well in the polynomial trend shown on the graph.

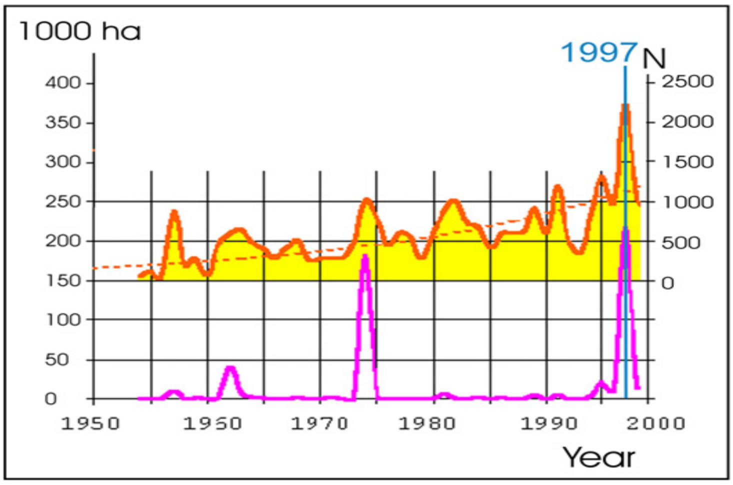


Fig. 65. Graph for frequency of Kazakhstan forest fires between 1950 and 2000.
Registered number of forest fires is marked in red;
Areas affected by forest fires are marked light in violet.

A similar evolution pattern in forest fire statistics is observed for other regions of Earth as well. For instance, Kazakhstan in 1997 witnessed a "leap" in the form of a sharp increase in the number of forest fires and fire-affected areas, Fig. 65.

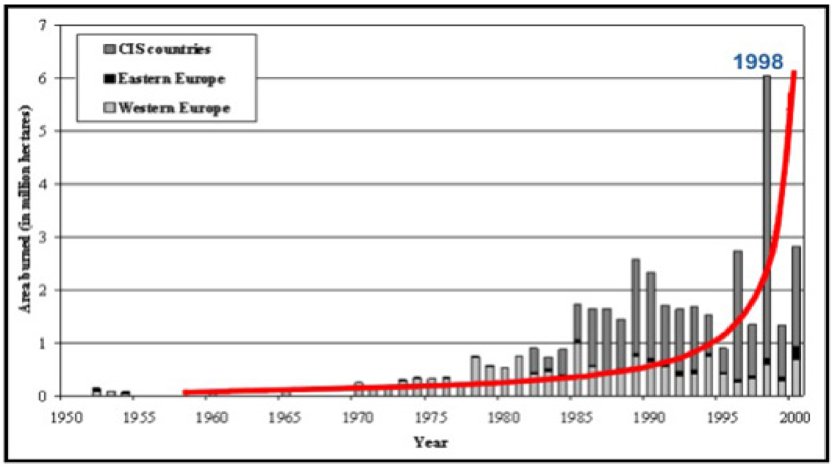


Fig. 66. Graph for evolution of areas affected by forest fires in Eastern and Western Europe and CIS countries
http://www.fao.org/docrep/008/ae428e/ae428e02.htm
Exponential trend is marked red.

The tendency for a sharp increase in the annual numbers of forest fires is observed for the territory of Eastern and Western Europe and the CIS countries as well. The general nature of forest fire dynamics in this region can also be described by an exponential trend marked in red in Fig. 66. As one can see from the graph, there is a 1998 "leap" in the number of forest fires.

Chapter 7.
THE ROLE OF NATURAL FACTORS IN GLOBAL CLIMATE CHANGE

Introduction

One of the most important issues in global climate change studies is to reveal the priority of anthropogenic or natural factors' influences. In recent years, more and more scientists feel inclined to conclude that natural processes are the primary cause of global climate change.

IPCC's stance is well-known. Now, let us review some basic geologic factors that are also capable of affecting global climate change.

We shall consider the basic natural factors that might have a significant impact on global climate change:
1. *Drift of Earth's geographic pole*
2. *Drift of Earth's geomagnetic pole and fluctuations of magnetospheric parameters*
3. *Change of the angular velocity of Earth's rotation*
4. *Change of Earth's endogenous activity*
5. *Solar activity*

7.1. DRIFT OF EARTH'S GEOGRAPHIC POLE

Hipparchus discovered the phenomenon of axial precession in 123 BC. James Bradley discovered another phenomenon, nutation of Earth's axis of rotation, in 1755. Fig. 67 demonstrates the trajectory of the Geographic North Pole's 1996-2000 motion.

The maximum aberration of the instantaneous pole from the mean pole was observed in 1996, followed by its spiral winding and coming to a minimum distance from the spiral's center by 2000. The pole was unwinding from 2000 to 2003; now it is winding again, gradually moving in a spiral course and approaching its mean position (N. S. Sidorenkov, 2004).

The most distant displacement of the instantaneous pole from the mean pole has never exceeded 15m. Spiral winding and unwinding of the trajectory of the instantaneous pole is explained by the fact that it performs two periodic motions: a free motion with a period of about 14 months (named the Chandler wobble after S. Chandler discovered it in 1891), and a forced motion with a one-year period, Fig 67.

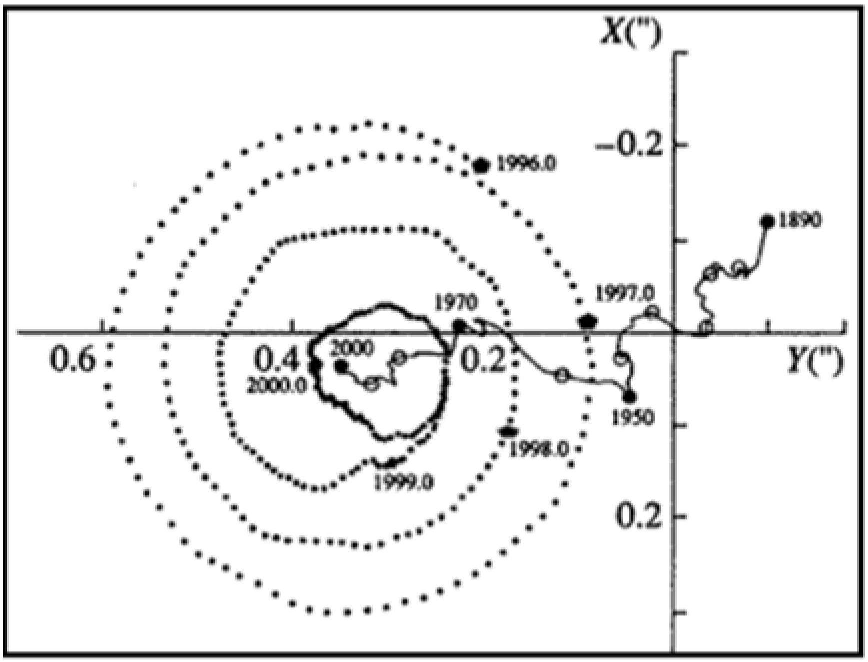


Fig. 67. Geographic North Pole's trajectory of motion between 1996 and 2000.
Solid curve represents trajectory of mean pole from 1890 to 2000.
(According to International Earth Rotation and Reference Systems Service, 2000)

The Chandler wobble occurs when Earth's axis of rotation deviates from the axis of its greatest moment of inertia. The forced motion is caused by the action on Earth of periodic atmospheric and hydrospheric forces with a one-year cyclicity. We will not go further into what causes the Chandler wobble and many other types of movement of Earth's axis, which are well described in N. S. Sidorenkov's study (2004). Meanwhile, it is obvious that the complex oscillations of Earth's axis and, consequently, of its geographic pole, have an impact on global climate processes since it is "swings" of Earth's axis that bring about seasonal climate changes.

7.2. DRIFT OF EARTH'S NORTH GEOMAGNETIC POLE

The problem of drifting of the North Geomagnetic Pole is described in more detail in the previous sections. This section demonstrates that the problem of examining the relationship between the drift of Earth's North Geomagnetic Pole and global climate change is of topical importance. Fig. 68 compares a graph representing the change in velocity of the North Geomagnetic Pole with a graph of variations of Earth's global temperature. The initial comparison suggests a certain correlation between these two processes. One can notice that almost all periods of acceleration of the magnetic pole's motion coincide with periods of global temperature rise.

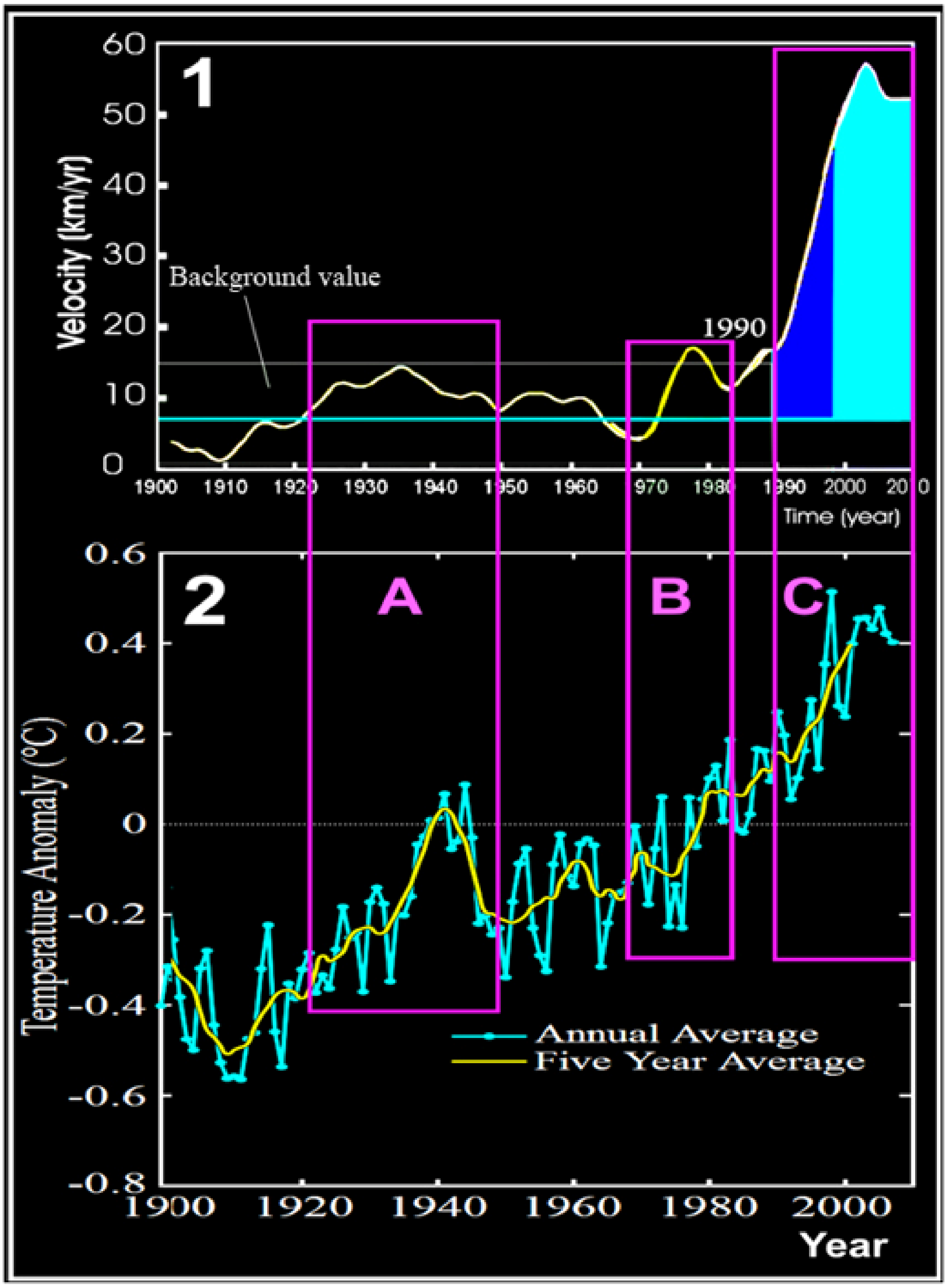


Fig. 68. Comparison of graphs of North Magnetic Pole's drift velocity variations and global temperature change (by E. N. Khalilov, 2010)

1 – graph of North Magnetic Pole's drift velocity variations; 2 – graph of global temperature change (Hansen J. et al., 2006); A,B,C – identical periods of increased values of magnetic pole's drift rate and global atmospheric temperature

The geomagnetic field forms a kind of magnetic shield that prevents solar radiation, including charged high-energy particles, from penetrating to Earth's surface.

At the same time, there are so-called cusps, or polar gaps, in polar ice cap regions. They receive the radiation material of the solar wind and interplanetary space; i.e., the polar regions are penetrated by a huge amount of extra matter and energy, which leads to "heating" of polar ice caps.

Of course, the change in position of the geomagnetic poles entails shifting of cusps and, as a consequence, of regions of high solar and cosmic radiation flux to Earth. Naturally, this process ought to cause redistribution of our planet's system of cyclones and anticyclones and lead, in our opinion, to serious global climate change.

It is difficult to overestimate the role of Earth's magnetosphere in the redistribution of solar and cosmic ray energy entering Earth's atmosphere and surface. The magnetosphere regulates the flux of solar and cosmic radiation into Earth's atmosphere and onto its surface (J. K. Hargreaves, 1982).

The magnetosphere is the part of near-Earth space where the motion of charged particles is controlled by the geomagnetic field.

The impartiality of this study rests upon the use of the research findings and conclusions of reputable scientists who have devoted their lives to studying the physics of atmospheric processes and their relationship to solar and near-earth space processes.

J.K. Hargreaves in his book "The Upper Atmosphere and Solar-Terrestrial Relations" wrote: "The source of weather change must be controlled by the geomagnetic field since it is that field that determines the localization of auroral zones".

The solar-terrestrial relation chain is: Solar radiation – magnetosphere – ionosphere – Earth's atmosphere.

Today, there is solid evidence of Sun's effect on Earth's climate in both pre- and post-industrial era.

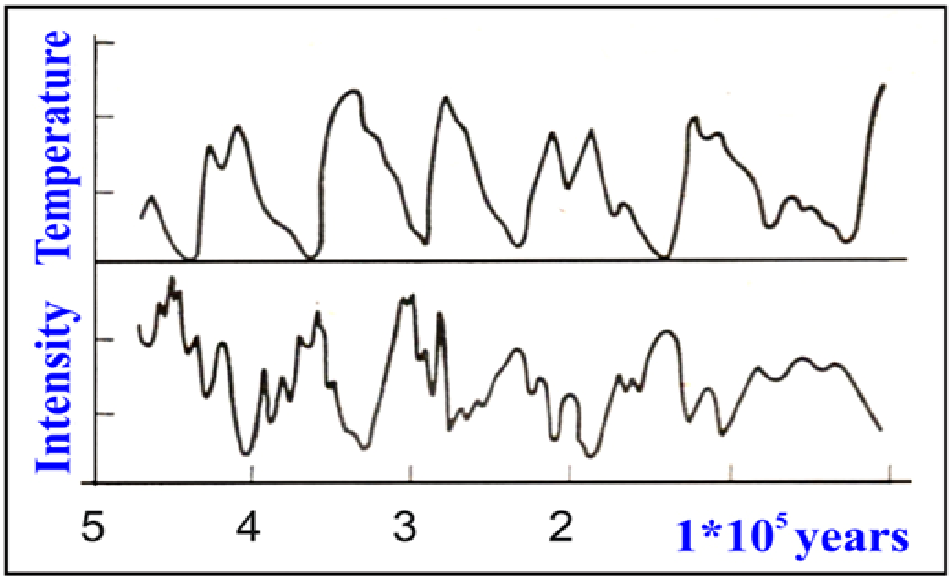


Fig. 69. Temperature according to oxygen isotope analysis data and magnetic field intensity according to deep sea drilling data

(J. W. King, private message, Wallis et al., 1974, in J.K. Hargreaves' book, 1982)

J. K. Hargreaves in his study (1982) points out that there is a relationship between the intensity of the geomagnetic field and global temperature changes. In the zones with the greatest magnetic field intensity, air temperature and humidity tend to be low. The inverse correlation between the global temperature and magnetic field intensity, Fig. 69, is also indicative of that relationship.

7.3. VOLCANIC ACTIVITY AND GLOBAL CLIMATE CHANGE

Meanwhile, as mentioned above, the IPCC report names the sharply increased greenhouse gas content in Earth's atmosphere as the main cause of global climate change. At the same time, it is known that volcanic eruptions emit a large amount of various gases, including greenhouse gases such as CO_2, CO, SO_2, H_2S, CS_2, OCS, and NO, into Earth's atmosphere.

Carbon dioxide concentration varies from 1 to 10% of the total mass of volcanic gases, with 0.1-0.7% of CO (N. M. Gerlach, 1980). Sulfur-containing gases of volcanic eruptions produce the most detrimental effect on global climate change. Those eruptions are accompanied by emission of sulfur dioxide SO_2, hydrogen sulfide H_2S, carbon disulfide CS_2, carbonyl sulfide OCS and particles of solid sulfur into the atmosphere. As Cadle's studies demonstrate, SO_2 gas accounts for about 10% of all volcanic gas emissions and its annual emissions amount to $2 \cdot 10^7$ t (R.D. Cadle, 1975). Analysis of volcanic gas emissions has shown that the principal sulfur-containing gas is SO_2 (2-10 Mt per year). In general, the proportion of sulfur dioxide in volcanic gases is between 1 and 10% (M. L. Athaturov and others, 1986).

Of great interest is to analyze changes of CO_2 content in Earth's atmosphere in the geological past and compare that data with the volcanic activity level. The results of these studies are shown in Fig. 70 (M. L. Athaturov and others, 1986).

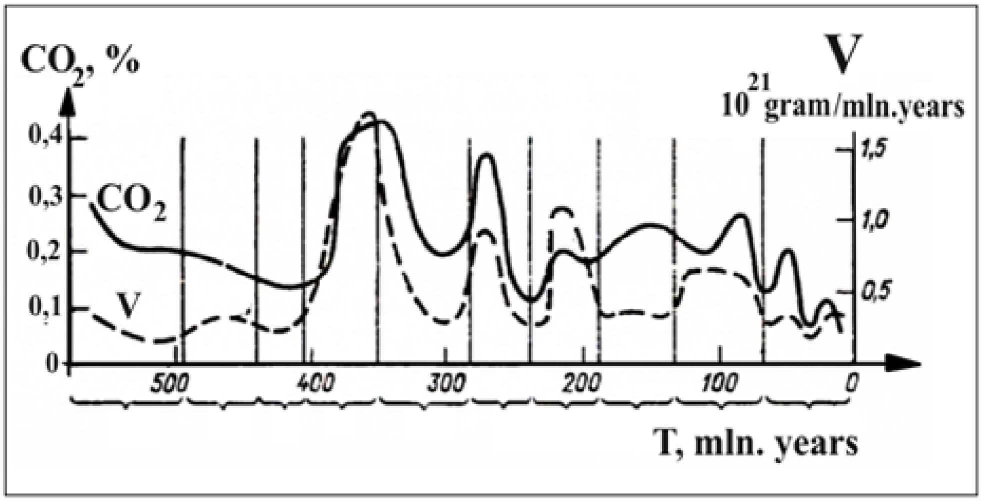


Fig. 70. Changes in carbon dioxide amount in atmosphere and formation rate of volcanogenic rocks in Phanerozoic Eon
(M. L. Athaturov and others, 1986)

As seen from Fig. 70, the concentration of carbon dioxide in the Phanerozoic Eon varied from 0.1 to 0.4%. In the diagram, volcanic activity is characterized by the rate of formation of volcanogenic rocks during the Phanerozoic Eon. The figure clearly shows that the Phanerozoic volcanic activity consists of pronounced cycles with periods of 80-100 million years.

The results of comparing the graphs shown in Fig. 70 indicate that CO_2 concentration is directly dependent on volcanic activity. In our view, the clearly observed (Fig. 70) lag of CO_2 content growth as compared to volcanogenic rocks' formation rate is an interesting and important feature of this dependence. That is quite logical according to the cause-and-effect principle: the initial increase in the activity of volcanic eruptions is then followed by a higher CO_2 concentration in the atmosphere, with a certain time lag between these processes. The larger the scale of the cyclicity period considered, the longer is the lag time.

Carbon dioxide is transparent for short-wave radiation but absorbs long-wave radiation of electromagnetic waves at several frequencies. As a result, it is a significant contributor to the greenhouse effect that increases the temperature of Earth's lower atmosphere.

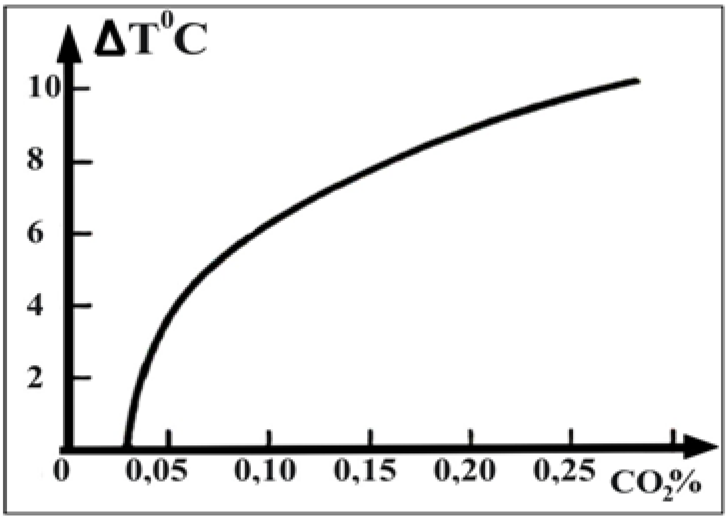


Fig. 71. Dependence of mean air temperature on carbon dioxide concentration (M. I. Budyko, 1979)

When examining the relationship between the CO_2 content in the atmosphere and average annual temperature variations, the logarithmic dependence shown in Fig. 71 is employed. M. I. Budyko investigated this relationship with empirical data based on studying the geological past. Budyko's works show the existence of a direct link between volcanic eruptions and global climate change (M. I. Budyko, 1968 - 1984).

We have given a very brief overview of some major studies that demonstrate the presence of objective and reliable connection between volcanic activity and global climate change.

To determine the degree of possible impact of volcanic eruption cyclicity on global warming, V. E. Khain and E. N. Khalilov compared the graphs of Earth's mean temperature change and of the average number of eruptions of magma volcanoes of

Earth's compression zones between 1850 and 2000, Fig. 72 (V. E. Khain, E. N. Khalilov, 2008).

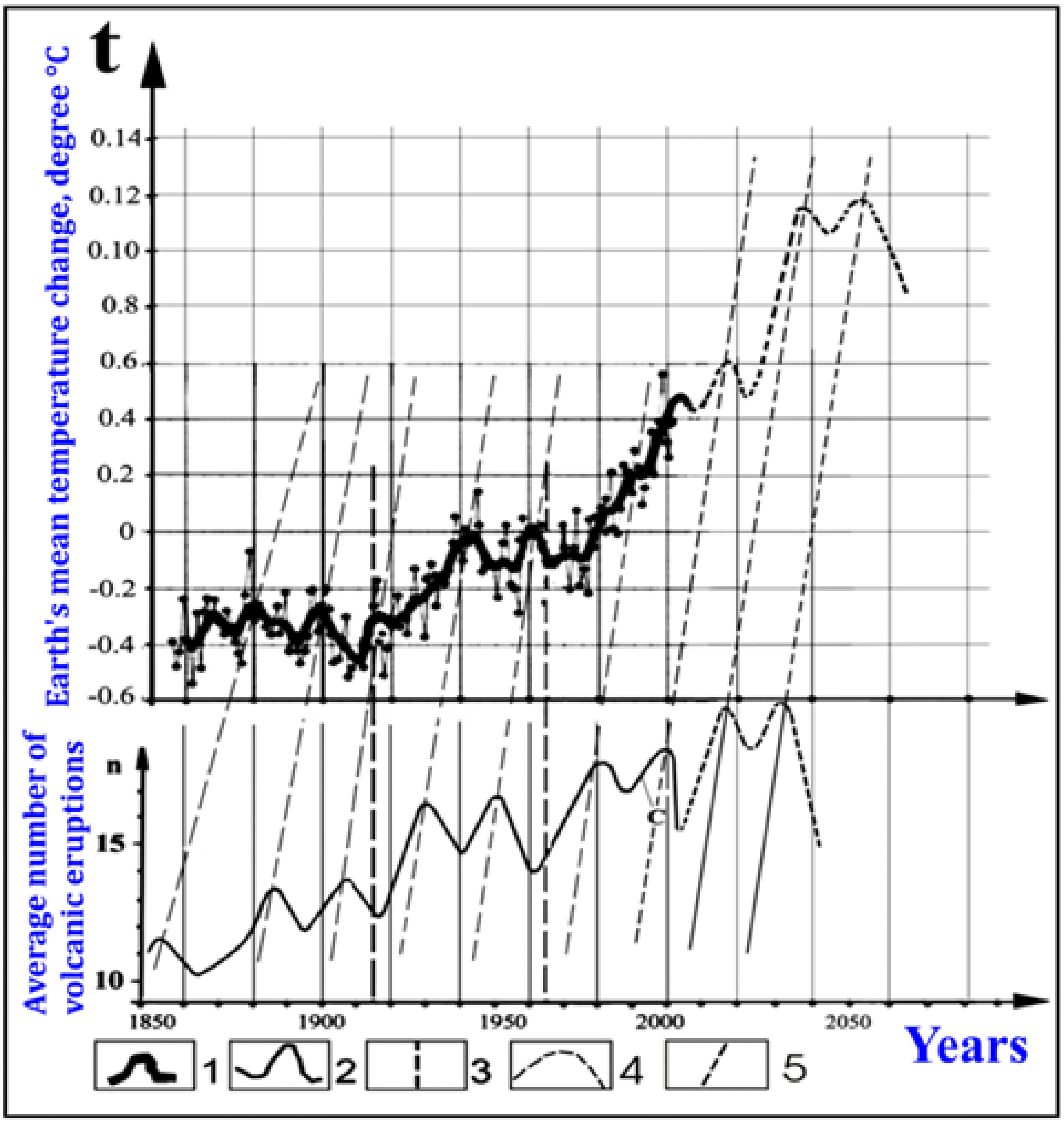


Fig. 72. Comparison of graphs of Earth's mean temperature change and average number of eruptions of magma volcanoes of Earth's compression zones between 1850 and 2000 (by V. E. Khain and E. N. Khalilov, 2008).

1 – Graph for Earth's temperature changes in C° (graph's forecasted part is supplemented by V. E. Khain and E. N. Khalilov, 2008) (http://www.seed.slb.com/ru/scictr/watch/climate_change/index.htm);

2 – volcanic activity graph;

3 – straight lines limiting doubled cycles of volcanic activity and temperature changes;

4 – forecasted sections of graphs for mean temperature change and volcanic activity;

5 – straight lines connecting extreme points of volcanic activity cycles and average annual temperature variations.

Comparing the graphs has revealed a high similarity in the nature of temporal changes of both the average annual temperature and volcanic activity. Both graphs can be conditionally divided into three phases (years): 1853 - 1915; 1916 - 1965; 1966 - 2000. Each phase is characterized by a surge in both the temperature and volcanic activity in 1915 and 1965. It is noteworthy that the first phase has three high activity cycles standing out on both graphs, with two cycles during the second phase and two (and possibly more) cycles during the third phase.

The most interesting fact is the lagging of the temperature rise cycles behind the increased volcanic activity cycles. This lagging is a result of the cause-and-effect relationship between the two processes. We noted this feature earlier when comparing graphs for volcanic activity and CO_2 content in Earth's atmosphere during the Phanerozoic Eon, Fig. 70.

Let us examine the mechanism of causality between volcanic activity and Earth's temperature changes. A higher number of volcanic eruptions leads to an increased emission into the atmosphere of volcanic gases contributing to the enhanced greenhouse effect and ultimately results in a higher atmospheric temperature. The high similarity between the graphs of global temperature changes on our planet and of Earth's volcanic activity has a rationale in terms of physical aspects. The almost doubled average annual number of volcanic eruptions ought to have caused doubling of the amount of gases released into the atmosphere during volcanic eruptions; first and foremost, this refers to CO_2 which plays a leading role in creating the greenhouse effect and raising the average annual temperature on Earth.

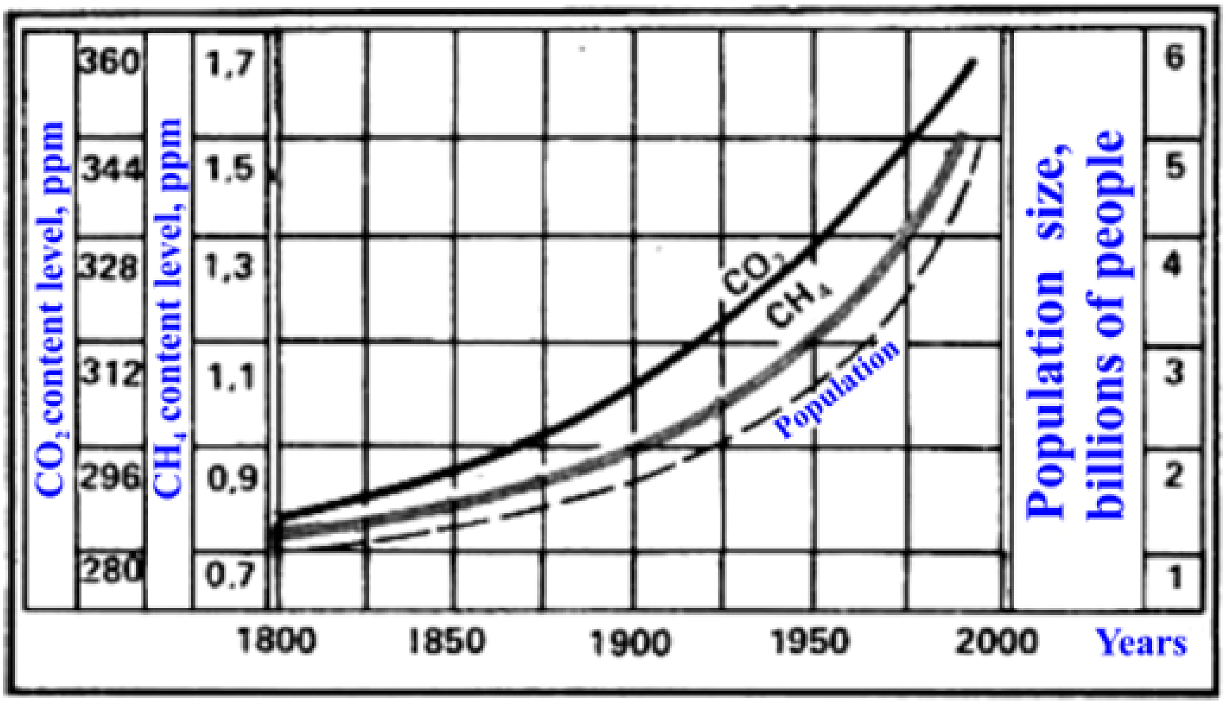


Fig. 73. Change of CO_2 and CH_4 content in atmosphere and world's population growth between 1800 and 2000 www.ipcc.ch

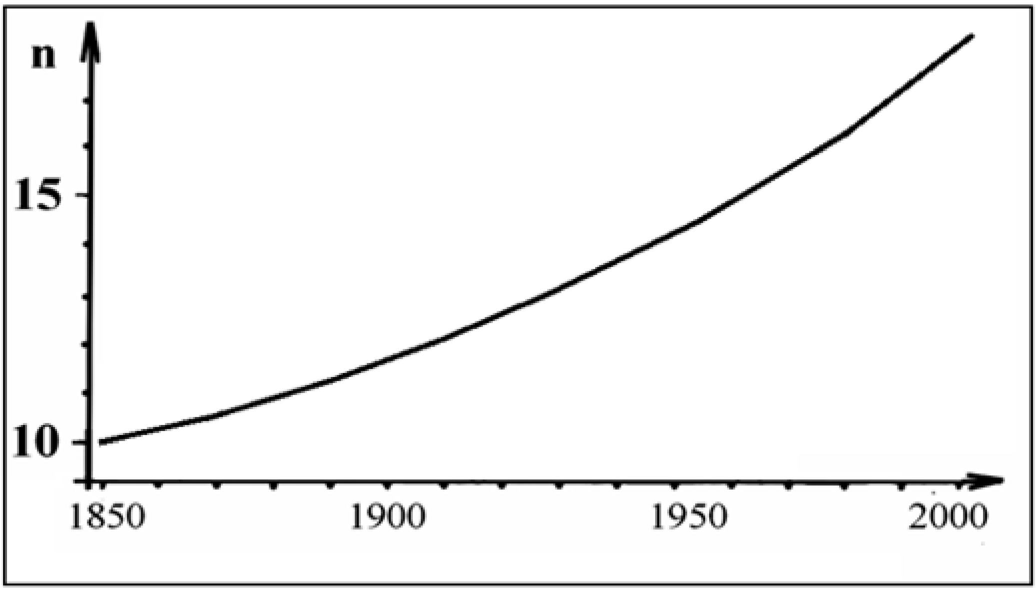


Fig. 74. Volcanic activity trend
(From V. E. Khain and E. N. Khalilov's work, 2008)

Fig. 73 shows the trends for changes in CO_2 and CH_4 content and for Earth's population growth between 1800 and 2000, according to IPCC data. Fig. 74 provides a volcanic activity trend reflecting the general increase in the number of volcanic eruptions from 1850 to 2000. The comparison of those graphs reveals their high similarity.

In reality, the increased population growth and higher content of greenhouse gases in the atmosphere are not evidential of a connection between the two processes. As shown in previous sections, a similar increase has been observed for the same period in seismic and volcanic activity, as well as in the North Magnetic Pole's drift acceleration, higher number of tsunamis, and in many other processes. Why, if there are such a large number of natural factors, does the IPCC focus its attention only on the relationship between the anthropogenic factor and global warming?

So, the main question to the proponents of anthropogenic global warming is as follows: How can you explain the existence of cycles in global temperature change? There is no scientific evidence that the anthropogenic factor has a similar cyclicity.

Fig. 75 provides a comparison of graphs of Earth's global temperature change (1) and of volcanic activity (2) between 1900 and 2010. The similar pattern of change in both parameters is clearly seen from the graphs. The red lines connect corresponding cycles of higher values of global temperature changes and volcanic eruption numbers.

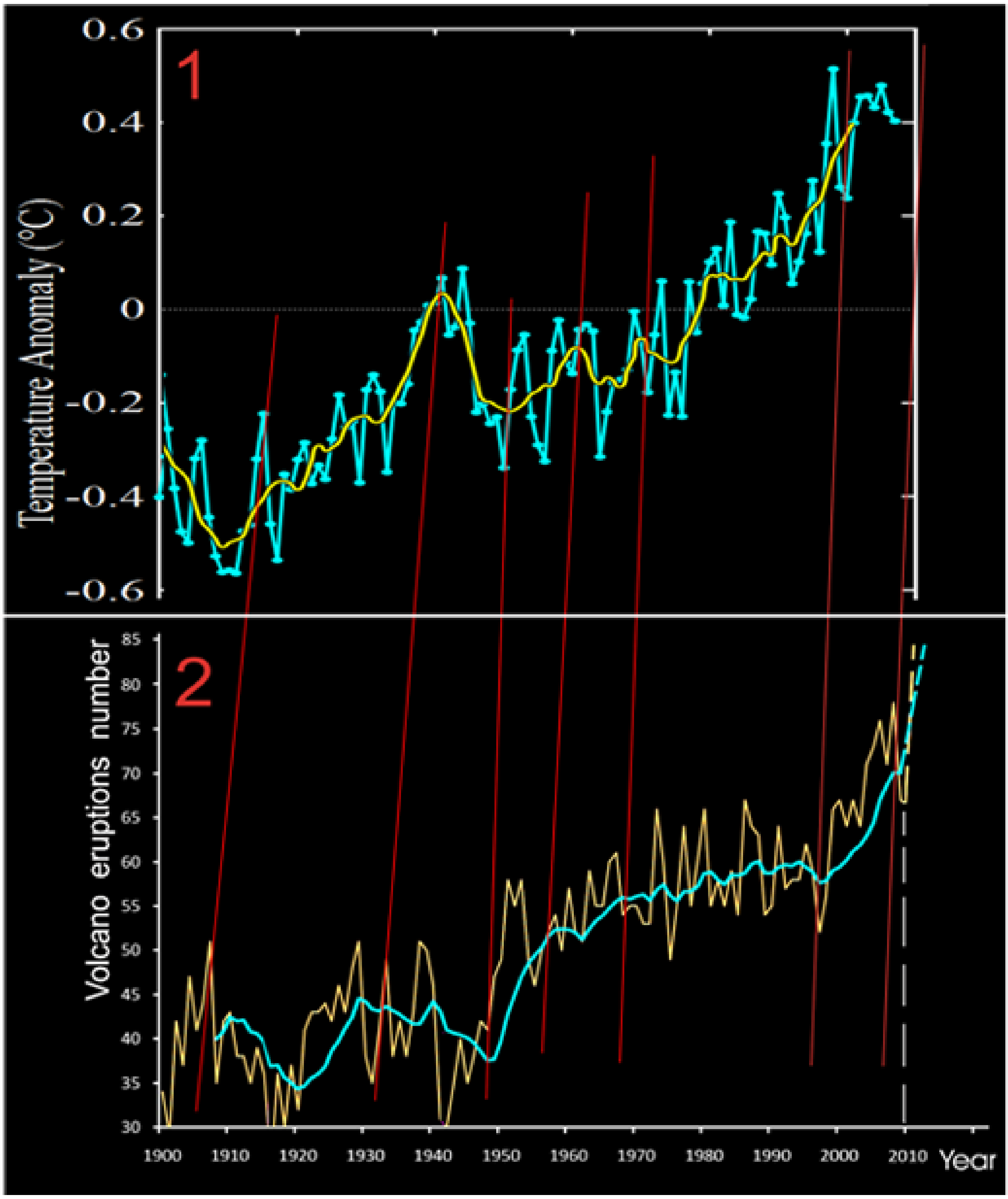


Fig. 75. Comparison of graphs for global temperature changes and Earth's volcanic activity
(by E. N. Khalilov, 2010)

1 – global changes of average annual temperature according to IPCC: graph for variations of average annual temperature is marked in blue; trend of average annual temperature change is marked in yellow;
2 – number of volcanic eruptions worldwide: annual numbers of volcanic eruptions are marked in dark yellow; trend of numbers of volcanic eruptions based on 7-year averages is marked in blue; red lines connect corresponding cycles of higher values of global temperature and volcanic eruptions numbers on trends.

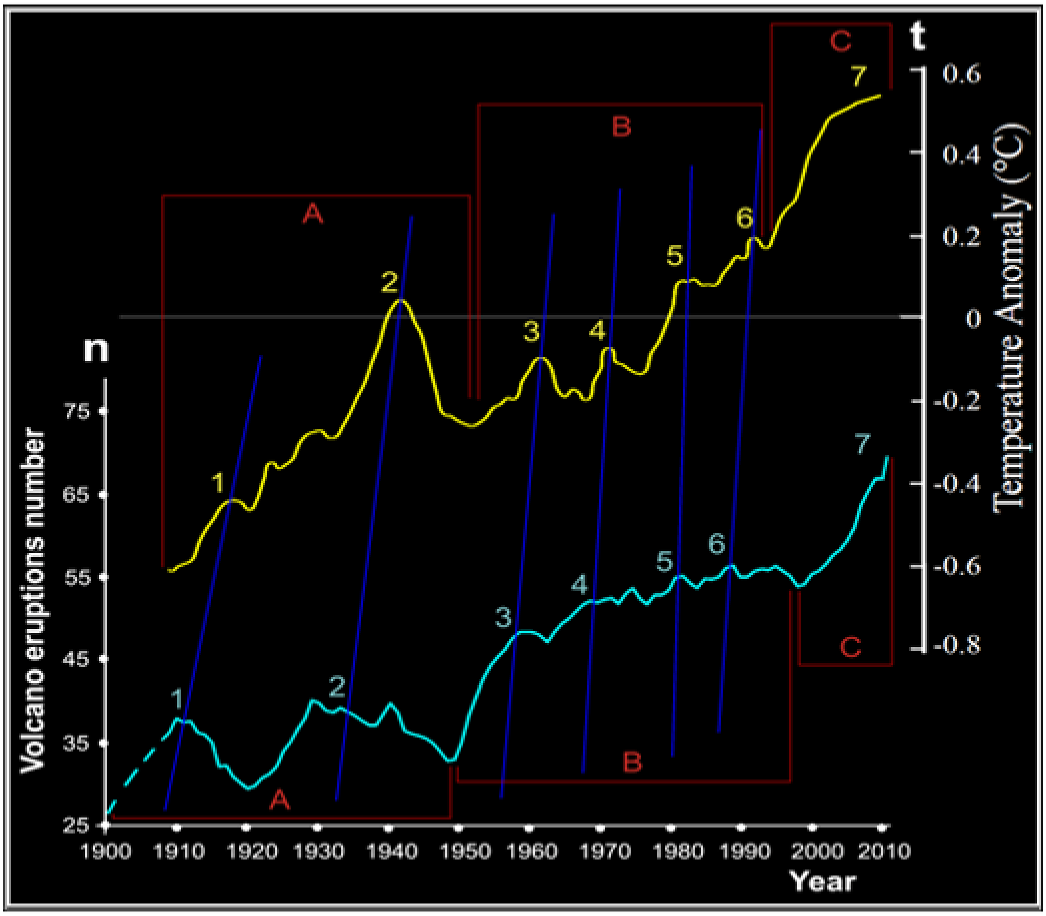


Fig. 76. Comparison of graphs (trends) of global temperature change and Earth's volcanic activity (by E. N. Khalilov, 2010)

Global changes of average annual temperature according to IPCC data are marked in yellow, numbers of world's volcanic eruptions are marked in blue; 1-7 – cycles with higher values of global temperature and volcanic eruptions; A, B, C – identified phases in global temperature change and volcanic activity.

We have used this report to refine and supplement with new supporting data the research carried out in the works of V. E. Khain and E. N. Khalilov (2008) on a possible connection between Earth's volcanic activity and global temperature changes (E. N. Khalilov, 2010). The graphs shown in Fig. 76 demonstrate that the lag time of global temperature rise is 4-7 years on average as compared against the increased volcanic activity. That is, Earth's global temperature rises during 4-7 years following the increase in volcanic activity. That means that 4-7 years are required for global temperature to grow as a result of the greenhouse effect caused by gases of volcanic origin. The higher concentration of greenhouse gases in the atmosphere as a result of volcanic eruptions and other processes of degassing of the mantle leads to the enhanced greenhouse effect. It is important to determine the quantitative relationship between the increase in the number of volcanic eruptions and global temperature changes.

Cycle number in Fig 76	Global temperature change amplitude (^{0}C)	Volcanic eruptions number amplitude
1	- 0.44	43
2	0.05	44
3	- 0.1	44
4	- 0.07	52
5	0.1	59
6	0.19	60
7	0.54	72

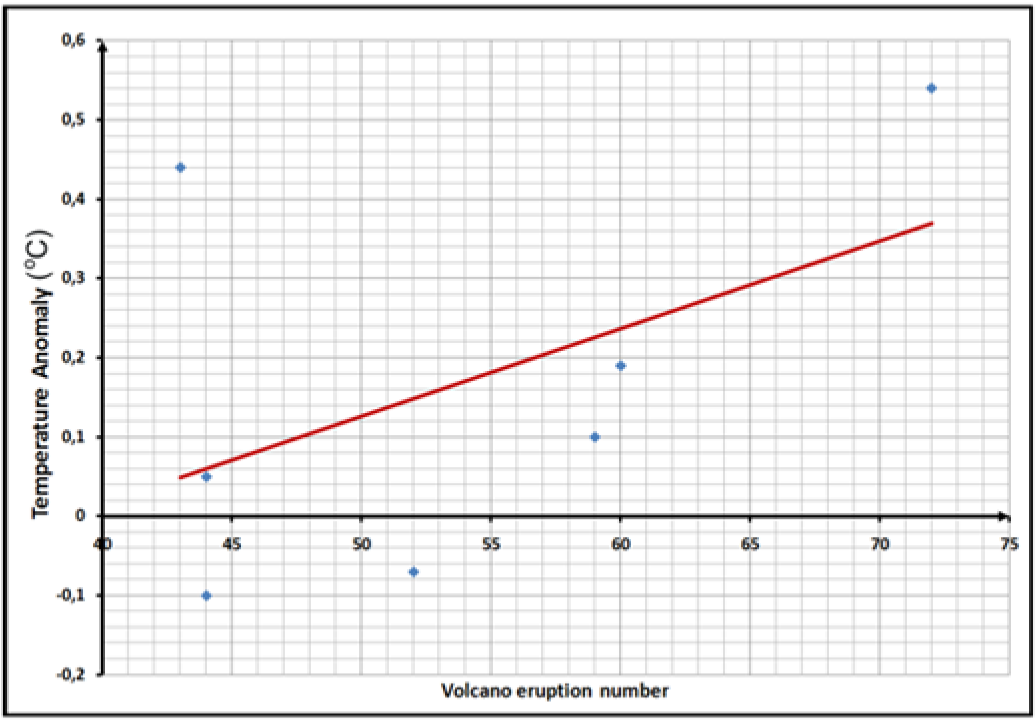


Fig. 77. Graph of dependence of global temperature variations on number of volcanic eruptions (by E. N. Khalilov, 2010)
Straight-line trend is marked in red

The straight-line trend in Fig. 77 indicates the existence of a direct link between global temperature change and the number of volcanic eruptions.

The polynomial trend in Fig. 78 allows us to conclude that global temperature change is most affected after the number of volcanic eruptions reaches 53.

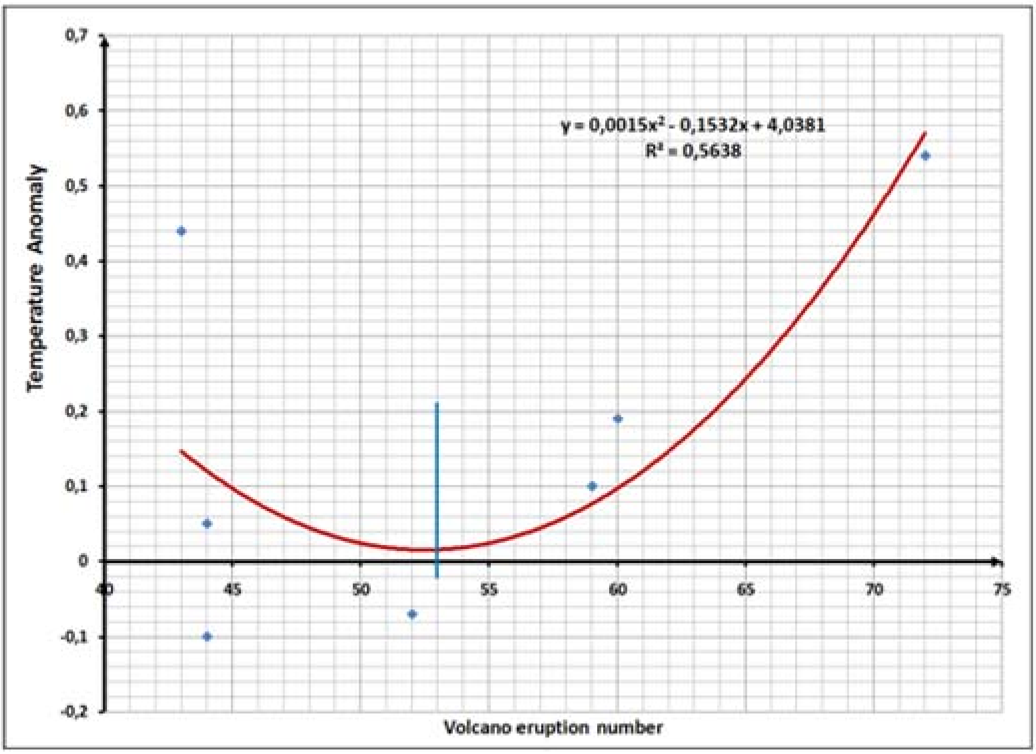


Fig. 78. Graph of dependence of global temperature variations on number of volcanic eruptions (by E. N. Khalilov, 2010)
Polynomial trend of second degree is marked in red

The polynomial trend shows that the increase in the number of volcanic eruptions by 20 (from 53 to 72 eruptions) corresponds to the temperature change of 0.56 ^{0} C.

7.4. NON-VOLCANIC DEGASSING OF EARTH

It should be borne in mind that the volcanic eruptions graph represents major eruptions documented by people and listed in catalogs. These eruptions can be considered indicators of Earth's increasing endogenous activity. However, they do not reflect the full extent of volcanic activity which manifests itself very intensively within the mid-ocean ridges, accompanying the spreading processes.

A lot of underwater volcanic eruptions remain unnoticed by researchers and are not included in catalogs because they are hidden under the layers of oceanic water. It should be noted that degassing of the mantle in the mid-ocean ridges is a constant process. During the periods of Earth's increased overall activity, degassing of the mantle in the mid-oceanic ridges significantly intensifies as well, saturating soil, water and the atmosphere with mantle gases. This is also indicated by many years' researches of several authors (Sh.F.Mehdiyev, E.N.Khalilov, 1983, 1984; V.E.Khain, Sh.F.Mehdiyev, T.A.Ismail-Zade, E.N. Khalilov, 1986; V.E.Khain, E.N. Khalilov, 2008, 2009). Eruptions of rift zone volcanoes such as the eruption of the Icelandic Eyjafjallajokull volcano in March and April of 2010 serve as indicators of the increased activity of the ocean floor spreading processes.

Not only volcanoes but also earthquakes which activate many deep crustal faults to enable the mantle gases to break through to Earth's surface and saturate the atmosphere can be a channel for deep greenhouse gases to penetrate Earth's atmosphere.

Through deep faults located in oceanic and continental rift zones and subduction zones, as well as transform faults are perfect for channeling Earth's deep gases into the atmosphere during the periods of increased geodynamic activity of our planet. This is evidenced by the results of numerous researches in the field of studying and forecasting earthquakes, based on the higher deep gas content level in the atmosphere, water and soil of open deep fault zones. A study by A.I.Kvartsov and A.I. Friedman states that "The composition and migration intensity of natural gases are conditioned mainly by the geotectonic regime. During seismic activity periods, there is a gas outflow from great depths, possibly from the mantle" (A.I.Kvartsov, A.I. Friedman, 1974). Following routine observations, L.M.Zorkin, S.L.Zuoayraev, E.V.Karus and others have established that the impact of seismic shocks leads not only to the increased concentration, but also to the altered composition of the hydrocarbon part of gases as well as the ratio between individual gas components (L.M.Zorkin et al, 1977).

The increase in the natural gas concentration around deep faults before and after large earthquakes is a proven geological fact corroborated by studies of many world scientists.

Earthquakes and volcanic eruptions are indicators of increased geodynamic activity. But the real scale of degassing of the mantle is significantly higher than estimated gas emissions into the atmosphere during the periods of documented eruptions of large volcanoes.

One of the most important questions the concept of "anthropogenic origin of global warming" is unable to answer is why there is a cyclicity observed in global temperature anomalies and represented by periodic significant global temperature drops. This cyclicity is not observed in anthropogenic activity. However, similar cycles can be seen in volcanic and seismic activity changes and some other geological and geophysical parameters as well.

V. Barsukov in his work points out that there is a two or threefold increase of hydrogen and carbon dioxide (CO_2) ion content in groundwater 1-2 months prior to an earthquake (V. Barsukov, 1976).

The research we are carrying out proves that the endogenous processes on our planet have greatly intensified in the past two decades. This is evidenced by the nature of changes in seismic and volcanic activity, the geomagnetic poles' rate of motion, global temperature changes in Earth's atmosphere and the content of endogenous gases therein, global sea level changes, etc.

7.5. GLOBAL WARMING: ALTERNATIVE VIEWS OF SCIENTISTS

The ultimate goal of any research is to acquire objective knowledge of the subject being studied. Opinions of different scientists on the problem of global climate change may vary, but in order to get a correct answer to questions arising, one has to consider and analyze all existing views. Only after a generalized analysis of arguments of all parties involved, it will be possible to determine the degree of both the anthropogenic and natural factors' impact on Earth's climate. To do that, researchers having different opinions must be equally provided with a platform to speak out.

In recent years, many researchers have come up with scientific justification of the fact that it is incorrect to call global climate change global warming. The average annual temperature variations are cyclical in nature, with the natural factor playing a big role in those processes. Presently, the average annual temperature growth rate has declined substantially as evidenced by NASA and Hadley data given in D. Sc. Jarl R. Ahlbeck's study (Abo Akademi University, Finland 08.10.2008, http://www.factsandarts.com/articles/no-significant-global-warming-since-1995/).

Fig. 79 contains a graph showing changes in Earth's surface temperature between 1995 and 2009, according to Hadley data (D. Sc. Jarl R. Ahlbeck, 2008). It is clearly seen from the graph that over the last 15 years, the global temperature on Earth's surface has not increased, but rather has dropped to some extent. A similar pattern is observed for temperature changes in the troposphere. Fig. 80 indicates some decline in the overall tropospheric temperature trend during the period reviewed. Thus, it becomes evident that temperature may fluctuate within certain limits, regardless of the anthropogenic factor, due to natural processes on Earth and within the solar system.

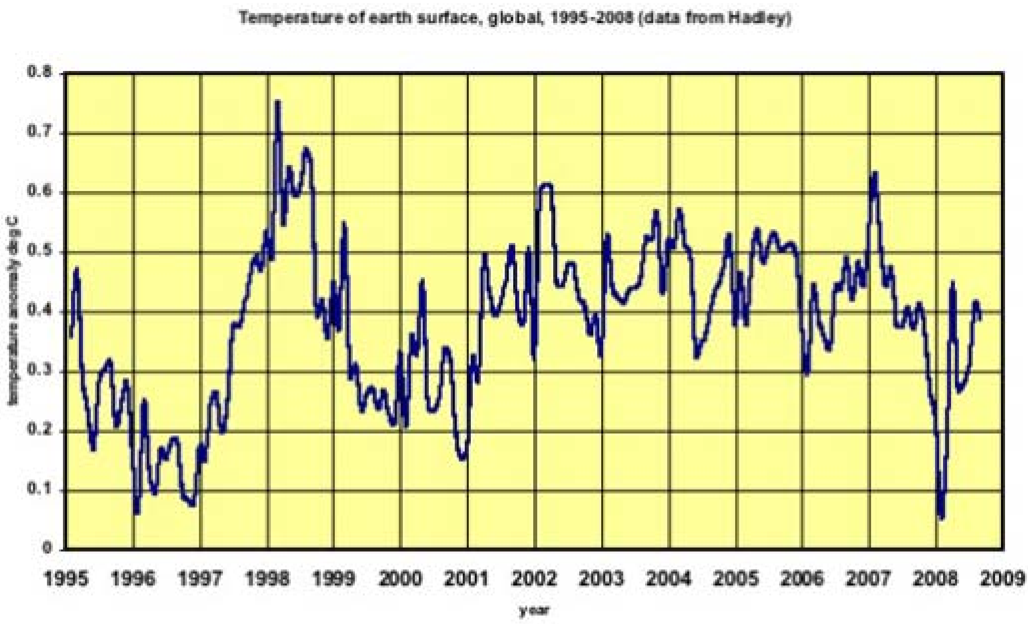


Fig.79. Temperature change on Earth's surface

From D. Sc. Jarl R. Ahlbeck's article (Abo Akademi University, Finland 08.10.2008, http://www.factsandarts.com/articles/no-significant-global-warming-since-1995/)

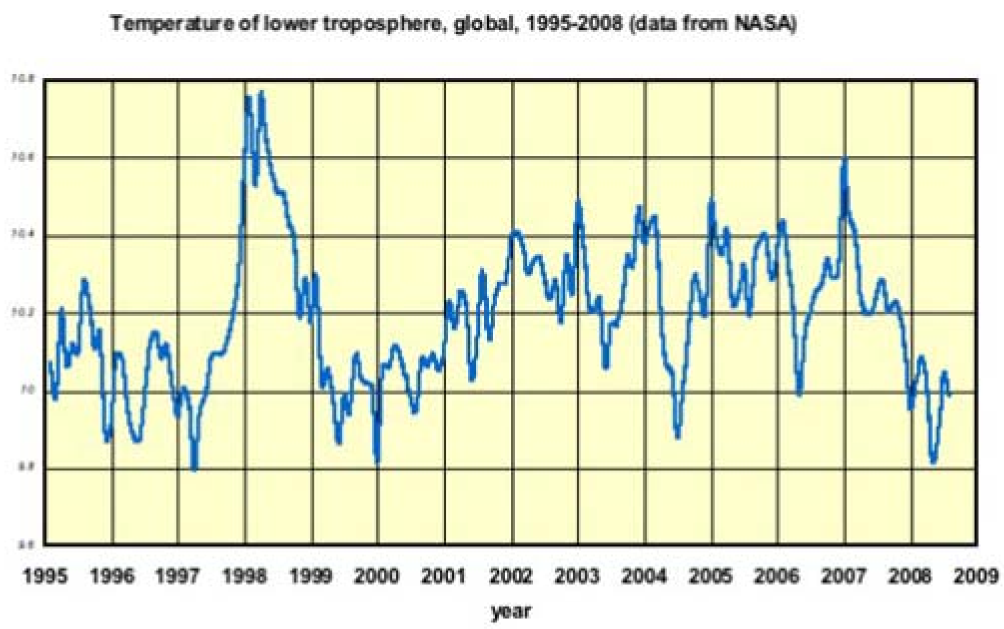


Fig.80. Temperature change in troposphere

From D. Sc. Jarl R. Ahlbeck's article (Abo Akademi University, Finland 08.10.2008 http://www.factsandarts.com/articles/no-significant-global-warming-since-1995/)

IPCC reports have repeatedly suggested a direct link between storms, hurricanes, tornadoes and global warming. Now it is important to find out to what extent this view is consistent with scientific facts.

Fig. 81 compares global temperature changes and named North Atlantic storm frequency from 1920 to 2007. There are three pronounced cycles designated as A, B and C in the diagram.

However, the temperature rise cycles and storm numbers cycles are in antiphase. It could be assumed that there is an inverse relationship between these two processes. But then, how can one explain the fact of simultaneous increase in global temperatures and storm numbers since 1990? In this case, we have a direct rather than inverse relationship. Thus, we see no direct correlation between these two processes in the diagram.

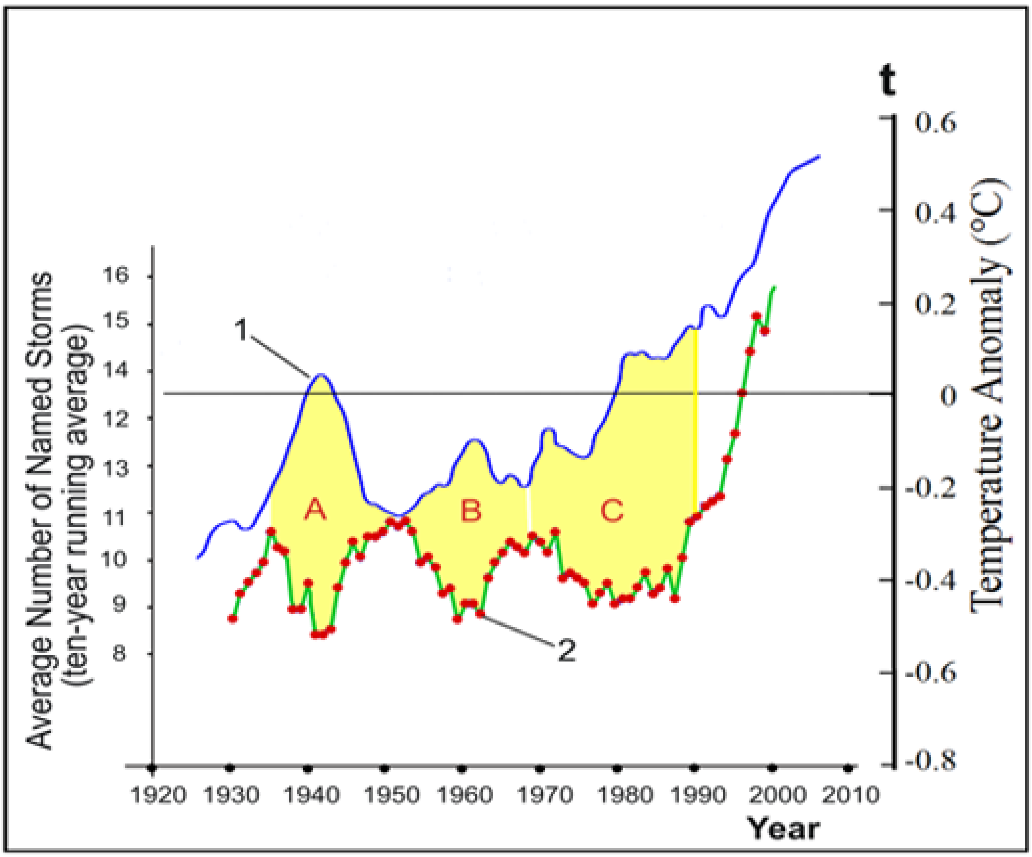


Fig.81. Comparison of graphs for global temperature variations and named North Atlantic storms (by E.N.Khalilov, 2010)

1 – graph for global temperature variations according to IPCC data;

2 – graph for numbers of named tropical storms in North Atlantic Basin (by Pew Center on Global Climate Change

http://www.pewclimate.org/global-warming-basics/facts_and_figures/impacts/storms.cfm)

We have conducted a similar analysis for tornadoes. Fig. 82 compares the graphs for changes in global temperatures and numbers of US tornadoes from 1920 to 2005. Comparison of global temperature with the US tornado number graph shows that there is no correlation between these two processes.

Meanwhile, a lot of scientists have come to this conclusion much earlier. For instance, Antony Watts in his report points to the absence of any scientifically valid relationship between global warming and the number of tornadoes and storms (Antony Watts, 2009, http://wattsupwiththat.com/2009/10/28/tornados-and-global-warming-link-just-not-there/).

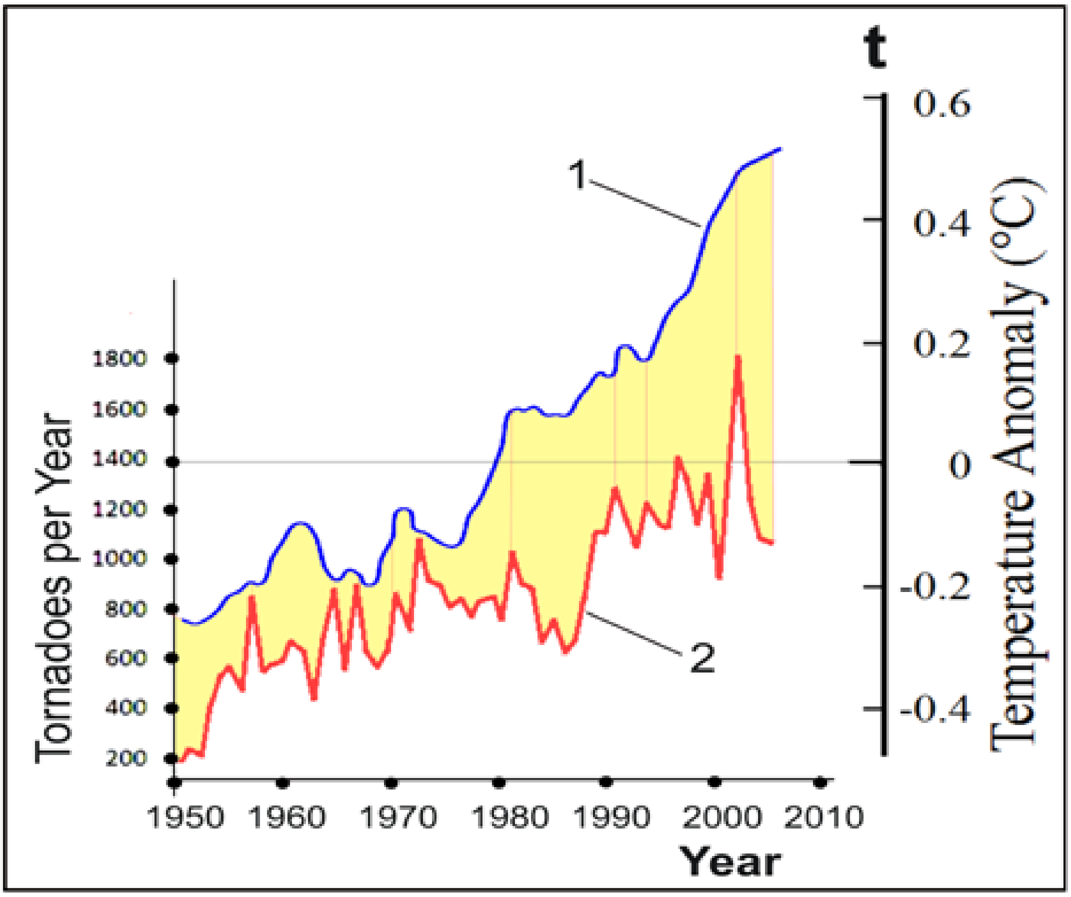


Fig.82. Comparison of graphs for global temperature changes and US tornadoes. (by E.N.Khalilov, 2010)

As pointed out by Sterling Burnett H., (1997), the majority of world scientists disagree with the notion that global climate change is of anthropogenic nature. This is also evidenced by the analysis of a scientists and public opinion survey, provided in the following article (http://www.ncpa.org/pub/ba230 and http://www.ncpa.org/pdfs/ba230.pdf).

A detailed analysis of the possible effect of the anthropogenic and natural factors on global climate warming is given in a work by Arthur B. Robinson, Noan E. Robinson and Andwillie Soon (2007). The results of those studies incline the reader to the view that the natural factor's impact on climate change prevails over that of the anthropogenic factor.

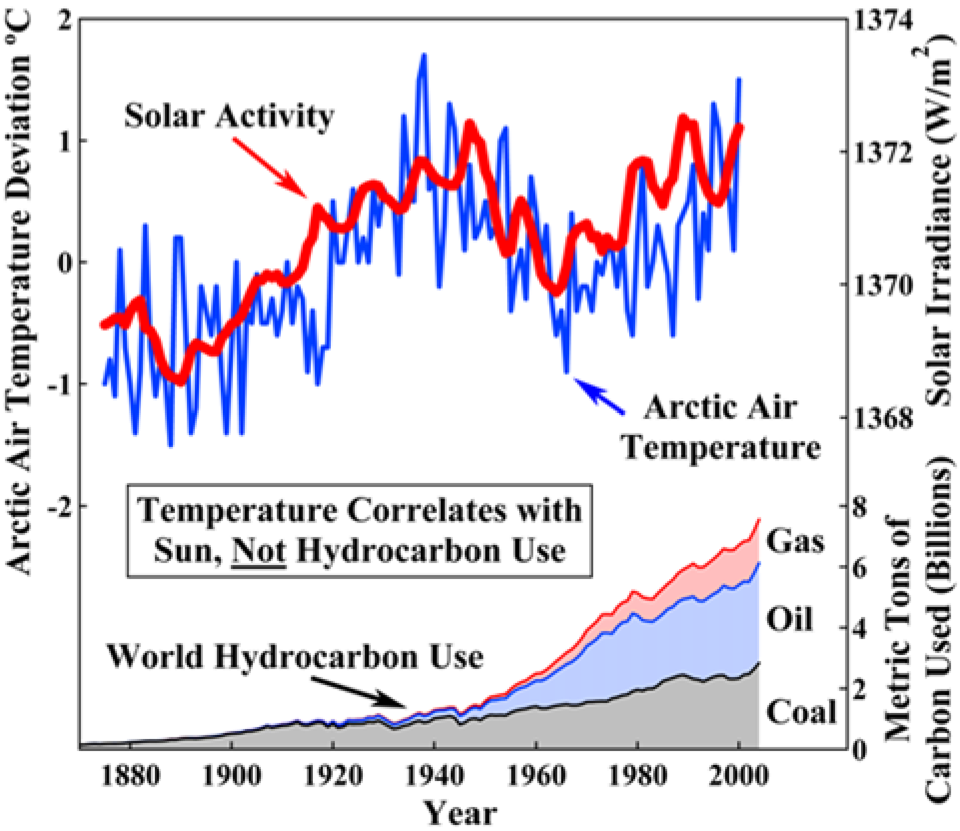


Fig. 83. Comparison of Arctic surface air temperature and solar activity (solar constant)
(Arthur B. Robinson, Noan E. Robinson and Andwillie Soon, 2007)

Comparing the Arctic surface air temperature with the solar constant from 1880 to 2005 in Fig. 83 reveals a high correlation between these two processes. At the same time, these graphs show no correlation with the graphs for utilization of various types of hydrocarbons.

We did not aim to provide in this report a detailed analysis of most of alternative studies on the problem of "global warming". We have shown some important aspects of alternative views. This problem is to be comprehensively reviewed and discussed in the next IC GCGE "GEOCHANGE" reports.

Conclusions

- The role of Earth's volcanic activity in global climate change is significantly higher than assumed.

- Increased degassing of the mantle during the periods of intensification of Earth's endogenous activity can be one of the main factors causing global temperature changes. This process occurs as a result of the following: growing number of volcanic eruptions; increased seismic activity and higher rate of gases entering the atmosphere through deep faults in the crust; deep gases penetrating into the world ocean and subsequently the atmosphere as a result of intensification of the spreading processes. All this ought to result in higher amount of greenhouse gases released from the mantle into the atmosphere. For instance, the volcanic activity index from 1850 to the present day has grown by 80-85% as compared to the background value. Therefore, it is logical to assume that the amount of volcanic gases emitted during volcanic eruptions has increased during this period by 80-85% as well.

- An important role in climate change is attributed to global changes in the parameters of the geomagnetic field and magnetosphere; this refers in particular to the more than 500% increase in the north magnetic pole's drift rate and reduction of the geomagnetic field intensity. Today, the impact of magnetospheric processes on Earth's climate is considered a proven scientific fact.

- Global climate change is also affected by solar activity, solar constant variations (flux of solar radiation) in particular, which is also a proven scientific fact.

Chapter 8.
CONCLUSION

The conclusions drawn on the basis of the initial research findings described in Chapters 6 and 7 are as follows:

1. Magnetic poles' drift acceleration

The explosive, more than fivefold growth of the North Magnetic Pole's drift rate from 1990 to the present has been accompanied by a significant increase in Earth's endogenous activity. In 1998, the North Magnetic Pole's drift rate approached its maximum value. From roughly 1998 on, there has been observed a sharp increase in the number of large earthquakes and earthquake fatalities, of volcanic eruptions and tsunamis (catastrophic, medium-sized and weak).

2. Anomalous J_2 coefficient change

1998 saw the beginning of abnormal changes in some of Earth's geophysical parameters, a leap in J_2 coefficient values in particular. This coefficient is determined using measurements made by the laser ranging system from US satellites.

The J_2 coefficient demonstrates the dynamics of the ratio between Earth's equatorial and polar radii. According to NASA, the J_2 coefficient had been decreasing for many years supposedly due to the release of meltwater from the mantle since the ice age. This was indicative of an increase in Earth's radius at the poles and its reduction at the equator. Meanwhile, new data show that since 1998 the J_2 coefficient began to grow. This process reflects the global redistribution of Earth's masses, as well as Earth's expansion at the equator and its flattening at the poles. Thus, some global-scale event is thought to have occurred in 1998; this could mean both global redistribution of Earth' masses and minor changes of its shape.

3. Global sea level change

During the period between 1997 and 1999, sea level fluctuations of the Indian Ocean, Western and Central Pacific were in antiphase to fluctuations of the Eastern Pacific and Atlantic Ocean. While the level of the Eastern Pacific and Atlantic Ocean began to rise sharply from 1997 with a peak in 1998 (about 3 cm), the level of the Indian Ocean, Western and Central Pacific was falling with a 1998 minimum (about 3 cm). The timing of these processes coincided with the J_2 coefficient anomaly. Meanwhile, an article by B. F. Chao and others (B.F. Chao et al., 2003) indicates that even considering the model of possible impact of the redistribution of water masses in the world ocean, the actually observed effect of the J_2 coefficient is 3 times greater than those influences.

4. Global tropospheric temperature change

An anomalous, explosive growth of the global tropospheric temperature was observed in 1998.

5. Large earthquakes

A comparative analysis of anomalous J_2 variations and the dynamics of numbers of large M> 8 earthquakes between 1980 and May 2010 has revealed that starting from 1997-1999, there has been a surge in the number of large earthquakes and fatalities caused by them according to the exponential law.

6. Volcanic eruptions

A comparative analysis of volcanic eruptions and J_2 variations has also showed that 1997-1998 were years of deep minimum of volcanic activity, followed by a sharp increase in volcanic activity observed to date.

7. Tsunamis

Since 1998, there has been observed a dramatic change in the tendency for statistical distribution of the annual numbers of catastrophic, medium-sized and weak tsunamis. The "leap" in the annual tsunami number statistics, witnessed since 1998 is described by exponential trends.

8. Floods

Analysis of the evolution of numbers of severe U.S. floods over the past 100 years makes it possible to conclude that there has been a substantial increase in this indicator since 1998.

Studying the dynamics of the numbers of worldwide flood notifications from 2002 to late May, 2010 (according to the Global Flood Detection System, an experimental system aimed at providing flood disaster alerts) has shown a steady increase in the number of floods since 2005. Meanwhile, comparing the number of seasonal floods from 2005 to May 2010 (from February to late May) for the same period in previous years indicates some constant increase in the number of seasonal floods from year to year. In particular, the number of worldwide flood notifications received for the period between February 2010 and late May 2010 is more than 2,5 times higher than the figures for the same periods from 2002 to 2006 inclusive.

9. Tornadoes

Germany has been given as an example of a sharp increase in the number of tornadoes since 1998. There were 2,5 times more tornadoes in Germany for 5 years (between 2000 and 2005) than over the preceding ten years. A similar situation can be observed in the U.S. (Section 4.1.2).

10. Hurricanes and storms

A surge was observed between 1998 and 2007 in the number of North Atlantic tropical storms, and this tendency continues today. An increase in the total number of Atlantic Basin hurricanes from 1944 to the present is observed as well (Section 4.1.1.).

11. Forest fires

The dynamics of the annual numbers of U.S. forest fires from 1960 to 2007 reveals their tendency to grow, with the "surge" beginning in 1998 as well. A similar pattern in the dynamics of forest fire statistics is observed in other regions of Earth. For instance, Kazakhstan in 1997 witnessed a "surge" in the form of a sharp increase in the number of forest fires and fire-affected areas. As for the territory of Eastern and Western Europe and the CIS, there is a tendency for the annual numbers of forest fires to soar as well, with the general nature of their dynamics described by an exponential trend. Around 1998, there was observed a "surge" in the number of forest fires.

12. The role of natural factors in global climate change:

- The role of Earth's volcanic activity in global climate change is significantly higher than suggested in IPCC reports.

- Increased degassing of the mantle during the periods of intensification of Earth's endogenous activity can be one of the main factors causing global temperature changes. This process occurs as a result of the following: growing number of volcanic eruptions; increased seismic activity and higher rate of gases entering the atmosphere through deep faults in the crust; deep gases penetrating into the world ocean and subsequently the atmosphere as a result of intensification of the spreading processes. All this ought to result in higher amount of greenhouse gases released from the mantle into the atmosphere.

- An important role in climate change is attributed to global changes in the parameters of the geomagnetic field and magnetosphere; this refers in particular to the more than 500% increase in the North Magnetic Pole's drift rate and reduction of the geomagnetic field intensity. Today, the impact of magnetospheric processes on Earth's climate is considered a proven scientific fact.

- Global climate change is also affected by solar activity, solar constant variations (flux of solar radiation) in particular, which is also a proven scientific fact.

As a result of the studies conducted, a conclusion has been drawn about the beginning of the so-called global "energy spike" in our planet's energy manifesting itself across all its strata: the lithosphere, hydrosphere, atmosphere and magnetosphere. The starting point for the global "energy spike" is roughly 1998.

The global "energy spike" is explicitly reflected in the soaring statistical indicators for the vast majority of natural disasters most dangerous to humanity: earthquakes, volcanic eruptions, tsunamis, tornadoes, hurricanes, storms, floods and forest fires.

The role of natural factors in global climate change is much more substantial than suggested in the official IPCC conclusions.

Appendix 1

POSSIBLE FORECASTS OF SOME NATURAL CATACLYSMS AND COSMIC PROCESSES

Introduction

The first IC GEOCHANGE GCGE report can hardly be called complete without this appendix. The analysis conducted on the dynamics of statistics of many natural hazards, geophysical and cosmic parameters has showed their tendency to increase substantially since about 1998. However, it is obvious that the main point of this study is not about a formal statement of facts but rather in a possible prediction of future events.

Not only must we demonstrate the evolution of the dynamics of the number and scale of natural disasters, but we must also suggest possible patterns of future development of events, that is, provide a long-term forecast for Earth's most dangerous hazards. This section does not address other types of disasters, which is planned for the next IC GCGE reports.

Attitude to the problem of forecasting natural disasters may be disputable; therefore this section is not included in the basic contents of the first IC GCGE report, being instead given as a special Appendix 1.

We are not trying to predict specific events since it is too complicated and controversial an issue. Our objective is long-term forecasting of changes in the next decade's dynamics of global seismic and volcanic activity and tsunami manifestations. Tsunamis typically result from seismic and volcanic activity except for rare cases when they may be caused by other geological processes.

In producing long-term forecasts, we have been relying on the well-known principle which long-term forecasts in all areas of science are based on. The principle is as follows: "To look into the future, one must study the past well".

Long-term forecast of Earth's seismic activity dynamics

Methodology

Following the basic principle of long-term forecasting, we have attempted to examine the regularity in the evolution of monthly numbers of earthquakes of different magnitudes and for different time intervals.

The main purpose of this research is to identify Earth's seismic activity dynamics patterns.

One of the fundamental regularities of all natural processes is cyclicity. Revealing the objectively existing cyclicity in Earth's seismic activity dynamics is an important aspect for long-term forecasting. Meanwhile, there are special techniques for detecting hidden periodicities in the time series of different processes. These techniques include linear and nonlinear transformations of time series. Linear transformations may refer to various types of averaging of time series for different time intervals. As to this problem, we apply the running average method. Another approach is based on spectral analysis, which helps identify different harmonics in the time series. If both methods are employed without any special technology, an incorrect result may be obtained because it heavily depends on the length of the filter and other preset parameters. However, there are special methods to use spectral analysis with as objective a result as possible. This technique is described by the author in a number of works (E.N.Khalilov, 1987; V.E.Khain, E.N.Khalilov, 2008; 2009).

As numerous studies by various authors (Sh.F. Mehdiyev, E.N. Khalilov, 1987; V.E. Khain, E.N. Khalilov, 2009) have demonstrated, there are cycles of different orders in volcanic and seismic activity, ranging from hundreds of millions of years to several months.

However, this chapter does not address detailed time series analyses. In this case, we have only applied initial treatment and trend analysis to identify a general tendency in processes as they progress with time by approximating them with simpler functions (straight line, sine curve, polynomial trend, exponential function). We find it very interesting to reveal trends in global seismic activity for different time intervals and earthquakes of different energy.

Research

During the first phase, the evolution of monthly numbers of earthquakes with M> 6.5 was studied for the period between 1976 to May 2010 smoothed with 11-month running averages. Fig. 84 provides a diagram for variations of monthly numbers of earthquakes with M> 6.5 together with a straight-line trend and a sinusoidal trend both reflecting the dynamics and cyclical nature of the studied process. The cycles described by the sine curve have a period of about 18 years. Drawing the sine curve further along the straight-line trend from May 2010 to 2016 allows us to forecast the general dynamics of changes in monthly numbers of earthquakes. Thus, according to the sine curve's projected segment, a rise in the seismic activity level is expected for 2010 to 2016.

The straight-line trend also indicates the stable dynamics of increase in monthly numbers of earthquakes in the course of time. Thus, the overlapping straight-line and sinusoidal trends intensify the total effect of increased earthquake numbers from 2010 to 2016.

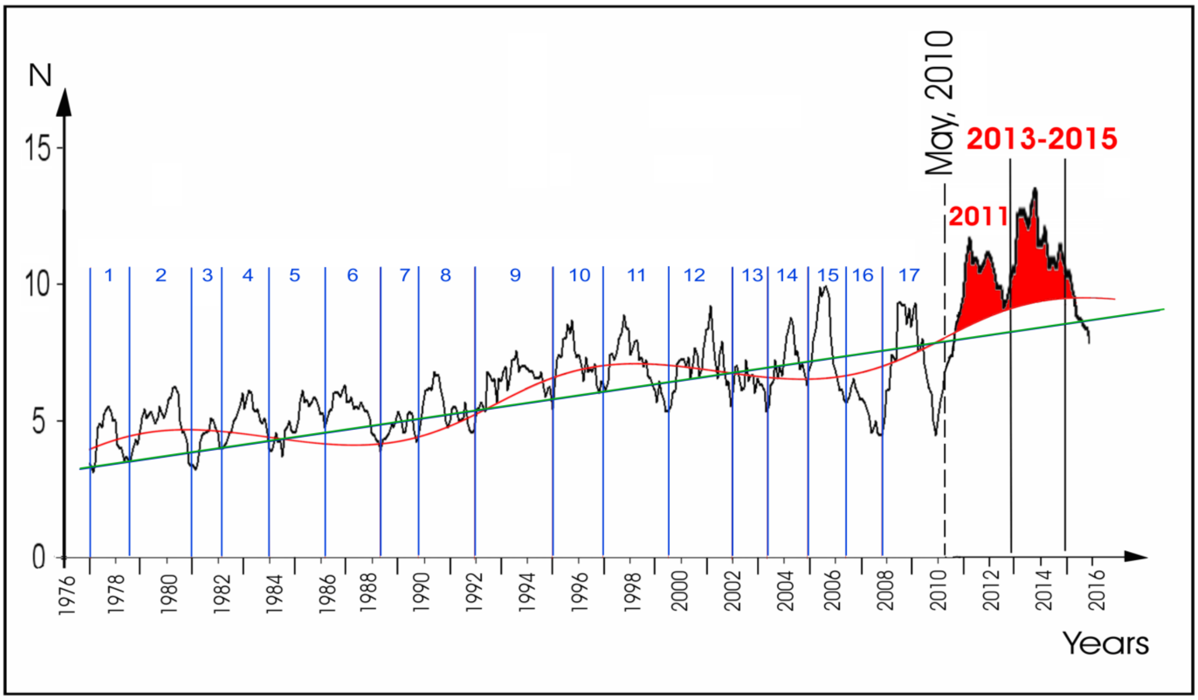


Fig. 84. Graph for monthly numbers of M >6,5 earthquakes between 1976 and 2010 projected to 2016 by highlighting sinusoidal trend (by E.N.Khalilov, 2010, according to USGS data)

Sinusoidal trend with projected seismic activity segment is marked in red; number of earthquakes graph smoothed with 11-month running averages is marked in black; straight-line trend is marked in green; figures 1-17 denote 2-3 year seismic activity cycles.

At the same time, the cycles with periods ranging from 1.5 to 3 years and numbered 1-17 are clearly seen in the diagram. By superimposing those cycles on the sine curve, we obtained a forecasted graph for global seismic activity from 2010 to 2016 which contains two minor seismic activity cycles with average periods of 2-3 years. Within the first cycle, peak numbers of large earthquakes are expected for 2011 with a subsequent relative decrease in activity in 2012, and the second, higher peak of seismic activity is forecast for 2013-2015 to be followed by an expected decline.

For greater research objectivity, we tried a different approach to long-term forecasting of global seismic activity. Fig. 85 contains a graph for monthly numbers of M> 6.5 earthquakes for the period between 1976 and May 2010. The highest peak values of the number of earthquakes are indicated with red dots. If we take a closer look at the graph, we will notice that the distances between the peak values (red dots) correspond to the periods of the cycles highlighted above, 1,5-3 years on average. We have drawn a trend enveloping the peak values marked with red dots, which is described by a sine curve as well with a period of 17-18 years, as seen from the image.

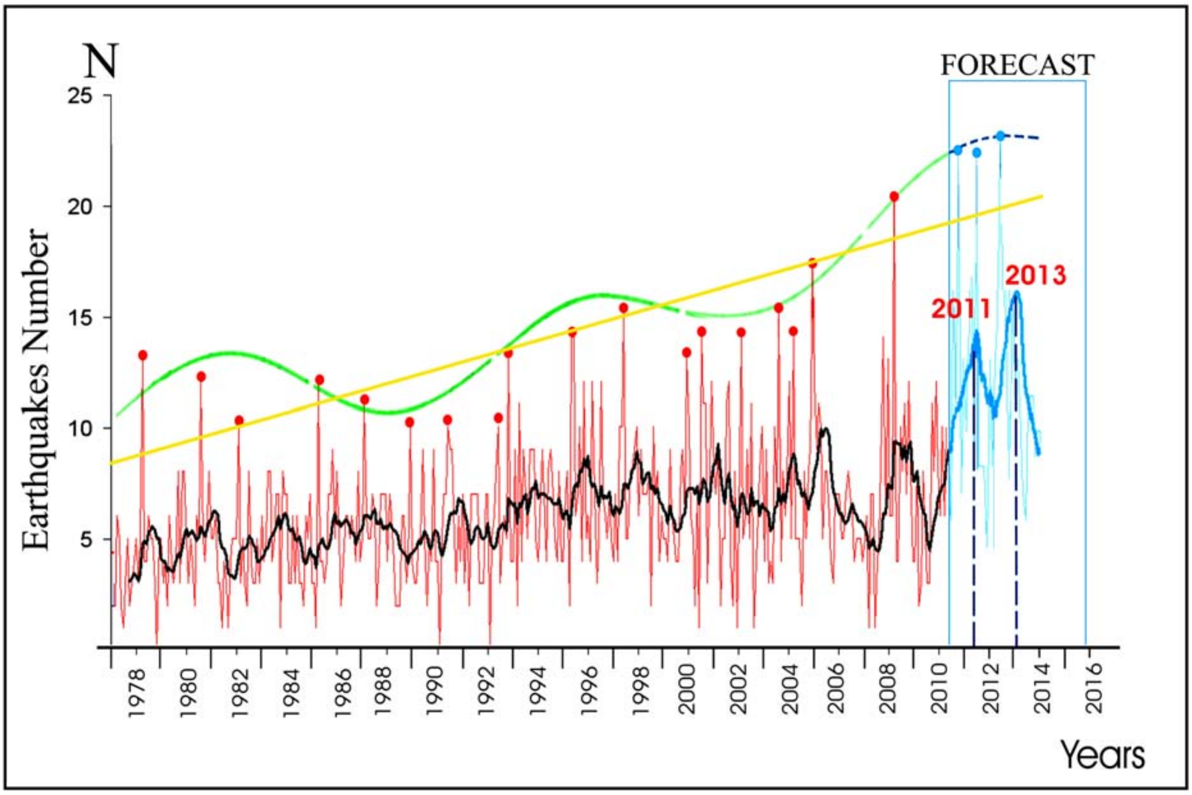


Fig.85. Graph for monthly numbers of M> 6,5 earthquakes between 1976 and 2010 forecasted until 2015 by highlighting sinusoidal trend (by E.N.Khalilov, 2010, according to USGS data)

Graph for monthly earthquake figures is marked in red; sinusoidal trend enveloping highest peaks of monthly earthquake figures is marked in green; number of earthquakes graph smoothed with 11-month averages is marked in black; straight-line trend is marked in yellow; projected segment of seismic activity graph is marked in blue.

The highest part of the enveloping sine curve falls within the time period between 2010 and 2015 as well. Employing the same principle that sums up the dynamics of the straight-line and sinusoidal trends and the cycles with a period of 2-3 years, we get the forecasted segment of the graph where 2011 and 2013 indicate the highest levels of Earth's global seismic activity.

Long-term forecasting of catastrophic earthquakes with M> 8 is also a matter of interest. To that effect, we have drawn a graph for the dynamics of annual numbers of large M> 8 earthquakes for the period from 1980 to 2010, Fig. 86. The diagram shows a straight-line trend and a sinusoidal trend both describing the general nature of the dynamics of the global seismic process. The straight-line trend points to the stable dynamics of growth in the number of large earthquakes in the course of time. The sinusoidal trend helps reveal some cyclicity with a period of 17 years. Thus, the periods of cycles revealed for large earthquakes and for M> 6.5 earthquakes coincide for the period between 1976 and May 2010. In addition, the diagram also exposes some cycles with periods of 1,5-3 years on average, which is also in line with the results obtained earlier.

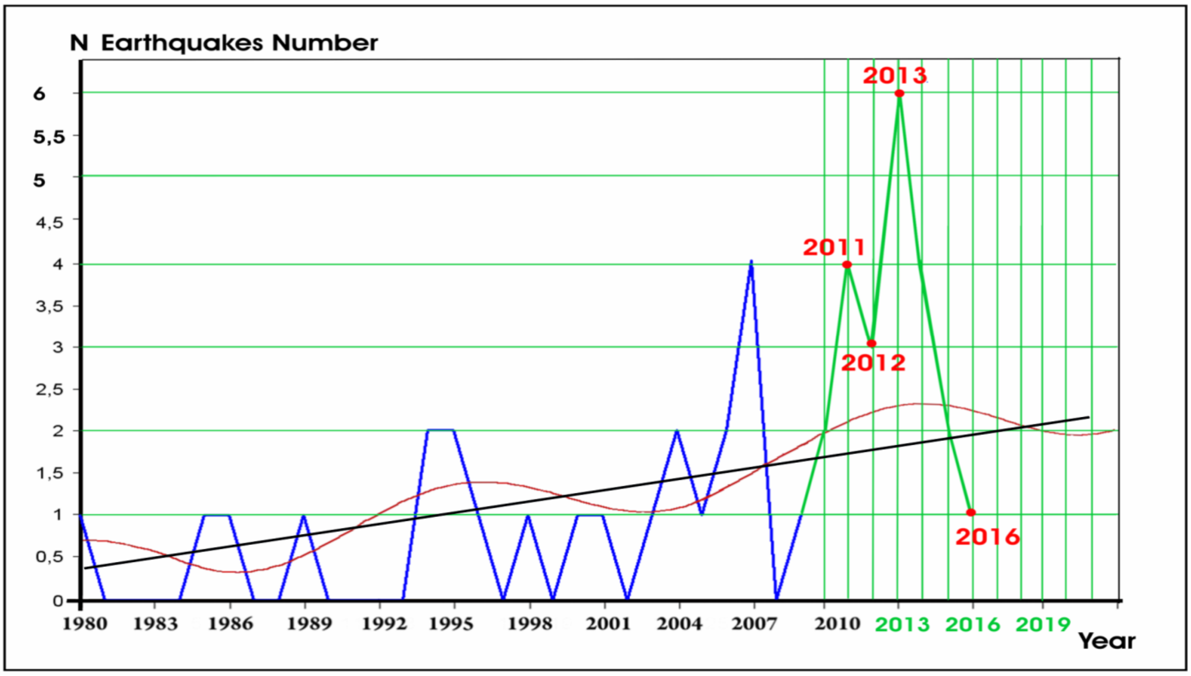


Fig.86. Graph for numbers of M> 8 earthquakes between 1980 and 2010 forecasted until 2016 (by E.N.Khalilov, 2010, according to USGS data)

Annual number of earthquakes graph is marked in blue; sinusoidal trend is marked in red; straight-line trend is marked in black; forecasted seismic activity graph for M>8 earthquakes is marked in green.

Using the principle that sums up the dynamics of the straight-line and sinusoidal trends and the cycles with a period of 2-3 years, we get the graph's forecasted part (marked in green) where 2011 and 2013 indicate the highest levels of Earth's global seismic activity, with a relative minimum in 2012. 2016 is expected to see a substantial decline in seismic activity.

Let us investigate the dynamics of catastrophic M> 8 earthquakes for the period between 1900 and May 2010 for the purpose of long-term forecasting, Fig. 87.

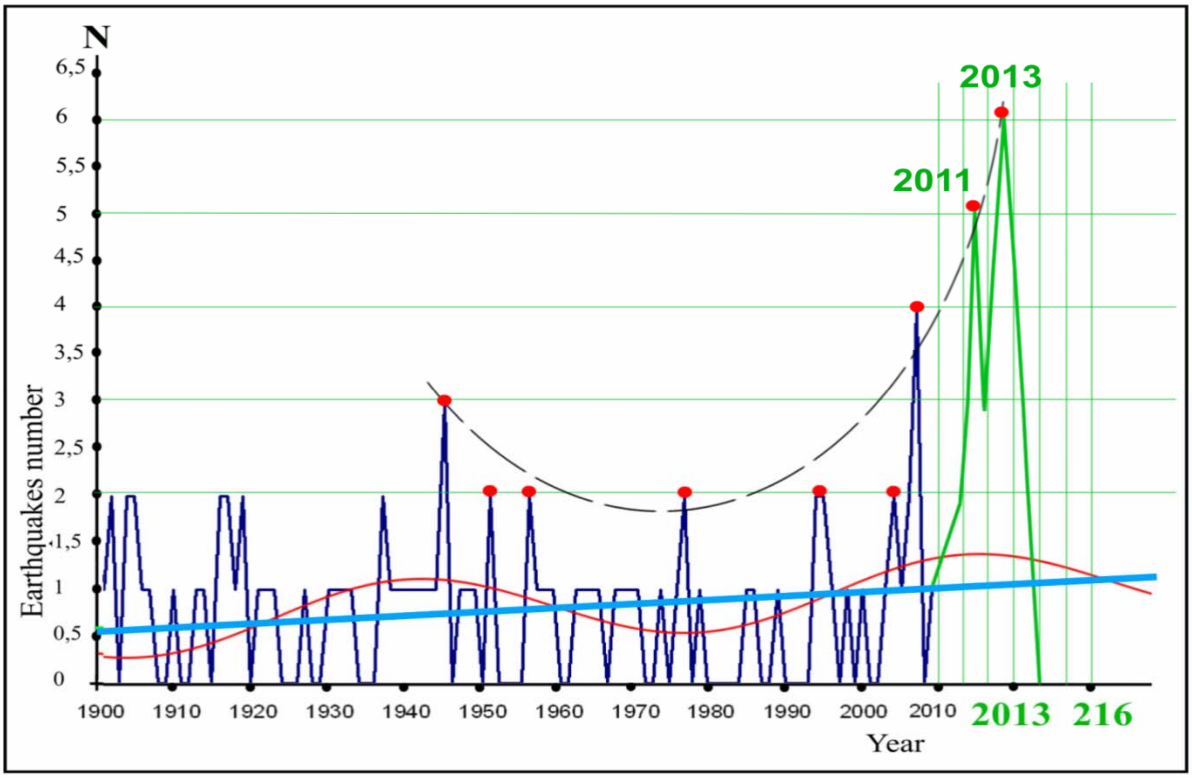


Fig.87. Graph for numbers of M> 8 earthquakes between 1900 and 2010 forecasted until 2016 (by E.N.Khalilov, 2010, according to USGS data)

Annual number of earthquakes graph is marked in darker blue; sinusoidal trend is marked in red; curve enveloping peak values of earthquake numbers graph is marked in black; straight-line trend is marked in lighter blue; forecasted seismic activity graph for M> 8 earthquakes is marked in green.

As in the previous cases, the graph here is approximated with a straight-line (lighter blue) and sinusoidal (red) trends, Fig. 87. The straight-line trend indicates a steady evolution of numbers of catastrophic earthquakes in the course of time. The sinusoidal trend reveals longer cycles of seismic activity with a period of 75 years (1905-1980).

The peak of the next global seismic activity cycle falls within the period between 2011 and 2015. The diagram also clearly shows the cycles with an average period of 2 to 3 years. Summing up the dynamics of the straight-line trend, sinusoidal trend and the cycles with a period of 2-3 years, we get the forecasted part of the graph (marked in green) with peaks in 2011 and 2013 and a relative minimum in 2012.

As stated above, the peak values of the highest seismic activity cycles can be yet another indicator as marked with red dots on the diagram. Peak values distribution is most effectively described by a parabolic trend marked in black in the diagram. The parabolic trend has allowed us to determine the approximate amplitudes of the forecasted cycles of seismic activity with peaks in 2011 and 2013.

Long-term forecast of Earth's volcanic activity dynamics

In forecasting global volcanic activity, we have employed the same methods and approaches that have been used in forecasting global seismic activity.

Fig. 88 contains a graph for annual numbers of world volcanic eruptions between 1900 and 2009 forecasted up to 2016. The graph is approximated with a sinusoidal trend and a straight-line trend. The latter reflects the stable dynamics of annual increase in the number of volcanic eruptions while the former indicates a certain cyclicity in the observed process. The sine curve allowed us to identify cycles with a period of about 26 years. Of course, these cycles are not as apparent as the double cycles with a period of 5-7 years consisting of shorter cycles with a period of 2,5 to 3,5 years on average. Thus, these cycles are similar to the cycles of global seismic activity with a period of 2-3 years. Summing up the effects of superimposing the straight-line and sinusoidal trends, the diagram shows the projected part with two activity cycles highlighted as well, with peaks in 2011 and 2013 and a local minimum in 2012.

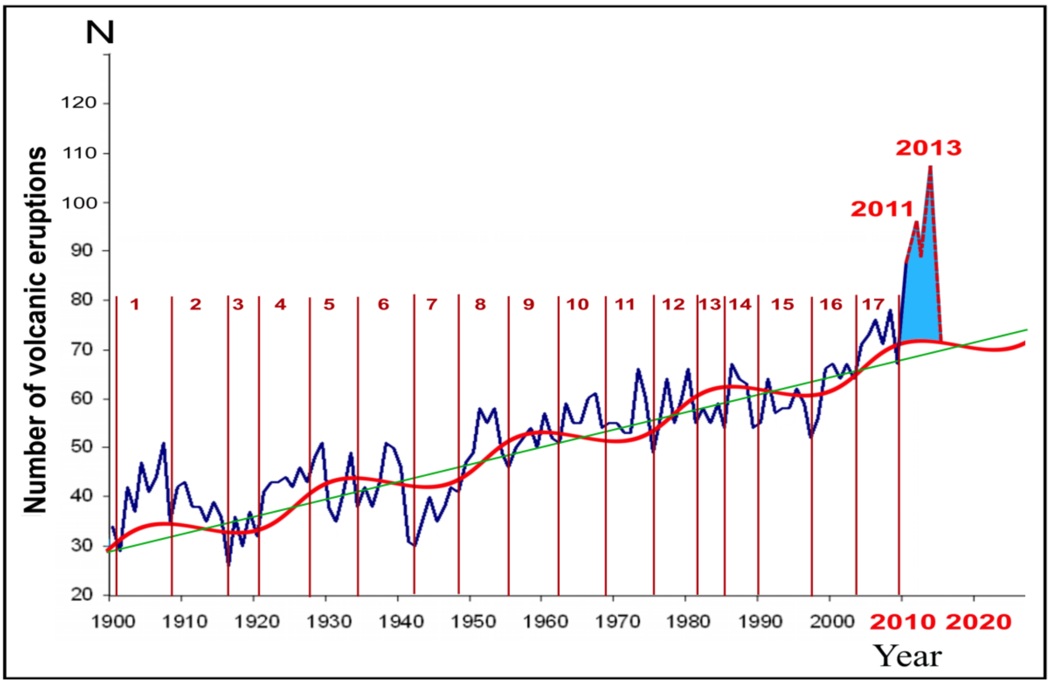


Fig.88. Graph for annual numbers of world's volcanic eruptions between 1900 and 2009 forecasted until 2020 (by E.N.Khalilov, 2010, according to Global Volcanism Program)
http://www.volcano.si.edu/world/find_eruptions.cfm
Graph for annual volcanic eruption numbers is marked in blue; sinusoidal trend is marked in red; straight-line trend is marked in green; 1-17 are cycles of volcanic activity.

What is the reason of such a high amplitude of the forecasted global volcanic activity cycles? The answer to this question has a logical basis. For the period between January 01, 2010 and May 31, 2010, 52 officially confirmed volcanic eruptions occurred according to the Global Volcanism Program. *Therefore it can be expected that by the end of 2010 at least 90 eruptions will have taken place (in a year). In our view, cycle amplitudes indicating 100 eruptions in 2011 and about 110 eruptions in 2013 are quite acceptable.*

Long-term forecast of the dynamics of major tsunami numbers

Forecasting of major tsunamis depends to some degree on forecasting of strong, tsunami-generating earthquakes and volcanic eruptions. We have studied a possible pattern of evolution of numbers of large tsunamis for the next five years.

Fig. 89 provides a graph for the numbers of catastrophic tsunamis which have occurred between 1990 and May 2010, according to *ITIC (International Tsunami Information Centre)*. The analysis of tsunami dynamics demonstrated that for the considered time period, two distinct cycles with a period of 3 years can be singled out, which correspond to the cycles identified in the dynamics of annual numbers of large earthquakes and volcanic eruptions. This is quite logical since for the most part, tsunamis are directly related to large earthquakes and (submarine) volcanic eruptions.

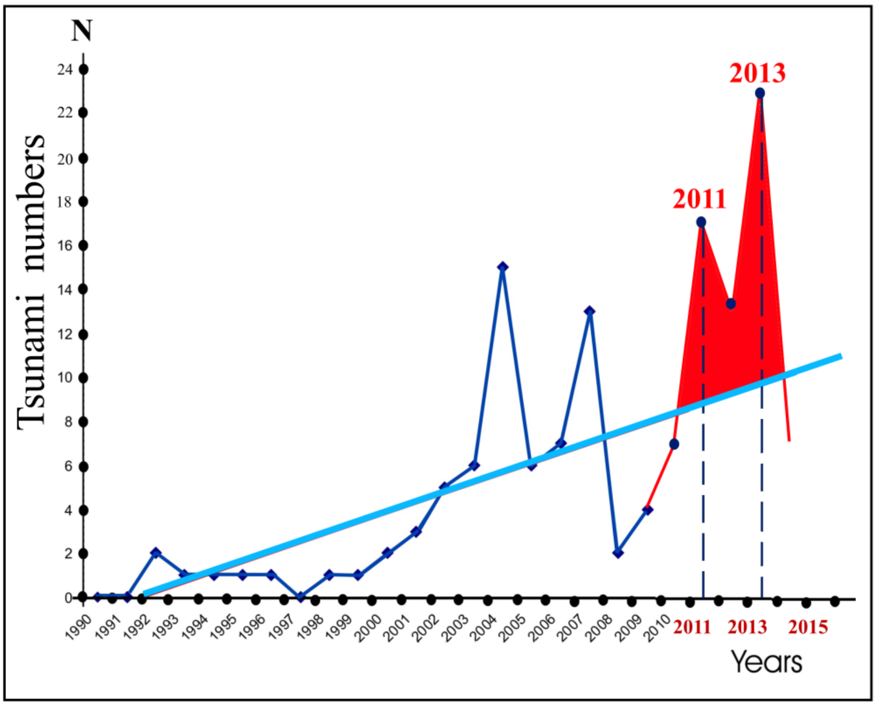


Fig.89. Graph for tsunami numbers between 1900 and 2010
(by E.N.Khalilov, 2010, according to ITIC – International Tsunami Information Centre data)

Tsunami numbers graph is marked in darker blue; straight-line trend is marked in lighter blue; forecasted graph for 2010-2015 tsunami numbers is marked in red.

The straight-line trend points to a steady increase in the number of catastrophic tsunamis in the course of time. By analogy with long-term forecasting of global seismic and volcanic activity, the graph's projected part is marked in red, with two highlighted cycles of increased catastrophic tsunami numbers with peaks in 2011 and 2013 and a local minimum in 2012.

Long-term forecast of solar activity

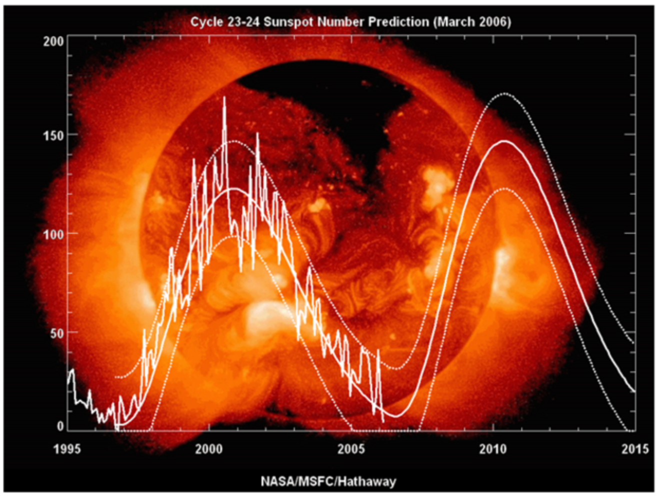
Forecasting of solar activity is one of the most important tasks solar activity studies face. It can be divided into three basic types, which are short-term (up to 10 days), medium-term (up to several months) and long-term (up to several decades) forecasting. Solar activity forecasts are of great practical importance since the impact on people of solar activity manifestations, first of all magnetic storms and increased solar radiation penetrating to Earth's surface, can be considered proven for now. That is why people in many countries are warned of the approaching magnetic storms and those periods are deemed most dangerous for persons engaged in a high-risk professional activity (operating all kinds of sea, land and air transport, etc.).

The increased solar activity expressed by powerful solar flares, solar wind and magnetic storms can have very dangerous consequences for the stability of human activity and affect the stable operation of radio communication systems and sophisticated electronic equipment. However, the greatest danger of high solar activity comes from its effect on climate and many natural disasters as evidenced by various scientists' research findings described in section 5.4.

As far as this study is concerned, we are interested in long-term forecasting only. Despite the fact that sufficiently pronounced cycles have been revealed in solar activity, long-term forecasting even for well-studied 11-year cycles is quite complicated a task. This is evidenced by the fact that virtually not a single prediction made by various world scientists and organizations in forecasting the 24th 11-year cycle has been verified yet.

Many forecasts are based on creating physico-mathematical models to describe the process of solar activity growth. We do not aim to discuss these models, confining ourselves to just giving the evolution of NASA (United States National Aeronautics and Space Administration) forecasts shown in Fig. 90.

As can be seen from the image, the 24th solar activity cycle forecasted in March 2006 had a peak value in 2012. The predicted amplitude of the 24th cycle was considerably higher than that of the 23rd cycle. The forecast of January 2009 demonstrated a more moderate amplitude – at the same level as or slightly lower than the 23rd cycle's amplitude. In June 2010, the peak of the forecasted 24th 11-year solar activity cycle shifted to 2013, with its amplitude shown as being significantly lower than that of the 23rd cycle.



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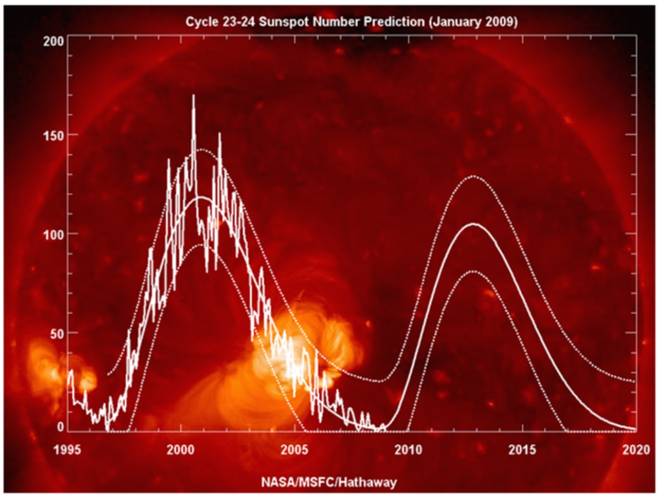

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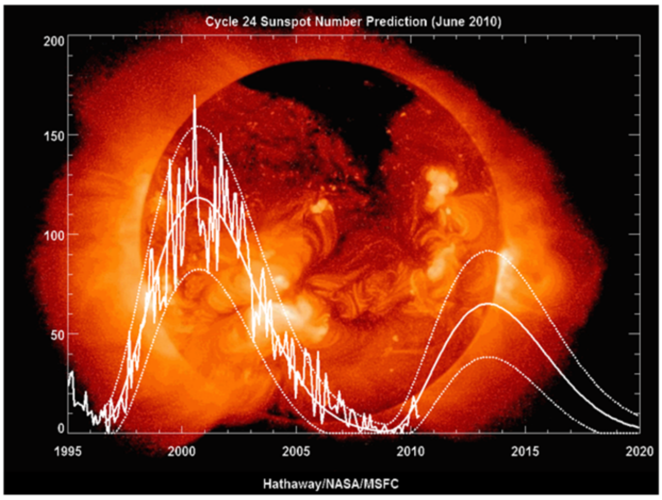

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Fig.90. Evolution of NASA predictions for solar activity

(1) is number of sunspots in 23rd cycle and prediction for 24th cycle (NASA, March 2006);
(2) is number of sunspots in 23rd cycle and prediction for 24th cycle (NASA, January 2009);
(3) is number of sunspots in 23rd cycle and prediction for 24th cycle (NASA, June 2010).

What caused those changes in NASA predictions in different years? First of all, from the very start the progress of the 24th solar activity cycle followed a different scenario than had been presumed in various models. In the first place, the 24th cycle did not begin in 2008 as expected, but rather at the end of 2009. As a result, the physico-mathematical models previously considered the most successful were refuted.

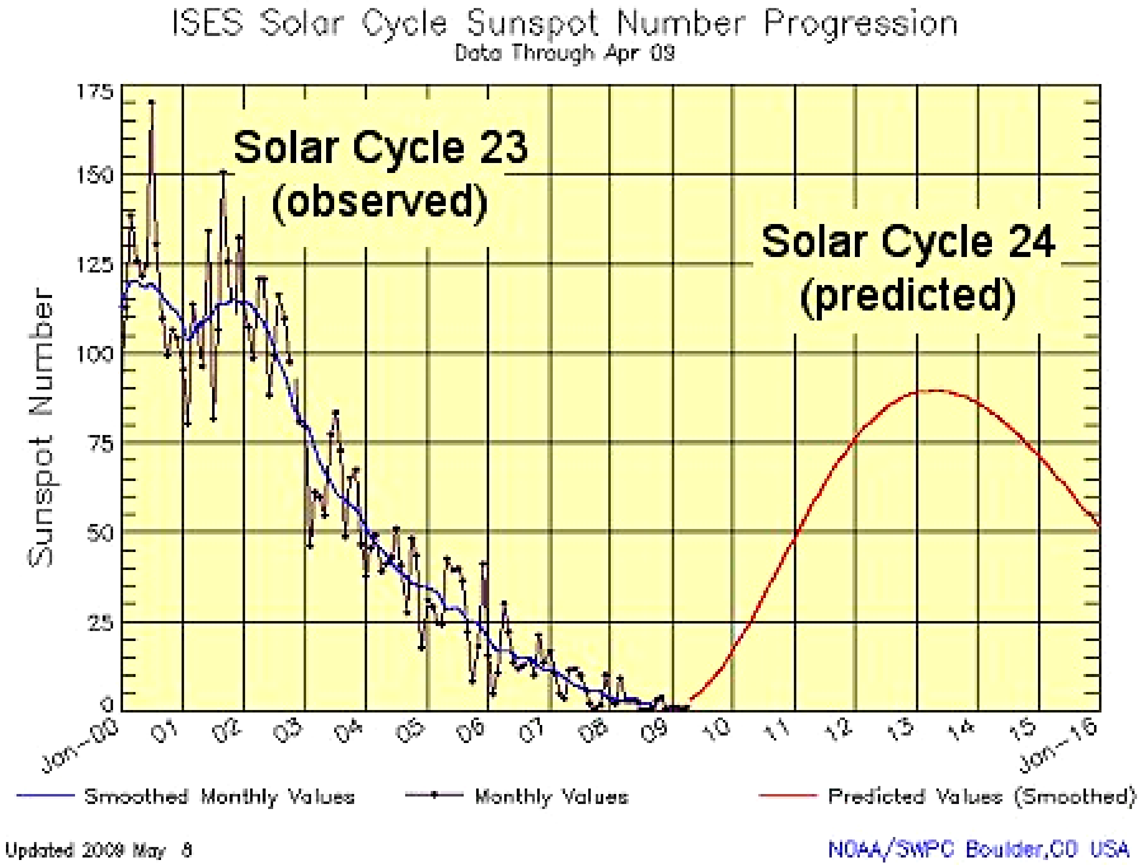

Fig.91. Prediction for 24th solar activity cycle by NOAA - United States National Oceanic and Atmospheric Administration, May 2009
http://images.spaceref.com/news/2009/prediction_strip2.jpg

Another service providing solar activity forecasts is NOAA (United States National Oceanic and Atmospheric Administration). The predictions presented by NOAA in different years had similar dynamics, which is quite logical. Fig. 91 contains one of the forecasts provided by NOAA in May 2009.

In our view, for a more objective forecasting of solar activity it would be useful to consider a longer period of display of one of the most important parameters of solar activity, the solar constant. The point is that unlike the Wolf numbers (for sunspots) resting on the rather formalized solar activity index which cannot be clearly expressed in terms of energy, the solar constant reflects the changes in solar radiation per unit area.

The graph for solar constant variations has both similarities and significant differences with the Wolf numbers. The similarity lies in the fact that this graph also shows up the

11-year solar activity cycles fully correlating with the similar cycles in the Wolf numbers.

At the same time, as can be seen from the solar constant graph for 1611 to May 2010 (Fig. 92), the amounts of radiated solar energy at the maximum and minimum values of the 11-year solar cycles vary considerably for different years, which is not observed in the Wolf numbers. Thus, the solar constant has a pronounced amplitude modulation, apparently due to superimposition of larger solar cycles with a different scale.

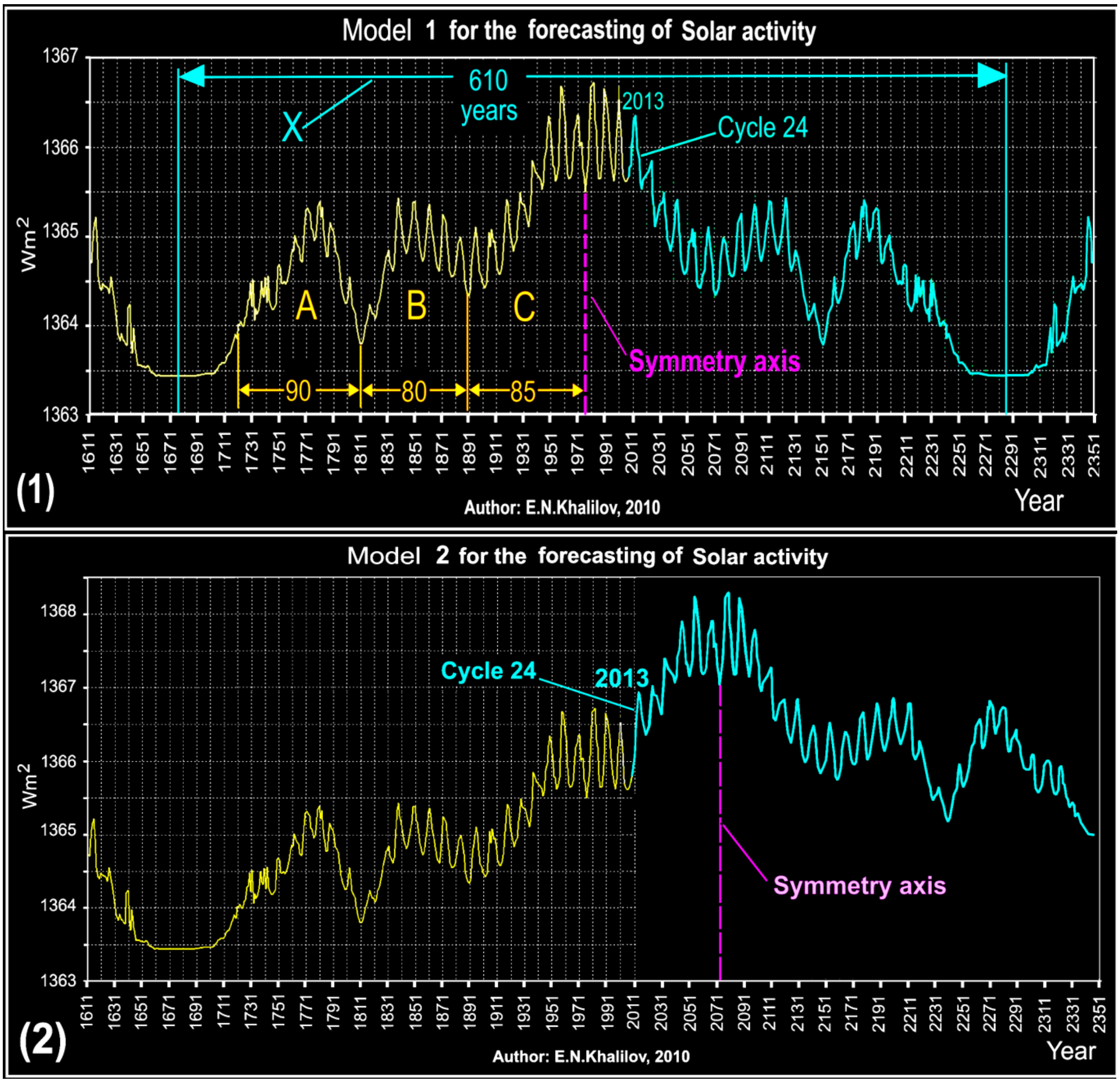

Fig.92. Possible models for long-term solar activity forecasting

(1) is model 1 for solar activity forecasting; (2) is model 2 for solar activity forecasting; graph for actually registered values of solar constant from 1611 to May 2010 is marked in yellow; forecast graphs of solar activity are marked in blue; A, B, C are 80-90-year cycles of solar activity.

In particular, Fig. 92 (1) demonstrates the presence of three major cycles - A, B, C with a period of 80-90 years. The maximum values of cycle A (1780) and cycle B (1838) have almost the same amplitude whereas the amplitude of the peak values of cycle C (1959) is much higher.

Thus, as stated by many scientists engaged in solar activity studies, there are larger cycles standing out against the background of the 11-year solar activity cycles. However, in our view, the specifics of large-scale variations of the solar constant may help in forecasting the amplitude of the 24^{th} solar activity cycle. To do that, we used the method of trend mirroring (E.N.Khalilov, 2010). The essence of the method is that any trend can be viewed as part of a larger cycle of the process in question. In this case, to predict the possible development of the process, the trend can be mirrored as a continuation of the actually observed process, i.e. as its forecasted part. That is the way how one or another model of the possible development of a process can be formed if we are not aware of the considered process' development pattern for a longer time interval.

Fig. 92 (1 and 2) provides a review of two possible models for further evolution of solar activity. By mirroring the left side of the graph on its extension, it is assumed that the time span between 1675 and 1975 is half the period of a larger solar activity cycle with a period of 610 years, Fig. 92 (1). In that case, the low amplitude of the 24^{th} cycle indeed becomes obvious. This cycle may reflect another cycle with a period of 554 years, highlighted by D. Schove (Y.I.Vitinskii, 1976).

The second model of solar activity evolution suggests that the trend observed in solar constant variations reflects part of a cycle longer than 610 years, which we may be unaware of. In that case, the 24^{th} solar activity cycle will have a higher amplitude than the 23^{rd}.

So, we have two conceptually possible solar activity evolution models where larger-scale cycles are described by the solar constant trend. Both models definitely contain 11-year and 85-year solar activity cycles.

The first model (1) is unambiguous since in such a course of events, the large cycle's total period is just about 610 years. This cycle's symmetry axis falls approximately on 1975. With such developments as mentioned above, it is to be expected that the 24^{th} solar cycle will be lower than the 23^{rd}.

The second model (2) is ambiguous in terms of the large-scale cycle's period length. The second model's symmetry axis falls approximately on 2071, but it can move to the right if the period of the major cycle is still longer. Therefore, we cannot speak definitely about the time period for the large-scale cycle in the second model. At the same time, the amplitude of the 24^{th} cycle in the second model is expected to be higher than that of 23^{rd}.

For the present (prior to May 31, 2010), it is not possible to state that the evolution of solar activity exactly follows one of the models. The continuing low activity level at the beginning of the 24^{th} solar cycle may not be an indicator of its low amplitude in 2013. Within the next few years, nature will answer this question more precisely.

CONCLUSIONS

We have carried out long-term forecasting of the evolution of global seismic, volcanic, tsunami and solar activity. The forecasting was based on identification of cyclicities and other regularities in the distribution of numbers of earthquakes, volcanic eruptions and tsunamis for past periods of time and use of the established regularities in the development patterns for future processes.

All long-term forecasts for natural disasters have been made for the period between 2010 and 2016. Two cycles of increased activity with peaks in 2011 and 2013 and a local minimum in 2012 have been identified in long-term forecasts for large earthquakes, volcanic eruptions and tsunamis. By 2016, a decline in activity of all geodynamic cataclysms is expected.

Global changes in a number of geophysical parameters and the high correlation of the period of "explosive intensification" of natural disasters throughout the entire volume of Earth including the lithosphere, hydrosphere and atmosphere over the past two decades – all are indicative of release of an unusually high level of extra endogenous and exogenous energy.

The expected activity of natural disasters may have very serious negative consequences for the stable progress of civilization, leading to death and destruction unprecedented in human history. Economic implications for countries prone to natural disasters may be catastrophic.

It is necessary to unite scientists, international organizations and governments of various states under UN auspices in order to take effective measures to counter natural disasters and minimize casualties and damage they cause to humanity.

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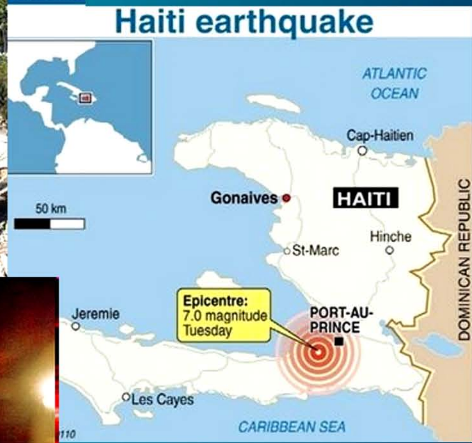
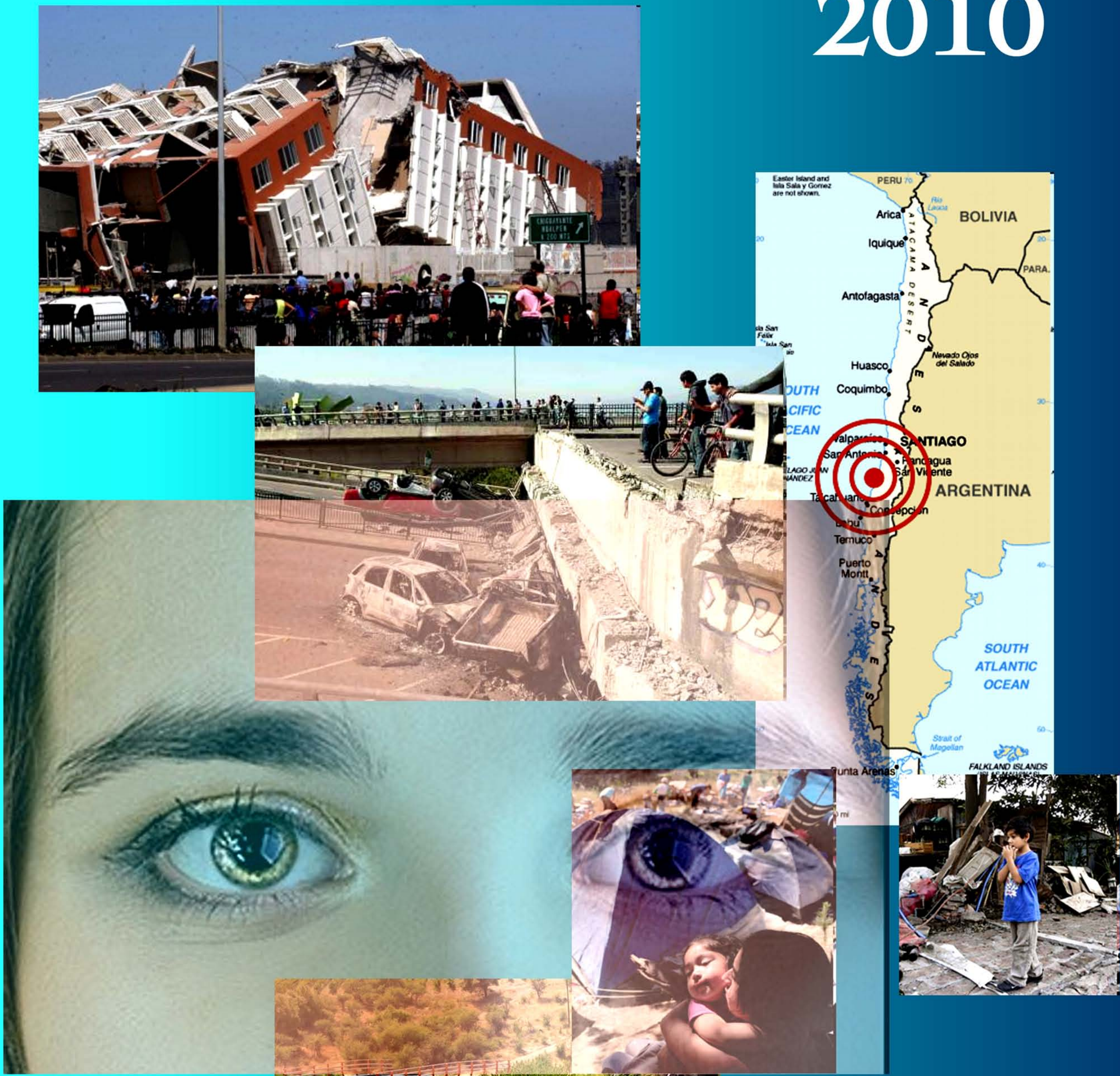


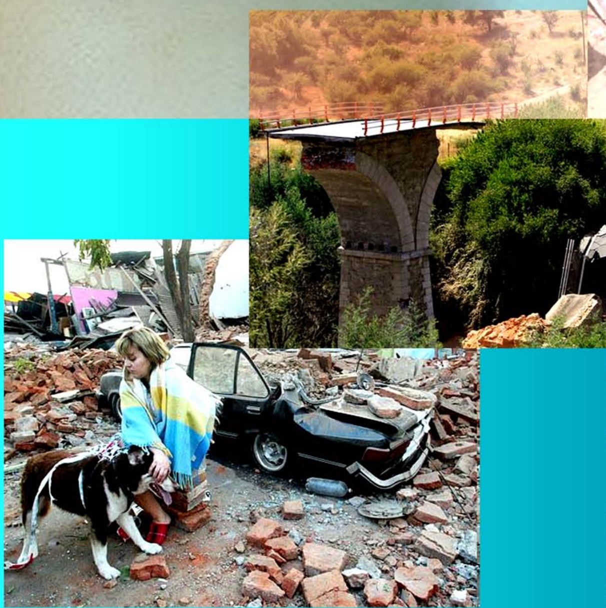
2010

HAITI EARTHQUAKE
12/01/2010, 16:53

Haitian Government reported that an estimated 230,000 people had died, 300,000 had been injured and 1,000,000 made homeless

2010





The 2010 Chilean earthquake occurred off the coast of the Maule Region of Chile[4] on February 27, 2010, at 03:34 local time (06:34 UTC), rating a magnitude of 8.8 on the moment magnitude scale and lasting 90 seconds.

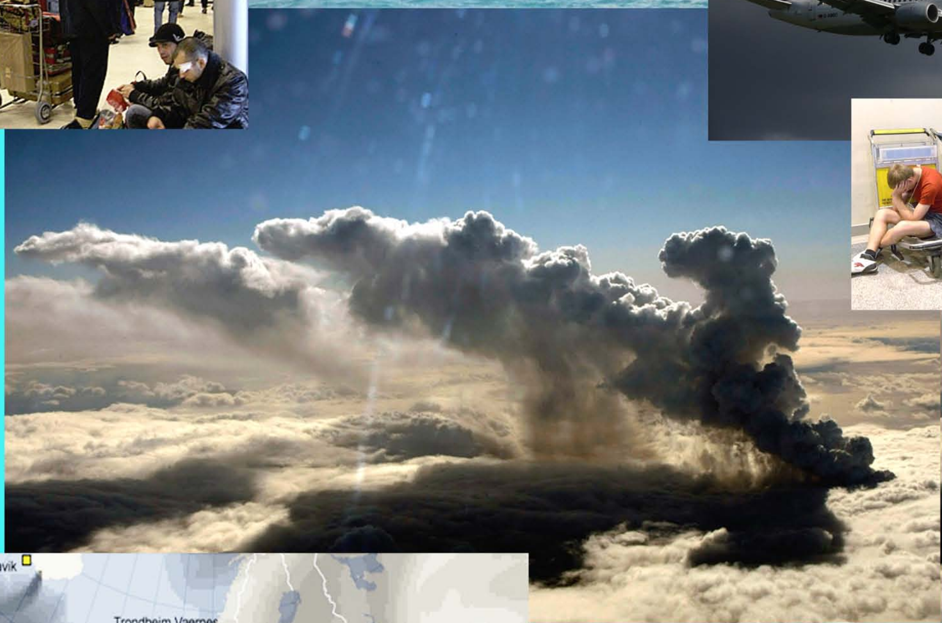
The latest death toll as of April 7, 2010 is 486 victims.

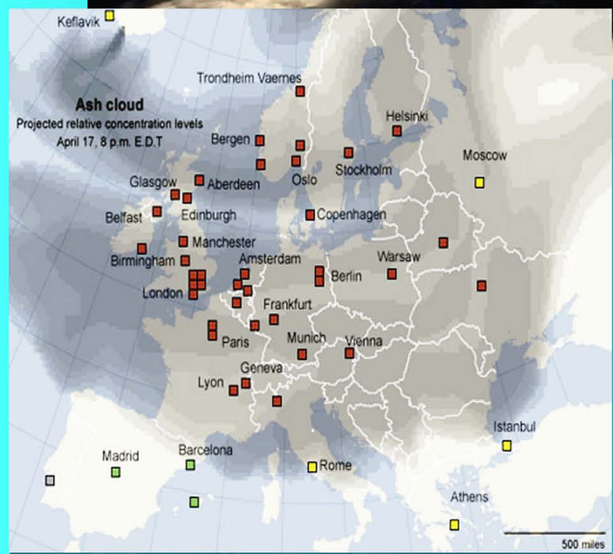
2010

EASTERN TURKEY:
An earthquake in Okcular Village, in Elazig Province, of magnitude-6.1 killed 51 villagers in eastern Turkey early on Monday, March 08, 2010.

The beginning of eruption of a volcano - on March, 20th 2010

2010





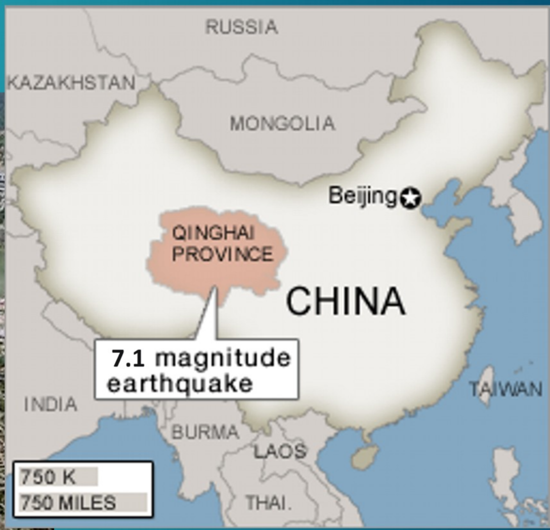
An Icelandic volcano, dormant for 200 years, has erupted, ripping a 1km-long fissure in a field of ice.

The volcano near Eyjafjallajoekull glacier began to erupt just after midnight, sending lava a hundred metres high. Icelandic airspace has been closed, flights diverted and roads closed. The eruption was about 120km (75 miles) east of the capital, Reykjavik.

Iceland lies on the Mid-Atlantic Ridge, the highly volatile boundary between the Eurasian and North American continental plates, with quakes and eruptions.
The last volcanic eruption in the Eyjafjallajoekull area occurred in 1821.

According to a report by the Wall Street Journal, the Icelandic volcano eruption has not only continued to frustrate air travelers but it has also inflicted a heavy financial cost on airlines. The flight disruptions are causing airlines more than $200 million in daily loss of revenues.

China earthquake 2010



7.1 earthquake hit the Qinghai region of China On April, 14th 2010 in the morning. The devastation is astonishing. Over 1500 people have been reported dead.
It is destroyed more than
90 % of houses.

Floods 2010

Floods 2010
Nashville flood, Tennessee, US, 02 May 2010

Warsaw, Poland, 22-24 May 2010

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