EGU2012-6103

# THE INFLUENCE OF REGIONAL URBANIZATION AND ABNORMAL WEATHER CONDITIONS ON THE PROCESSES OF HUMAN CLIMATIC ADAPTATION AT MOUNTAIN RESORTS


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Map.1

The work is a further development in the direction of the weather pathogenicity index (WPI) study and the negative impact of urbanization on the health status of people with impaired adaptation during rehabilitation at mountain resorts (EGU2011-6740-3. Vol.13; EGU2010-4911. Vol. 12).

According to the WHO from 20 to 45% of healthy individuals and from 40 to 80% of people with chronic diseases in the world suffer from raised meteo sensitivity (MS). Raised MS is revealed in (41 - 96)% of patients who come to the spa treatment in the region of Caucasian Mineral Waters (CMW), that is 2-4.5 times frequently than in healthy volunteers. The problem of MS people is socially significant and actual in conditions of climate changes and the inevitable process of urbanization, which negatively affect the environment, even in resort areas far from industrial.

In 2010-2011 260 patients were under observation, including 60 patients with metabolic syndrome (MS), 60 patients with irritable bowel syndrome (IBS) and 80 patients with bronchial asthma (BA). In addition, as a control under the supervision were 60 volunteers - relatively healthy (RH) men. Of these, the share of weather-sensitive is showed in Figure 1.

The criterion used to estimate the pollution of the atmosphere is an integrated pathogenicity index (k), which takes into account the range of factors. When k <0,3 atmosphere was considered as clean, with k> 0,7 - elevated levels of air pollution..

In the present work systematic medical and bioclimatic monitoring, researches in different altitudinal levels were performed. Measurements of aerosol pollution of the atmosphere were carried out in urban areas (600-900 m asl) and in the background at Kislovodsk high-mountain station (KHMS), 43.73oN, 42.66oE, 2070 m asl, the Northern Caucasus, Russia. Satellite data were actively used to detect the scale and geographic location of fires.

Some global and mesoscale atmospheric processes, connected with climate changes, the main features of long-range transport of pollution of anthropogenic and natural origin were identified. Urbanization processes that have a negative impact on natural ecosystems and human opportunities of climatic adaptation were revealed in the KMV region

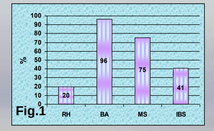


Fig.1

RH -relatively healthy men;
BA - patients with bronchial asthma;
MS patients with the metabolic syndrome;
IBS - patients with irritable bowel syndrome

**Results**:

A statistical and spectral analysis of medical, meteorological, and synoptic data, including global circulation indices SOI, NAO was carried out.

Features of strengthening of the zonal and blocking components of the meridional part of circulation is registered. The connection of the occurrence of atmospheric blocking and of their intensity with a large-scale atmospheric circulation is confirmed

In particular, in the years of formation of the phenomena El-Nino/La-Ninya powers of summer blocking anticyclones in high latitudes is amplified.That situation took place in the summer of 2010, and was accompanied by the formation of a strong blocking anticyclone over the central region of European Russia. Moscow megalopolis was in a zone of the blocking anticyclone from June 18 to August 18, 2010, the CMS resorts - from July 26 to August 18. The average monthly temperature exceeded the climatic average in Moscow on 7.8 ° C, at the resorts of CMW and KVNS - on 5-6 ° C. High temperatures, drought, the increased surface inversion complicated ecological situation in the resorts of CMW. Concentrations of atmospheric pollutants reached the MPC sometimes, but the advantages of mountain areas, the presence of forced ventilation (mountain-valley circulation), the absence of a large number of precursors of photochemical reactions didn't allow to bring up the catastrophic ecological situation. Ozone generation intensified under the conditions of high air temperature and solar irradiance. In July-August 2010, it exceeded the seasonal norm by 15ppb, but this was less than in the Moscow megalopolis area. Continued drought affected the gas-and moisture-exchange in plants and caused an increased and prolonged fire danger in the South of Russia, and it remained high until the end of 2010, before the snow.

Applying modeling drifts contaminants from areas of varying distances (local fires, regional industrial enterprises) in the area of CMS some active remote sources of pollution were identified : Donetsk Iron and Steel Factory (DISF), located 600 km to west of the Stavropol region (Map.1). Reported: extreme area of fires spread in the summer of 2010 coincides with a train of regular source of pollution offsets (DMK).

Figure 4 shows the values of average daily concentration of aerosol from measurements of aerosol spectrometer (counters LAS-P r and OEAS) on KHMS, and the city of Kislovodsk in the period specified above, a strong fire in the Elbrus region. Both devices recorded the excess of aerosol pollution over the background, and even over the maximum permissible concentrations (MPC) repeatedly during the month (Nov2010). Studies have shown that an increase in aerosol pollution promotes adverse effects of natural air ionization (NAI). In the clean atmosphere with increasing altitude above sea level from 600 m to 2040 m.a.s.l. the total ionization of the air increased from 1400 to 3700 ion/cm3.

Figure 3. . Trajectory (for 3 heights above the surface: 100, 200, 300m) - trail of fire in the Elbrus region (red rectangles-burning regions) in the area of Kislovodsk and other resort areas KMW. The white parts of the map - the glaciers of Mount Elbrus.

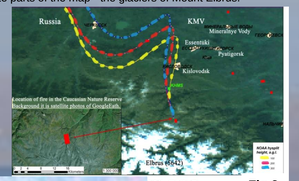


Fig.3

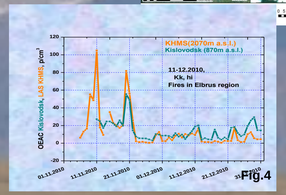


Fig.4

**Figure 4. Daily mean values of aerosol counter concentration measured by aerosol spectrometer (LAS-P and OEAS, Russia) at the Kislovodsk high-mountain scientific station (KHMS, 2070m asl) and in the town Kislovodsk during the period of strong vegetation fires at Elbrus region (15km and 35km to the SW from the KHNS and from Kislovodsk, respectively).**

The effect of fire in the Elbrus region in November 2010 on the air basin of Kislovodsk was analysed (Fig. 2). Fire situation in the region was estimated according to the MODIS satellites Terra / Agua on November 7, 2010. The location of several fires (possible sources of gas and aerosol pollution) was determined (Fig. 3). Trajectory distribution of pollutants from the source, built on the model of NOAA HYSPLYT for different heights (100, 200, 300 m) above the ground showed that the cause of the observed anomaly (to MPC) of the air in early November 2010 was a strong fire in the Elbrus region, 15 km and 35 km SW of the Kislovodsk high-mountain research station (KHMS, 2070 m.a.s.l.) and from Kislovodsk (860 m asl), respectively.


Fig.2

Studies have shown that when an increase in aerosol pollution then adverse effects of natural air ionization (NAI) take place. When the blocking anticyclone and thermobaric depression, even in relatively clean air, conditions for the accumulation of aerosol appear, which lead to a reduction in the number of negative ions of the N-and N + on the prevalence of N-(Fig. 5). In conditions of low gradient of pressure field , and the passage of cyclones with precipitation a high ionization of the air with great presence of N- is revealed that is considered in balneology as a favorable medical and health resort treatment factor. The absolute values and the ratio N + / N-for different types of weather - are changing rapidly, they depend on many factors, but it is a dominant negative factor of the aerosol (ranging in size from 500 to 20,000 nm), in whose presence the most susceptible to neutralization are negative ions (Fig. 6).

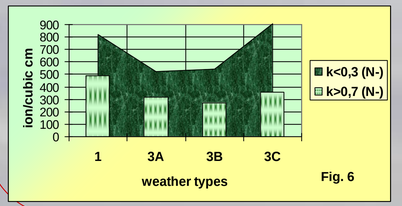


Fig. 6

Environmental factors influence the degree of biorhythms harmonization, the nature of functional and pathological changes in the body that affect the level of human adaptation. According to the fractal analysis of cardiac rhythms, studied with help t the software-hardware complex "Lotus" (SPA "Dynamics"), it was found that in healthy people adaptive response to the weather conditions is negligible, but in polluted atmosphere of the remote fires, their adaptation level is dramatically reduced. The high degree of response to adverse weather conditions and atmospheric aerosol pollution revealed in patients with MS and BA (Fig. 7).

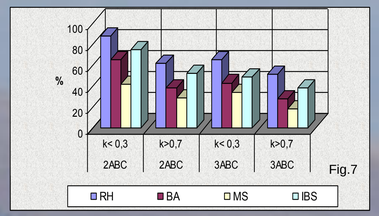


Fig.7

**Fig. 7. Adaptability indicators by fractal analysis data of biorhythms in healthy people (HP), patient with metabolic syndrome (MS), irritable bowel syndrome (IBS) at favorable (2ABC) and adverse (3ABC) types of weather in the conditions of weak (k<0.3) and the raised concentration of an aerosol at advection of pollution from areas of remote fires (k>0.7) on mountain resorts of the Caucasian Mineral Waters**
**k<0.30 - low pollution of the atmosphere; k>0,7 – the increased pollution the atmosphere (mainly by aerosols from remote fires ore from remote desert)**

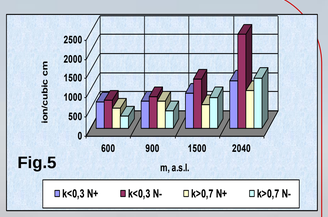


Fig.5

Fig. 5. Dynamics of total air ionization at various heights above sea level at favorable type of weather (1 type) in the conditions of low (k<03) and high aerosol pollution of atmosphere from the remote fires (k>0.7) in resort region of the Caucasian Mineral Waters
k<0.30 - low pollution of the atmosphere; k>0,7 – the increased pollution the atmosphere (aerosols from remote fires).

Fig. 6. Dynamics of negatively charged aeroions at various types of weather in the conditions of low (k<0.3) and high aerosol pollution of the atmosphere (k>0.7)

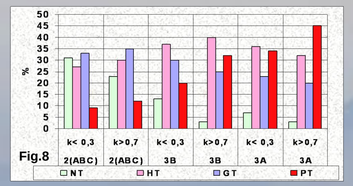


Fig.8

Fig. 8. Dynamics of vasomotor indicators of patien with metabolic syndrome at various types of weather [2ABC; 3AB] at low (k<0.30) and high pollution of atmosphere by aerosols from remote fires (k>0.7) at regenerative treatment on a resort of Essentuki (h=600 m a.s.l)
NT-normoreactive type; HT- hyperreactive type; GT-hiporeactive type; PT-paradox type

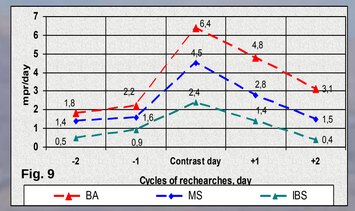


Fig. 9

**Рис.9. . Meteopathic reactions tests (MPR) of patients with bronchial asthma (BA), a metabolic syndrome (MS) and a irritable bowel syndrome (IBS) at high aerosol pollution of the atmosphere (k>0,7) and low level of pollution of the atmosphere (k<0,3) at regenerative treatment in the mountain resort of Essentuki (600 m a.s.l)**

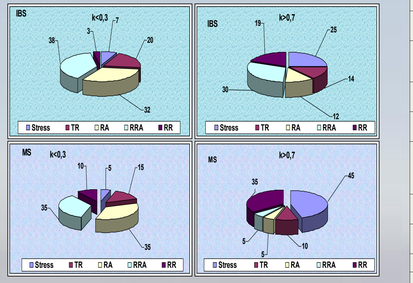


Fig.10

Fig. 10. Dynamics of body nonspecific adaptable reactions (BNAR) according to the percentage of lymphocytes in the peripheral blood of patients with a metabolic syndrome and of patients with an irritable bowel syndrome in regenerative treatment on a mountain resort of Essentuki at weather type 2A in the conditions of low (k<0.30) and high pollution of atmosphere by aerosols from remote fires (k>0,7)
S – stress; TR - training reaction; RA – reaction of quiet activation; RRA – reaction of the raised activation; RR – reactivation reactions

When a sudden change in weather patients with MS, having coronary artery disease get a decrease of vasomotor responses (VMR) of normal reactive type (NRT) and an increase in VMP hyperreactivity (HRT), hyporeactivity (GORT) and paradoxical (PT) types. The largest shift of the HPT in the PT, was observed in the 3A-type weathers - in stabilizing anticyclone with high air temperatures (above 300C), low PAI (Σ ≥ 600; Kui> 2), the highest deviations from the norm of oxygen in the air (<± 20 g/m3), and high values of aerosol pollution of the atmosphere (Fig. 8). According to the analysis of system monitoring MPR in patients with metabolic syndrome, asthma and IBS in comparison with medical types of weather by the "superposed epoch" increase in the MPR / person is registered in all study groups. However, the clinical manifestations of weather factors and air pollution were greater in patients with asthma (Figure 9).
With prolonged exposure (3-7 days) to high air pollution (k> 0,7) from remote fires even when the weather is good there are adverse changes in the leucocyte count in peripheral blood. In patients with MS, burdened with coronary heart disease, increase in stress reactions from 5% to 45% is registered, in patients with IBS - from 7% to 25% (Fig. 10).

**As a result of comparing the characteristics of health with medical care and climate modules (using non-parametric statistics methods) the index ranks of weather pathogenicity are clarified. This allows to develop new physiological limits of the optimum, standard and pessimum to classify environmental emergency weather situations (Fig. 11).**

**Fig. 11.** The scheme of stylized estimate of some categories of pathogenicity index (ki) of the dominant medical-meteorological modules for the calculation of PPI and medical types of weather for the low-mountain resorts

| Medical-meteorological modules | The degree of pathogenicity / criteria for pathogenicity index (ki) of medical-meteorological modules | | | | |
|---|---|---|---|---|---|
| | Indifferent ki ≤0,25 | Weak/ ki =0,26–0,45 | Moderate/ ki= 0,46–0,65 | High/ ki =0,66–0,8 | Excessively high/ ki =0,81–1,00 |
| ЭЭТ, пересч.,degrees | ≥-10 - ≤+ 22 | ≥-20 - ≤+25 | ≥ -30 - ≤+30 | ≥-40 - ≤+35 | < -40 или >+35 |
| Ta (° C)/«ощ» (hPa) / the degree of atmospheric "stuffiness" | <20⁰C/<15 hPa / absent | <25⁰C/<19 hPa / episodes | <30⁰C/<23 hPa / 1 level | <35⁰C/<27 hPa / 2 level | >35⁰C/ >27 hPa / 3 level |
| DDV of air temperature in time, ° C | <±4 | <± 8 | <± 12 | <± 16 | ≥± 16 |
| DDV*** of pressure in time, hPa | <±2 | <±4 | ≤±8 | <±12 | > ±12 |
| The amount of natural ions [N + + N-], (ion/sm3) / unipolarity coefficient of ions (N + / N-) | ≥1200/ <1.2 | > 800/ <2 | ≥600/ <3 | >400/ <4,0 | <400/ >4,0 |
| DFCN of oxygen concentration,in time g/m3 | <± 5 | <±10 | <± 15 | <± 20 | ≥± 20 |
| DDV of oxygen concentration,in time g/m3 | <± 4 | <±8 | <± 12 | <± 16 | ≥± 16 |
| Ultraviolet index, UVI | 1-3 | 4-5 | 6-7 | 8-10 | > 10 |
| The index of geomagnetic activity, Ap | 0-4 | 5-11 | 12-20 | 21-31 | >31 |
| Pathogenicity indices of atmospheric pollution: | | | | | |
| Air Pollution Index (API) to 1 | low | moderate | Higher than moderate | high | Excessively high |
| The total concentration of various pollutants in the atmosphere (as a fraction of the total MPC) | < 0.4 MPC | 0,4 -0,6 MPC | 0,61-0,8 MPC | 0,81-1,5 MPC | >1,5 MPC |
| The level of the mass concentration of submicron aerosol ug/m3 | <60 | 60 - 85 | 86 - 120 | 121 - 225 | >225 |

**The comprehensive medical, environmental and geophysical studies have shown that climatic anomalies, particularly, desertification, regional urbanization and abnormal environmental emergencies (fires) impact negativly on the natural properties of the resort, recreational ecosystems and human health. As a limiting marker for the prediction of dangerous adaptive reactions for resorts can be used such characteristics as the concentration of aerosol with a particle size of 500-5000 nm in the lower troposphere (in an amount exceeding 60 particles/cm3); the number of negative aeroions (N-) (below 200 ion / cm3); the values of value coefficient of unipolarity ions (N + / N-) (higher than 2-6); mass concentration of submicron aerosol (above 120 μg/m3), and other physical modules of the environment.**
**Methods of weather forecasting and medical meteoreaction prevention can be used in other mountainous regions of the world**
**The results indicate the importance of further study and development of recommendations on substantiation of optimum physiological limits, rules and pessimum for a resort and recreational ecosystems and to clarify categories of emergency environmental and weather situations**


The studies were performed by support of the Program "Basic Sciences – for Medicine" and RFBR project No.10-05-01014_a.