Possible Influence of Solar Extreme Events and Related Geomagnetic Disturbances on Human Physiological State: Results of Collaborative Bulgarian-Azerbaijani Studies

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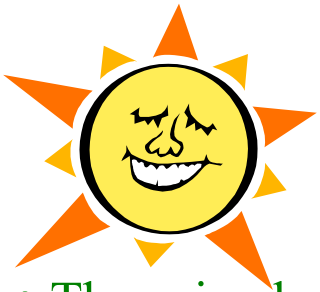


Why we work on the problem?

• There is always a skepticism about the investigations on the possible relationship between geomagnetic field (GMF) variations of solar origin and human being's functional health state;

•But there are also a lot of publications about the influence of changes of helio-geophysical situation on biological systems and processes;

• Continuous initiatives and researches, collaboration at regional and international levels; increasing amount of papers;

•Recently established Bulgarian-Azerbaijani collaboration;

• 2 teams have studied possible influence of changes in geomagnetic activity (GMA) by using different indices (Ap-, Kp-, Dst-indices and amplitude of H-component of local GMF) on human physiological and psycho-physiological parameters as well as on some cardio-vascular diseases and mortality in middle latitudes;

•Analogical investigations at different longitudes and latitudes;

• Studies could be useful in clarifying physiological and biophysical mechanisms of heliobiological relations.

What, whom and when did we examine?

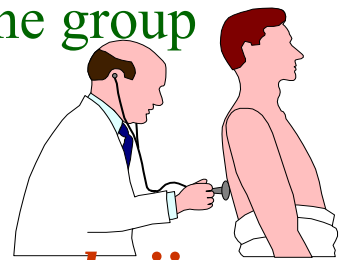
1. ***Experiments conducted in Sofia (42°43'N; 23°20' E), Bulgaria***

   What: Such physiological parameters as Arterial Blood Pressure (ABP) and Heart Rate (HR); in total 2799 registrations;

   Who: 86 healthy volunteers; the average age of the group members - 47.8 y.o.; at one and the same day time for each person in the group

   When: Each working day in:

   - autumn 2001 [1.10.01 – 9.11.01]
   - spring 2002 [08.04.02 – 28.05.02]

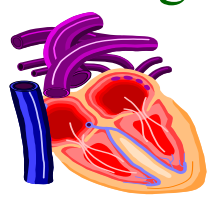


2. ***Experiments conducted in Baku (40°23'N;49°51'E), Azerbaijan***

   What: Electrocardiograms (ECGs); RR intervals (RRmin, RRmax and RRavg) and HR values were derived from ECGs; in total 1038 digital recordings;

   Who: 7 functionally healthy persons on working days (including Saturdays); the average age of the group was 31.6 y.o.;

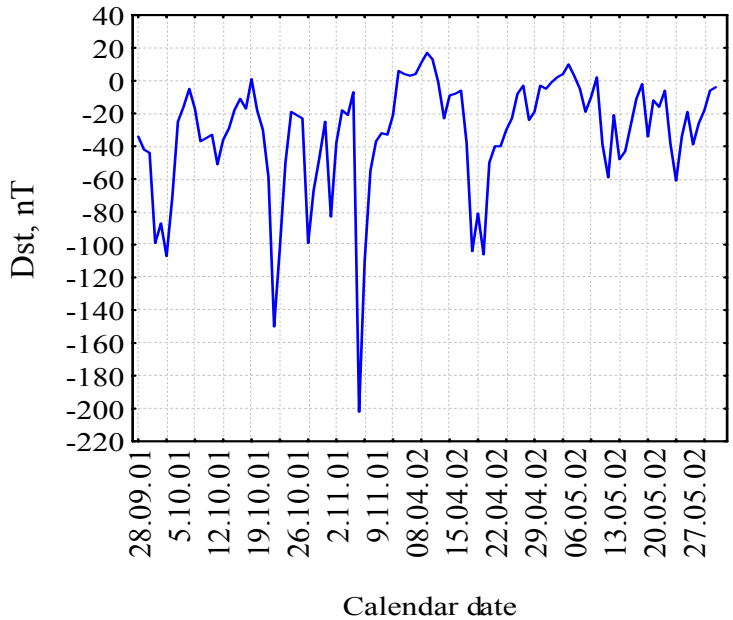
   When: from 15.07.2006 till 21.04.2007.



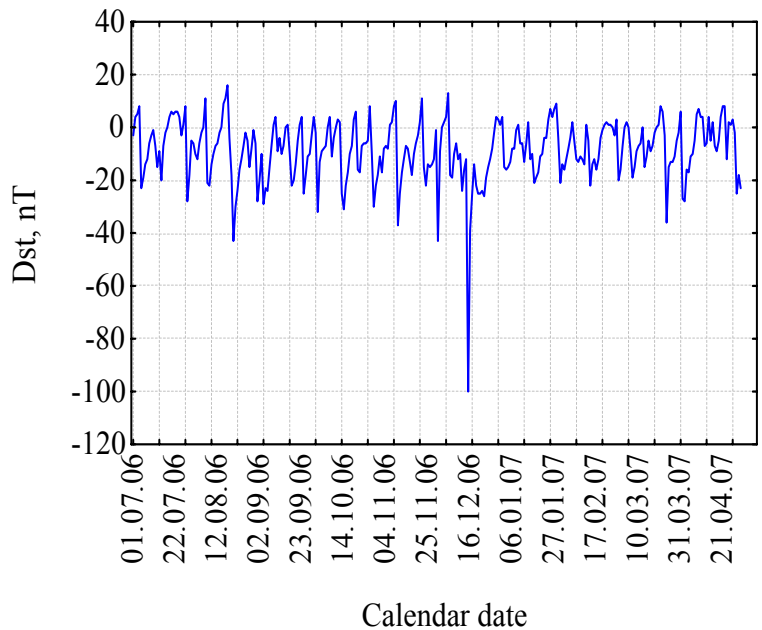
Dst-index levels and the number of days and measurements in Sofia/Baku

Dst level	1 calm GMA	2 weak storm	3 moderate storm	4 major storm	5 severe storm
Dst, nT	Dst>-20	-50<Dst≤ -20	-100<Dst≤-50	-150<Dst≤-100	Dst≤-150
Days	45/240	37/40	14/-	5/1	2/-
Meas.	1209/899	1053/134	321/-	148/5	68/-

- - no measurements



Dst-index variations during examination periods in Sofia.



Dst-index variations during examination periods in Baku.

Methods

- **AN**alysis **O**f **VA**riance (ANOVA) was applied to establish statistical significance of the influence of GMA level on ***SBP, DBP, HR, RRmin, RRmax*** **and** ***RRavg;***
- ANOVA was also used for study the effect of geomagnetic storms before and after their development on the physiological parameters of examined patients;
- GMA impact up to 3 days before and 3 days after sharp geomagnetic changes was studied;
- Post-hoc analysis (Newman-Keuls test) was used to establish statistical significance of the differences between the average values of the measured physiological parameters in the separate factors levels;
- The chosen level for statistical significance was $p<0.05$.

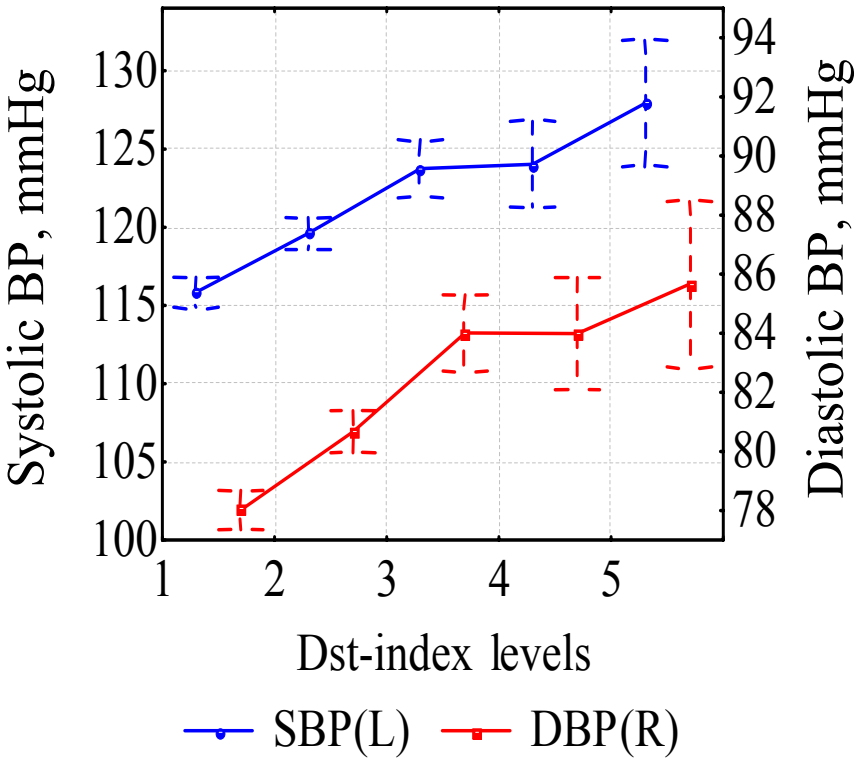
Results

1. ANOVA for the physiological parameters examined in Sofia

Significance levels (p-values) of Dst-index influence on the physiological parameters under ANOVA analyses for the days before, during and after geomagnetic storms development

Day	*p-values*		
	SBP	***DBP***	***HR***
-3	0.227	0.106	0.851
-2	0.000	0.000	0.924
-1	0.000	0.000	0.637
0	0.000	0.000	0.351
+1	0.000	0.000	0.015
+2	0.000	0.000	0.099
+3	0.000	0.000	0.139

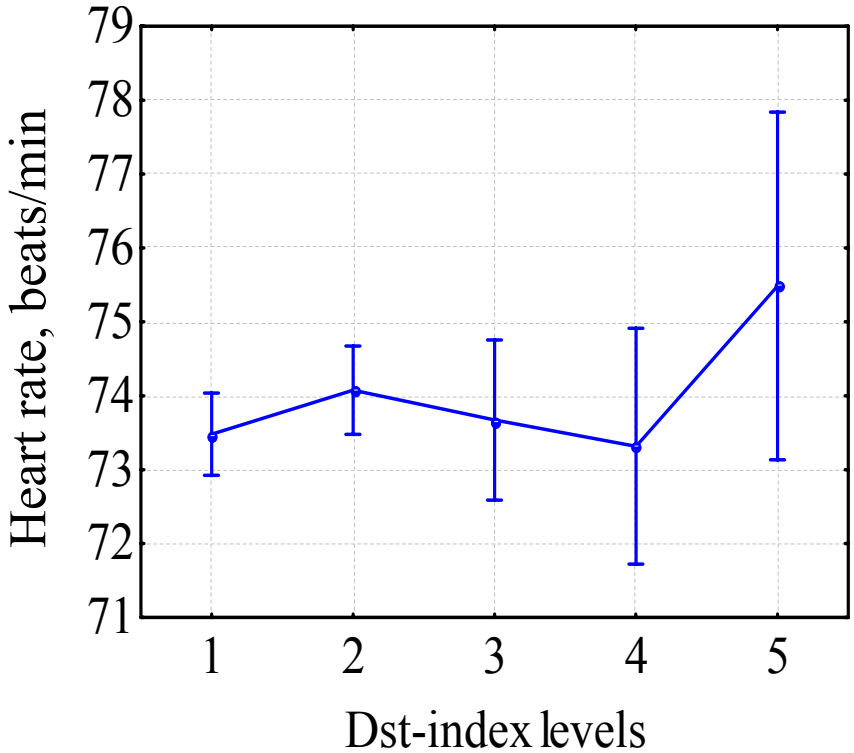
Dst-index effect on SBP and DBP



SBP
10.4%
1≠2,3,4,5
2≠1,3,4,5
3≠1,2,5
4≠1,2,5

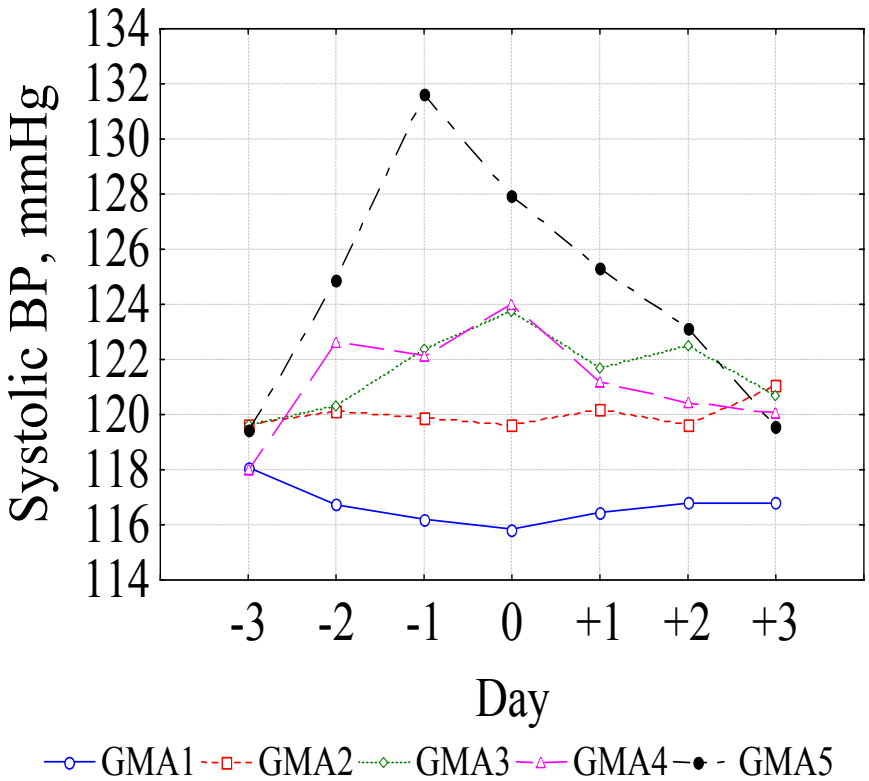
DBP
9.7%
1≠2,3,4,5
2≠1,3,4,5

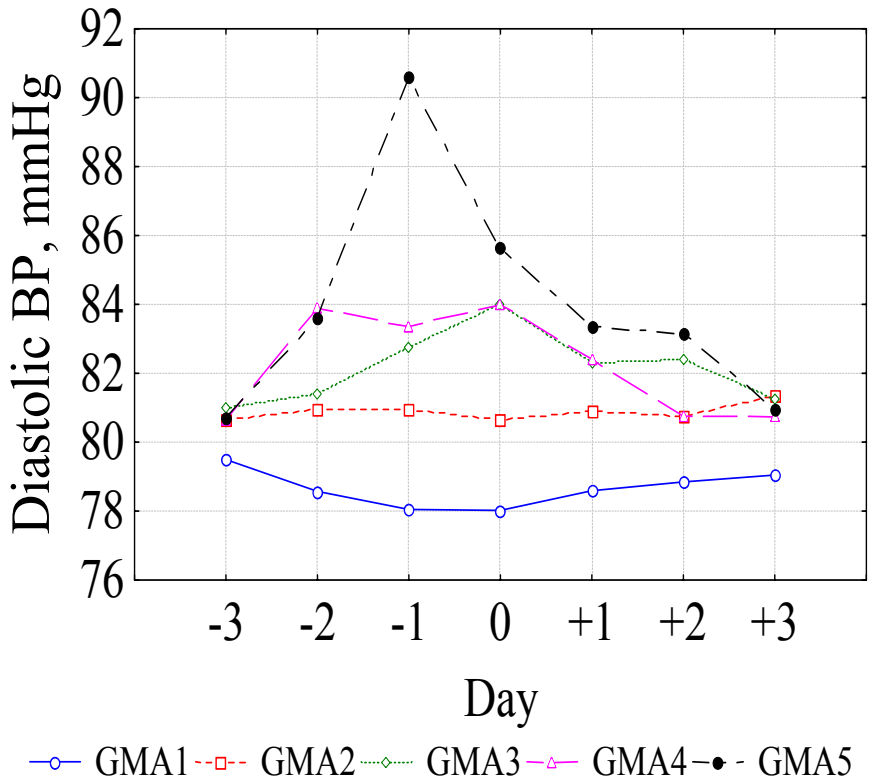
Dst-index effect on HR



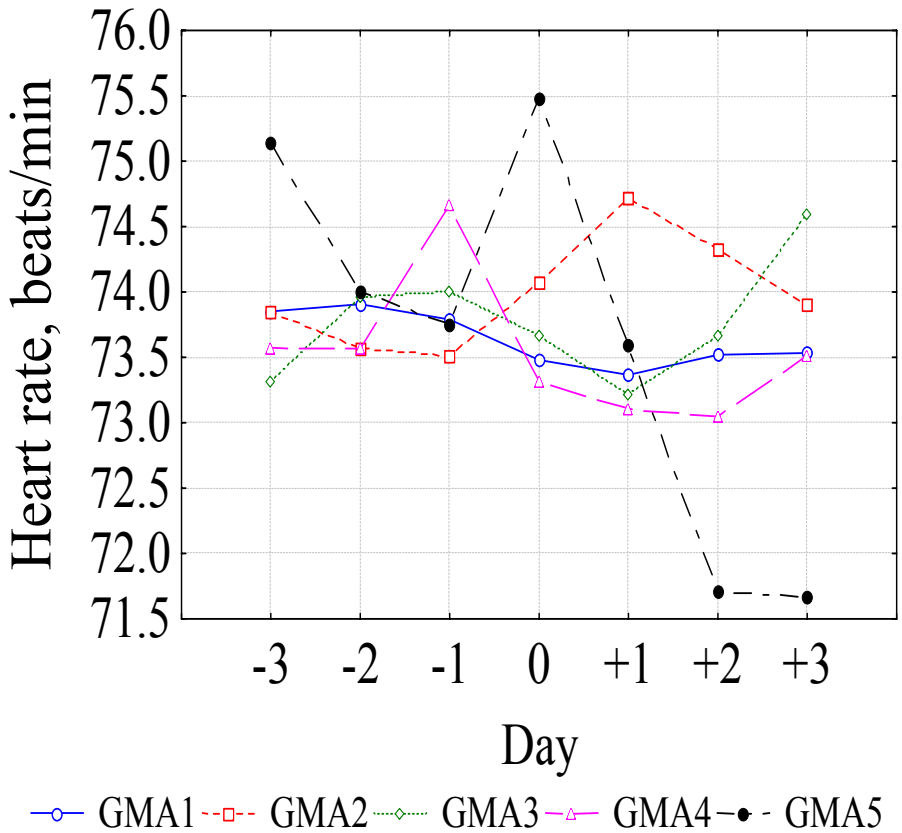
HR
2.9%

Dst-index effect on SBP and DBP before, during and after geomagnetic storms development





Dst-index effect on HR before, during and after geomagnetic storms development



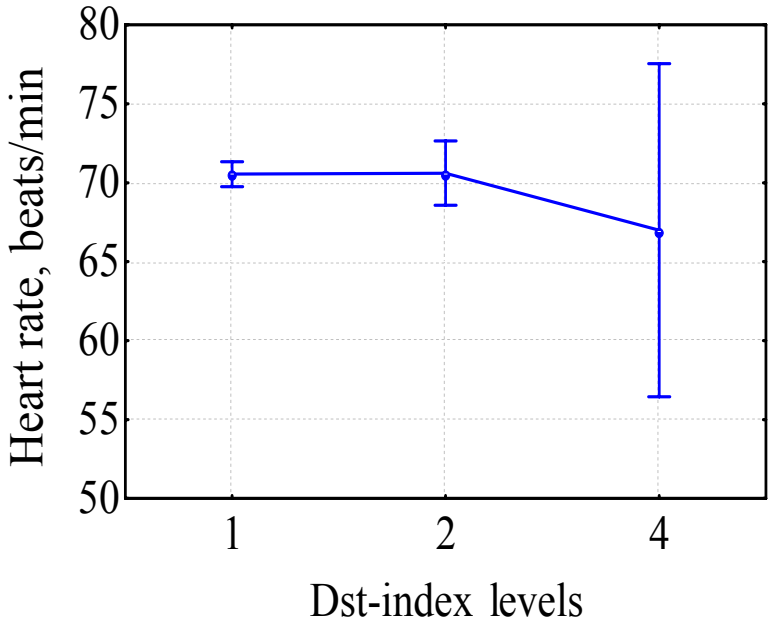
Results

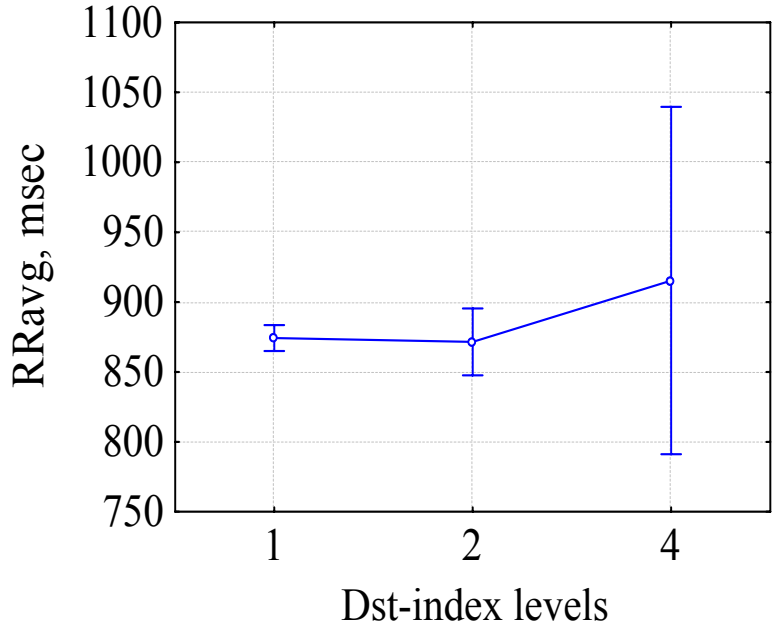
2. ANOVA for the physiological parameters examined in Baku

Significance levels (p-values) of Dst-index influence on the physiological parameters under ANOVA analyses for the days before, during and after geomagnetic storms development

Day	*p-values*			
	HR	***RRmin***	***RRmax***	***RRavg***
-2	0.31	0.88	0.392	0.559
-1	0.812	0.71	0.638	0.844
0	0.803	0.667	0.937	0.79
+1	0.792	0.939	0.594	0.761
+2	0.727	0.587	0.25	0.489

Dst-index effect on HR and RRavg

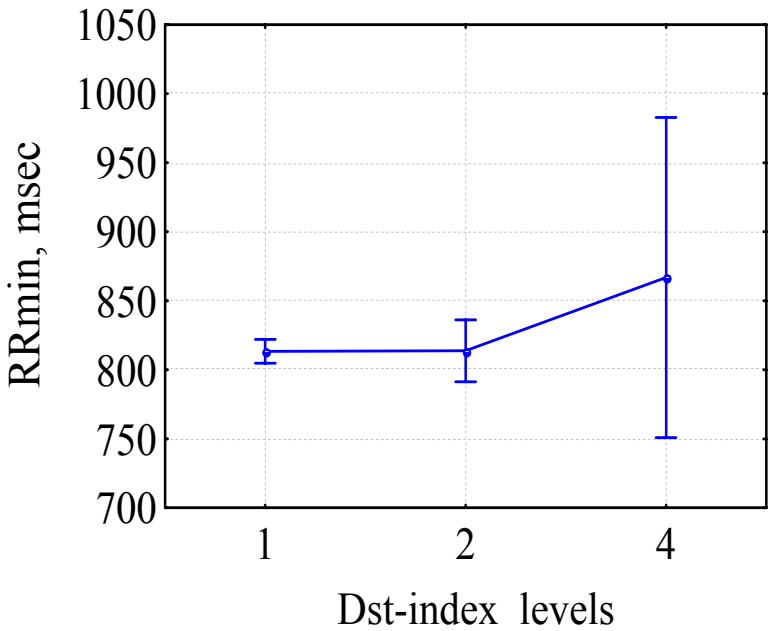


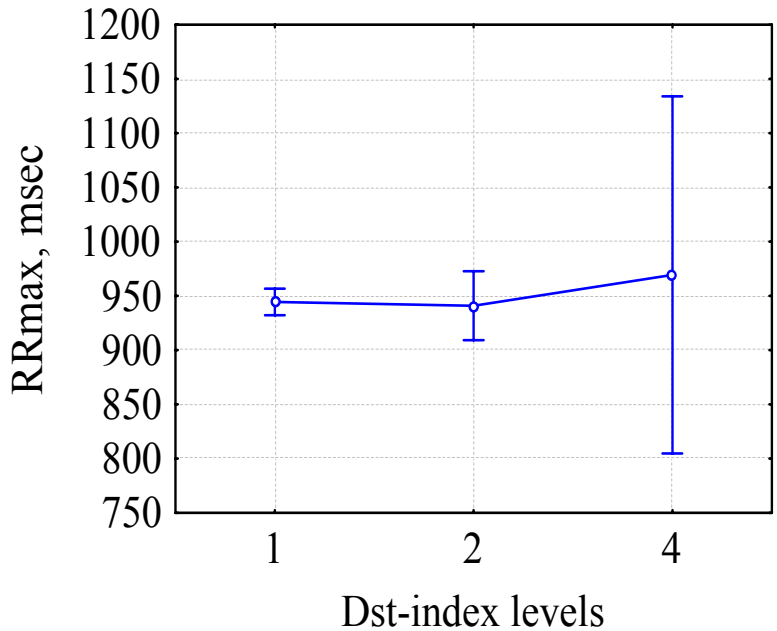


HR
5.4%

RRavg
5%

Dst-index effect on RRmin and RRmax

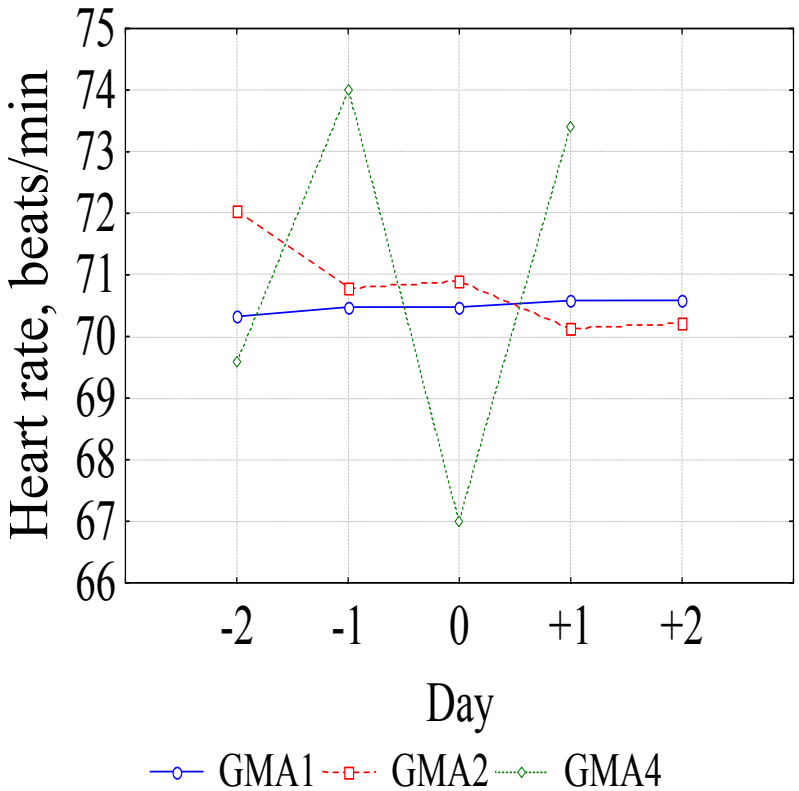


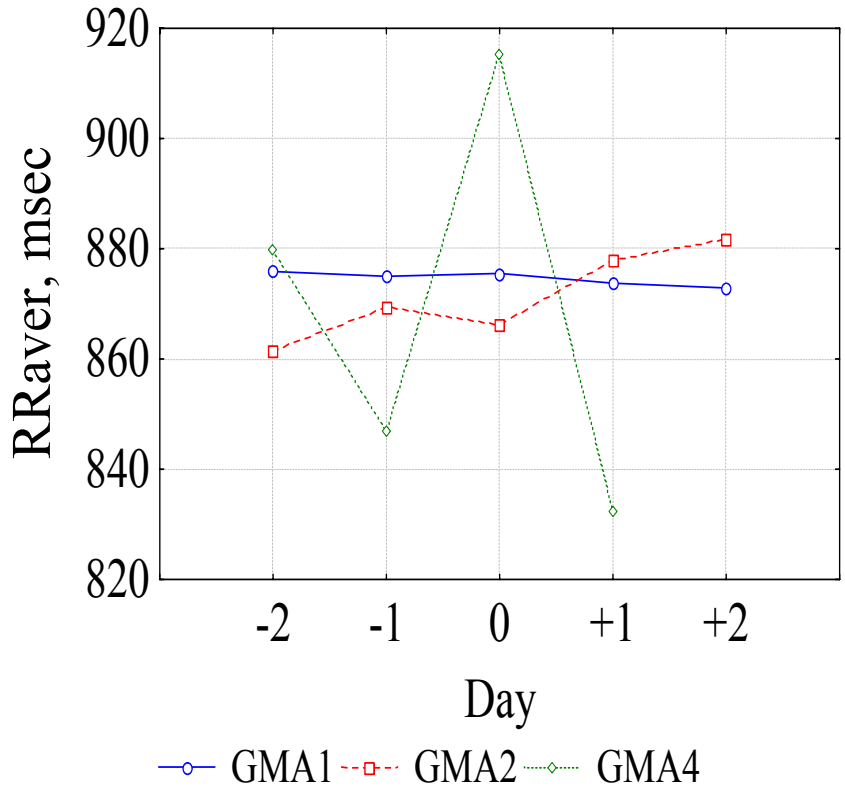


RRmin
6.6%

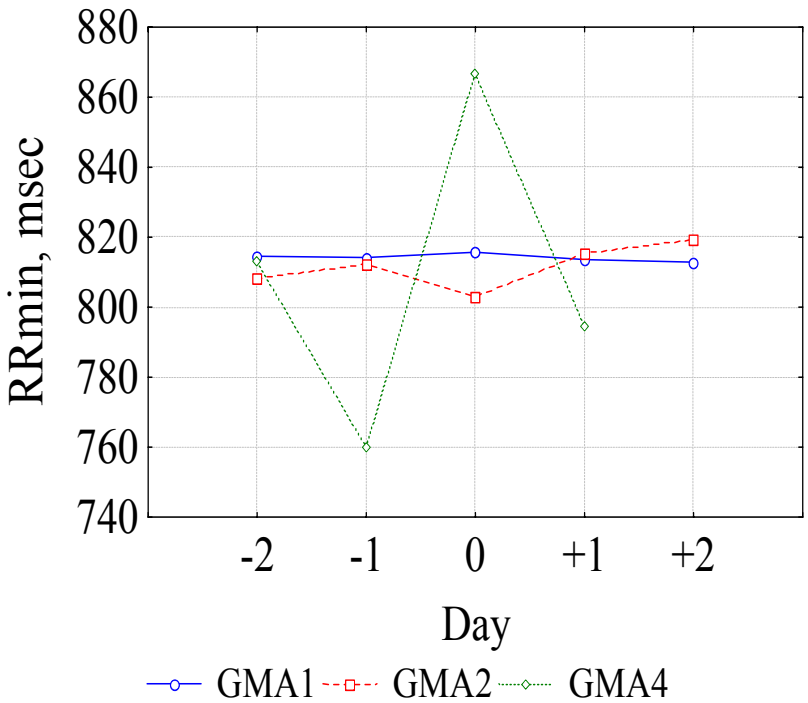
RRmax
3%

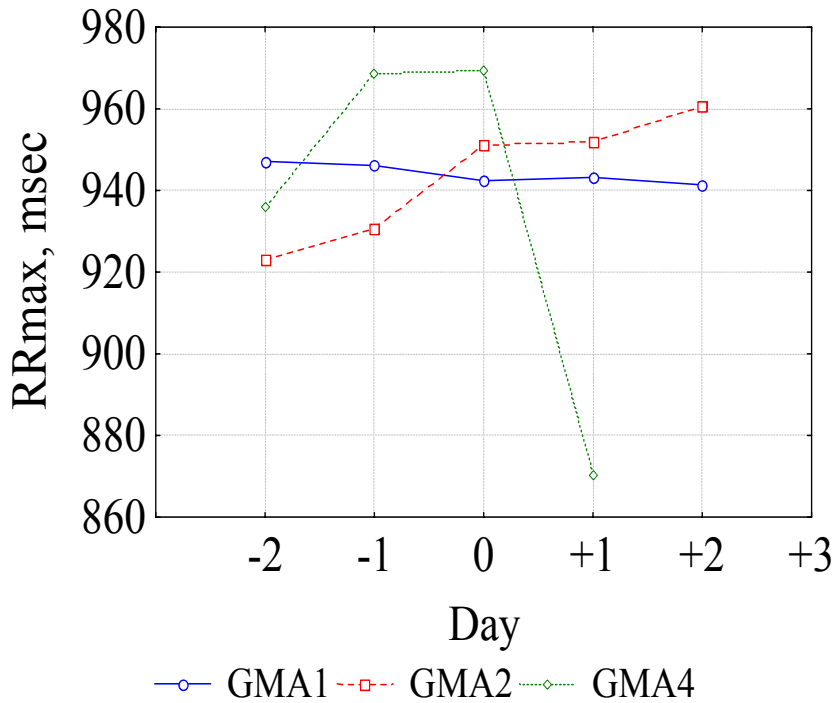
Dst-index effect on HR and RRaver before, during and after geomagnetic storms development





Dst-index effect on RRmin and RRmax before, during and after geomagnetic storms development





CONCLUSIONS

• Results revealed statistically significant increment for **systolic blood pressure** (SBP) and **diastolic blood pressure** (DBP) with GMA increase.

•**Arterial blood pressure** (ABP) values began increasing significantly on -2 day before moderate, major and severe geomagnetic storms and kept higher values up to +2 and even +3 day after them.

• **Heart rate** (HR) did not react statistically significantly for both examined groups under changes of geomagnetic conditions.

• It should be noted that persons examined were healthy. It seems that **heart rate** is more stable physiological parameter for healthy persons under GMF variations than other considered parameters.

• Probably the dynamics of **arterial blood pressure** reveals a compensatory reaction of human organism as adequate reaction to environmental changes.

Future plans

- Continuing experiments in different heliogeophysical situations;
- Involving other research groups located in other longitude and latitudes;
- Investigating more physiological parameters on daily experimental basis.