

The relation of the human cardiac-events to the environmental complex variations

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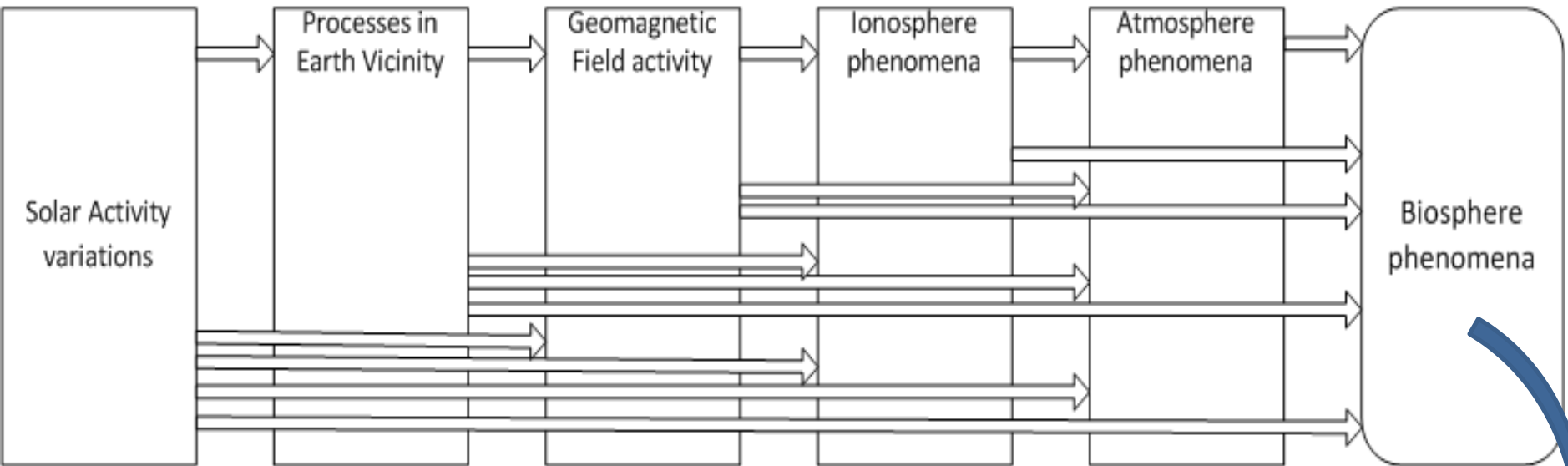
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⁴North-Western State Medical University named after I.I. Mechnikov,

sergeinoskov@mail.ru

The work scheme of the environmental impact on any bio-system on the Earth surface



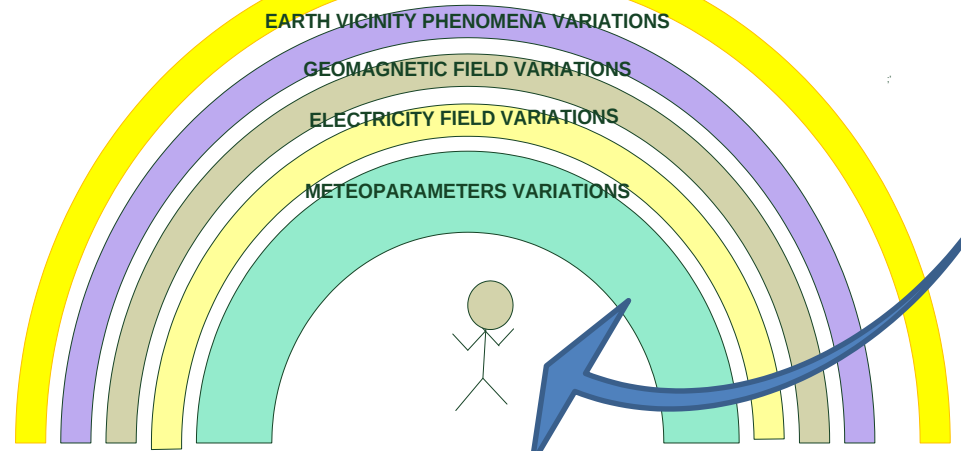
SOLAR ACTIVITY PHENOMENA VARIATIONS
=Global Sun variations+flare component variations

EARTH VICINITY PHENOMENA VARIATIONS

GEOMAGNETIC FIELD VARIATIONS

ELECTRICITY FIELD VARIATIONS

METEOPARAMETERS VARIATIONS



Data for Study 1:

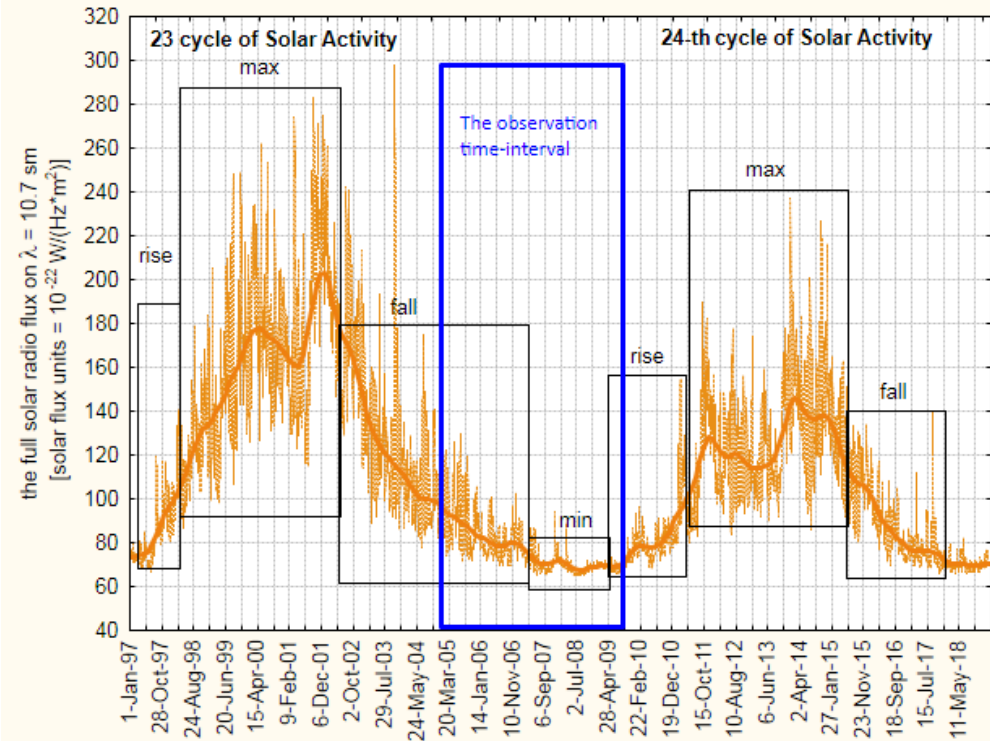
Medical Data:

the days with Ischemia cases maximal number ("Max" in this work) vs. the days of such cases absence ("Nobody" in this work). Maximums we have calculated separately for Ischemia cases in different gender groups but "Nobody" means the empty days for these events at all - nobody in the men group and the same in the women group.

The source: the daily number of **Ischemia** cases in the one of Saint-Petersburg districts (*from the call logs of medical officials*).

Comparing category: "Max" vs. "Nobody"

Time interval: 19.12.2005 – 31.12.2009



The Ischemia cases amount: 15122

Data for Study 2

Environment characteristics:

The environmental parameters complex

➤ consists of 2 components:

1. Space weather parameters
2. Terrestrial weather parameters;

➤ the **structure** of the complex:

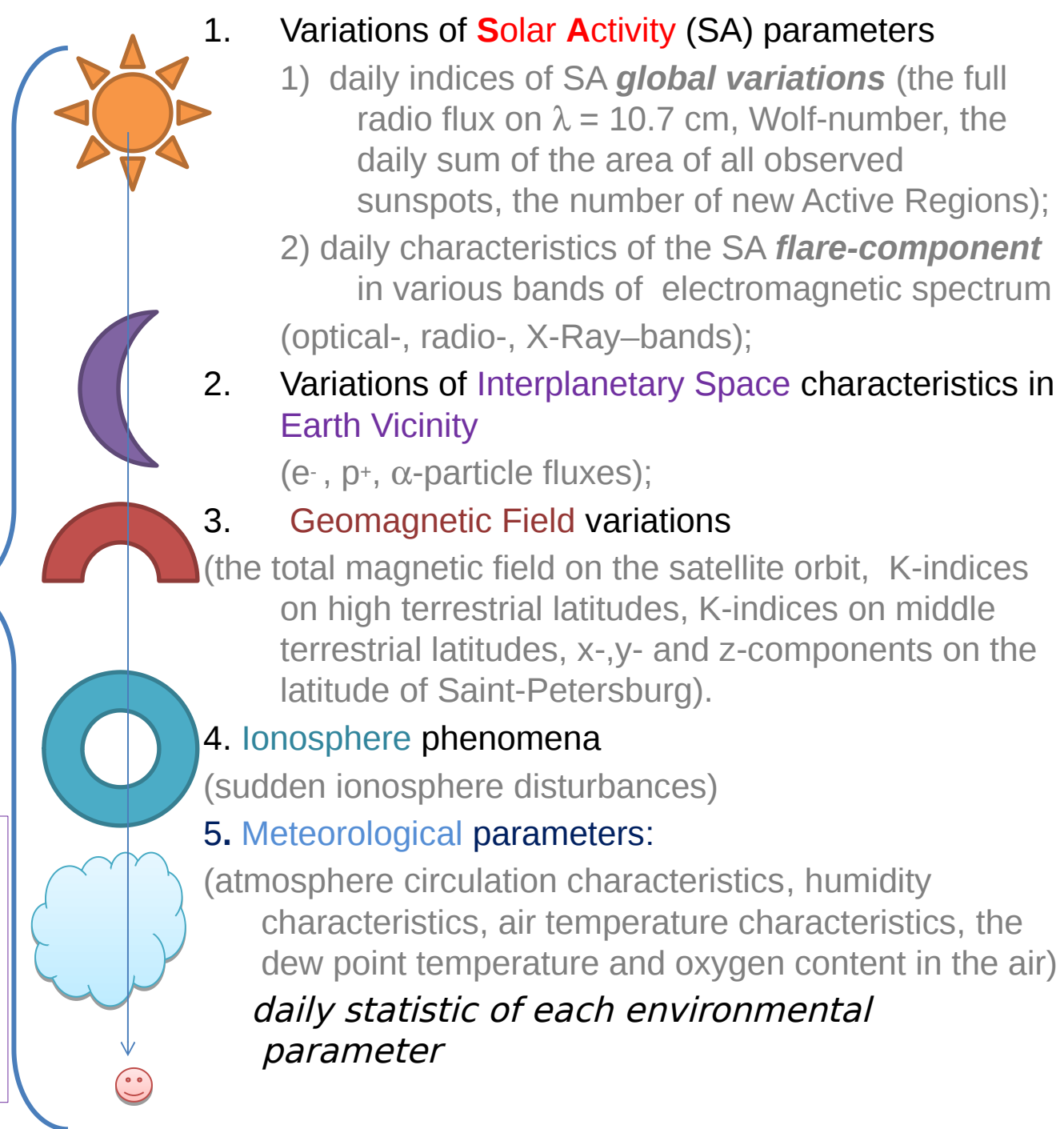
Data sources:

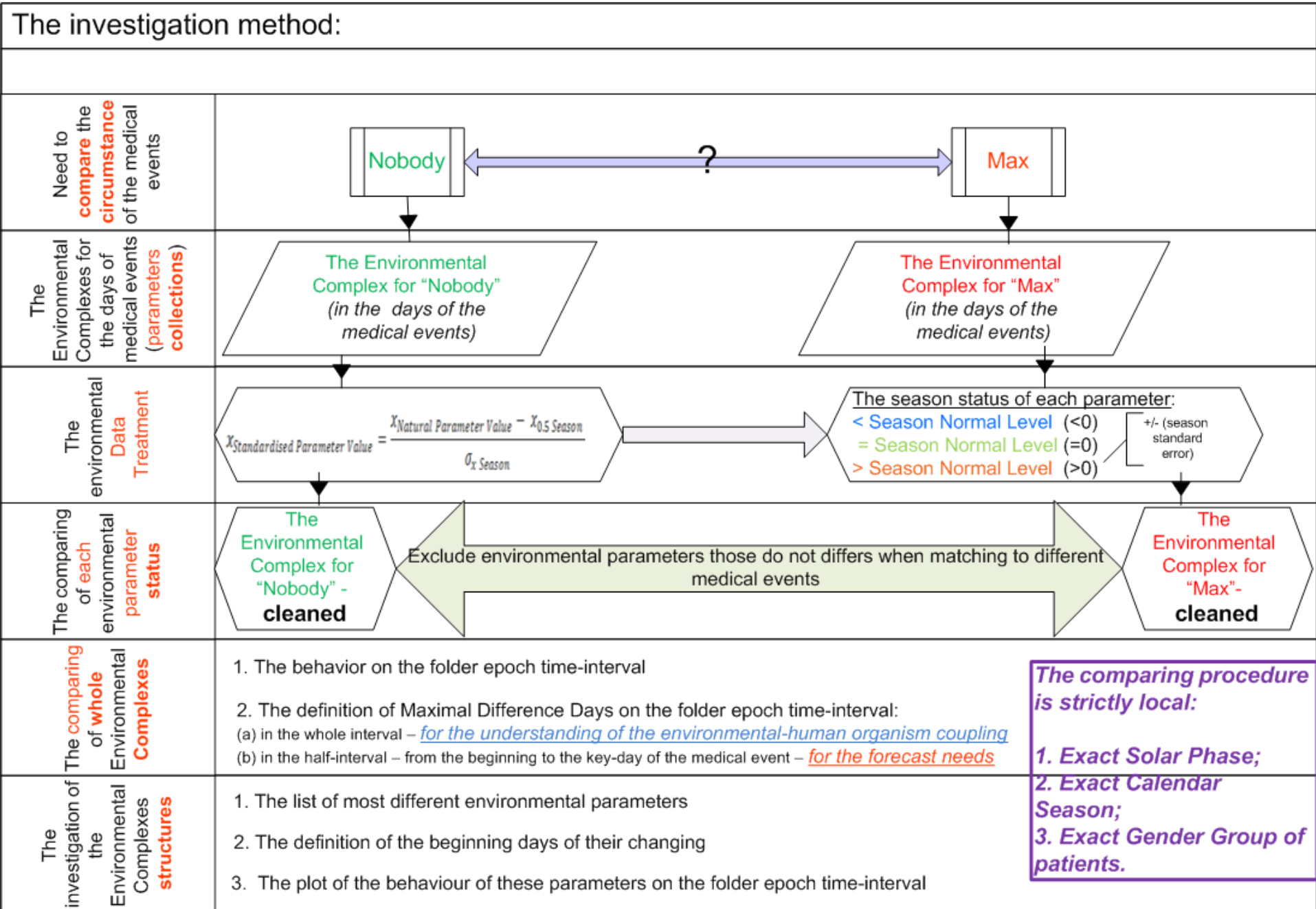
<https://www.swpc.noaa.gov/>

<https://satdat.ngdc.noaa.gov/se/m/goes/data/avg/>

<https://www.ngdc.noaa.gov/stp/space-weather/ionospheric-dat>

Saint-Petersburg meteorology station, #26063, (59°58'N 30°18'E)





Data Treating Method:

$$1. \quad X_{\text{Standardised Parameter Value}} = \frac{X_{\text{Natural Parameter Value}} - X_{0.5 \text{ Season}}}{\sigma_x \text{ Season}}$$

➤ To see the organic whole environmental complex: the collection of different parameters each of them in their own units after standardization transforms to the sample with members of uniform units (*the unit is the characteristic of the deviation from the center of the season distribution*), then we can calculate descriptive statistics for this sample and so we can describe the whole environmental sample by its mathematical expectation, variance, etc.;

➤ To estimate the deviation of environmental complex from the NORMA of exact calendar season (*if the mathematical expectation of environmental sample is close to 0 then we can conclude that the environment is close to the season Norma*);

➤ To compare environmental complexes those are corresponding to the different clinical outcomes by their descriptive statistics.

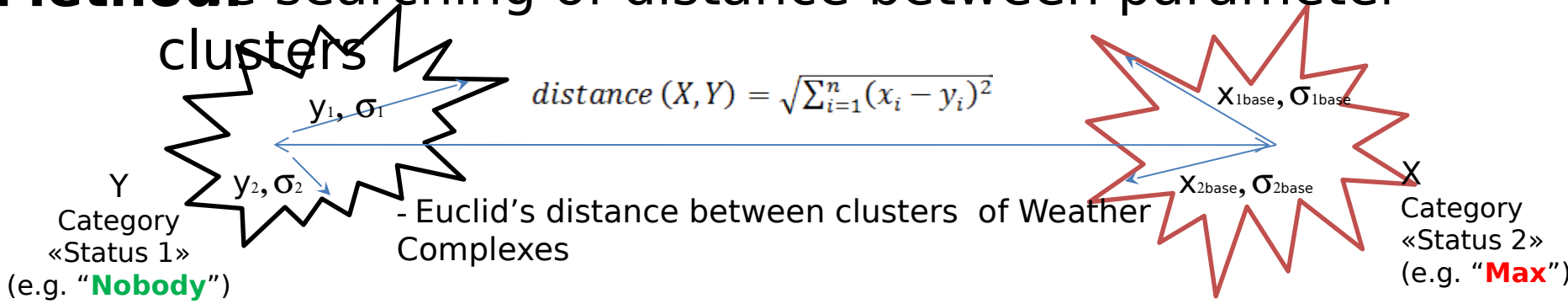
If environmental complexes descriptive statistics are different for days with different clinical outcomes than we can assume the reliable different environmental conditions for such outcomes.

2. The conjunction between the environmental parameters variation and exact medical category (“Nobody”-“Max”): the day of the registration of each medical category was described by the environmental parameters set for the observation day.

➤ Such **parameters sets** are very close to the definition of “cluster” in the Cluster Analysis

Data Treating

Method 3 The searching of distance between parameter clusters



$$\cos \alpha_i = \frac{x_i - y_i}{distance(X, Y)} \quad - \text{Leading Cos of each environmental parameter}$$

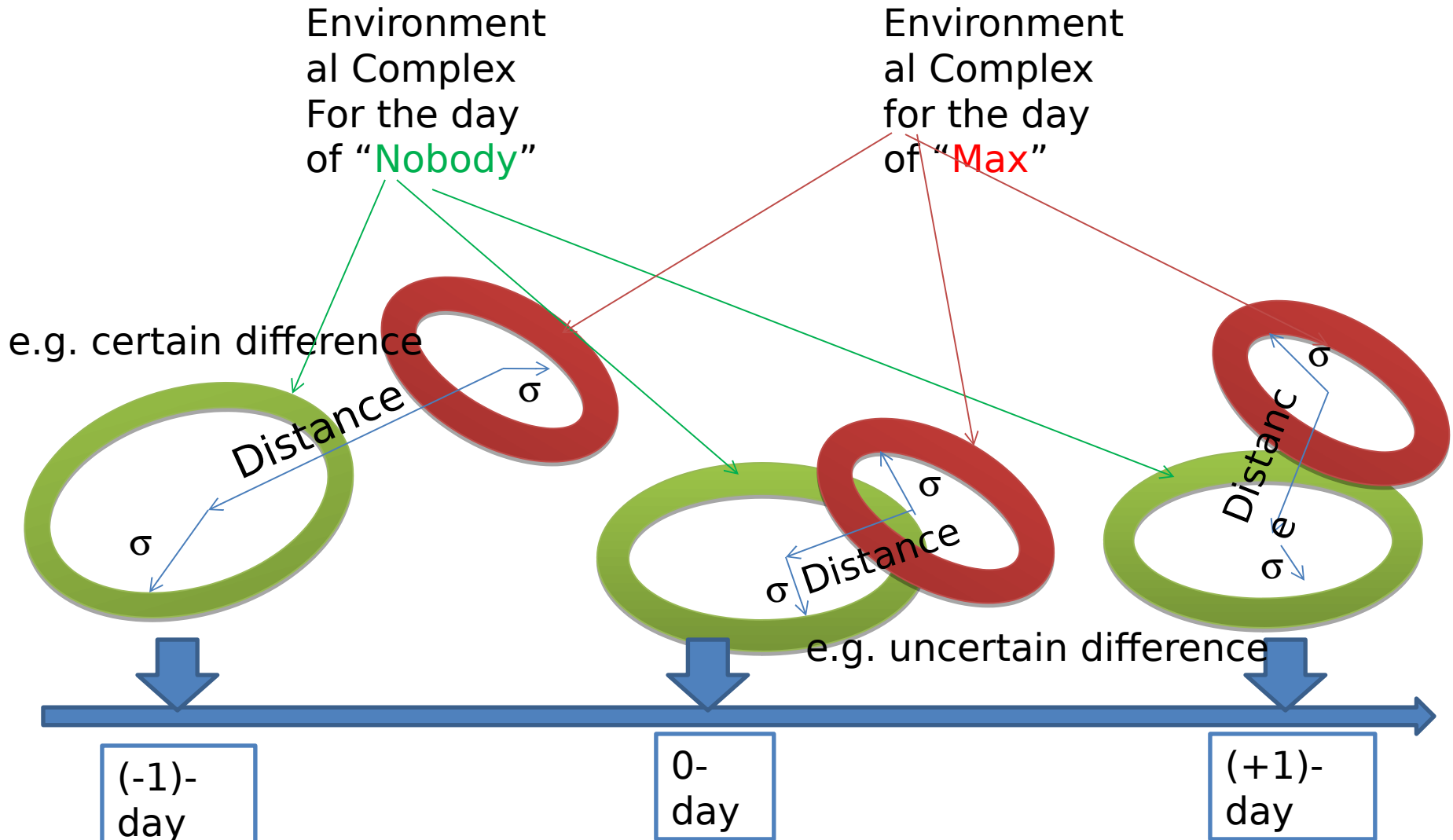
$$\cos \alpha_{max} = \max_i (\cos \alpha_i) \quad - \text{Maximal leading Cos}$$

$$InnerDistance = \sqrt{\left(\frac{\cos \alpha_{max}}{\sqrt{\sum_{i=1}^n \frac{\cos^2 \alpha_i}{\sigma_i^2}}} * \frac{\cos \alpha_i}{\cos \alpha_{max}} \right)^2}$$

$$\Delta Distance = distance(X, Y) - (InnerDistance_{\text{базовой категории}} + InnerDistance_{\text{сравниваемой категории}})$$

Data Treating Method:

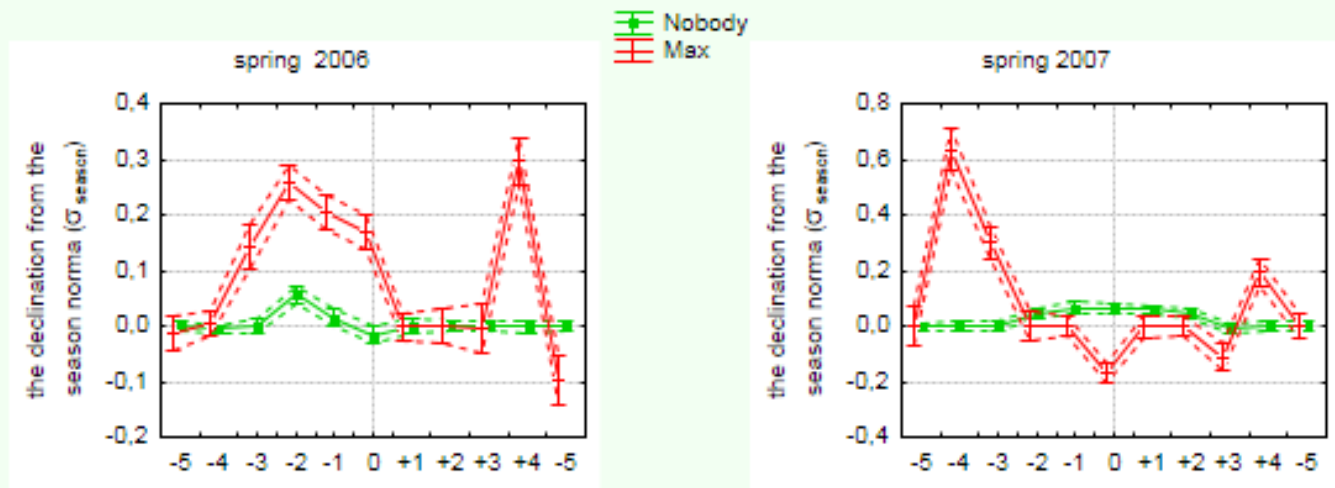
- The choosing of day of maximum distance by folding epochs method



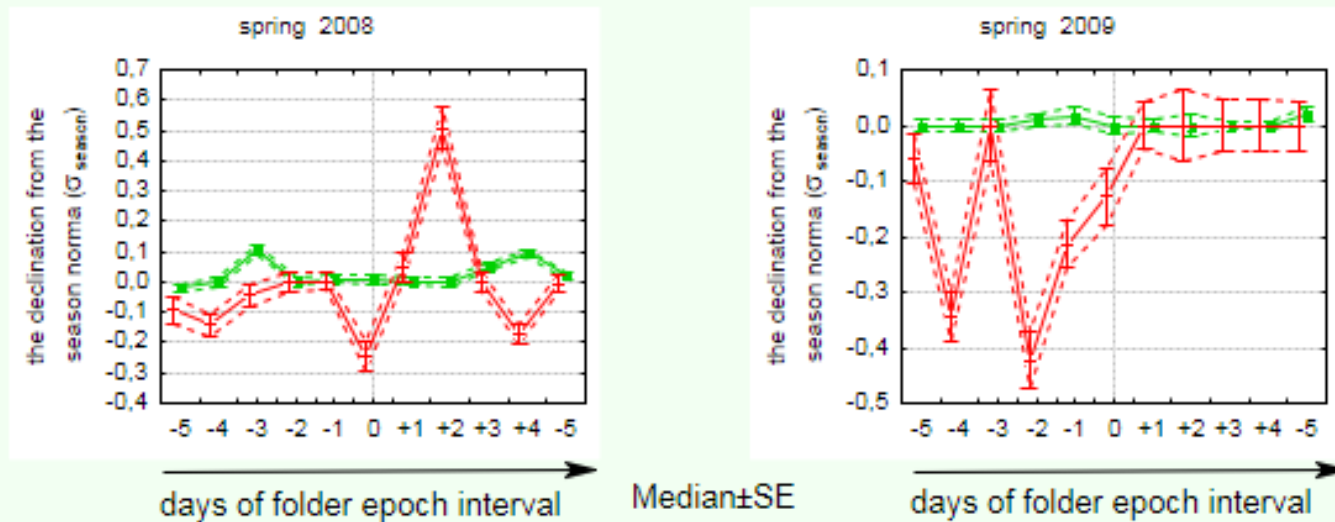
Data Treating Method:

5. The selection of environmental parameters with follows characteristics :
 - 1) Their **distances between different Weather Complexes** are more than 1 Euclid's distance between clusters of Weather Complexes;
 - 2) Their **declination from the NORMA** of exact calendar season ("**<Season Norma**" , "**=Season Norma**" , "**>Season Norma**") are alternative when they are matching different Medical categories.
6. The investigation of selected parameters behaviour on the time-interval of the folding epochs method.

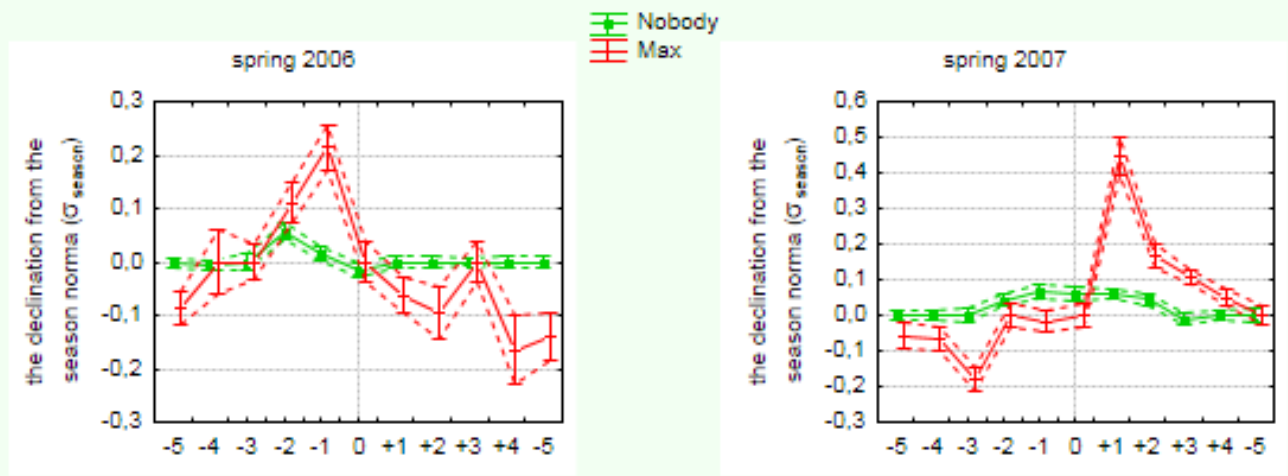
Men - spring-time:



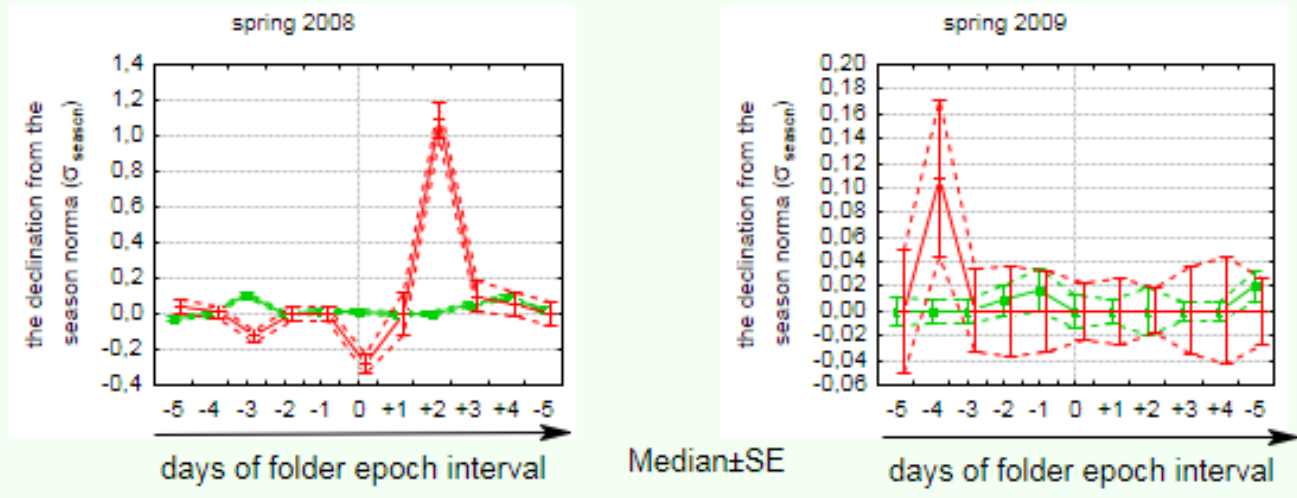
Ischemia cases (men)



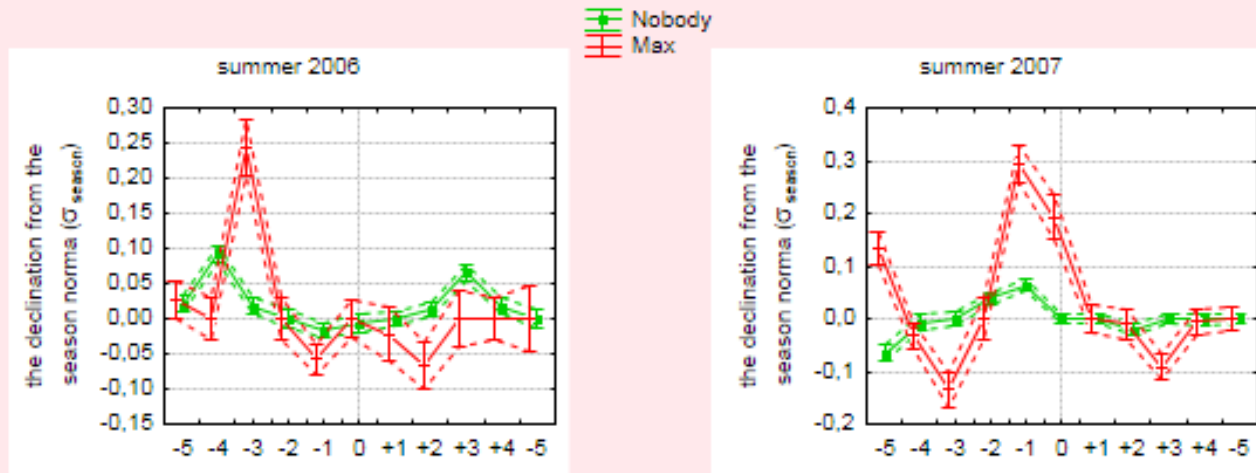
Women - spring-time:



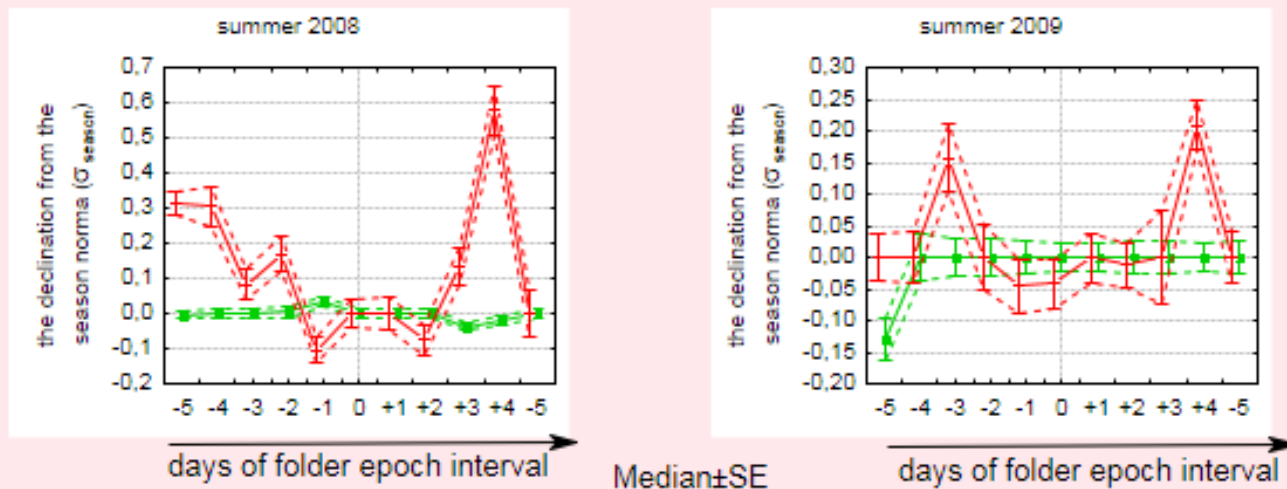
Ischemia cases (women)



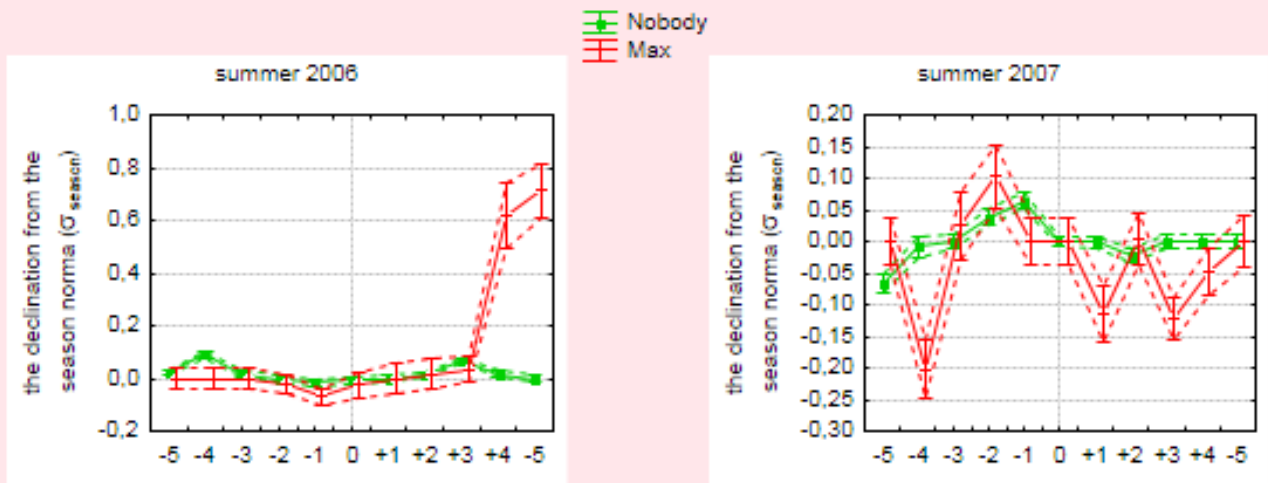
Men - summer-time:



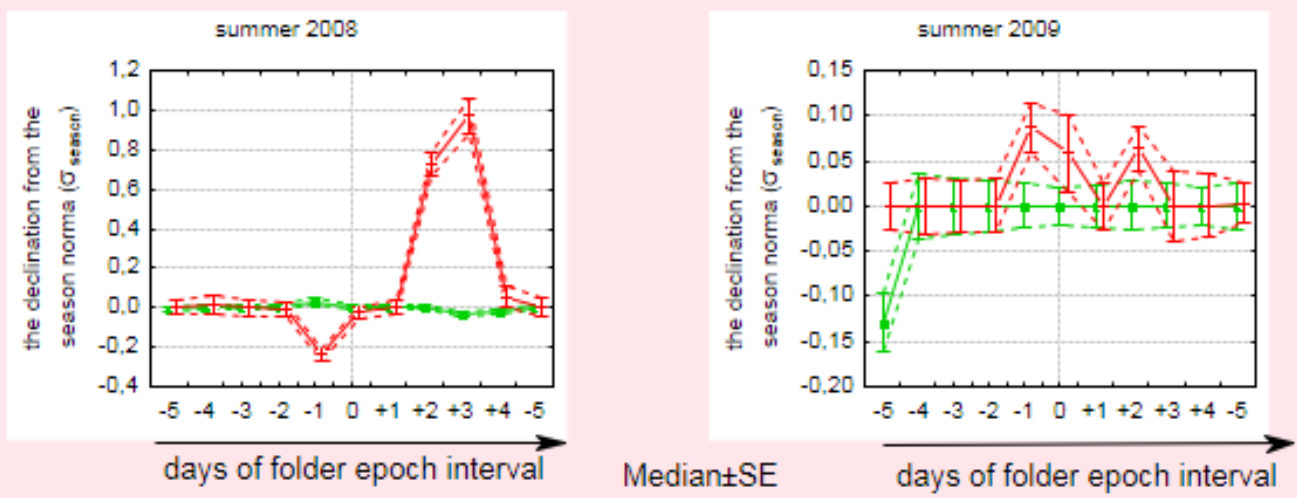
Ischemia cases (men)



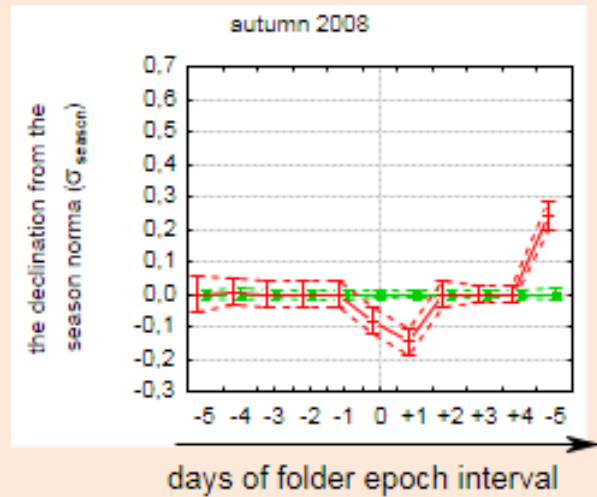
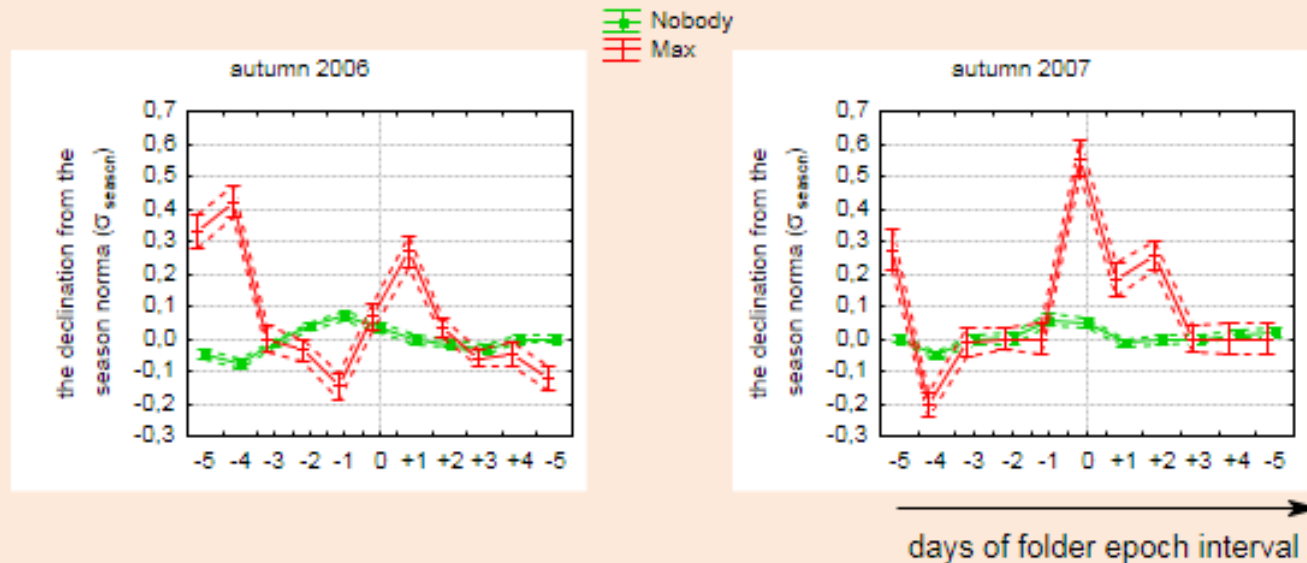
Women - summer-time:



Ischemia cases (women)



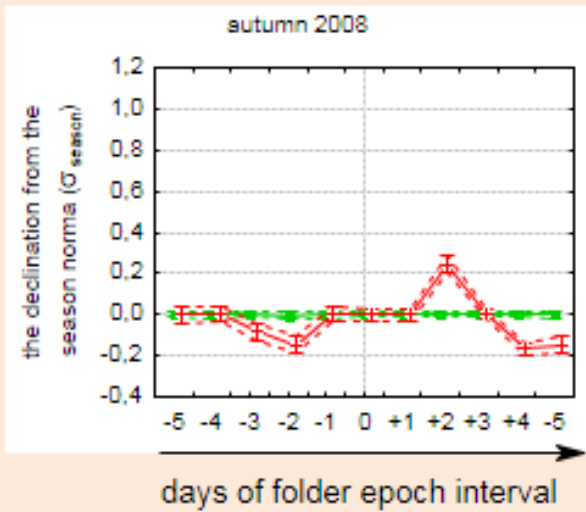
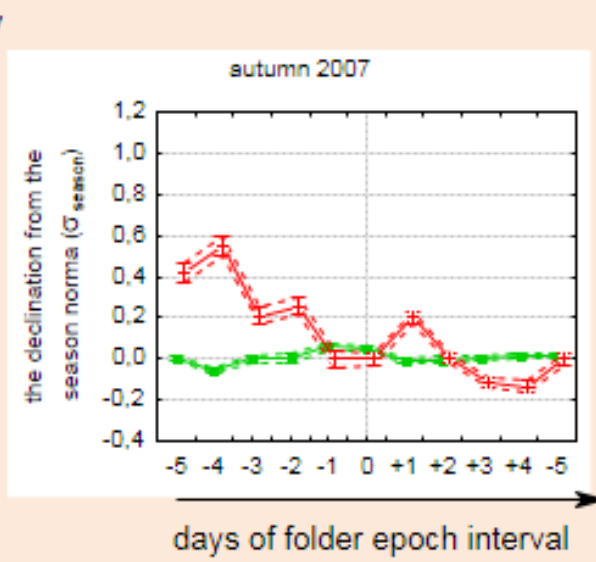
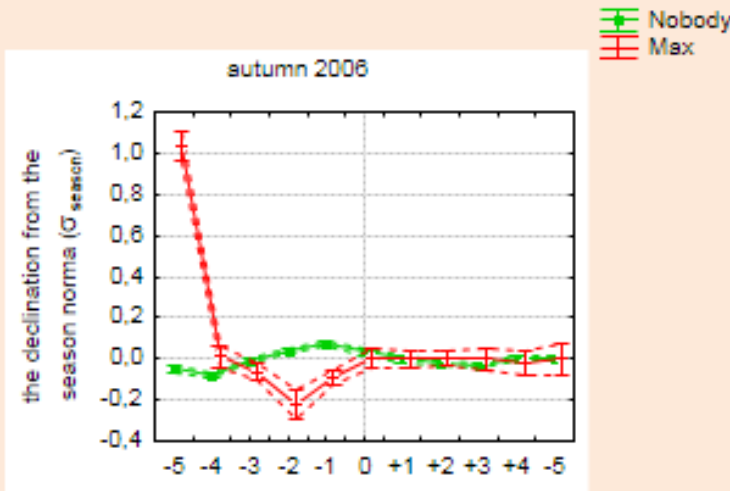
Men - autumn-time:



Ischemia cases (men)

Median±SE

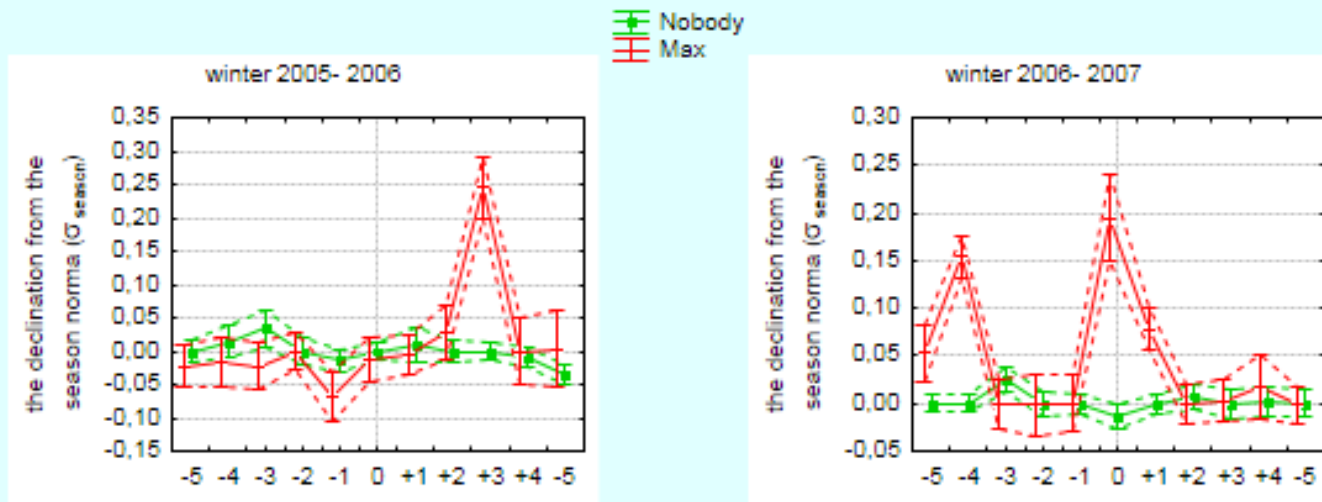
Women - autumn-time:



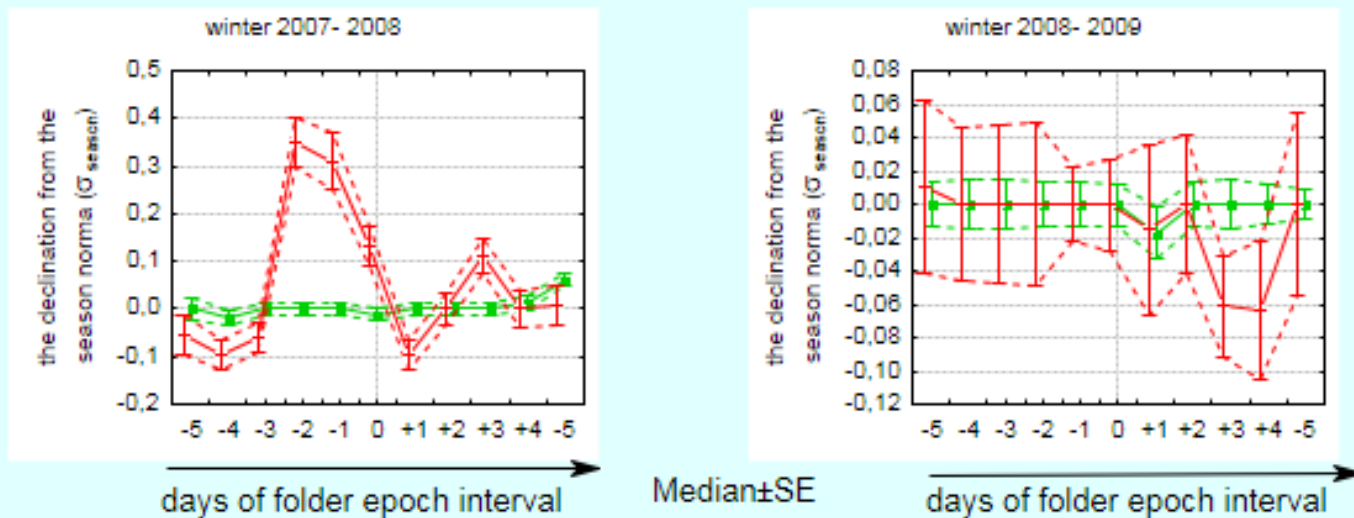
Ischemia cases (women)

Median±SE

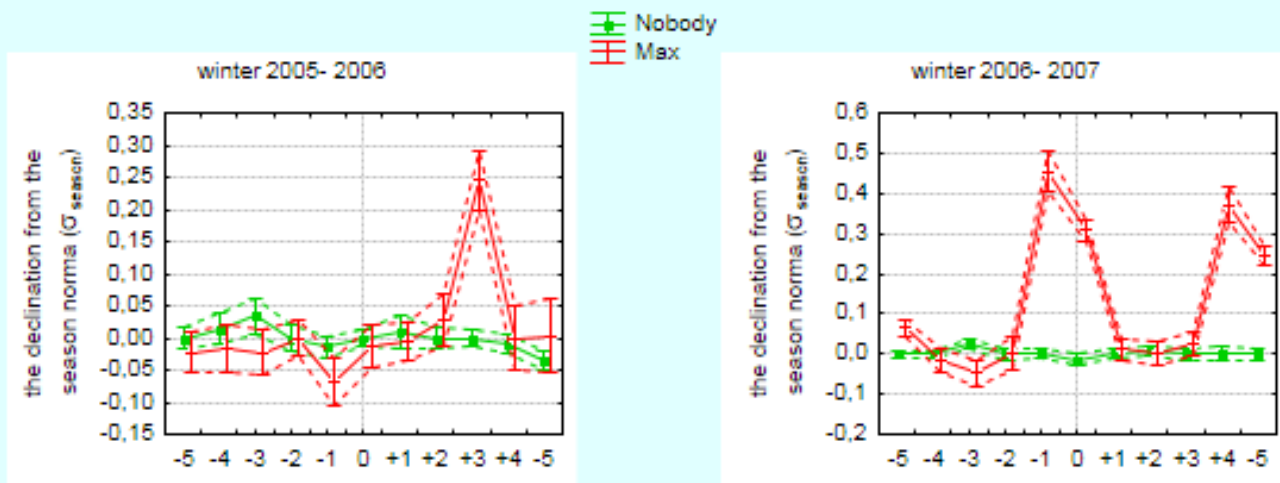
Men - winter-time:



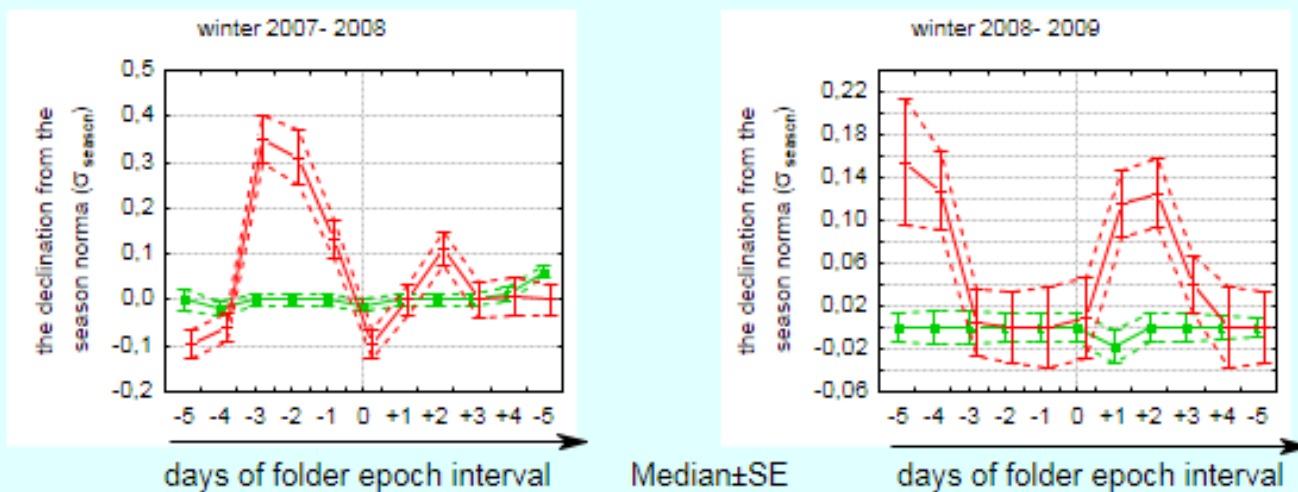
Ischemia cases (men)



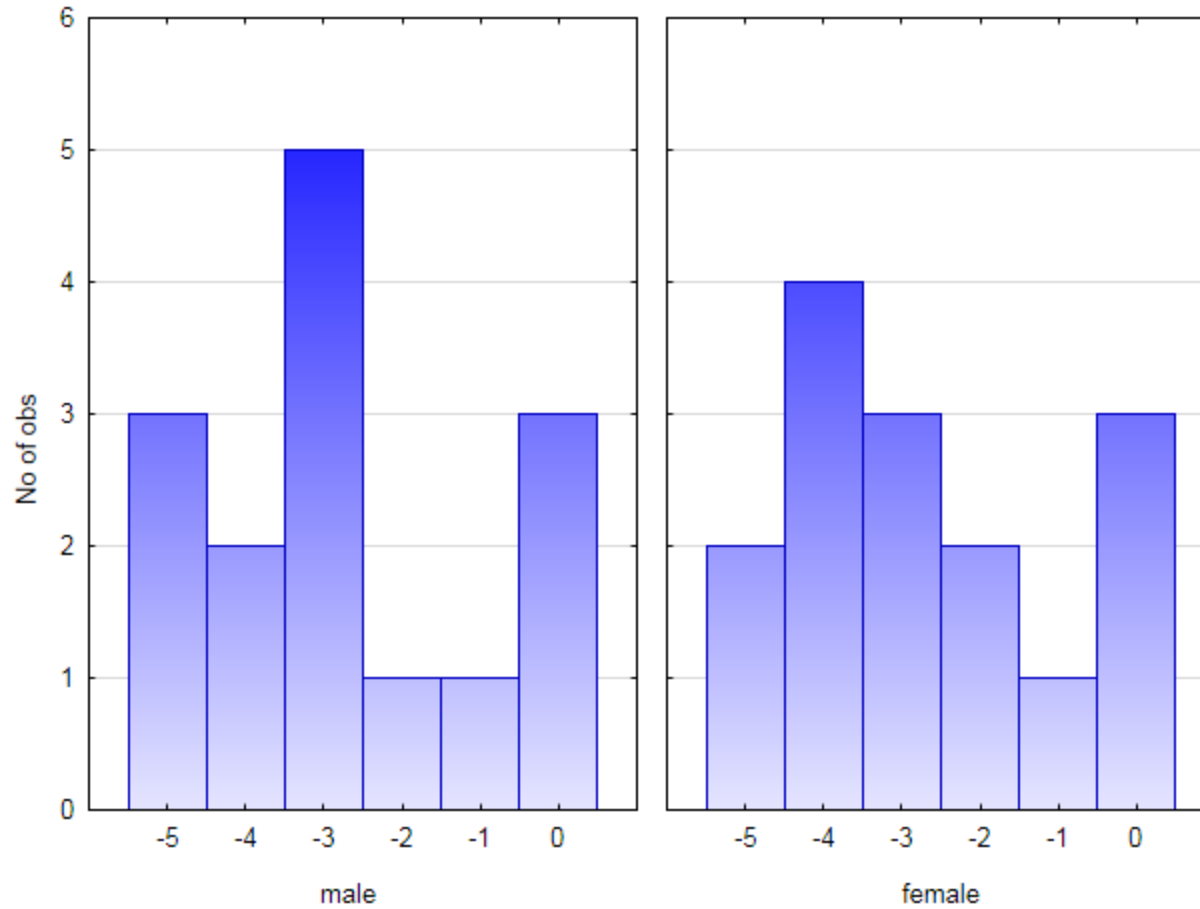
Women - winter-time:



Ischemia cases (women)



The distribution of the days of the maximal difference between Weather Complexes on the half-interval of folder epochs.
Different gender groups of Ischemia cases.



Space Weather (Earth Vicinity) parameters those were significant difference when matched different medical events (“Max”-“Nobody”)

The environmental parameter	Possible forecast lead time
Solar wind Plasma Flow Pressure - daily coefficient of variation	4-3 days before medical event “Max”
Plasma Flow Speed - daily median	4-3 days before medical event “Max”
The daily integrated proton fluxes of energies > 100 MeV	3 days before medical event “Max”
Solar Wind Plasma Flow Longitude Angle, Geocentric Solar Ecliptic System (GSE), daily maximum	1 day before medical event “Max”

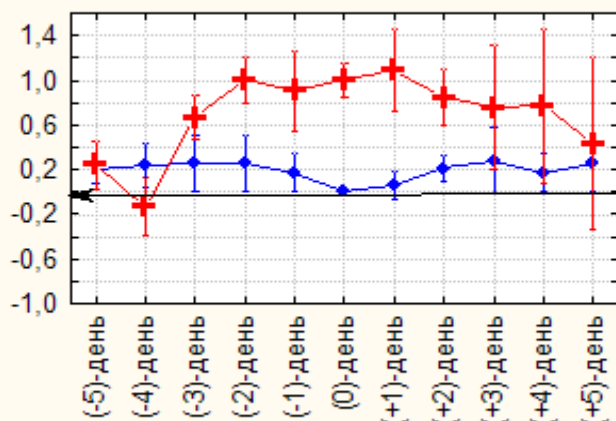
Space Weather (Geomagnetic Field) parameters

those were significant difference when matched different medical events

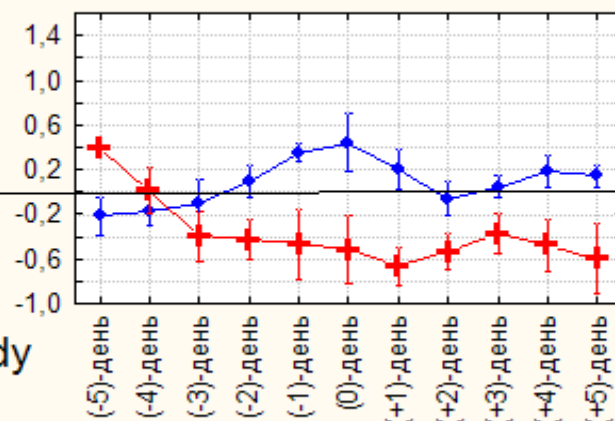
(“Max”-“Nobody”)

The environmental parameter	Possible forecast lead time
Geomagnetic Field z-component Magnitude, Geocentric Solar Ecliptic System (GSE) - daily maximum	1 day before medical event “Max”
Geomagnetic Field Magnitude Average $ B = 1/N \text{ SUM } B $ (N= number of points in the observation sample) - daily coefficient of variation	2-3 days before medical event “Max”

околоземное пространство
 суммарный за сутки поток протонов
 с энергией $E > 100$ МэВ

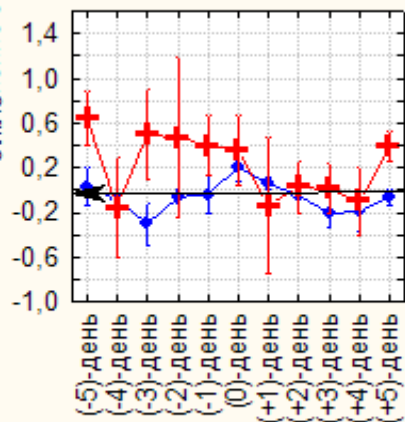


околоземное пространство
 суточная медиана скорости потока плазмы

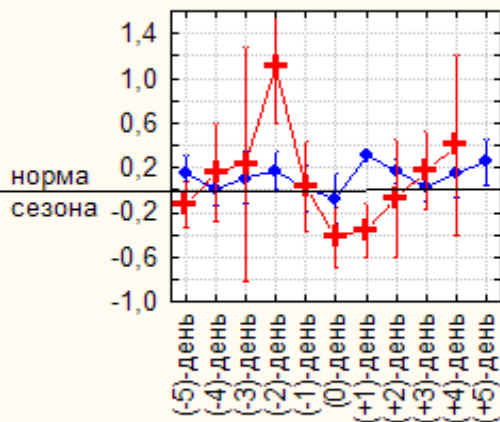


отклонение от сезонной нормы ($\sigma_{\text{сезона}}$)

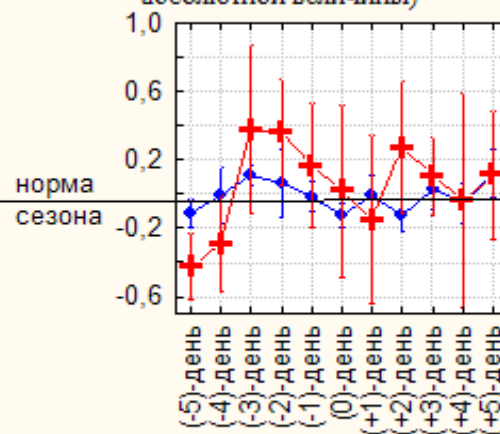
околоземное пространство
 суточный коэффициент осцилляции
 потока протонов с энергией $E > 30$ МэВ



околоземное пространство
 суточный коэффициент вариации
 давления потока плазмы



геомагнитное поле (ГМП)
 Суточный коэффициент осцилляции
 напряженности ГМП
 (среднее арифметическое
 абсолютной величины)

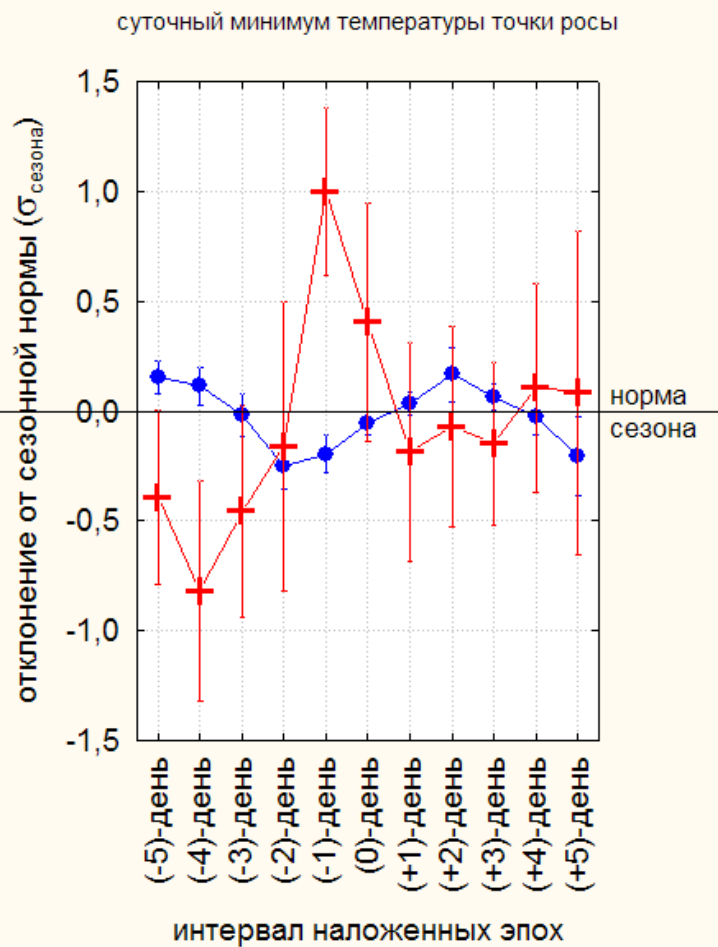
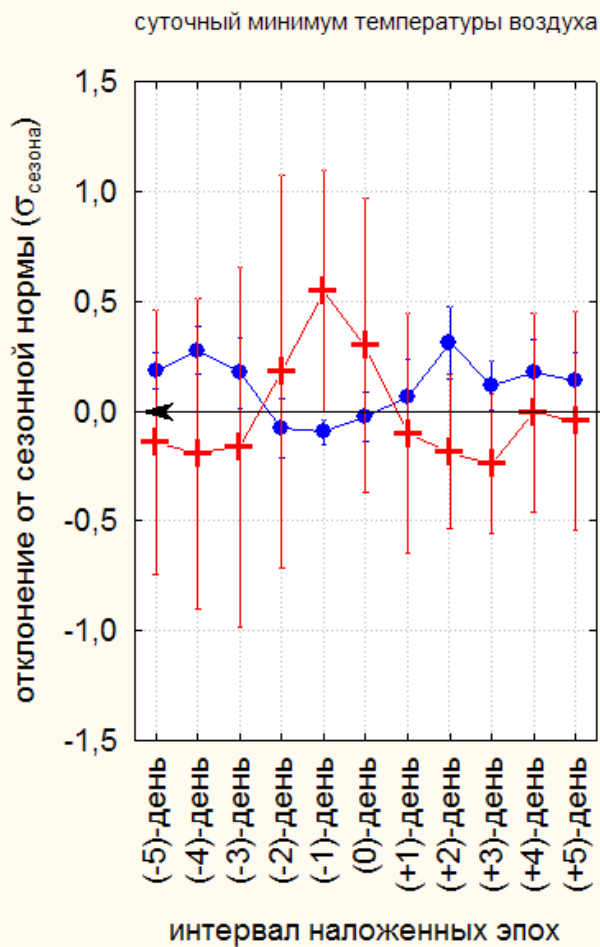


Mean; Whisker: Mean \pm SE

Terrestrial Weather (Air Temperature, Humidity) parameters
those were significant difference when matched different medical
events

(“Max”-“Nobody”)

The environmental parameter	Possible forecast lead time
Air temperature – daily maximum	1 day before medical event “Max”
Air temperature – daily median	1 day before medical event “Max”
Air temperature – daily minimum	1 day before medical event “Max”
Temperature of Dew Point– daily maximum	1 day before medical event “Max”
Temperature of Dew Point– daily mean	1 day before medical event “Max”



◆ Nobody
+ Max

Mean; Whisker: Mean \pm SE

The condition for the repeating of certain parameters importance
 (parameters are listed above in the previous tables).

The phase of Solar Activity cycle	The calendar season	Gender group
any	autumns	women
the fall branch	summers	women
the fall branch	winters	any
the fall branch	springs	women
the fall branch	autumns	women
minimum SA	autumns	men
minimum + rise branch	autumns	women
minimum + rise branch	summers	women
minimum + rise branch	springs	any
minimum + rise branch	winters	women

The conclusions:

1. In the frame of our study we have found that Weather Complexes had significant different status when matching alternative medical events: maximal daily number of Ischemia cases in the sample of the inhabitants of the one Saint-Petersburg's district vs. absence of such cases in the sample. But these differences were not exactly in a day of concrete medical events. So we can suppose that the dramatic medical events were placing on the line of the weather (Space and Terrestrial) changing.
2. In the frame of our study we have found out the concrete environmental parameters those may be responsible for the creation of the environmental circumstance for the alternative medical events.
3. In the frame of our study we have found the condition for the repeating of certain parameters importance.
4. Most generalization of the previous point (exact common repeating time-interval and exact common repeating parameters) we can do for the women-group.
5. Space Weather characteristics more frequent then those of Terrestrial Weather were different when they corresponded to different medical events.
6. All changing of important parameters began before the dramatic events.
This fact gives us possibility for the development of forecast for dangerous situation.

Thank you for your
attention!

