Influence of the Space Weather and conductivity of the ground surface on thermal regime of the stratosphere

L.N. Makarova and A.V. Shirochkov

Arctic and Antarctic Research Institute,
Saint-Petersburg, 199397 Russia

SPARC General Assembly, Bologna, Italy
August 31 – September 5, 2008

The quasi-stationary values of the solar activity and magnetic field of the solar wind show maximum in 21 and 22 cycles and minimum in 20 and 23 cycles. (The coefficient correlation between sunspot activity and IMF is ~0. 65)

- **It is turned out that 23 cycle is similar to 20 cycle by level activity**

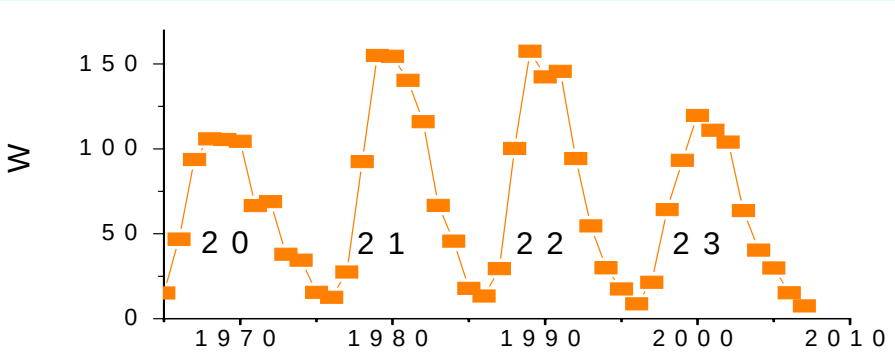


Fig.1 Long term variations of the solar activity expressed in SSN variations

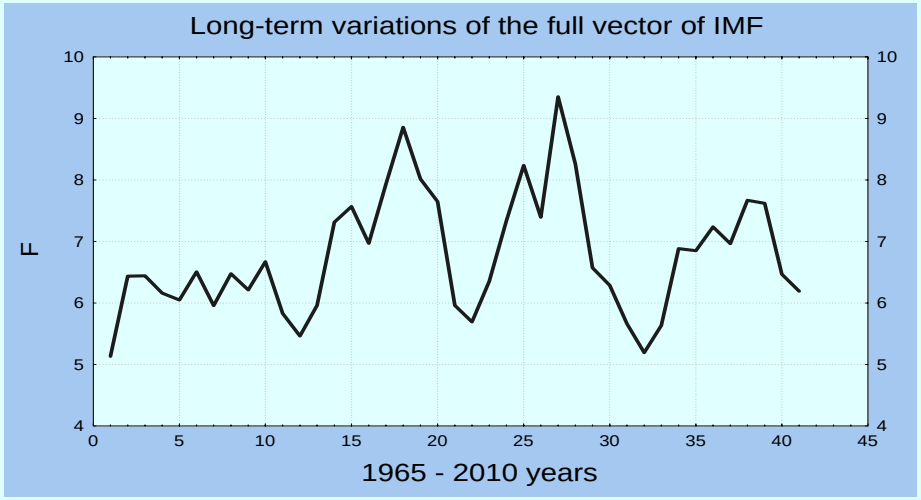
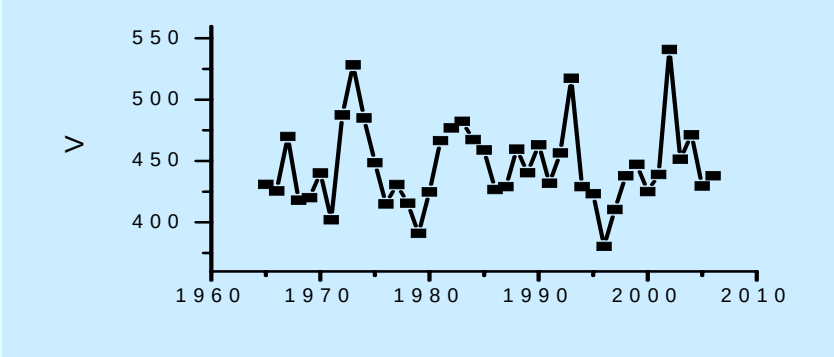
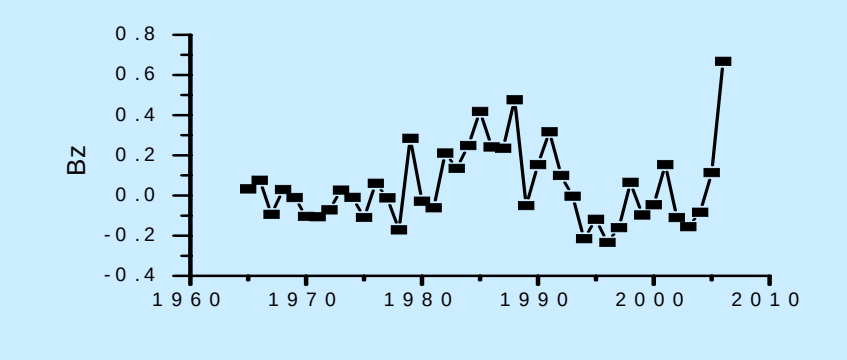


Fig.2 Long term variations of the full vector of Interplanetary Magnetic Field (F, nT)

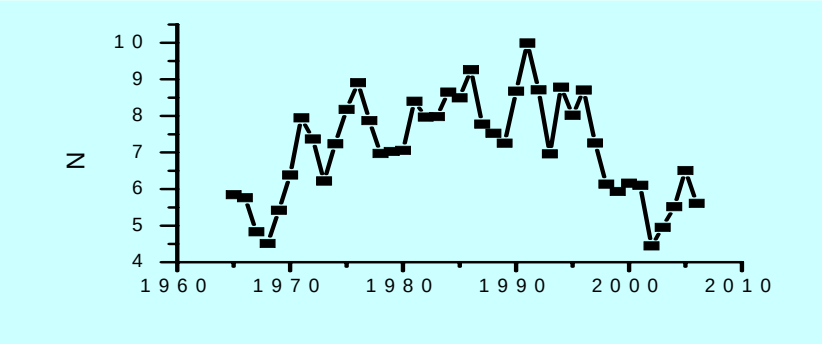
Long term variations of the parameters of the solar wind



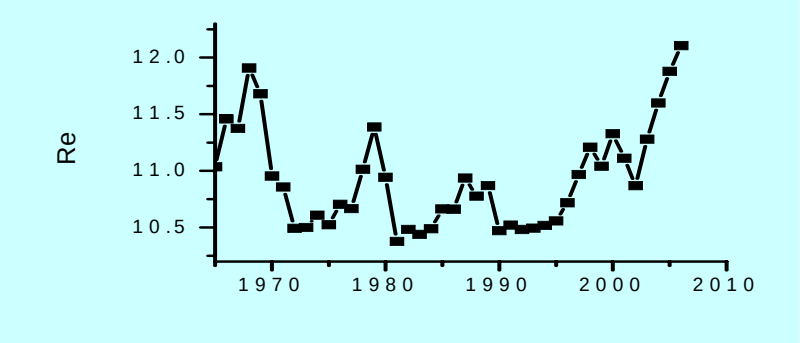
Long term variations of the velocity of the solar wind



Long term variations of the vertical component of the IMF

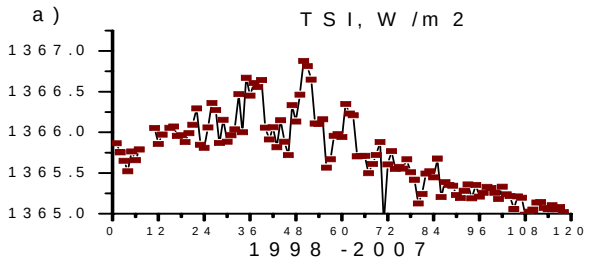


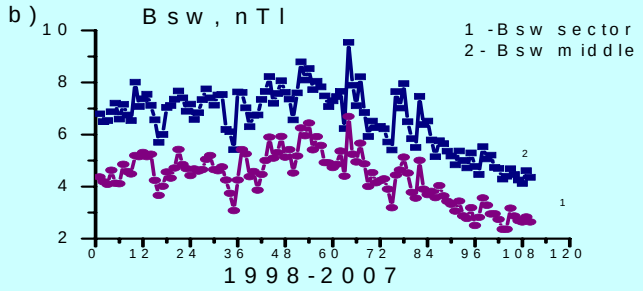
Long term variations of the density of the solar wind



Long term variations of the position of the magnetopause of the magnetosphere Earth

Variations TSI (a), values of the magnetic field of the solar wind (b) and position of the magnetopause (c) during 23 solar cycle activity





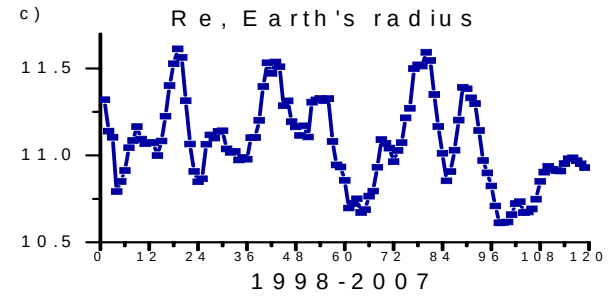


Fig. 3

The main peculiarity of the 23 cycle of the Sun activity is diminishing TSI (a) and magnetic field of the solar wind (b) on the end of this cycle.

The magnetopause position is not located close to the Earth during last years (c).

The energy of the solar wind is not high.

Parameters of global electrical circuit must have some peculiarities during this especial period.

Values of the electric field, measured at Vostok Station, Antarctica during last years

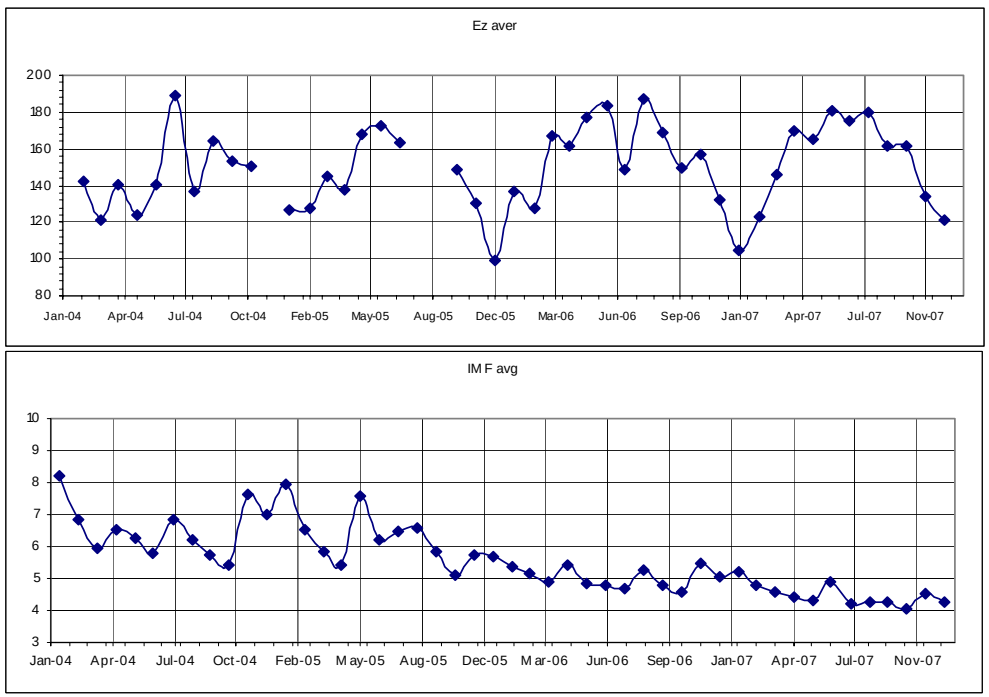


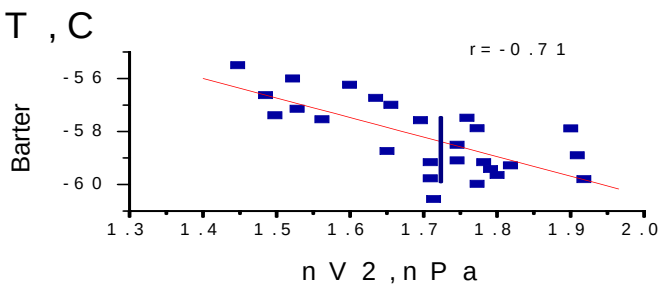
Fig.4 Monthly averaged values of Ez at Vostok for 2004 - 2007 and the average values of interplanetary magnetic field.

Fig.4 presents the results of the last 4 years of EF observations. During 2006 and 2007 (a period of very quite Sun) variability of Ez was minimal and the annual variability of the electric field followed the classical curve of seasonal thunderstorm activity.

Influence of the solar wind electromagnetic energy is low. Parameters of the global electric circuit will be determined by solar EUV and conductivity of the ground surface.

- **Our data showed that thermal regime of the stratosphere connected with parameters of the solar wind.**
- **It was proposed mechanism influence electric field and currents of the global electric circuit as Joule heating in stratosphere.**
- **Model simulation showed that this mechanism can be important for thermal regime of the stratosphere**
- **Model assessment of the solar wind effects on the general circulation of the atmosphere and global ozone distribution can be found in http://www.pmodwrc.ch/eugene1560/sowa/results.phtml**

Dependence of the stratospheric temperature variations on the electrical conductivity of the ground surface



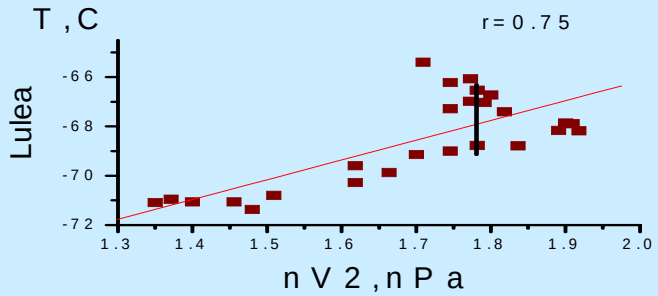


Fig. 5 Dependence of December atmospheric temperature at baric surface 50 hPa on solar wind dynamic pressure at some Arctic stations during the last decades. Vertical lines on the lines indicate confidence interval derived by the Student method

- **Station Barter (Alaska) is located at permanent permafrost while Lulea (middle Sweden) is a station with a good conductivity of ground surface. There are two kinds of dependence of temperature stratosphere on the solar wind dynamic pressure.**
- **Experimental data demonstrated dependence of the stratospheric temperature variations on the electrical conductivity of the ground surface. It is well known that this parameter varies in great interval of magnitudes (several orders). The Polar Regions demonstrate such variations especially clear.**
- **The satellite measurements of the atmospheric temperature above the Arctic in winter 2007 -2008 demonstrate existence of two different regions of the stratosphere temperature which is difficult to explain by only influence of solar UV radiation (see the next Figure).**

❖Comparison of distribution of permafrost in the polar region with stratospheric temperature measured by satellite

Distribution of permafrost in the Polar region.

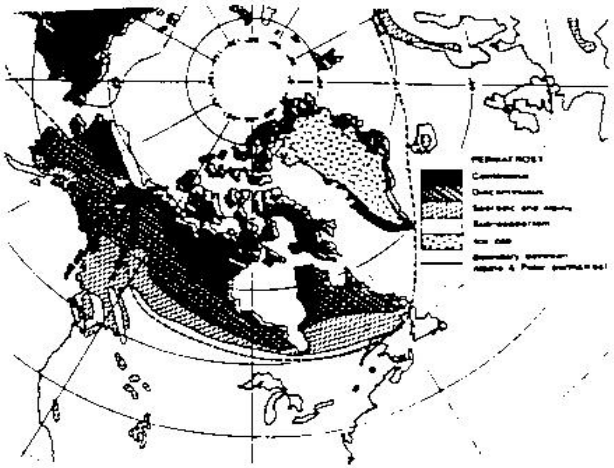
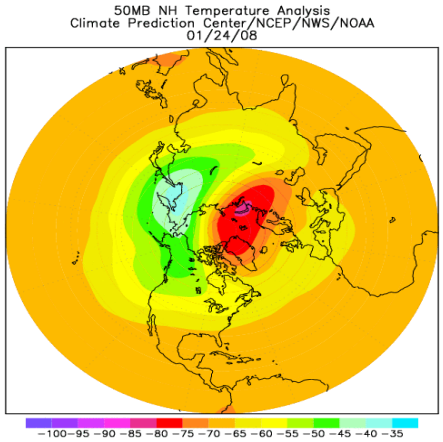


FIGURE 2

Fig.6 The continuous permafrost region is defined as that area where in subfreezing ground exists at some depth for all points in the region. (after Ben Best, Cryonics:The Issues) .

Temperature on the baric surface 50 hPa on North and South hemisphere on 01. 24.2008



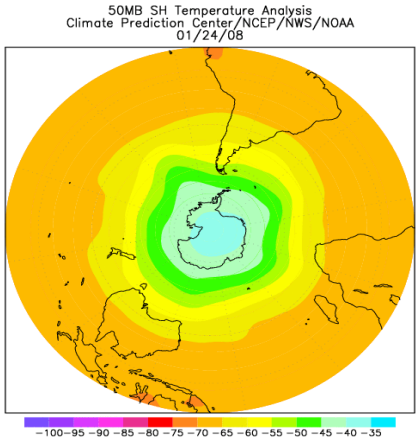


Fig. 7 Stratospheric temperature is warmer above regions with permafrost (low electric conductivity) and vice versa it is cooler above regions with high electrical conductivity of ground surface during the low values electric field and currents.

Conclusions

1. Long –term variations of the different kind of the solar activity can influence on electromagnetic energy and fluxes of galactic or solar charged particles transferred into the near- Earth Space and consequently change the Earth climate and weather.
2. The results showing connection of thermal regime of the stratosphere with parameters of the solar wind can be explained in the framework of the global electrical circuit driven by energy of the solar wind.
3. The temperature of the stratosphere during low atmospheric electric field is more high above permafrost regions than above regions with a good conductivity.
4. The temperature of the stratosphere increases if the electric field of the global electric circuit is strong (annual increasing electric field during summer in North hemisphere or during disturbances of the solar wind) and when conductivity of the Earth's surface is high. Vice versa-the temperature of the stratosphere above permafrost or places covered by ice has a negative correlation with energy of the solar wind.
5. Influence of energy of the electric circuit on the thermal regime of stratosphere can be additional source to UV radiation.