Secular variations at Ukrainian magnetic observatories

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Secular variations (SV) are the main origin of the information on the processes inside of the Earth, that geomagnetic field generate. SV are calculated by means of the mean year values of the geomagnetic field components measured at the magnetic observatories. It is generally accepted, that SV consist of two components, the first component is generated by internal origins, and second — by the external ones [Kalinin, 1984]. The external origins are magnetospheric-ionospheric currents. Variations from ionospheric currents have different sign and therefore their mean per year values are equeal about zero. Magnetospheric ring current is created during magnetic storms. The current flows to the West and therefore it creates negative variation of horizontal component (*H*) and positive ones in vertical component (*Z*). In *Z*-component the effect intensifies to the high latitudes and in *H*-component — to the equator. In the years of low solar and magnetic activities, quantity of the magnetic storms is little. It means that the mean year values of *H*-component are lesser and *Z*-component — greater in such years, and vice versa in the years of high solar activity. There are shortperiod and longperiod SV generated by external sources. About one-two year period SV are high correlated with geomagnetic activity. It mean that their sources are magnetosphere-ionosphere currents [Sumaruk, 2001]. However in [Ladynin, Popova, 2008] assumption is made that these quasibiennial SV-variations are connected with the changes of the dipole field parameters, i. e. they have internal sources. The most probable quasibiennial SV have as external so internal sources. Existence of quasibiennial variations on the SV graphs on quiet and also disturbed days is argument for such assumption. Longperiod SV include elevenyear [Shevnin et. al, 2009] and eightyyear (80-year) [Sumaruk, 2001] variations. The goal this work is:

1) to investigate SV on Ukrainian magnetic observatories;

2) to separate components connected to solar and geomagnetic activities. We used mean year values of geomagnetic field three components on all (*a*), quiet (*q*) and disturbed (d) days at magnetic observatories "Lviv" (LVV), "Kyiv" (KIV) and "Odesa" (ODE).

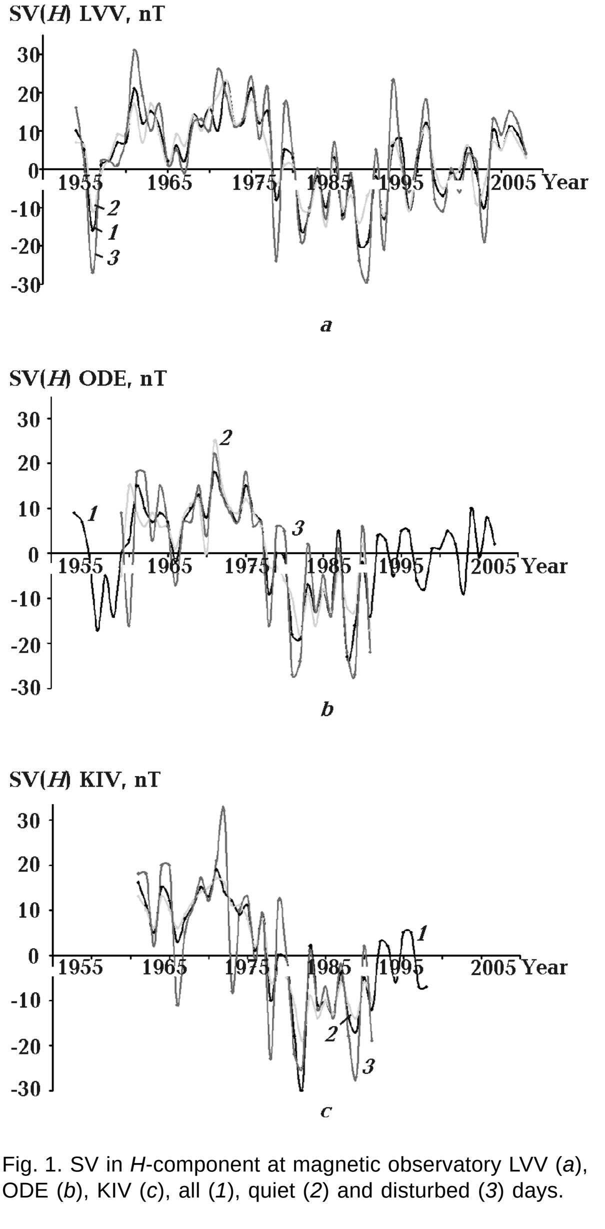

Fig. 1. SV in *H*-component at magnetic observatory LVV (*a*), ODE (*b*), KIV (*c*), all (*1*), quiet (*2*) and disturbed (*3*) days.

Fig. 1 shows SV in *H*-component at magnetic observatory LVV (*a*), ODE (*b*), KIV (*c*) on all (black), quiet (green) and disturbed (red) days. Short period variations at three observatories in *H*-component change in phase, but their amplitudes are different. The greatest amplitudes on all, quiet and disturbed days are observed at LVV. At all observatories short-period SV have greater amplitudes on disturbed days.

Fig. 2 shows SV in *Z*-component at magnetic observatory LVV (*a*), ODE (*b*), KIV (*c*) on all (black), quiet (green) and disturbed (red) days, and Fig. 3 the same for *D*-component. In Z- and *D*-components for shortperiod SV one may see the same as for *H*-component, but amplitudes are lesser as for disturbed days so for all and queit days. Shortperiod

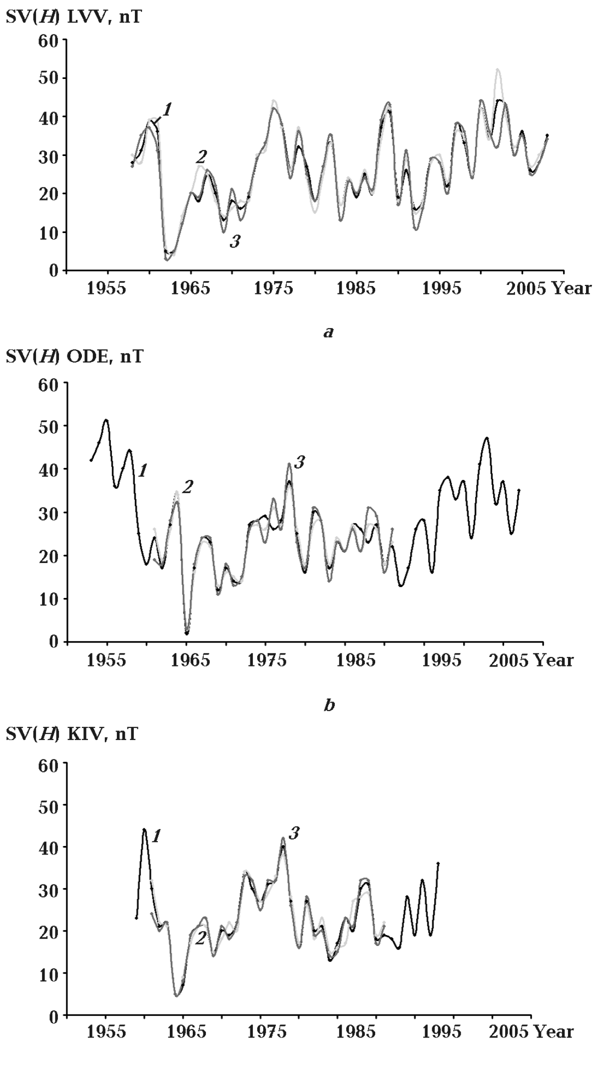

Fig. 2. SV in *Z*-component at magnetic observatory LVV (*a*), ODE (*b*), KIV (*c*) all (*1*), quiet (*2*) and disturbed (*3*) days.

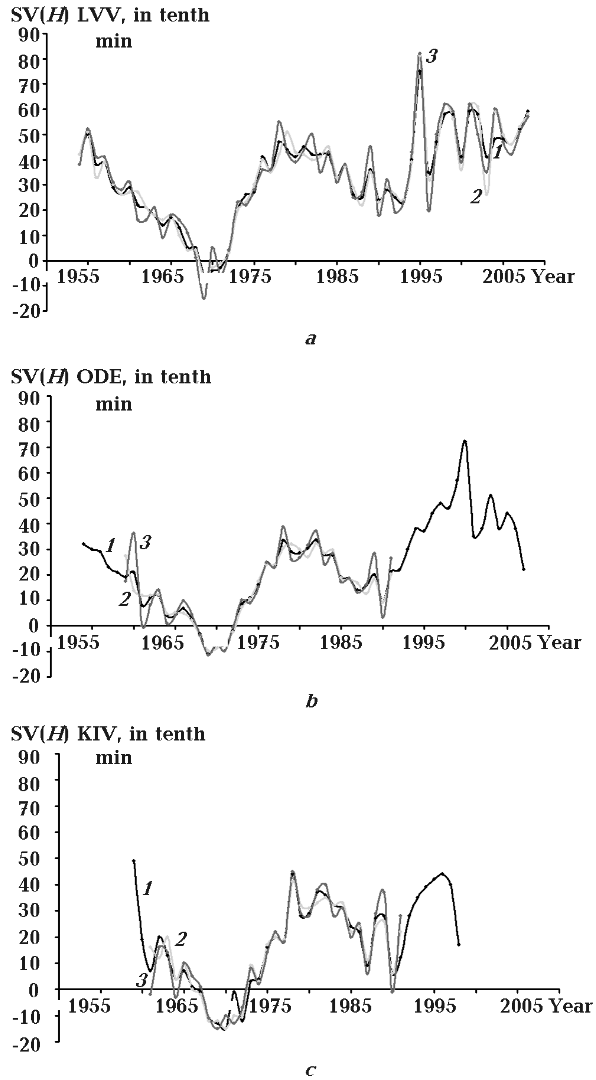

Fig. 3. SV in *D*-component at magnetic observatory LVV (*a*), ODE (*b*), KIV (*c*) all (*1*), quiet (*2*) and disturbed (*3*) days.

SV in *Z*- and *D*-component change in opposite phase to *H*-component phase. It is factor to evidence the external sources of these variations. Shortperiod variations we exclude by trapets method. After excluding shortperiod SV, about 11-year SV are seen dictinctly. These variations are connected to changes of cyclic solar activity. On the growth (fall) stage of solar activity, the SV decreases (increases).

Smoothing at 11-year running window exclude cyclic changes of SV. By excluding shortperiod and cyclic SV variations, we received quasisinusoidal curve. Unfortunaly Ukrainian magnetic observatories observed only part of the quasisinusoid. It was shown in [Sumaruk, 2001] that such observatories as Hartland (HAD, observational row from 1846), Coimbra (COI, from 1866), Voejkovo (LNN, from 1869) observed SV with period about 80 years. It may suppose, that 80-years SV also have external source so far as they correlate to mean per solar cycle Wolf numbers.

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Quasi-biennial variations of the solar and geomagnetic activities

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In the spectrum of the solar activity expressed with Wolf numbers or other indices, the period about 2—3 years is distinguished [Gnevyshev, 1977; Apostolov, 1985]. Quasi-biennial oscillations (QBO) manifest itself on all geliolongitudes and it was shown in [Ivanov-Kholodny et al., 2003], the common structure of the QBO exists on the Sun.

Statistical analysis of the connection between QBO and solar magnetic fields shows high correlation between phenomena [Ivanov-Kholodny et al., 2004]. The same QBO were found out in the interplanetary environment [Okhopkov, 1998], in the critical frequencies of the ionosphere layers E and F_2 [Ivanov-Kholodny et al., 2000; 2003], in some geophysical and meteorological processes [Rakipova, Ephimova, 1975; Gabis, Troshichev, 2001; Fadel et al., 2002]. The best QBO manifests itself at the beginnings of the solar cycles as a fade out oscillations. The amplitude of the first oscillation is the greatest and then it decreases to the end of the cycle. At the growth phase of the solar cycle activity the periods of the oscillations are about three years, but at the minima they are about two years [Kononovich, Shefov, 2003].

The physical interpretation of the QBO in the solar activity is based on the changes of the solar convective zone parameters G. S. Ivanov-Kholodny et al. draw conclusion, that QBO have the same origins in all phenomena [Ivanov-Kholodny et al., 2004]. Yu. D. Kalinin [Kalinin, 1952] was first, who discovers QBO in the magnetic field variations. Availability of the QBO in the geomagnetic field variations in middle latitudes was shown in [Sumaruk T., Sumaruk P., 2009]. Our purpose is to see of QBO in the geomagnetic field secular variations (SV) and their correlation to solar and geomagnetic activities.

Fig. 1. QBO(W) for 1750—2000.