served 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.

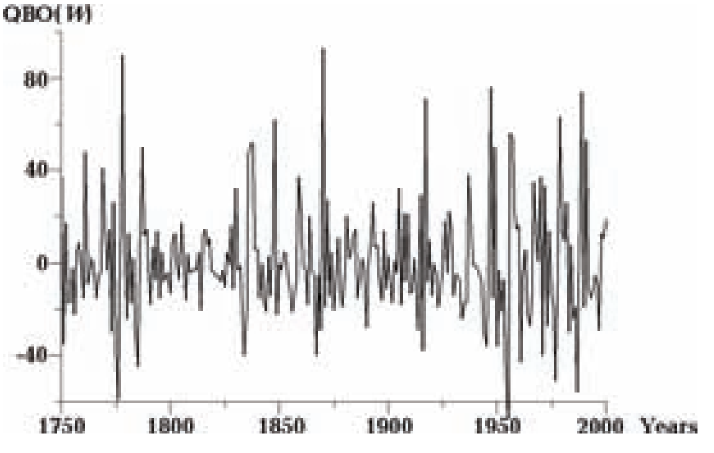

Fig. 1. QBO(W) for 1750—2000.

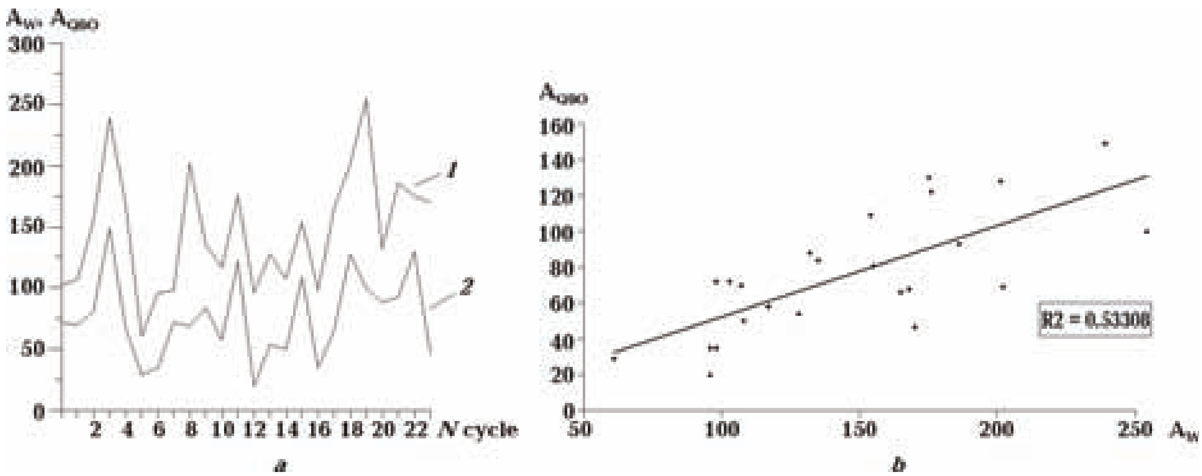

Fig. 2. Amplitudes of the Wolf number A_W (*1*) and amplitudes of QBO (W) A_{QBO} (*2*) for every solar cycle (*a*) and correlation between A_W and A_{QBO} (*b*).

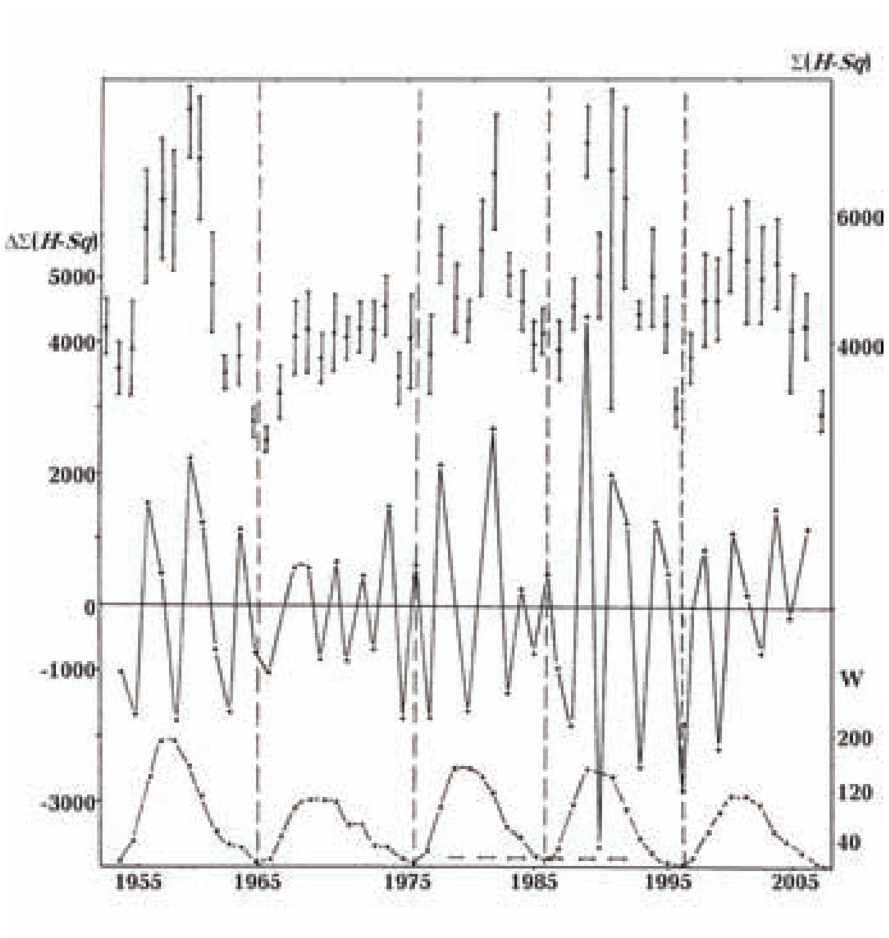

Fig. 3. Mean per year $\Sigma(H\text{–}S_q)$ values and their dispersion, $\Delta\Sigma(H\text{–}S_q)$, Wolf number for 1954 till 2005.

The starting data were the mean year Wolf numbers (*W*) and values of horizontal component (*H*) at magnetic observatory "Lviv". The measure of magnetic activity was the mean monthly per year sum of differences between hourly absolute values of *H* and correspondent *H* on five international quiet days

(S_q)–(Σ(H–S_q)). SV were calculated as difference between successive mean year values of *H*. To select QBO was used method of [Ivanov-Kholodny, Chertoprud, 1992], which consist in finding differences of double values of correspondent parameter and the same for previous and next years.

Fig. 1 shows QBO(W) for 1750—2004. From three to five oscillations are observed during every solar cycle. Amplitudes of oscillations are maximal at the beginnings and decreases to the ends of the cycles. In the odd solar cycles the amplitudes are to a great extent larger. Two cycles odd and even present as if one group and it reflect the change of sign of the Sun polar magnetic field.

Fig. 2, *a*. presents the amplitudes of the Wolf number (*1*) and amplitudes of QBO (W) (*2*) for every solar cycle.

The high correlation between values exists. Fig. 2, *b*. shows it dependence.

As E. Gibson shows [Gibson, 1973] about eighty year solar cycle exist. Amplitudes of QBO(W) also show the same cyclisity. Minimal amplitudes of QBO(W) was observed in cycle № 5, the next minimum was in cycle № 12 and the next — cycle № 20. Solar activity increased from cycle № 14, the same increasing shown amplitudes of QBO(W).

As it was shown T. Sumaruk [Sumaruk T., Sumaruk P., 2009] QBO exist also in middle latitude geomagnetic variations. Geomagnetic activity was measured by the monthly Σ(H–S_q) for geomagnetic observatory "Lviv". So far as the amplitudes of S_q change with the seasons [Sumaruk T., Sumaruk Yu., 2004; 2005] it means that seasonal variations of Σ(H–S_q) were excluded.

Fig. 3 shows mean per year Σ(H–S_q) values and their dispersion from 1954 till 2005. Central curve shows QBO of Σ(H–S_q)–ΔΣ(H–S_q). Bottom curve shows mean year Wolf number. Scale values of Σ(H–S_q) — on right, of ΔΣ(H–S_q) — on the left. Vertical lines show solar activity minima. Amplitudes of the QBO of Σ(H–S_q) change from one cycle to other and in the cycle. Periods of Σ(H–S_q) QBO change from two to four years.

At the bottom of Fig. 3 thick horizontal lines show the interval of time when east wind exist in the equatorial atmosphere [Gabis, Troshichev, 2001]. The wind is the characteristic of many meteorological processes. One may see that time of the east direction of the wind coincides to positive peaks of QBO in the geomagnetic activity indices. It means that one may use these QBO as prognosis factor.

So far as QBO in solar activity reflects in the geomagnetic activity, and the last manifests itself in secular variations (SV) the geomagnetic field, it may be waits of QBO in the SV. Au:Fig. 4 shows QBO in the SV (red) of *H*-component at magnetic observatory "Lviv" four 1953—2008. The bottom curve shows QBO in the Σ(H–S_q) (blue). It is easy to sea good negative correlation between values. Deflection from correlations is observed in 1957 and 1979, the years of maximal solar activity. Amplitudes of QBO in SV(H) increase from 20 to 23 solar cycles.

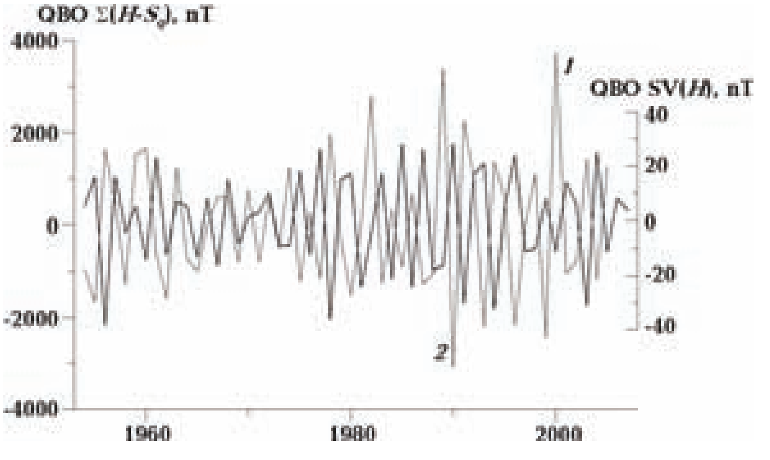

Fig. 4. QBO in the SV of *H*-component at magnetic observatory "Lviv" four 1953—2008.

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3D Spherical models of coupled mantle thermo-chemical evolution, plate tectonics, magmatism and core evolution incorporating self-consistently calculated mineralogy

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High pressure and temperature experiments and calculations of the properties of mantle minerals show that many different mineral phases exist as a function of pressure, temperature and composition (e. g., [Irifune, Ringwood, 1987]), and that these have a first-order influence on properties such as density, which has a large effect on the dynamics, and elastic moduli, which influence seismic velocity. Numerical models of thermo-chemical mantle convection have typically used a simple approximation to treat these complex variations in material properties, such as the extended Boussinesq approximation. Some numerical models have attempted to implement multiple, composition-dependent phases into thermo-chemical mantle convection (e. g., [Tackley, Xie, 2004]) and to calculate seismic anomalies from mantle convection simulations based on polynominal fitting for temperature, composition and mineral phase [Nakagawa, Tackley, 2006]. However, their linearised treatments are still approximations and may not adequately represent properties including effect of composition on phase transitions. In order to get closer to a realistic mineralogy, we calculate composition-dependent mineral assemblages and their physical properties using the code PERPLEX, which minimizes free energy for a given combination of oxides as a function of temperature and pressure [Connolly, 2005], and use this in a numerical model of thermo-chemical mantle convection in a three-dimensional spherical