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# SST-ANALYSIS OF HOURLY GEOMAGNETIC FIELD VALUES TO DETERMINE THE VARIATIONS CAUSED BY THE MAIN MAGNETIC FIELD OF THE EARTH AND SOLAR ACTIVITY CYCLE

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**Abstract.** In our idea, a large-scale magnetospheric current system persisting for many years, has a most steady state. The STEADY STATE (SSt) of variable magnetic field of the Earth conforms to the steady state of the magnetosphere. We suppose that the SSt can be determined from processing the hourly averaged values of geomagnetic field components measured at magnetic observatories. The SSt can become a reference level for geomagnetic activity and an indicator of reasonableness and availability of classical indices of geomagnetic activity that were introduced at the initial stage of the study of magnetospheric current generation mechanisms. By using the SSt, we can classify space weather states for scientific and applied problems more reliably. Hourly averaged amplitudes of the horizontal vector of geomagnetic field measured at the *aa*-index observatories for the period of 1981-2003 were studied based on the method of separation of the most frequently occurring values for every UT hour during each season of the year. This method enables to find the most steady state of the geomagnetic field ($X_0$,$Y_0$) for every UT hour during each season of the year at any observatory and to study annual ($X_0$, $Y_0$) variation and ($X_0$, $Y_0$) variation for 1981-2003. These variations are caused by seasonal and annual variation of the ionospheric conductivity, dynamics of the Earth's location in space, secular variation of the Main magnetic field of the Earth and 11-year cycle of solar activity.

We studied hourly averaged amplitudes of the horizontal vector H of geomagnetic field measured at *aa*-index observatories located in both Northern and Southern hemispheres (Hartland and Canberra) for the long period of 1981-2003. Geographic coordinates of Hartland are 50°59' N and 35°31' E, and Canberra are 35°22' S and 149° 40' E.

Sets of points $\{H(UT)_i\}$ related to every UT hour have been selected for every two-month period (January-February, March-April, May-June, July-August, September-October, November-December) for every year. The most frequent value of vector H for every hour of every period have been calculated as the gravity centre of the set $\{H(UT)_i\}$. We assume that $SSt(H(UT)_i)$ is the amplitude of vector of gravity center for every hour of the two-month period. SSt(H) for every period has been calculated as daily average of $\{SSt(H(UT)_i\}$.

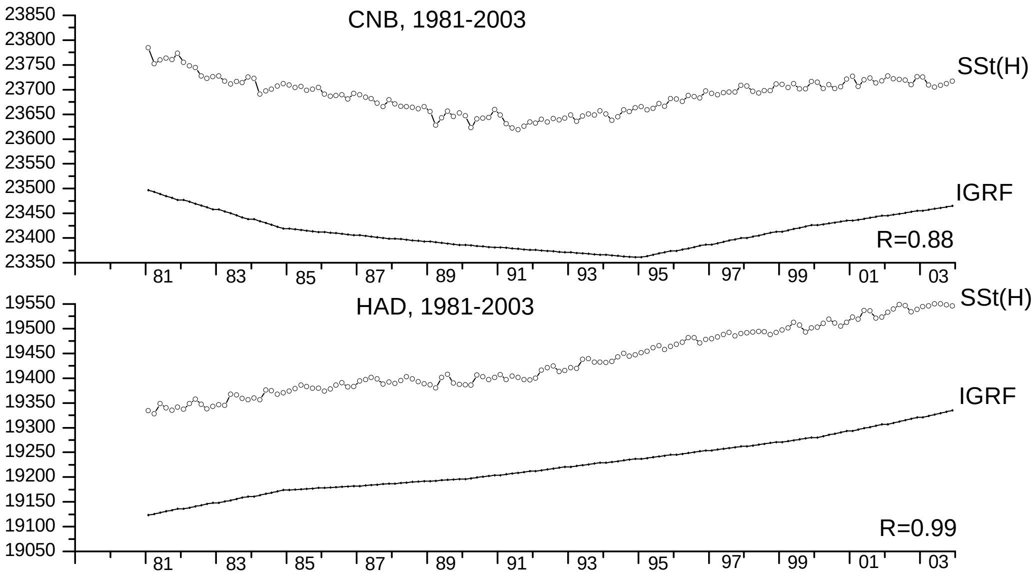


Fig1. Variatons of SSt(H) and the Main of geomagnetic field of the Earth (IGRF) for every year and coefficiant of correlation between them for Canberra(at the top) and Hartland(at the bottom).

Fig. 1 shows SSt(H) variations derived from data at Hartland and Canberra during 1981-2003 and variations of the the Main magnetic field of the Earth based on IGRF model for every observatory and every year. Coefficients of correlation between SSt(H) and the Main magnetic field of the Earth are rather high for both observatories (0.99 for Hartland and 0.88 for Canberra).

In our opinion, SSt(H) variation includes the variation of the Main magnetic field of the Earth (IGRF), seasonal and annual variations of the ionospheric conductivity within solar cycle (F10.7), variations of parameters of Interplanetary magnetic field (Solar wind velocity V and the module of Interplanetary magnetic field B). SSt(H) has been correlated consecutively with IGRF, F10.7 V, B step by step and at every step of correlation SSt(H) has been cleared from the relation with respective parameter.

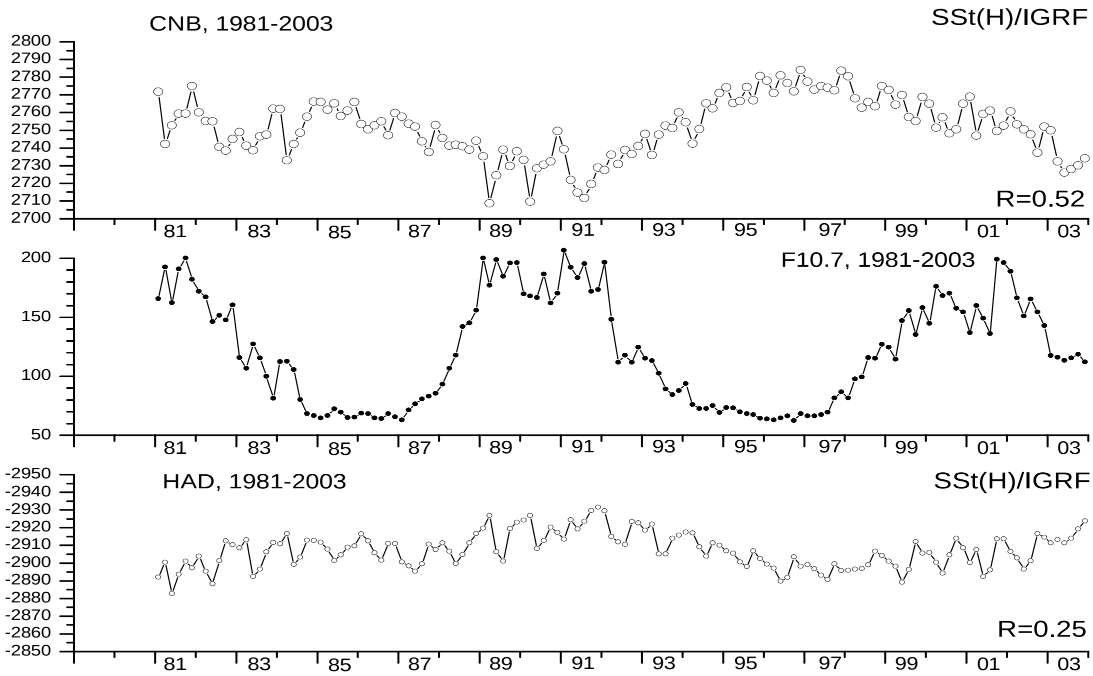


Fig.2 (From top to bottom). The variation of SSt(H)/IGRF for Canberra, the F10.7 variation, the variation of SSt(H)/IGRF for Hartland. SSt(H)/IGRF is SSt(H) from which IGRF has been extracted. R is coefficients of correlation between SSt(H)/IGRF and F10.7 for each observatory.

At the first step IGRF has been extracted from SSt(H), SSt(H)/IGRF is STEADY STATE, cleared from effect of the Main magnetic field of the Earth. Fig. 2 presents variations of SSt(H)/IGRF for Canberra and Hartland, and F10.7 variation. Variation of SSt(H)/IGRF for Canberra is more similar to F10.7 variation than SSt(H)/IGRF variation for Hartland. Coefficients of correlation between SSt(H) /IGRF and F10.7 are 0.25 for Hartland and 0.52 for Canberra. Hartland is located at higher latitude than Canberra therefore relation between SSt(H) /IGRF and F10.7 for Hartland is weaker than for Canberra.

At the next step F10.7 has been extracted from SSt(H)/IGRF. SSt(H)/IGRF/F10.7 is STEADY STATE cleared from effect of the Main magnetic field of the Earth and of ionospheric conductivity . Variation of SSt(H)/IGRF/F10.7 for Canberra and Hartland, and the variation of Solar wind velocity V are shown in Fig 3. The variations for Canberra and Hartland became similar, coefficients of correlation between SSt(H)/IGRF/F10.7 and V are not high and are equal to 0.47 for Hartland and 0.45 for Canberra.

Figure 4 illustrates the next step of the analysis. Solar wind velocity V was extracted from SSt(H)/IGRF/F10.7. Variations of SSt(H)/IGRF/F10.7/V for Canberra and Hartland became are shown in the top and bottom panels. The middle panel shows the variation module of Interplanetary magnetic field B. The correlation between SSt(H)/IGRF/F10.7/V and B is weak for both observatories (0.24 for Canberra и 0.20 for Hartland).

Figure 5 shows the results of exracting B from SSt(H)/IGRF/F10.7/V. Variation of SSt(H)/IGRF/F10.7/V/B for Canberra and Hartland are similar. We can suppose that STEADY STATE cleared from effect of

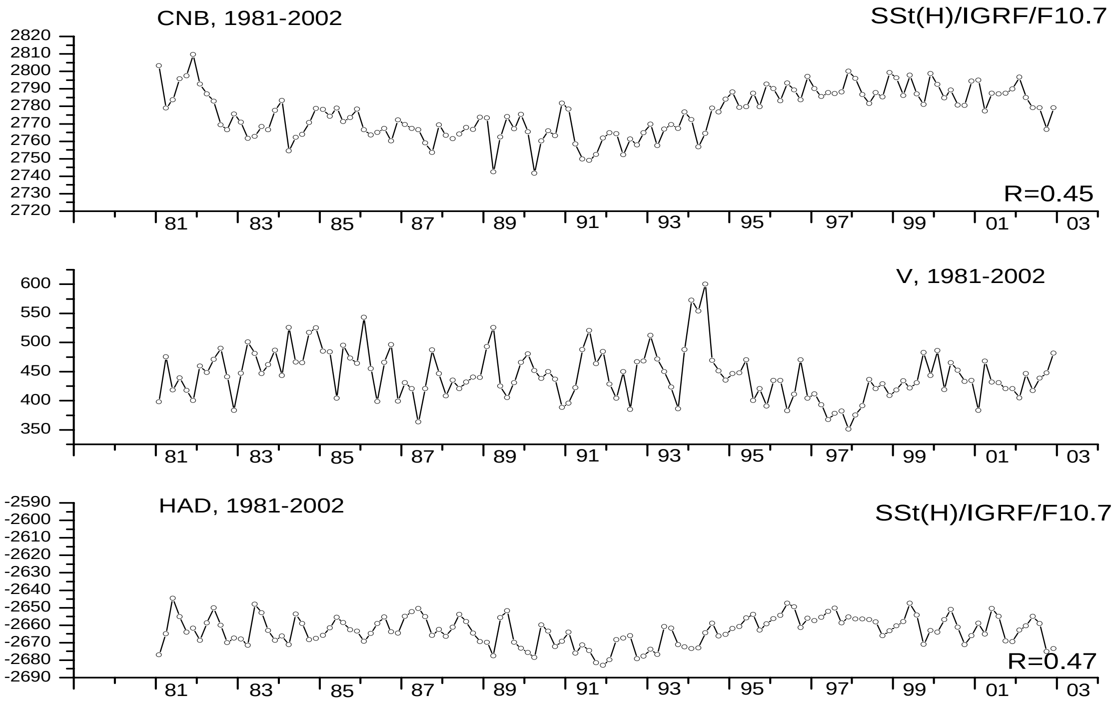


Fig 3. (From top to bottom). The variation of SSt(H) from which IGRF and F10.7 have been extracted (SSt(H)/IGRF/F10.7) for Canberra, the varaition of Solar wind velocity V, SSt(H)/IGRF/F10.7 for Hartland. R is coefficients of correlation between SSt(H)/IGRF/F10.7 and V for each observatory.

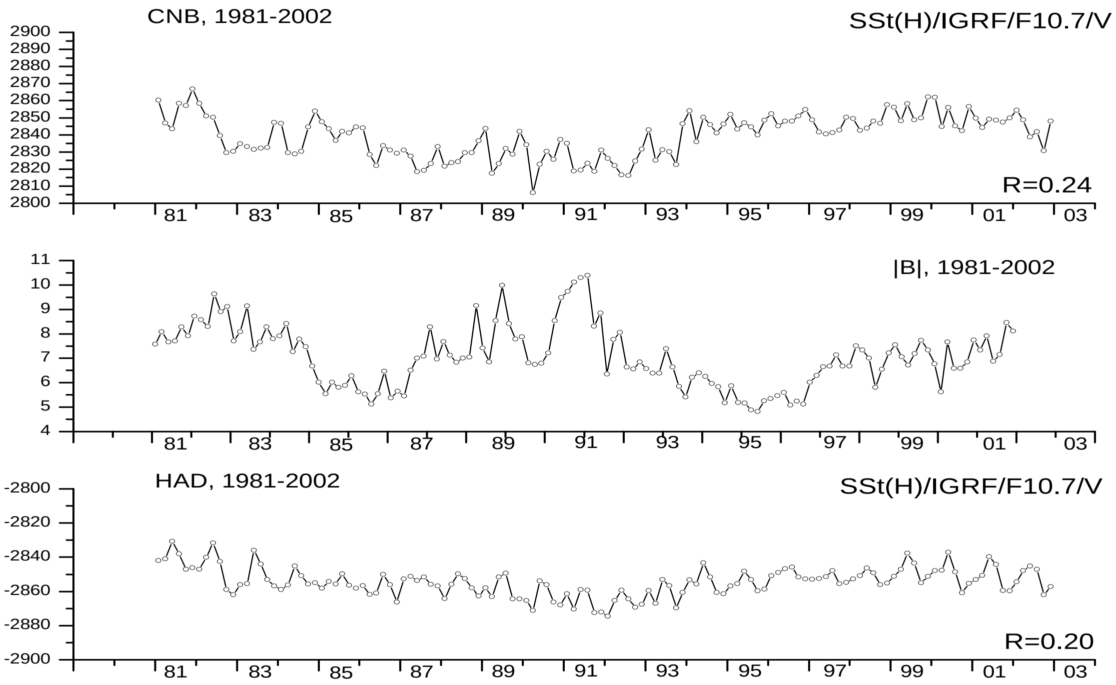


Fig.4 (From top,to bottom). The variation of SSt(H) from which IGRF, F10.7 and V have been extracted (SSt(H)/IGRF/F10./V) for Canberra, the variation of Interplanetary magnetic field module |B|, SSt(H)/IGRF/F10.7/V for Hartland.R is coefficients of corralation between SSt(H)/IGRF/F10.7/V and |B|for each observatory.

Main magnetic field of the Earth and of the large-scale magnetospheric-ionospheric current systems describes some local internal magnetospheric processes.

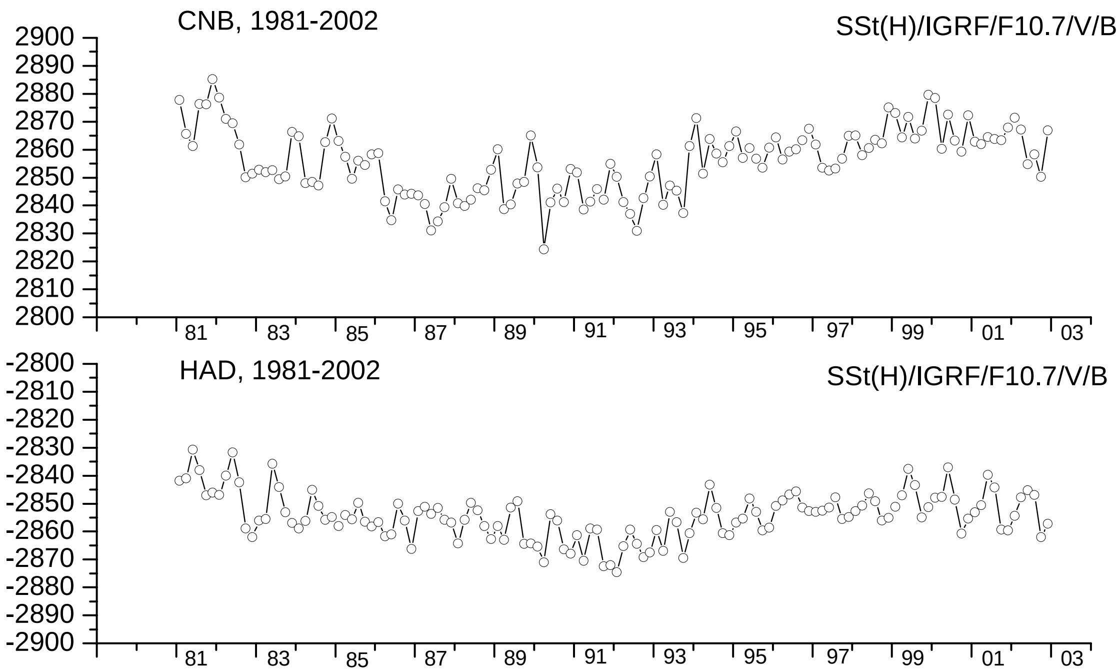


Fig.5 The variation of SSt(H) from which IGRF, F10.7,V,and |B| have been extracted(SSt(H)/IGRF/F10.7/V/|B|) for Canberra (at the top) and for Hartland (at the bottom).

We have described the method which can be determination of the STEADY STATE as processing of the hourly averaged values of geomagnetic field components measured at magnetic observatories. The SSt can become a reference level for geomagnetic activity and an indicator of reasonableness and availability of classical indices of geomagnetic activity. Based on STEADY STATE we would be able to describe classification of space weather states more properly and to use it for solving scientific and applied problems.

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