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REAL-TIME ASSESSMENT OF GEOMAGNETIC ACTIVITY BASED ON SATELLITE MAGNETIC FIELD MEASUREMENTS

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Abstract. Because of the negative effect of environment, a satellite's orbit may be changed, or even its crash can take place. The environment effect monitoring is based on dynamic models of the upper atmospheric density parameterized by the solar and geomagnetic activity. Satellite measurements of the magnetic field and modern magnetospheric magnetic field models may be used for real-time monitoring of geomagnetic field state. We present some examples of real-time monitoring of the geomagnetic activity states basing on comparison of the magnetic field measurements of CHAMP low-orbiting satellite with Paraboloid model of the magnetospheric magnetic field.

Introduction

In our idea, satellite data of the magnetic field module and its components measured along each pass(or any of its segments) should be compared with magnetic field calculated by using some model of the magnetospheric magnetic field for some external conditions. These conditions are to be arranged into groups according to geomagnetic activity states. Geomagnetic activity states (quiet, disturbed, strongly disturbed conditions) are determined by the model input parameterized by Interplanetary Magnetic Field/Solar Wind (IMF/SW) or indices of geomagnetic activity. Model magnetic field calculated for all points of the satellite pass for each geomagnetic activity state is compared with real-time satellite measurements. On-board computer chooses the geomagnetic activity state that gives the best agreement of the observed data with a model. We used the magnetic field measurements of CHAMP satellite and Paraboloid model of the magnetospheric magnetic field (PM) for real-time monitoring of the geomagnetic activity level.

CHAMP measurements and PM modelling

To use CHAMP measurements for real-time describing the geomagnetic activity level data for each CHAMP pass the Main magnetic field of the Earth has been modeled by IGRF2005 coerced to measurement date taking into account the model of the secular variation. These values have been subtracted from Champ vector measurements of the magnetic field. To create a model of the magnetic field of magnetosphere current systems CHAMP data have been smoothed by running average with step equal 81 [*Filippov et al.*, 2006]. Abrupt change of high-latitude magnetic field may occur under different level of geomagnetic activity and any model is not able to describe real field measured by satellites rather plausible, therefore only middle-latitudinal segments of CHAMP passes have been chosen for modeling.

Table 1. Interplanetary Magnetic Field/Solar Wind parameters and geomagnetic activity indices for different states of geomagnetic activity.

	Quiet state (Q)	Disturbed state (D)	Strongly disturbed State (SD)
Bz, nT	3.0	- 5.0	-8.0
By, nT	2.0	4.0	6.0
N, cek^{-1}	5	10	15
V, km/cek	400	600	700
Dst, nT	-10	-50	-100
AL	-70	-300	-500

The magnetospheric magnetic field modeled by PM has been parameterized by IMF components (Bz and By), SW (velocity V and density N), Dst and AL indices of geomagnetic activity [*Feldstein et al.*, 2005]. Depending on geomagnetic activity level and IMF/SW conditions the input parameters were arranged into groups according to quiet, disturbed and strongly disturbed states of geomagnetic activity. Table 1 shows states of geomagnetic activity chosen for our study and Interplanetary Magnetic Field/Solar Wind parameters and geomagnetic activity indices for them.

Real-time monitoring of the geomagnetic activity levels

For real-time monitoring of the geomagnetic activity levels PM model magnetic field are calculated for each point of two CHAMP passes and for each states presented at Table 1. For each interval of Champ passes real state of geomagnetic activity is determined as the minimum discrepancy between module (or one of components of the magnetic field) of measured magnetic field and module (or one of components of the magnetic field) of the magnetic field modeled for quiet, disturbed or strongly disturbed state.

Table 2 presents results real-time describing geomagnetic activity basing on comparison the magnetic field module measured by CHAMP and model magnetic field module. It contents date and UT of Champ passes, time-averaged discrepancies between measured data and model module of the magnetic field for each activity state. Minimum discrepancies are selected by BOLD, they show geomagnetic activity state during the CHAMP passes. The last column shows Kp-index value during the CHAMP passes.

Figure 1 shows module of the magnetic field measured by CHAMP and module of model magnetic field for events under different states of geomagnetic activity: quiet state, disturbed state and strong disturbed state. Events have been chosen according to Table 2.

Table 2. Real-time describing geomagnetic activity during Champ passes.

DATE	UT	DISCREPANCY			*Kp*
		Quiet (*Q*)	Disturbed (*D*)	Strong Disturbed (*SD*)	
10.11.04	00-03	167.26	160.05	**145.86**	8-
04.12.04	00-03	**9.87**	18.41	26.37	0
12.12.04	00-03	29.30	**24.07**	28.36	5-
18.12.04	00-03	21.70	**20.94**	29.01	4+
23.12.04	00-03	**18.03**	25.14	33.18	2+
02.01.05	00-03	44.32	**35.65**	36.99	4+
08.01.05	00-03	88.48	76.30	**65.25**	7
10.01.05	00-03	**14.17**	25.65	33.87	1-
18.01.05	00-03	64.03	54.07	**47.06**	7
26.01.05	00-03	**14.54**	28.14	39.78	1-
05.02.05	00-03	**9.98**	25.90	39.22	0+
14.02.05	00-02	**11.75**	28.92	44.95	1-
16.02.05	00-02	**9.82**	11.53	24.2	2+

Figure 2 shows variation of components (X, Y, Z, module) of the magnetic field measured by CHAMP and the same components and module of model magnetic field during two CHAMP passes on February 16, 2005(Q-state).

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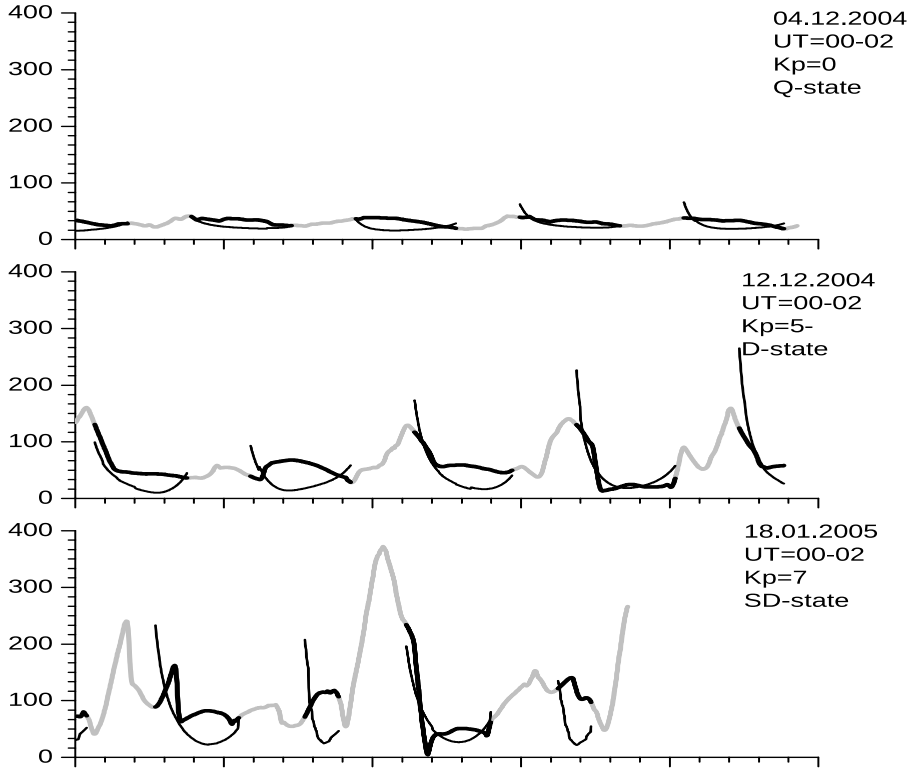

Figure 1. Module of the magnetic field measured by Champ (thick light grey + black line) and module of the model magnetic field (thin line) for intervals with different geomagnetic activity states (from top to bottom): quiet state, disturbed state and strong disturbed state. Thick black lines mark middle-latitudinal segments of CHAMP passes chosen for modeling and comparison.

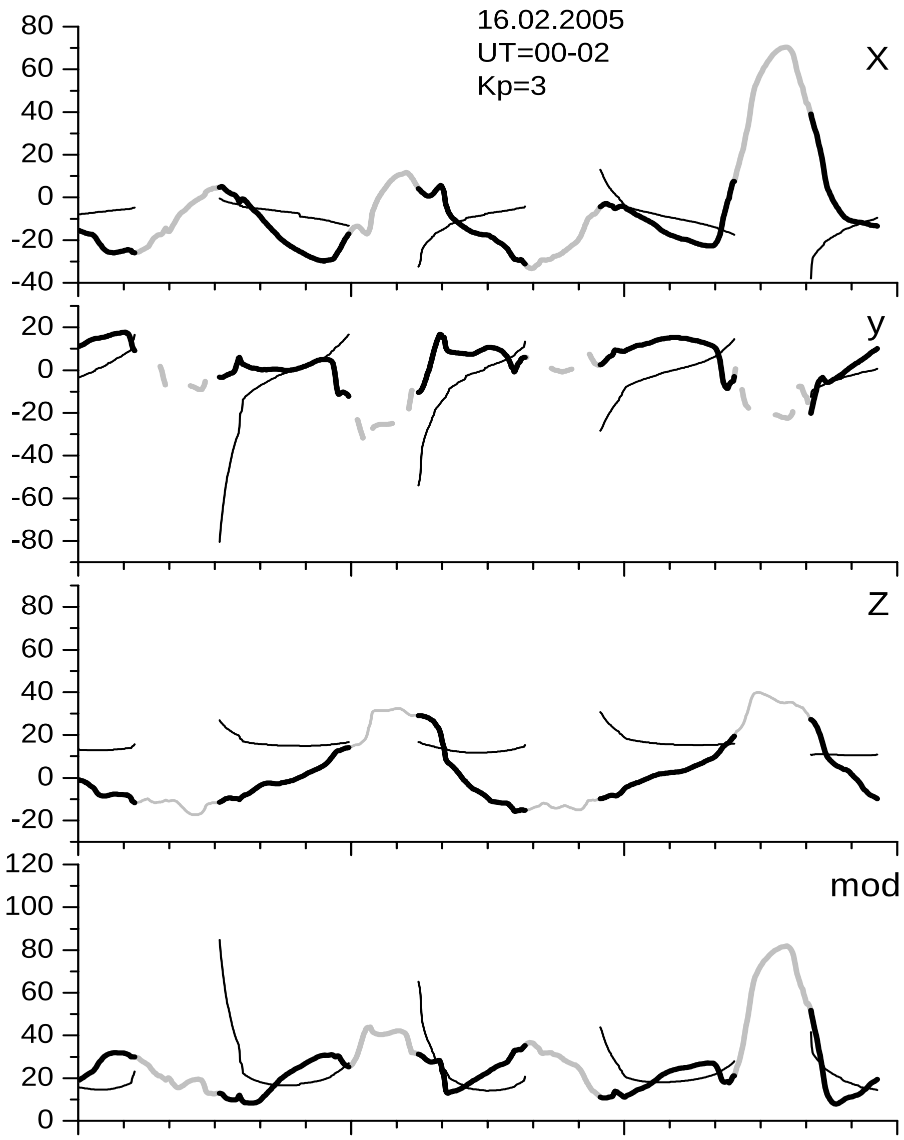

Figure 2. Components and module of the magnetic field measured by Champ (thick light grey + black line) and components and module of the model magnetic field (thin line), from top to bottom: X, Y, Z components and module of magnetic field during two Champ passes on February 6, 2005. Thick black lines mark middle latitudinal segment of Champ passes chosen for modeling.