KASI ACTIVITIES OF SPACE WEATHER

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ABSTRACT

It is well known that solar and space weather activities can affect modern technology and human life. Since 2007, the Korea Astronomy and Space Science Institute has initiated a research project for the construction of Korean Space Weather Prediction Center (KSWPC) to make preparations for the maximum (~2013) of next solar cycle. In this paper, we are going to report on the current progress of space weather activities in KASI; extension of ground observation system, construction of space weather database and network, development of prediction models, and space weather researches. In addition, future plans for KSWPC will be discussed.

1. INTRODUCTION

The sun is not as quiet as we see but produces abrupt events named solar flares and coronal mass ejections (CMEs) etc,. Solar flares release intense radiations in X-rays and radio waves. CMEs are billions of tons of plasma gas moving into the interplanetary space. Usually, the earth's magnetosphere deflects most of the solar wind and high-energy particles from the Sun. Sometimes, these solar activities change the earth's upper atmospheric physical properties and the origin of aurora and geomagnetic storm.. This space environmental change between the sun and the earth, is so-called “space weather” or “space environment”. As civilization spreads into space, we rely on space-borne (e.g. satellites) technologies that are vulnerable to space weather. The effects of the space weather on modern technological system are of growing interest in all around the world. To protect Korean space assets and support space technology development, we have taken a space weather project named “construction of space weather center in Korean” since 2007.

Our interesting topics in the project are

● Monitoring solar activity
● Geomagnetic disturbance prediction
● Monitoring HF communication and GPS errors
● Modeling magnetospheric plasmas
● Degradation of spacecraft altitude in low earth orbit
●Interference and degradation of spacecraft electric components due to geomagnetic storms
● Human body effects by space radiation

2. RECENT ACTIVITIES

We have made sunspot observations since 1987 using the 20cm refraction Sunspot Telescope. In 1995 the SOlar Flare Telescope (SOFT) was installed at Bohyun Mountain to observe solar activity through white light, Hα, and vector magnetograph. We have also made spectroscopic observations using Coelostat-type Solar Spectroscopy Telescope since 2002. Recognizing on these achievements, in the year 2001 the SOlar and Space Weather Research Group was chosen as Solar Activity Research Laboratory (one of the National Research Lab.) by the Ministry of Science and

Technology (MOST). Since then, we have developed Solar Full Disk Monitoring System which consists of Hα full-disk and coronagraphic polarimeter. In the year 2004, the Solar and Space environment research group(SOS) initiated a new project, which comprises of the development of Korean Solar Radio Burst Locator (K-SRBL) and participation in the construction of 1.6 m New Solar Telescope (NST).

Since 2007, SOS has conducted a new project to establish a Korean Space Weather Prediction Center (KSWPC) for domestic satellites and communication systems. Scope of the project includes extension of ground observation system, construction of space weather database and networking, development of prediction models, and space weather studies.

Followings are summary of current activities of the KSWPC.

3-1. Instruments

As a part of the project, the SOS has installed a magnetometer on Bohyun Mountain for the space weather study and joined a global network of frequency-agile radio spectrometers which was constructed in collaboration with ETHZ, Switzerland. For study of ionosphere/upper atmosphere under the project, the SOS has installed an All-Sky Imager on Bohyun Mountain , a Scintillation Monitor in KASI main building and constructing a VHF Coherent Scatter Radar in the Korean Air Force region.

Figure 1 shows the instruments that installed by the SOS.

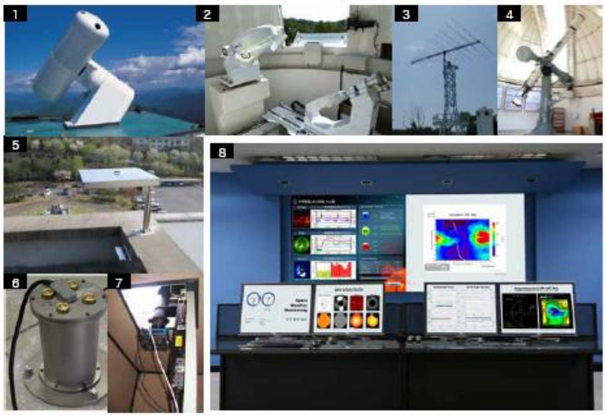

Fig. 1 Observation systems in KASI. (1) Solar Flare Telescope, (2) Solar Imaging Spectrograph, (3)E-Callisto, (4) Sunspot Telescope, (5) Scintimon, (6) Magnetomenter, (7) All Sky Camera, (8) Space weather monitoring Lab.

3-2. Researches

Our research in solar-terrestrial physics focuses on evaluating and understanding the solar activity and associated space weather effects. These include studies of CME and type II radio burst shock kinematics (Cho et al., 2008), helicity measurements and conservation, magnetic field strength in the solar corona, eruption from a sigmoidal solar active regions, magnetic reconnection of flare-associated CMEs (Bong et al., 2006), small-scale X-ray/EUV jets (Kim et al., 2005), vector magnetic fields in the photosphere, and Hα spectral properties of quiescent filaments.

The solar activity produces magnetic fields eruptions and other phenomena and expels them with solar wind. Some of the solar wind energy finds its way into the Earth's magnetosphere, ionosphere and atmosphere, and drives many phenomena including geomagnetic activity. Because of these effects, the investigations of changes in the solar wind plasma parameters (density, velocity, etc.) and interplanetary magnetic field (IMF) are very important for magnetospheric and ionospheric physics. These connections are more important when the CME reaches in the vicinity of the Earth because its intense magnetic field and mass can excite a geomagnetic storm making disruptions to radio communications and electric power systems.

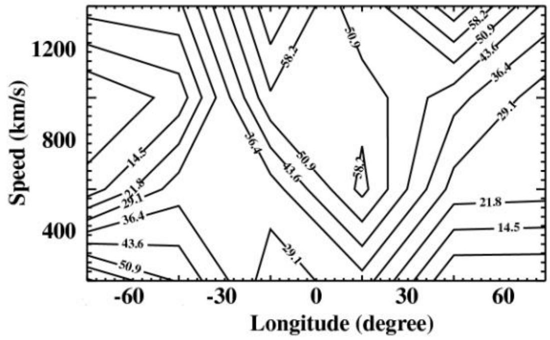

Fig. 2. Probability of CME geoeffectiveness depending on the combination of CME location and speed for moderate geomagnetic storm (Dst ≤ -50 nT).

In respect to the space weather forecast, the CME is one of the most important events that could trigger geomagnetic storm. Space weather forecast with initially observed CME parameters at the Sun would be very meaningful in that they allow us to make an earlier warning 2~3 days in advance. For this reasons, we examined the geoeffectiveness of the CME properties as shown in Figure 2, and developed an empirical geomagnetic storm prediction model based on solar information (Kim et al., 2008).

Energy transmission from the solar wind increase the energetic charged particles that are trapped within the Earth's magnetosphere. Within the magnetosphere, these particles are energized, transported, and eventually lost in the Earth's upper atmosphere or interplanetary space. Our research in magnetosphere physics focuses on evaluating and understanding the processes responsible for this energize, transport, and loss, combining observations, theory, and modeling. These include studies on the acceleration and loss mechanisms of relativistic electrons, relationship between substorm and whistler chorus wave (Hwang et al., 2007), magnetotail responses to sudden solar wind variations, relationship between magnetotail flow bursts and ground ULF waves, and relativistic electrons associated with corotating interaction regions. In addition, we consider the variety of other disturbances in the solar wind which couple to the magnetosphere and ionosphere.

As the nearest space environment to us, the Earth's upper atmosphere including the thermosphere and the ionosphere is strongly coupled and forced system: The coupling between neutral and plasma species brings dynamic complexities of the system; the state of the upper atmosphere depends strongly on the solar activity. The broad focus of our upper atmosphere include the ionosphere section is directed toward evaluating and understanding the electrodynamics, dynamics, and densities of these layers and their response to the solar and magnetospheric energy and momentum inputs (Kwak et al., 2007), through the observations, analyses, and numerical simulations. Especially, to studies for an improved physical understanding the mid-latitude upper atmosphere and ionosphere, we need to construct new infra such as Coherent Scatter Radar (CSR), All-Sky Imager (ASI), and Scintillation Monitor (SCINTMON) and will be install in a near future in Korea.

3. SUMMARY

The SOS is actively involved in the front line research in the field of solar physics and space weather. We initiated a new project in the year 2007 to establish a Korean Space Weather Prediction Center (K-SWPC) for domestic satellites and communication systems. As activities of the KSWPC, we are constructing K-SRBL and VHF Coherent Scatter Radar as well as managing the SOFT, the Solar Spectroscopy Telescope, the Sunspot Telescope, the E-CALLISTO, Magnetometer, the SCINTMON, and the All-Sky Imager. Through these projects, we will develop observational systems that can monitor solar activities and space weather, and concentrate on the research of space weather and its effects on the modern space technologies. On the other hand we are looking for international partner who could exchange space weather information and/or scientific collaboration to better understand solar-terrestrial interaction.

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