

# OPERATIONAL SPACE WEATHER ACTIVITY IN CRL

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## ABSTRACT/RESUME

Communications Research Laboratory (CRL) has activities of space weather forecasting operation as well as space weather research. For operational forecasting, observation, modelling, database, and information service are important issues. For solar observation, we operate an optical telescope and a radio spectrograph. For magnetosphere and ionosphere, HF radar and ionosonde are principal facilities. Satellite data reception facility is dedicated for real time reception of telemetry data from ACE and IMAGE spacecraft. Recently, near real-time data exchange via Internet has an essential importance for operational forecast. Information service system for space weather nowcasting and forecasting for end-user consists of automatic recording phone system, e-mail, FAX, and WWW system. Contents include near real-time alert, event report, and space environment overview including prospects on solar and geomagnetic activity. In this presentation, observation and information service by CRL are briefly reported. CRL proposes space weather mission at 5th Lagrangian point (L5 mission) for space weather research. We report the overview of the plan and current status of preliminary studies on L5 mission.

## 1. GENERAL SPECIFICATIONS

Communications Research Laboratory (CRL) has started Space Weather program in 1989, which is research and development toward construction of operational forecast of space weather to support space development. The program contains ground-based solar observation and geomagnetic storm prediction based on real-time data of ACE spacecraft. At present, the space weather information service with various contents is operated routinely. The service contains space weather overview and alerts daily updated, event reports and user friendly display of space weather data. The informations are distributed widely to support space system operations, radio communications, GPS applications, and so on.

This article reports overview of current status of operational space weather activity in CRL.

## 2. OBSERVATION AND DATA COLLECTION

### 2.1 Observation by CRL

CRL operates following observation crucial for operational space weather forecast.

<**Solar H Alpha**> Hiraiso/CRL operates High Definition H alpha Solar Telescope for patrol of flares, filament eruptions, and evolution of active region with center, blue wing and red wing of H alpha line. Full-disk images in every three minutes and higher cadence close-up image are taken every fine day.



Fig.1. H alpha and radio telescope at Hiraiso Solar Observatory/CRL

<**Solar radio observation**> Radio spectrograph from 25MHz to 2.5GHz is operated for monitoring radio burst. Type II and IV bursts are good proxies for interplanetary shock waves caused by CMEs. 2.8GHz fixed frequency data are used for overall solar activity monitoring and spacecraft orbit prediction.

<**Geomagnetic field data network**> CRL operates several magnetometers and real time data link via Internet or satellite communications. Hiraiso/CRL is one of Japanese GIN of INTERMAGNET program providing data link with several Asian geomagnetic stations.

**<Ionosphere Observation>** The ionosphere is monitored every 15 minutes by ionosondes based at Wakkanai, Kokubunji, Yamagawa, Okinawa, and Syowa station in Antarctica. The ionosonde data are used for short wave propagation forecast including Sporadic E layer.

**<Real-time reception facility for ACE and Image spacecraft>** Both IMAGE and ACE satellites have capabilities to send their observed data in real-time. CRL has been a part of the ground station network for ACE real-time solar wind monitor since 1998. Since 2000, CRL is also receiving global aurora images taken by IMAGE in real-time. Products based on these real-time data are available via WWW service.

These observations and real-time data links are operated for operational forecast as well as research of space weather mechanism.

## 2.2. Data access via Internet

CRL has constructed and operated database systems for collection and browsing real-time data to support operational forecasters task since 1989. The data collected via Internet and observations by CRL are used for daily forecasting operation. So far, ISES code (URSIGRAM) has been used for exchange data and information including daily GEOALERT. At present, forecasters can easily access of various kind of ground-based and spacecraft data in near real-time due to rapid progress of information technology in the last decade. Some spacecraft for science missions provide real-time data transmission for space weather applications. For example, ACE spacecraft real-time data is crucial for geomagnetic storm prediction and SOHO's daily movie is widely used as CME monitoring data.

## 3. OVERVIEW OF DAILY FORECAST OPERATION

### 3.1 Work flow of operational forecast in CRL

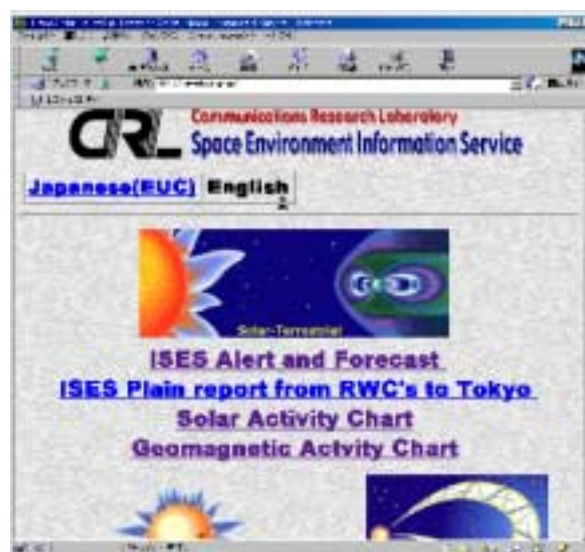
CRL has two sites for daily operational forecast. Hiraiso Solar Observatory is a facility for daily solar observation and research of solar physics and solar wind physics. Hiraiso is in charge of monitoring flare, CME, and solar activity and alert of solar flare and solar energetic particle event based on local observation and data via Internet. Koganei site in CRL's headquarters is for magnetosphere and ionosphere forecast.

In CRL, GEOALERT for ISES network and daily space environment information are updated by 06:00UT every day. By the update deadline, duty forecasters analyze data and finally decide daily

forecast after discussion at forecasters meeting with TV conference facility between Hiraiso and Koganei.



Fig.2. Forecast center at Hiraiso Solar Observatory/CRL



## 3.2 Information Outreach

Daily information and alert on space weather are distributed with (1) WWW for Space Environment Information Service, (2) an automatic telephone service system, and (3) mailing list for registered users. CRL's information service covers solar activities, geomagnetic activity, ionosphere disturbances, and particle environment. For daily information outreach, we prepare standard sample set of sentences with multiple options for various kinds of activity level and indices. Duty forecasters can issue daily report by selecting options and filling indices. The daily information service contains event report of Solar flares, CME, geomagnetic disturbances, Es occurrence and so on. In addition, free style information is issued in case of outstanding space weather events such as major flares, geomagnetic storms, and proton events. Every Friday, brief overview of the space weather activity and event summary are issued as a weekly Fig.3. Entrance page of Space Environment Information Service (<http://hirweb.crl.go.jp>)

report. A main entrance of the information is <http://hirweb.crl.go.jp>. Some contents are provided only in Japanese.

#### **4. A STUDY FOR L5 MISSION -Future program for Space weather operations and researches-**

We proposed and study L5 mission program for space weather observation and experiment. Construction of space weather observation network with international collaboration is necessary for future progress of space development. L5 mission program aims for contribution as an important element of the network.

Main targets of L5 mission are

- Observation of CME propagation between sun-earth space and understanding of various phenomena during their propagation such as particle acceleration in interplanetary shock wave.
- Multi-perspective observation by collaborative observation with other spacecraft.
- Getting a new in-situ measurement point for solar wind structure observation in multiple point.

Table \*\*\* is a candidate list of onboard instrument. In CRL, BBM model of wide field coronal imager with nearly 10000 dynamic range (S/N ratio) is under development. We are proposing a launch in next solar maximum to the government.

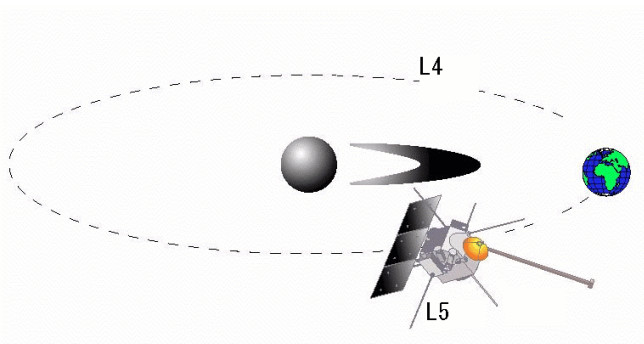


Fig.4. Cartoon image of L5 mission