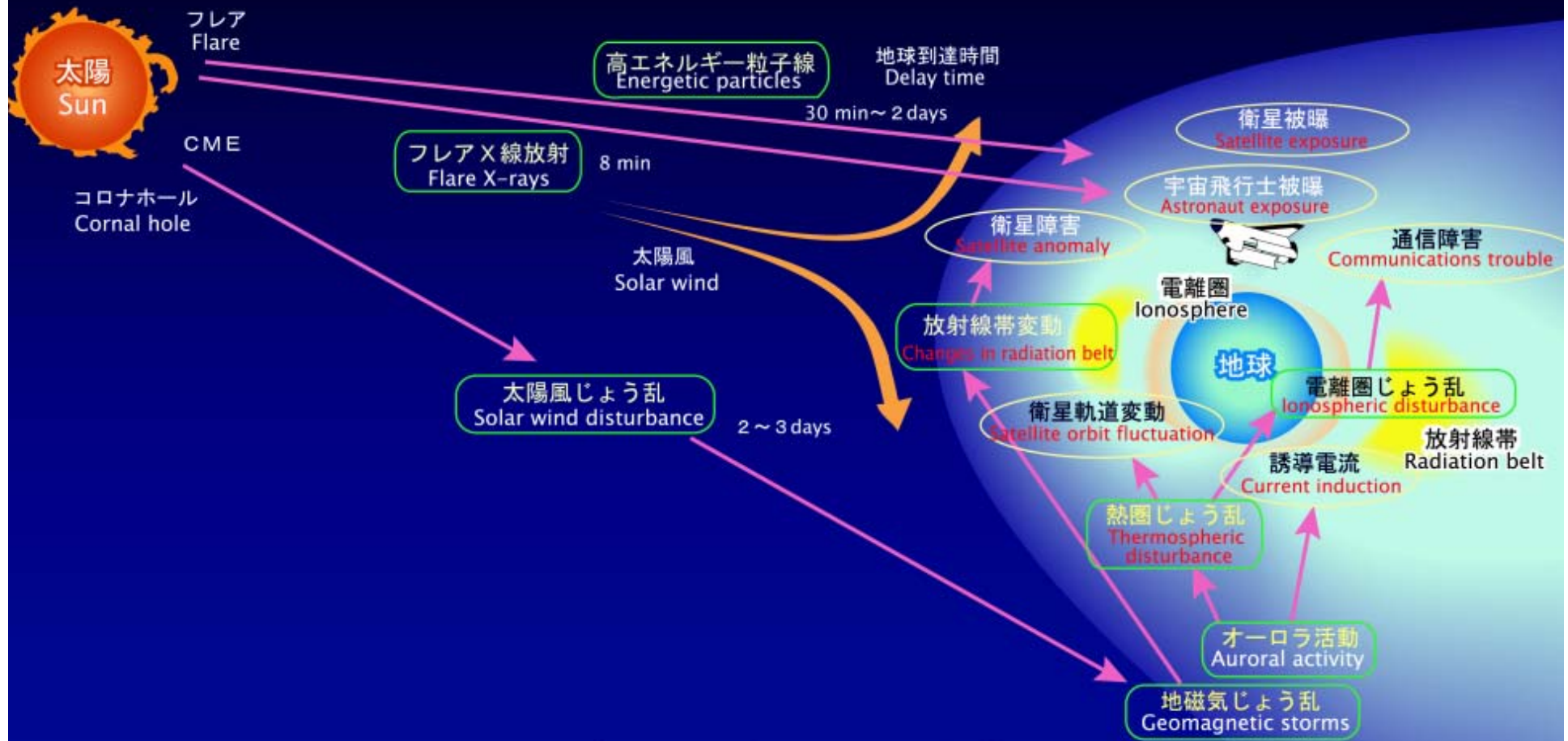


INTRODUCTION OF RECENT JAPANESE SWX ACTIVITY, PSTEP PROJECT

Mamoru Ishii

National Institute of Information and
Communications Technology,
Japan

What is "Space Weather"?



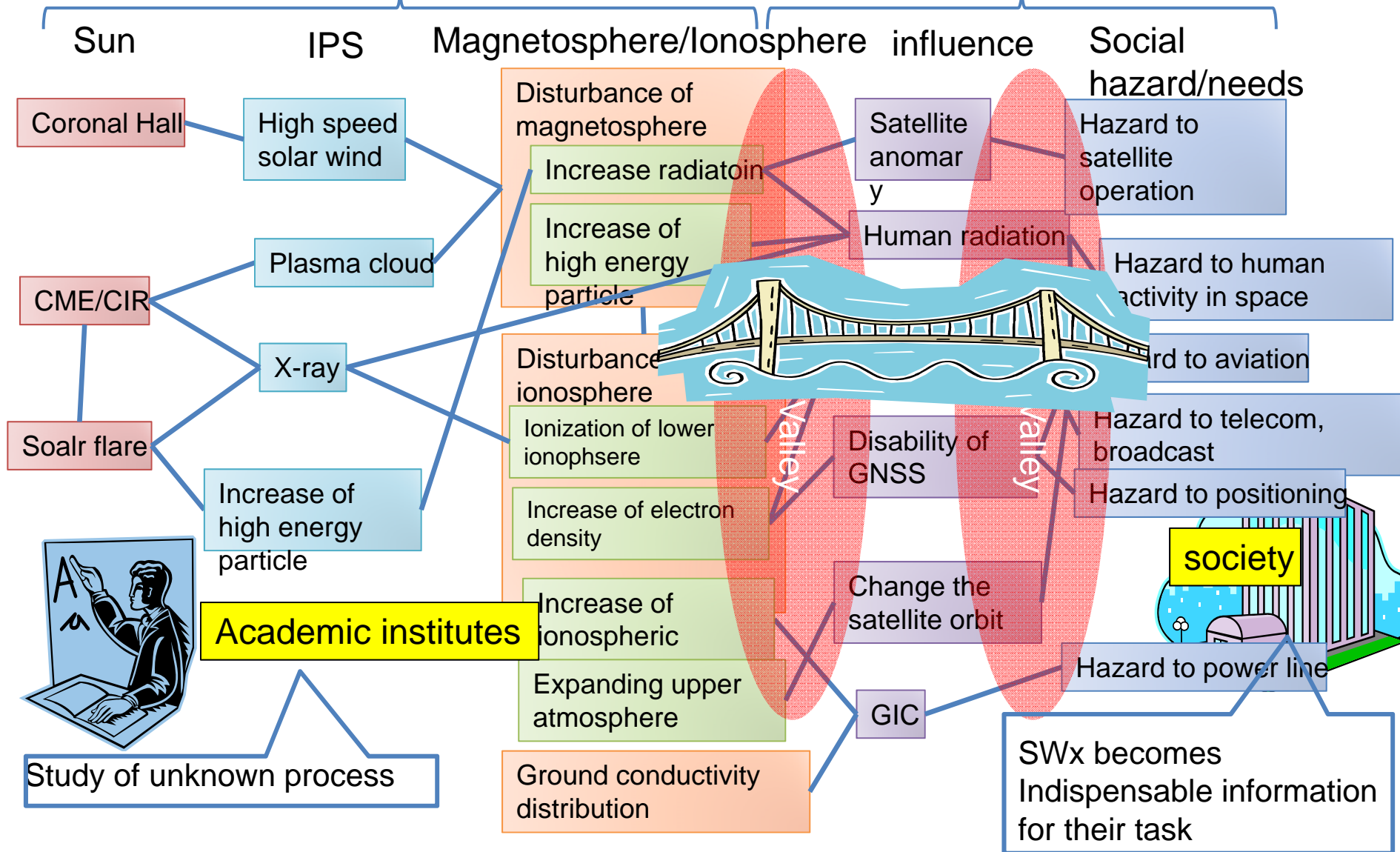
Space weather: cause and effect
宇宙環境擾乱の発生と障害

磁気圏
Magnetosphere

Relation of Needs-Seeds in SWx

Solar Terr. Phys.

SWx the social needs

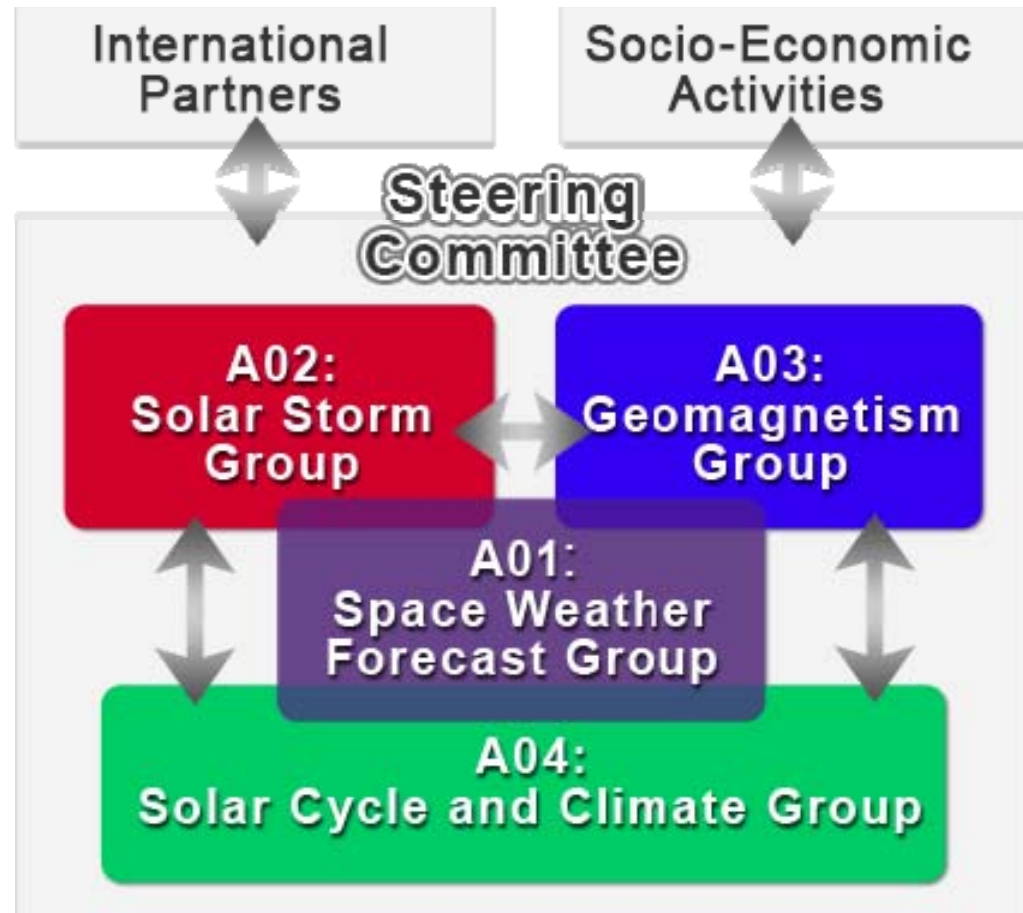


Status and problem

- Present Status
 - Lack of scientific understandings for SWx
 - Occurrence of flare mechanism, variation of radiation belt etc
 - Present SWx forecast is mainly based on statistic method
 - Scale of solar flare (A/B/C/M/X) => scale of geomagnetic disturbance (1/2/3/4)
- Issues to be solved
 - Difficulty to predict significant event we have never experienced
 - Difficulty to connect between SWx various phenomena and social effects

Structure of the project

- There are four working groups in PSTEP
- A01: space weather forecast group
- A02: Solar storm group
- A03: Geomagnetism group
- A04: Solar cycle and climate group



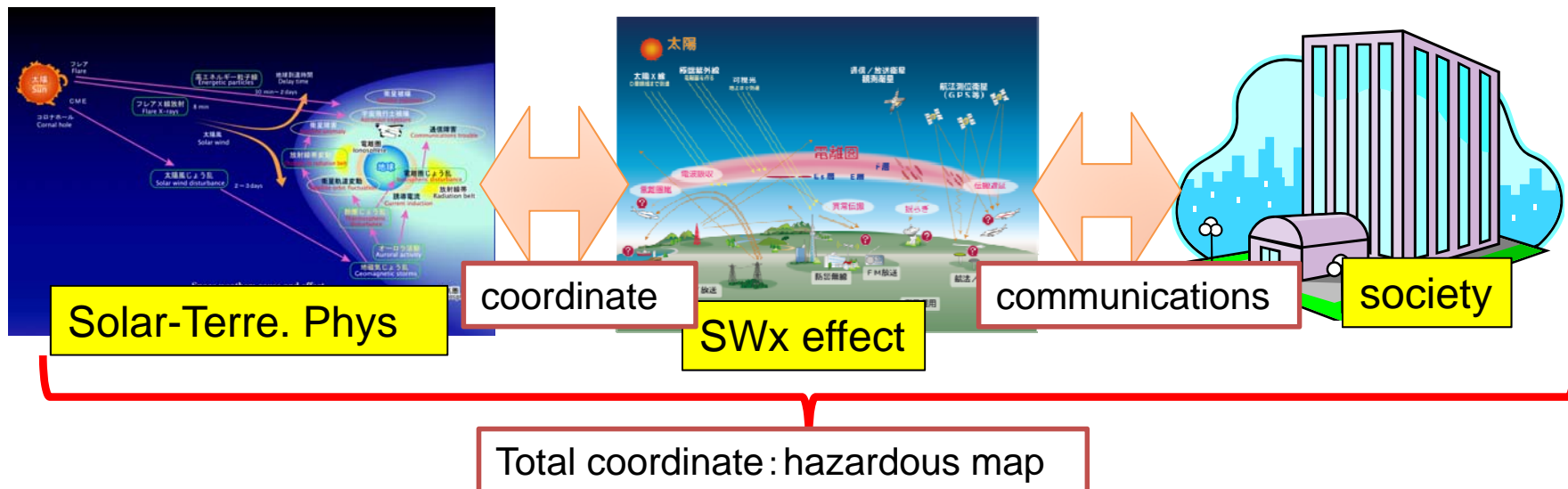
PSTEP-A01 : next generation space weather forecast

Issues to be solved

- The effect of SWx to high concentrated ICT society is unknown
- It is necessary to establish an integrated space weather system in the society against significant space weather event in the next solar cycle.
- Most of potential users do not know the importance of SWx.: necessary to communicate to them

actions

- Build a system to provide a useful information for users
- Identified simulation model among sun/solar wind/magnetosphere/ionosphere
- Establish Japanese original hazardous map to make sure the next solar cycle



Sub Group in A01

Radio propagatio SG

Satellite Anomary SG

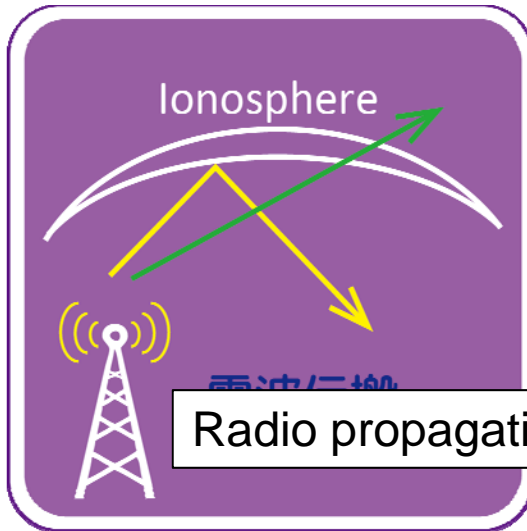
Human radiation SG

GIC SG

Model Integrated SG

Hazardous map SG

Product to be created



Radio propagation simulator



人体被曝量
推定システム

Human radiation
estimation system



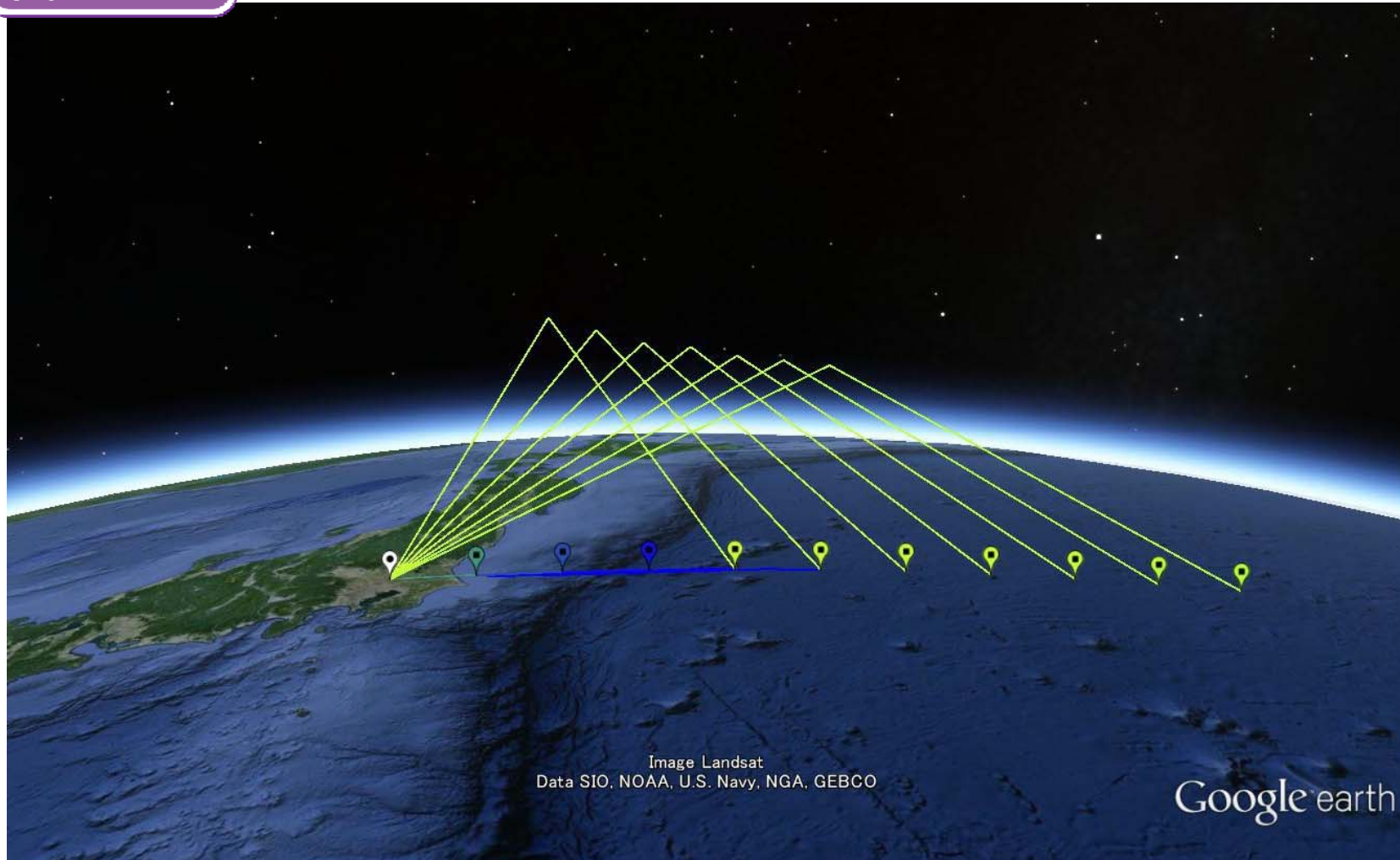
GIC hazardous warning
system

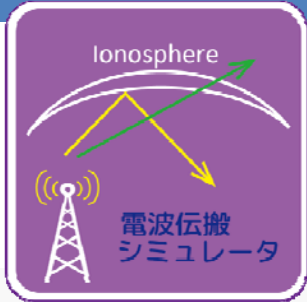


"Taylor-made Space weather" satellite
Warning system

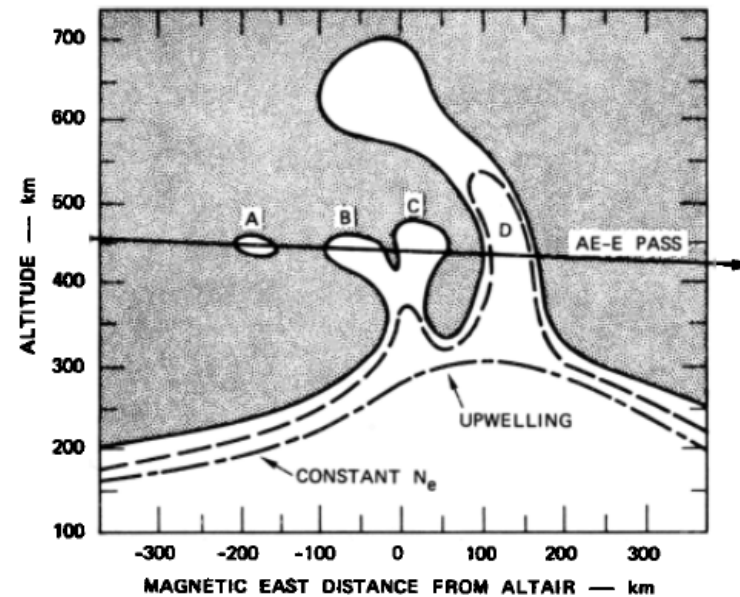
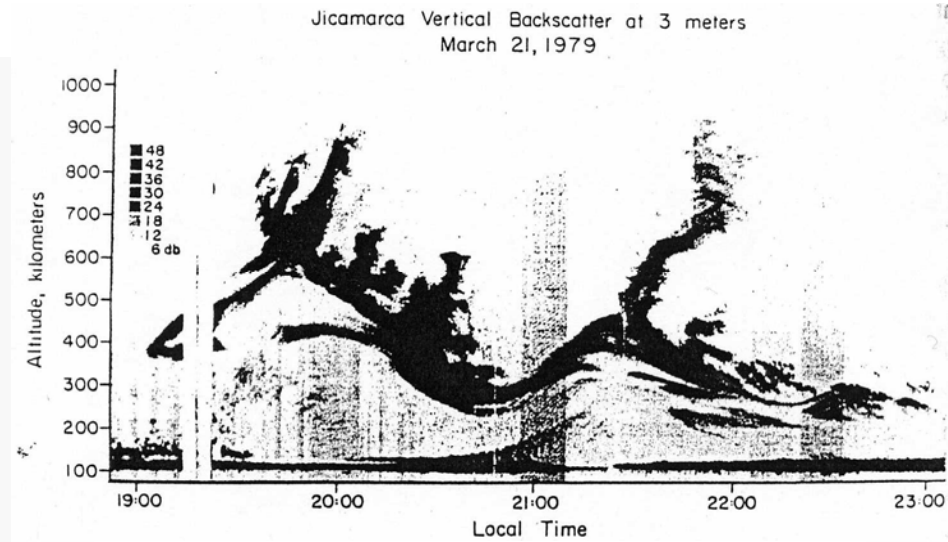
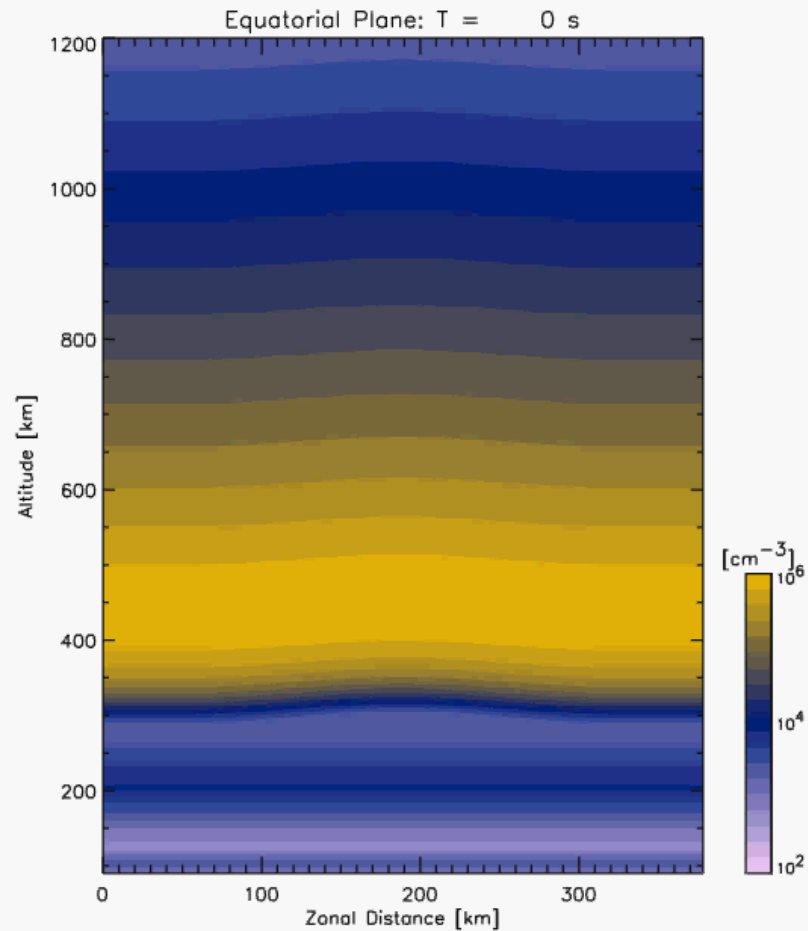


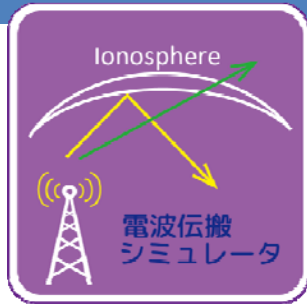
Sample of radio propagation simulator





EPB (Equatorial Plasma Bubble)





Purpose of establishing the radio propagation simulator

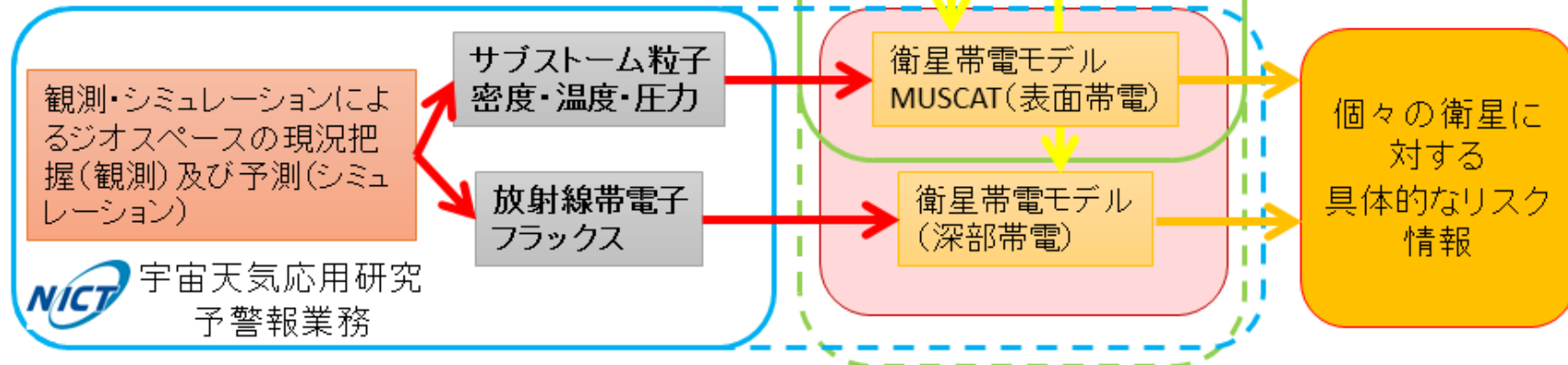
- Initial purpose
 - Is to estimate the disabled area of HF, VHF and satellite positioning. We discuss the interface of the product with users of GNSS
- Final goal
 - Is to build the forecast system of radio propagation disturbance with ionospheric perturbation using the results of A02~04 groups



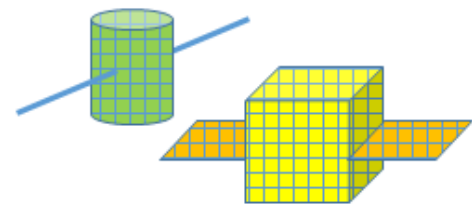
“Taylor-made space weather” for satellite anomaly

割合は低減しつつあるが、帯電・放電は依然として主要な衛星障害の原因。

Constructing a system for alerting satellite anomaly considering with the spec of each satellite



JAXA 衛星搭載機器開発
衛星設計への反映



個々の衛星形状モデル

衛星帯電モデル MUSCAT(表面帯電)

衛星帯電モデル(深部帯電)

個々の衛星に対する
具体的なリスク
情報



Purpose of Estimation system of human exposure

- Initial purpose
 - Is to establish the system for providing the present radiation level in the airplane when the large proton event is occurred to happen to the GLE events.
- Final goal
 - Is to develop the system to provide the forecast of temporal variation of human radiation in the airplane with several hours from the event occurred.
 - And to develop the system to estimate the nowcast and forecast of human radiation in ISS



Requirements from the estimation system of human exposure

- Radiation on the airplane

SEP flux at 86km of height (larger than $\sim 100\text{MeV}$ as a function of lat. lon. and energy)

- Radiation on the ISS

SEP flux along the ISS orbit (larger than $\sim 30\text{MeV}$ as a function of energy)

As soon as possible from the occurrence of events

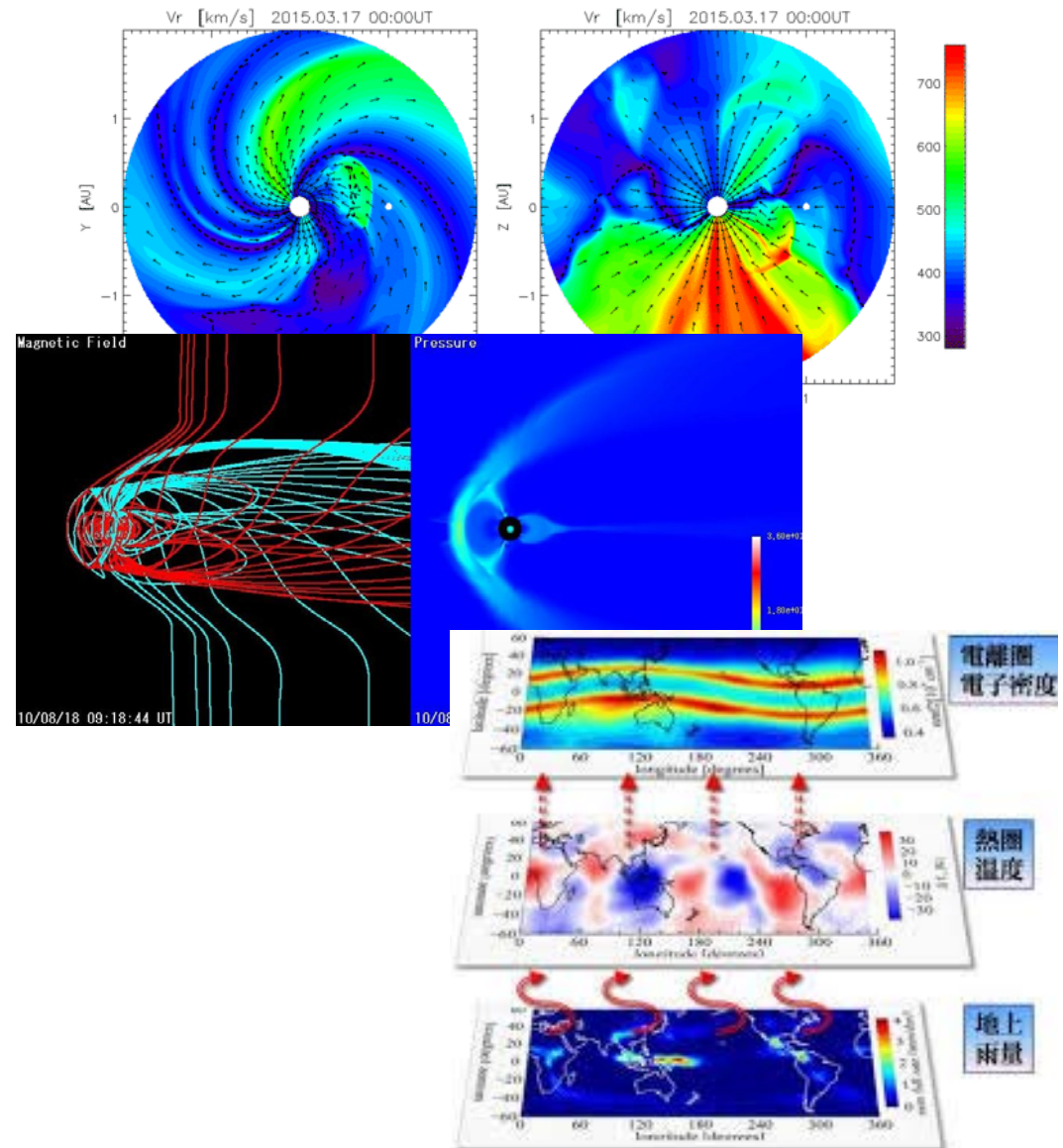


Power line hazardous system

- We will make necessary arrangements with users e.g., TEPCO coordinating with A03 group.
- And we will provide hazardous map in case of extreme events and prepare manual.
- Requirements: we need to grasp the threshold of extreme event in which the social effect becomes critical.

Building Integrated model from the sun to the Earth

- Another mission of A01: communicate / cooperate among the scientists in different fields in STP.
- Connecting models / codes in three fields; solar wind, magnetosphere and ionosphere



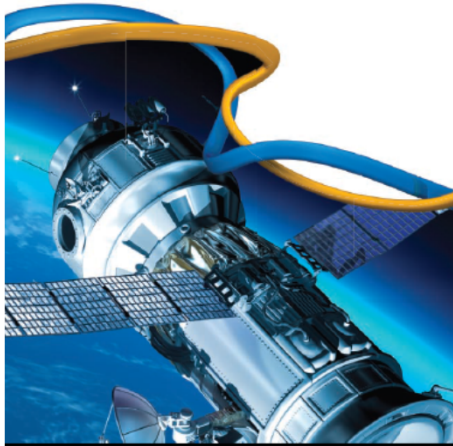
Roadmap to develop the application

| | 2015 | 2016 | 2017 | 2018 | 2019 |
|--------------------------------------|-------------------------------|---|--|---|---------------------------------|
| Radio propagation simulator | Discuss the concept, planning | develop | validate | Nowcast, connecting several models | |
| Nowcast ionospheric condition | planning | develop | validate | Connecting with radio propagation simulator | |
| Taylor-made space weather | planning | Improving models Planning information system | Establishing Beta ver. of information system | Communicate with users | Establishing information system |
| Estimation system of human Radiation | Develop SEP Nowcast model | Nowcast with WASAVIES | High speed, integrated | evaluation | establishment |
| GIC hazardous system | Working with A03 | | Discussing how to show hazardous maps | | evaluation |

Learning Hazardous maps in foreign countries/industries



Extreme space weather:
impacts on engineered
systems and infrastructure



「우주전파재난」
위기관리 표준매뉴얼

2013. 4.

미래창조과학부

Economic loss in case of Carrington event

ScienceDaily®

Your source for the latest research news

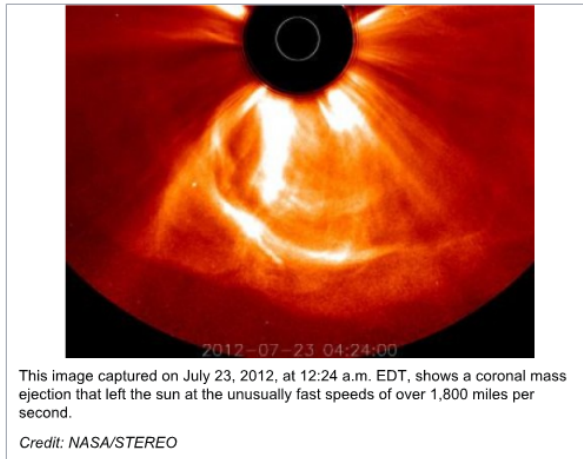
Fierce 2012 magnetic storm just missed us: Earth dodged huge magnetic bullet from the sun

Date: March 18, 2014

Source: University of California - Berkeley

Earth dodged a huge magnetic bullet from the sun on July 23, 2012.

According to University of California, Berkeley, and Chinese researchers, a rapid succession of coronal mass ejections -- the most intense eruptions on the sun -- sent a pulse of magnetized plasma barreling into space and through Earth's orbit. Had the eruption come nine days earlier, it would have hit Earth, potentially wreaking havoc with the electrical grid, disabling satellites and GPS, and disrupting our increasingly electronic lives.



This image captured on July 23, 2012, at 12:24 a.m. EDT, shows a coronal mass ejection that left the sun at the unusually fast speeds of over 1,800 miles per second.

Credit: NASA/STEREO

Carrington level flares occurs on July 23 but not hit the Earth

| Regions | Best | Worst |
|-----------------|---------|---------|
| US, Canada | 128,808 | 163,866 |
| Scandinavia, UK | 28,903 | 37,210 |
| Central Europe | 73,934 | 95,185 |
| Total Europe | 102,837 | 132,395 |
| Japan | 41,746 | 53,745 |
| Australia | 7,617 | 9,806 |

Ref. : economic loss in East Japan Earthquake: 100,000-250,000 (mil. Dollers)

Reference: SWISS Re, Space Weather Workshop 2014, April 8-11, 2014, Boulder US.

Lloyd's said "the most dangerous city against the Solar storm is Tokyo"

The screenshot shows a web browser displaying the Lloyd's City Risk Index website. The page title is "LLOYD'S Lloyd's City Risk Index 2015-2025". The navigation menu includes "Home", "Locations", "Threats", "Case studies", and "About". The main content area features a map of Japan with a pop-up window for "Solar storm Tokyo".

Select threat
Solar storm

Solar storm
GDP@Risk: All cities
\$64.95bn

GDP@Risk: Top 20 cities
\$22.14bn
34.08% of All cities total

GDP@Risk: Top 5 cities

| | | |
|---|-------------|----------|
| 1 | Tokyo | \$2.42bn |
| 2 | New York | \$2.27bn |
| 3 | Moscow | \$1.63bn |
| 4 | Los Angeles | \$1.49bn |
| 5 | Paris | \$1.24bn |

[View top 20](#)

[View Solar storm case study](#)

Share this data
in [Twitter](#) [Facebook](#) [Email](#)

Solar storm Tokyo
GDP@Risk
\$2.42bn
GDP@Risk ranking
1/301 cities
Share of Total GDP@Risk
1.58%
Tokyo Total GDP@Risk: \$153.28bn
Threat severity
Very low threat

オホーツク海
東シナ海
上海
韓国
大阪
日本
東京

UNIVERSITY OF CAMBRIDGE Centre for Risk Studies Judge Business School
Lloyd's is a registered trade mark of the Society of Lloyd's. Lloyd's is authorised under the Financial Services and Markets Act 2000. Lloyd's Copyright 2015.

Share [in](#) [Twitter](#) [Facebook](#) [Email](#) [Lloyds.com](#) | [Terms & Conditions](#) | [Contact us](#)

20:11
2016/01/11

Establishing SWx user committee

- NICT has been communicating with the SWx users in the framework of SWx users forum more than 10 years.
- We will establish SWx user committee under the framework of PSTEP for detailed communication with users requirements
- The kickoff meeting was held on Feb.5.



Workshop on Space Weather Forecast Method at NICT (Dec. 10, 2015)



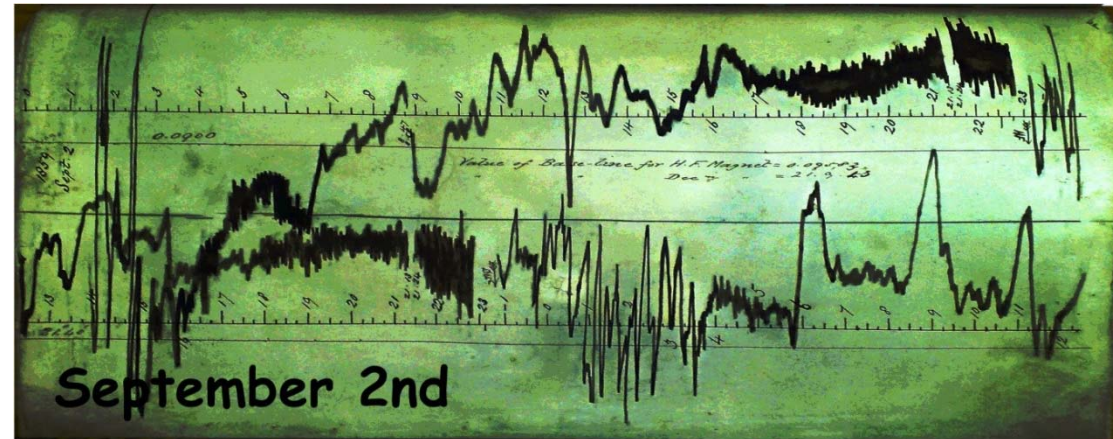
NICT presented the method of SWx forecast in detail and discuss where we can improve with cutting-edge results getting on PSTEP.

In addition, we introduced validation methods which are discussed in international framework.



The largest SWx event on record

Carrington Event (Sep. 1-2, 1859)



- 電信線が帯電
- 電信オフィスが発火
- 非常に明るいオーロラが発生し、夜でも新聞が読めた

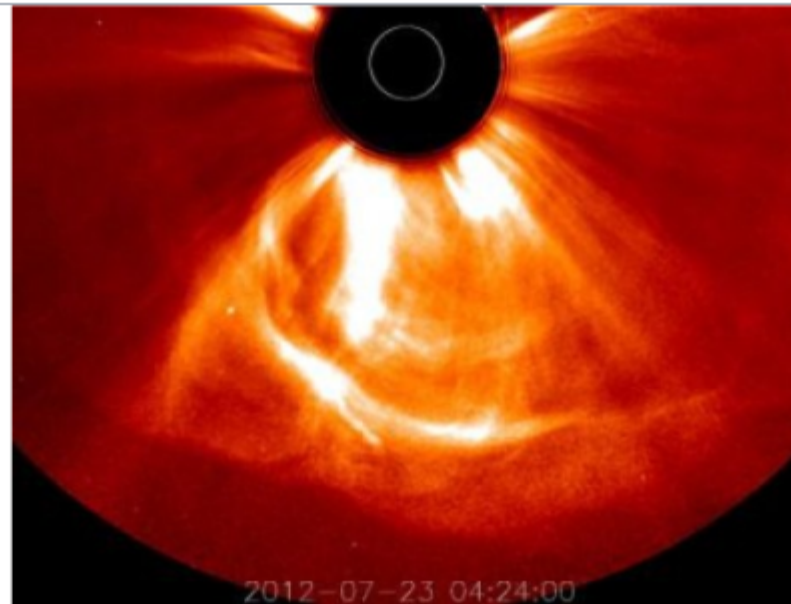
Fierce 2012 magnetic storm just missed us: Earth dodged huge magnetic bullet from the sun

Date: March 18, 2014

Source: University of California - Berkeley

Earth dodged a huge magnetic bullet from the sun on July 23, 2012.

According to University of California, Berkeley, and Chinese researchers, a rapid succession of coronal mass ejections -- the most intense eruptions on the sun -- sent a pulse of magnetized plasma barreling into space and through Earth's orbit. Had the eruption come nine days earlier, it would have hit Earth, potentially wreaking havoc with the electrical grid, disabling satellites and GPS, and disrupting our increasingly electronic lives.



This image captured on July 23, 2012, at 12:24 a.m. EDT, shows a coronal mass ejection that left the sun at the unusually fast speeds of over 1,800 miles per second.

Credit: NASA/STEREO

もし現在キャリントン級の現象が起こったら？ 経済的損失の計算

| Regions | Best | Worst |
|------------|---------|---------|
| 米国、カナダ | 128,808 | 163,866 |
| スカンジナビア、英国 | 28,903 | 37,210 |
| 独・仏・伊・瑞・澳 | 73,934 | 95,185 |
| 欧州全体 | 102,837 | 132,395 |
| 日本 | 41,746 | 53,745 |
| 豪州 | 7,617 | 9,806 |

Unit; 百万ドル

- 潜在的・地球レベルの影響は本計算に含んでいない
- 東日本大震災の経済損失: 100,000-250,000 (百万ドル)

Reference: SWISS Re, Space Weather Workshop 2014, April 8-11, 2014, Boulder US.

米国は

宇宙天気を地震や津波と並べ、米国戦略的国家危機評価 (US Strategic National Risk Assessment) の一つとして検討

| Threat/ Hazard Group | Threat/Hazard Type | National-level Event Description |
|----------------------------|--|---|
| Natural | Animal Disease Outbreak | An unintentional introduction of the foot-and-mouth disease virus into the domestic livestock population in a U.S. state |
| | Earthquake | An earthquake occurs within the U.S. resulting in direct economic losses greater than \$100 Million |
| | Flood | A flood occurs within the U.S. resulting in direct economic losses greater than \$100 Million |
| | Human Pandemic Outbreak | A severe outbreak of pandemic influenza with a 25% gross clinical attack rate spreads across the U.S. populace |
| | Hurricane | A tropical storm or hurricane impacts the U.S. resulting in direct economic losses of greater than \$100 Million |
| | Space Weather | The sun emits bursts of electromagnetic radiation and energetic particles causing utility outages and damage to infrastructure |
| | Tsunami | A tsunami with a wave of approximately 50 feet impacts the Pacific Coast of the U.S. |
| | Volcanic Eruption | A volcano in the Pacific Northwest erupts impacting the surrounding areas with lava flows and ash and areas east with smoke and ash |
| Wildfire | A wildfire occurs within the U.S. resulting in direct economic losses greater than \$100 Million | |



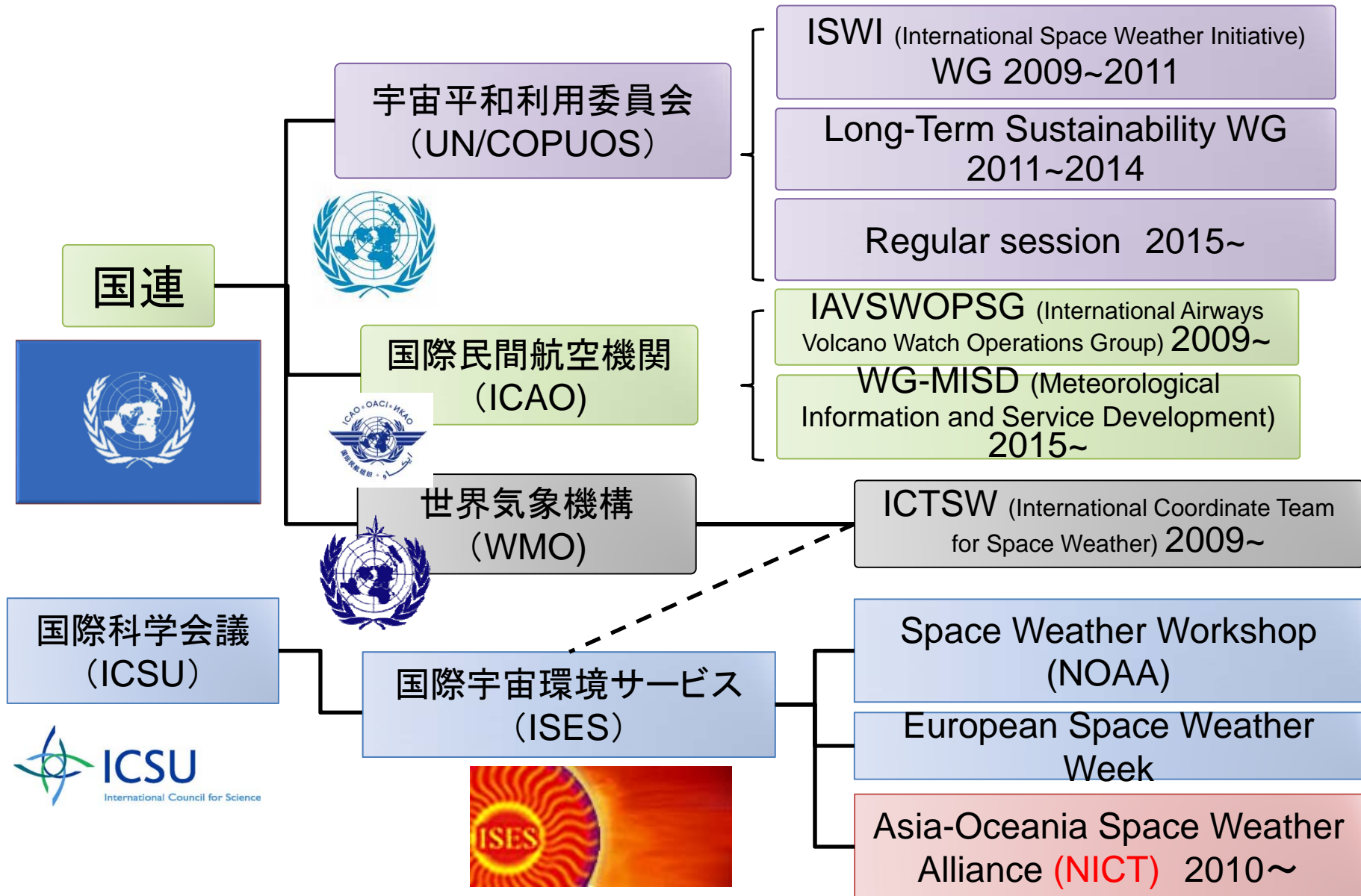
US National Space Weather Strategy

Nov 2014 – Space Weather Operations, Research, and Mitigation (SWORM) Task Force is established

Tasked to develop:

- National Space Weather Strategy*
- Space Weather Action Plan





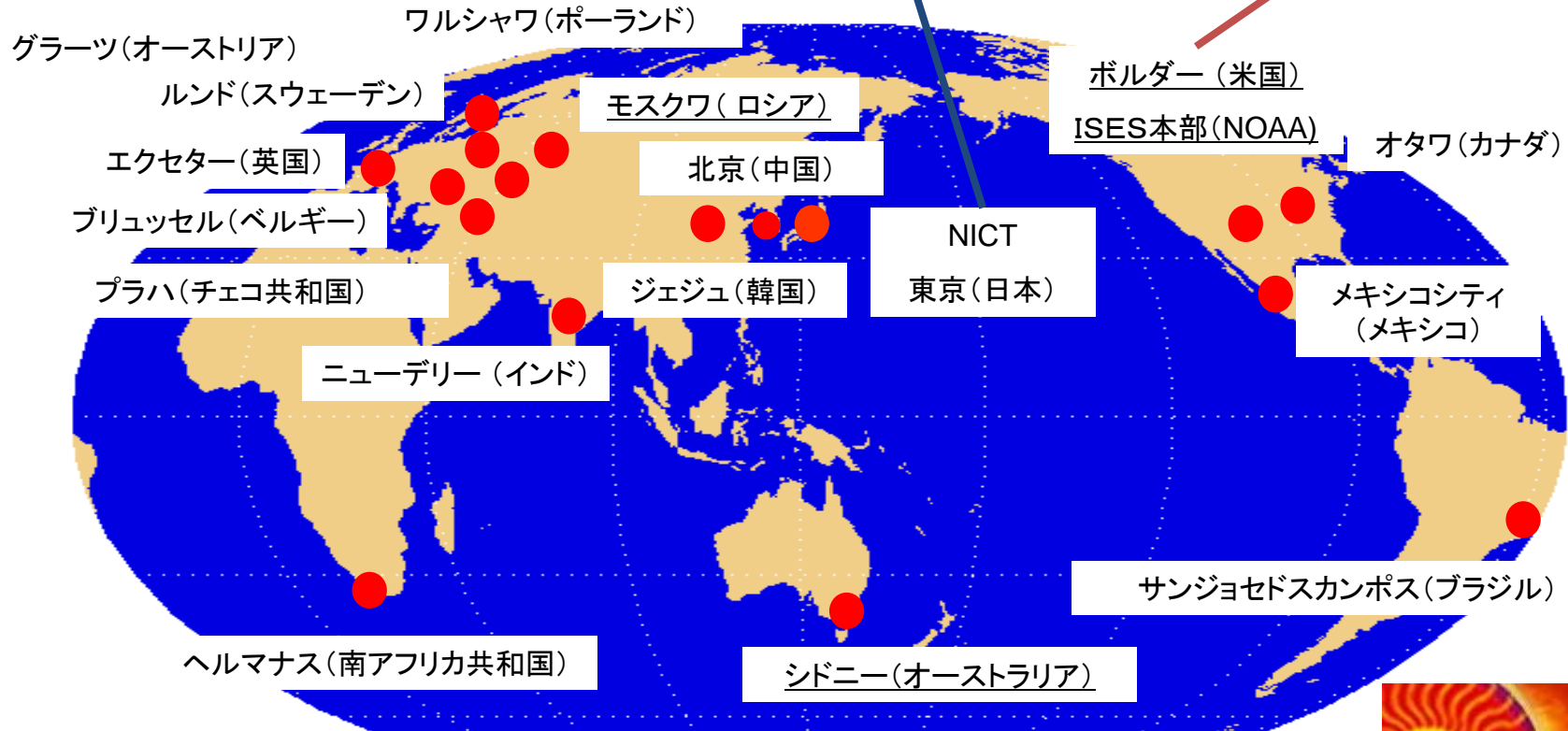


ISES: 国際宇宙環境サービス

(17か国が加盟。ESAがCollaborative Expert Centerとして参加)

局所的電離圏観測や地磁気観測の地上観測網が充実している他、独自の宇宙天気数値予測モデル(太陽風、磁気圏、電離圏)の開発を実施。

太陽監視衛星、太陽風監視衛星、静止軌道衛星など多くの衛星を運用し、データを提供。

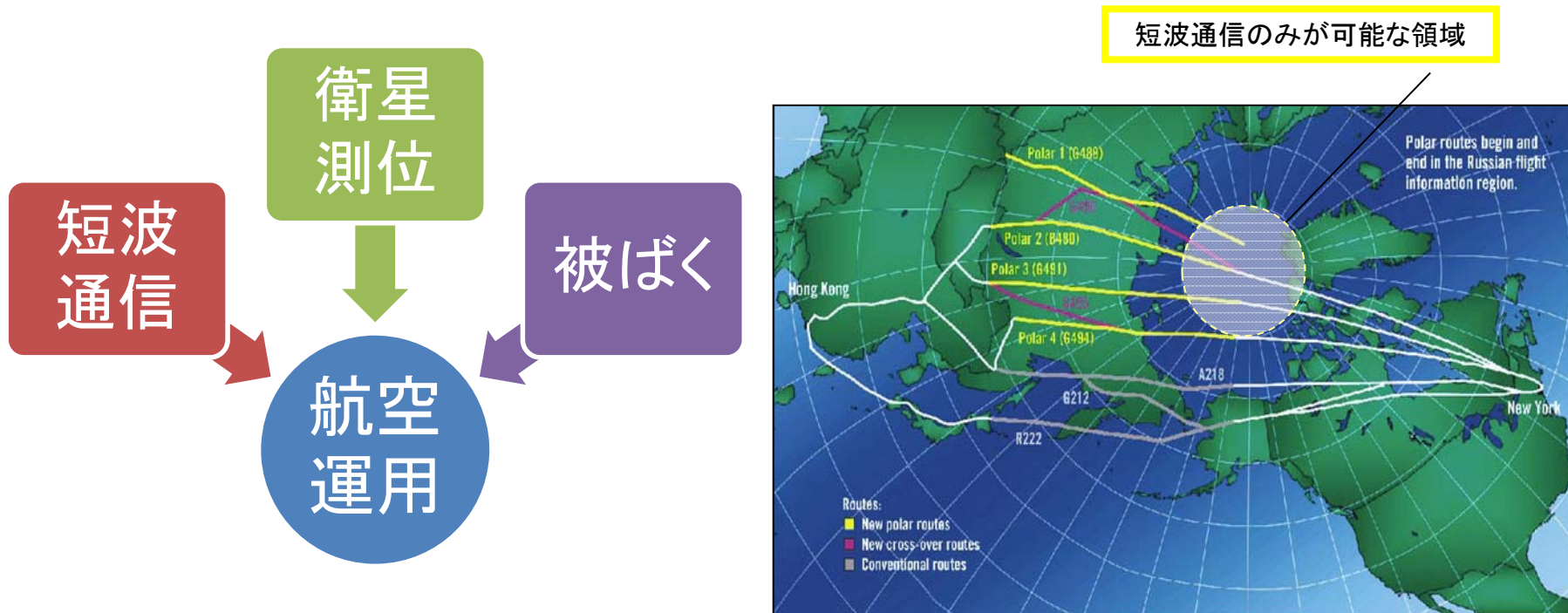


国際協力によって宇宙天気予報を推進。



ICAO/WG-MISD

- 国際民間航空機関(ICAO)第3付属書:航空機の運行責任者等に提供しなければならない気象情報を規定。
- 現在、宇宙天気情報を含めるよう第3付属書の改定が進められている。
- 2020年代には、宇宙天気情報が航空運用に不可欠な情報として使用される見込み



Space Weather Sub-Group Activities

| No | Activity | Predecessor | Due Date |
|-----|--|-------------|----------------|
| 3.1 | Revised Space Weather Concept of Operations for endorsement by the MET Panel | | May 2016 |
| 3.2 | Space weather information performance requirements for endorsement by the MET Panel | 3.1 | June 2016 |
| 3.3 | Space Weather Center selection criteria for endorsement by the MET Panel | 3.2 | July 2016 |
| 3.4 | Proposals for Amendment of ICAO Annex 3 with respect to space weather information | 3.1 | September 2016 |
| 3.5 | Space Weather Information Manual | 3.1 and 3.2 | September 2017 |

Space Wx Webex/Meeting Schedule

Webexes and Face-to-Face Meetings

