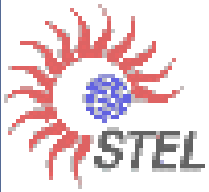
SCOSTEP
Scientific Committee on Solar-Terrestrial Physics



2012 Oct 11
ISWI International Meeting at Quito, Ecuador

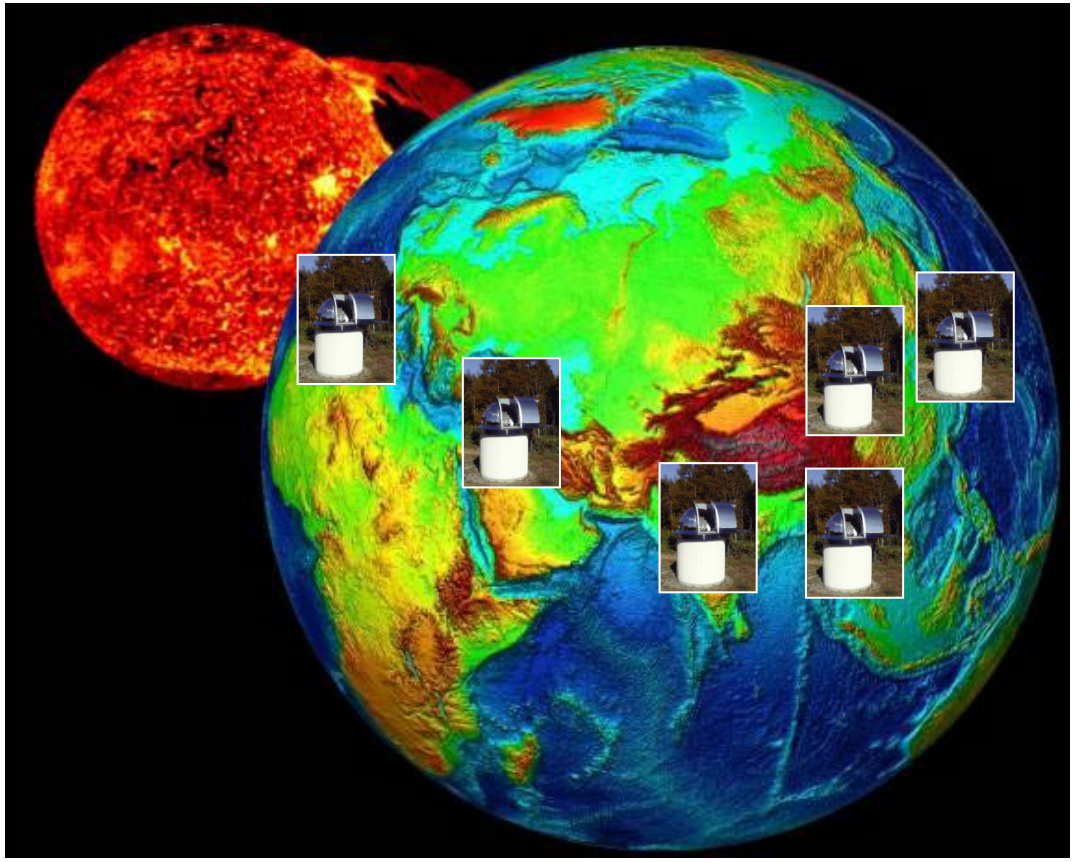
International collaboration and academic exchange of the CHAIN project in this three years (ISWI period)

S.UeNo, K.Shibata, S.Morita, G.Kimura,
A.Asai, R.Kitai, K.Ichimoto, S.Nagata,
T.T. Ishii, Y.Nakatani, et al.
（Kwasan & Hida Observatories, Kyoto University, JAPAN）

With cooperation of **ISWI**, SCOSTEP/CAWSES-II,
National Astronomical Observatory of Japan,
Nagoya Univ/STEL (Japan)
IGP (Peru), Ica Univ (Peru), CRAAG (Algeria) et al.

Purposes of CHAIN Project

(**C**ontinuous **H**-**a**lpha **I**maging **N**etwork Project)



Reinforcement of observations of the solar activity by **formation of an international network of ground-based solar observations**

Observation and study of **filament eruptions, shockwaves (Moreton wave) with solar flares and variation of UV radiation on the full-disk Sun** in order to understand and predict the change of space-weather envirionment from the Sun to the Earth.

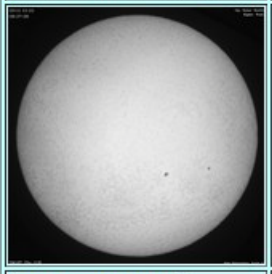
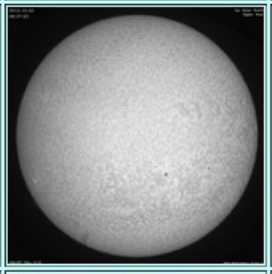
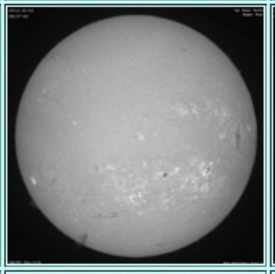
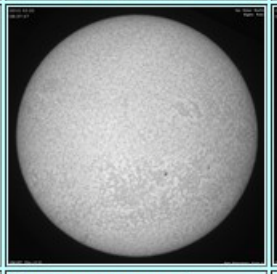
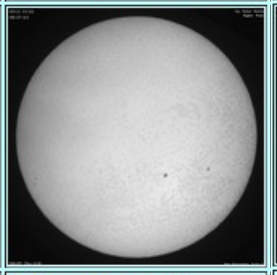
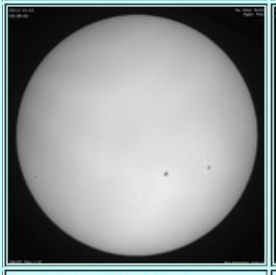
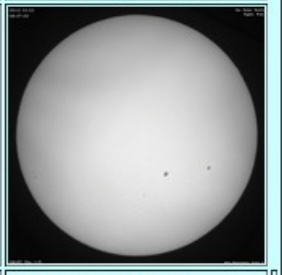
International spread, academic exchange and promotion of the space-weather research including developing countries.

[1] Formation of the international network of ground-based solar observations during ISWI period

In Japan, currently, we are using **the Solar Magnetic Activity Research Telescope (SMART)** that was installed at Hida Observatory in 2003 for the CHAIN project.

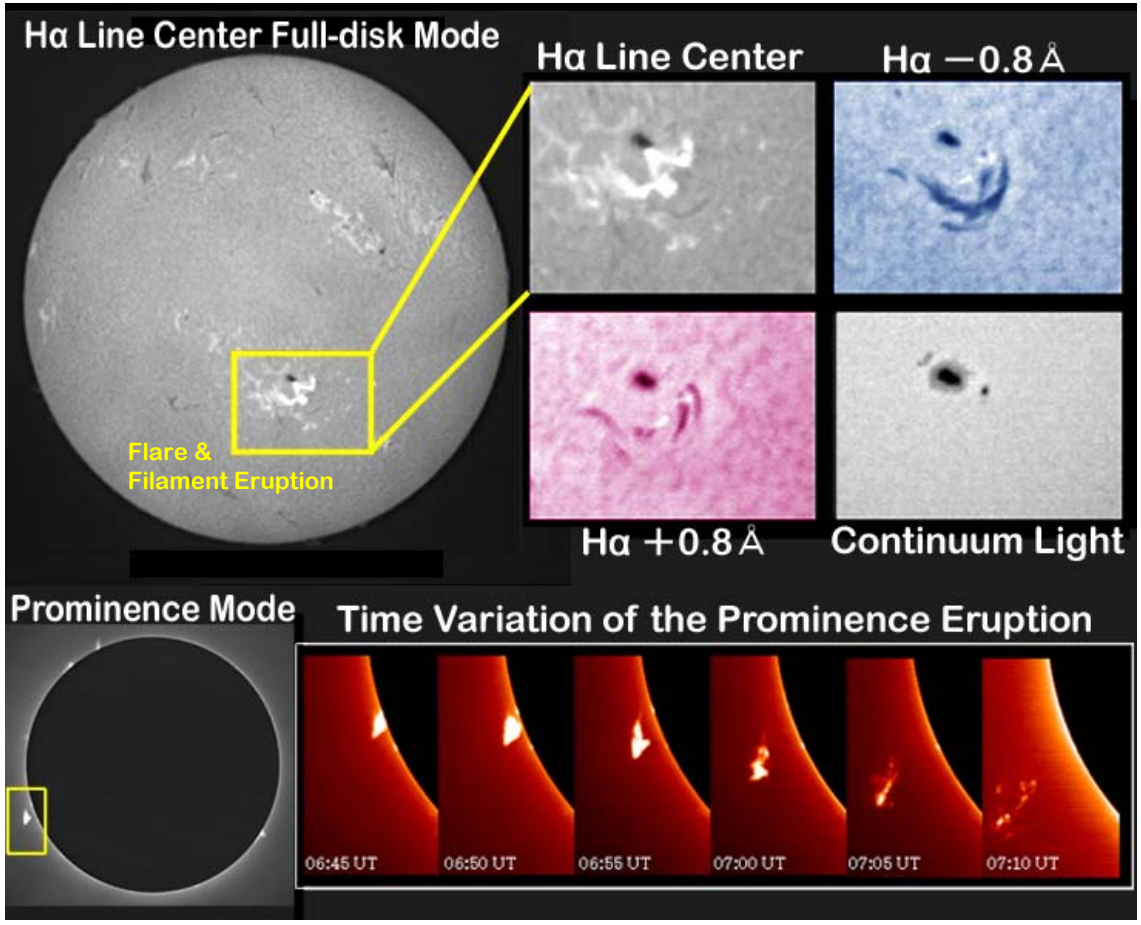
This telescope daily observes H-alpha multi-wavelength full-disk chromospheric images

SMART T1 images on 20121003

H-alpha − 0.8 A	H-alpha − 0.5 A	H-alpha center	H-alpha + 0.5 A	H-alpha + 0.8 A	H-alpha + 1.2 A	H-alpha − 1.2 A
						
Javascript Movie Download FITS files Download JPEG files	Javascript Movie Download FITS files Download JPEG files	Javascript Movie Download FITS files Download JPEG files	Javascript Movie Download FITS files Download JPEG files	Javascript Movie Download FITS files Download JPEG files	Javascript Movie Download FITS files Download JPEG files	Javascript Movie Download FITS files Download JPEG files

The main instrument for other countries of CHAIN:

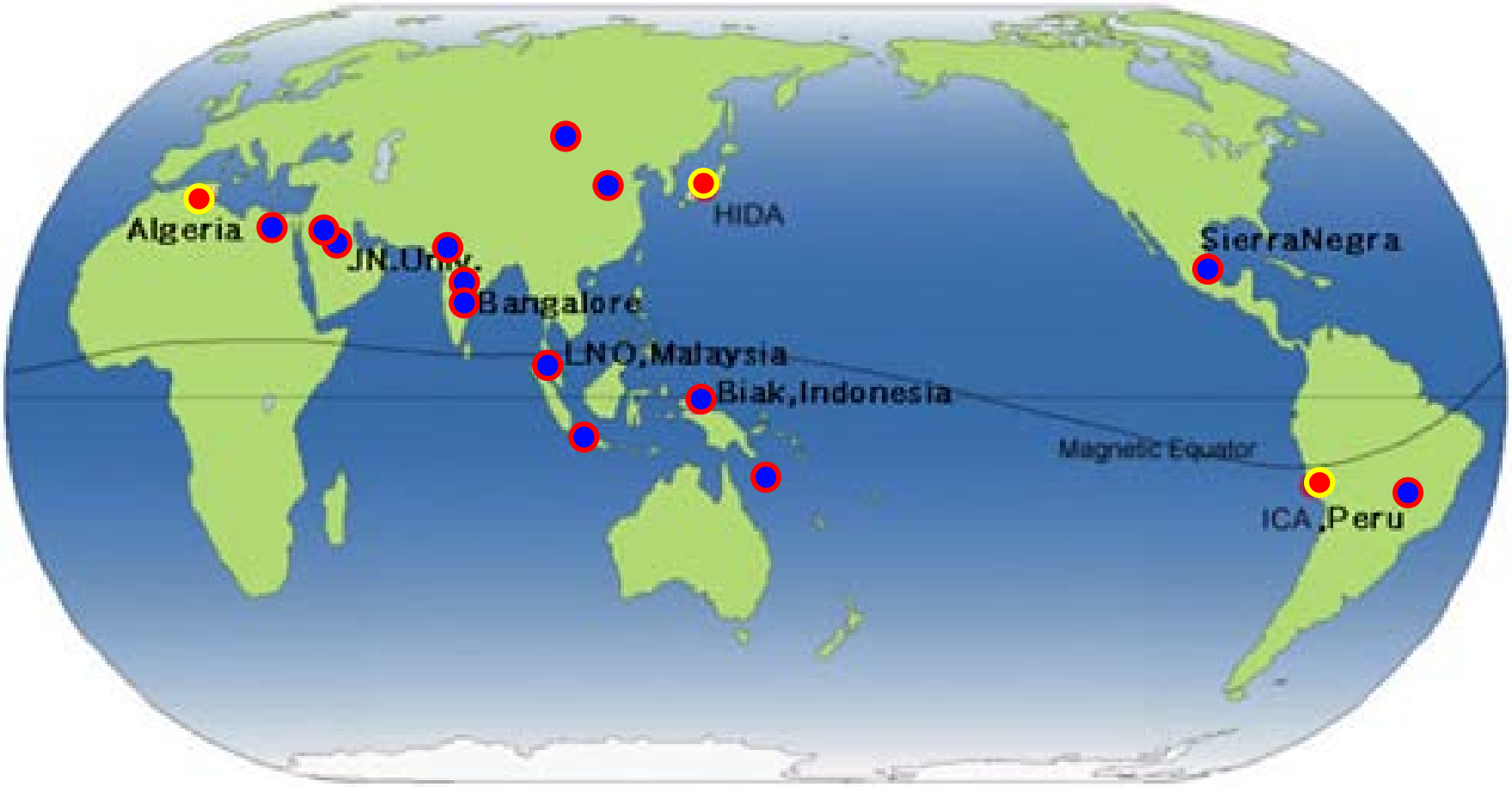
Flare Monitoring Telescope(FMT)



The FMT simultaneously observes full-disk solar chromosphere at multi-wavelength around H-alpha.

So, we can measure physical parameters , such as 3D velocity field, density and temperature…, of explosive solar phenomena, as well as the SMART telescope.

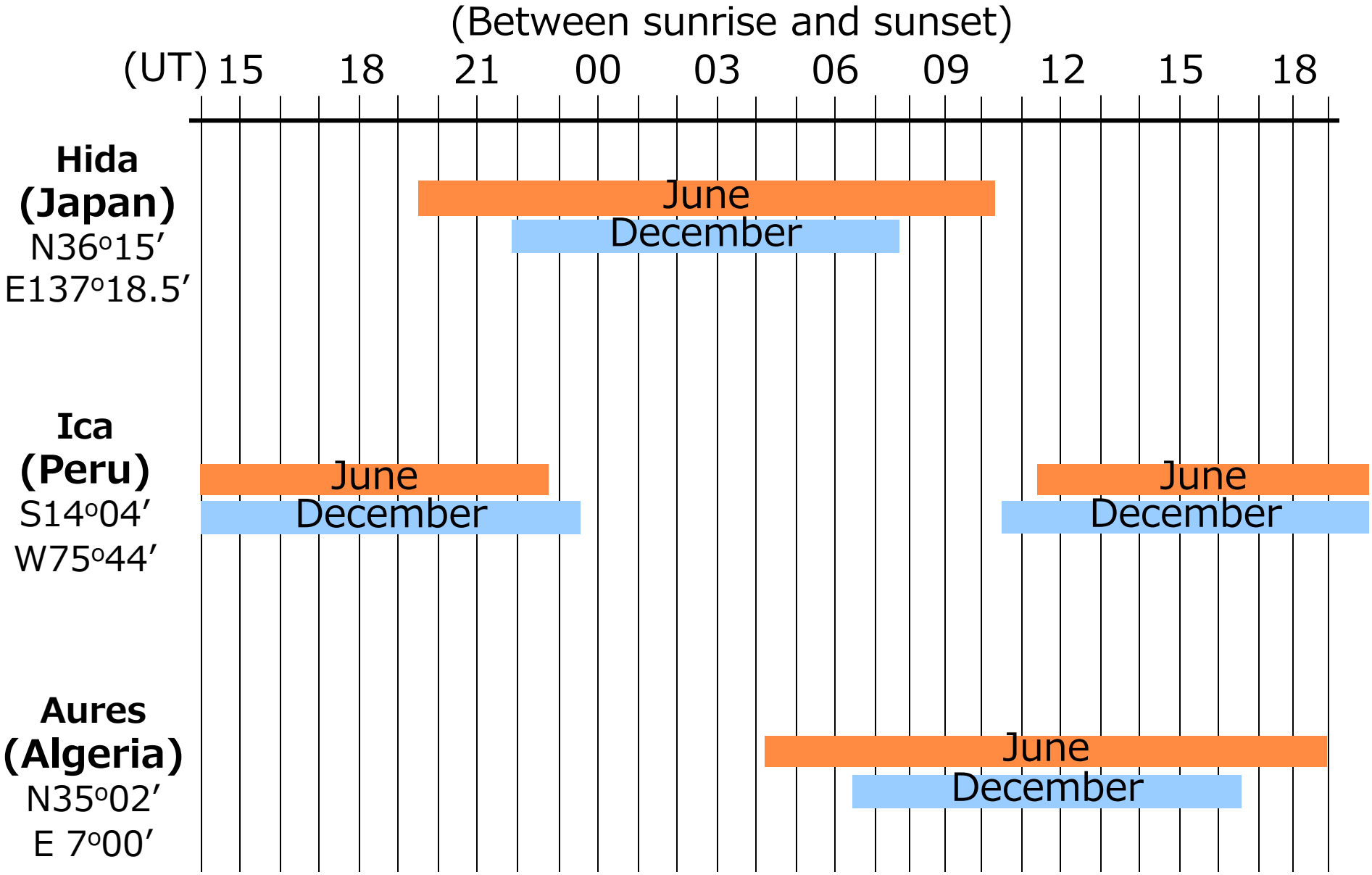
Main Stations and Candidate Sites of CHAIN as of May.2012



Main Stations

* Hida Obs., Japan : The “SMART” telescope is working for the CHAIN.
* Ica Univ., Peru : The 1st oversea FMT was already installed.
* Aures, Algeria : The 2nd oversea FMT is planned to be installed.

Observation time zone at main 3 sites



Because, if we use these three stations at least, we can monitor the Sun for 24 hours continuously without blank time all year round, in principle.

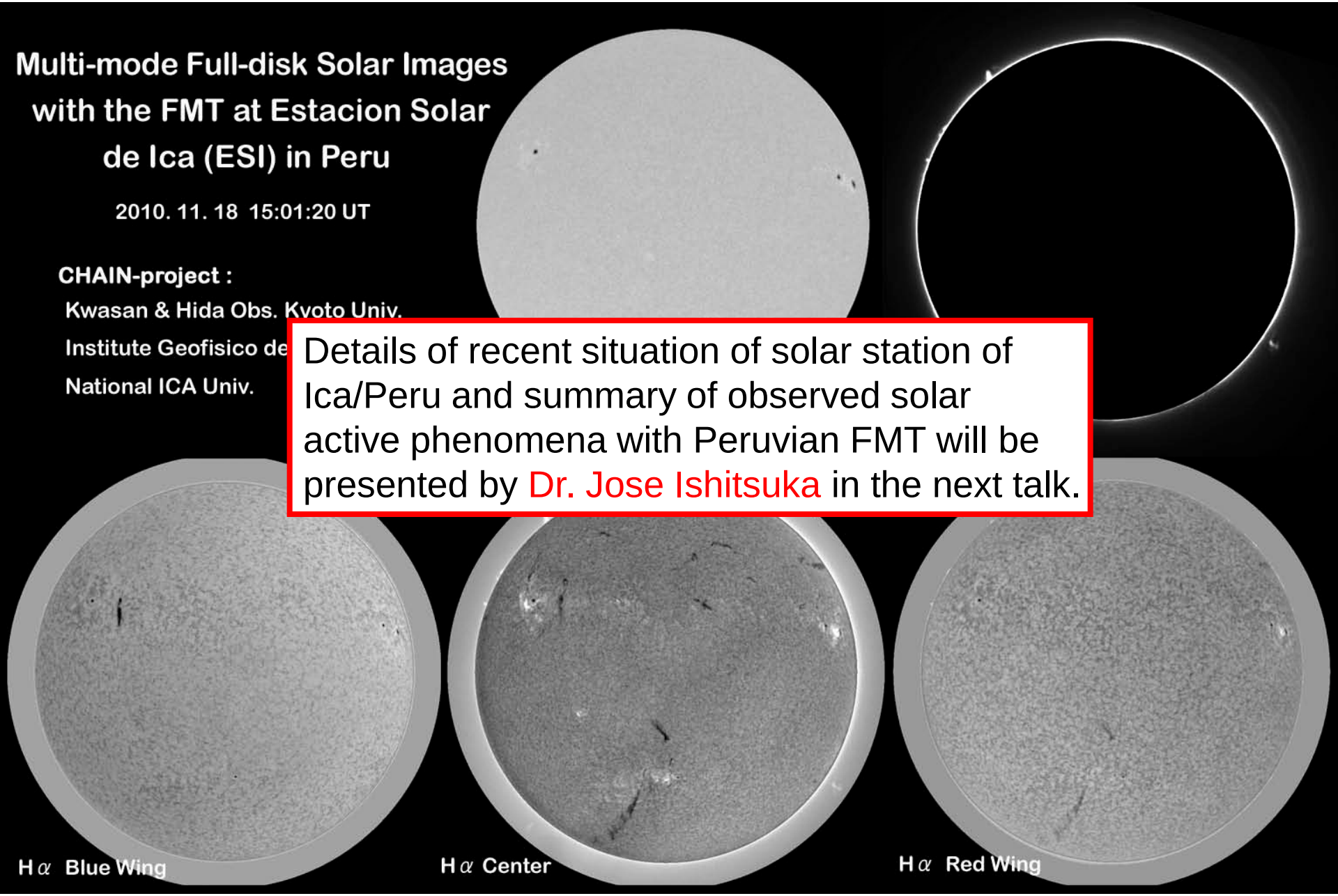
The 1st oversea FMT of CHAIN project was installed at Ica University in Peru in March 2010
with cooperation of IGP and Ica Univ.

National Ica University, Peru

Latitude : - 14° 11’
Altitude : ~ 80 m
Rain : 0 mm/year
Temperature : 10 - 27 ℃
Avrg. Humidity : 20 %

March 18th 2010:

Installation of the FMT in the Solar Station (ESI) of ICA Univ. was completed.


Multi-mode Full-disk Solar Images with the FMT at Estacion Solar de Ica (ESI) in Peru
2010. 11. 18 15:01:20 UT
CHAIN-project :
Kwasan & Hida Obs. Kyoto Univ.
Institute Geofisico de
National ICA Univ.
Details of recent situation of solar station of Ica/Peru and summary of observed solar active phenomena with Peruvian FMT will be presented by Dr. Jose Ishitsuka in the next talk.
Hα Blue Wing
Hα Center
Hα Red Wing

On the other hand,
although CHAIN-team has continued to make efforts for obtaining funds for installation of new FMT in **Algeria** (2nd oversea main station) mainly in Japan, it has not succeeded yet.

The largest reason is …

Cost of a Standard New FMT without Infrastructure

(where 1 USD = 80 JPY)

Telescope itself (1)	351,125 USD
Optical Filters (5)	75,750 USD
CCD Cemaras (5)	41,125 USD
Computers for Cameras (5)	14,250 USD
Computer for Analysis (1)	8,625 USD
Transfer & Installation	112,500 USD
Total:	**603,375 USD**

It is not so expensive **compared with** other professional solar telescopes,
But it is never cheap.

However, in this year, **C**entre de **R**echerche en **A**stronomie, **A**strophysique et **G**eophysique (CRAAG) in Algeria began to consider the possibility of installing FMT by their own funds.

The Situation of Algeria/CRAAG

(Centre de Recherche Astronomie Astrophysique et Géophysique)

Administration Council

Scientific Council

Direction

Administration

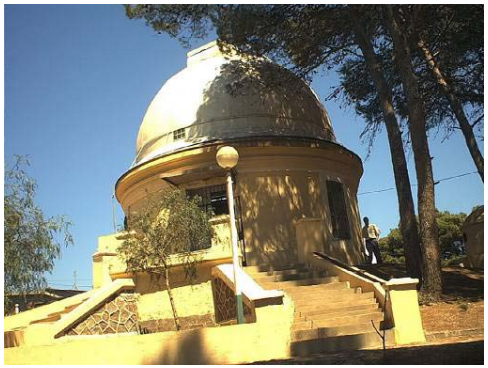
Department of Astronomy & Astrophysics

Department of Geophysics

Department of Seismology

Chief: Dr. N.Seghouani

Tamanrasset Observatory
(Director Prof. Nouredine AKACEM)



Alger Observatory since 1890

80 cm reflector for night-astronomy

New observatory in more better condition

A new solar telescope

Improving activity

In December of this year, CRAAG will hold a future-planning symposium in which the installation-site of the new solar telescope will also be decided finally.

Kyoto University will also perform scientific and technical advice to CRAAG in this symposium.

Classification of other candidate sites (13 institutes)

- Candidate Site who has (will have) multi-wavelength solar telescope or some other kinds of instruments:
  - * King Saud University in Saudi-Arabia (Under planning)
  - * Helwan Observatory, Cairo, Egypt (Spectrograph)
  - * Huairou Solar Observatory, China (Solar imaging telescope, sometimes multi-wavelength)

- Candidate Site who has some solar telescope but at only one wavelength:
  - * National Space Agency of Malaysia
  - * Tanjung-sari Solar Observatory, Indonesia
  - * Bosscha Observatory in Indonesia
  - * Bangalore Association for Science Education, India
  - * Research Center of Astronomy and Geophysics, Mongolia
  - * King Abdul-Aziz University, Saudi-Arabia

- Candidate Site who does not have any solar telescope:
  - * Jawaharlal Nehru University, India
  - * Universidad Nacional Autonoma de Mexico, Mexico
  - * Southern Space Observatory (SSO) in Brazil
  - * Space and Upper Atmosphere Research Commission (SUPARCO) Space Sciences Division in Pakistan

Plan of King Saud Univ., Saudi Araby

Contact person:
Dr. Ahmed Ibrahim (Physics and astronomy department, King Saud Univ.)
(an OB of Kwasan & Hida Observatories, Kyoto Univ.)

They have a 6.6m astronomical dome in the university. In this dome, they have a old 15cm refractor telescope (made by C.Zeiss).

They will replace this refractor with the FMT by their own fund.

At present, 25 Sep. – 25 Nov., it is public announcement period for the open tender.
After 7 months from the tender (around July 2013), the new FMT will be installed at King Saud Univ.

In this process, Kyoto Univ has also performed scientific and technical advice to them.

Classification of other candidate sites (13 institutes)

- Candidate Site who has (will have) multi-wavelength solar telescope or some other kinds of instruments:
  * King Saud University in Saudi-Arabia (Under planning)
  * Helwan Observatory, Cairo, Egypt (Spectrograph)
  * Huairou Solar Observatory, China (Solar imaging telescope, sometimes multi-wavelength)

- Candidate Site who has some solar telescope but at only one wavelength:
  * National Space Agency of Malaysia
  * Tanjung-sari Solar Observatory, Indonesia
  * Bosscha Observatory in Indonesia
  * Bangalore Association for Science Education, Indi
  * Research Center of Astronomy and Geophysics, M
  * King Abdul-Aziz University, Saudi-Arabia

- Candidate Site who does not have any solar tele ope:
  * Jawaharlal Nehru University, India
  * Universidad Nacional Autonoma de Mexico, Mexico
  * Southern Space Observatory (SSO) in Brazil
  * Space and Upper Atmosphere Research Commission (SUPARCO) Space Sciences Division in Pakistan

Concerning other two groups of candidate sites, currently, it is difficult for us to provide them with some new instruments because of lack of fund.

Classification of other candidate sites (13 institutes)

- Candidate Site who has (will have) multi-wavelength solar telescope or some other kinds of instruments:
  - * King Saud University in Saudi-Arabia (Under planning)
  - * Helwan Observatory, Cairo, Egypt (S
  - * Huairou Solar Observatory, China (Solar

- Candidate Site who has some solar telesco
  - * National Space Agency of Malaysia
  - * Tanjung-sari Solar Observatory, Indonesia
  - * Bosscha Observatory in Indonesia
  - * Bangalore Association for Science
  - * Research Center of Astronomy and Geop
  - * King Abdul-Aziz University, Saudi-Arabia

- Candidate Site who does not have any sola
  - * Jawaharlal Nehru University, India
  - * Universidad Nacional Autonoma de
  - * Southern Space Observatory (SSO) in Brazil
  - * Space and Upper Atmosphere Research Commission (SUPARCO) Space Sciences Division in Pakistan

Viewed from the aspect of academic exchange, we can promote cooperation on scientific researches.

* Training of solar observation and its instrument by sending or inviting researchers or students.
* Training of data analysis by using existing data.
* Participation in international workshop, summer school etc. together. (like MAGDAS session in ISWI meeting, MAGDAS school …)

[2] Capacity Building Activities of CHAIN Project during ISWI period (some parts including IHY period)

2.1 Lectures

About Solar physics and Space weather:

(IHY period)

Jan. 2007 at Ica University in Peru,

Jan. 2007 at IGP in Peru,

May 2008 at CRAAG in Algeria,

June 2008 at Ica in Peru

(ISWI period)

Mar 2010 at Ica in Peru

May 2011 at Ryadh, Saudi Arabia

Jan. 2007 at IGP

Jan. 2007 at Ica Univ.

Mar. 2010 at Ica Univ.

2.2 Technical Training

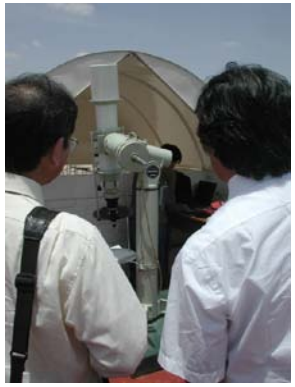
***Technical Training of Peruvian Staffs in Japan**

July 2009 at Hida Obs. Kyoto Univ.

- Lecture of solar physics and space weather
- Solar observation method
- Maintenance method of solar telescopes
- Camera controlling software
- Data archiving & analysis software

***Guidance of the Solar Observation Method in Peru**

2007 ～ 2010 at Ica & Lima



2.3 Scientific Education at Observation-Site

*Scientific training of Peruvian students and young researchers in Peru

Dr. Morita (an assistant teaching staff) of Hida Observatory stayed in Peru and trained Peruvian students and young researchers at Ica University, in **June** and **Octover – November** in 2010.

The subjects are

* Acquisition method of **calibration data** and calibration method
* Calculation of physical parameters from multi-wavelength solar images and **scientific analysis**
* Lectures of **solar physics and space weather.**

At Ica University in Peru, June 2010

2.4 Scientific Data-analysis Workshops

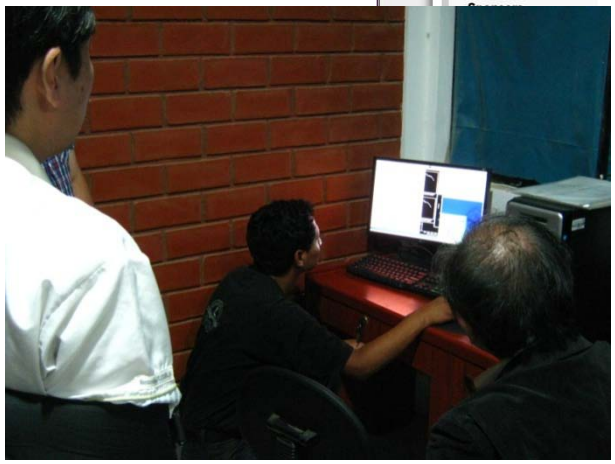
*Science Workshop of Solar Physics and Space-weather with the FMT data

22 – 26 Nov. 2010

Home Page of the WS:
http://esi.igp.gob.pe/FMTworkshop/

The purpose of this workshop is to bring together the prospective user community of FMT to explore current and future science targets of solar observations.

(SCOSTEP/CAWSES-II committee financially supported for this workshop.)



The 2nd Japan & Peru Data Analysis Workshop

20 – 31 Jul. 2011

8 days : at Hida Observatory

4 days : at NAOJ, Mitaka

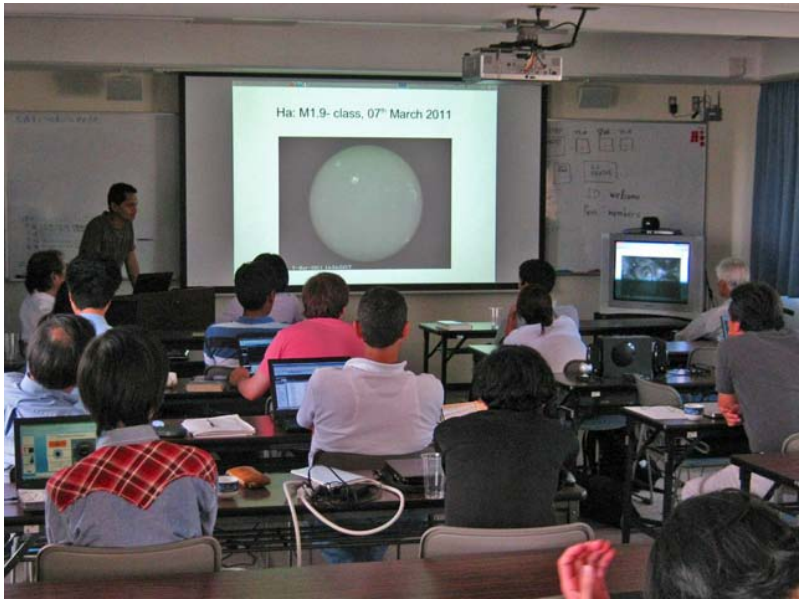
8 people from Peru

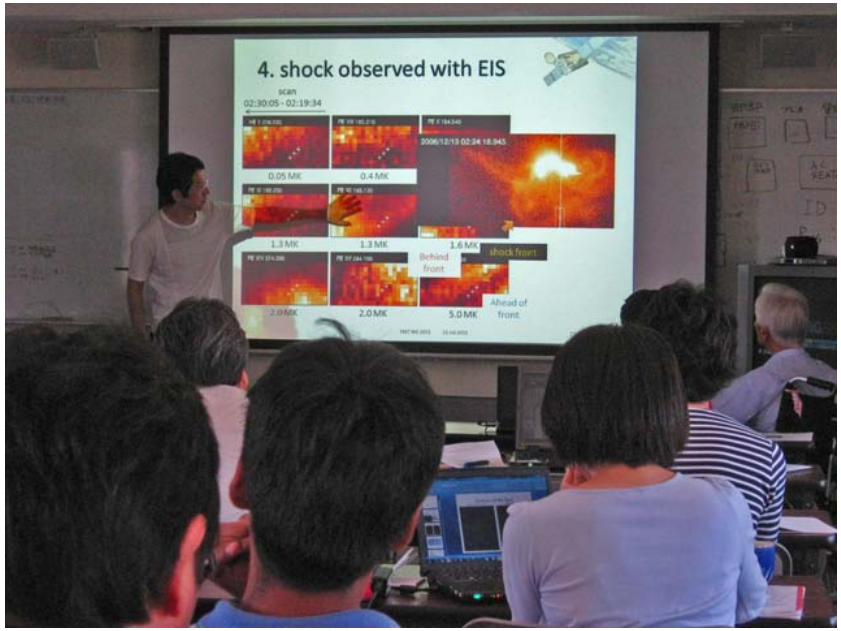
20 Japanese researchers

1 British &1 Egyptian researcher

1 student from Brazil through internet TV

(SCOSTEP/CAWSES-II committee financially supported for this workshop.)





Moreover, …

The 3rd Japan & Peru Data Analysis Workshop

Feb. or Mar. 2013

1 week : at Hida Observatory, Japan

Now preparing.

Main purpose: Get all analyzed results in shape of papers

2.5 Presentations at International Symposiums

Talks about activities of CHAIN project and its achievements.

(IHY period)
- Dec. 2006 **IHY** Sympo. in Bangalore, India,
- Jun. 2007 **IHY** Sympo. in Mitaka, Japan,
- Oct. 2007 **CAWSES** Sympo. in Kyoto, Japan,
- Apr. 2008 Auresian Astrophysics Workshop in Batna, Algeria,
- May 2008 JpGU **IHY** International Session
- Jul. 2008 **AOGS** Sympo. in Busan, Korea,
- Nov. 2008 **IGY+50** Sympo. in Tsukuba, Japan,

(ISWI period)
- Jul. 2010 SCOSTEP/**CAWSES-II** Sympo. in Berlin, Germany
- Nov. 2010 **ISWI** Sympo. in Cairo, Egypt
- Oct. 2011 **ISWI** Sympo. in Abuja, Nigeria
- 2009-2012 JpGU / **CAWSES-II & ISWI** International session

etc.

A remarkable point is that young researchers in host country began to attend international meetings and give talks by themselves in ISWI period.

[3] Observation and Studies of Solar Flares, Shockwaves and UV-radiation during ISWI period

3.1 3D Velocity Field Measurement of eruptive phenomena

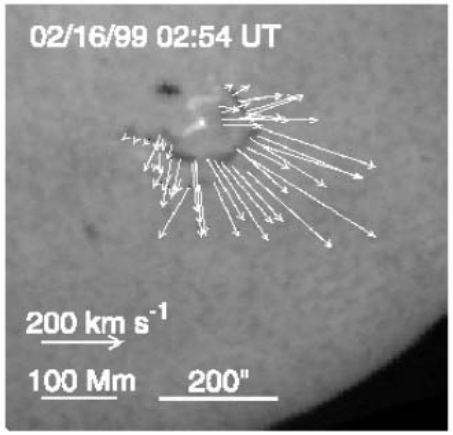
Calculating physical parameters of floating and moving features on the chromosphere by applying “cloud model fitting” to multi-wavelength solar chromospheric images.

We especially focus on the 3D velocity field to understand the process of growth and propagation of “coronal mass ejection (CME)”.

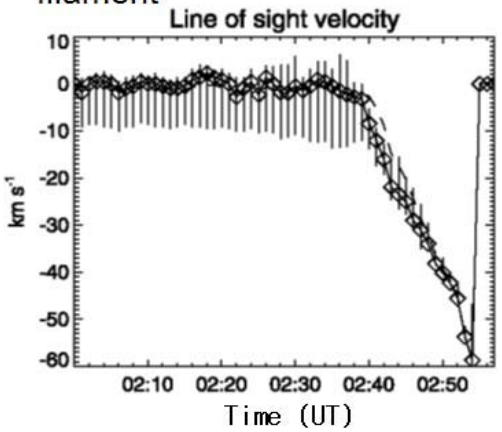
Investigation of relationship between filament eruptions and other typical phenomena in the space.

Example of calculation of 3D velocity field and its time-evolution for an erupting filament

Transversal Velocity Field



Time Evolution of the Doppler Velocity at the top of the filament



Cloud Model Fitting

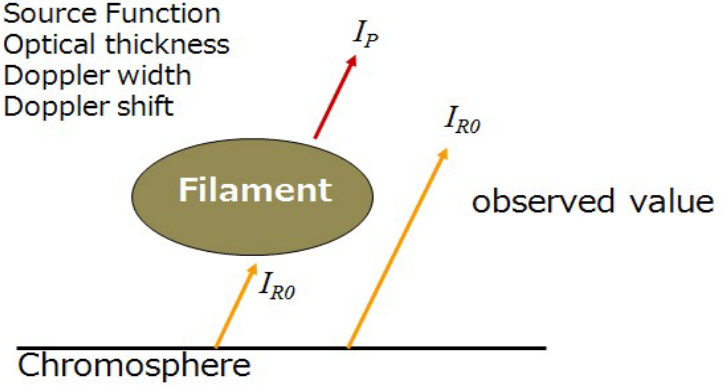
Observed contrast: $C(x,\Delta\lambda) = [I_P(x,\Delta\lambda) - I_{R0}(\Delta\lambda)]/I_{R0}(\Delta\lambda)$

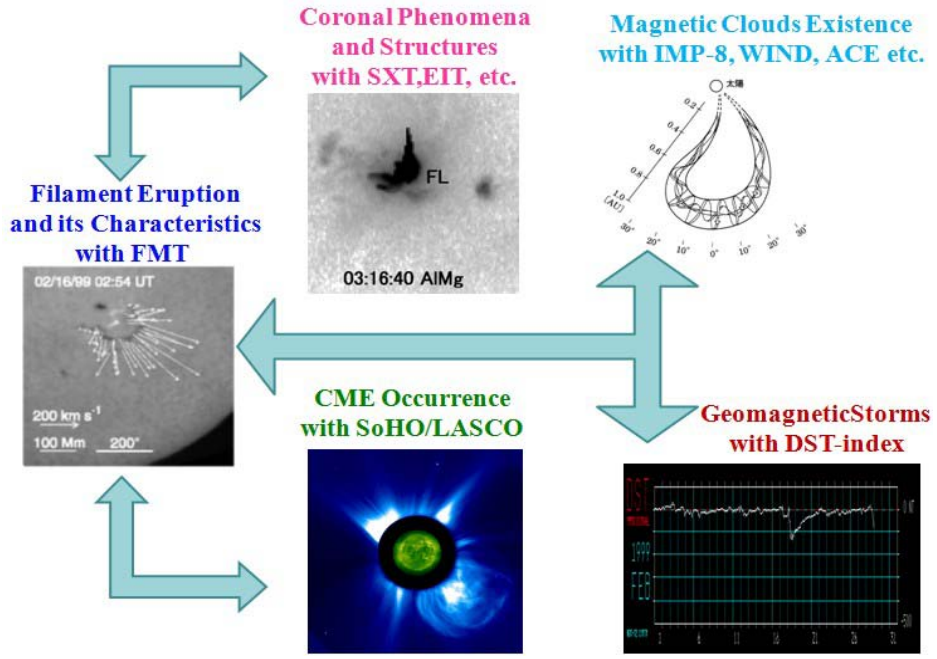
$$C(\Delta\lambda) = \left[\frac{S}{I_{R0}(\Delta\lambda)} - 1\right]\{1 - \exp[-\tau(\Delta\lambda)]\}$$

parameters

$$\tau(\Delta\lambda) = \tau_0 \exp\{-[(\Delta\lambda - \Delta\lambda_S)/\Delta\lambda_D]^2\}$$

S : Source Function
$\tau(\Delta\lambda)$: Optical thickness
$\Delta\lambda_D$: Doppler width
$\Delta\lambda_S$: Doppler shift





Morimoto & Kurokawa (2003) already observationally showed that

“Chromospheric H-alpha filament eruption => CME”
is 100% True

with the FMT data.

Then,

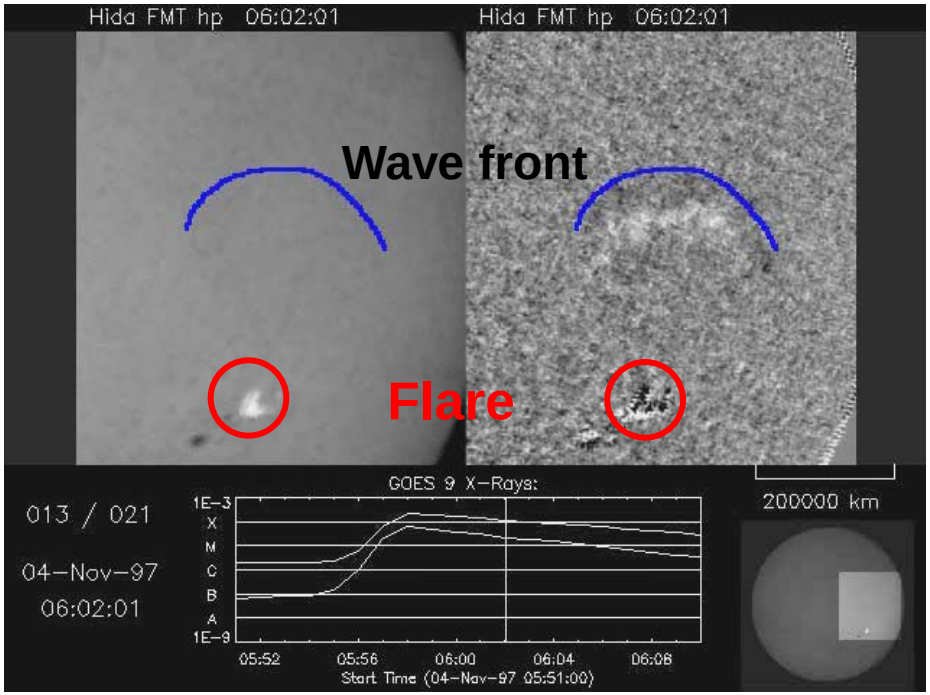
“CME => Chromospheric H-alpha filament erupted”

is true ? Or, Are there some exceptions ?

An elementary case-study of this exception and generating process of the CME will be presented by **Ms. Maria V. GUTIERREZ** in this session.

Moreover, in the future, we want to investigate relationship between characteristics of filament eruptions and geo-effectiveness of the CMEs.

3.2 Shock Wave Detection (Moreton Wave)

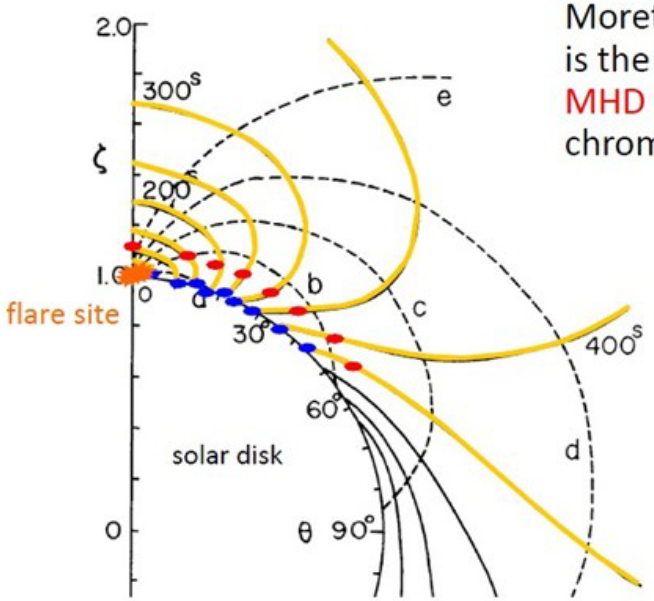


Shock waves are also very important phenomena that determine intensity and timing of large disturbances of space weather and that accelerate SEP.

The FMT is quite effective to detect intersections of shock waves on the solar chromosphere (Moreton waves).

Uchida Model for Moreton Wave

(1968)



Moreton wave (Moreton 1960) is the intersections of a coronal MHD fast shock front and the chromosphere

shock front

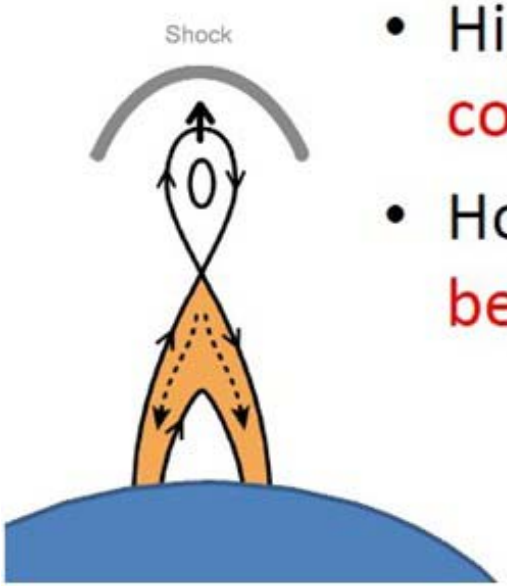
Moreton wave

X-ray wave, coronal counterpart of Moreton wave

However, for the flares that has almost the same intensity, sometimes they are accompanied by Moreton waves, sometimes they are not accompanied by them.

Subjects during ISWI period:

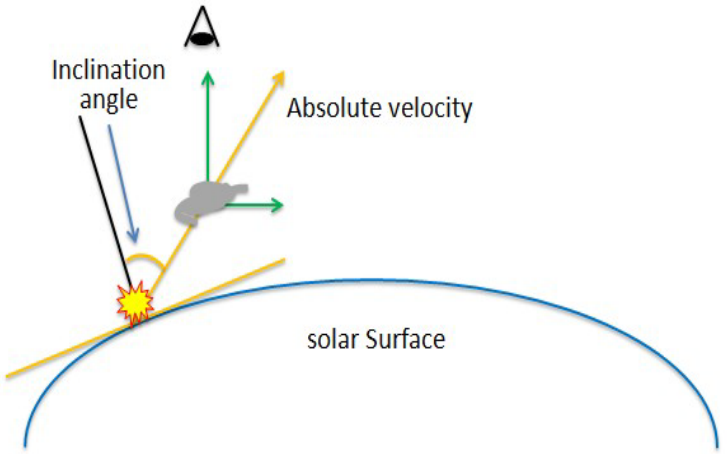
- What is different between flares “with” and “without” Moreton waves?
- Impulsive flares (GOES X-ray light curves are impulsive)? →must be confirmed
- High speed filaments? →must be confirmed
- Horizontal filament eruptions? →must be confirmed



Statistics of Shock Waves (Yamaguchi, Asai et al.)

The number of Moreton wave observed between 1997 and 2007 in the world → 27 events
(1: C class , 9 : M class , 17 : X class flare)
The FMT observed 20 events among them.

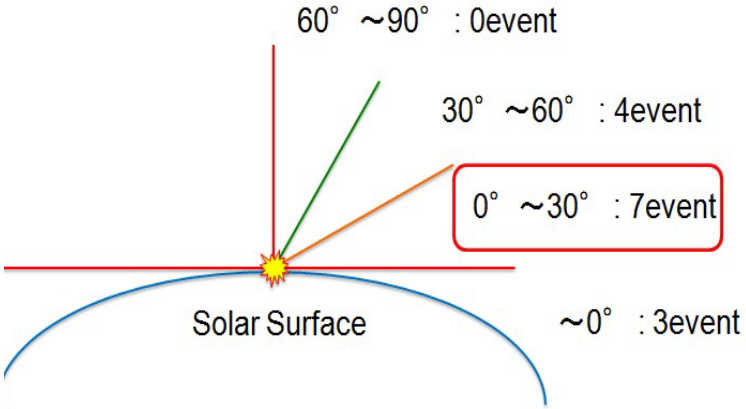
We have investigated absolute velocity and inclination angle of erupted filaments for the flares with Moreton waves.



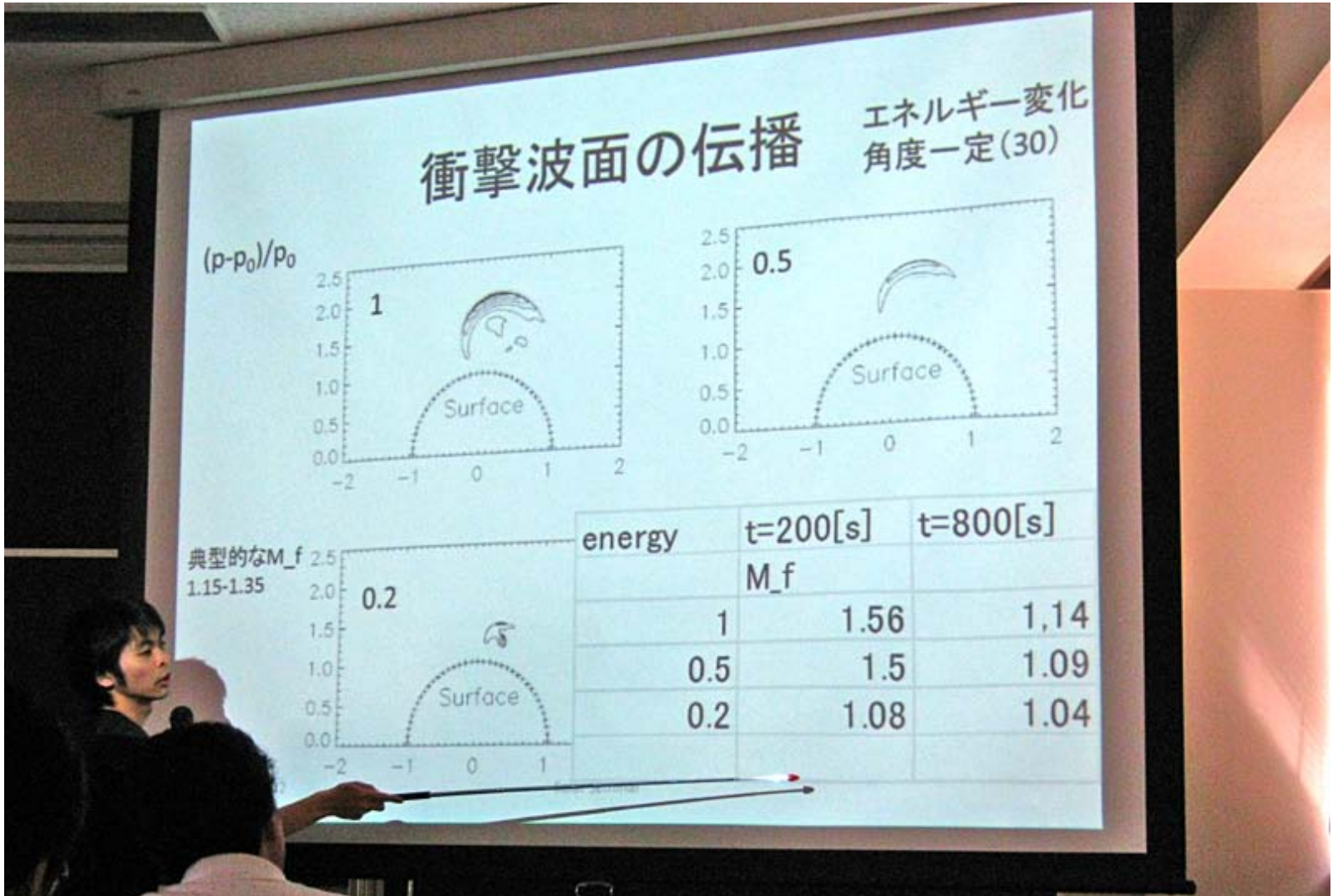
Preliminary Result (MW: Moreton Wave, WF: Winking Filament)

Flare					Moreton wave and/or winking filament(*)	Inclination	Absolute Speed	Orientation
Date	Peak time	Position	NOAA AR	Class				
1997/11/3	4:38	S20 W13	8100	C8.6	MW	104	170	NE
1997/11/4	5:58	S14 W33	8100	X2.1	MW & WF	79	200	N
1998/8/8	3:17	N17 E74	8299	M3.0	MW	81	50	S
1999/2/16	3:12	S23 W14	8458	M3.2	MW & WF	55	100	NW
2000/3/3	2:14	S15 W60	8882	M3.8	MW	47	140	SE
2000/6/15	23:43	N19 E19	9040	M2.0	MW	96	160	S
2000/7/16	6:14	S08 W25	9082	C3.8	MW	60	110	W
2001/5/12	23:35	S17 E00	9455	M3.0	MW	70	160	S
2001/5/13	3:04	S18 W01	9455	M3.6	MW	37	30	SW
2001/12/19	2:32	N09 E37	9742	C4.9	MW	82	170	NE
2002/8/22	1:57	S07 W62	69	M5.4	MW	79	150	S
2002/10/4	22:43	N13 E43	139	M2.7	MW	127	170	S
2003/5/27	23:07	S07 W17	365	X1.3	MW	65	60	S
2005/8/3	5:06	S13 E45	794	M3.4	MW	86	130	S

- We analyzed the velocity fields of **14** filament eruptions that is observed by FMT between 1997 and 2006.
- The average value of absolute velocity was 160km/s, and the direction of eruption was **near horizontal**



Tamazawa (a graduate student of Kyoto Univ), Shibata et al. are investigating the difference of time evolution of shockwaves between the filament eruption “with” Moreton wave and “without” Moreton wave by 2D MHD simulation.



In this ISWI meeting,
Mr. Denis CABEZAS will talk about an case-study on a filament eruption that does not have Moreton wave but that shows other evidences of existence of shock wave.

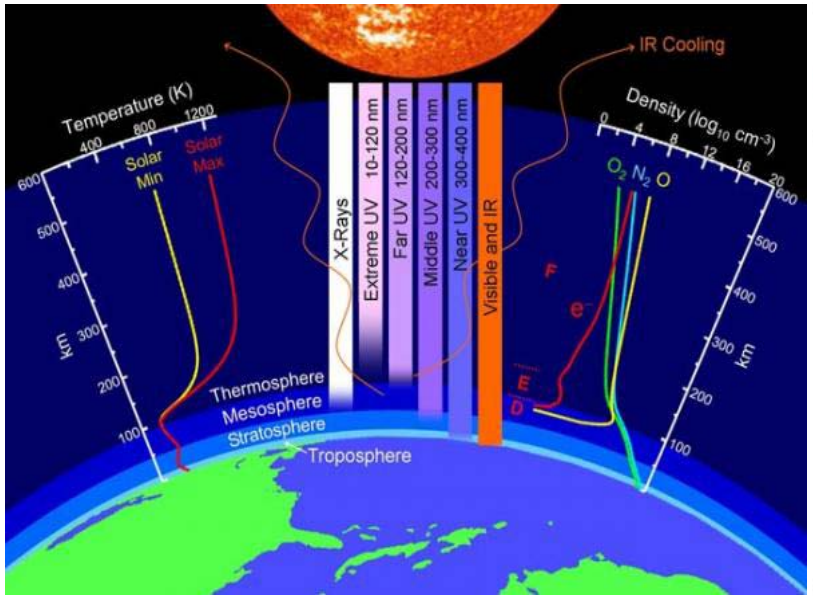
3.3 Estimation of Solar UV Radiation

Solar radiation is also one of very important element for understanding the change of space weather. Especially solar UV around from 50 to 140 nm has strong influence for the ionosphere of the earth.

One of good index of the change of ionosphere is the “Geo-magnetic Solar daily Quiet variation (Sq)”.

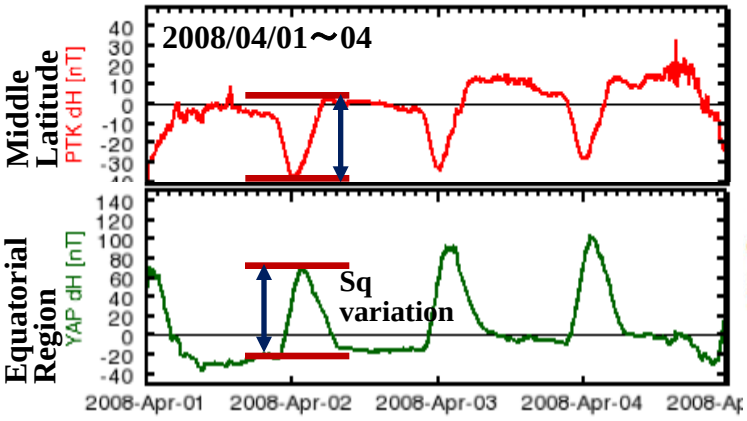
It basically changes obeying the solar activity due to the variation of solar UV radiation.

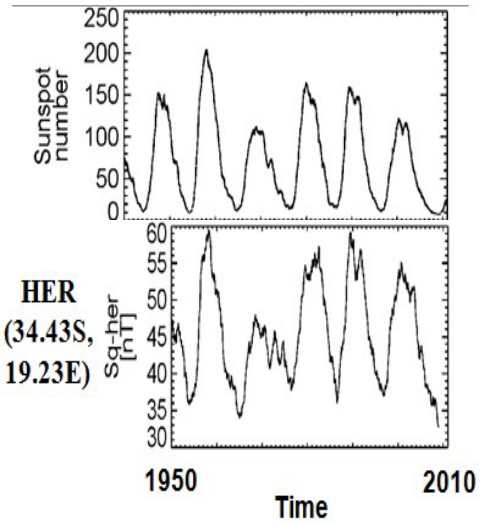
Actual UV observations started just after around 1995.
So, we are trying to reproduce more long-term UV radiation by using long-term solar chromospheric full-disk images.

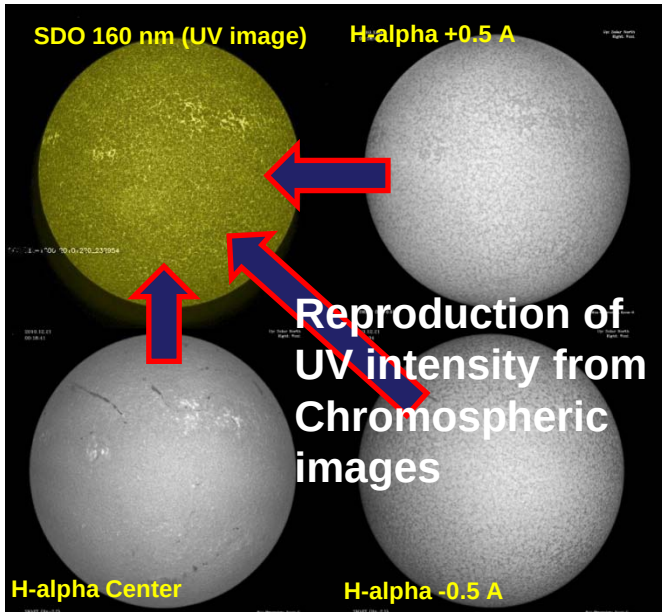


Element	Ionization	
	Vp(eV)	λ(nm)
N_2	15.58	79.6
O_2	12.08	102.6
O	13.61	91.1
N	14.54	85.3
NO	9.25	134
H	13.59	91.2
He	24.58	50.4

Example of Geomagnetic Solar daily Quiet variation (Sq)





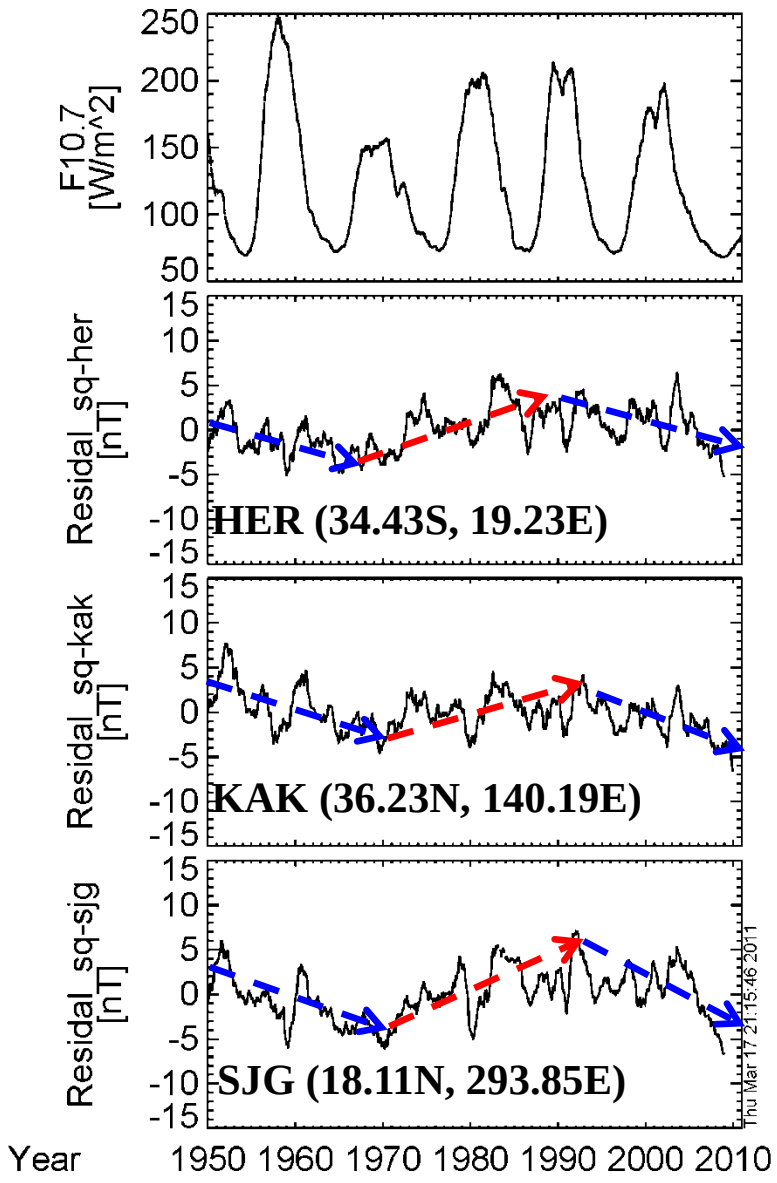


Our two main themes:

1)Contribution of solar radiation to long-term variation of Sq

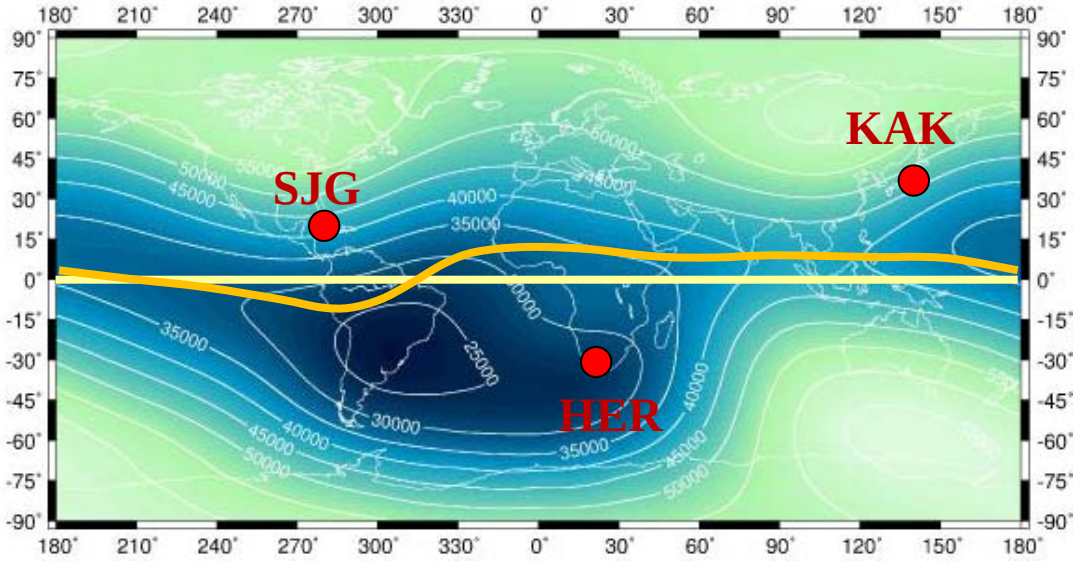
2)Reason of unusual fall of Sq at solar minimum phase around 2008

Result of long-term & multi-point analysis



Shinbori, UeNo, Asai et al.

Three examples among 178 stations

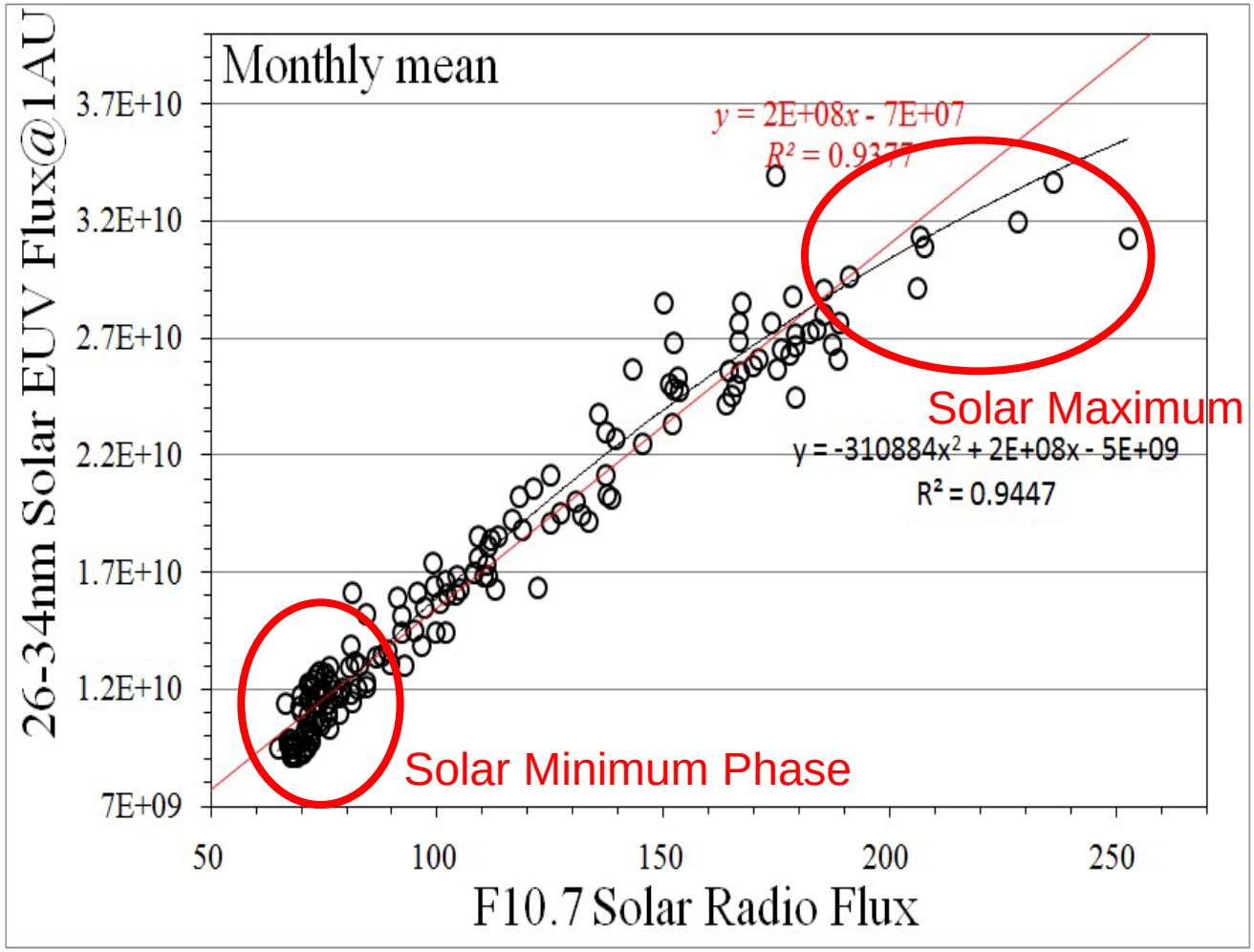


Station map

After subtraction of solar activity's variation from 60 years variation of Sq observed at many station, we could find global long-term variation in the residual Sq.

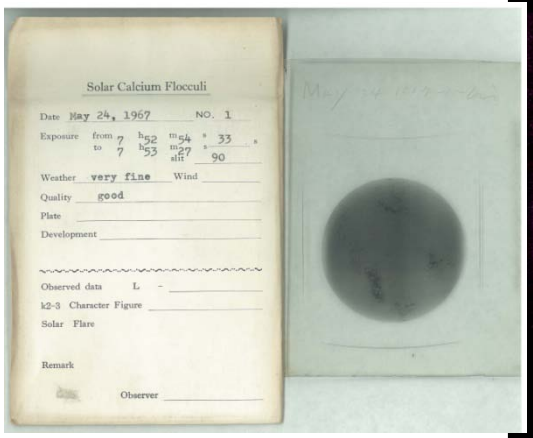
Note: We used F10.7 flux as the index of solar activity.

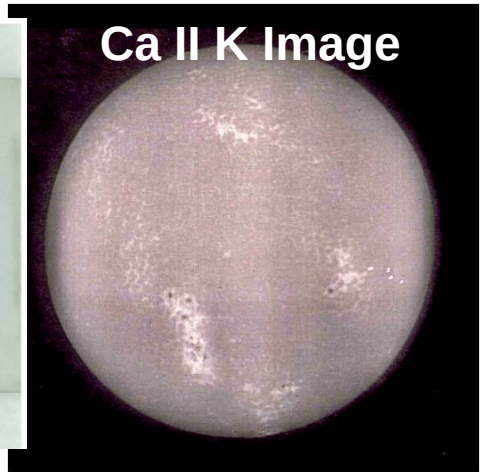
However, actually, we cannot neglect difference between the variation of F10.7 flux and variation of UV flux especially at solar maximum phase and at minimum phase.

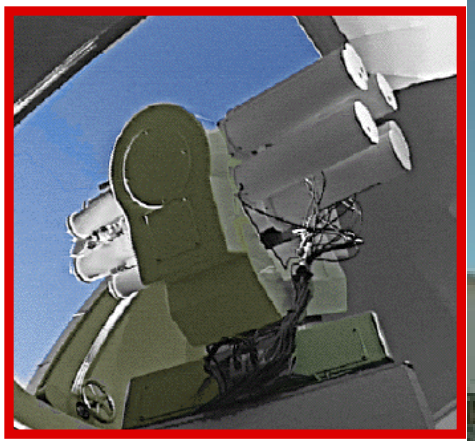


So, we have to know the long-term variation of UV radiation itself.

Estimation of long-term variation of solar UV radiation using chromospheric images

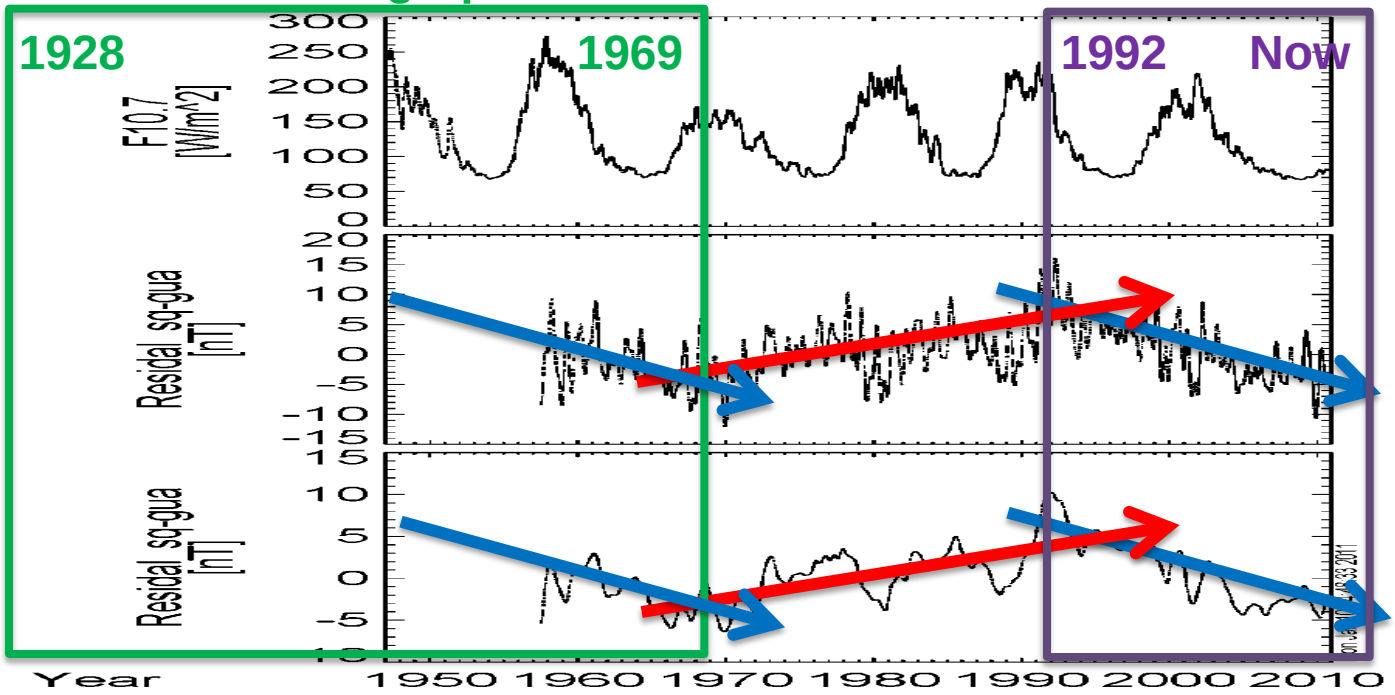






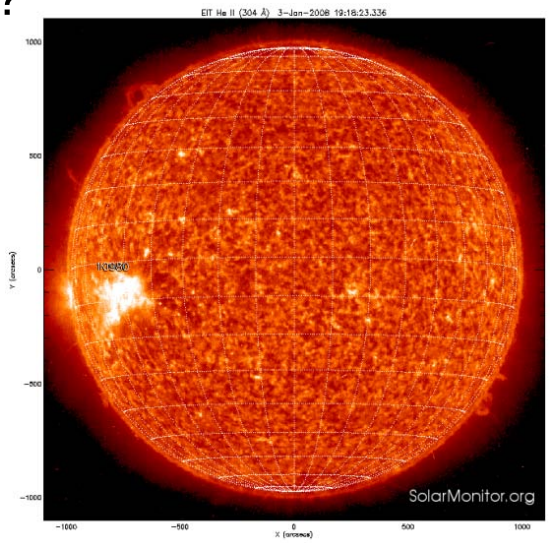
Data of Old Photographic Plates

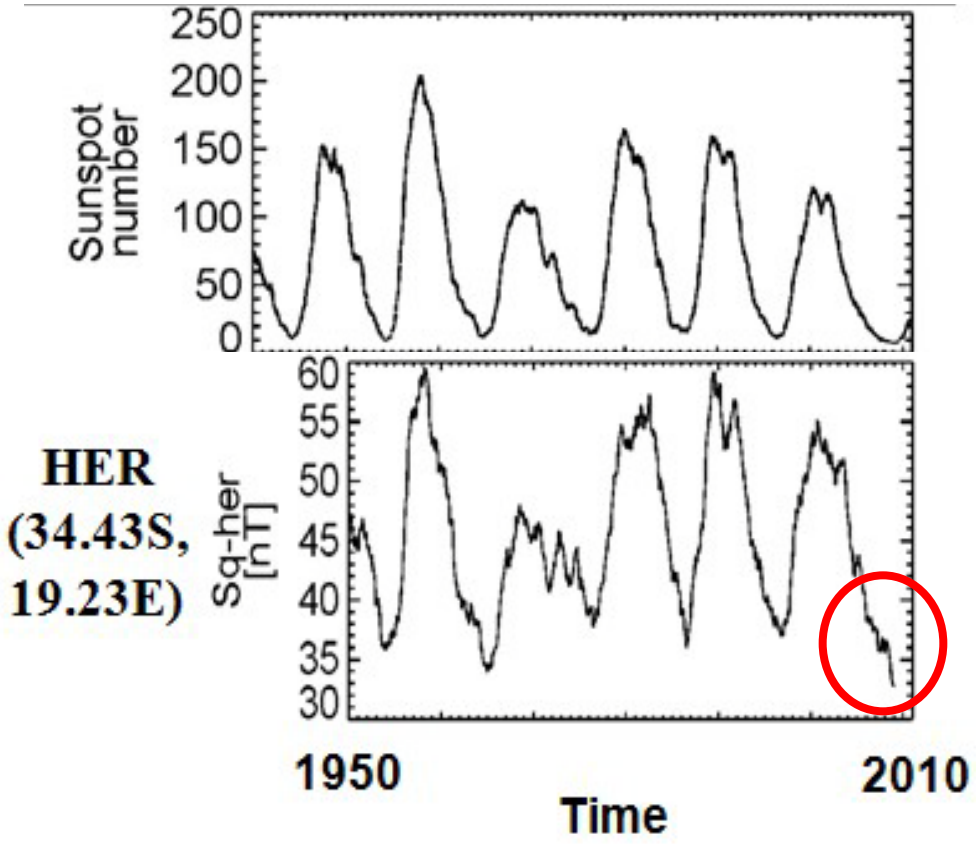
Data of CHAIN Telescopes



Why Sq variation and solar UV radiation show unusual fall at solar minimum phase around 2008 ?

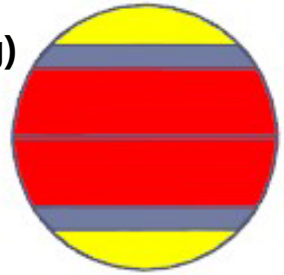
SoHO/EIT 30.4 nm

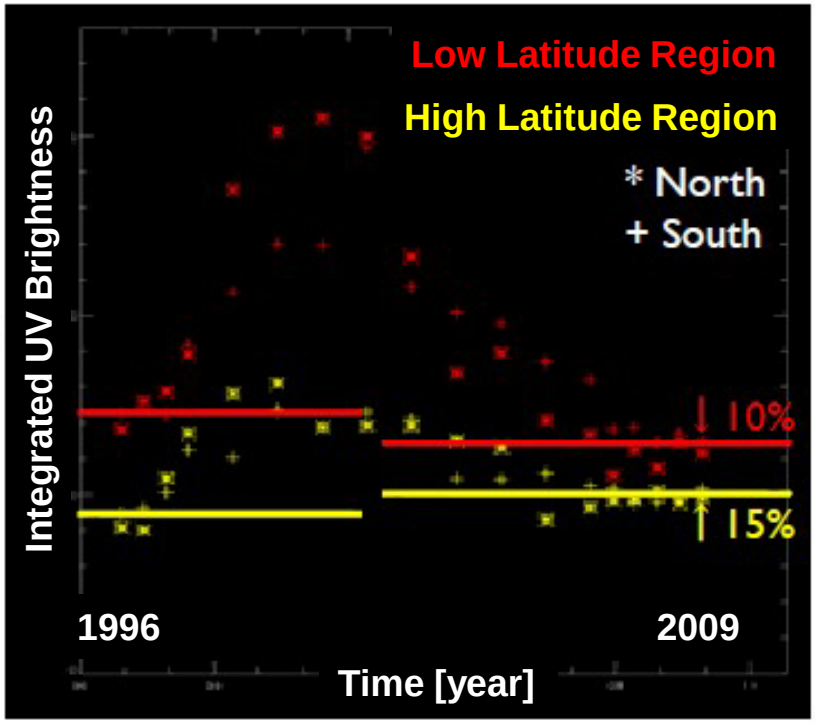




High Latitude Region
(-90 to -60, +60 to +90 deg)

Low Latitude Region
(-30 to 0, 0 to +30 deg)





Asai, Isobe, Kitai, UeNo et al.

We are investigating the reason why solar UV radiation from low latitude region were sufficiently weak around 2008
by using chromospheric images obtained with CHAIN telescopes.

We think this kind of study will also become an influential candidate as a theme of the future international cooperative studies.

For example, in this year, the Pakistan/ Space and Upper Atmosphere Research Commission(SUPARCO) made proposal to CHAIN-project to cooperatively study on the following themes:

- Study of Maximum Electron Density NmF2 at Karachi and Islamabad **during Solar Minimum (1996) and Solar Maximum (2000)**
- Variations in F2-layer parameters and comparison with IRI over Pakistan **for deep solar minimum**
- Ionospheric variability of low and mid latitude **for solar cycle 22 and 23**
- **Solar cycle effect** on coupling of neutral and ionized species at F2 altitude

Anyway, we plan to summarize our results of analyzing these three scientific themes in the ISWI period into some papers in the workshop that will be held in next February or March.

[Summary of CHAIN-project in the ISWI period]

■ Instrument Array:

- We installed the 1st oversea FMT to Peru/Ica on March 2010.
- Installation of the 2nd oversea FMT to Algeria is not achieved yet because of lack of fund.
  However, CRAAG of Algeria plan to build the FMT by their own fund.
- On the other hand, KSU of Saudi Arabia started a plan to build a FMT in their university by their own fund.

■ Capacity Building:

We have performed the following capacity building activities:

Lectures, Technical training, Scientific education,
Holding scientific data-analysis workshops,
Presentations at international symposiums

■ Cooperative Researches:

We have promoted international cooperative researches, focusing on the following three themes :

1. 3D velocity field measurement of eruptive phenomena
2. Shock wave detection
3. Estimation of solar UV radiation

[Summary of Future Activities of CHAIN-project]

■ In the field of instruments:

- Currently, we have no fund for some new instruments for more new stations, yet. => continue to make efforts
- For the candidate sites, we intend to provide technical training and advising on instruments, operation, data calibration of the FMT or of their own instruments.
  (For example, by sending researchers and engineers, or by inviting staffs of each country to Japan)

■ In the field of academic exchange:

- Education of scientific data analysis by using the CHAIN's H-alpha data or each station's data
- International cooperative research
  Existing themes should be further progressed.
  New themes should also be started.
- Holding and support of some scientific workshops etc.

"Developing nations" are continuously important existence for spreading this project.

The End