NASA Mission Management Updates to the *Hinode* Science Working Group

September 2015

SABRI NASA VAGE

On behalf of the US instrument teams

2-2. HOP Observations

Lead HOP information site: http://www.isas.jaxa.jp/home/solar/guidance/index.html

Guidance for Hinode scientific operations

July. 27, 2015

HOP PROPOSAL FORM

- Message to accepted HOP proposers: Hinode Ground-based coordination protocol (updated on Dec. 23, 2009)
- New policy regarding major flare watches, target of opportunity HOPs, and synoptic/long-term study HOPs (updated on July 31, 2010)
- Prioritization of Flare observations for Hinode: (updated on December 20, 2011)
- Prioritization of IRIS-Hinode Operations Plans (IHOPs) (updated on June 18, 2015)

- Introduction (Announcement for Solar News on 1 July 2008)
- Guidance for proposal observations (HOP)
    - Deadline for submission
    - Information required in submitted proposals
    - The following types of observations are strongly recommended to be submitted as HOPs, regardless of whether the proposers are inside or outside the Hinode team:
    - Points of contact for HOP submissions

- Information about the Hinode Instruments'
- Remarks
- Guideline for Hinode scientific operations

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2-2. HOP Observations

NASA site: http://hinode.msfc.nasa.gov/hops.html

HINODE OPERATION PLANS (HOPS)

Information needed for proposal development outlined below.
Also refer to http://www.isas.jaxa.jp/home/solar/guidance/index.html as the lead reference.

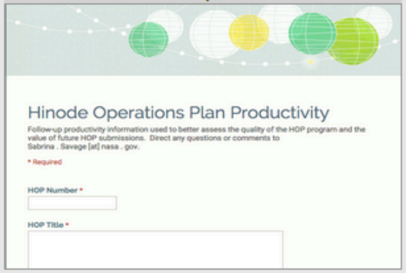
After reviewing the material, ****SUBMIT A HOP PROPOSAL HERE****.

HOPs List & Guidance

HOPs Coordination Calendar

POST-SUBMISSION PRODUCTIVITY UPDATES

SUBMIT HOP Results / Output



HOP & Proposer Productivity Logs

HOP Productivity Log

Log reliant on proposer-provided information and is therefore not complete.
Please contact sabrina.savage [at] nasa.gov to have any information updated.

137 Total Productivity Outputs   Histogram Per Year   Histogram Per HOP

HOP Proposer Productivity Log

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Abramenko
Aime

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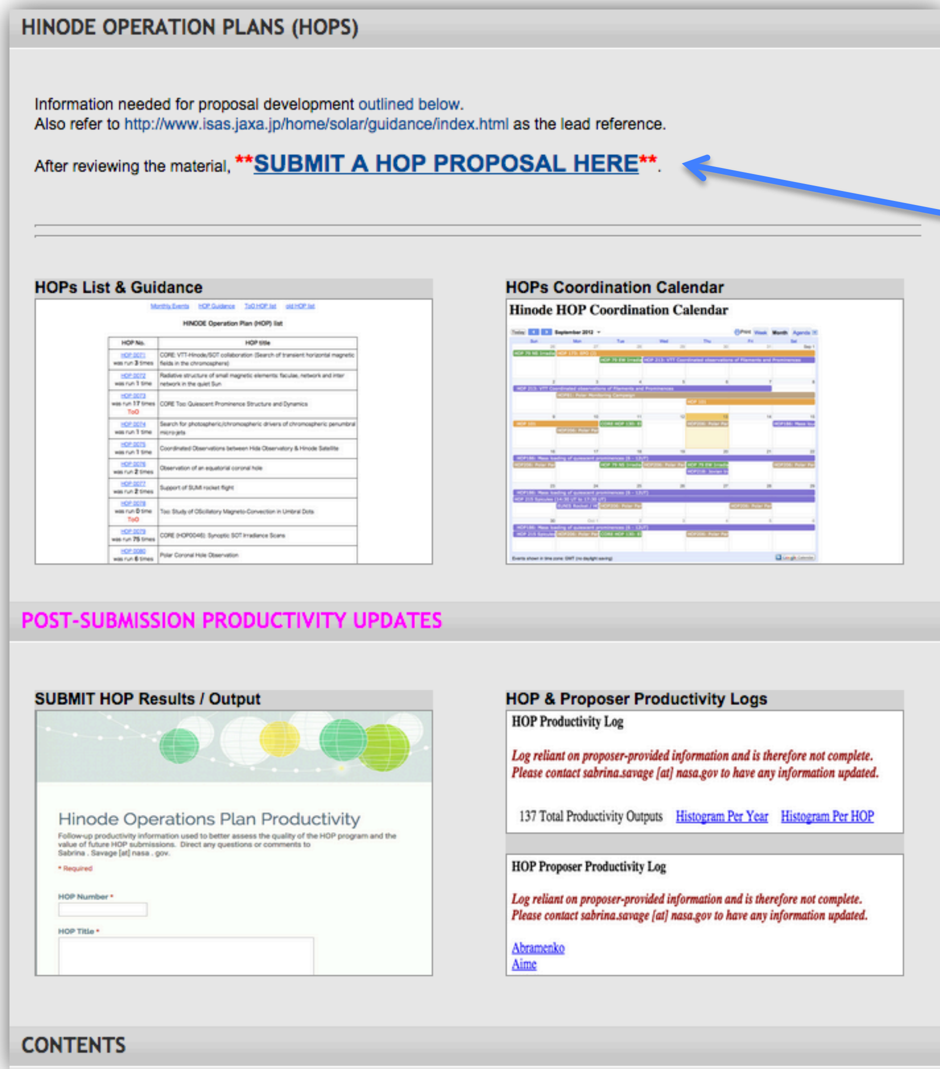
2-2. HOP Observations

Submission Form: https://docs.google.com/forms/d/1mvUqVsIlEZ0ta4hbzkVqKKv_kW8x6IHI584IkvaOzX8/viewform



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HINODE Operation Plan (HOP) list

HOPs Coordination Calendar

Hinode HOP Coordination Calendar

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SUBMIT HOP Results / Output

Hinode Operations Plan Productivity

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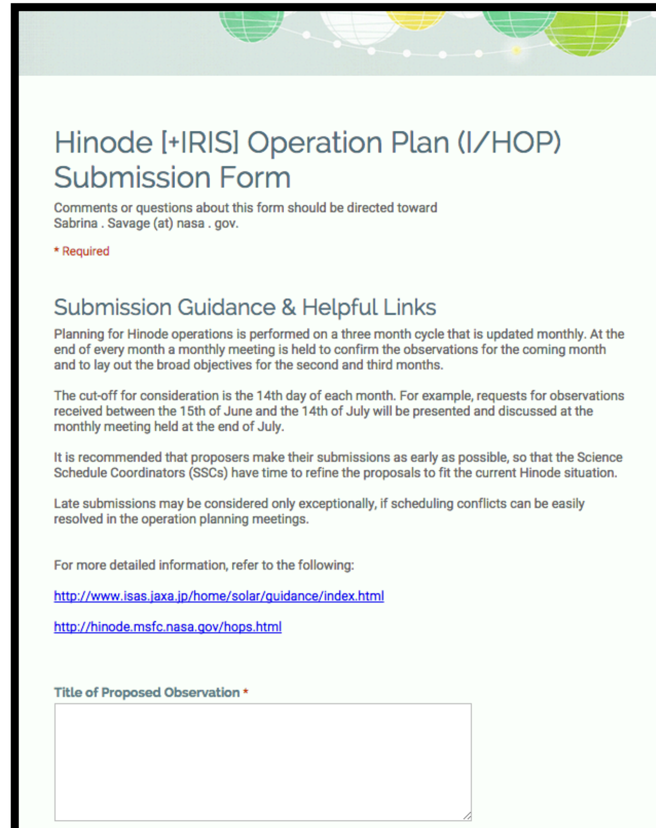


Hinode [+IRIS] Operation Plan (I/HOP) Submission Form

Comments or questions about this form should be directed toward Sabrina . Savage (at) nasa . gov.

* Required

Submission Guidance & Helpful Links

Planning for Hinode operations is performed on a three month cycle that is updated monthly. At the end of every month a monthly meeting is held to confirm the observations for the coming month and to lay out the broad objectives for the second and third months.

The cut-off for consideration is the 14th day of each month. For example, requests for observations received between the 15th of June and the 14th of July will be presented and discussed at the monthly meeting held at the end of July.

It is recommended that proposers make their submissions as early as possible, so that the Science Schedule Coordinators (SSCs) have time to refine the proposals to fit the current Hinode situation.

Late submissions may be considered only exceptionally, if scheduling conflicts can be easily resolved in the operation planning meetings.

For more detailed information, refer to the following:

http://www.isas.jaxa.jp/home/solar/guidance/index.html

http://hinode.msfc.nasa.gov/hops.html

Title of Proposed Observation *

2-2. HOP Observations

Calendar: http://hinode.msfc.nasa.gov/status.html

Scientific Justification *

Short statement describing the observation and scientific justification. This should be as short and concise as possible, but it should still contain all the key details. This statement is important because Hinode's limited data volume situation may make it necessary to modify some planned observations on some days. The Hinode team will refer to this statement when setting priorities for which observations to perform.

Hinode Calendar

Please see http://hinode.msfc.nasa.gov/status.html for important planning information (e.g., Hinode & IRIS eclipse season, Focused Mode period, etc.)

Dates *

Enter "ToO" if not specific. 1. Provide the start and end dates with reason. 2. Provide the minimum number of observation days during the period. 3. Provide desires and requirements for continuity of observations, for example: "three consecutive days are desired, but not required," "three consecutive days are required," or "it is not necessary for observations to be on consecutive days."

Time window

Time window in day, if required. 1. Provide the "minimum" duration with the start and end times in UT, if it is a coordinated observation with ground-based or space-based observatories. 2. Specify whether any short interruptions (e.g., for ten-minute synoptics) are allowed over the observing periods.

TECHNICAL STATUS

- **Hinode operations are nominal.**
- **Monthly Events**
- **Focused Mode Calendar** (*Subject to Revision*)

XRT

- **XRT operations are nominal.**
- **Bakeouts**
  - Bakeout List
- Filter Wheel 1 is in full use.

2-2. HOP Observations

SSC planning site: http://hinode.msfc.nasa.gov/submitted_hops.html

HINODE OPERATION PLANS SUBMISSIONS -- AUGUST 2015 SSC MEETING

RECENT/UPCOMING SUBMISSIONS

HOP 289 Filament/Su : Aug 1-8 : 17-21 UT
HOP 287 GREGOR/Verma : Aug 10-19 : 8:30-10:30 UT
HOP 292 Brightenings/Kanoh : Aug 10+ : 3 hours min
HOP 286 NST/Hong : Aug 17-19 : 18-21 UT
HOP 291 Hida/Ueno : Aug 17-23 : 0-4 UT
HOP 173 EPO/Yaji : Aug 24-29 : 2-6 UT
HOP 252 MOSES-II/Kankelborg : **Aug 27 : 17:25-18:40 UT +/- (11:25 MDT)**
HOP 288 Flares/Cheng : Aug 27-31 : 17-23 UT
HOP 290 CLASP/Ishikawa : Sep 3** : 17:16-18:16 UT +/-
HOP 257 SST/Tarbell : Sep 3-Oct 14 : 8-11 UT

NEW/UPDATED SUBMISSIONS

HOP206 -- PolarMap/Shimojo : September : Once every 3 days for 6 hours (SAA-free)
Submitted HOP #1: Jets/Savcheva : Oct 19-25 : 6 hrs/day

Submitted HOP # 1:

Full Proposal

Title: Coordinated UV/EUV/X-Ray observations of coronal jets
Main Objective: Identify the structure and dynamics of the jet acceleration region and the mechanism for supplying plasma and acceleration

ToO: No
Proposer: Antonia Savcheva, Paola Testa, Katharine Reeves

Previous Submissions:

Savcheva: None
Testa
Reeves

Dates: 2015 Oct 19-25
Times: 6 hours per day, time of day not important
Target/Pointing: AR with some inclusion polarities on the outskirts, or near a coronal hole

SOT:
SP maps of the photospheric magnetic field

EIS:
A study similar to ISSI_jet_1, but add a few more cool lines (e.g., FeVIII, IX) with shorter exposure times, and a smaller raster size to overlap better with the IRIS FOV.

XRT:
384"x384" FOV, thin-Be filter, fast cadence (~20 sec) for as much of the observing period as telemetry allows.

Other instruments:
IRIS: medium 8-step dense raster, 4 sec exposure time, 1330 & 1400 SJIs, large linelist (OBS ID: 3600257226).

Comments:

Ongoing HOP # 206/81:

HOP description

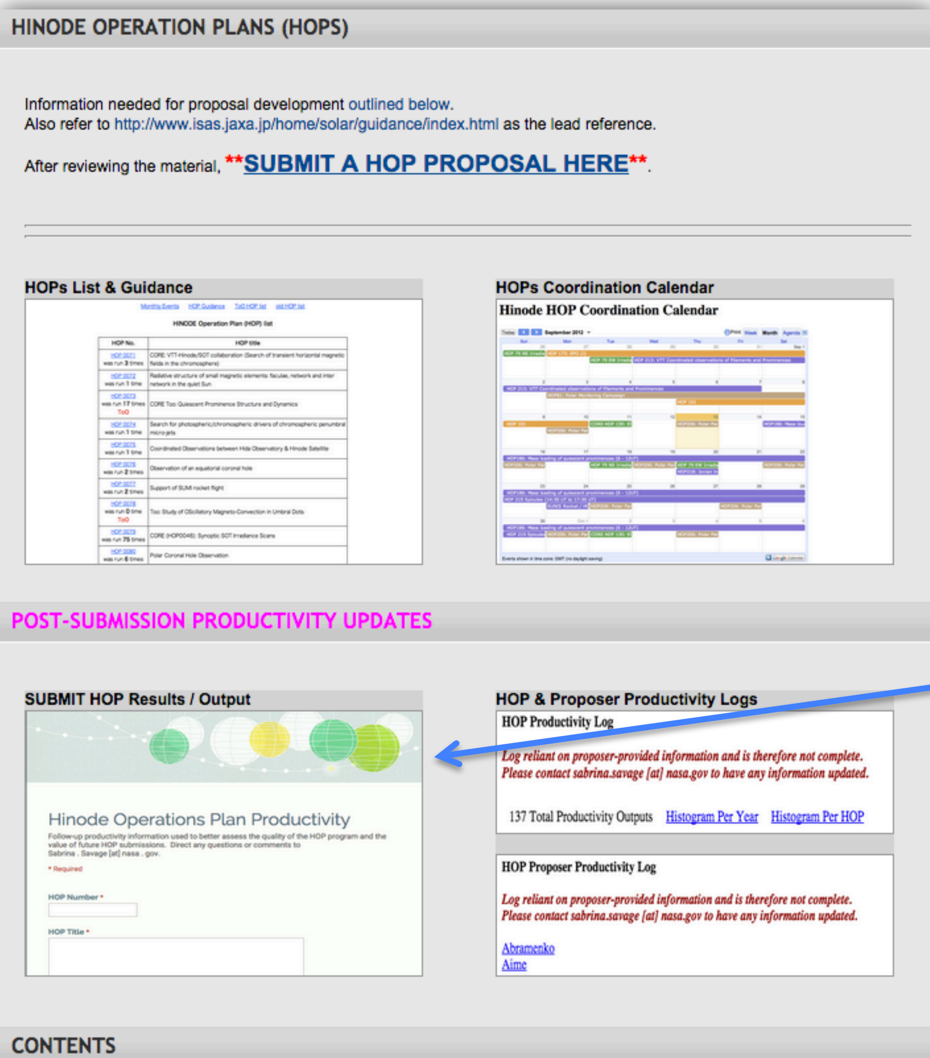
Title: Polar Panorama Map for understanding Polar Reversal in Cycle 24
ToO: No
Proposer: Shimojo, Tsuneta, Shiota, Sako, Anjali
Dates: September
Times: Once every 3 days for 6 hours
Target/Pointing: North Pole

Comments:
September is the month for the North pole, and we need to schedule runs of HOP 81 (6-days) and the Polar Panorama HOP 206 (every 2-3 days for a month). You may recall that he made the standing request at the SWG meeting this year. Both take 6-7 hours of SAA-free time per run.

2-2. HOP Observations

New

Productivity Form: https://docs.google.com/forms/d/1KeBH_RCLjzChGvrA-flyKKyvtouqJ3M00Acj3SrR5_E/viewform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SUBMIT HOP Results / Output

Hinode Operations Plan Productivity

HOP & Proposer Productivity Logs

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137 Total Productivity Outputs Histogram Per Year Histogram Per HOP

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Abramenko
Aime

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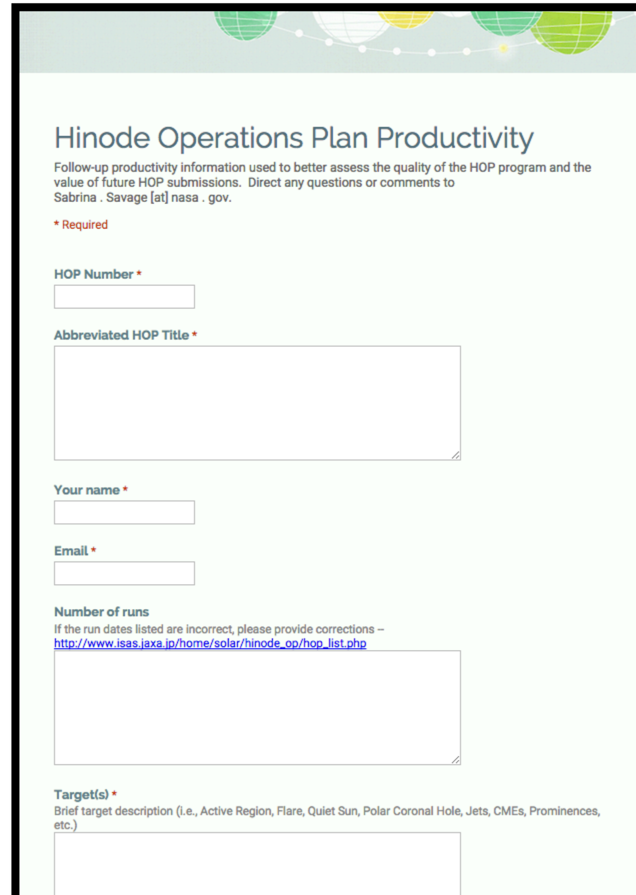

Hinode Operations Plan Productivity

Follow-up productivity information used to better assess the quality of the HOP program and the value of future HOP submissions. Direct any questions or comments to Sabrina . Savage [at] nasa . gov.

* Required

HOP Number *

Abbreviated HOP Title *

Your name *

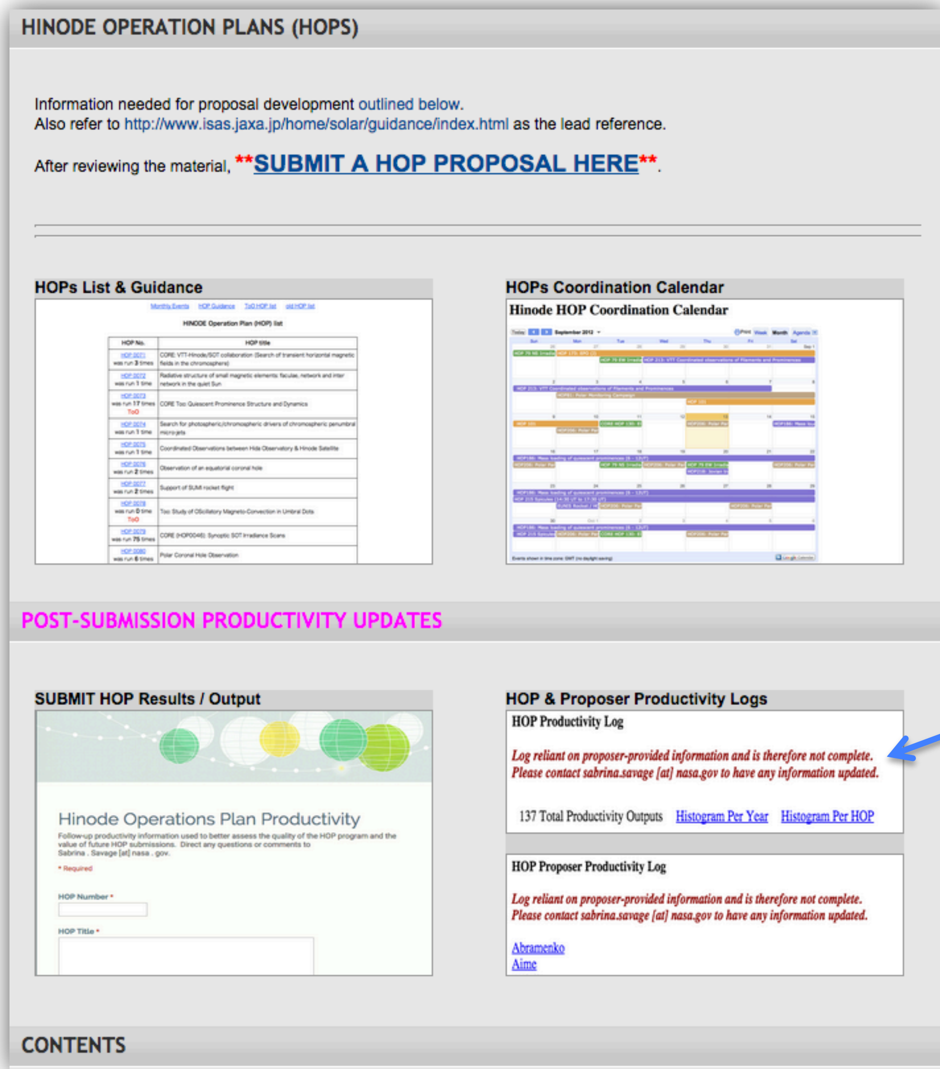
Email *

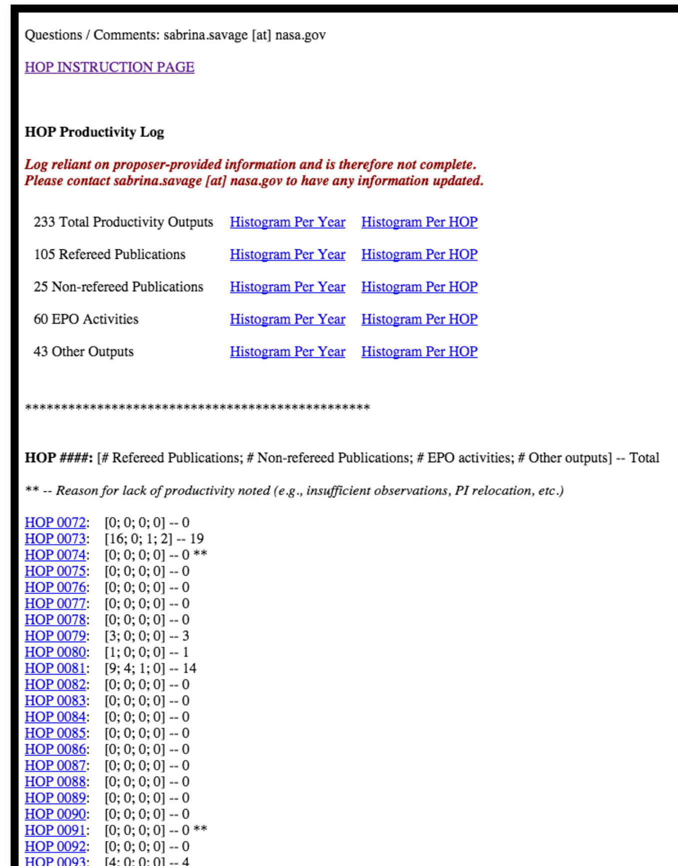
Number of runs
If the run dates listed are incorrect, please provide corrections -- http://www.isas.jaxa.jp/home/solar/hinode_op/hop_list.php

Target(s) *
Brief target description (i.e., Active Region, Flare, Quiet Sun, Polar Coronal Hole, Jets, CMEs, Prominences, etc.)

2-2. HOP Observations

HOP Productivity Log: http://hinode.msfc.nasa.gov/operations/hop_assessment/HOP_Productivity_Log.html





Questions / Comments: sabrina.savage [at] nasa.gov

HOP INSTRUCTION PAGE

HOP Productivity Log

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Please contact sabrina.savage [at] nasa.gov to have any information updated.

233 Total Productivity Outputs	Histogram Per Year	Histogram Per HOP
105 Refereed Publications	Histogram Per Year	Histogram Per HOP
25 Non-refereed Publications	Histogram Per Year	Histogram Per HOP
60 EPO Activities	Histogram Per Year	Histogram Per HOP
43 Other Outputs	Histogram Per Year	Histogram Per HOP

****

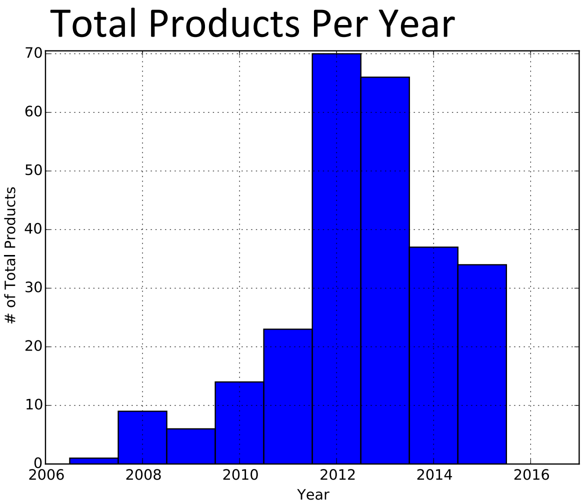
HOP ####: [# Refereed Publications; # Non-refereed Publications; # EPO activities; # Other outputs] -- Total

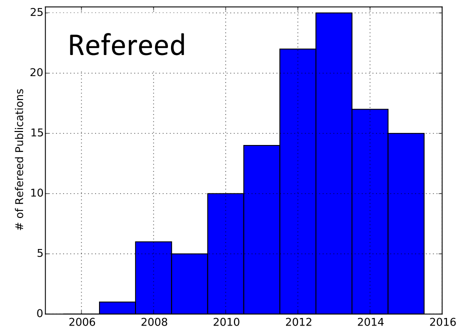
** -- *Reason for lack of productivity noted (e.g., insufficient observations, PI relocation, etc.)*

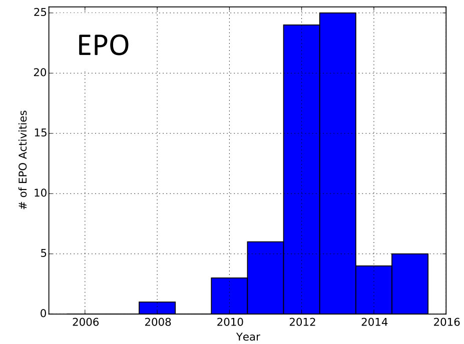
HOP 0072: [0; 0; 0; 0] -- 0
HOP 0073: [16; 0; 1; 2] -- 19
HOP 0074: [0; 0; 0; 0] -- 0 **
HOP 0075: [0; 0; 0; 0] -- 0
HOP 0076: [0; 0; 0; 0] -- 0
HOP 0077: [0; 0; 0; 0] -- 0
HOP 0078: [0; 0; 0; 0] -- 0
HOP 0079: [3; 0; 0; 0] -- 3
HOP 0080: [1; 0; 0; 0] -- 1
HOP 0081: [9; 4; 1; 0] -- 14
HOP 0082: [0; 0; 0; 0] -- 0
HOP 0083: [0; 0; 0; 0] -- 0
HOP 0084: [0; 0; 0; 0] -- 0
HOP 0085: [0; 0; 0; 0] -- 0
HOP 0086: [0; 0; 0; 0] -- 0
HOP 0087: [0; 0; 0; 0] -- 0
HOP 0088: [0; 0; 0; 0] -- 0
HOP 0089: [0; 0; 0; 0] -- 0
HOP 0090: [0; 0; 0; 0] -- 0
HOP 0091: [0; 0; 0; 0] -- 0 **
HOP 0092: [0; 0; 0; 0] -- 0
HOP 0093: [4; 0; 0; 0] -- 4

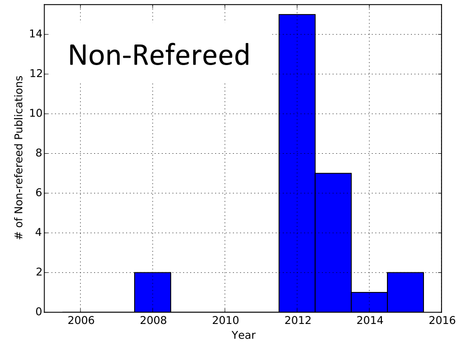
** Lack of productivity reason given (e.g., insufficient observations, bad seeing, not aligned, etc.)

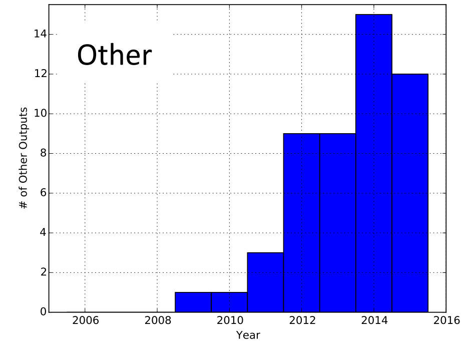
2-2. HOP Observations

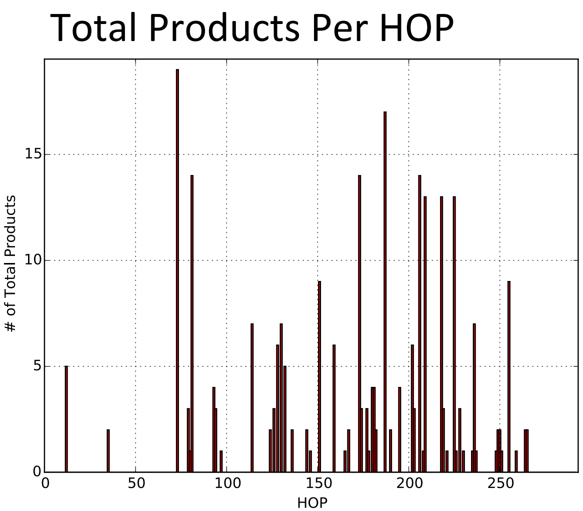












Current report (as of Sept. 10, 2015):

84 HOPs reporting (~37% for HOPs < 71 + 2 < 71)
259 Total Productivity Outputs
115 Refereed Publications
27 Non-refereed Publications [e.g., Conf. Proceedings]
67 EPO Activities
50 Other Outputs [e.g., Talks, Posters]

2-2. HOP Observations

Notes:

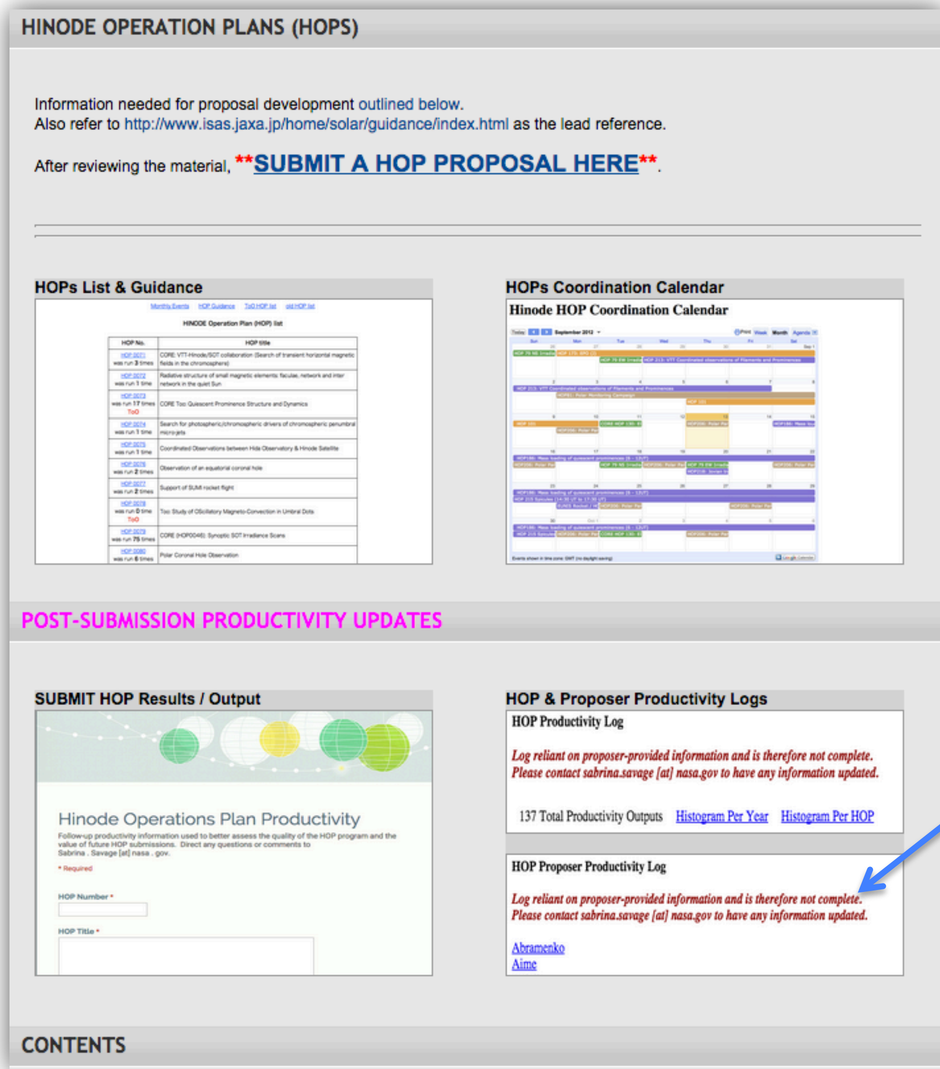
1. HOP run dates not always correct on HOP listing page.

2. Complaint from Proposer (Antolin):

> "The HOP number does not seem to be included in the details of the observation for the Hinode instruments (it is included in the IRIS run details). This makes it very hard and time consuming to gather all the information for a specific HOP."

2-2. HOP Observations

HOP Proposer Log: http://hinode.msfc.nasa.gov/operations/hop_assessment/HOP_Proposer_Productivity_Log.html



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Abramenko
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Anan
Anjali
Antolin
Anzer
Arnaud
Asai
Asensio Ramos
Attie
Attrill
Aulanier
Bai
Baker
Balmaceda
Balthasar
Bando
Banerjee
Bastian
Becher
Beck
Bellot Rubio
Bemporad
Berger
Berghmans
Bewsher
Blanco
Bogachev
Brajsa
Brooks
Brosius
Cabello
Cadavid
Carlsson
Carnonell
Casini
Cauzzi
Centeno
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2-2. HOP Observations

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2-2. HOP Observations

Hinode regularly coordinates with both ground- and space-based observatories and complements several regularly scheduled data-collecting observatories(*) . Hinode also co-observes with sounding rocket and balloon technology development demonstrations. Much of the coordination is scheduled through the Hinode Operations Plan (HOP) program. Since 2008, partnering sites and instrumentation include (but not limited to):

Ground-based:

Atacama Large Millimeter/Submillimeter Array (ALMA) – Chile
Bialkow Observatory – Poland
Big Bear Solar Observatory (BBSO) [NST/FISS/IRIM] – New Jersey
Dunn Solar Telescope (DST/NSO) [IBIS/ROSA/SHAZAM/FIRS] – New Mexico
Dutch Open Telescope (DOT) – La Palma
Fuxian Lake Solar Observatory – China
GREGOR Solar Telescope [GRIS] – Tenerife
Haleakala Observatory – Hawaii
Hida Observatory [DST] – Japan
Iitate Radio Telescope (IPRT) – Tohoku University/Japan
Kanzelhohe Solar Observatory (KSO) – Austria
Lomnicky Peak Observatory [CoMP] – Czech Republic
Mauna Loa Solar Observatory (MLSO) [CoMP] – Hawaii
McMath-Pierce Telescope (NSO) – New Mexico
Meudon Solar Tower – Paris
Ondrejov Observatory – Czech Republic
Pic du Midi Observatory – France
Solar Magnetic Activity Research Telescope (SMART) – Japan
Solar Terrestrial Laboratory [IPS] – Nagoya University/Japan
Solar Tower Telescope of Nanjing University – China
Swedish Solar Telescope (SST) [CRISP/TRIPPEL] – La Palma
Synoptic Optical Long-term Investigations of the Sun (SOLIS/NSO) – New Mexico
Vacuum Tower Telescope (VTT) – Tenerife
Very Large Array (VLA)

(Note: Several High Schools and Science Museums in Japan)

Space-based:

Active Cavity Radiometer Irradiance Monitor Satellite (ACRIM)
*Advanced Composition Explorer (ACE)
Akatsuki (Venus probe)
Cassini (Saturn mission)
Hubble Space Telescope (HST) [WFPC3]
Interface Region Imaging Spectrograph (IRIS)
Mercury Surface, Space Environment, Geochemistry, and Ranging (Mercury mission)
Nuclear Spectroscopic Telescope Array (NuSTAR)
Project for OnBoard Autonomy 2 (PROBA2) [SWAP]
*Ramaty High Energy Solar Spectroscopic Imager (RHESSI)
Solar and Heliospheric Observatory (SOHO) [SUMER/EIT/CDS/UVCS/MDI/LASCO]
*Solar Dynamics Observatory (SDO) [AIA/EVE/HMI]
Solar Radiation and Climate Experiment (SORCE) [TIM]
*Solar Terrestrial Relations Observatory (STEREO) [EUVI]
Telescopes for EUV Spectral Imaging of the Sun (TESIS)
Time History of Events and Macroscale Interactions during Substorms (THEMIS)
Transient Region and Coronal Explorer (TRACE)
*Wind: Comprehensive Solar Wind Laboratory for Long-Term Solar Wind Measurements

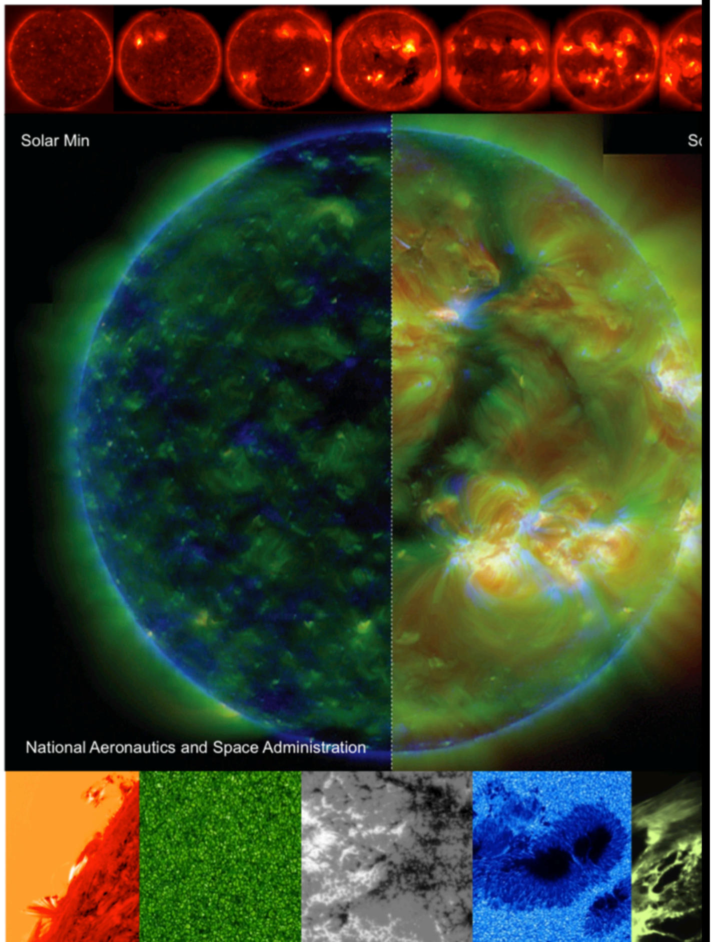
Technology Demonstrations:

SUMI	HIC (1)	CLASP
RAISE	FOXSI	
SUNRISE (Balloon)	MOSES (1 & 2)	
EUNIS	VAULT	

51 Total Observatories/Rockets/Balloons

2-3. Hinode Scientific Activities

Hinode: A Comprehensive Mission to Study the Variable Su



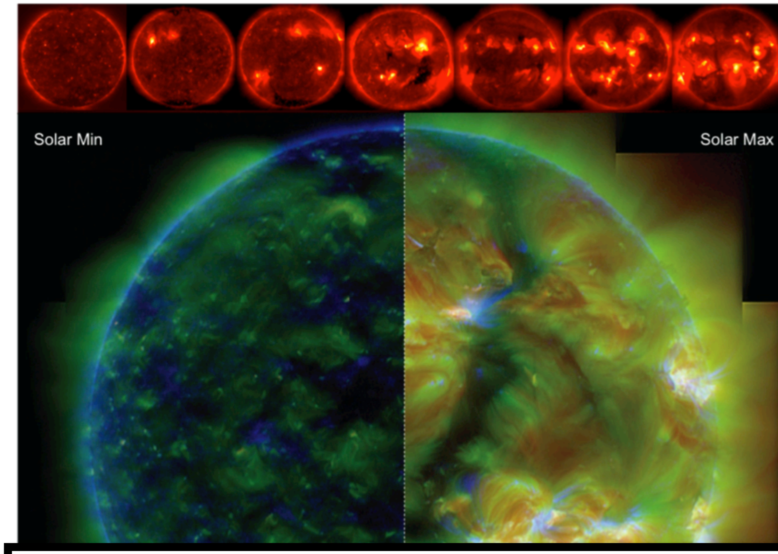
A proposal to the Senior Review of Heliophysics Operating Missions
March 2015

Table 1: Recent Extended Mission Science results linked to relevant 2014 Heliophysics Roadmap Research Focus Areas (RFAs) and 2012 Decadal Survey Challenges (DSCs). *Additional example results are described in the text.*

RFAs & DSCs	§	SCIENCE OBJECTIVE	Example Results
§ 2.1: Understand the structure and stability of the magnetized atmosphere			
	2.1.1	Observe the emergence of flux ropes	- Emerging flux shown to have connectivity in the corona through twist
RFA H1	2.1.2	Study the evolution of polar crown filaments	- Transverse waves in a quiescent prominence imply chromospheric driving of high-frequency waves
DSCs SH 2 & 3	2.1.3	Map topological structures and the origin of the slow solar wind	- Slow solar wind sources strongly rooted in active region boundaries
§ 2.2: Measure the storage and release of mass and energy from the corona			
RFA F5	2.2.1	Determine the correlation between chromospheric and coronal heating	- Rapid brightenings in the chromosphere and transition region link to accelerated particles and heating
RFA F1	2.2.2	Characterize the properties of flare-forming regions and reconnection sites	- Reconnection likely produces plasma heating via turbulence
RFA F2	2.2.3	Isolate the locations of CME initiation	- Compact pre-eruption brightentings observed at the base of flaring active regions and above the erupting loop tops
RFA H1	2.2.4	Determine the role of magnetic field line braiding in atmospheric heating	- Transient brightening heating events favor stranded coronal loop models.
DSCs SH 1 & 2			
§ 2.3: Characterize energy and mass transfer from the photosphere to the corona			
RFA H1	2.3.1	Determine the role of the chromosphere in providing hot plasma to the corona	- Emerging flux quiescently reconnecting with pre-existing fields leads to total radiated energy comparable to M-class flares
RFA F5 DSCs SH 2 & 3	2.3.2	Study the propagation of Alfvén waves through the solar atmosphere	- Reflected energy measurements indicate the generation of Alfvén wave turbulence in active region loops
§ 2.4: Quantify variations over the solar cycle			
RFA F4	2.4.1	Monitor dynamo and magnetic field changes	- Internetwork fields transfer flux to the magnetic network at a rate that could replace the entire network in 18-24 hours.
RFA H1 DSCs SH 2 & 3	2.4.2	Survey irradiance variability	- The XRT solar irradiance time profile can provide quantitative correction to the *GOES* flux during low activity periods.

2-3. Hinode Scientific Activities

Hinode: A Comprehensive Mission to Study the Variable Sun



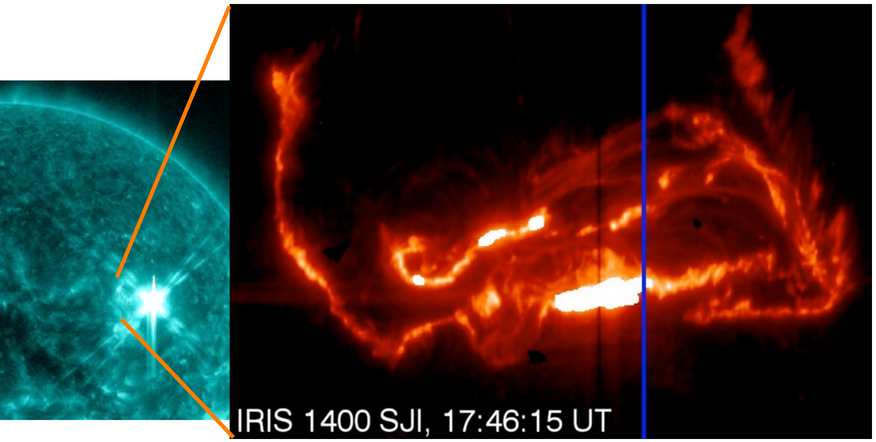
In response to the 2012 NRC Decadal Survey Science Challenges and 2014 Heliophysics Roadmap Research Focus Areas, the *Hinode* mission has set forth four **Prioritized Science Goals (PSGs)**:

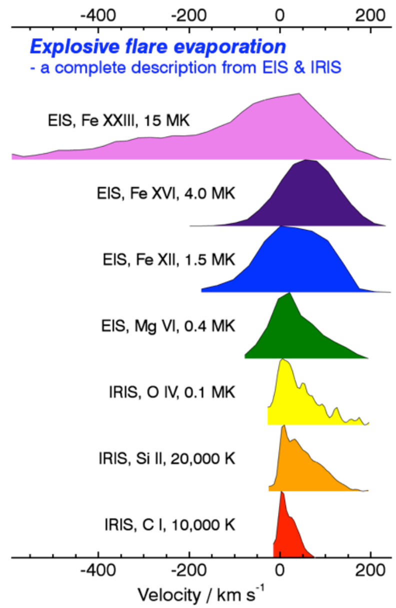
- Study the sources and evolution of highly energetic dynamic events.
- Characterize cross-scale magnetic field topology and stability.
- Trace mass and energy flow from the photosphere to the corona.
- Continue long term synoptic support to quantify cycle variability.

Table 2: Prioritized Science Goals and required observations mapped to the 2014 Heliophysics Roadmap Research Focus Areas (RFAs) and 2012 Decadal Survey Challenges (DSCs).

RFAs & DSCs	§	SCIENCE OBJECTIVE	SAMPLE OBSERVATIONS
§ 3.1: PSG1 – Study the sources and evolution of highly energetic dynamic events			
RFA H1	3.1.1	Observe large-scale eruptive events from flare to particle acceleration.	- Coordinated radio, EUV, and X-ray observations of thermal & non-thermal eruption processes
RFA F2	3.1.2	Characterize the energetics of nanoflares and properties of non-thermal electrons.	- Nanoflare electron beam studies with *NuSTAR*
RFA F1	3.1.3	Probe magnetic reconnection flux transfer and energy release during flaring events.	- Spectrally probing chromospheric evaporation/condensation in flare loops
			Focused Mode opportunity: CME watch
DSCs SH 2 & 3			**Synergies:** *IRIS*, *ALMA VLA*, *EOVSA*, *NuSTAR*, *SDO*, *RHESSI*, *STEREO*
§ 3.2: PSG2 – Characterize the cross-scale magnetic field topology and stability.			
RFA H1	3.2.1	Study active region energy storage, topology, and evolution.	- Monitor the temperature stratification above ARs to potentially predict energy releases
RFA F2	3.2.2	Determine the impact of small-scale magnetic fields on the solar atmosphere.	- Specifically-designed sequences for *IRIS* coordination to observe unresolved fine structure in the transition region
	3.2.3	Determine the impact of large-scale magnetic field variations on the heliosphere.	- Test S-web model predictions concerning magnetic field topology in the outer corona with deep, wide-field SXR imaging
DSCs SH 2 & 3			**Focused Mode opportunity:** AR evolution
			Synergies: *IRIS*, *SDO*
§ 3.3: PSG3 – Trace mass and energy flow from the photosphere to the corona.			
RFA H1	3.3.1	Isolate solar wind sources and measure their mass supply.	- New EIS observing modes scanning for slow solar wind sources
RFA F5	3.3.2	Characterize the heating of the chromosphere.	- Link chromospheric heating diagnostic ion transport with Poynting flux estimates
	3.3.3	Quantify the generation, dissipation, and impact of magnetic waves.	- Vorticity measurements tracing chromospheric twist into the corona
DSCs SH 2 & 3			**Focused Mode opportunity:** EIS scans
			Synergies: *ACE*, *IRIS*, *SDO*
§ 3.4: PSG4 – Continue long term synoptic support to quantify cycle variability.			
RFA F4	3.4.1	Understand solar irradiance variations.	- Derive continuum contrast from SOT continuum bands and *IRIS* Mg II index
RFA H1	3.4.2	Monitor solar cycle evolution and stability.	- Polar magnetic fields, X-ray bright points, and magnetic activity band progression as indicators of solar cycle evolution and activity
	3.4.3	Relate solar variability to stellar evolution.	- Application of "Sun-as-a-star" methods to synoptic data for stellar abundance profiles
DSCs SH 1 & 3			**Synergies:** *IRIS*, *SDO*

2-3. Hinode Scientific Activities

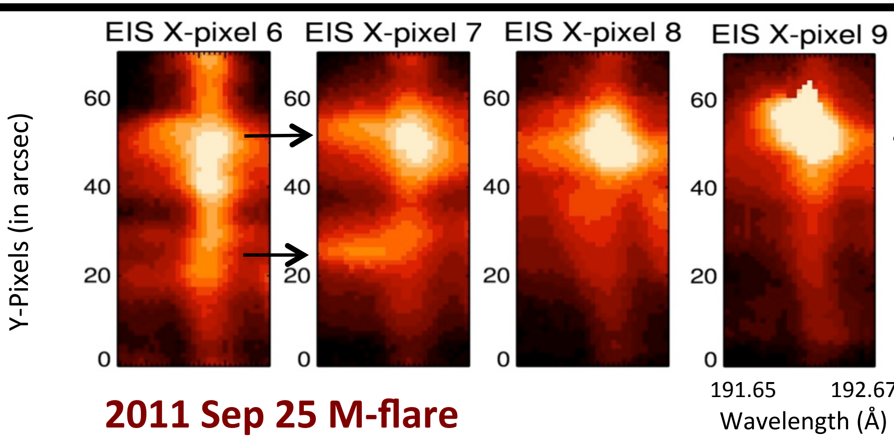


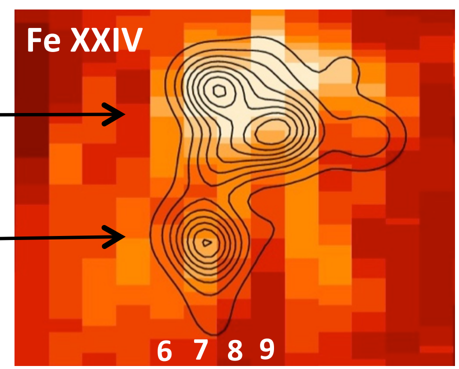


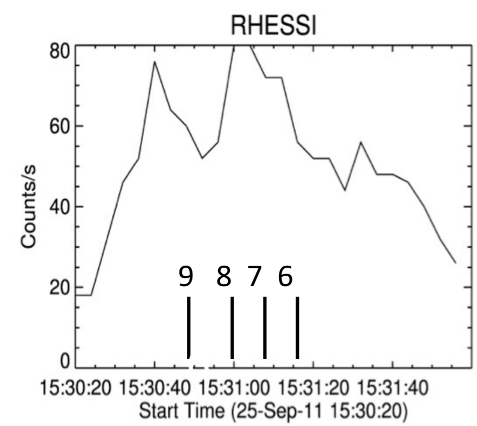
2014 March 29 X-flare

EIS and *IRIS* spectral line profiles

Energy release at chromosphere sends cooler plasma down to surface; heated, 15 MK plasma rises into corona







2011 Sep 25 M-flare

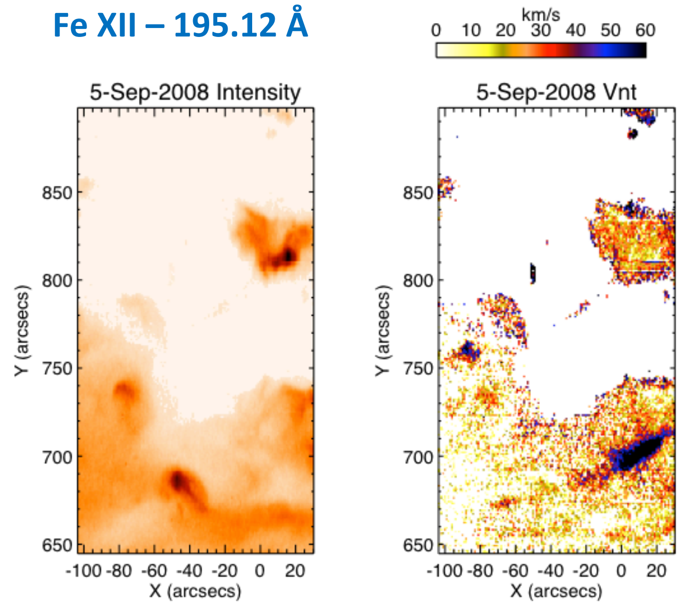
Evaporation in solar flare footpoints observed by *Hinode*/EIS and *RHESSI*. Upflow velocities In excess of 600 km/s were found for multi-million degree (~12 MK) lines of Fe XXIV and Fe XXIII. The data are compared with predictions of 1D hydrodynamic simulations. The arrows indicate footpoint regions (Doschek et al., to be submitted, 2014).

2-3. Hinode Scientific Activities

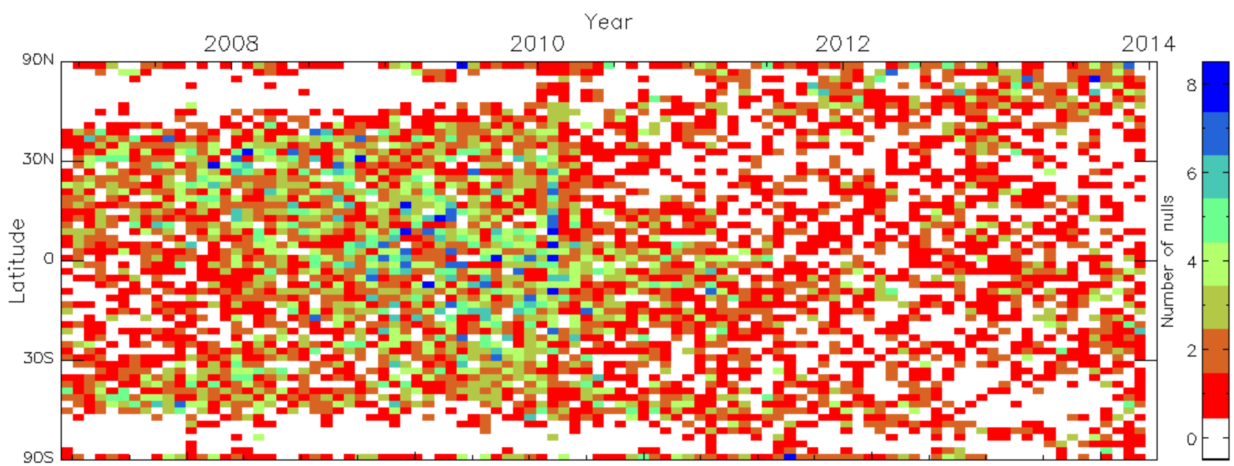
Coronal Non-Thermal Velocity in Polar Regions from Solar Minimum to Cycle 24 Solar Maximum

- The **non-thermal velocities** (Vnt) (e.g., turbulence, multiple flow sites) have been measured in the corona using the spectral line of Fe XII at 195.12 Å observed by *Hinode*/EIS.
- The magnetic nulls at high latitude regions were determined. These show changes during the cycle induced by the opposite polarity streams reaching the poles.
- The coronal Vnt does not show such variation – this lack of variation during the cycle indicates that a **local dynamo may exist**.

Fe XII – 195.12 Å



Magnetic Nulls

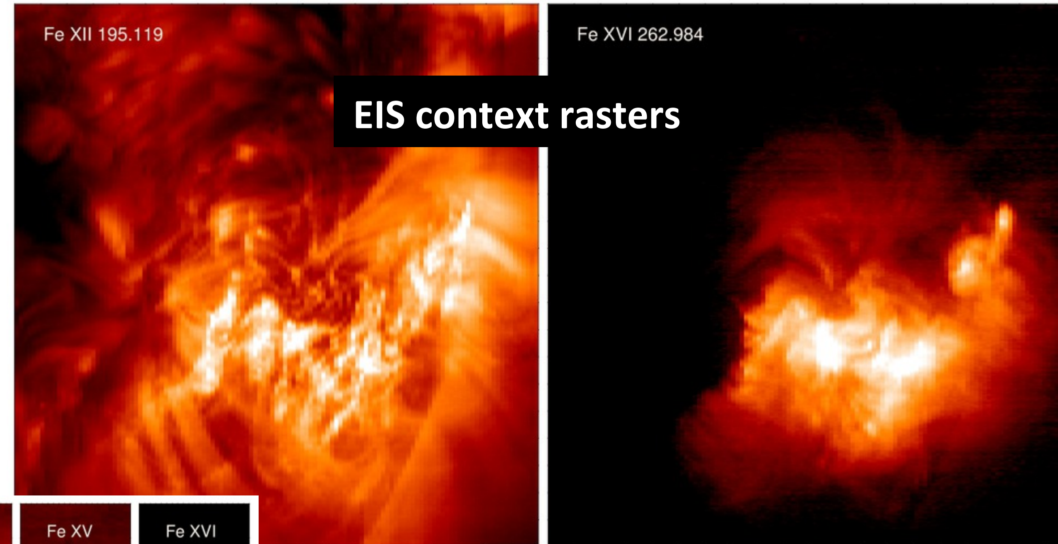


Harra et al., Solar Phys., submitted 2014

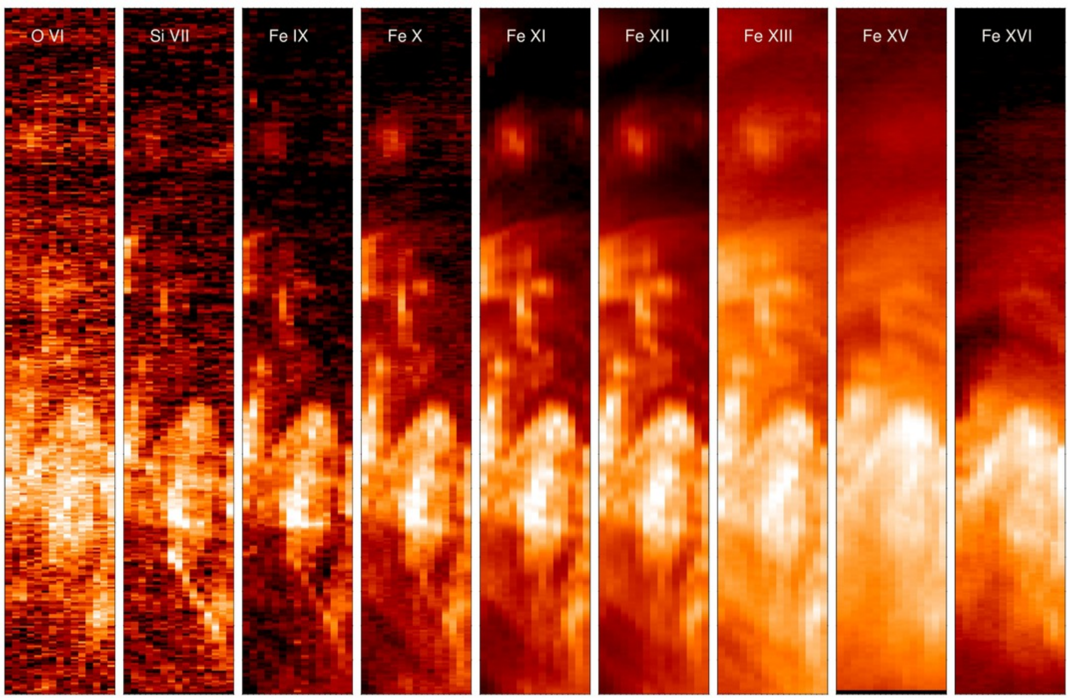
2-3. Hinode Scientific Activities

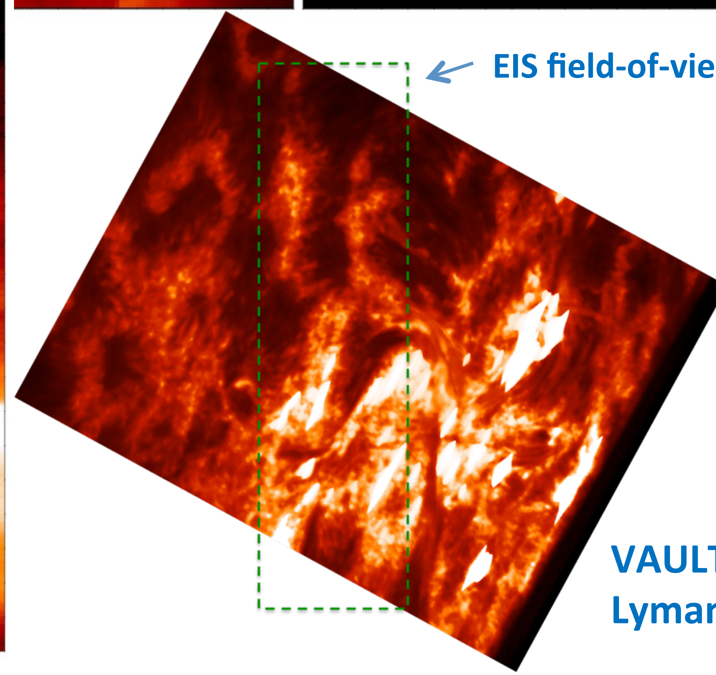
Hinode/EIS Coordinated Observations with the NRL VAULT Rocket on 2014 Sept 30

•What is the connection between the chromosphere , transition region, and corona? Coordinated observations lead us towards the answers.



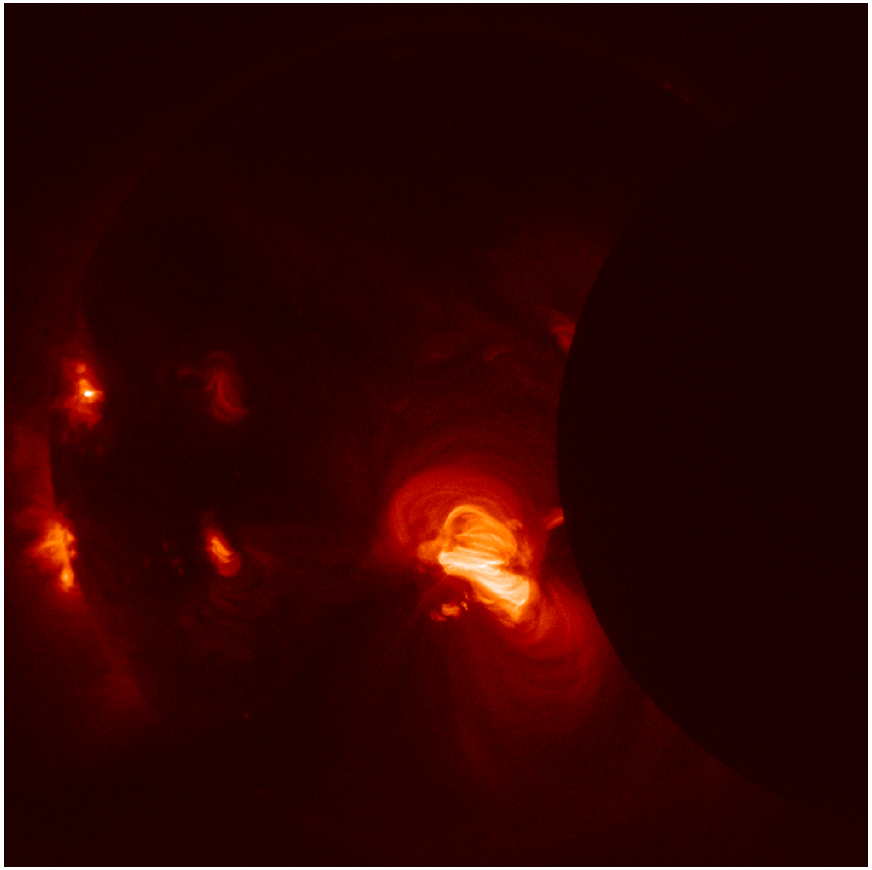
EIS raster images in different spectral lines

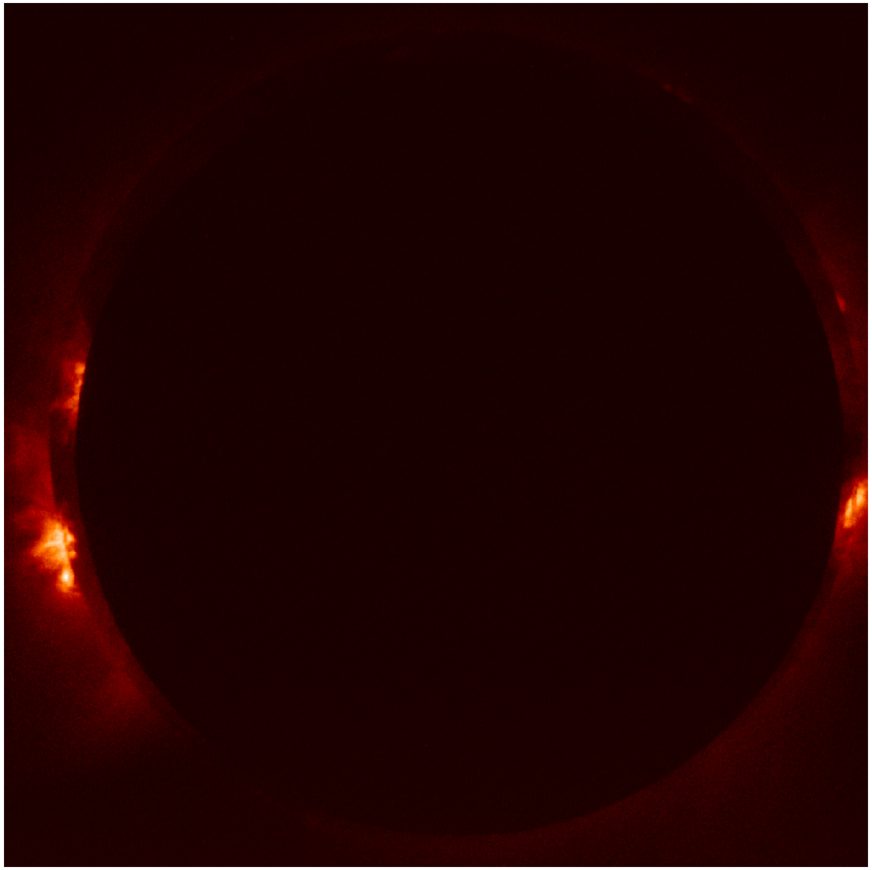




Contributed by the Hinode/EIS team through the Naval Research Laboratory and University College London / Mullard Space Sciences Laboratory

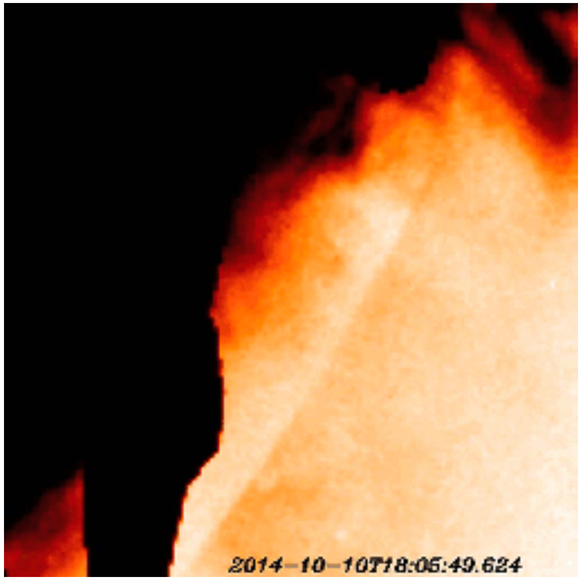
2-3. Hinode Scientific Activities





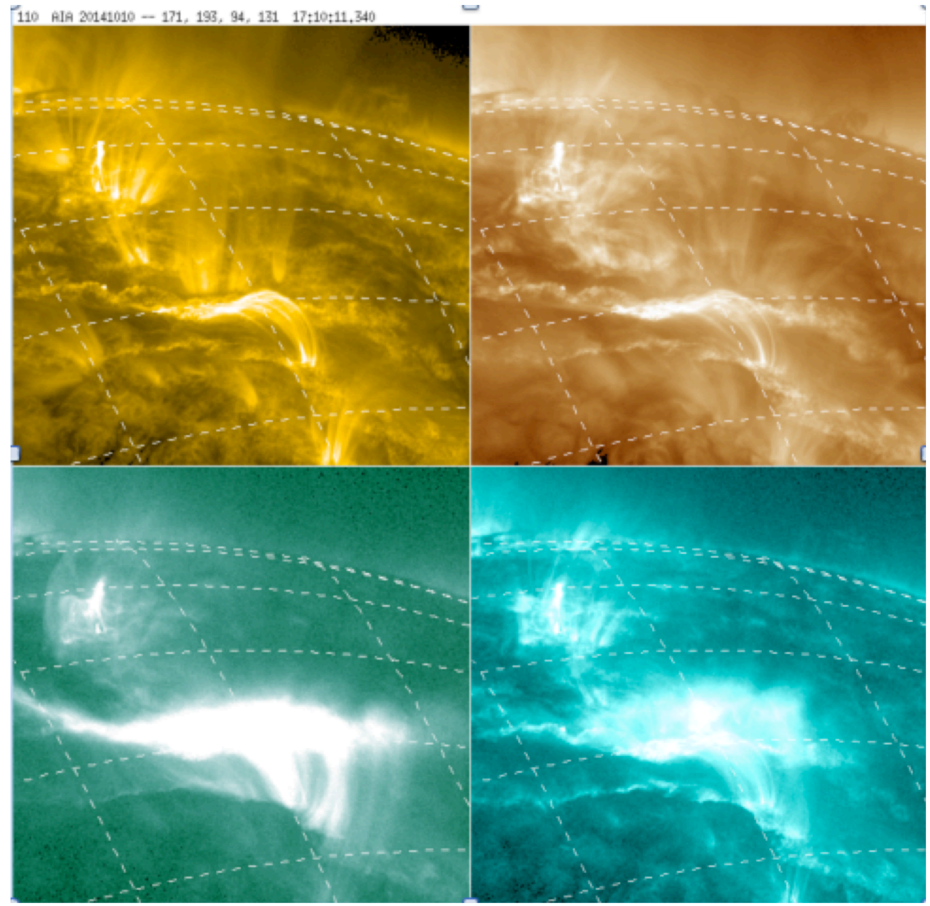
“The Hinode satellite’s X-Ray Telescope recently observed the solar eclipse that crossed over North America on October 23rd. This rare event occurred as Hinode monitored solar flares from the largest active region seen on the Sun in over two decades."

2-3. Hinode Scientific Activities



Hinode XRT – Thin-Be

SDO/AIA – 171, 193, 94, 131



C1.0 flare on Oct 10th shows clear signatures of supra-arcade downflowing loops (SADLs) in XRT and the hot AIA channels. SADLs are thought to be closely related to magnetic reconnection. (Savage et al. 2012)

2-3. Hinode Scientific Activities

nature COMMUNICATIONS

ARTICLE

Received 24 Jun 2014 | Accepted 24 Nov 2014 | Published 6 Jan 2015

DOI: 10.1038/ncomms6947

Full-Sun observations for identifying the source of the slow solar wind

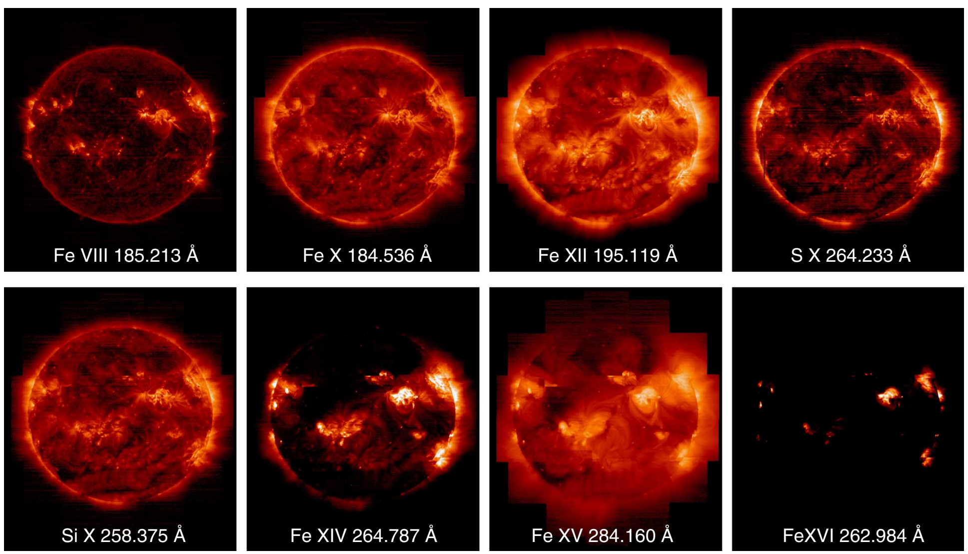
David H. Brooks[1,†], Ignacio Ugarte-Urra[1] & Harry P. Warren[2]

Goal: Identify sources of the flow of energy and matter throughout the solar system.

Solar wind has two components:

1. Fast: coronal holes
2. Slow: ??

Plasma composition used to distinguish the two components and link to solar structures.



EIS mosaics (2-day spectrometer scan during January 2013):

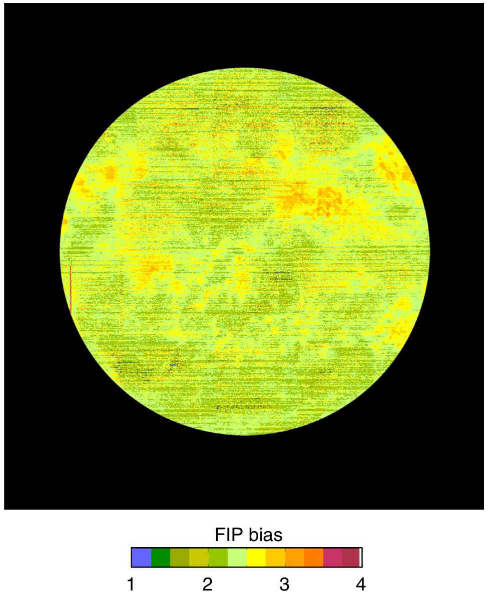
- Temperatures: ~.5 - 3 MK

- Pure temperature images of the **full Sun** at the highest spatial resolution yet achieved

- Observation not normally practical due to time and telemetry

Derived from recent publication from the Hinode/EIS team through the Naval Research Laboratory

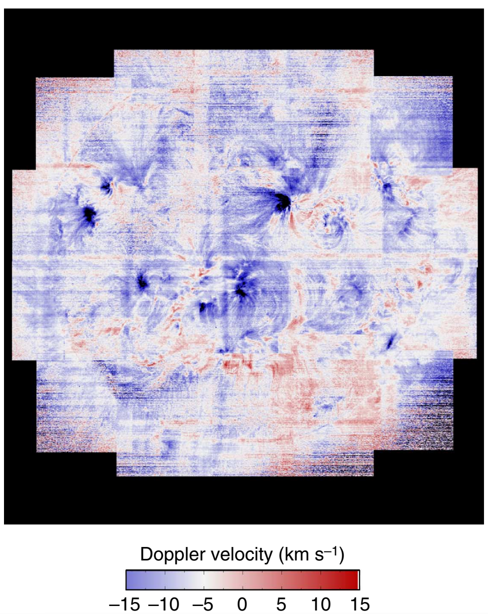
2-3. Hinode Scientific Activities



Full Sun plasma composition map

- *Required 16 million calculations to create!*
- Darker → Photospheric abundances
- **Lighter → Coronal abundances**

Slow solar wind trends toward coronal abundances.

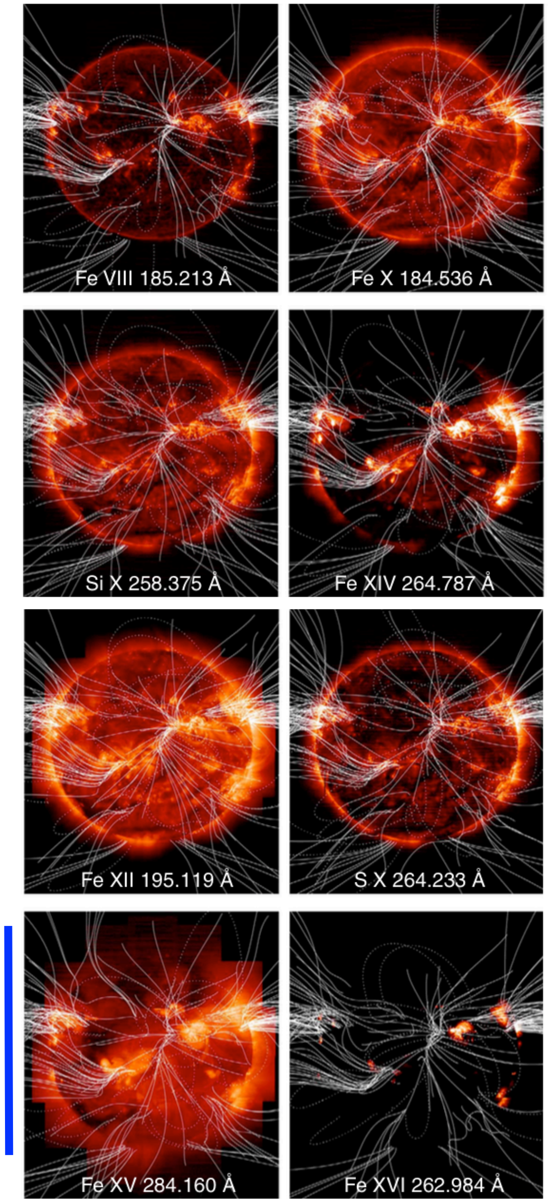


Doppler radial velocity map (2 MK)

- Red → Inflow (toward Sun)
- **Blue → Outflow (away from Sun)**

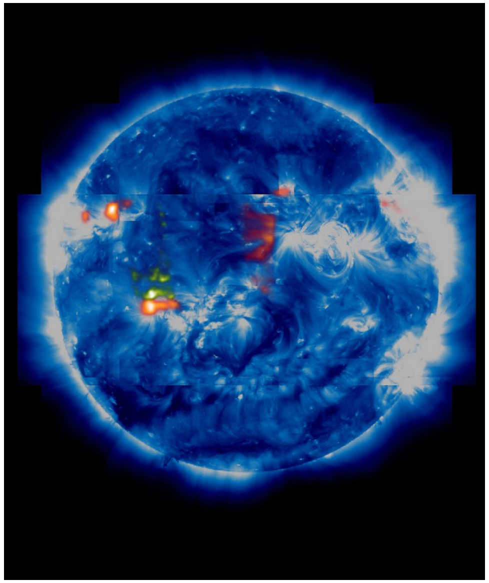
Magnetic field modeling of large-scale coronal field

- Subset of ~1.6 million lines shown
- Dotted → Closed
- **Solid → Open**

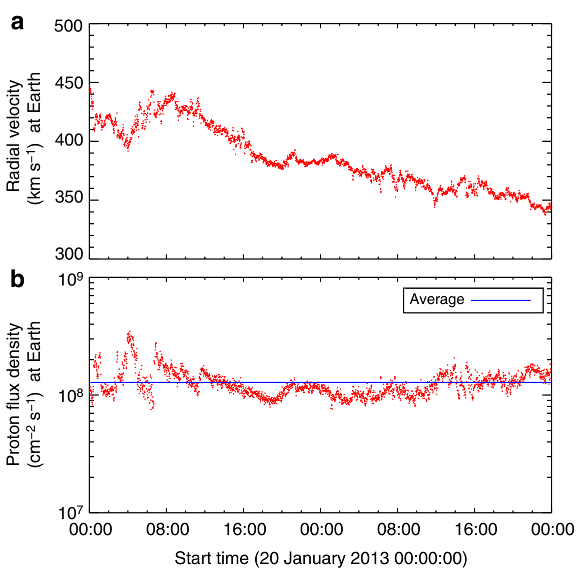


Derived from recent publication from the Hinode/EIS team through the Naval Research Laboratory

2-3. Hinode Scientific Activities

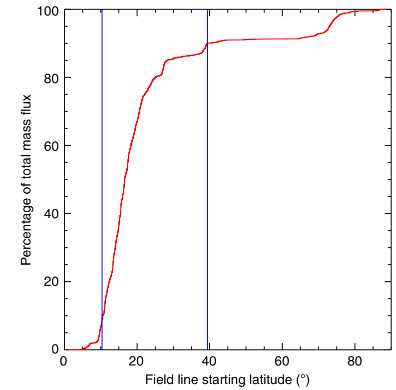


Slow solar wind source map
- Shear line due to solar rotation during 2-day scan
- Red/Green:
  * Coronal composition
  * Outflowing plasma
  * Open field that extends down to ecliptic plane
- **Red → Active region (AR) boundaries**
- Green → ~Holes b/t ARs
- [Other unknown source high in corona]



In situ measurements from ACE
- Stable slow solar wind
- EIS source map potentially accounts for **50-80%** of the flux

Note:



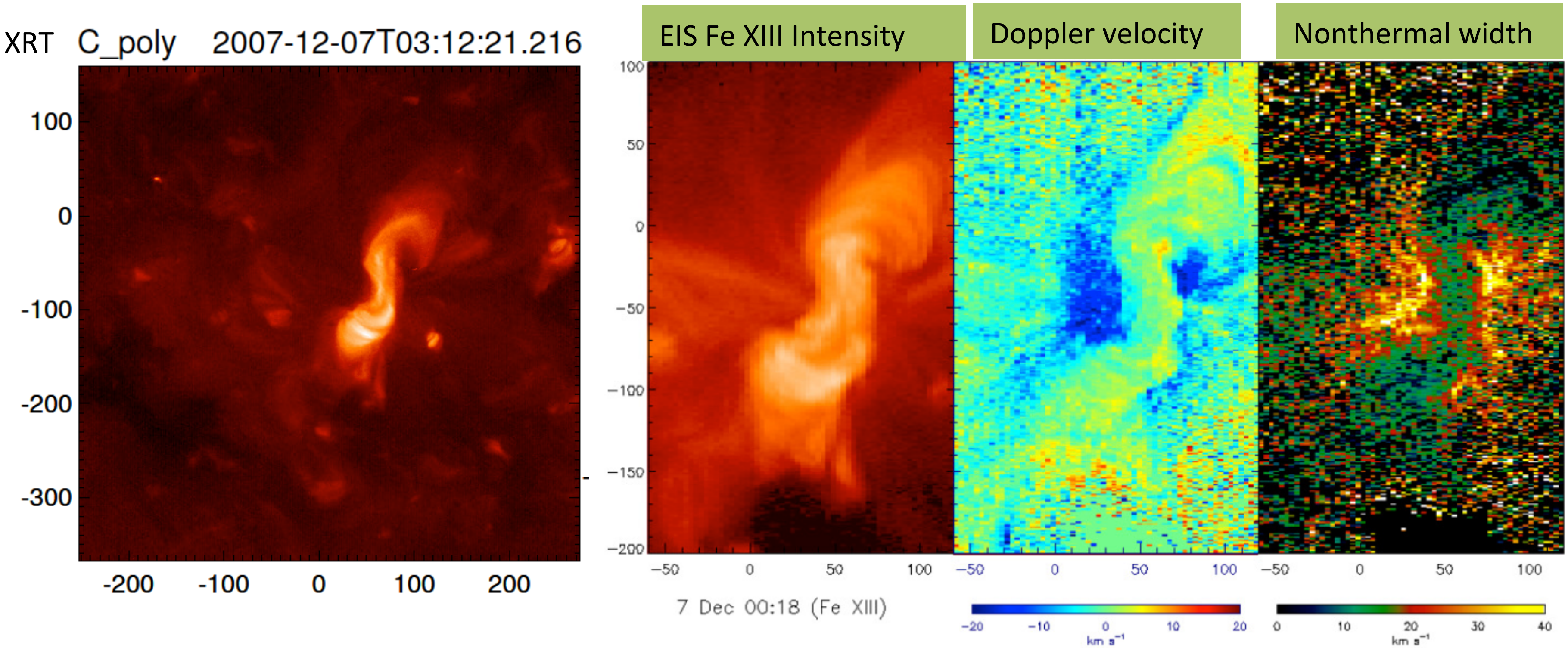
~90% of the solar wind flux originates below 40° latitude

Optimal candidate campaign for ***Hinode* Focused Mode operations**, except for significant tech. issue:
- ***Reduced number of commands available***

Possible solution: Reduce number of pointings to encompass this 90% region.

Telemetry would still be a challenge.

2-3. Hinode Scientific Activities

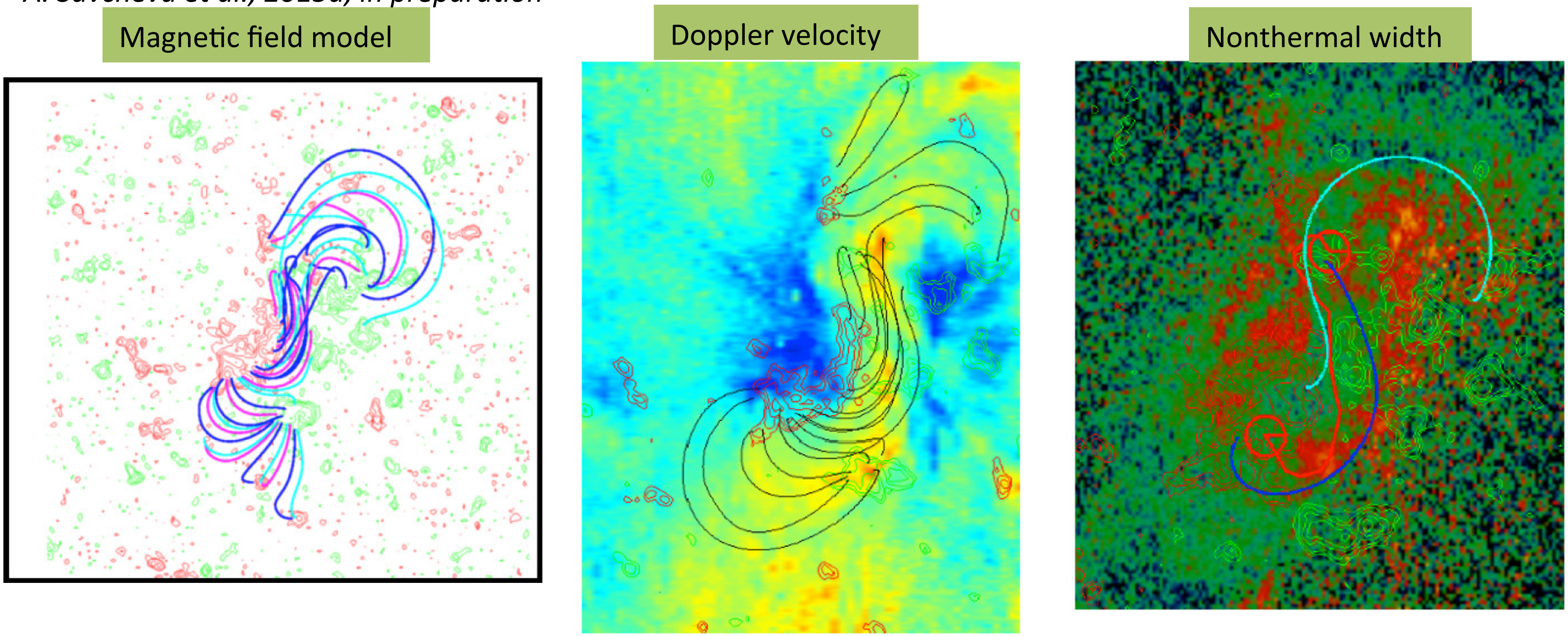


One of the best sigmoidal active regions of the Hinode mission was observed on December 6/7, 2007. It is still providing a wealth of information about these kinds of structures today.

Contributed by the Hinode/XRT team through the Smithsonian Astrophysical Observatory

2-3. Hinode Scientific Activities

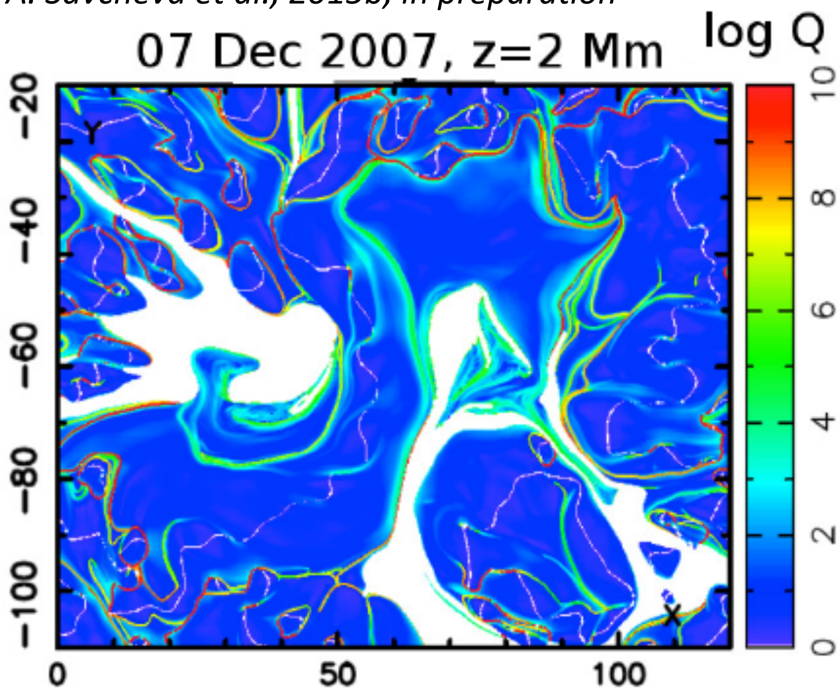
A. Savcheva et al., 2015a, in preparation

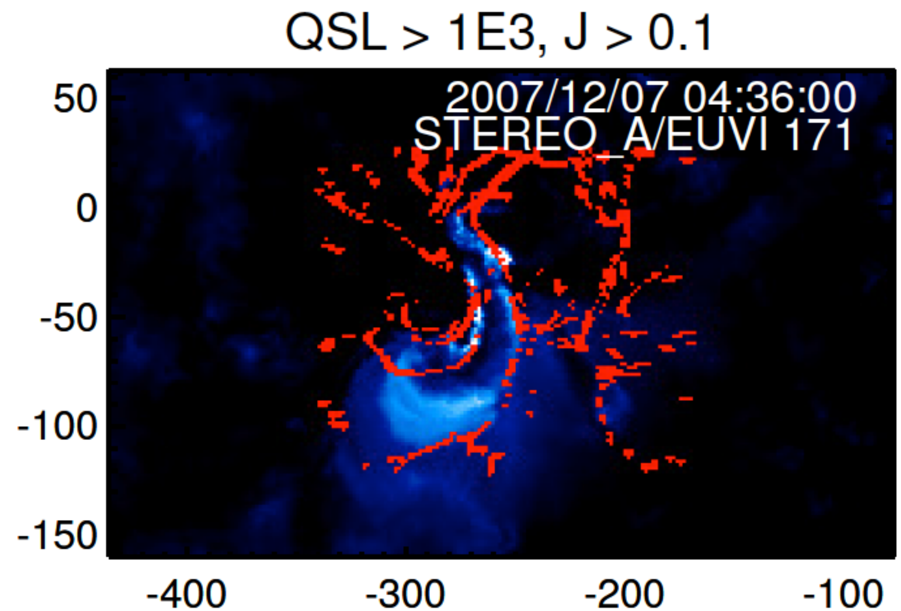


Non-linear force-free magnetic field (NLFFF) models are constructed from photospheric magnetograms and constrained by XRT data. When compared with EIS observations, the field model shows that the twisted core loops contain downflowing plasma, and provides evidence that large non-thermal widths are caused by additional heating due to reconnection that takes place at the edge of the flux rope.

2-3. Hinode Scientific Activities

A. Savcheva et al., 2015b, in preparation



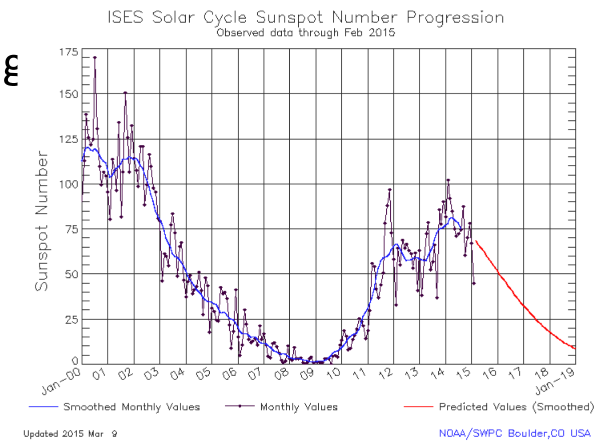


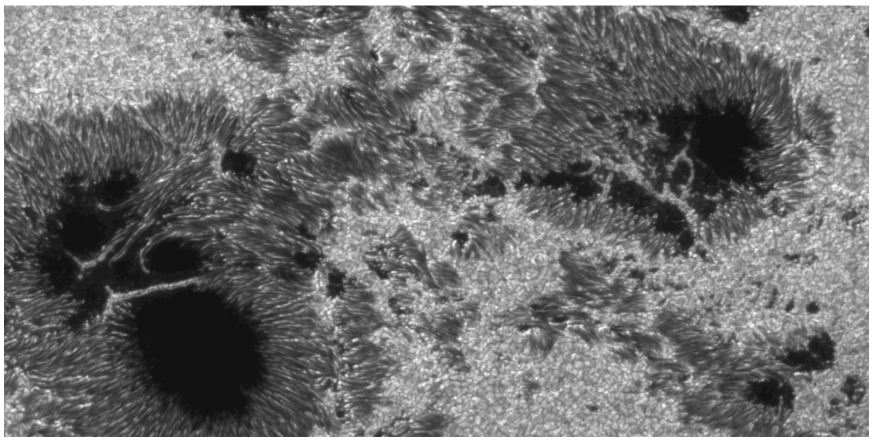
The above figure shows maps of the squashing factor Q (left) and an overlay of Q > 1E3 on a STERO EUVI 171 image (right) showing flare ribbons. High Q indicates highly divergent magnetic field structures.

Although the NLFFF models were optimized to match XRT observations, the Q maps derived from these models also correspond to observed flare ribbons in the EUV, indicating a connection between the magnetic topology and observed flare features.

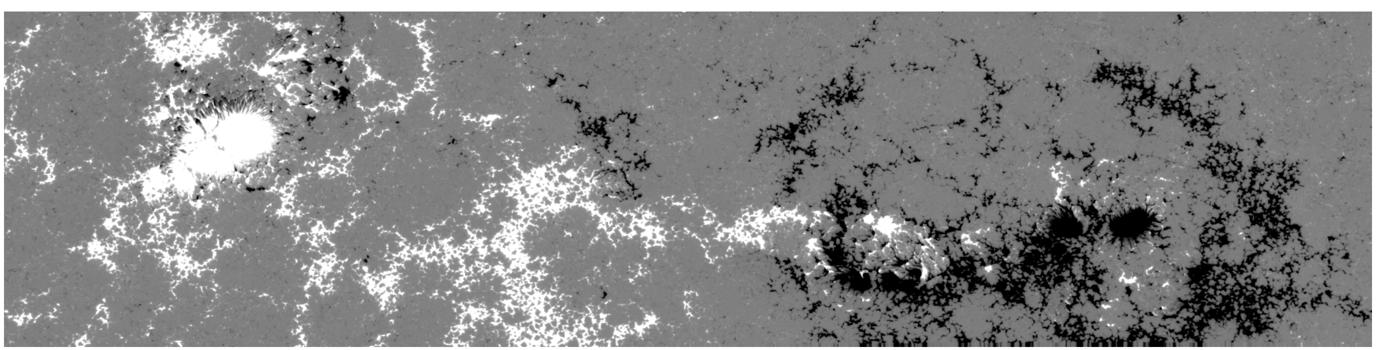
2-3. Hinode Scientific Activities

The largest active regions usually appear in the declining phase of the Solar cycle, after the peak of the sunspot number has passed.





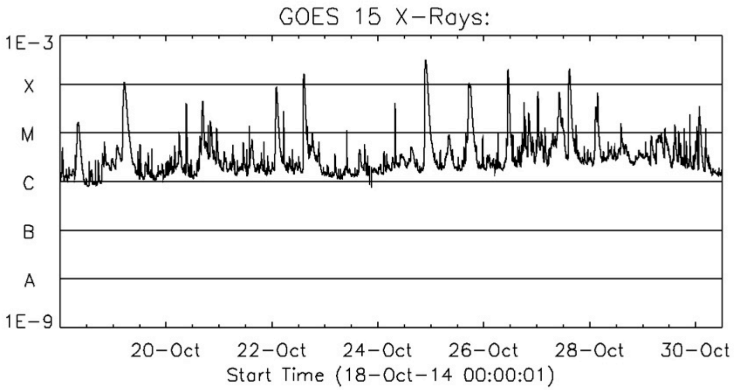
The sunspot group on 24 October 2014 (left) was the largest seen since 1990. It is larger than the Hinode SOT/BFI Field of View (220 x 110 arcseconds)

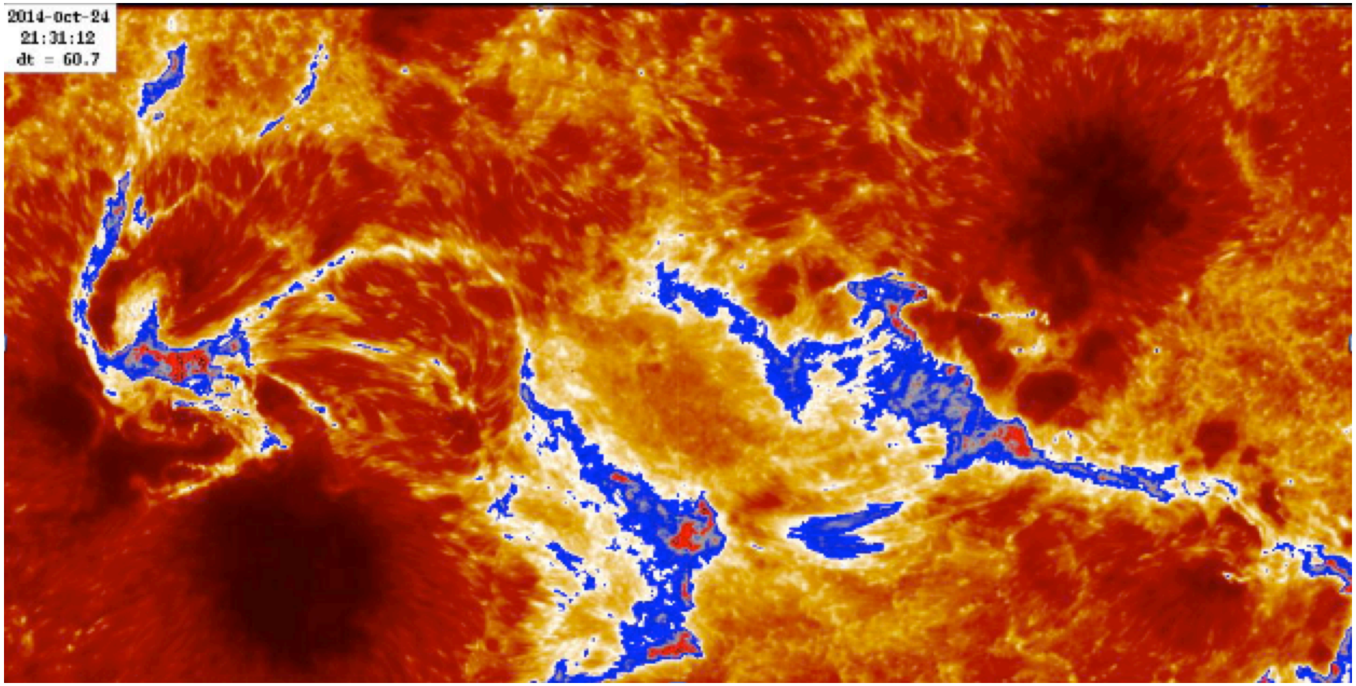


This region on 3 February 2015 has perhaps the largest area of any region this cycle. This vector magnetic map was made using the newly-perfected SOT/SP mosaic observing mode (600 x 160 arcsec)

2-3. Hinode Scientific Activities

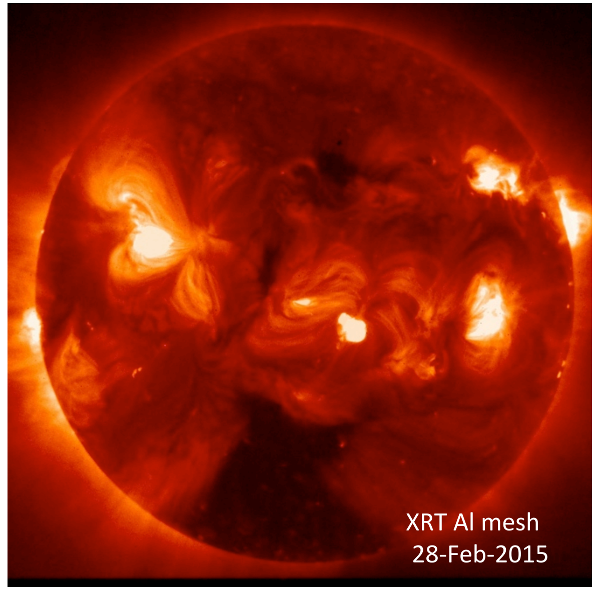
Large flares continue to occur well past the sunspot maximum, providing many X- and M-flares for Hinode, RHESSI, and the rest of the HSO to observe. This X3.1 flare on October 24, 2014, was in AR 12192, which produced 6 X-flares (right) but no CMEs. The reason for this lack of eruptions may be the relatively low “magnetic free energy” in this region, despite its huge sunspots and magnetic flux.

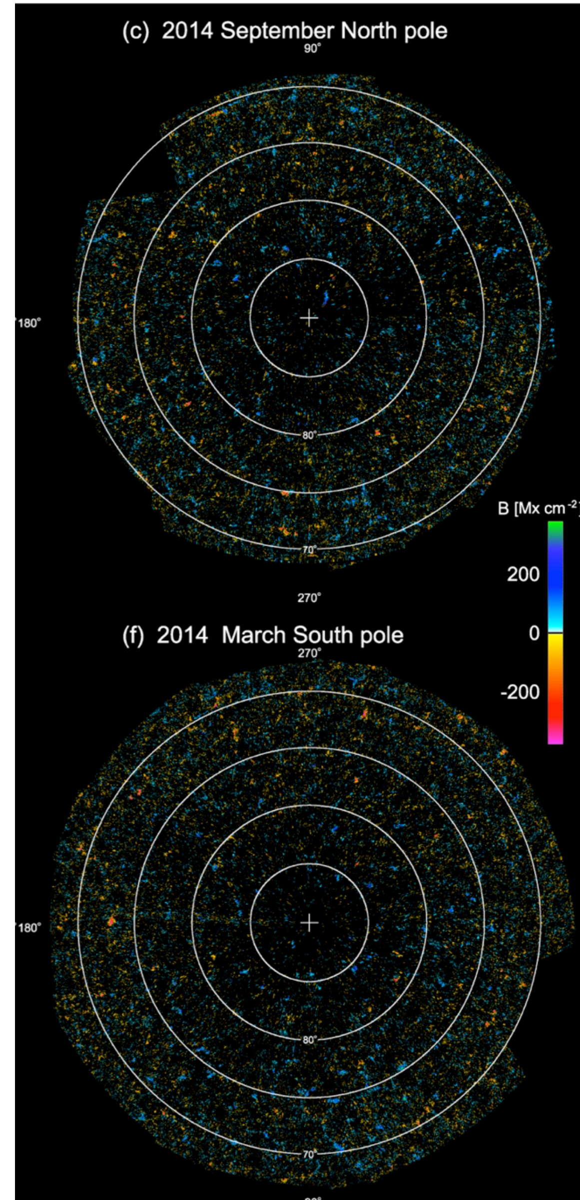


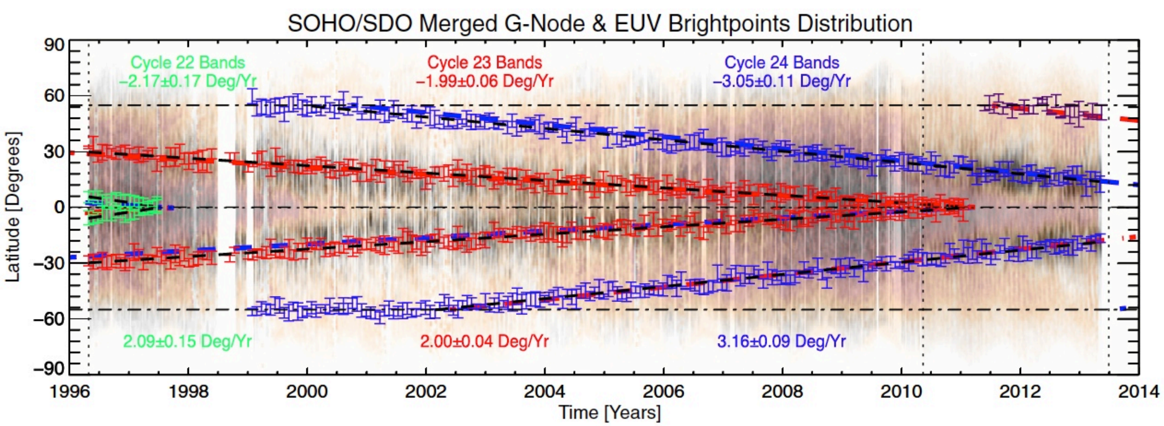


2-3. Hinode Scientific Activities

After reversing their polarity around Solar Maximum, the polar magnetic fields strengthen (Shiota et al, 2015, in prep). Polar coronal holes begin to form, intermittently at first, and some traces of the next solar cycle begin to appear at high latitudes.



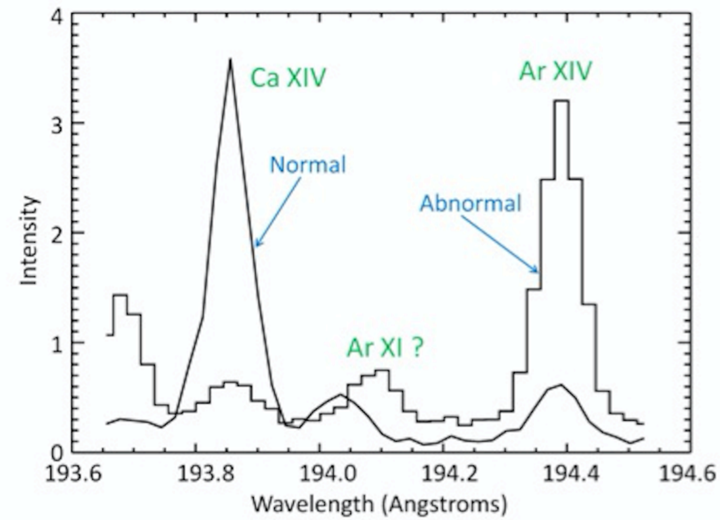


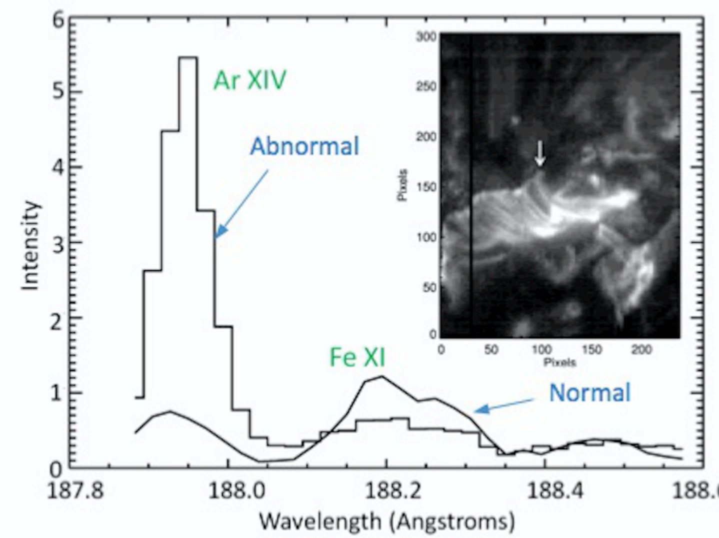


"Band-O-Gram," showing the latitude migration of EUV bright points and the presence of two cycles on the Sun simultaneously. The new cycle points can be seen in high Northern latitudes starting in 2011. One of the Hinode 2015 Senior Review science goals is to repeat these analyses with a full cycle of XRT images. From McIntosh et al, 2014 ApJ, 792, 12.

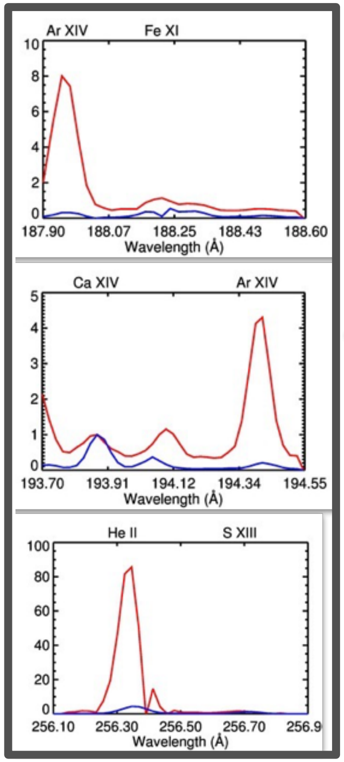
THE INVERSE FIRST IONIZATION POTENTIAL (FIP) EFFECT IS A PROCESS WHICH RESULTS IN DIFFERENT ELEMENT ABUNDANCES IN THE SOLAR CORONA THAN IN THE PHOTOSPHERE.

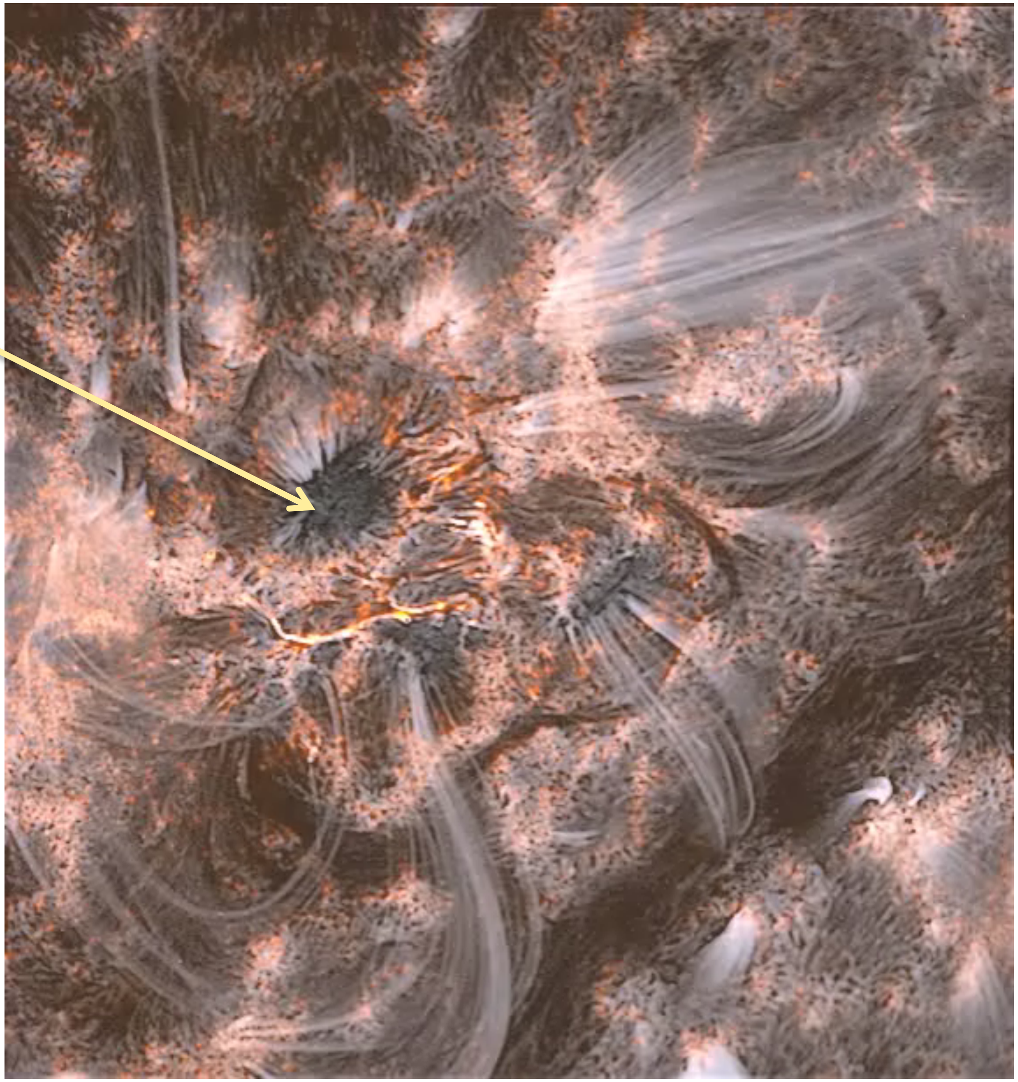
- The inverse FIP effect has never been observed before in the Sun.
- The inverse FIP effect has just been observed in our star by the Extreme-ultraviolet Imaging Spectrometer (EIS) on *Hinode*
- **Argon XIV** is enhanced by a factor of about 30 over its normal coronal abundance in the example shown here (yes, it's the best example!).
- The inverse FIP enhancement is <u>seven times larger</u> than the photospheric abundance!
- Other enhancements in other regions are a factor of two or three greater than photospheric.
- The enhancements are seen close to sunspots. The precise association is not known.
- The solar coronal electron density is ~4 x 10^{10} up to about 10^{12} cm^{-3}.





2-3. Hinode Scientific Activities



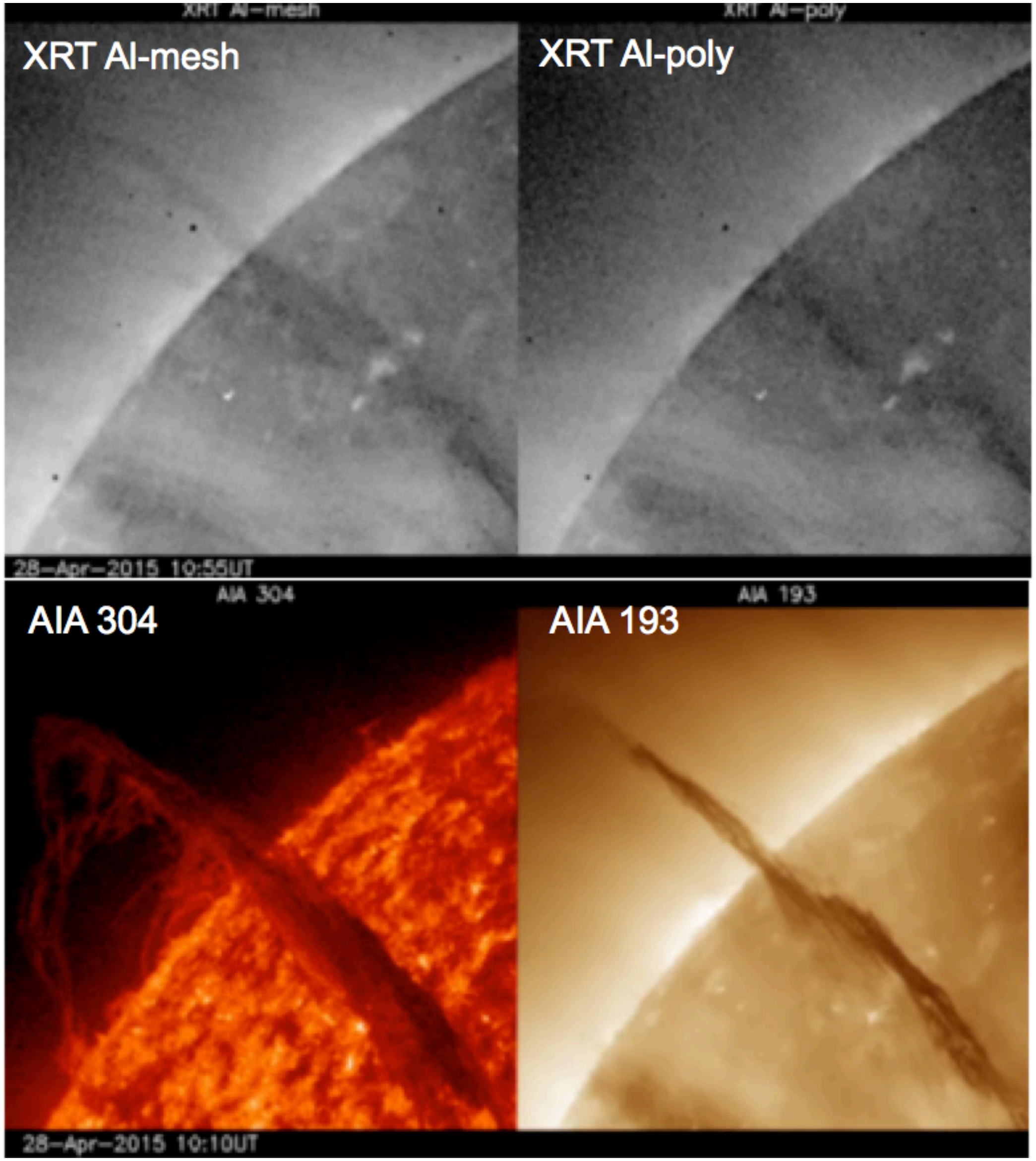


Summary:

** New study indicates inverse FIP effect observed during flare.

- Indicative of chromospheric evaporation in sunspot
- Observed in other stars but not before on Sun

2-3. Hinode Scientific Activities

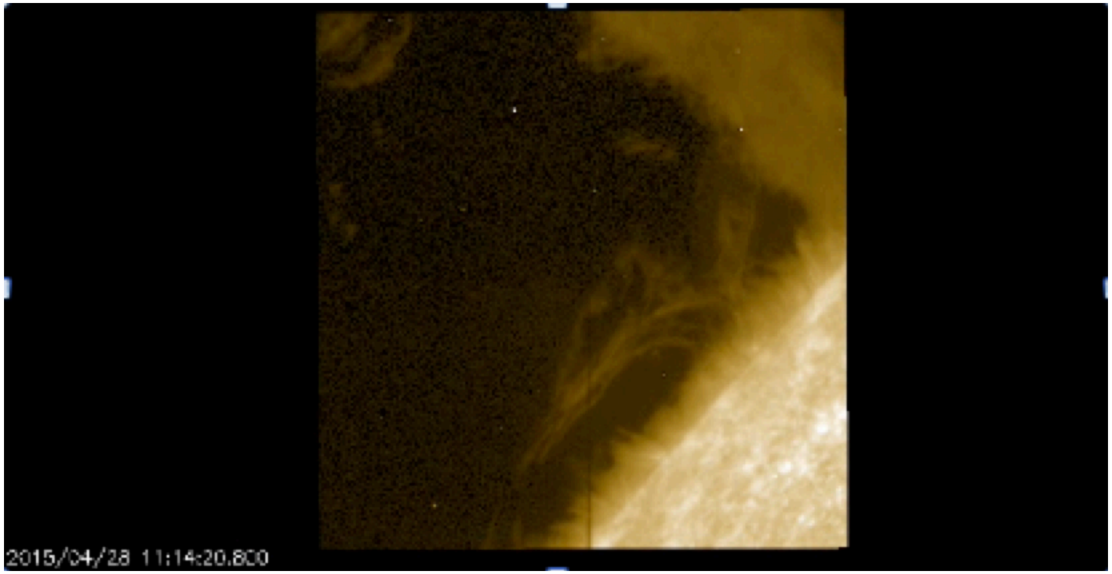


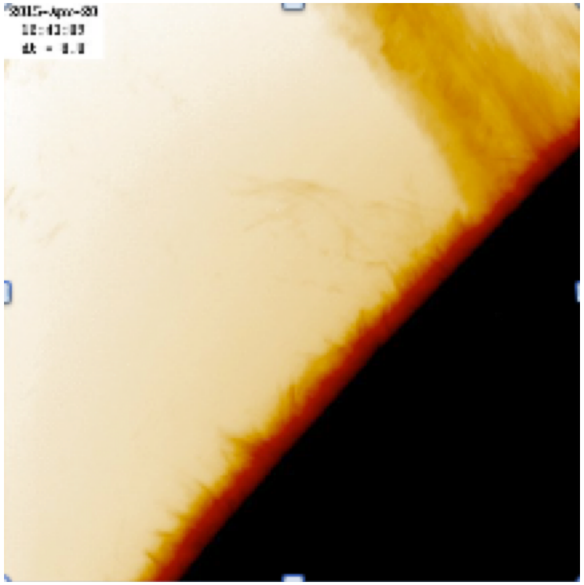
Hinode captured a spectacular filament eruption on April 28, 2015.

XRT Al-mesh images show the prominence better than the Al-poly images because of the low temperature response of that filter.

Bright loops and streamers that are the consequences of reconnection in the wake of the eruption are prominently seen in XRT data, and can also be seen (though more faintly) in the AIA 193 data.

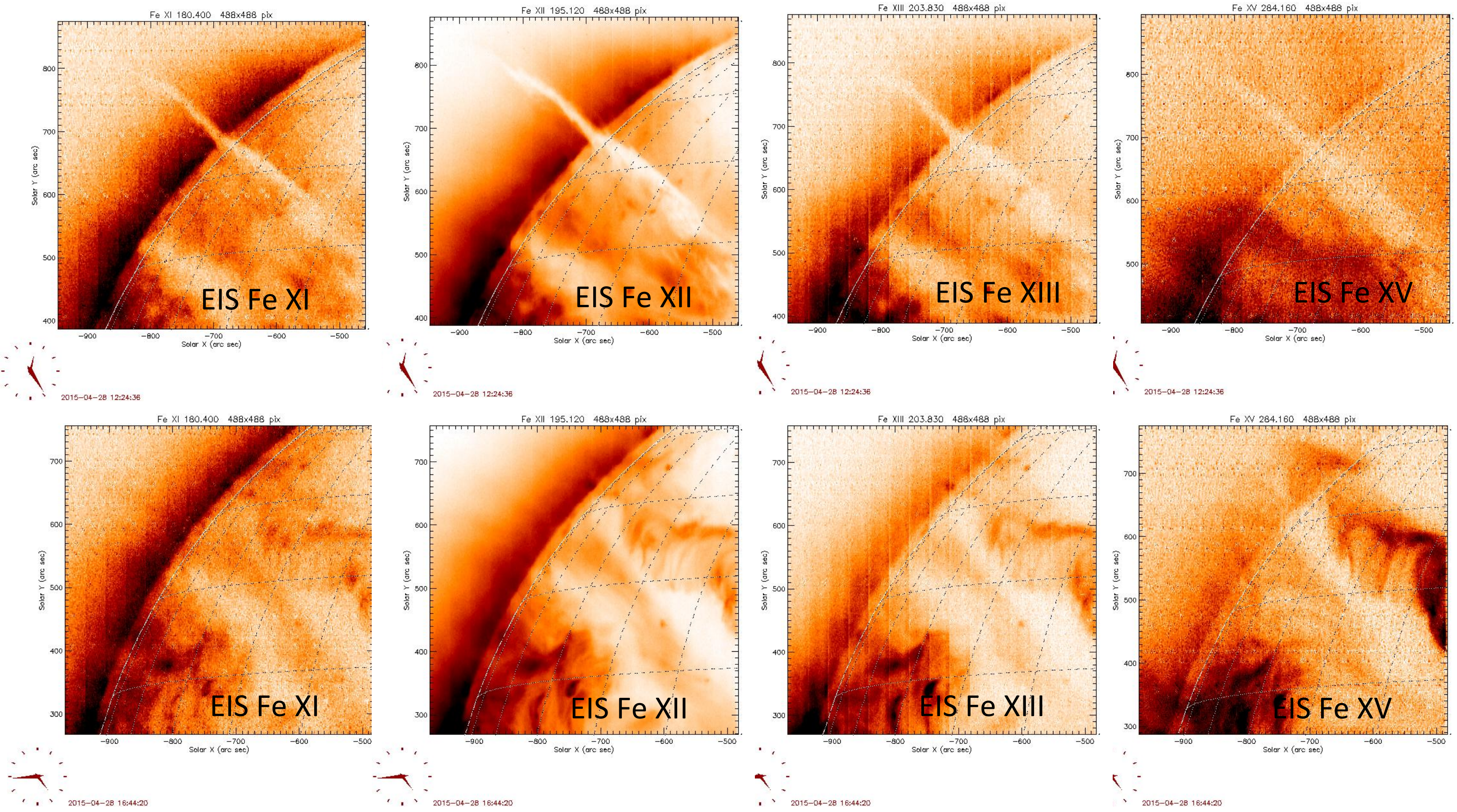
2-3. Hinode Scientific Activities





IRIS caught the filament liftoff, allowing for a detailed analysis of the dynamics of the eruption.

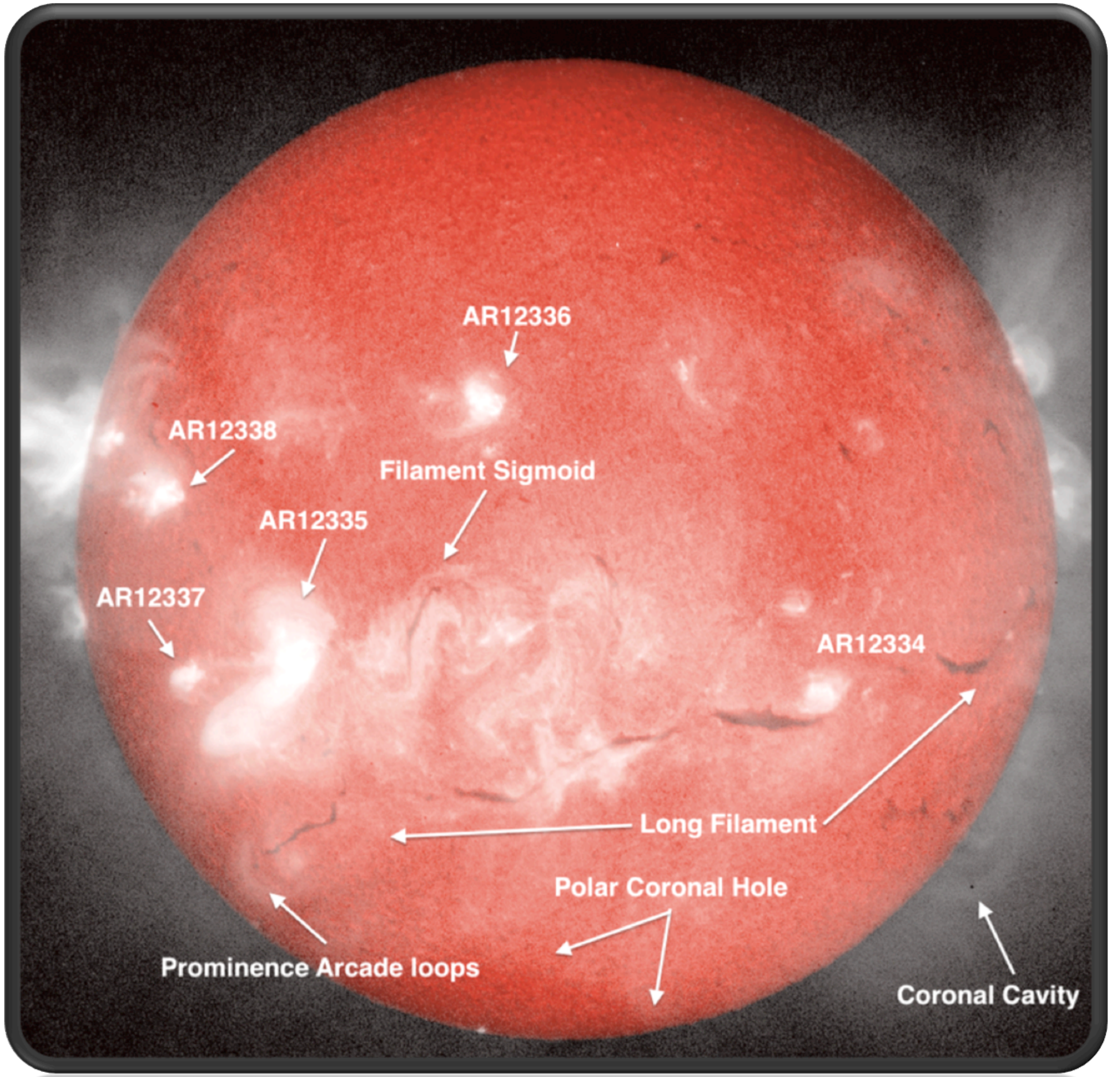
2-3. Hinode Scientific Activities



EIS scans in multiple wavelengths before and after the eruption show the changes in the corona caused by the disturbance. Post eruption loops are clearly seen in the Fe XV scan.

Contributed by the Hinode/XRT team through the Smithsonian Astrophysical Observatory

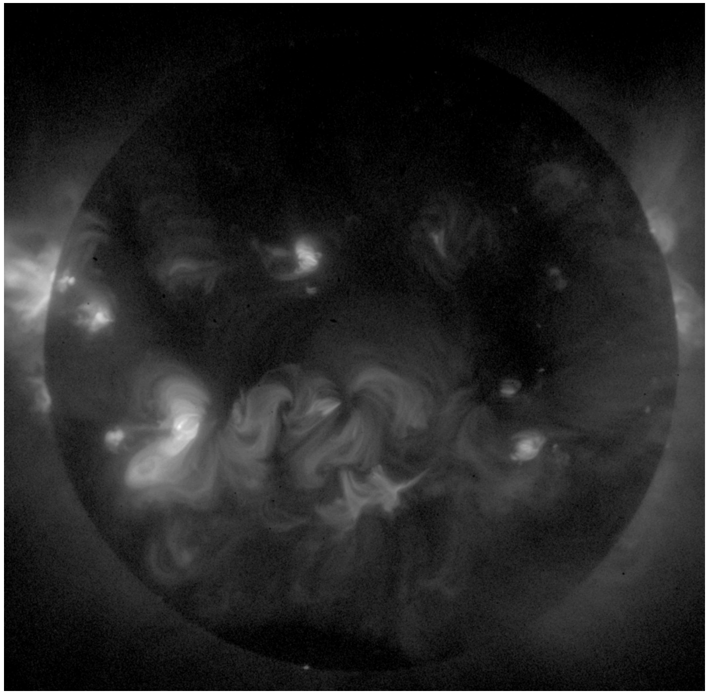
2-3. Hinode Scientific Activities

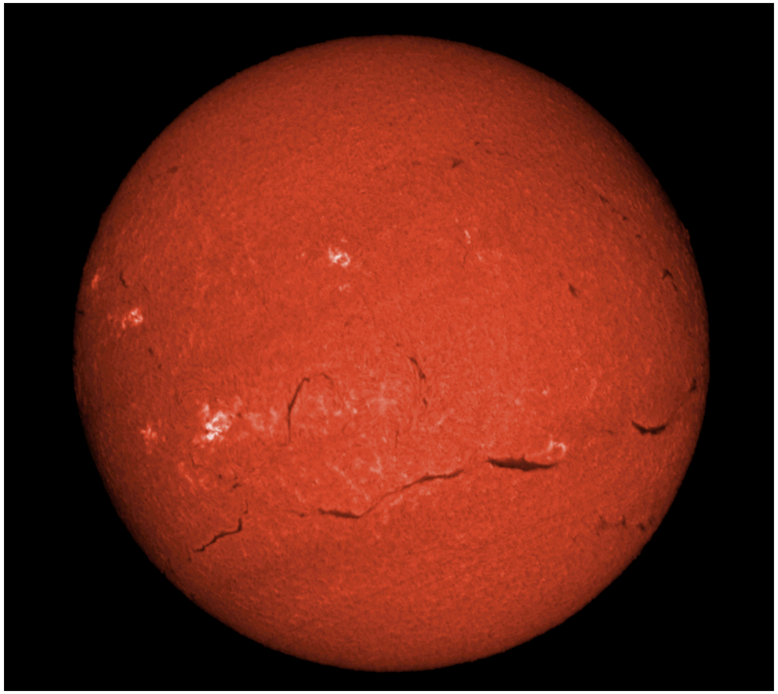


- Active Regions (AR) are regions where the sun's magnetic field is strong and hot and cool plasma is trapped.
- A filament (or filament channel, a.k.a. prominence on limb) is cool, thick plasma suspended above the surface where the magnetic field is changing. They appear shrouded in X-rays.
- A coronal cavity is a tube-like hole in the corona that typically sits above filament channels and are best viewed on the limb.
- Prominence arcade loops are the hot coronal loops that prevent prominences from erupting. When a prominence erupts, it has to tear these loops, which usually causes a coronal mass ejection with a solar flare.
- The south polar coronal hole is visible for this image. The poles are regions where weak magnetic fields exist of the same polarity. The fast solar wind originates in coronal holes.
- The filament sigmoid is a highly unpredictable filament that is likely to erupt. They are usually near or inside active regions are are closely monitored for space weather activity.

Via the Hinode/XRT team through the Smithsonian Astrophysical Observatory

2-3. Hinode Scientific Activities





XRT

Soft X-ray: Corona
0.5 – 20 Million degrees

Kanzelhöhe Solar Observatory
(ESA – Ground-based)

H-alpha: Chromosphere
~10,000 degrees

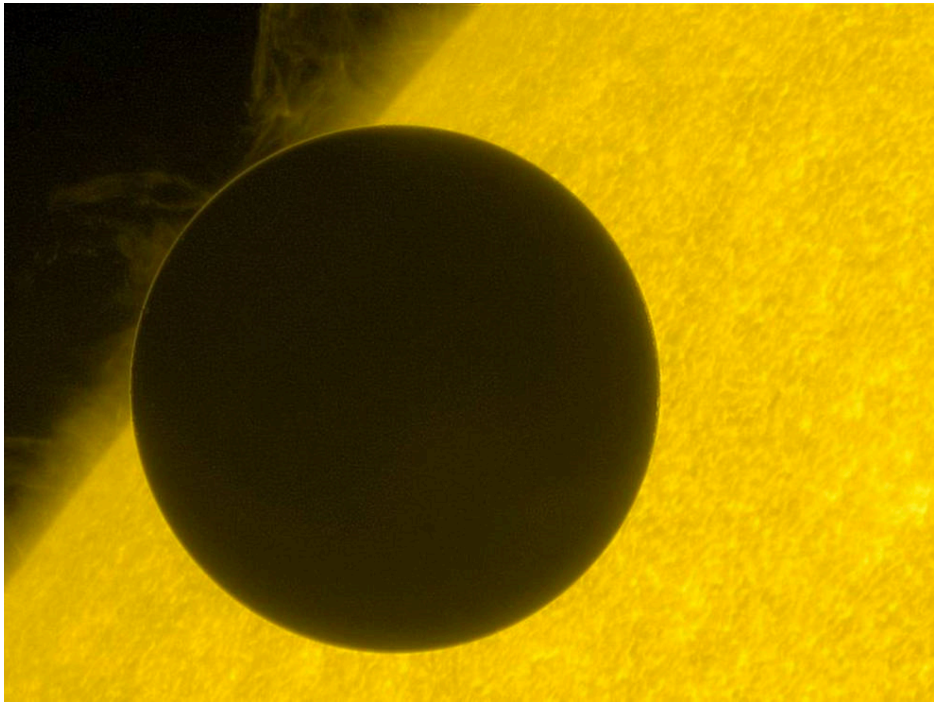
Using the transit of Venus to probe the upper planetary atmosphere

Nature Communications, June 2015, DOI: 10.1038/ncomms8563

http://www.nasa.gov/feature/goddard/scientists-study-venus-atmosphere-through-transit

http://www.csmonitor.com/Science/2015/0623/Venus-Does-this-sunlight-make-me-look-fat

http://www.natureasia.com/en/research/highlight/9988/



Venus transit images from *Hinode* and *SDO* show that the planet's atmosphere is more extended than previously thought, implications for exoplanetary transit measurements with different wavelengths and for planetary probes encountering and/or using atmospheric drag.

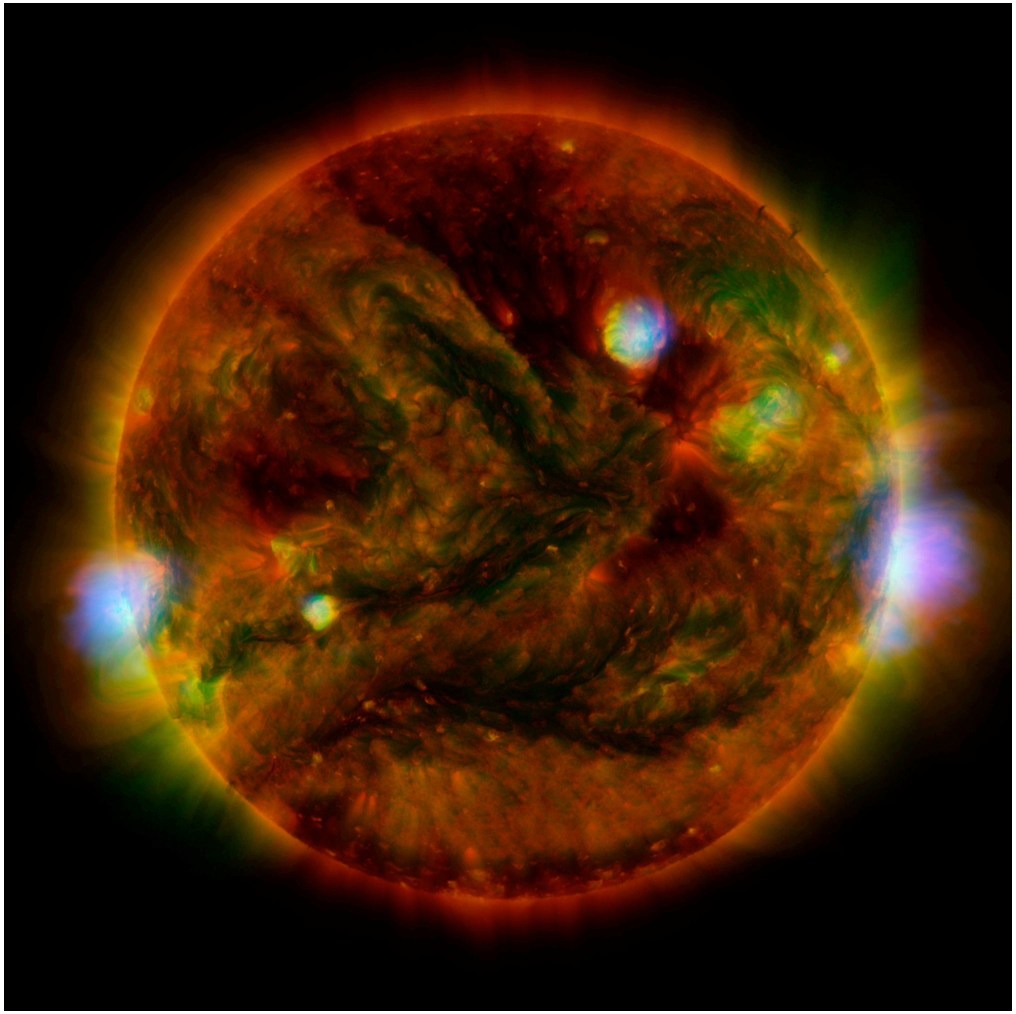
“Seering Sun seen in X-rays”

https://www.ras.org.uk/news-and-press/2676-searing-sun-seen-in-x-rays

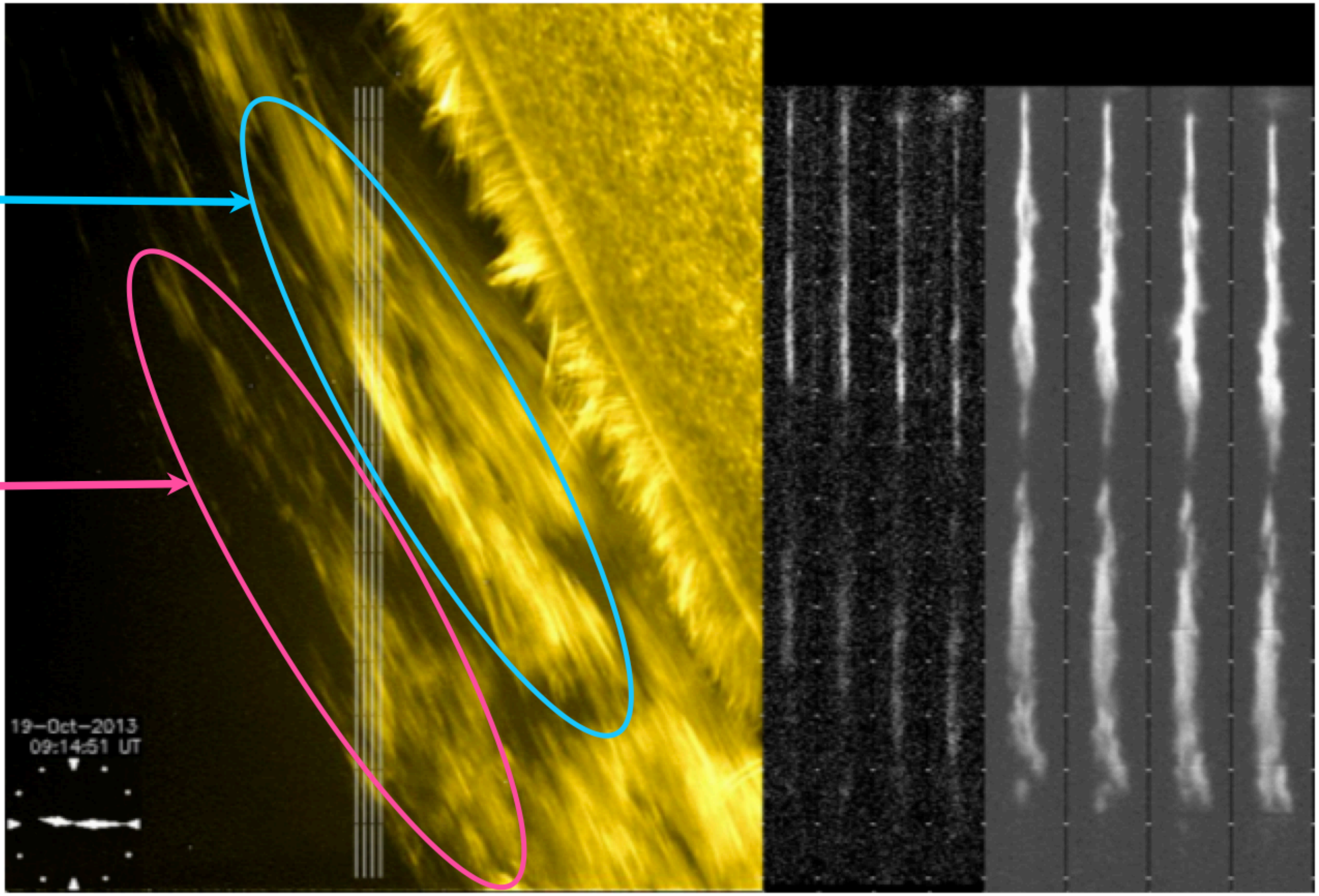
http://www.nasa.gov/jpl/nustar/searing-sun-seen-in-x-rays

Blue = *NuSTAR* (highest energy)
Green = *Hinode*/XRT
Red/Yellow = *SDO*/AIA

Combined data used to search for nanoflare heating of the corona.



2-3. Hinode Scientific Activities



Lower part
- long threads (SOT)
- small oscillations (SOT)
- long lifetimes (SOT)

Upper part
- short threads (SOT)
- large oscillations (SOT)
- short lifetimes (SOT)
- higher V_{LOS} (IRIS)
- broad line widths (IRIS)

↓

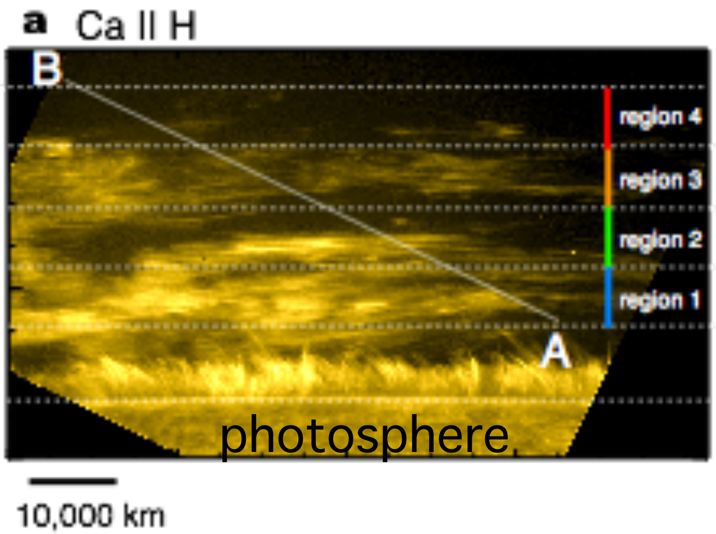
Evidence for heating by waves in the upper part

SOT observation:
Ca images, 8 sec cadence

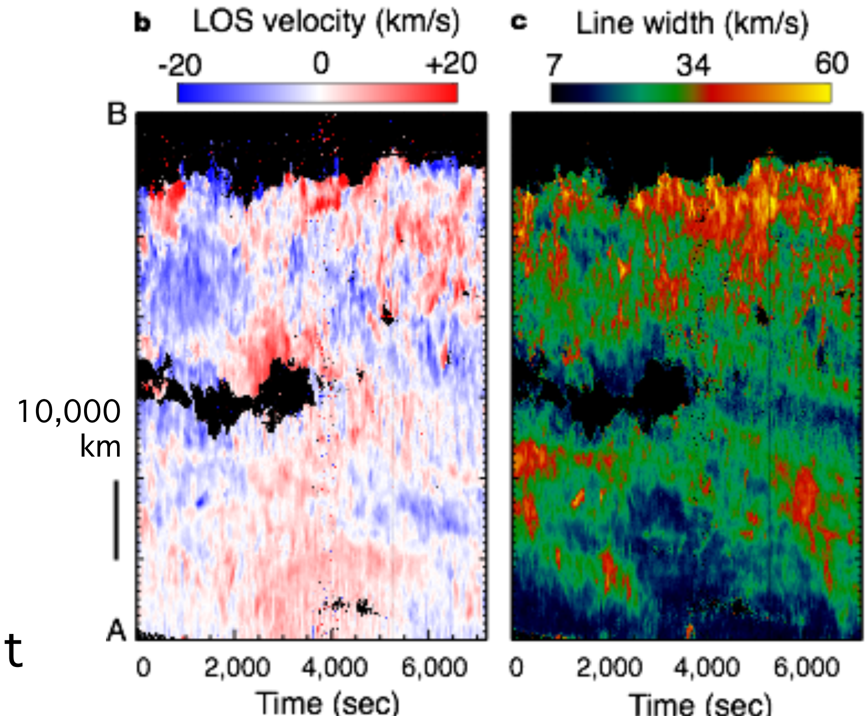
IRIS observation:
4-step raster & slit jaw images, 20 sec cadence

Joten Okamoto+15 coauthors, submitted to ApJ

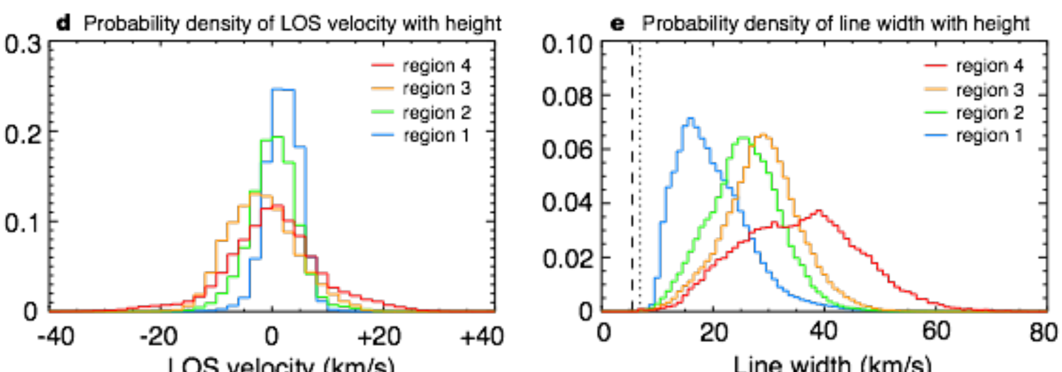
Hinode SOT Ca II



IRIS Mg II k



Histogram of v_{LOS} and line width with height

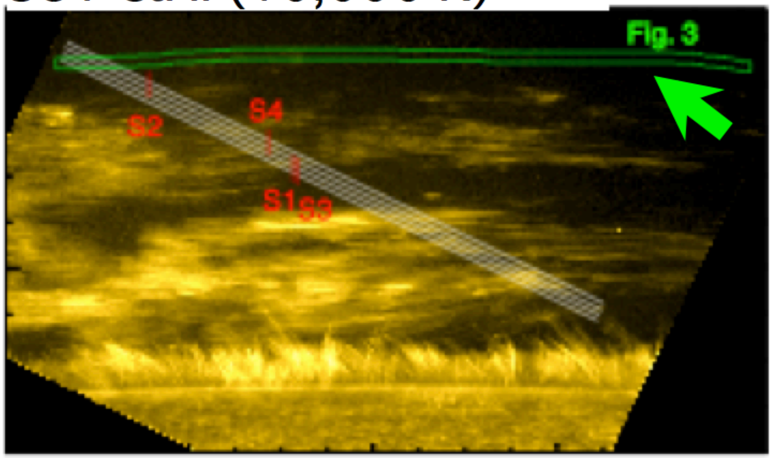


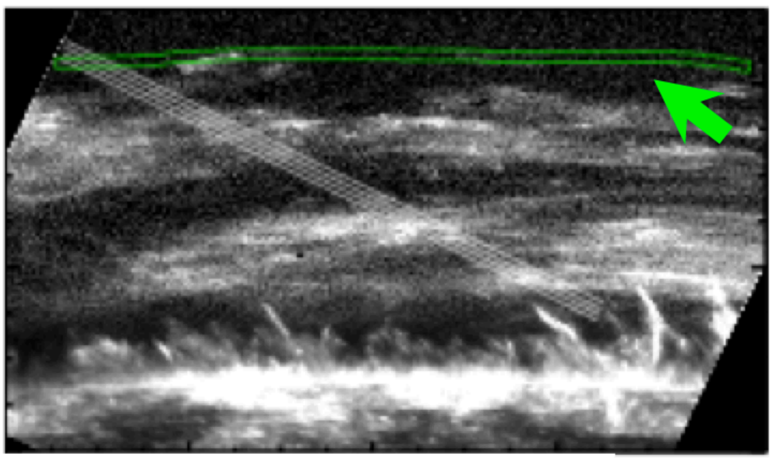
Upper region:
- higher v_{LOS}
- large non-thermal comp.

40 km/s
= thermal velocity of 250,000 K

2-3. Hinode Scientific Activities

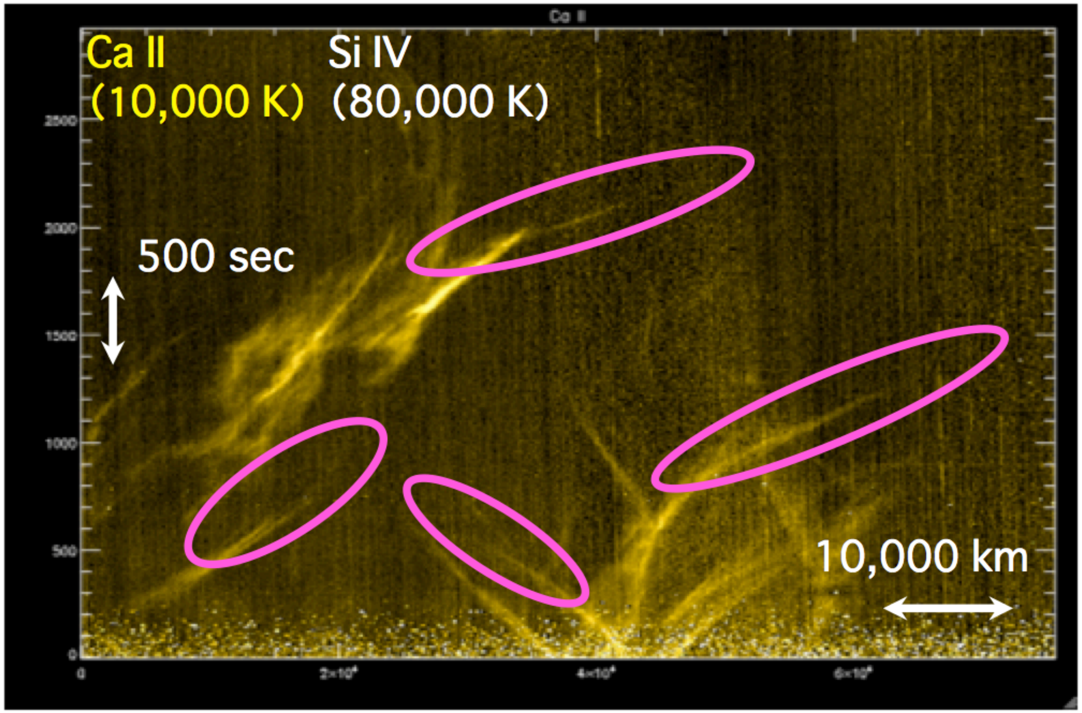
SOT Ca II (10,000 K)





IRIS Si IV (80,000 K)

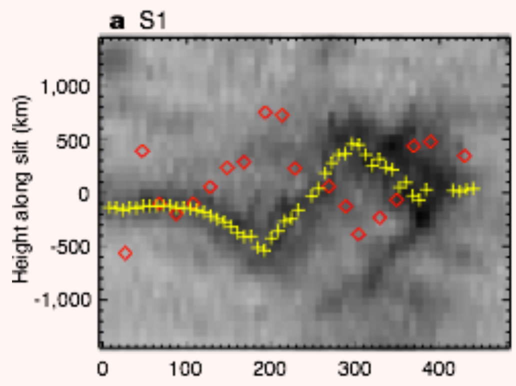
x-t plot



time

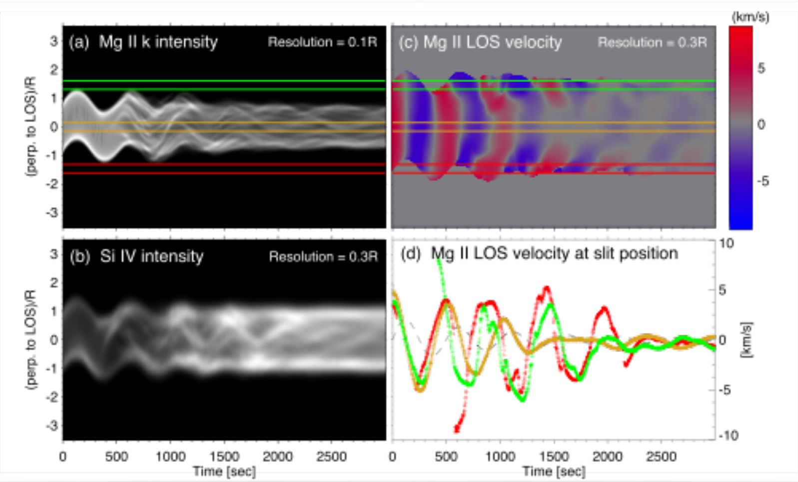
horizontal direction

Hinode and IRIS observations



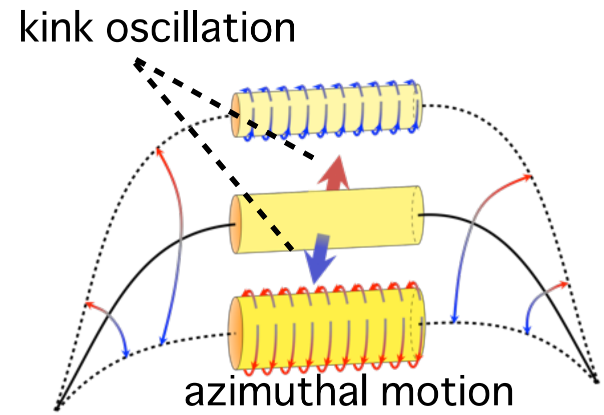
LOS velocity (red) and transverse displacement (yellow) over x-t plot (background)

Numerical simulation



Resonant Absorption triggers azimuthal flows on the surface of flux tube

(e.g., Ionson1978, Sakurai+1991, Goossens+2002)



This mechanism can explain the observed features:

- in-phase velocity patterns at 2 slit locations (green and red)
- changing velocity sign with time
- 180-degree difference between POS displacement and LOS velocity
- Temperature transition

3-1, 3-2. Focused Mode Coordination

- Status: Operable
  - No major issues reported from the teams.
  - (*Report from SOT upcoming.*)

- Request for FM HOPs sent to community via SolarNews.

- Focused Mode coordination
  - Priority list circulating with weekly meetings
    - Active Region evolution (flux emergence, waves in sunspots, flare monitoring)
    - Coronal Holes
    - Prominence / Filament
    - Disk-center (long baseline synoptic scans)
    - Polar magnetic network
  - Focused Mode Liaison no longer needed?

3-1, 3-2. Focused Mode Coordination

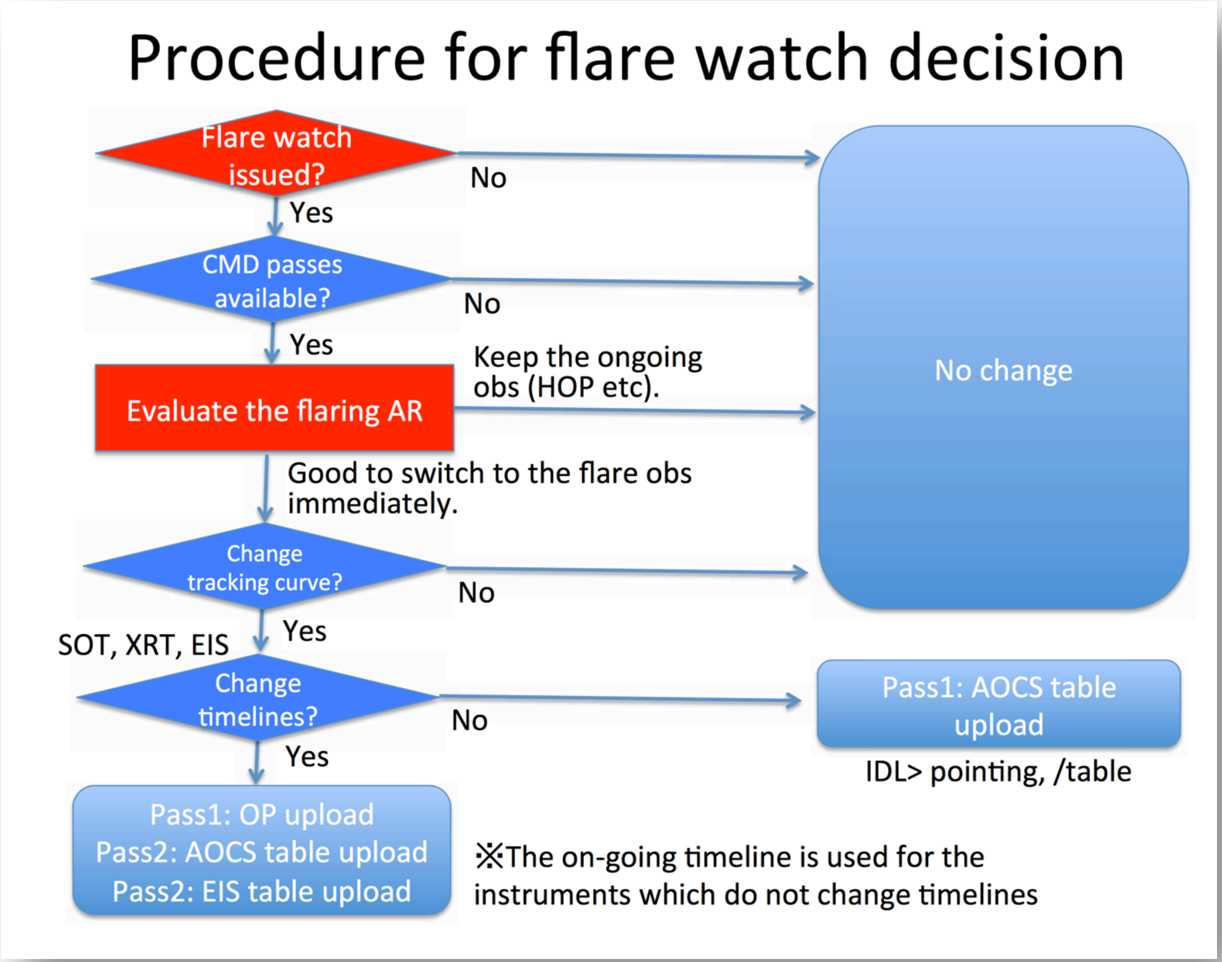
- Status:
  - SOT report:
    - Pure FM week easier and quicker than a normal week
      - Transition week is a little harder
    - Harder to stay on best AR target
    - Long continuous observations are good, but requires a decent target during planning
    - Not clear if it saves funds
      - Hours spent for mission ops is about the same in FM and normal mode (pourquoi?) and slightly higher in transitions--differences are not statistically significant; more significant effects are who is CO and if the shift shared by 2 people.
      - CO comments
        - It takes longer to do a 7 day plan but not 3 times longer. Health monitoring, data checking, coordination, reports take the same amount of time.
        - Yugma and pointing tool problems were highlighted with one planning opportunity per week

3-1, 3-2. Focused Mode Coordination

- HOP 79 could not be run in June due to a combination of focused mode and major flare watch restrictions
- HOP 285 (with VTT and IRIS) was limited due to availability of tracking curves in the 7-day plan
  - *This should be expected by or explained to the HOP proposers during FM.*
- Took longer to assemble a full set of SP/FG flat fields prior to and during eclipse season
- A pointing table upload had to be made during one of the 7-day plans, changing the SOT center pointing from a flare site between 2 emerging active regions to the leading spot of the westernmost region when activity returned to a lower level.
  - *Did this go smoothly?*

3-1, 3-2. Focused Mode Coordination

- Flare WatchDog
  - Yumi Bamba-san has been filling this position very well while working on her thesis
  - Suggestions for successor? Continue with a graduate student?
  - Does the procedure need to be sent around to the COs or just the FWD?



*Shimizu, SWG2014

3-3. Focused Mode Calendar

2015

January

S	M	T	W	T	F	S
				1	2	3
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29	30	31

February

S	M	T	W	T	F	S
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28

March

S	M	T	W	T	F	S
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30	31				

April

S	M	T	W	T	F	S
			1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30		

May

S	M	T	W	T	F	S
					1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30
31						

June

S	M	T	W	T	F	S
	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30				

July

S	M	T	W	T	F	S
			1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30	31	

August

S	M	T	W	T	F	S
						1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30	31					

September

S	M	T	W	T	F	S
		1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30			

October

S	M	T	W	T	F	S
				1	2	3
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29	30	31

November

S	M	T	W	T	F	S
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30					

December

S	M	T	W	T	F	S
		1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30	31		

Focused Mode (Tuesday upload only)

Normal (Tuesday, Thursday, Saturday uploads)

IRIS Coordination

Hinode Eclipse

IRIS Eclipse

Rocket Launch / Notable Campaign

~ HOP 130

November 24th is Thanksgiving week (less US support already) and well into IRIS eclipse season. FM during Dec/Jan holidays.

3-3. Focused Mode Calendar

Before looking ahead to 2016….

Fractional reduction in timeline creation (R):

$$R = \frac{N\_plans_{Norm} - N\_plans_{Norm+FM}}{N\_plans_{Norm}}$$

$$N\_plans_{Norm} \approx (52\,\text{weeks}) * (3\,\frac{\text{plans}}{\text{week}}) = 156\,\text{plans}$$

$$N\_plans_{Norm+FM} \approx N\_plans_{Norm} - (N\_weeks_{FM} * 2)$$

$$\mathbf{R} \approx \frac{\mathbf{N\_weeks_{FM} * 2}}{\mathbf{156}}$$

18 weeks of FM (2015) → 35% of the year; 23% reduction in number of plans generated
15 weeks of FM → 28% of the year; 19% reduction

Keep FM frequency as proposed or reduce by one 3 week run until the next review cycle (2018)? [i.e., phasing]

3-3. Focused Mode Calendar

PROPOSED PROPOSED PROPOSED **2016** PROPOSED PROPOSED PROPOSED

January

S	M	T	W	T	F	S
					1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30
31						

February

S	M	T	W	T	F	S
	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29					

March

S	M	T	W	T	F	S
		1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30	31		

April

S	M	T	W	T	F	S
					1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30

May

S	M	T	W	T	F	S
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30	31				

June

S	M	T	W	T	F	S
			1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30		

July

S	M	T	W	T	F	S
					1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30
31						

August

S	M	T	W	T	F	S
	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30	31			

September

S	M	T	W	T	F	S
				1	2	3
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29	30	

October

S	M	T	W	T	F	S
						1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30	31					

November

S	M	T	W	T	F	S
		1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30			

December

S	M	T	W	T	F	S
				1	2	3
4	5	6	7	8	9	10
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18	19	20	21	22	23	24
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Focused Mode (Tuesday upload only)

Normal (Tuesday, Thursday, Saturday uploads)

IRIS Coordination

Hinode Eclipse

IRIS Eclipse

Rocket Launch / Notable Campaign

~ HOP 130

*** Hi-C II launch in June/July?? **

November 22ND is Thanksgiving week (less US support already) and well into IRIS eclipse season (to be confirmed). FM during Dec/Jan holidays.

Hinode Overall Assessment and Findings

The 2015 Senior Review panel finds that the scientific return in recent years from *Hinode* is exceptional. The mission returns data in a unique niche of HSO data space, and the mission is in fair overall health with adequate data archiving efforts. Continuing the *Hinode* mission would ensure that a unique HSO asset is supported. The panel finds the proposal to demonstrate an excellent outlook for future collaborative work with other HSO missions (in particular, with IRIS, RHESSI, and SDO). The proposal meets the in-guide budget, and the team has developed new operating modes to be able to operate in an efficient manner while continuing to enable broad scientific discovery.

The Panel notes that the proposal includes approximately $2.6M/year for Science Data Analysis, which in our opinion should include funding both for routine data quality analysis and to perform relevant scientific investigations by the team. The Panel was surprised upon comments from the presenters that for the preceding extended mission phase, no mission-related science was performed under extended-phase funding. The Panel is concerned that this approach is the result of a misinterpretation of the 2013 Senior Review findings, and wishes here to clarify that there is no restriction on using part of that SDA funding to support *Hinode*-related science research by the team. This appears to be common practice across the other mission teams, with the caveat that this has to be balanced with the priority to meet data production commitments under a constrained overall budget which is likely to reduce with time.

5. NASA situation

The panel found that the major concerns raised in 2010 and 2013 SR cycles have been addressed: costs have been reduced, the instrument teams have developed new, efficient observing modes to further streamline operations while ensuring that high-quality data are obtained. There is still some minor concern regarding a high cost/science ratio in light of the contributions from international partners. The proposed science available to additional *Hinode* operations is compelling, and there is recognition that this is an extremely complex mission. The panel praises the *Hinode* team's proactive engagement in cross-mission collaborations. The scientific output has been very satisfactory, especially in the context of addressing fundamental outstanding questions and testing model predictions, with generally quantitative methods and results.

The Hinode extended mission proposal received an 8/10 median score for extended mission science, and 9/10 median score for contributions to Heliophysics Systems Observatory; both scores are in the highest, "compelling" category. The panel finds that continuing the *Hinode* mission would ensure continued systems-approach research to outstanding topics in solar and heliospheric physics.

Hinode Proposal Weaknesses

While the scientific achievements from *Hinode* data were compelling and fully exploited the possibility of "system" science, the panel found the presentation of the science to be somewhat fragmented. The proposal adequately describes the links between PSGs, the 2014 Heliophysics Roadmap Research Focus Areas and 2012 Decadal Survey Challenges, but the narrative could have better mirrored the "system science" approach to bring continuity between at times seemingly disparate investigation topics.

5. NASA situation

3. Mission Grades

	Mission Median	Science Std Dev		HSO Median	Science Std Dev
IBEX	9	1.6	ACE	9	1.9
IRIS	9	1.3	SDO	9	1.5
Van Allen	9	1.5	Hinode	9	1.8
AIM	8	1.2	IBEX	8	1.2
Hinode	8	1.2	IRIS	8	1.2
RHESSI	8	1.0	STEREO (2)	8	1.1
STEREO (2)	8	1.2	THEMIS	8	1.3
TIMED	8	1.2	Wind	8	1.3
Voyager	8	1.6	RHESSI	8	1.6
ACE	7	1.5	STEREO (1)	8	1.5
SDO	7	1.5	Voyager	7	1.6
STEREO (1)	7	1.4	AIM	7	1.3
THEMIS	7	1.8	TIMED	7	1.9
TWINS	7	1.3	TWINS	7	1.3
Wind	7	1.2	Van Allen	7	1.4
CINDI	7	1.2	CINDI	6	1.2

The mission grades are as follows: Grades (scale of 0 to 10, 10 is best)

10–8 Future contributions promise to be compelling

7–4 Excellent, but less compelling

3–0 Future contributions relatively modest

-