



flarewatch

putting things together (automatically)

Stefano Scardigli

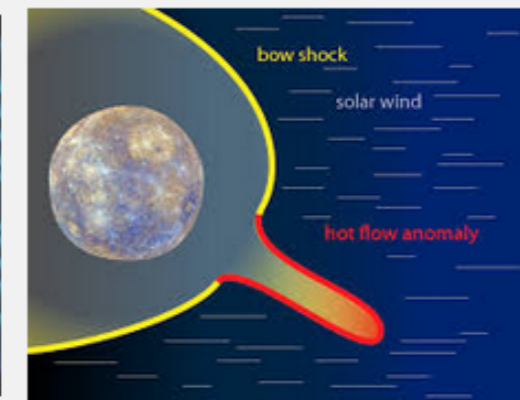
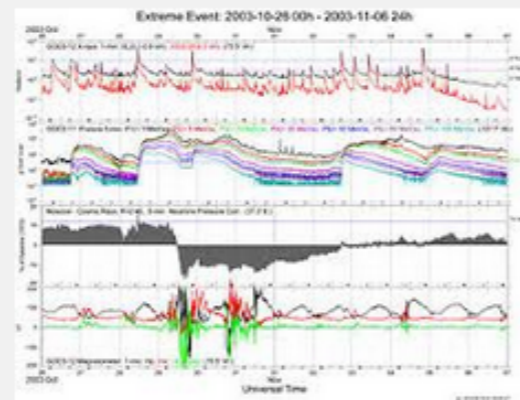
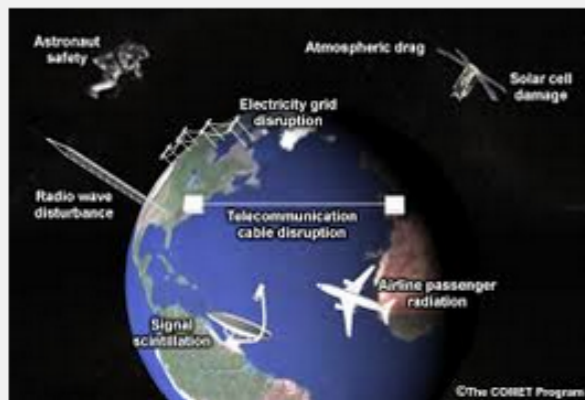
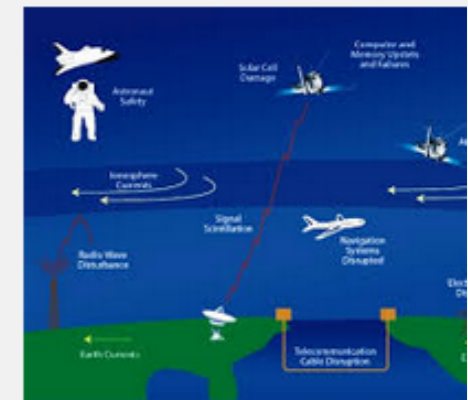
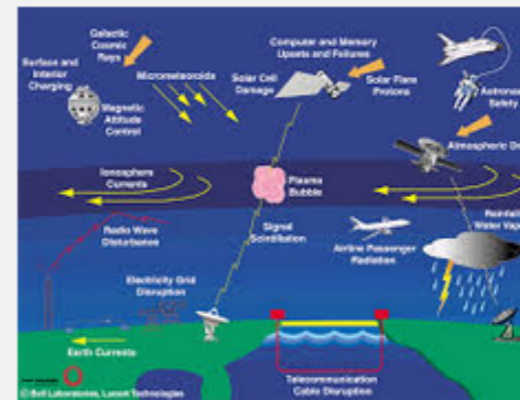
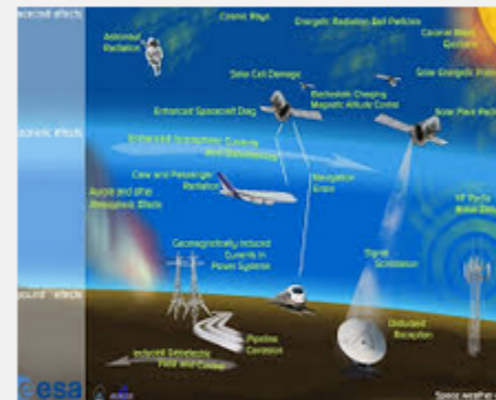
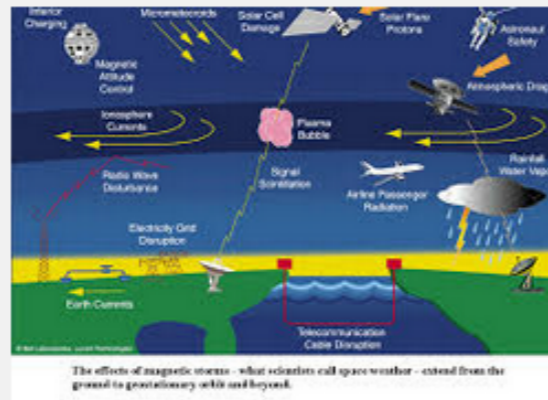
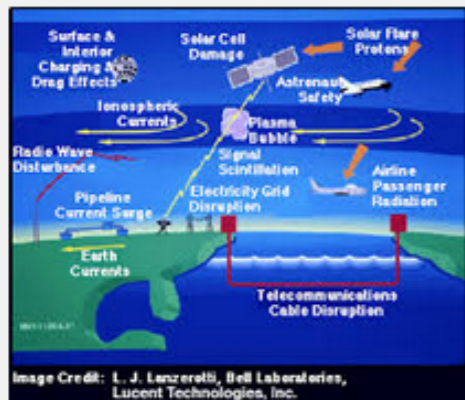
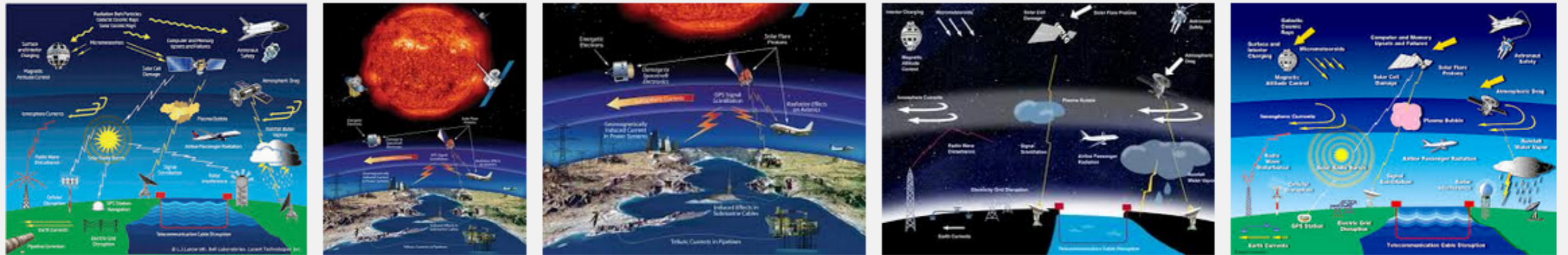
# FLARE FORECASTING



space weather



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Solar radiation X-Rays, UV Energetic Particles

Space Weather News: Effects on NASA Missions

TRANSIONOSPHERIC SIGNALS - IONOSPHERIC ROTATION EFFECTS

Solar flare (X-rays, protons)

Solar flare radio flux = 398 SFU

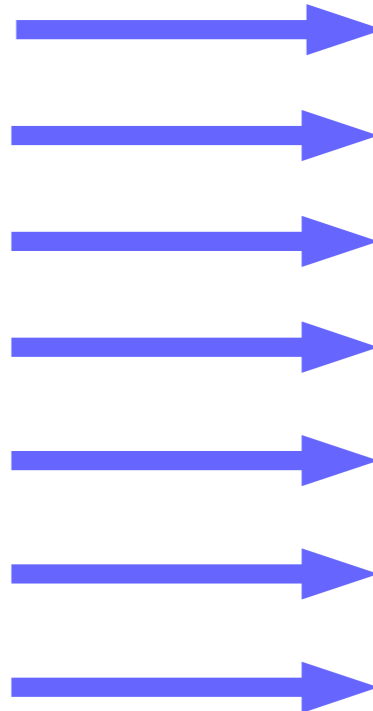
Communications frequency = 4888 Mhz

➔ **GEOEFFECTIVE SOLAR EVENT FORECASTING**

# GEOEFFECTIVE SOLAR EVENT FORECASTING

## Phenomena

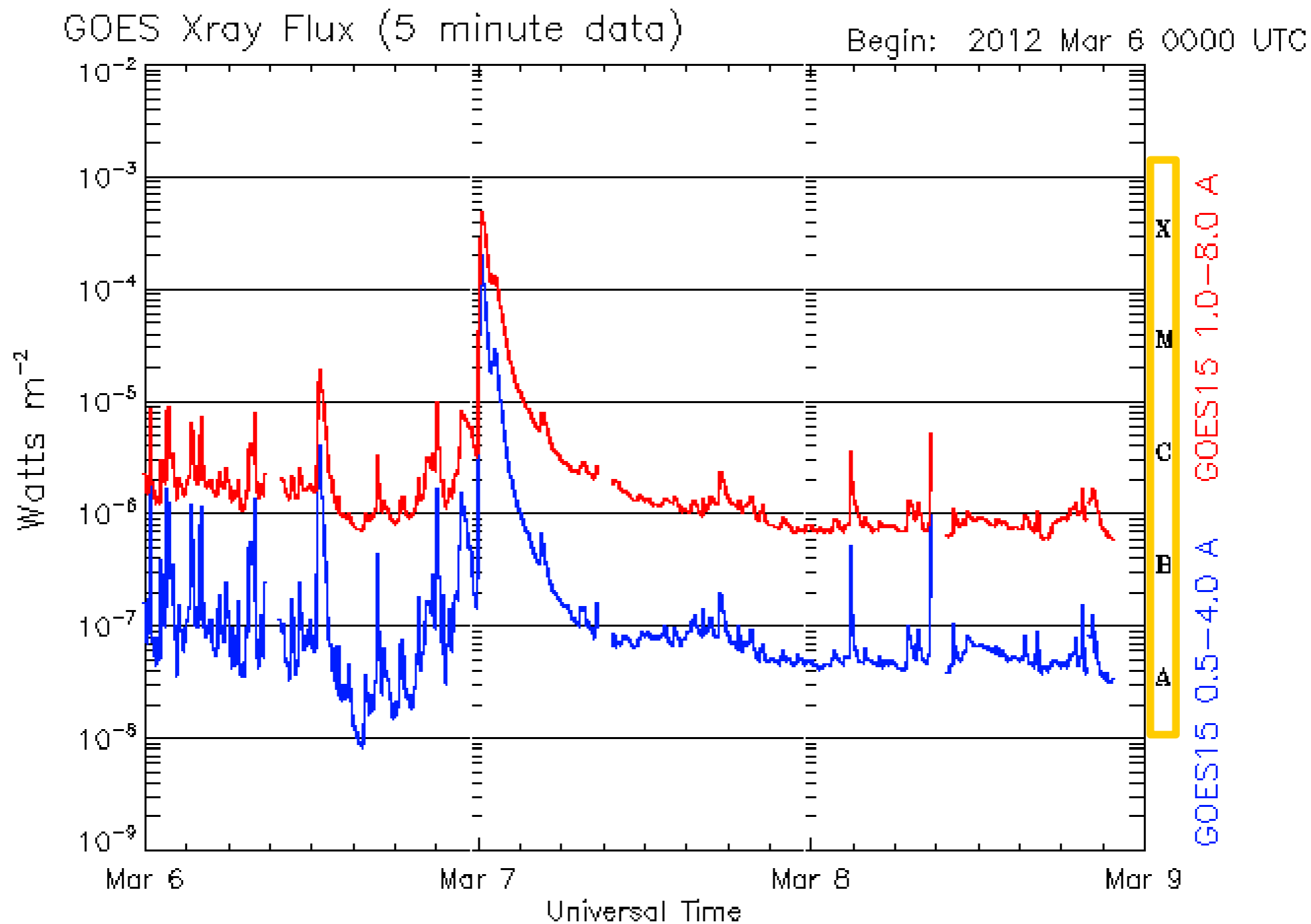
Coronal Holes  
Coronal Mass Ejections  
F10.7 cm Radio Emissions  
Solar EUV Irradiance  
\* Solar Flares  
Solar Radiation Storm  
Solar Wind  
Sunspots/Solar Cycle  
...



## Impacts

Electric Power Transmission  
GPS Systems  
HF Radio Communications  
Satellite Communications  
Satellite Drag  
Auroras  
Earth's Magnetosphere  
Galactic Cosmic Rays  
Ionosphere  
Ionospheric Scintillation  
Radiation Belts  
Earth's Climate  
...

# FLARE - definition



Updated 2012 Mar 8 21:55:12 UTC

NOAA/SWPC Boulder, CO USA

# FLARE - B7 vs. Galaxy-15

**BBC NEWS**

SCIENCE & ENVIRONMENT

14 January 2011 Last updated at 10:42 GMT

## 'Zombie-sat' rises like a phoenix

By Jonathan Amos  
Science correspondent, BBC News

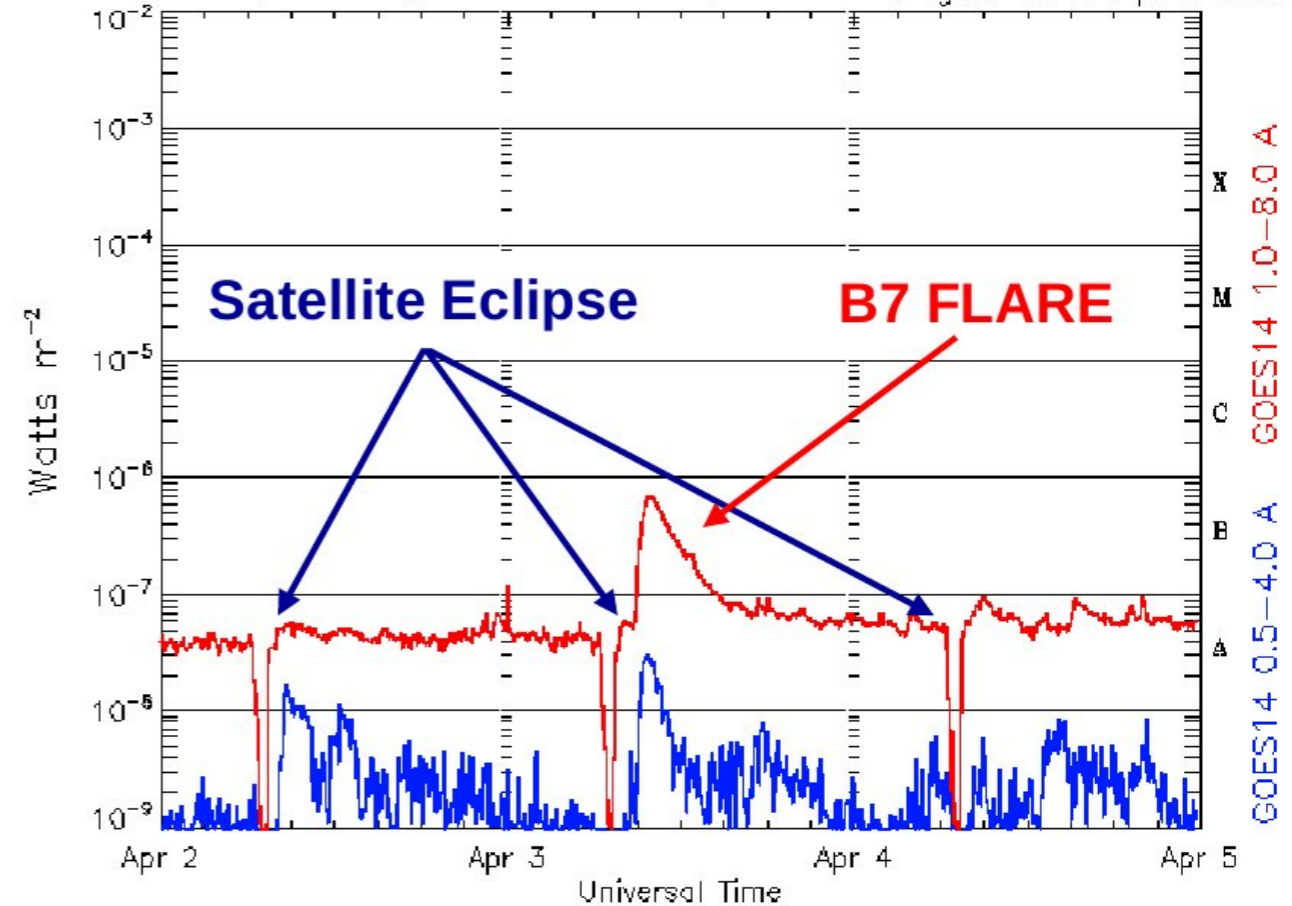
Intelsat says its once wayward Galaxy-15 spacecraft should deliver 10 years of service if put back

The satellite, which spent most of 2010 drifting out of control, is now under full command again and is back on its normal programme.

Assuming it is given a clean bill of health, Galaxy-15 will return to the business of relaying TV service for Intelsat.

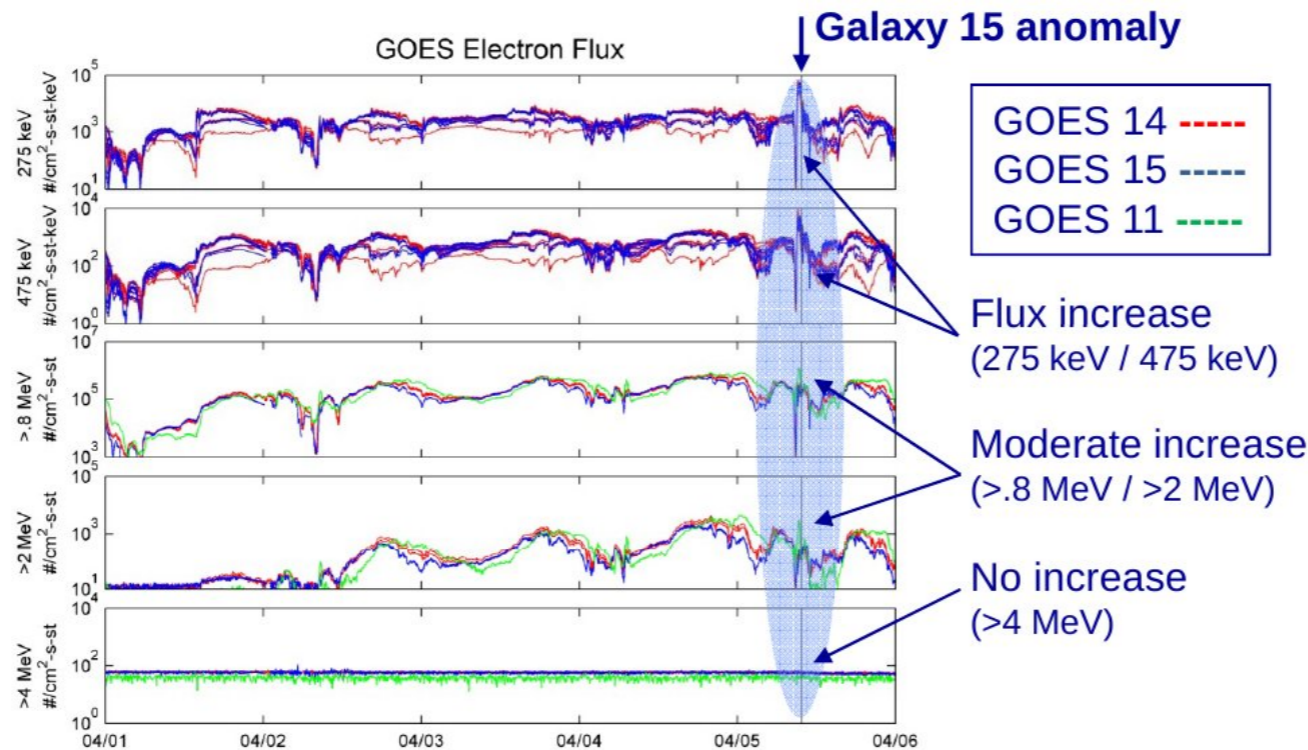
GOES Xray Flux (5 minute data)

Begin: 2010 Apr 2 0000 UTC

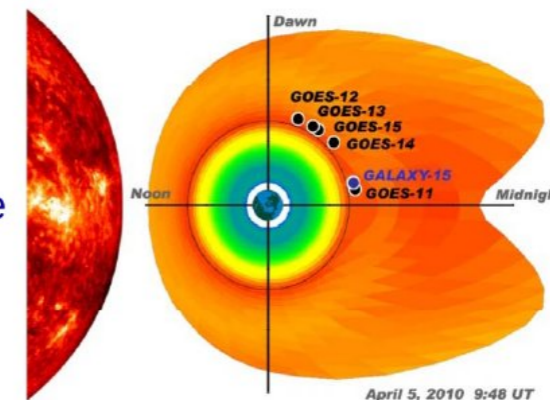


Updated 2010 Apr 4 23:55:11 UTC

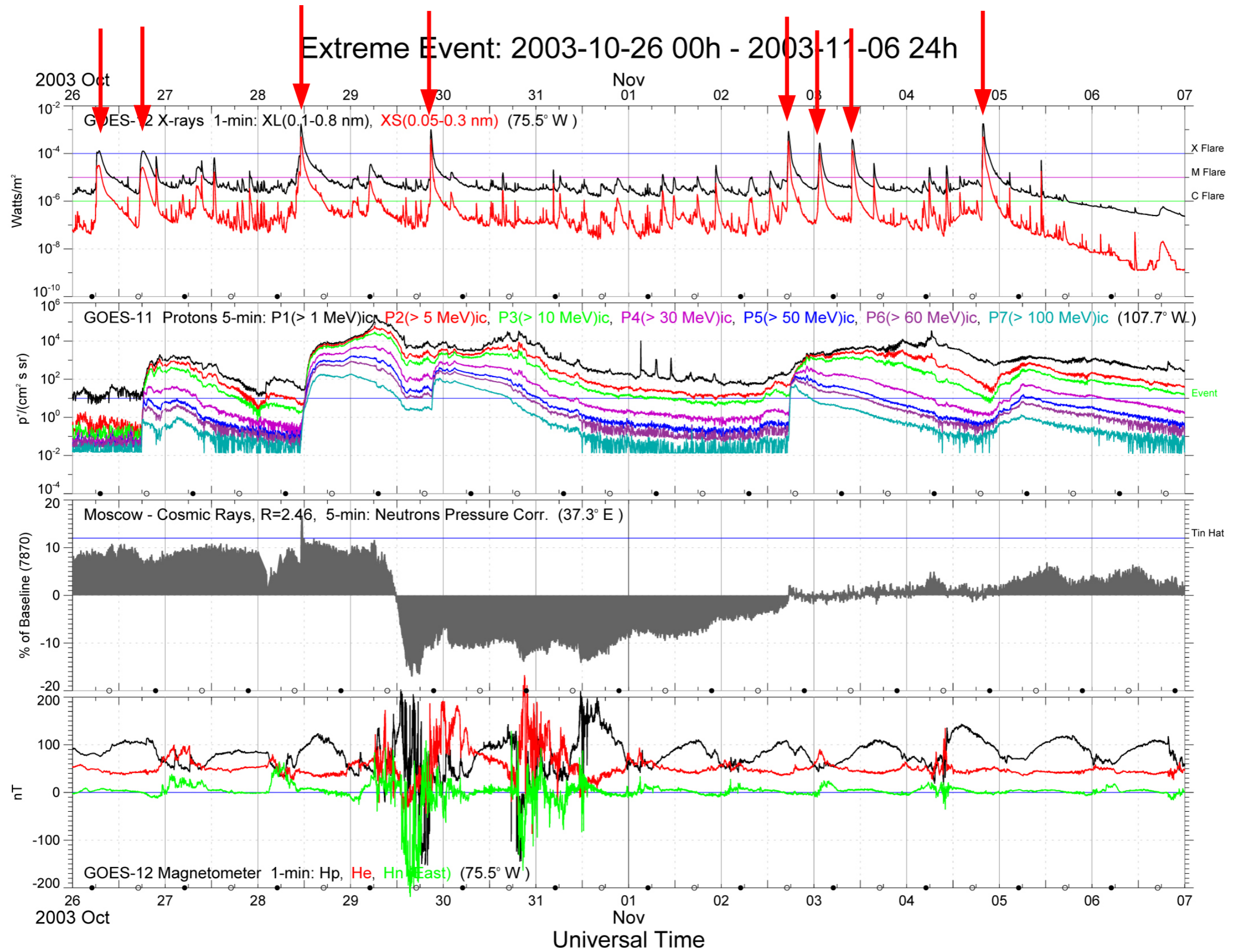
NOAA/SWPC Boulder, CO USA



Satellite Locations



# FLARE - Halloween storm (2003)

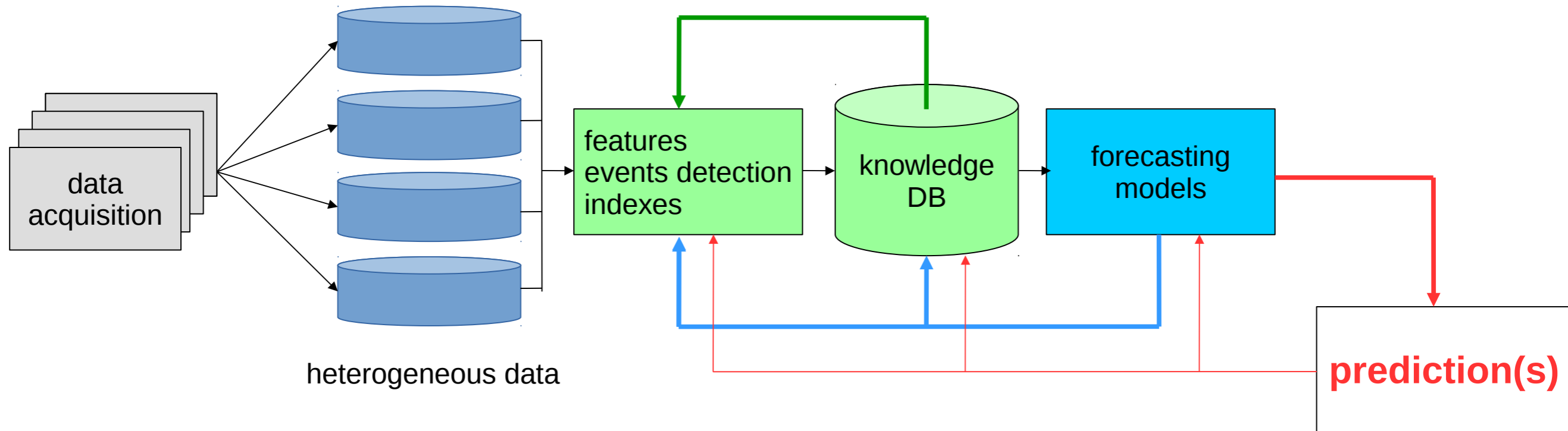


# **EXTREME EVENTS FORECASTING**

**What we need is**

**STATISTICS**

# EXTREME EVENTS FORECASTING



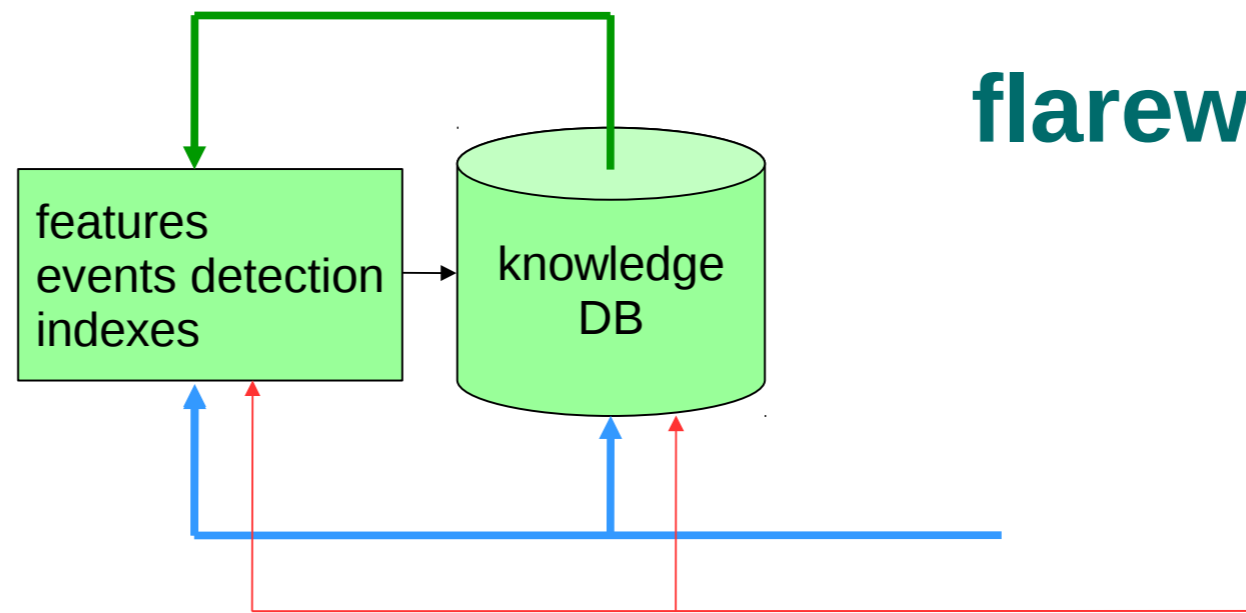
**flarewatch@UTOV**

**(BIG data!)**

- data harvesting
- standardization procedures
- post-elaboration algorithms
- indexes definition
- ...

- databases
- storages
- mirroring
- dissemination
- ...





## - data harvesting

- SDO/HMI -> JSOC procedure
- GONG-H $\alpha$  -> web crawling
- GOES-X -> ftp
- ...

## - standardization procedures

- resolution (imaging)
- disk rotation (imaging)
- timescale homogenization
- ...

## - post-elaboration algorithms

- data quality
- lacking data management
- event detection
- active region definition
- ...

## - indexes definition

- magnetic indexes (local fluxes, R,...)
- eliocentric angles
- ...

## - databases

- TBD

## - storages

- TBD

## - mirroring

- TBD

## - dissemination

- TBD

- ...

# flarewatch@UTOV



10

Bh – Big Bear

10

Ch – Cerro Tololo

10

Lh – Learmonth

10

Mh – Mauna Loa

10

Th – El Teide

10

Uh – Udaipur

**H $\alpha$**

10

SDO/HMI M\_720s\_nrt

**B**

10

SDO/HMI SHARP\_nrt

10

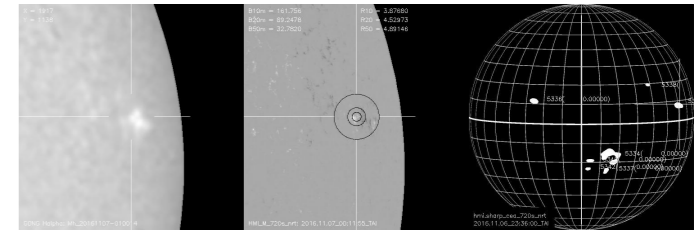
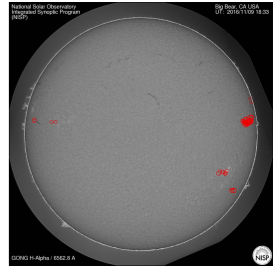
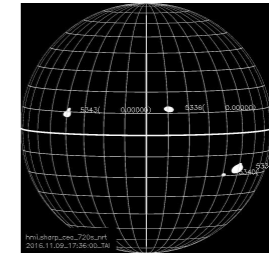
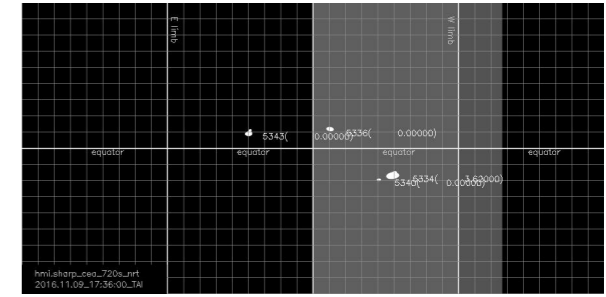
GOES-X

**X-ray flux**

STORAGE

DB1

DB2

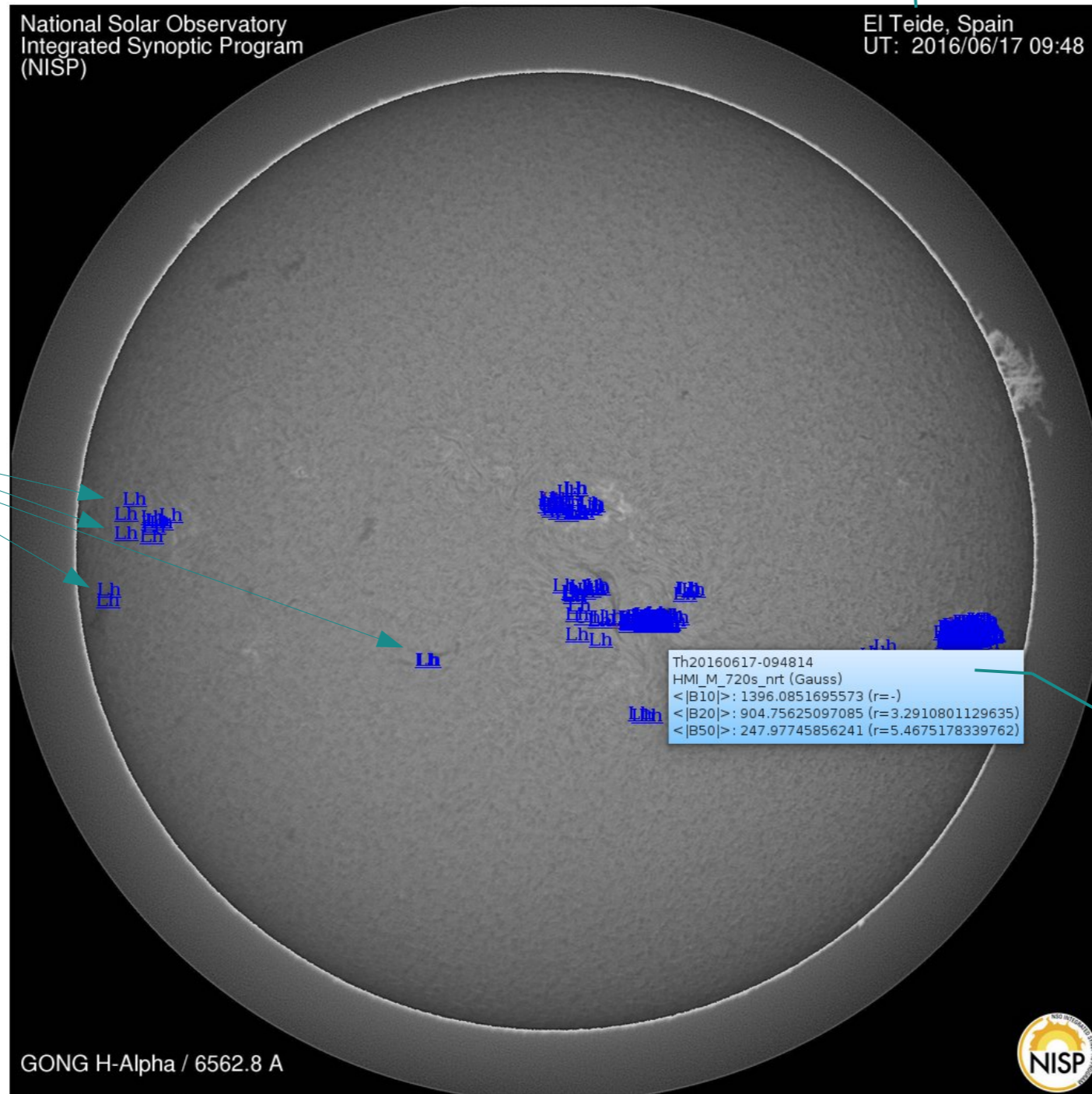


GONG	Days from 20140101	flag	check1	check2	check3	in pixels	bar-j-bar/regions	peak	name
Bh	1943.74	-1	14869900	0.999999	0.58018928	1764	663	1	86666/Bh-20161109-174654
	HMI_720		total [B10] (Gauss)	total [B20] (Gauss)	total [B50] (Gauss)				
	2016.11.09 16:47:55	TAD	44.7638	97.2454	38.1177				
		R	2.53	4.78	5.20				
SDO/HARPnet	AR: 5334		R=2.561	area (pix)= 5405					

GONG	Days from 20140101	flag	check1	check2	check3	in pixels	bar-j-bar/regions	peak	name
Ch	1943.74	0	230949	1.21251	1	14	1764	671	48739/Ch-20161109-175234
	HMI_720		total [B10] (Gauss)	total [B20] (Gauss)	total [B50] (Gauss)				
	2016.11.09 16:59:55	TAD	190.025	120.458	39.4589				
		R	3.83	5.00	5.20				
SDO/HARPnet	AR: 5334		R=3.561	area (pix)= 5405					

GONG	Days from 20140101	flag	check1	check2	check3	in pixels	bar-j-bar/regions	peak	name
Bh	1943.77	0	321250	0.999999	0.662536	1771	678	1	20648/Bh-20161109-183354
	HMI_720		total [B10] (Gauss)	total [B20] (Gauss)	total [B50] (Gauss)				
	2016.11.09 17:35:55	TAD	204.677	142.858	41.6233				
		R	3.81	5.02	5.22				
SDO/HARPnet	AR: 5334		R=3.554	area (pix)= 5677					

# quick recap display



background picture:  
latest H $\alpha$  in the selected time interval

candidate events (H $\alpha$ )

mouse-overing: SDO/HMI indexes

source	start	end
	yyyymmdd-hh	yyyymmdd-hh
All	20160617-00	latest

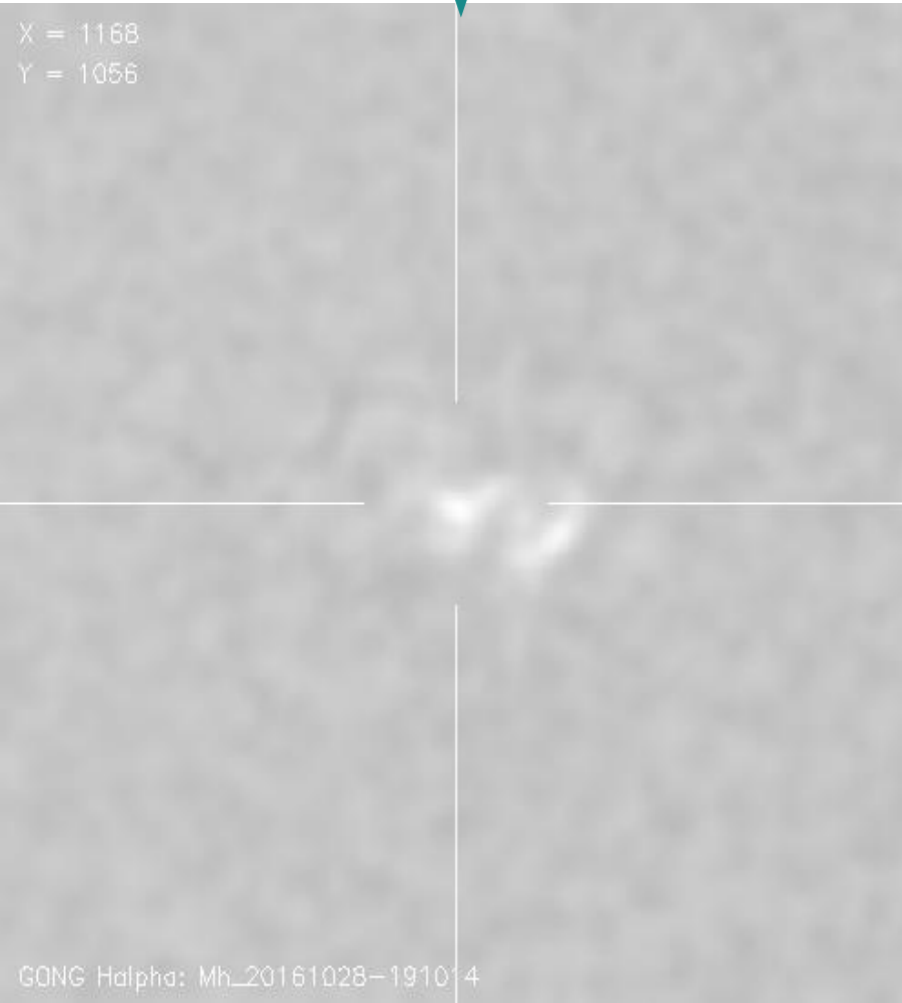
selection form

# candidate event details

## GONG H $\alpha$

coordinates

X = 1168  
Y = 1056



## SDO/HMI magnetogram

mean magnetic fluxes

B10m = 62.9509  
B20m = 69.9380  
B50m = 70.6080

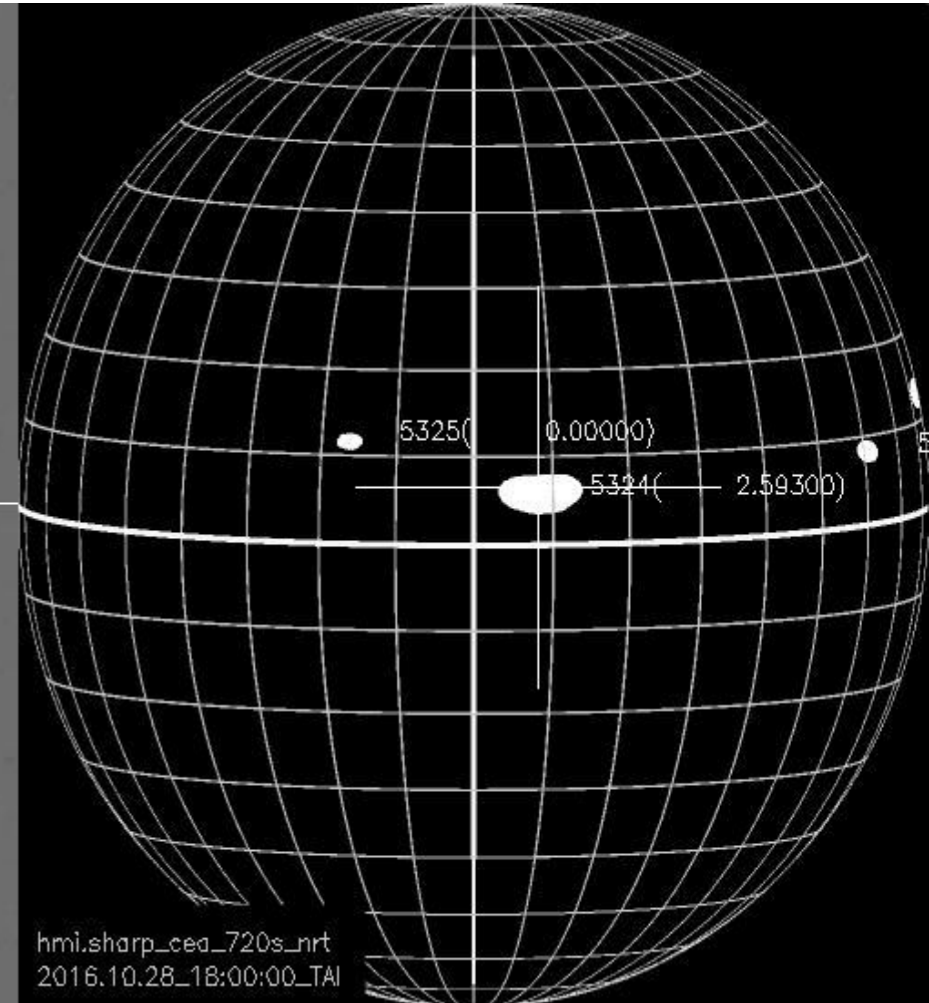


R indexes

R10 = 3.55943  
R20 = 4.39686  
R50 = 4.88709

target areas

## SDO HARP (nrt)



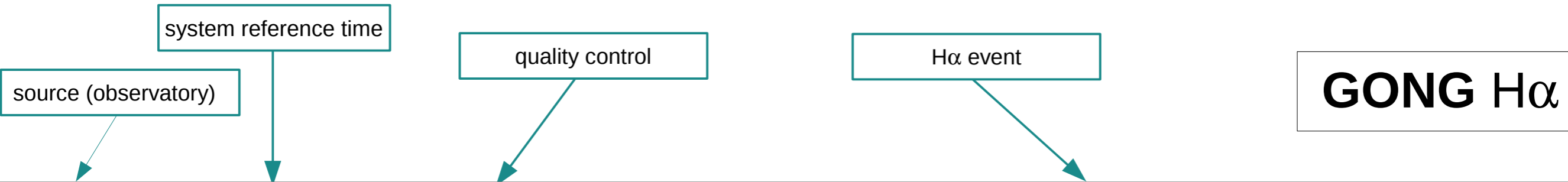
source (observatory)

event time

SDO/HMI release

SDO/HARP time

# candidate event sheet



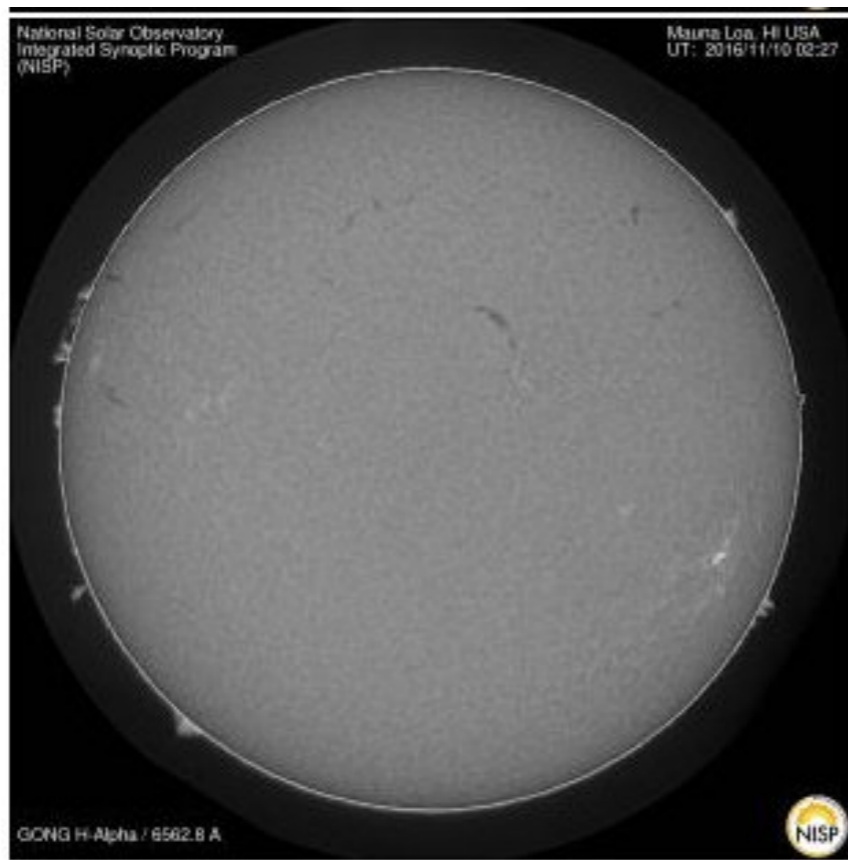
**GONG H $\alpha$**

GONG	Days from 20140101	flag	check1	check2	check3	n pixels	i-bar	j-bar	regions	peak	name
Mh	1044.1	0	9157610	0.999997	0.525171	138	1831	705	1	530473	Mh-20161110-022714
<b>HMI_720</b>		<b>total  B10  (Gauss)</b>	<b>total  B20  (Gauss)</b>	<b>total  B50  (Gauss)</b>							
2016.11.10_01:23:55_TAI		102.448	133.77	58.2576							
<b>R</b>		0.00	4.69	5.42							
<b>SDO/HARP(nrt)</b>	AR: 5334	R=3.745	area (pixs)= 6975								

magnetic fluxes

magnetic indexes

**SDO/HMI**



# flarewatch@UTOV: candidate event record

source:	Ch	←	observatory
days20140101:	1044.49	←	
crono:	20161110-114934	←	timing
diffsec:	63.2812		
flag:	0		
diff:	1703900		
diffmq:	1.52122	←	image quality
difftr:	1		
stddev1:	67.1379		
stddev2:	85.5		
npix:	2		
ibar:	1901		
jbar:	713	←	event geometry
nreg:	1		
peak:	6648		
b10:	158.483		
b20:	80.2328		
b50:	39.5091		
r10:	12113.9	←	SDO/HMI M_720s_nrt
r20:	62928.2		
r50:	161038		
HMItime:	2016.11.10_10:59:55_TAI		
ARHARP_nrt:	5334		
AR_R_nrt:	3.9	←	SDO/HMI SHARP_nrt
AR_npix_nrt:	6379		
image:	Ch-20161110-114934		
imglink:	<a href="http://gong2.nso.edu/HA/hag/201611/20161110/20161110114934Ch.jpg">http://gong2.nso.edu/HA/hag/201611/20161110/20161110114934Ch.jpg</a>		
quando:	2016-11-1003:51:36		

# open issues / to-do list / improvements

## H $\alpha$ team

### heliocentric coordinates:

- axes, angles,...

### image quality check:

- focusing, saturation, clouds, misalignment,...

### event detection improvement:

- 2-image
- n-image
- mixing images from different instruments
- differentiating features (filaments, pores,...)

## SDO/HMI team

### heliocentric coordinates:

- axes, angles,...

### magnetogram release

- quickness vs quality

### active regions

- definitions, homogenization

### magnetic indexes

- definition, improvements

## DB/systems team

### storage:

- platforms and servers definition
- redundancy
- source image conservation
- new elaborated image storing
- ...

### database:

- general architecture definition
- ...

## dissemination team

- web domain
- web site
- contacts
- ...