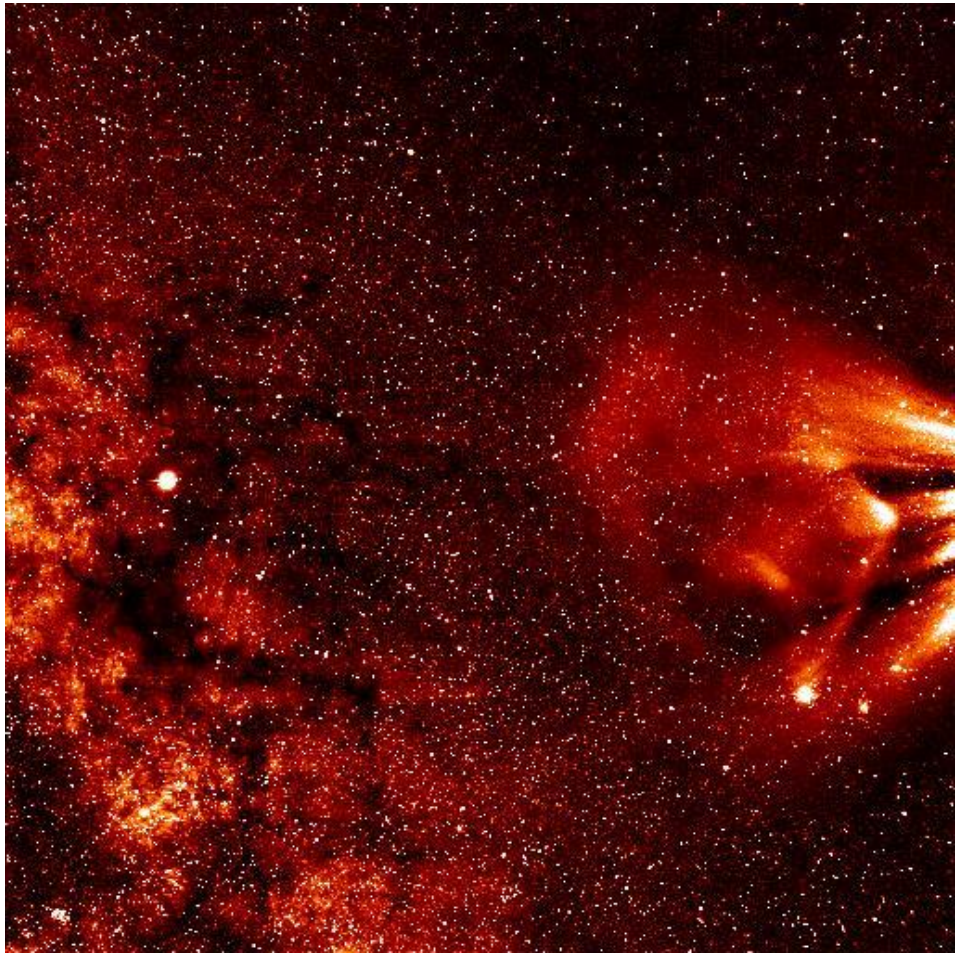


L5 – What have we learnt from the STEREO Heliospheric Imagers?

Prof Richard Harrison
Head of Space Physics Division & Chief Scientist,
RAL Space

RAL Space

Science & Technology Facilities Council

We have been there!

- NASA's STEREO
- Launched Oct 2006

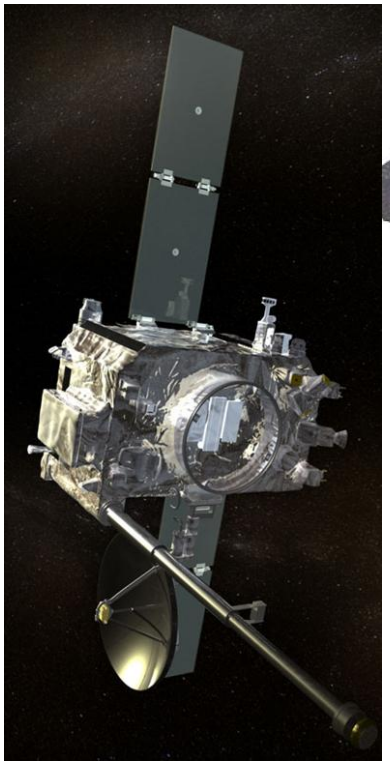
AND STEREO CONTINUES!!

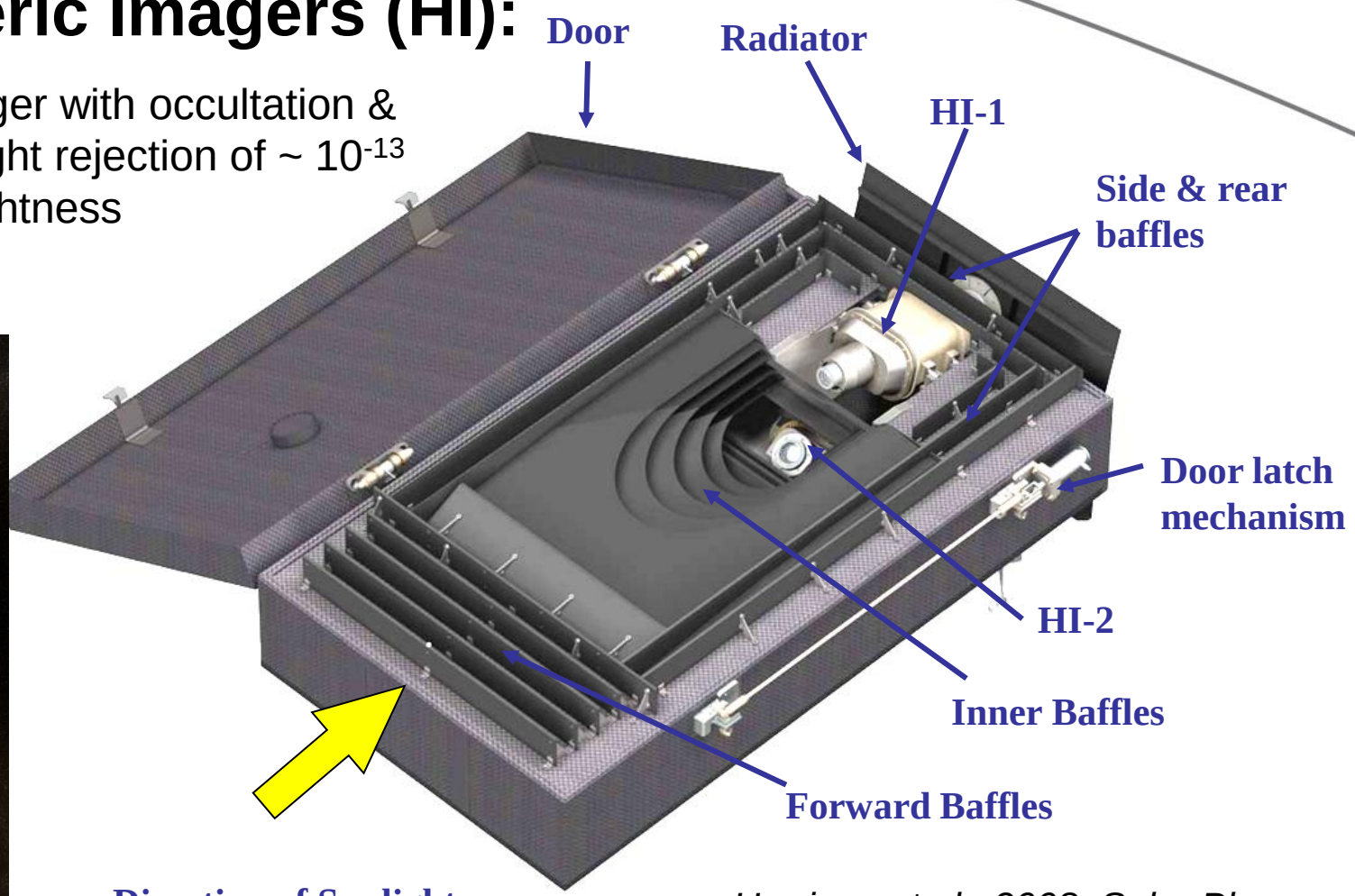
1. A brief tour of what you get from a Heliospheric Imager

2. Some statements about the use of an HI for space weather applications…..

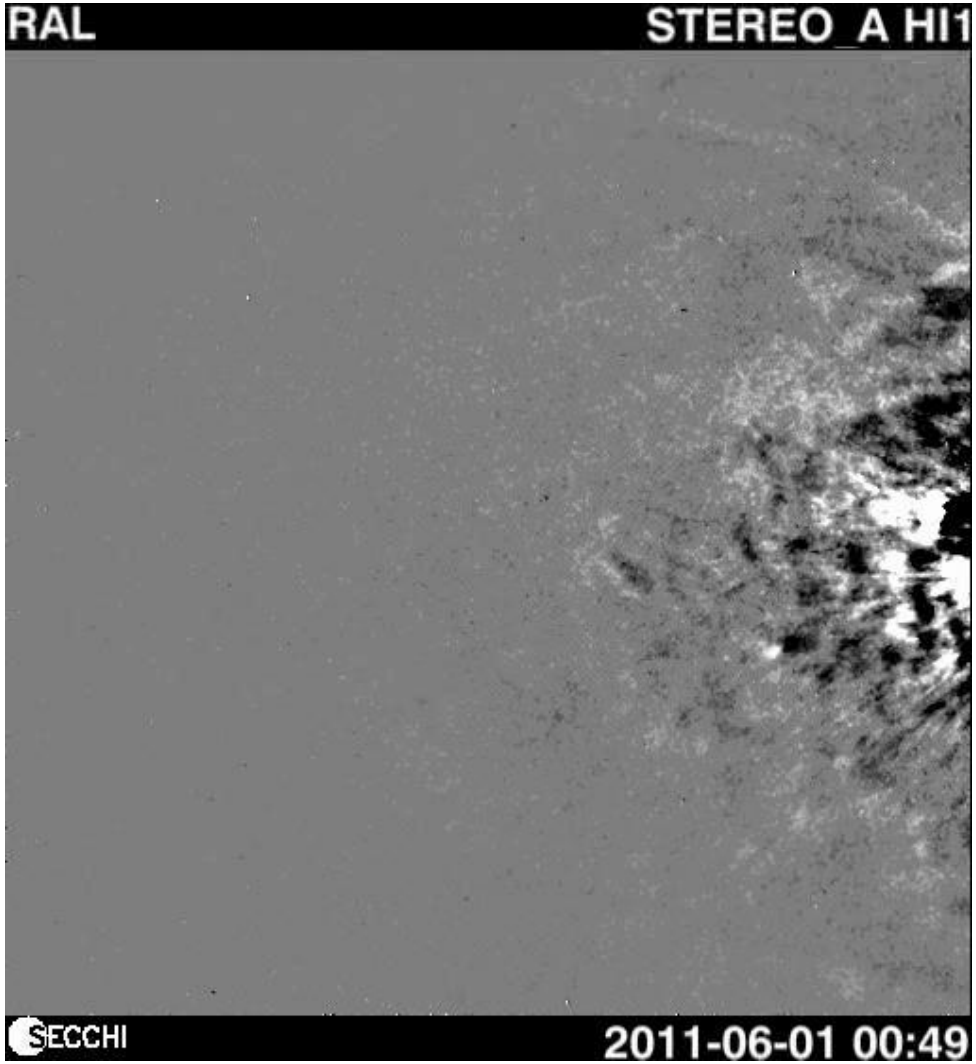
The STEREO Heliospheric Imagers (HI):

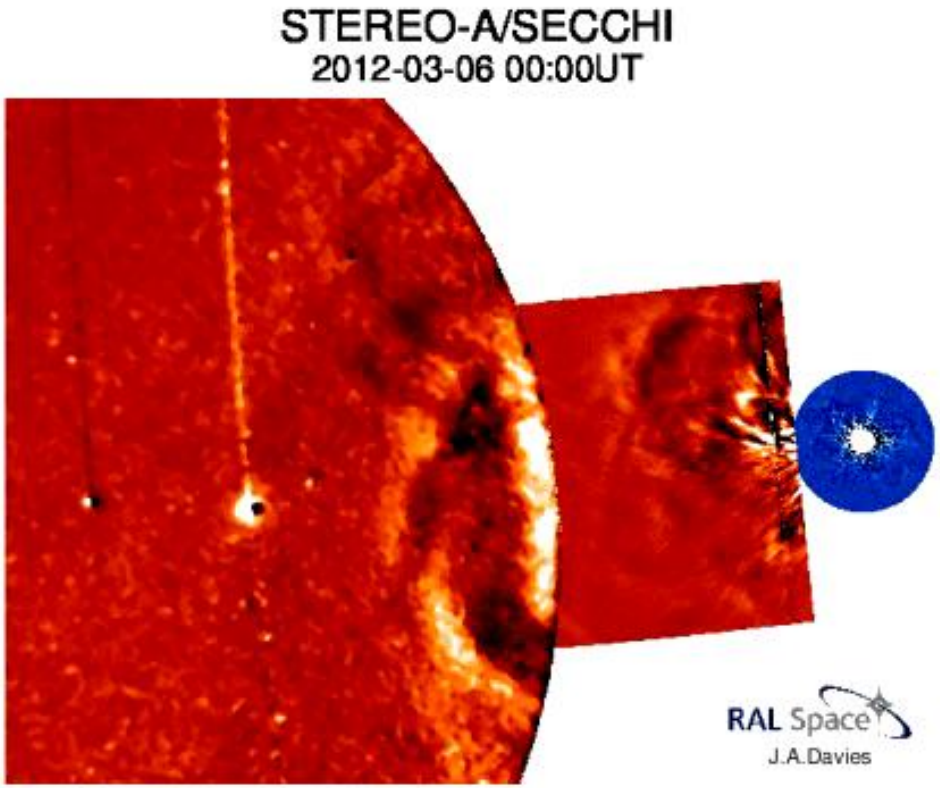
Wide-angle imager with occultation & baffle system; light rejection of ~ 10^{-13} of the Solar Brightness



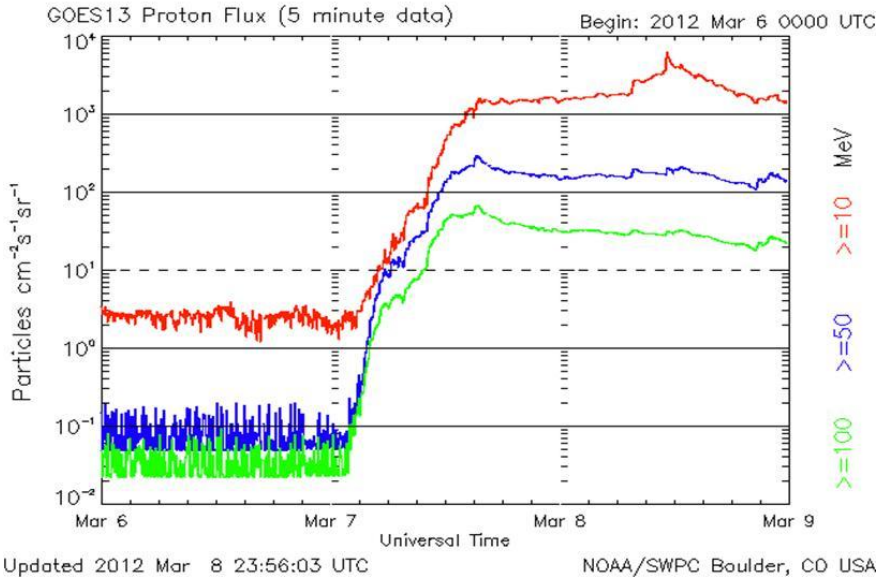


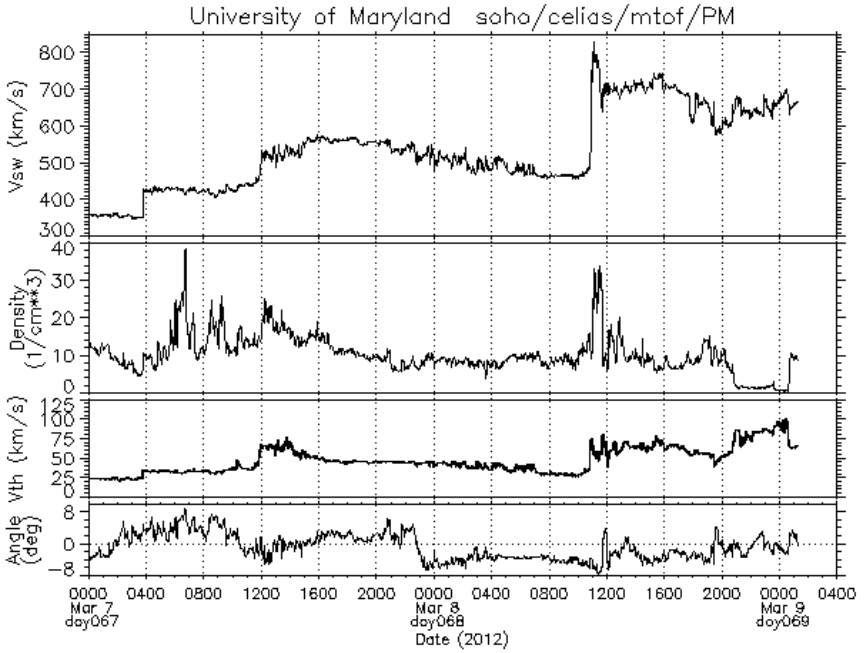
Harrison et al., 2008, Solar Phys.
Eyles et al., 2009, Solar Phys.
www.stereo.rl.ac.uk


RAL
STEREO_A HI1
SECCHI
2011-06-01 00:49

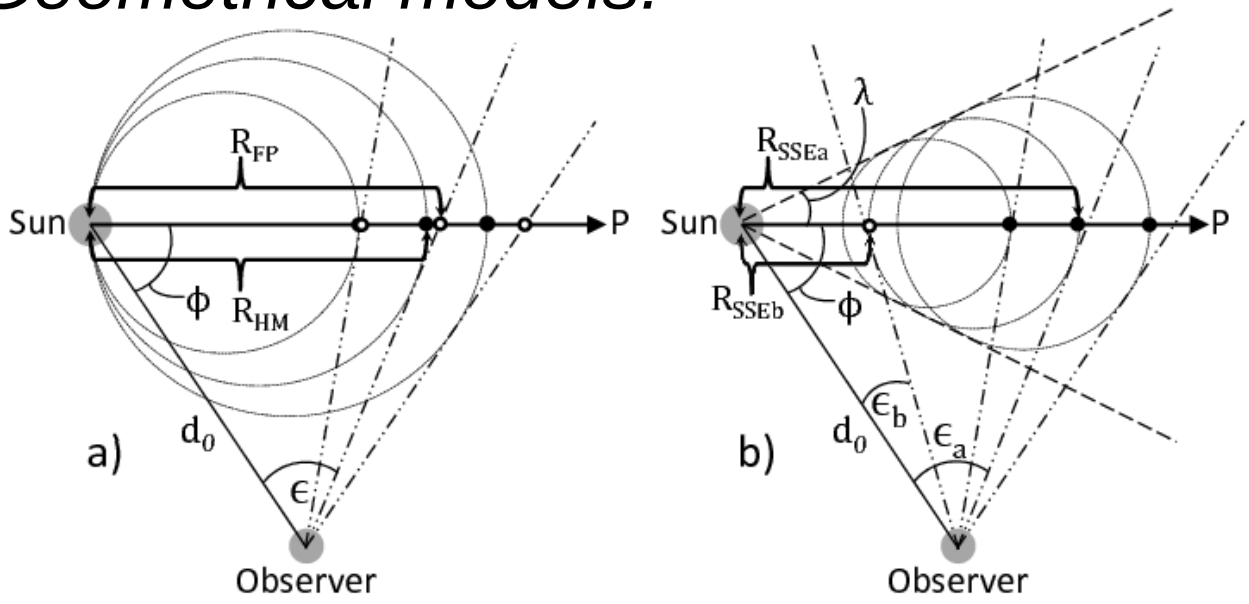


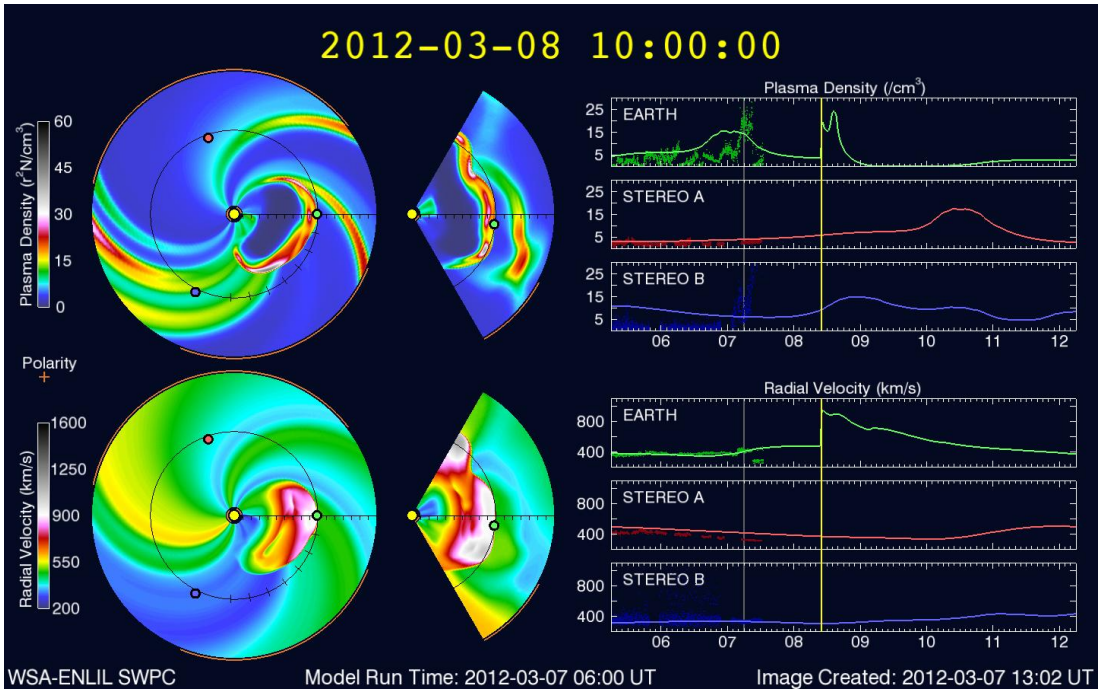
Research meets applications…

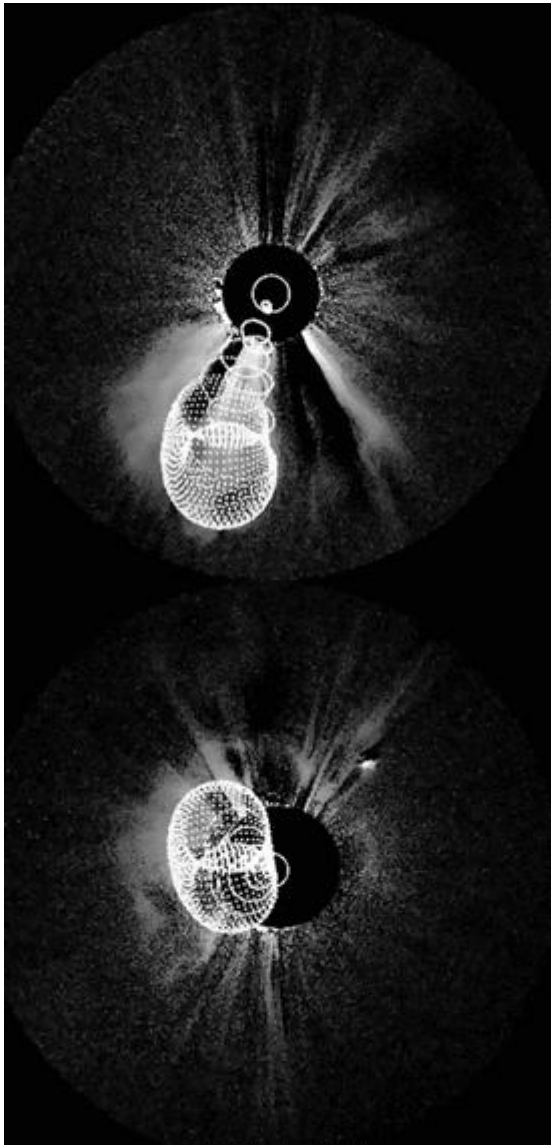

GOES13 Proton Flux (5 minute data)
Begin: 2012 Mar 6 0000 UTC
Particles cm⁻²s⁻¹sr⁻¹
MeV
>=10
>=50
>=100
Mar 6
Mar 7
Mar 8
Mar 9
Universal Time
Updated 2012 Mar 8 23:56:03 UTC
NOAA/SWPC Boulder, CO USA


University of Maryland soho/celias/mtof/PM
Vsw (km/s)
Density (1/cm**3)
Vth (km/s)
Angle (deg)
0000 Mar 7 day067
0400
0800
1200
1600
2000
0000 Mar 8 day068
0400
0800
1200
1600
2000
0000 Mar 9 day069
0400
Date (2012)

Geometrical models:







Forward models:

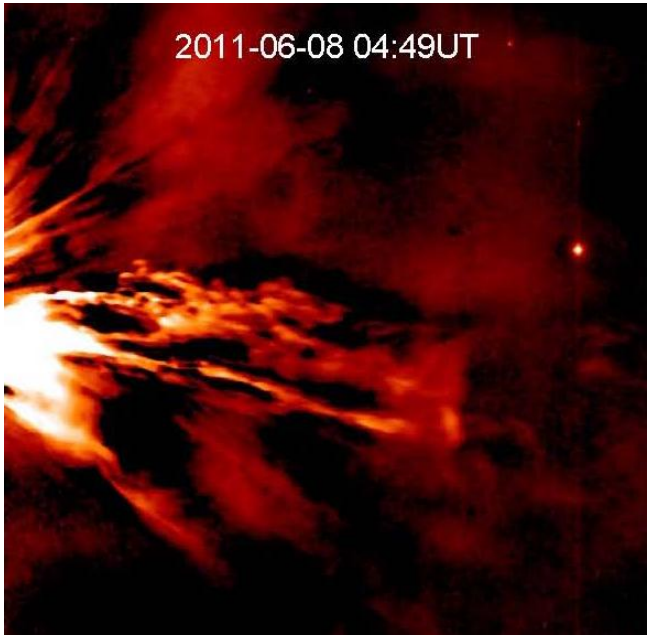
Numerical models:

Assessments of the use of HI data for space weather applications:

- Attempts at event prediction (broadcast data), compared to ‘traditional’ means (e.g. Biesecker)

- Inputs to Enlil (we can ‘see’ the inner edge of Enlil domain) (e.g. Reading/Met Office, IRAP)

…but there is much more that we have learnt from STEREO/HI



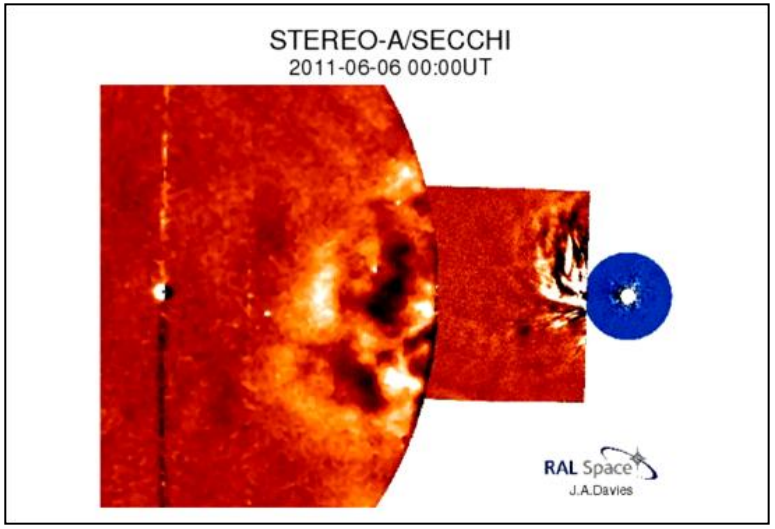
Opening up a wide-field from Sun to Earth, from L5: What does it give you?

<u>Tracking and prediction</u>: *It is a huge gap between the corona and Earth!*

1. Track transient through the heliosphere – speed, direction, density… the third dimension, and L5 also removes ‘halo problem’

- Earth-directed CMEs - 30^{o}+
- Triangulation, single s/c

2. Ability to update as event progresses

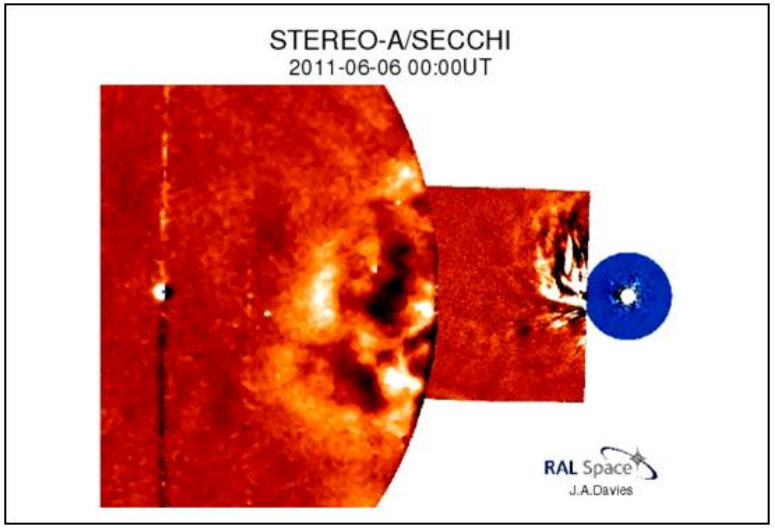


Opening up a wide-field from Sun to Earth, from L5: What does it give you?

Tracking and prediction: *It is a huge gap between the corona and Earth!*

3. Reducing uncertainty – compared to halo obs, & updating

4. Earth/CME in same image



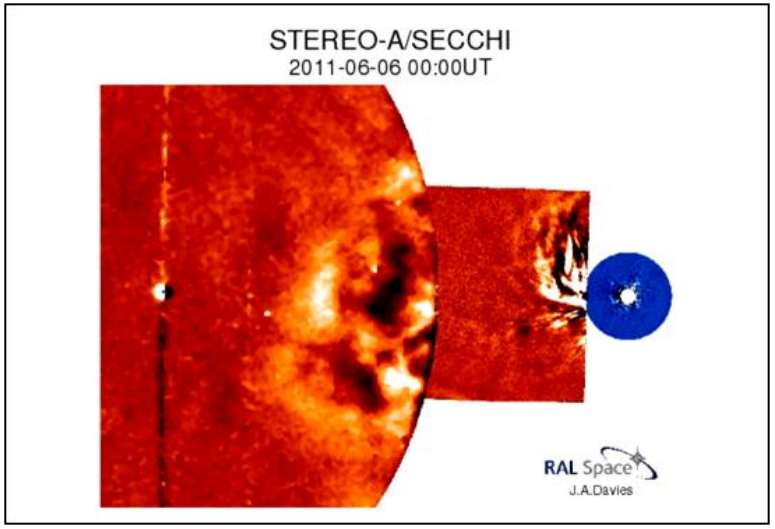
Opening up a wide-field from Sun to Earth, from L5: What does it give you?

Topology: *A lot can happen in 1 AU…*

1. Structure and evolution – amber/red strategy?

2. CME-CME interaction and interaction with the background solar wind

3. Multiple CMEs



Opening up a wide-field from Sun to Earth, from L5: What does it give you?

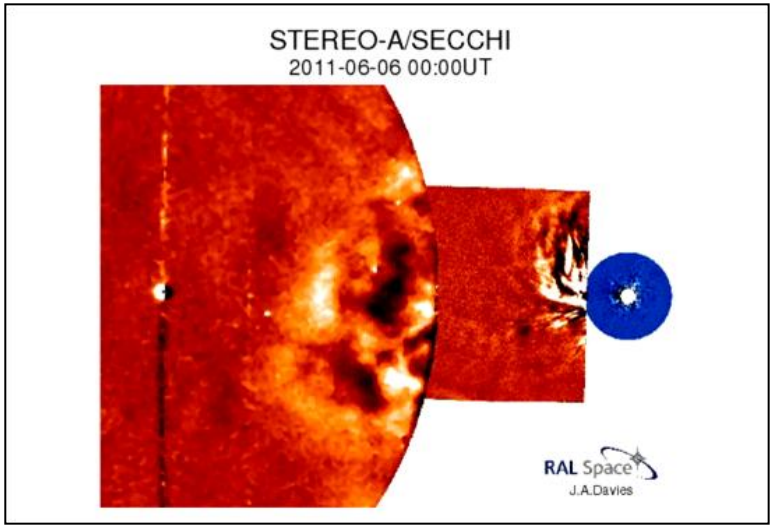
Comments:

1. Inputs to models – e.g. Enlil inner boundary

2. Broadcast vs science

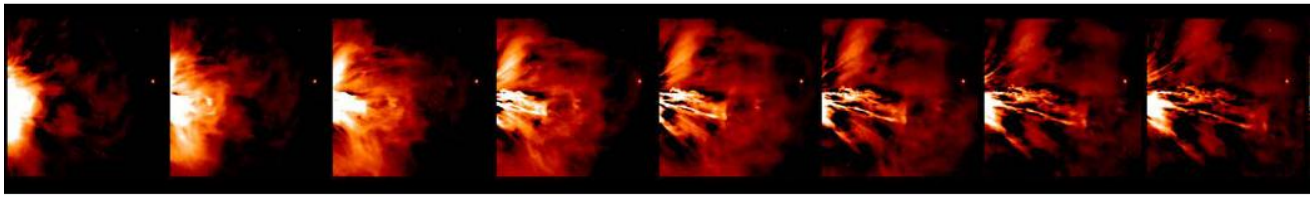
3. Not L5?

4. HELCATS – FP7 – major coordination of heliospheric CME cataloguing/modelling



HELCATS: Heliospheric Cataloguing, Analysis & Techniques Service

(www.helcats-fp7.eu)



- *to catalogue both transient (CMEs) & background (SIRs/CIRs) solar wind structures imaged by the STEREO/HI instruments, including estimates of their kinematic properties based on a variety of established modelling techniques and the prototyping of other, more speculative, approaches;*

- *to verify these kinematic properties, and thereby assess the validity of these techniques, through comparison both with solar source observations and in-situ measurements at multiple points throughout the heliosphere;*

- *to assess the potential for initialising advanced numerical models based on the derived kinematic properties of the transient & background solar wind structures;*

- *to assess the complementarity of using radio observations to detect structures and diagnose processes in the heliosphere (in particular Type II radio bursts and interplanetary scintillation) in combination with heliospheric imaging observations*

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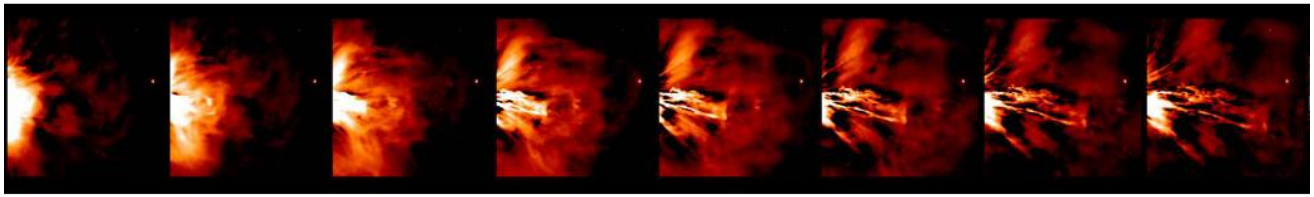

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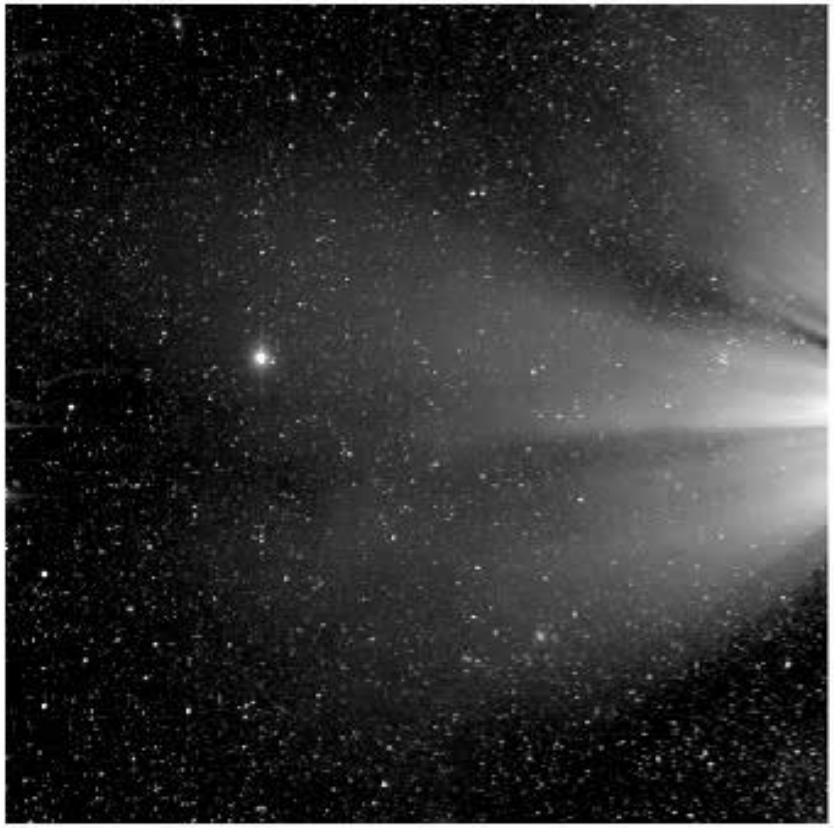
STEREO/SECCHI

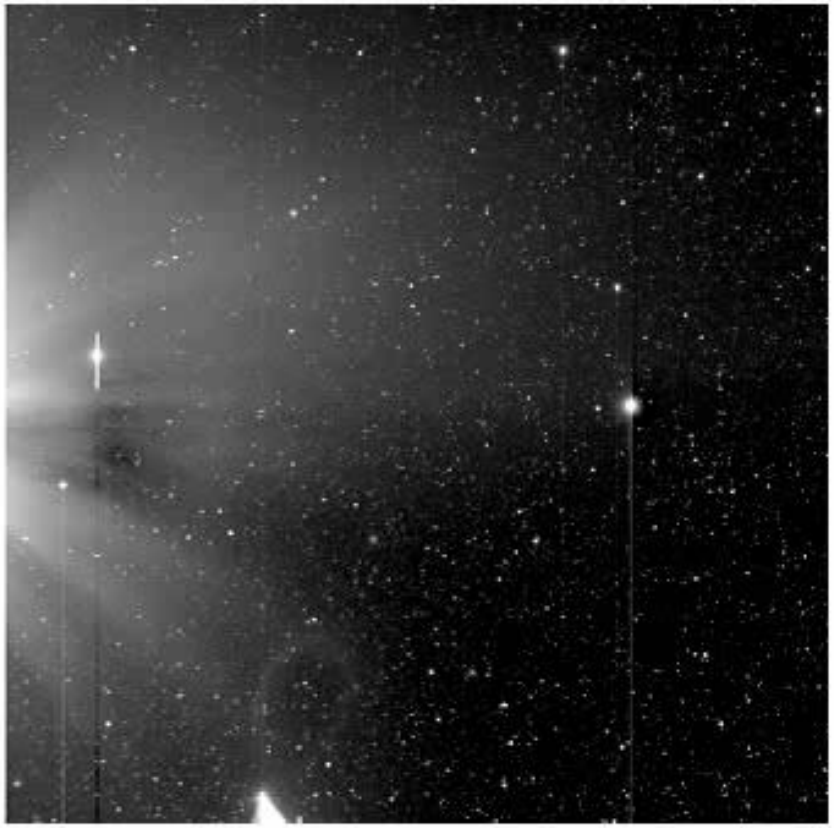
RAL Space

2013-03-10 00:09UT

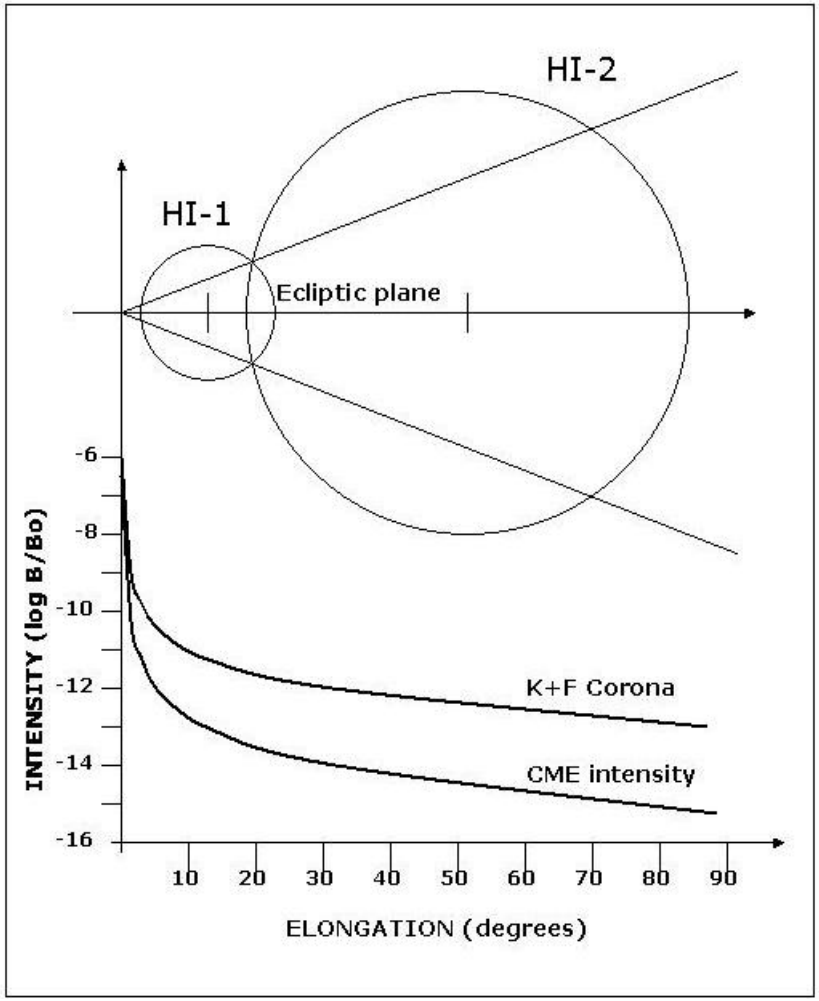
HI-1A



HI-1B



HI Performance:



	HI-1	HI-2
Direction of Centre of FOV	**14 degrees**	**53.7 degrees**
Angular Field of View	**20 degrees**	**70 degrees**
Angular Range	**4-24 degrees**	**18.7-88.7 degrees**
Image Array (2x2 binning)	**1024x1024**	**1024x1024**
Image Pixel Size	**70 arcsec**	**4 arcmin**
Spectral Bandpass	**630-730 nm**	**400-1000 nm**
Nominal Image Cadence	**40 min**	**120 min**
Brightness Sensitivity (B_o = solar disk)	**3×10^{-15} B_o**	**3×10^{-16} B_o**
Straylight Rejection	**3×10^{-13} B_o**	**10^{-14} B_o**

< 0.1 CME intensity at inner edge of FOV

~ magnitude 12; governed by anticipated CME intensity at outer edge