



User Manual

Solar Demon v1.0

[07/03/2013]

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Document History

Name	Type	Description	Date	Version
Emil Kraaikamp	Document creation	First version of the user manual.	07/01/2013	V0.1
Emil Kraaikamp	Update	Image 7 caption fix.	16/04/2013	V0.2

Publication

This document is intended for all Solar Demon users.

Introduction

Delivery

Solar Demon is a near real time dimming and EUV wave detector on quick-look SDO-AIA data. As dimmings and EUV waves are often the precursors of CMEs, careful detection and characterization of these features will aid space weather forecasters, leading to more accurate forecasts. A Solar Demon catalog is planned, which will help further research on dimmings and EUV waves. In this document the basic principles of the Solar Demon online catalogue will be explained. Solar Demon can be accessed from <http://www.solardemon.oma.be/>

Solar Demon is work in progress. This document will be updated as new features are implemented or other changes to the software occur. The latest version of this manual can be downloaded from the Solar Demon website.

Definitions

Term	Description
AFFECTS	Advanced Forecast For Ensuring Communications Through Space. (http://www.affects-fp7.eu/)
Solar Demon	Solar Dimming and EUV wave Monitor (http://www.solardemon.oma.be/)

Prerequisites

- Solar Demon has been tested on Microsoft Internet Explorer, Google Chrome and Mozilla Firefox browsers.
- Apple QuickTime plugin is required to view animations.

List of Images

Link	Description
Image 1	Overview of detected events
Image 2	Dimming and EUV wave characteristics
Image 3	Flare characteristics
Image 4	Dimming mask animations
Image 5	Difference image animations
Image 6	EUV wave difference image animations
Image 7	EUV wave animated graphs

1. Overview of detected events

The main page of Solar Demon shows an overview of detected events, as well as the current status of the detector, including the last processed image, last detected dimming, and last detection of a flare.

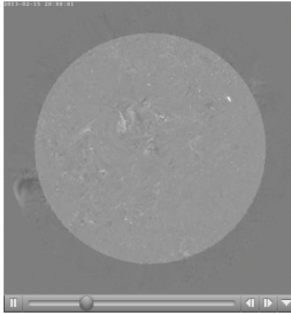
localhost/dimmings.php

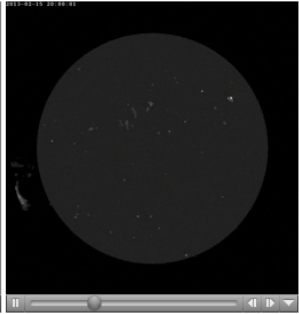
Solar DEMON

Last processed image:
2013-02-27 10:18:00, which is 193 hours and 60 minutes ago

Last detected dimming:
2013-02-15 20:33:01, which is 471 hours and 45 minutes ago

Last detected flare:
2013-02-27 00:48:01, which is 203 hours and 30 minutes ago

last event percentage base difference: 

...EUV wave: 

Overview of recent detections: (num pixels, area, intensity, and volume are averages for the detection duration!)

	start	end	#	images	detections	intensity * 10 ³	num pixels * 10 ³	area km ² * 10 ⁹	volume * 10 ⁹
February, 2013									
15	19:45	20:33	9	17	2	-92.6	4.1	0.0	0.0
12	22:12	22:57	8	16	1	-98.5	5.6	49.3	-789.1
9	05:30	06:45	7	26	11	-731.7	24.1	106.0	-2,782.5
6	02:24	03:15	6	17	1	-544.9	12.7	80.7	-2,748.2
5	23:57	01:00	5	22	6	-358.4	6.4	26.8	-1,324.5
3	17:36	18:36	10	21	5	-288.4	5.7	19.5	-896.2
January, 2013									
31	20:09	20:54	11	16	0	-67.5	2.5	8.5	-218.3
23	13:18	14:30	12	25	8	-170.0	12.0	74.3	-986.4
October, 2012									
23	07:33	08:57	14	29	14	-754.9	13.9	52.8	-2,697.4
23	03:09	03:57	13	17	1	-42.5	0.9	7.9	-342.9
March, 2012									
17	20:30	20:58	1	15	7	-74.6	2.8	11.6	-249.1
9	03:24	04:58	4	48	21	-480.8	15.7	63.1	-1,606.7
7	00:04	01:36	2	47	37	-1,370.5	37.3	206.6	-6,244.8
January, 2012									
23	03:30	04:44	3	38	17	-639.7	23.3	179.5	-3,993.5

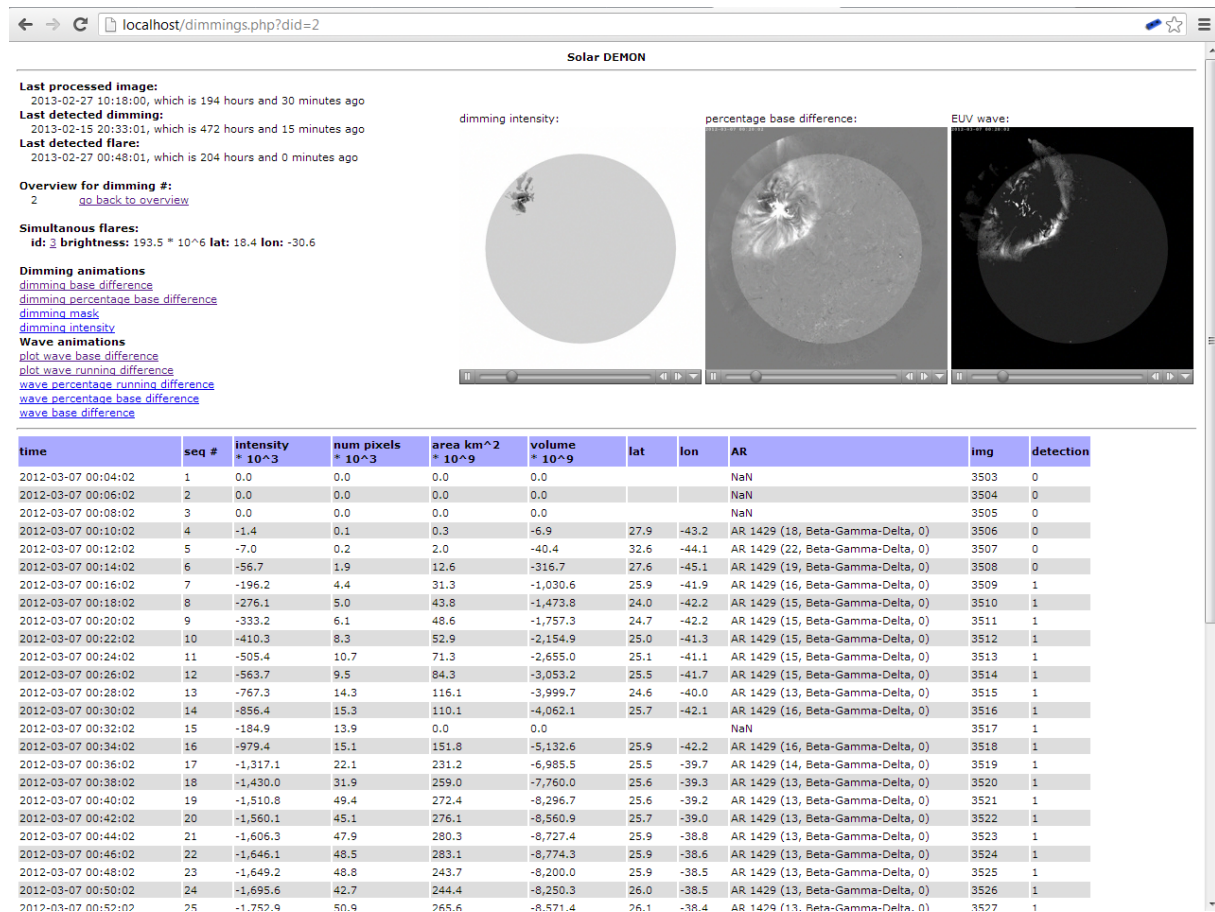
Image 1: An overview of all detections. This is the first view when opening the web page.

At the top right of the page the latest detections are shown as an animation. Below that, a list of all events can be seen. The list includes the start and end time, the dimming intensity, size, area on the surface of the sun, and a volume measurement which is the multiplication of the dimming area and intensity.

Events are detected 'on-the-fly', the statistics and movies will update as new data is being processed by the Solar Demon monitor. When the user clicks on a start time, it will show the Dimming and EUV wave characteristics of the selected event.

2. Dimming and EUV wave characteristics

When an event is selected, a page is shown describing the characteristics of the detected events, including a list of available animations as well as the evolution of the event over time.



The screenshot shows the Solar DEMON web interface. At the top, the browser address bar displays 'localhost/dimmings.php?did=2'. The page title is 'Solar DEMON'. The main content area is divided into several sections:

- Last processed image:** 2013-02-27 10:18:00, which is 194 hours and 30 minutes ago
- Last detected dimming:** 2013-02-15 20:33:01, which is 472 hours and 15 minutes ago
- Last detected flare:** 2013-02-27 00:48:01, which is 204 hours and 0 minutes ago
- Overview for dimming #:** 2, with a link to 'go back to overview'
- Simultaneous flares:** id: 3, brightness: 193.5×10^6 , lat: 18.4, lon: -30.6
- Dimming animations:** dimming base difference, dimming percentage base difference, dimming mask, dimming intensity
- Wave animations:** plot wave base difference, plot wave running difference, wave percentage running difference, wave percentage base difference, wave base difference

Three circular images are displayed: 'dimming intensity' (a dark spot on a light background), 'percentage base difference' (a bright, multi-lobed structure), and 'EUV wave' (a dark, curved structure). Below these images are three sliders for animation control.

time	seq #	intensity * 10 ³	num pixels * 10 ³	area km ² * 10 ⁹	volume * 10 ⁹	lat	lon	AR	img	detection
2012-03-07 00:04:02	1	0.0	0.0	0.0	0.0			NaN	3503	0
2012-03-07 00:06:02	2	0.0	0.0	0.0	0.0			NaN	3504	0
2012-03-07 00:08:02	3	0.0	0.0	0.0	0.0			NaN	3505	0
2012-03-07 00:10:02	4	-1.4	0.1	0.3	-6.9	27.9	-43.2	AR 1429 (18, Beta-Gamma-Delta, 0)	3506	0
2012-03-07 00:12:02	5	-7.0	0.2	2.0	-40.4	32.6	-44.1	AR 1429 (22, Beta-Gamma-Delta, 0)	3507	0
2012-03-07 00:14:02	6	-56.7	1.9	12.6	-316.7	27.6	-45.1	AR 1429 (19, Beta-Gamma-Delta, 0)	3508	0
2012-03-07 00:16:02	7	-196.2	4.4	31.3	-1,030.6	25.9	-41.9	AR 1429 (16, Beta-Gamma-Delta, 0)	3509	1
2012-03-07 00:18:02	8	-276.1	5.0	43.8	-1,473.8	24.0	-42.2	AR 1429 (15, Beta-Gamma-Delta, 0)	3510	1
2012-03-07 00:20:02	9	-333.2	6.1	48.6	-1,757.3	24.7	-42.2	AR 1429 (15, Beta-Gamma-Delta, 0)	3511	1
2012-03-07 00:22:02	10	-410.3	8.3	52.9	-2,154.9	25.0	-41.3	AR 1429 (15, Beta-Gamma-Delta, 0)	3512	1
2012-03-07 00:24:02	11	-505.4	10.7	71.3	-2,655.0	25.1	-41.1	AR 1429 (15, Beta-Gamma-Delta, 0)	3513	1
2012-03-07 00:26:02	12	-563.7	9.5	84.3	-3,053.2	25.5	-41.7	AR 1429 (15, Beta-Gamma-Delta, 0)	3514	1
2012-03-07 00:28:02	13	-767.3	14.3	116.1	-3,999.7	24.6	-40.0	AR 1429 (13, Beta-Gamma-Delta, 0)	3515	1
2012-03-07 00:30:02	14	-856.4	15.3	110.1	-4,062.1	25.7	-42.1	AR 1429 (16, Beta-Gamma-Delta, 0)	3516	1
2012-03-07 00:32:02	15	-184.9	13.9	0.0	0.0			NaN	3517	1
2012-03-07 00:34:02	16	-979.4	15.1	151.8	-5,132.6	25.9	-42.2	AR 1429 (16, Beta-Gamma-Delta, 0)	3518	1
2012-03-07 00:36:02	17	-1,317.1	22.1	231.2	-6,985.5	25.5	-39.7	AR 1429 (14, Beta-Gamma-Delta, 0)	3519	1
2012-03-07 00:38:02	18	-1,430.0	31.9	259.0	-7,760.0	25.6	-39.3	AR 1429 (13, Beta-Gamma-Delta, 0)	3520	1
2012-03-07 00:40:02	19	-1,510.8	49.4	272.4	-8,296.7	25.6	-39.2	AR 1429 (13, Beta-Gamma-Delta, 0)	3521	1
2012-03-07 00:42:02	20	-1,560.1	45.1	276.1	-8,560.9	25.7	-39.0	AR 1429 (13, Beta-Gamma-Delta, 0)	3522	1
2012-03-07 00:44:02	21	-1,606.3	47.9	280.3	-8,727.4	25.9	-38.8	AR 1429 (13, Beta-Gamma-Delta, 0)	3523	1
2012-03-07 00:46:02	22	-1,646.1	48.5	283.1	-8,774.3	25.9	-38.6	AR 1429 (13, Beta-Gamma-Delta, 0)	3524	1
2012-03-07 00:48:02	23	-1,649.2	48.8	243.7	-8,200.0	25.9	-38.5	AR 1429 (13, Beta-Gamma-Delta, 0)	3525	1
2012-03-07 00:50:02	24	-1,695.6	42.7	244.4	-8,250.3	26.0	-38.5	AR 1429 (13, Beta-Gamma-Delta, 0)	3526	1
2012-03-07 00:52:02	25	-1,752.9	50.9	265.6	-8,571.4	26.1	-38.4	AR 1429 (13, Beta-Gamma-Delta, 0)	3527	1

Image 2: An event shown in more detail.

Characteristics include the time, intensity, size, volume, location, and the active region which is closest to the detected event. These characteristics are provided for each processed image during which the event was detected.

At the top of the page a list of simultaneous flares, their detected brightness, and the location is shown, as well as links to all available animations and graphs of the selected event.

3. Flare characteristics

Overview for flare #:

3

[back to overview](#)

time	seq #	brightness * 10 ³	lat	lon	AR	img
2012-03-07 00:06:02	1	86.1	18.4	-32.2	AR 1429 (3, Beta-Gamma-Delta, 0)	3504
2012-03-07 00:08:02	2	1,756.4	18.1	-30.9	AR 1429 (2, Beta-Gamma-Delta, 0)	3505
2012-03-07 00:10:02	3	1,507.0	17.8	-30.5	AR 1429 (2, Beta-Gamma-Delta, 0)	3506
2012-03-07 00:12:02	4	1,835.1	17.8	-30.9	AR 1429 (2, Beta-Gamma-Delta, 0)	3507
2012-03-07 00:14:02	5	3,050.0	18.1	-31.4	AR 1429 (3, Beta-Gamma-Delta, 0)	3508
2012-03-07 00:16:02	6	3,265.4	18.1	-31.4	AR 1429 (3, Beta-Gamma-Delta, 0)	3509
2012-03-07 00:18:02	7	5,231.5	18.3	-31.2	AR 1429 (3, Beta-Gamma-Delta, 0)	3510
2012-03-07 00:20:02	8	5,536.3	18.2	-31.2	AR 1429 (2, Beta-Gamma-Delta, 0)	3511
2012-03-07 00:22:02	9	5,532.0	18.1	-31.1	AR 1429 (2, Beta-Gamma-Delta, 0)	3512
2012-03-07 00:24:02	10	5,614.4	18.1	-31.0	AR 1429 (2, Beta-Gamma-Delta, 0)	3513
2012-03-07 00:26:02	11	6,184.4	18.2	-31.1	AR 1429 (2, Beta-Gamma-Delta, 0)	3514
2012-03-07 00:28:02	12	6,329.9	18.4	-31.2	AR 1429 (3, Beta-Gamma-Delta, 0)	3515
2012-03-07 00:30:02	13	6,219.2	18.4	-31.2	AR 1429 (3, Beta-Gamma-Delta, 0)	3516

Image 3: An overview of a selected flare.

The overview for a selected flare displays the time, brightness, location and the active region closest to the detected flare (including the distance to and string of this active region).

4. Animations and graphs

Solar Demon automatically produces several types of graphs and animations on-the-fly. A summary is given in the sections below. In all animations the surface area of the sun is highlighted by either a dark or light shade.

- **Dimming intensity animation**

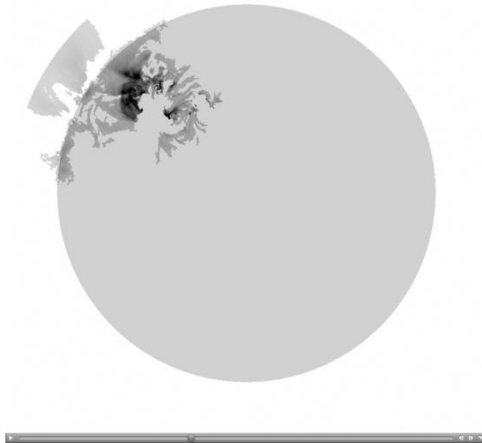


Image 4: The shape and intensity of the detected dimming as seen in the dimming intensity animation

The shape and intensity of the detected dimming is shown in the intensity mask animation.

- **Difference image animations**

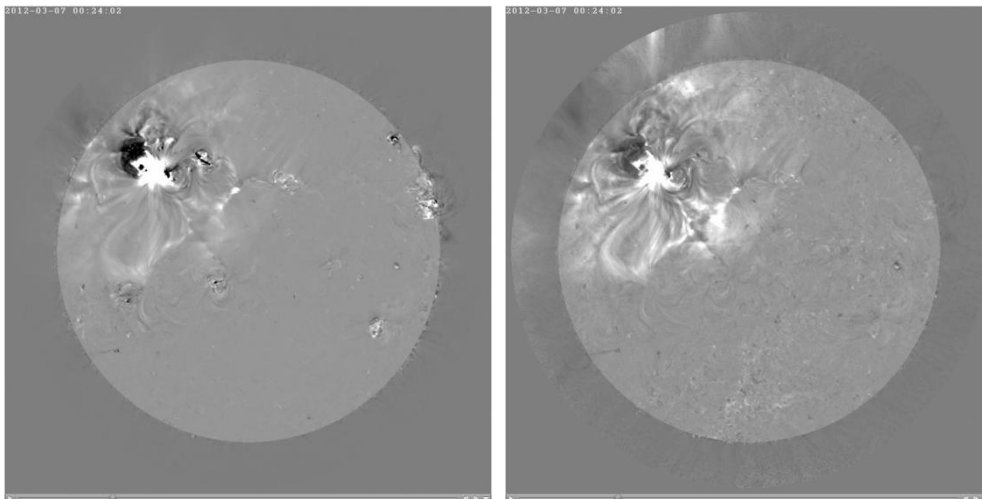


Image 5: Animations are created for both base difference images (left) and percentage base difference images (right).

Base difference animations show all the negative and positive intensity changes from the start of the event, by subtracting from each image a pre-event image.

The percentage base difference images are created by dividing each base difference image by the pre-event image. This produces images where changes in darker areas are accentuated and changes in brighter areas are made less apparent.

- **EUV wave difference image animations**

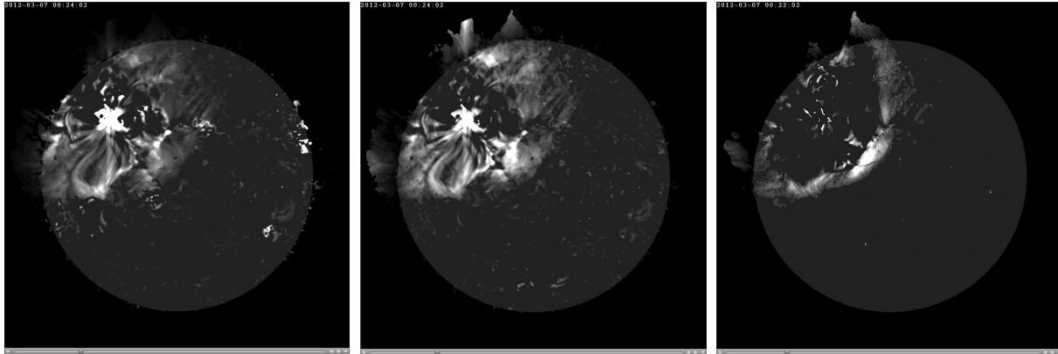


Image 6: From left to right: base difference, percentage base difference, and percentage running difference animations. Each of these animations show only those areas that were brighter, to accentuate a detected EUV wave.

Three types of animations are created to show a detected EUV wave. All these animations only show details that became brighter compare to a reference image, the areas that became darker are left out to emphasize on the EUV wave.

- A base difference animation shows all changes in the corona that became brighter since the beginning of the event.
- A percentage base difference animation emphasizes on brightness increases in the darker areas of the corona, an increase in brightness in brighter areas are made less apparent.
- A percentage running difference animation shows all changes between two subsequent images and usually shows the front of the EUV wave most clearly. This animation also emphasizes on changes in darker areas of the corona.

- **EUV wave animated graphs**

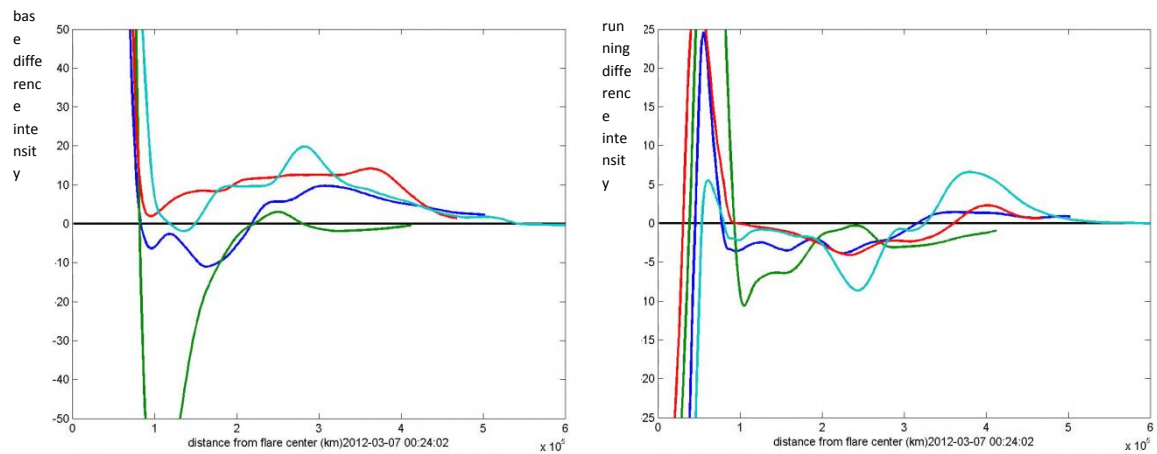


Image 7: Radial intensity profiles per quadrant centered on the eruption for base difference images (left) and running difference images (right)

Two graphs are created showing brightness changes in four quadrants around the center of the detected event. The base difference plot shows absolute brightness changes – both dimming and EUV wave – as a function of the distance to the eruption center. The running difference plot shows more clearly the front of an EUV wave and can be used to calculate the speed of the EUV wave in one of the four quadrants.

The graphs are animated, showing the evolution of the dimming and EUV wave over time. It is possible to show the graphs for specific timestamps within the animations.



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