Online Catalog of Solar Activity Events of Solar Cycle 24

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Solar cycle 24 (SC24):
- the weakest since SC14 (1902-1913)
- 4-th weakest ever

Beginning of SC24: Dec 2008

11018 (the first AR with latitude > 30°): May 2009

12754 (the last SC24 AR): Dec 2019

Duration: 11.0 years

First SC24 AR: NOAA 11018 (23 May 2009)

Last AR: NOAA 12754 (25 Dec 2019)

Maximum: April 2014

[i] SILSO Database of Royal Observatory of Belgium, Brussels
SC24 CATALOG

**1737 SC24 ARs**
- SOHO LASCO CME Catalog\(^b\)

**15154 SC24 SFs**
- observed after the emergence of AR 11018

**15140**
- SOHO LASCO CME Catalog\(^b\)

**1533 SC24 ARs**
- ARs that generated at least one SF and/or CME

**16178 SC24 CMEs**
- observed after the emergence of AR 11018

ARs that generated at least one SF and/or CME

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\[^c\] [https://hesperia.gsfc.nasa.gov/goes/goes_event_listings](https://hesperia.gsfc.nasa.gov/goes/goes_event_listings)
<table>
<thead>
<tr>
<th>NOAA No.</th>
<th>Date</th>
<th>Lat</th>
<th>Long</th>
<th>Type</th>
<th>Onset</th>
<th>CPA</th>
<th>AW</th>
<th>V</th>
<th>Start</th>
<th>Peak</th>
<th>End</th>
<th>Class</th>
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<tbody>
<tr>
<td>11018</td>
<td>23/05/2009</td>
<td>-33</td>
<td>-38</td>
<td>β</td>
<td>02:30:03</td>
<td>116</td>
<td>8</td>
<td>260</td>
<td>05:54:03</td>
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<td>17/06/2009</td>
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<td>71</td>
<td>α</td>
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<td>11024</td>
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<td>-2</td>
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<td>13</td>
<td>β</td>
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<tr>
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<td>17</td>
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<td>-</td>
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<tr>
<td>11026</td>
<td>21/09/2009</td>
<td>-29</td>
<td>-63</td>
<td>α</td>
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<tr>
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<td>22/09/2009</td>
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<td>128</td>
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<td>382</td>
<td>10:54</td>
<td>10:51</td>
<td>11:01</td>
<td>B3.6</td>
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</table>

...
Peak (2014):

- 113.3 sunspots
- 0.85 ARs
- 6.79 CMEs
- 6.19 SFs per day on average
Quiet period 2011–2015:
5 years
1826 days
### Solar Activity Events of Solar Cycle 24

<table>
<thead>
<tr>
<th></th>
<th>CMEs</th>
<th>Flares</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Number</strong></td>
<td>%</td>
<td></td>
</tr>
<tr>
<td>AR-related</td>
<td>8126</td>
<td>12512</td>
</tr>
<tr>
<td>Non-AR-rel</td>
<td>7715</td>
<td>2628</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>15841</td>
<td>15140</td>
</tr>
<tr>
<td><strong>%</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AR-related</td>
<td>51.3</td>
<td>82.6</td>
</tr>
<tr>
<td>Non-AR-rel</td>
<td>48.7</td>
<td>17.4</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>ARs</strong></th>
<th>Number</th>
<th>%</th>
<th>Number</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>327</td>
<td>18.8</td>
<td>1410</td>
<td>81.2</td>
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<tr>
<td></td>
<td>1033</td>
<td>59.5</td>
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<tr>
<td></td>
<td>1737</td>
<td>36.2</td>
<td>1109</td>
<td>63.8</td>
</tr>
<tr>
<td></td>
<td>768</td>
<td>44.2</td>
<td>1737</td>
<td>59.5</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>73.3</td>
<td>69.3</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- AR-related CMEs: >50%
- CME-productive ARs: >80% (73% CME-rich)
- SFs formed in AR: >80%
- SF-productive ARs: ~64% (69% SF-rich)
• 55% of all solar activity events were observed in the rising phase of the SC – 54% of ARs, 55% of CMEs and 56% of SFs.

• CMEs: before solar maximum – mostly AR-related (56%); after it – mostly originated outside AR (54%).

• SFs: most events were associated with ARs both before (79%) and after (84%) the peak of the SC.

### Historical Data

<table>
<thead>
<tr>
<th>Period</th>
<th>Rising phase (5.33 years)</th>
<th>Declining phase (5.75 years)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>AR</strong></td>
<td>1010 (54% of all ARs)</td>
<td>727 (46% of all ARs)</td>
</tr>
<tr>
<td><strong>CME</strong></td>
<td>8697 (55% of all CMEs)</td>
<td>7144 (45% of all CMEs)</td>
</tr>
<tr>
<td><strong>AR-related CMEs</strong></td>
<td>4862 (56% of CMEs until solar max)</td>
<td>3265 (46% of CMEs after solar max)</td>
</tr>
<tr>
<td><strong>SFs</strong></td>
<td>8539 (56% of all SFs)</td>
<td>6601 (44% of all SFs)</td>
</tr>
<tr>
<td><strong>AR-related SFs</strong></td>
<td>6751 (79% of SFs until solar max)</td>
<td>3265 (79% of SFs after solar max)</td>
</tr>
<tr>
<td><strong>All events</strong></td>
<td>55%</td>
<td>45%</td>
</tr>
</tbody>
</table>
ARs N–S asymmetry

Rising phase: 53%  Declining phase: 47%
Rising phase: 57%  Declining phase: 43%
Rising phase: 60%  Declining phase: 40%
Rising phase: 52%  Declining phase: 48%
Rising phase: 55%  Declining phase: 45%
CME speed distribution

Median:
AR-related CMEs – 319 km s\(^{-1}\)
CMEs Outside AR – 294 km s\(^{-1}\)

51% of all
46% of AR-related

400–600 km/s
CME angular width distribution

Median:
AR-related CMEs – 40°
CMEs Outside AR – 32°
Halo CMEs

Most Halo CMEs

Most CMEs
SFs class distribution

- **Mean:**
  - AR-related SFs – C4.0
  - SFs Outside AR – C3.5

- 91% of A-class SFs are not AR-related
- 100% of X-class SFs are AR-related
- 97% of M-class SFs are AR-related

### Diagram
- **A** class: Few events, mostly non-AR-related
- **B** class: Moderate events, AR-related
- **C** class: Many events, almost all AR-related
- **M** class: Fewer events than B, still AR-related
- **X** class: Extremely few events, AR-related
M- & X-class SFs

![Graph showing the number of events per year from 2009 to 2019. The graph compares M- & X-class SFs and M-class SFs. The years 2009, 2010, and 2018 are circled in red.]