

Solar Eruptive Event Monitoring for Space Weather

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Solar Eruptive Events: Flares and CMEs

- Energy is stored in the solar magnetic field (active regions and filaments): accumulated over a long period of time – days, weeks, months
- Energy is released in eruptions (flares, CMEs): in a short time scale (minutes, hours)

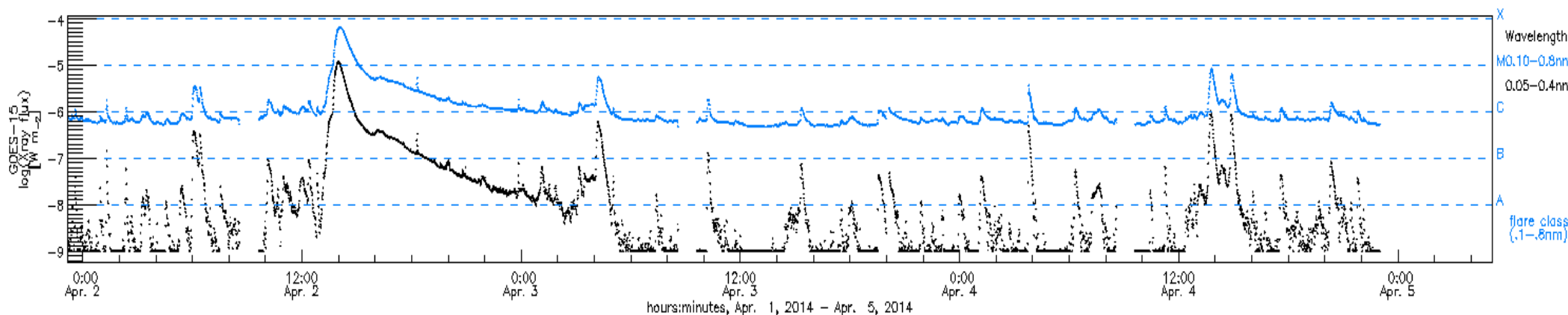
Magnetic energy is converted to thermal energy (and radiative energy) and kinetic energy (e.g. mass motion in CMEs and SEPs)

Solar Eruptions: Flares and CMEs

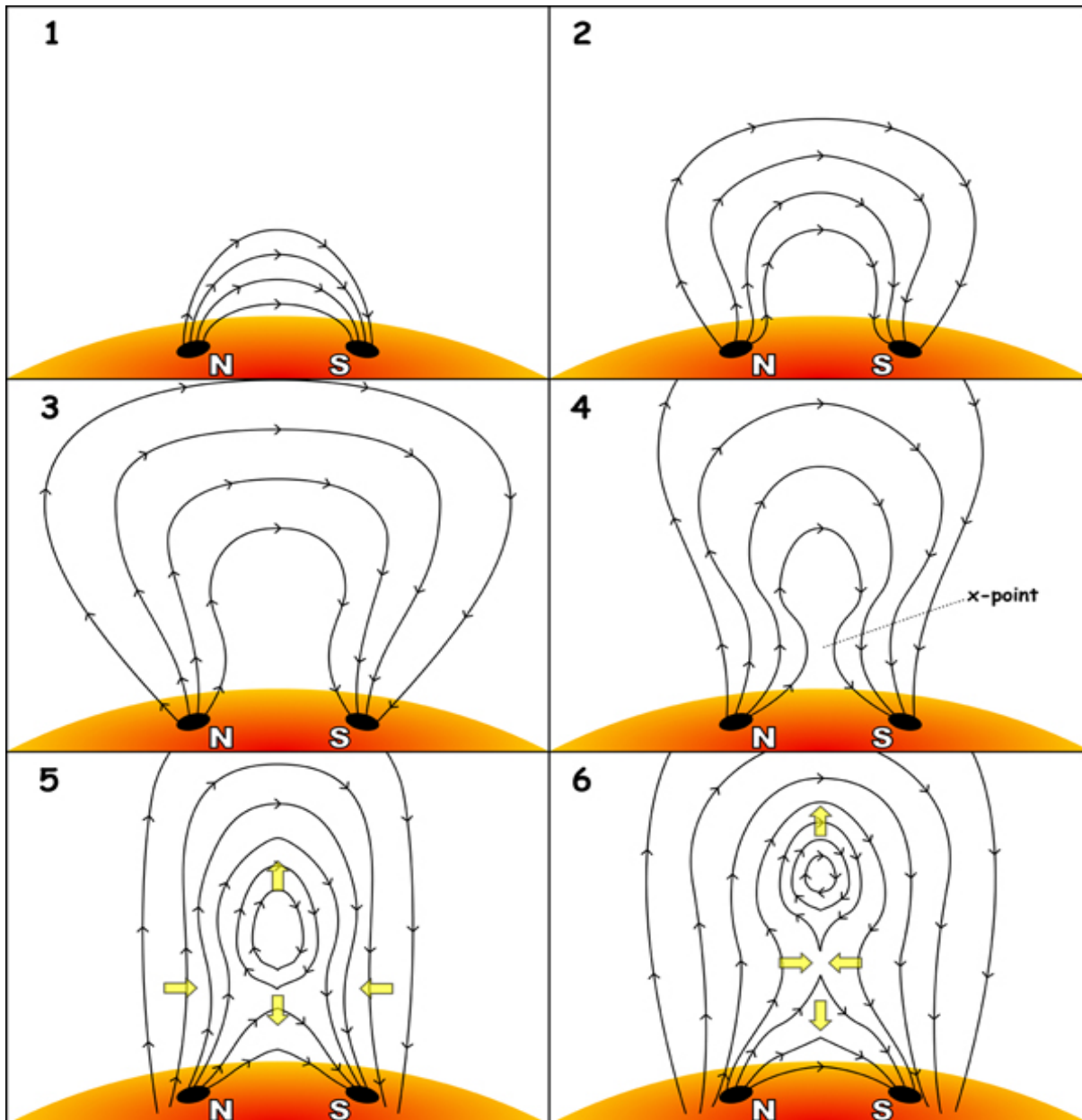
Solar Flares: Event that releases X-rays

X-ray monitor on-board GOES spacecraft (in Earth orbit), full disk monitor (no spatial information of location of flare on the sun)

larger events radiate also in other wavelengths especially in UV, EUV (and radio) → use SDO/AIA images to determine location!



Solar Eruptions: Flares and CMEs



one possible scenario for an eruption:

- reconnection at the x-point (energy release)
- CME escapes upward, field-lines open up
- Post-eruptive loops appear below x-point (additional heating)

Solar Eruptions: Flares and CMEs

Caution: the real sun is more complicated compared to the cartoon – e.g. magnetic field is a

3d structure

- some eruptions show no/very little X-ray signature (particularly filament eruptions)
- some flares have no CMEs

Large scale structures in the corona

- Images: SDO AIA 193 A, STEREO EUVI 195 A
(filter contains Fe XII 195 A line, $T \sim 1.5$ MK)
- Line-of-sight magnetograms: polarity inversion line (PIL)
- **Active Regions:** bi-polar, bright (emission), closed magnetic field (field lines perpendicular to PIL)
- **Filaments:** bi-polar, dark (absorption), closed magnetic field (field lines parallel to PIL)
- **Coronal hole:** uni-polar, dark (less dense), open magnetic field

Coronal signatures of CMEs

- Data to use: SDO AIA, STEREO EUVI (A & B)
- **Brightenings:** flares, post-eruptive arcade (193), arcade footpoints (304, 193)
- **Darkenings:** dimmings (transient coronal holes), dark/absorbing/cool material rising (filament eruption)
- **Off-limb:** opening of closed coronal field lines, AIA 304 emission structure
- Not a signature of eruption: active region loop brightenings, (small) flares

Coronal signatures of CMEs

Good period to study: SDO 2014-02-18 - 21
(use AIA 211, 193, 304)