

## Visit Tractebel

### *An introduction to Space Weather*



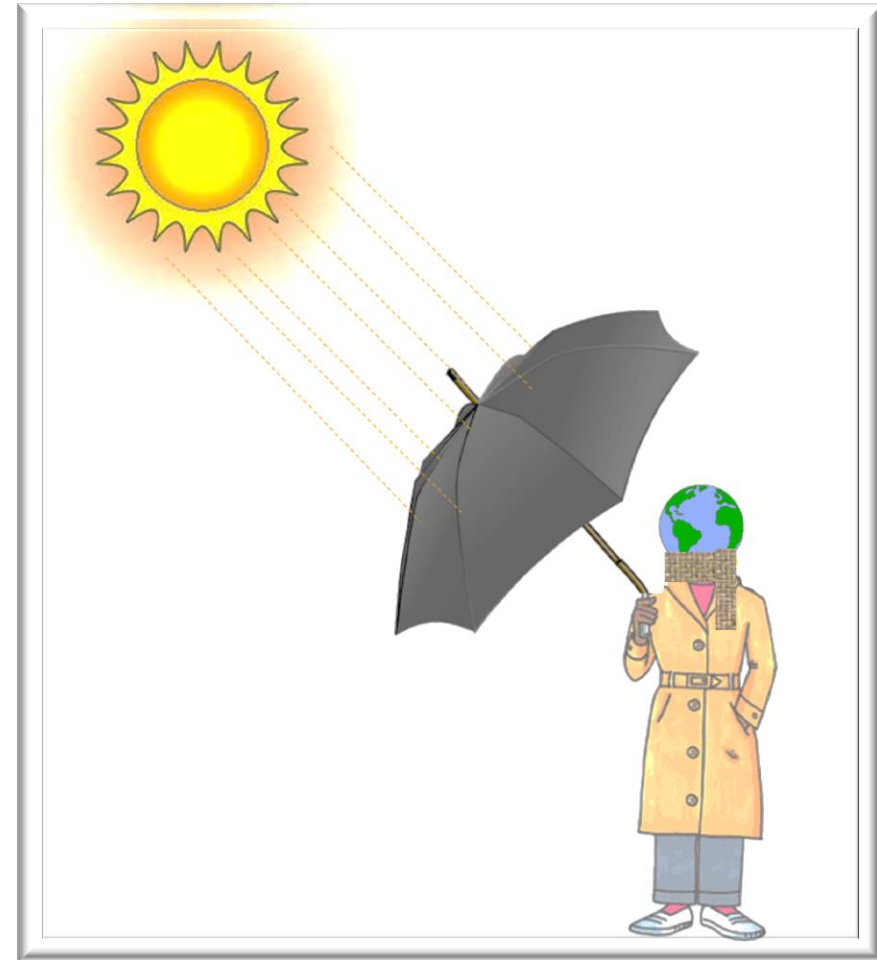
Jan Janssens

Solar-Terrestrial Centre of Excellence

26 April 2019

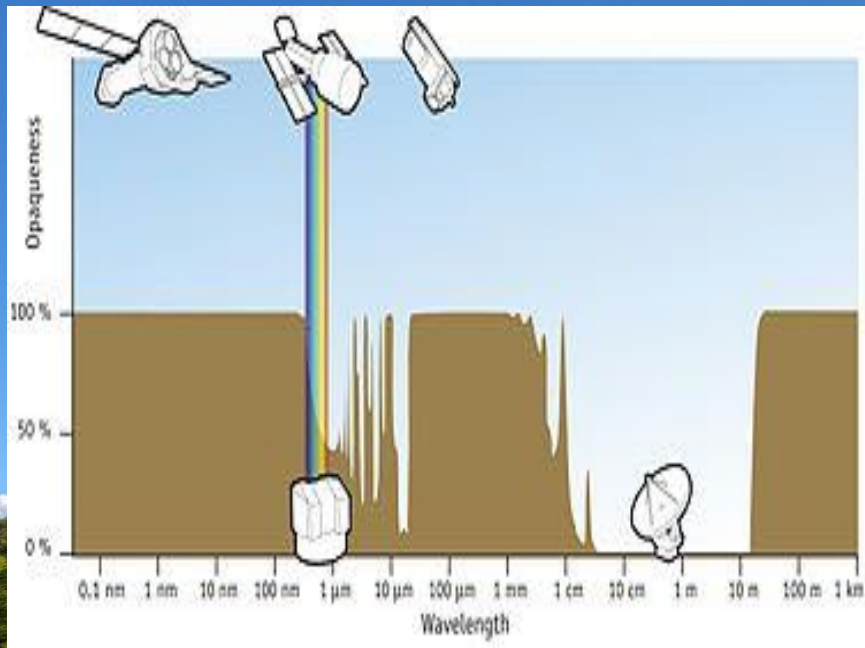
# Space Weather (SWx)

- Space weather refers to the environmental conditions in Earth's magnetosphere, ionosphere and thermosphere due to the Sun and the solar wind that can influence the functioning and reliability of spaceborne and ground-based systems and services or endanger property or human health.

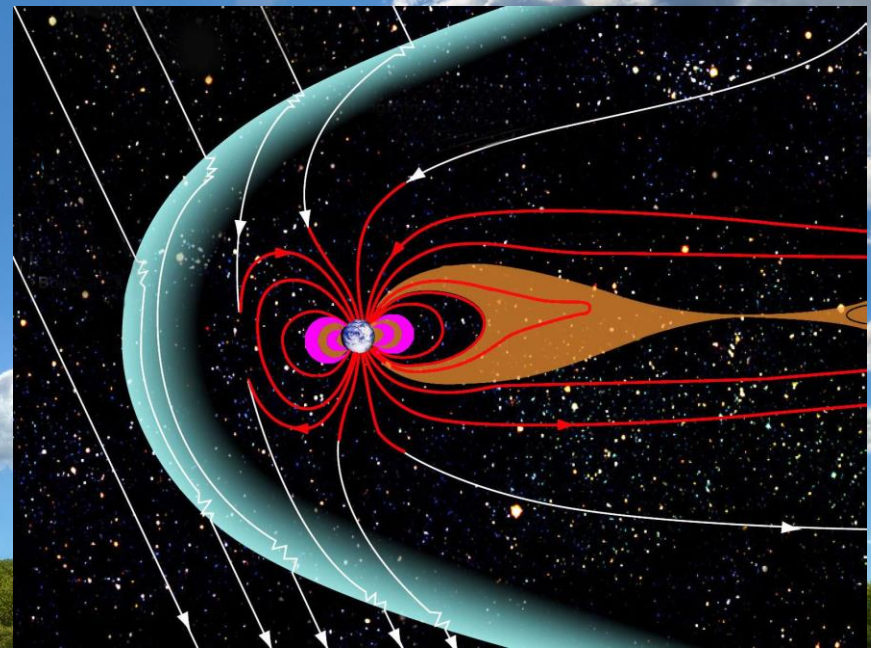


*NSWP, ESA*

# The quiet Sun



*Electromagnetic radiation*



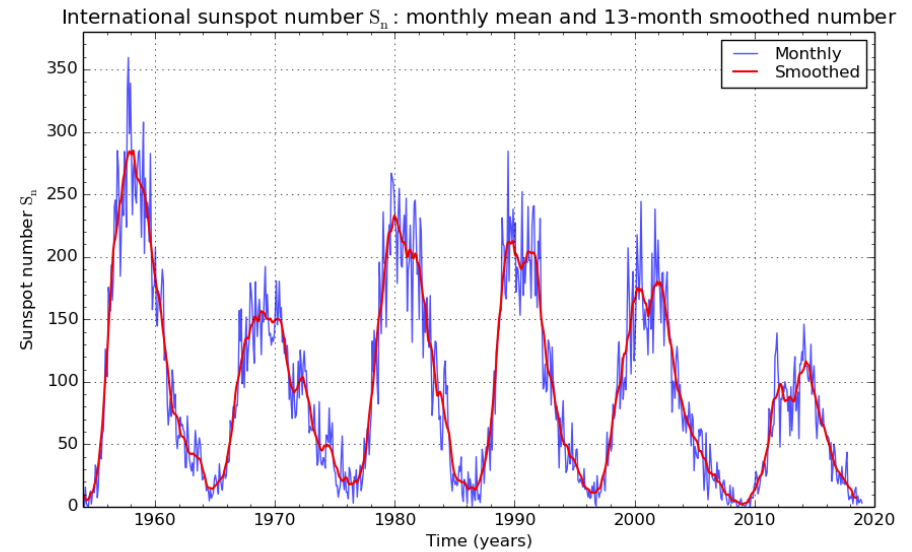
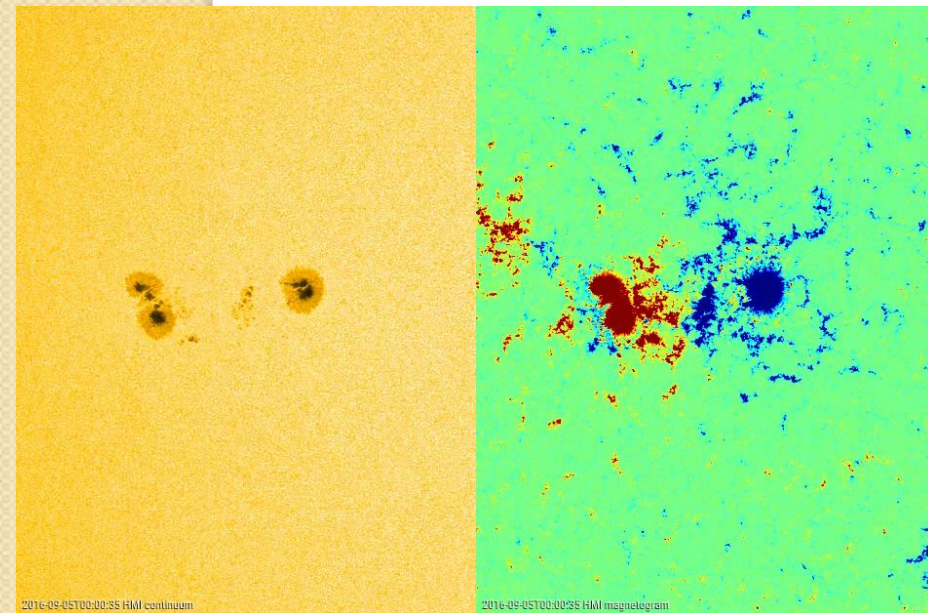
*Particles – Solar wind*

# Solar activity: Sunspots



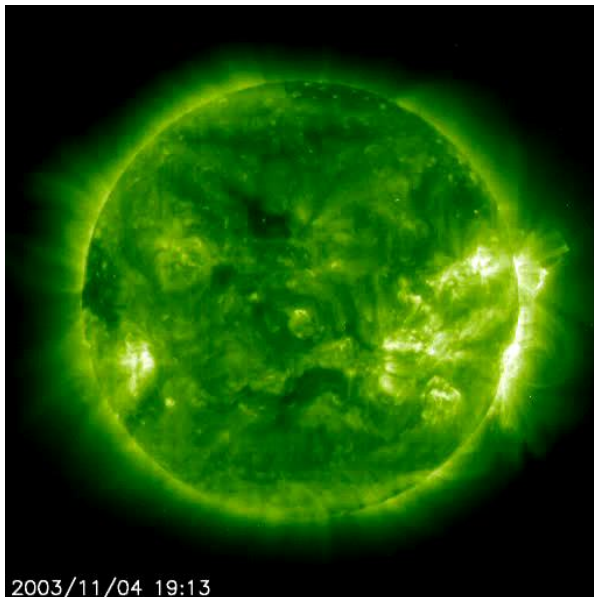
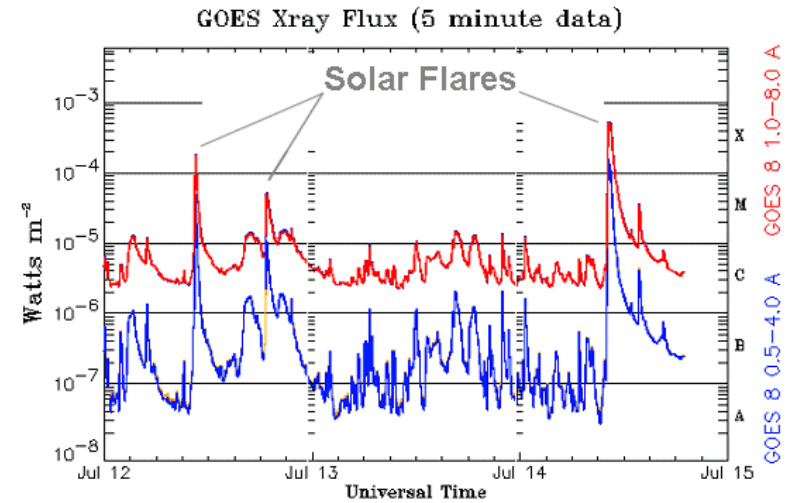
SDO/HMI Quick-Look Continuum 20140322\_010000

# Solar activity: Solar cycle

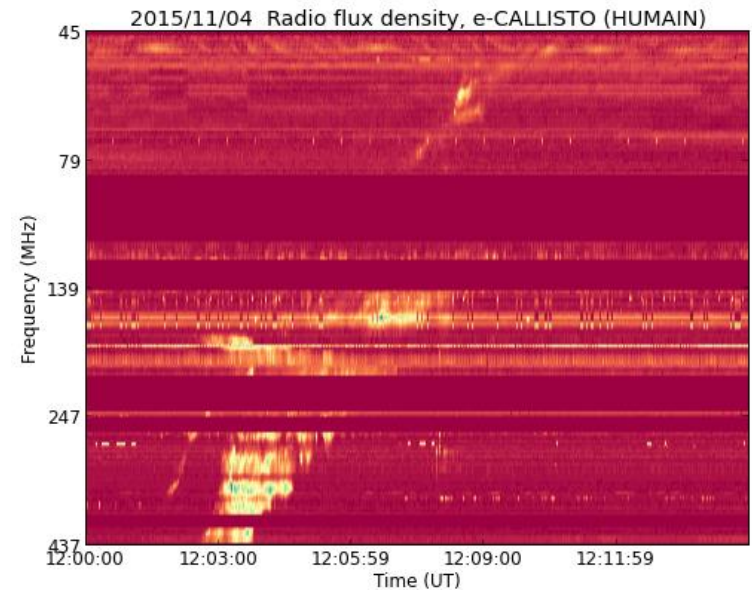


SILSO graphics (<http://sidc.be/silso>) Royal Observatory of Belgium 2019 January 8

# Solar flares (radiation)



2003/11/04 19:13



# Drivers of disturbed space weather

## Solar eruptions

## Solar corona

**Magnetic Reconnection**

**Solar wind**

**Radiation**

**Particles**

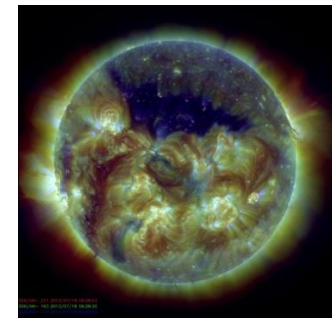
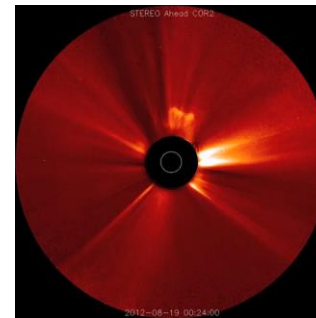
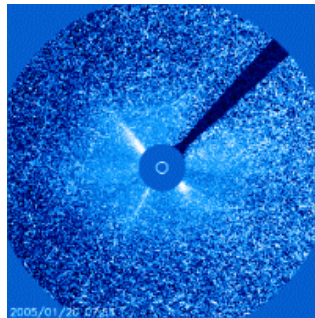
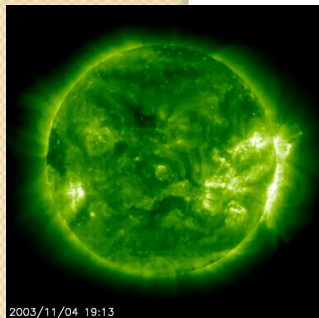
**Particles**

**Solar flares**

**Proton events**

**Coronal Mass Ejections**

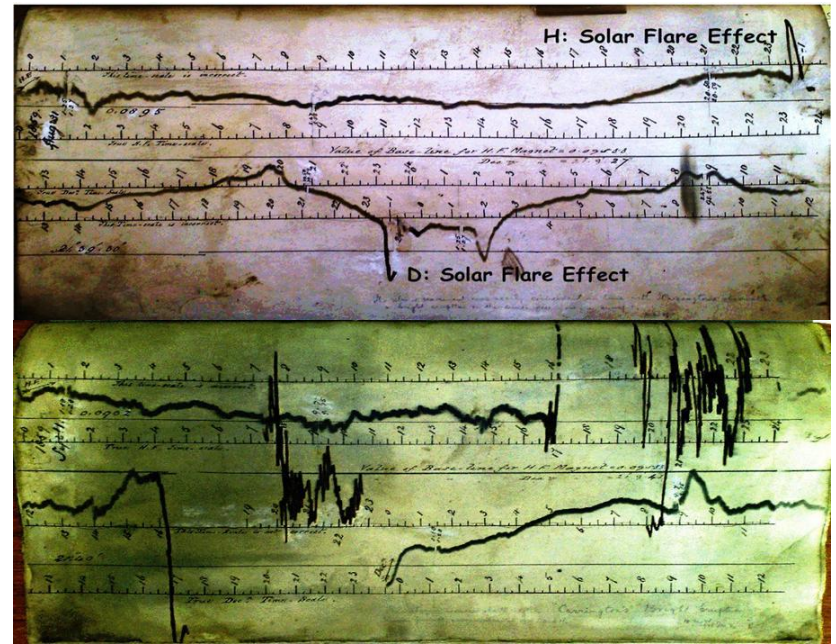
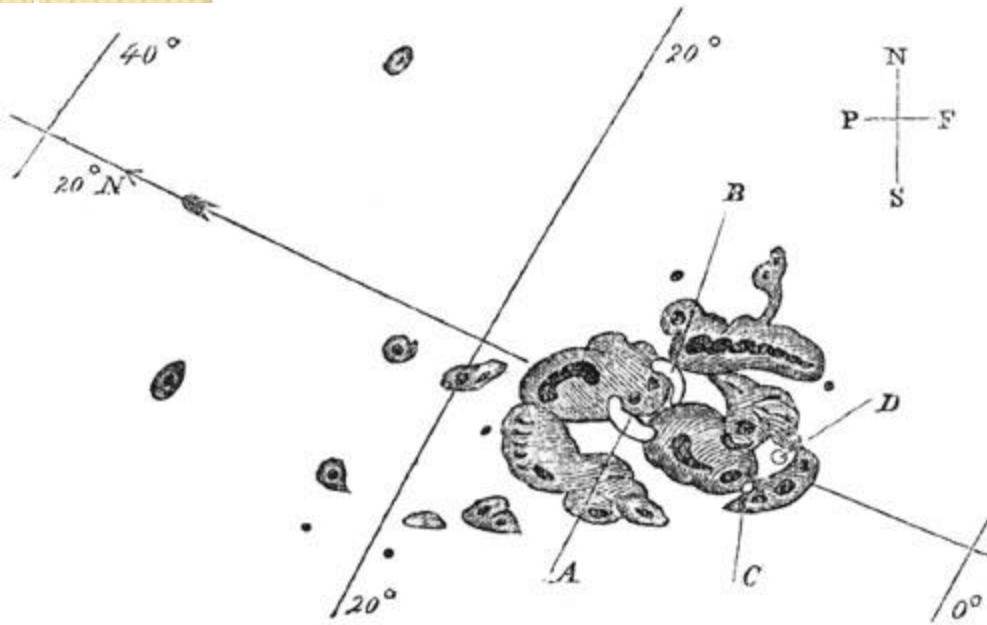
**Coronal Holes**



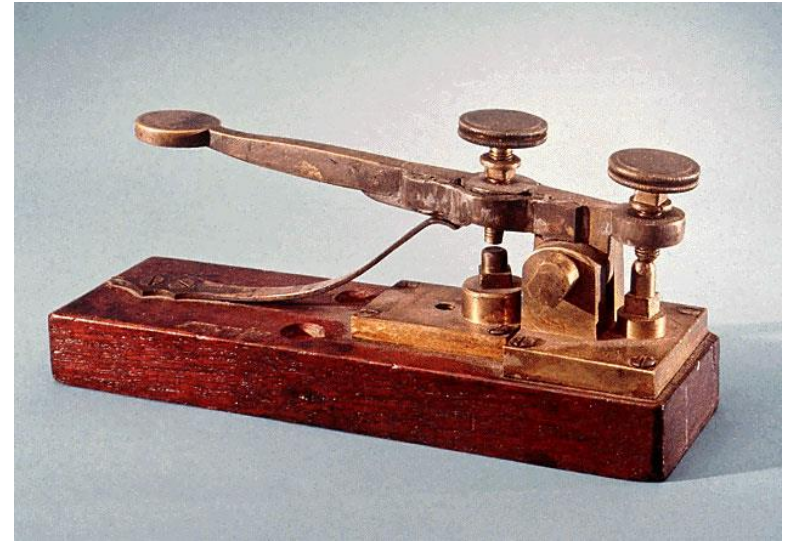
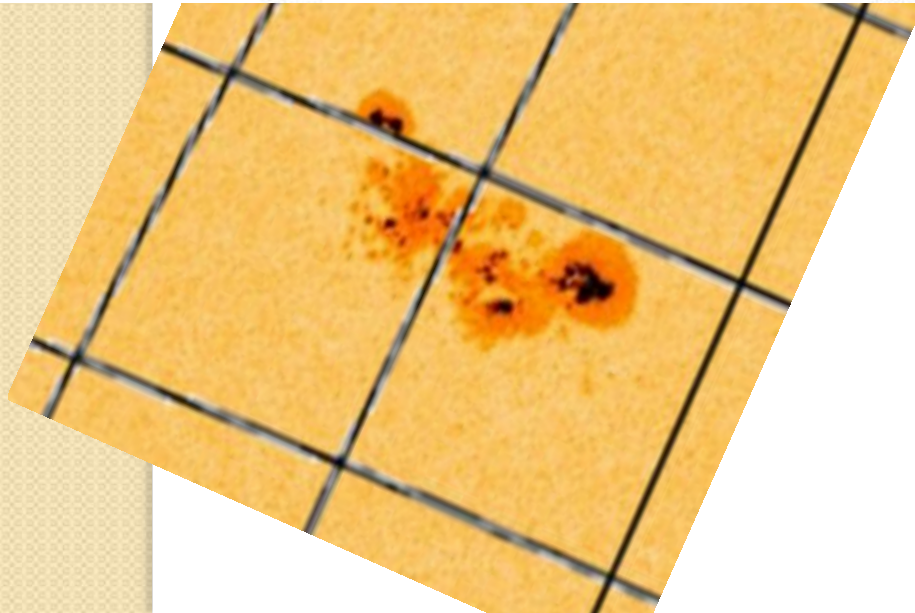




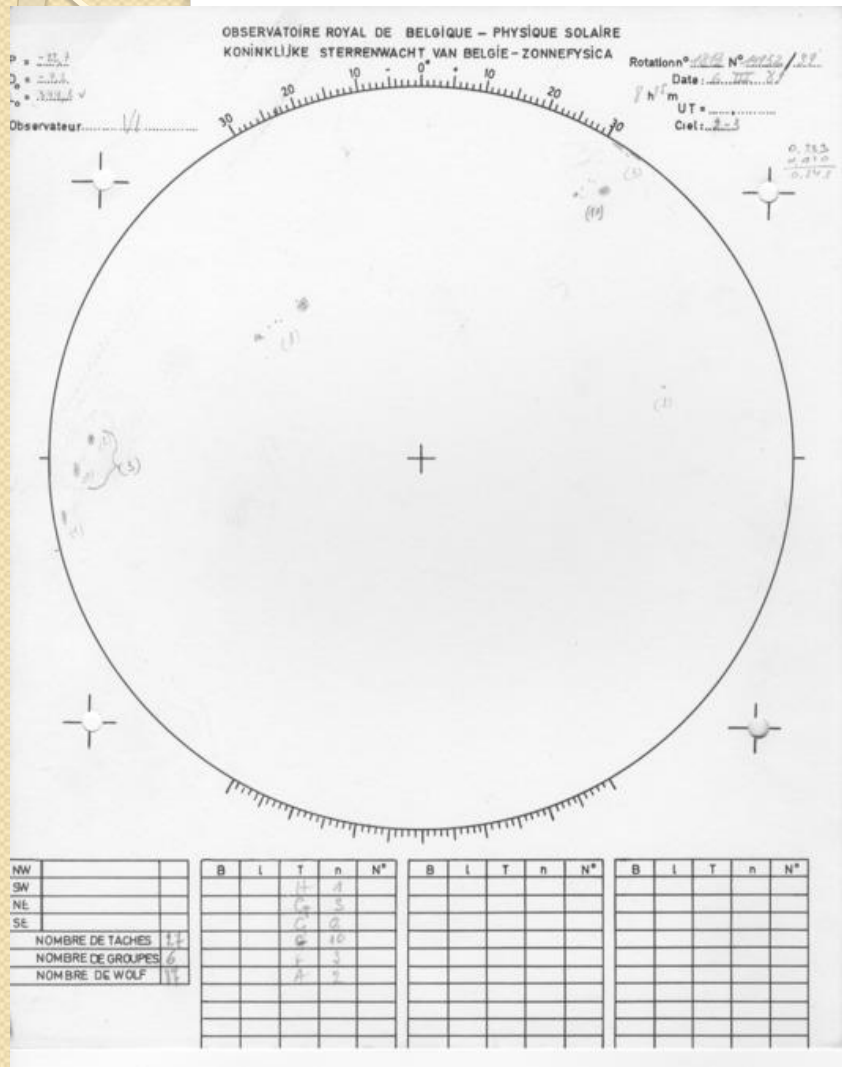
# 1 September 1859: Carrington event



<http://www.geomag.bgs.ac.uk/education/carrington.html>



# 13-14 March 1989: Québec event



# 28 October 2003: Halloween event



# SWx storms and less-known GIC events



***15 May 1921 – New York Railroad System***



***August 1972 – Transcont. cable, IL, USA***



***13-14 July 1982 – Railroad lights, Sweden***



***6-7 April 2000 – Pipeline corrosion, Canada***

# SWx effects during SC24

- 24-25 October 2011
  - WAAS/EGNOS services interrupted; blood-red aurora
- 24 January 2012
  - Polar flight detours
- 7 March 2012
  - Polar flight detours
- 7 January 2014
  - Delay launch supply rocket ISS
- 1 September 2014
  - ST-B lost sun-lock
- 4 November 2015
  - Swedish Air Traffic down
- 6-12 September 2017
  - HF comms down during hurricane Irma



# Questions?

- **SIDC:**
  - <http://www.sidc.be/>
- **SSCC:**
  - <http://swe.ssa.esa.int/web/guest/contact>
  - [helpdesk.swe@ssa.esa.int](mailto:helpdesk.swe@ssa.esa.int)
- **STCE:**
  - <http://www.stce.be/>
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1180 Uccle - Ukkel
  - BELGIUM



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**SC24 highlights page** NEW  
Every year, the STCE publishes a news item with an overview of the most memorable solar and space weather highlights.

**Backside eruptions** NEW  
Once again, solar observers were

**STCE Annual meeting** GOOD

**European Space Weather Week** GOOD  
**13TH EUROPEAN SPACE WEATHER WEEK**  
November 14-16, 2014  
Oostende, BELGIUM  
At ESWW13 we try to make the