Observations of the photosphere and chromosphere carried out in Catania

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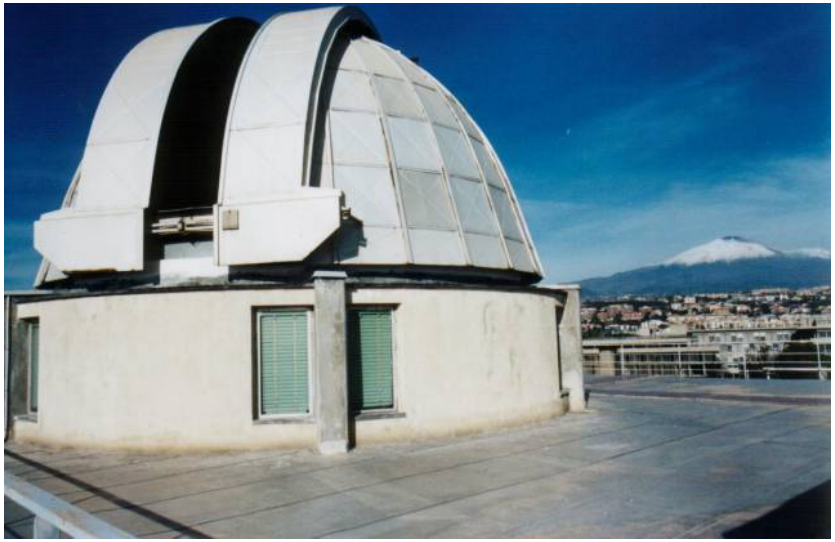
A long tradition and expertise

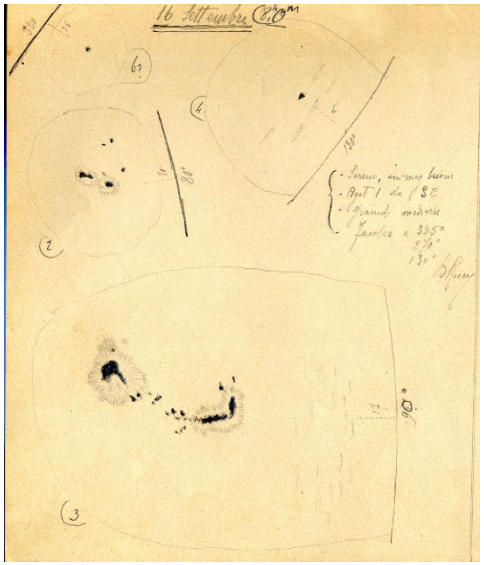
Solar observations of the photosphere and chromosphere have been carried out at the Catania Astrophysical Observatory (OACt) since 1876, the year of its foundation.

Lat: 37° 31′ 43.71″ N
Lon: 15° 4′ 17.38″ E
h: ~ 35 m a.s.l.

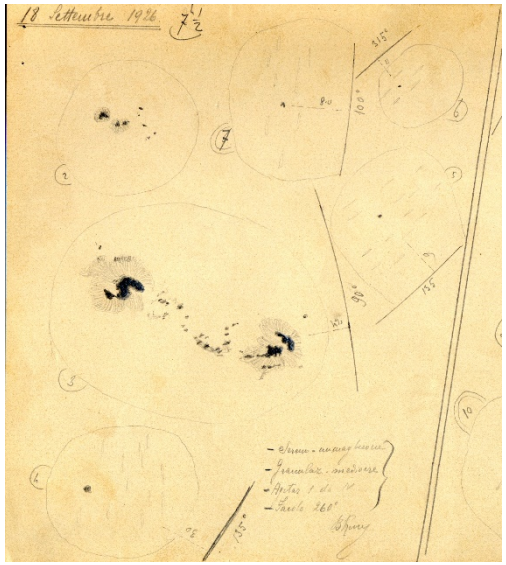
Observations by Pierfrancesco Costa and Mariachiara Falco

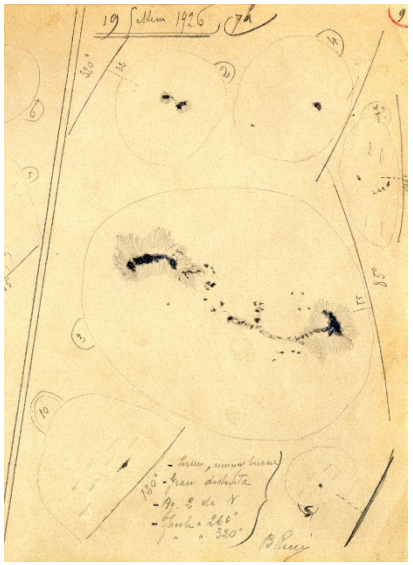
Supervision by Paolo Romano

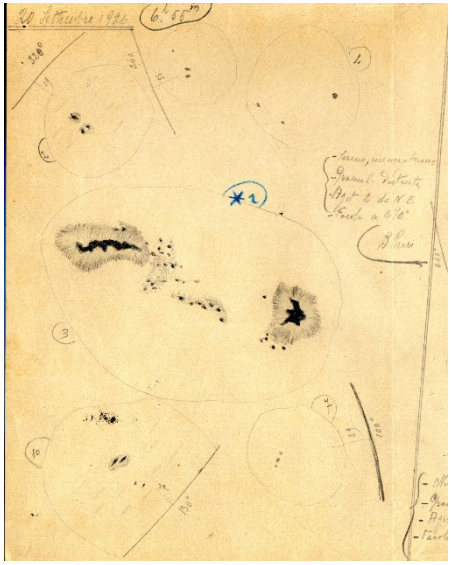



16 Settembre


17 Settembre 1926

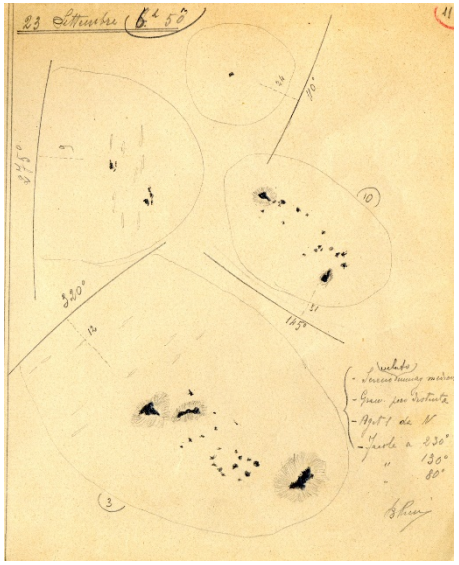

18 Settembre 1926


19 Settembre 1926


20 Settembre 1926


21 Settembre 26


22 Settembre 1926


23 Settembre

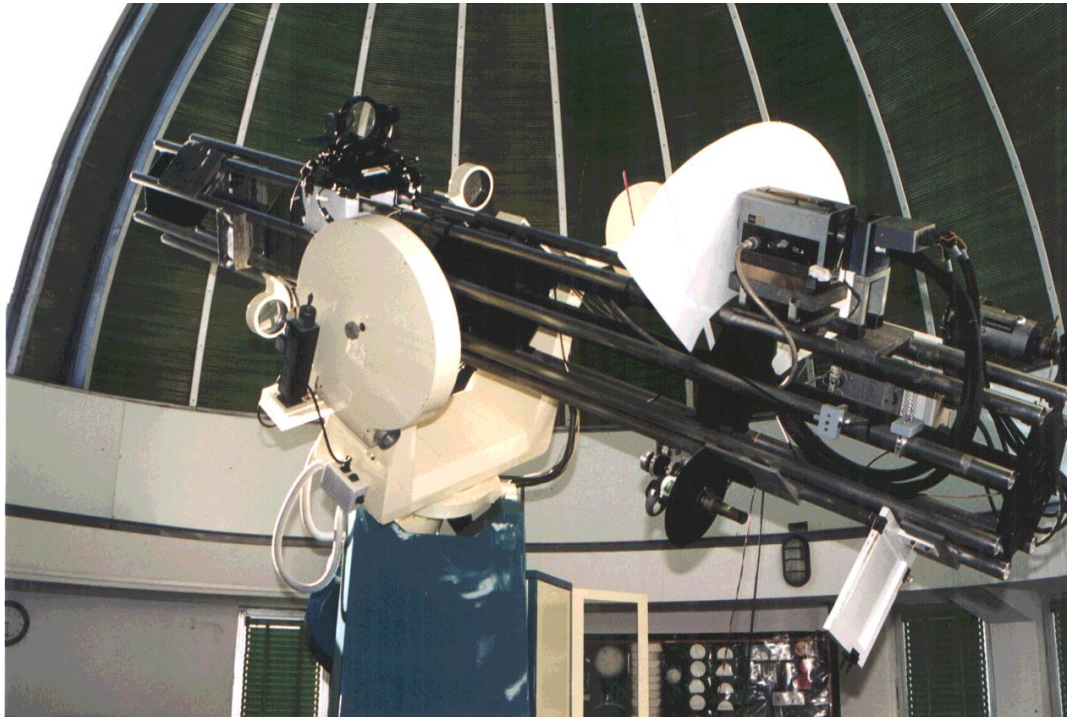
The telescope

An equatorial spar which includes the following instruments:

- a Cook refractor, used to make daily drawings of sunspot groups from visual observations;

- a 150-mm refractor (f=2230mm) with a Hα Lyot filter for chromospheric and photospheric observations;

- a 150-mm refractor feeding a Hα Halle filter for limb observations of the chromosphere.



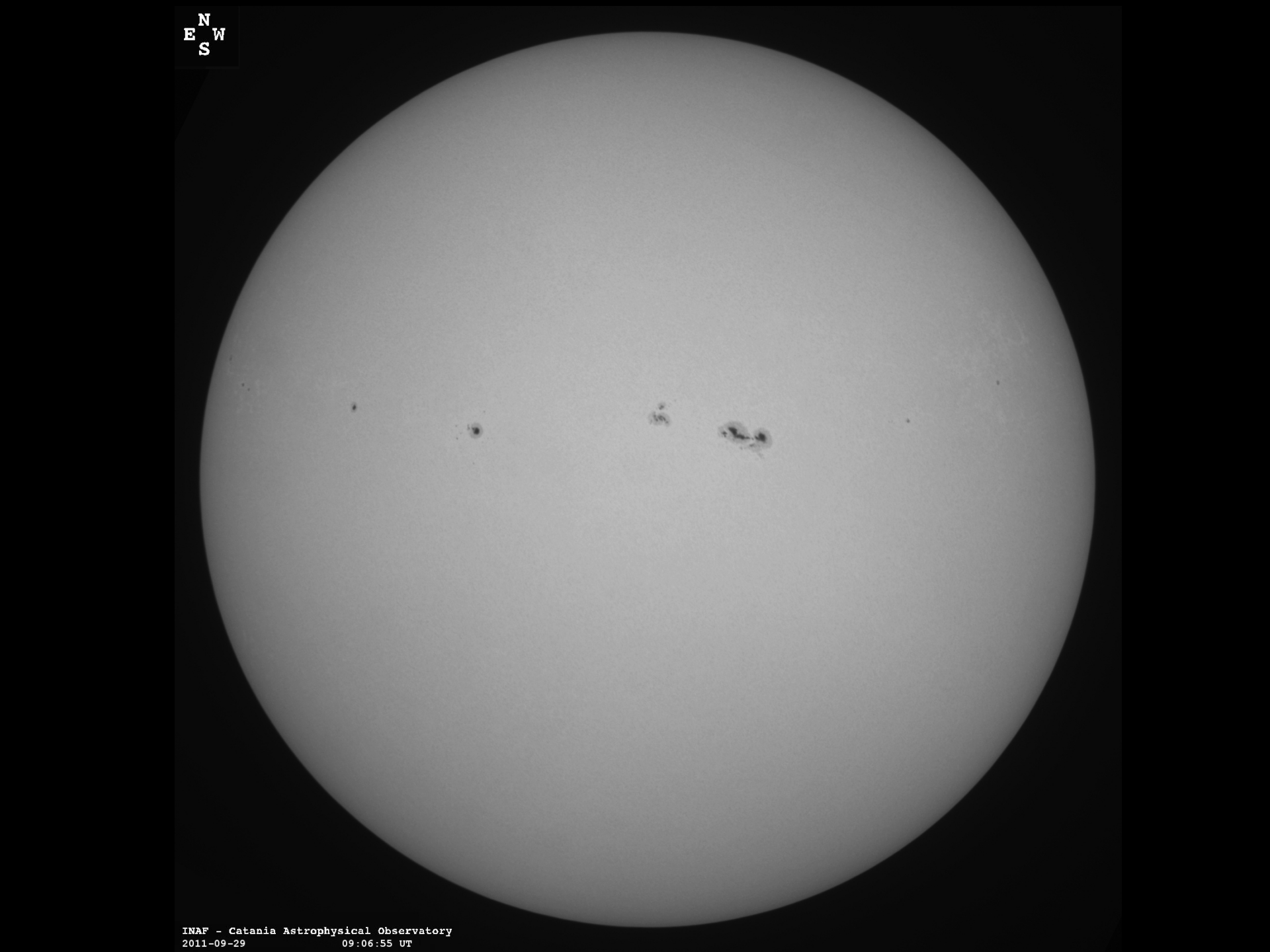
- a CCD Camera Apogee Alta U9000-HC D09L (array size: 3096 x 3096 pixels, pixel size: 12 μm, digital resolution: 16 bit, noise: 12 e^- RMS, dark current <1.5 e^-/pixel/s)

Data

Currently, the daily observation program provides:

- **Full-disc images acquired in the center of the Hα line at 6562.8 Å**
  spatial resolution: 2''
  FWHM: 0.25 Å
  time cadence: 60 min,
  observation time interval: from 7:30 to 13:30 CET
- **Full disc images acquired in the continuum near the Hα line at 652.8 + 0.5 Å**
  spatial resolution: 2''
  FWHM: 0.25 Å
  time cadence: 15 min,
  observation time interval: from 7:30 to 13:30 CET
- **USSPS sunspot data**
  daily measurements

The fits files of chromospheric images are daily provided to the Global High Resolution Halpha Network.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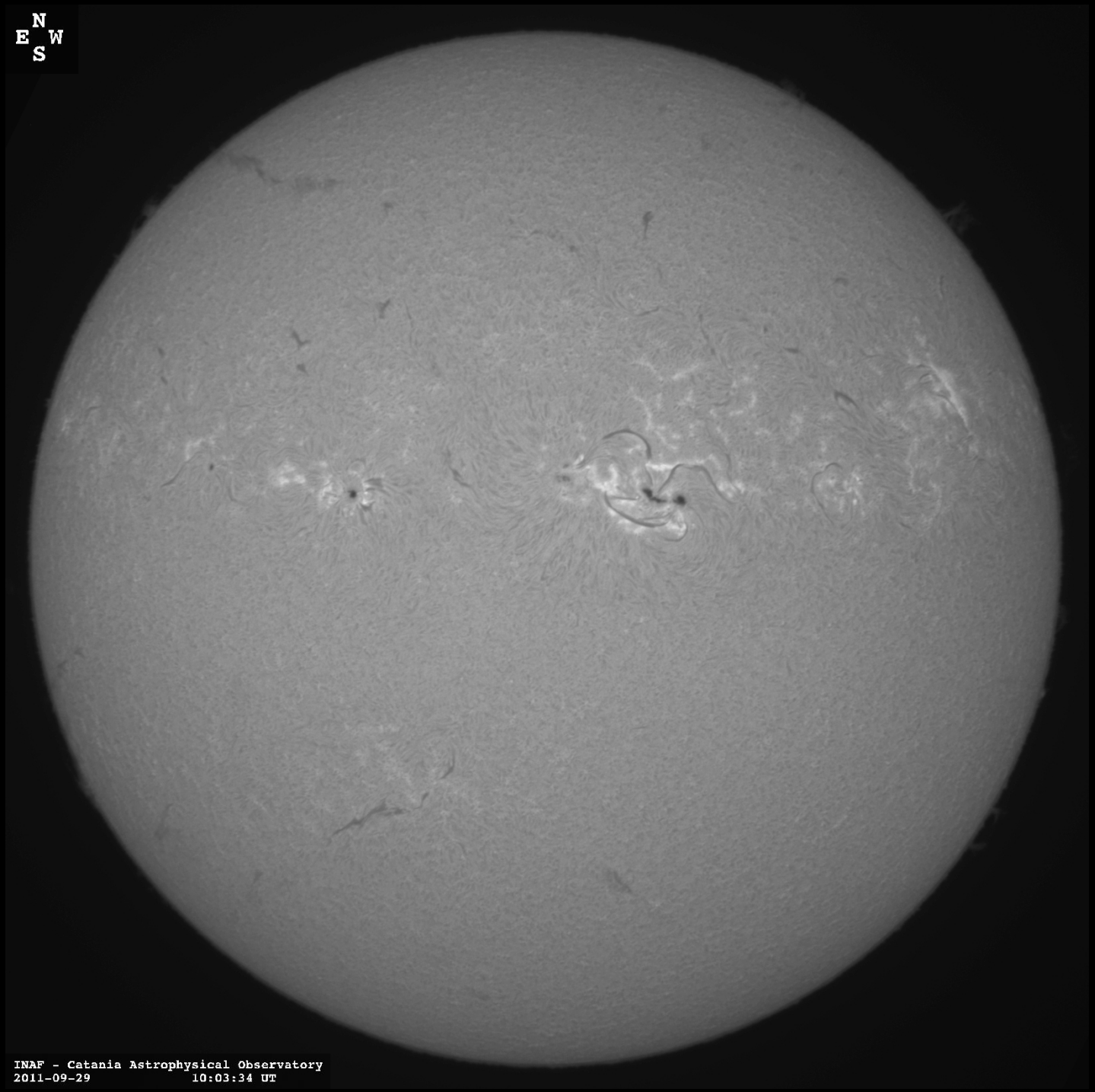
INAF - Catania Astrophysical Observatory
2011-09-29 09:06:55 UT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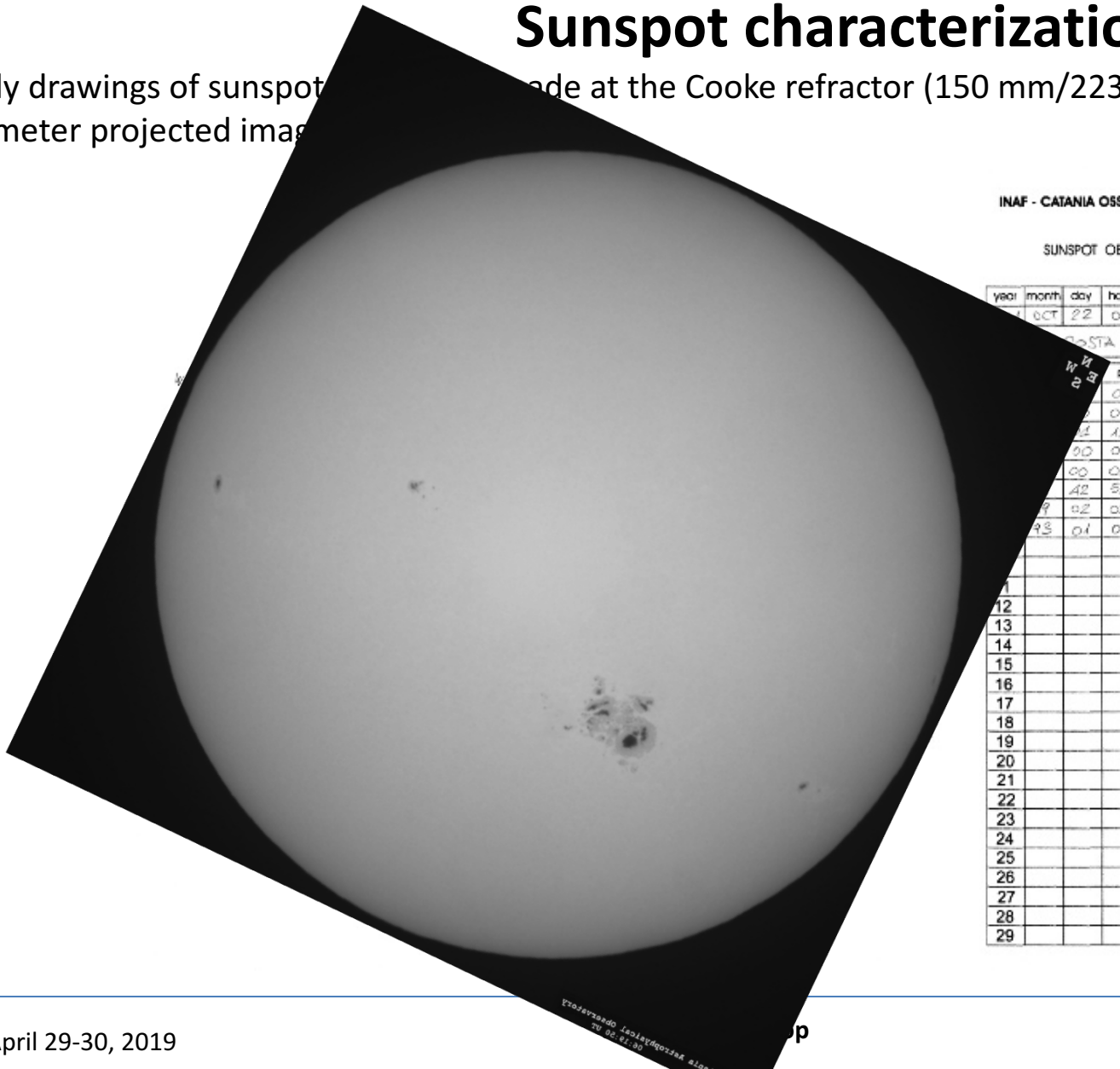
Sunspot characterization

Daily drawings of sunspot… …de at the Cooke refractor (150 mm/2230 mm) on a 24.5 cm diameter projected imag…



INAF - CATANIA OSSERVATORIO ASTROFISICO

SUNSPOT OBSERVATIONS (U.T.)

year	month	day	hour	min	P	Bo	Lo
	OCT	22	08	30	-26.34	+5.34	262.65

STA S 3 Q 3 R 202

	p	z	lat	long	A [mm]
	01	C	08 S	58 W	000.25
	01	A	12 S	33 W	000.75
	12	C	05 N	22 W	013.00
	01	A	10 S	14 W	000.25
	02	A	18 N	01 E	000.50
	53	F	15 S	15 W	000.25
	02	C	12 S	54 W	000.50
	00	J	06 N	60 W	000.00
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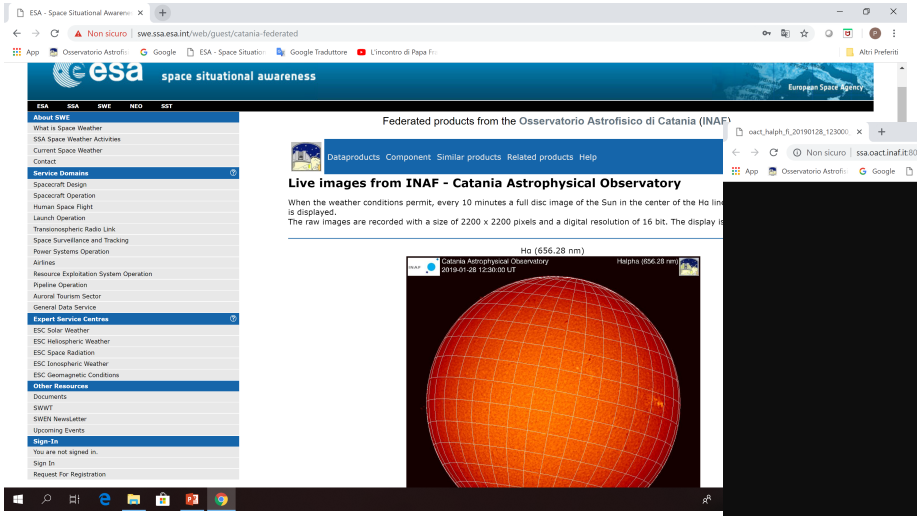
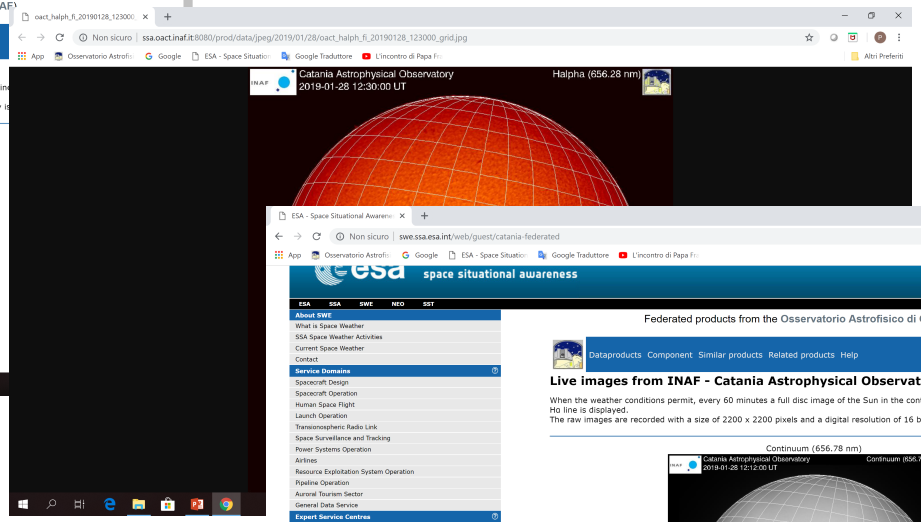
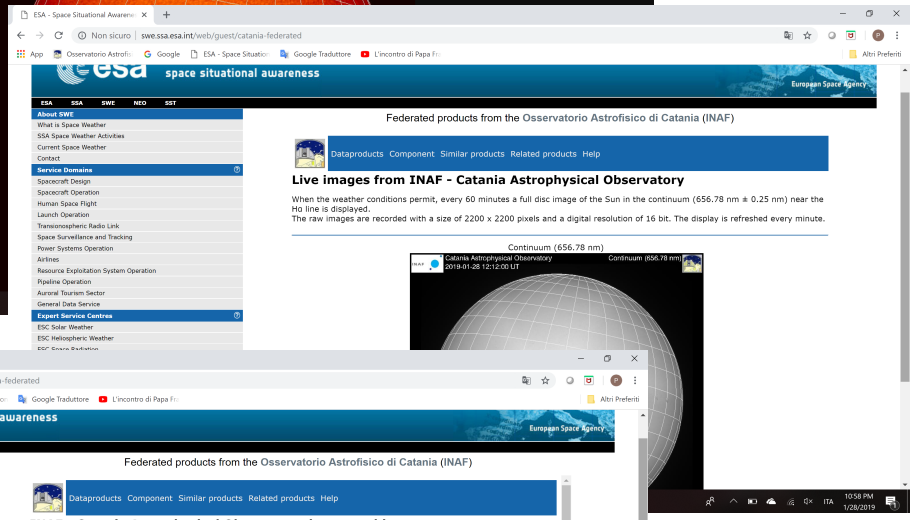
Observations of the photosphere and chromosphere carried out in Catania

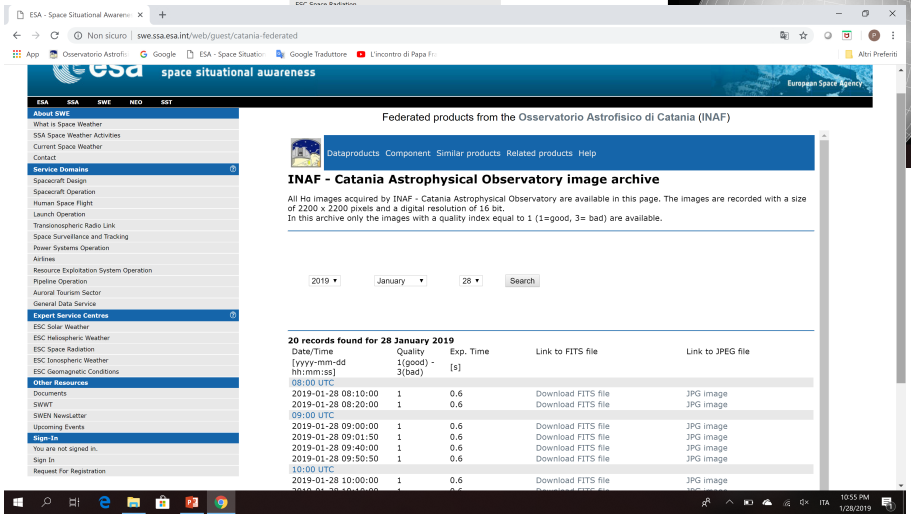
Dipartimento di Fisica e Astronomia "Ettore Majorana"

Space Situational Awareness









We provide our data to ESA portal dedicated to the SSA programme with the objective *to support Europe's utilization of, and access to, space through the provision of timely and accurate information regarding the space environment, and particularly regarding hazards to infrastructure in orbit and on the ground.*

Flare forecasting service

We use 5 parameters in our flare forecasting service:

- Number of sunspots and pores (SS)
- Projected area (AA)
- Group type according to Zurich classification (t1)
- Type of penumbra of the main sunspot (t2)
- Relative importance between leading spot and density of the sunspot population (t3)

The dataset is formed by daily observations of INAF- Catania Astrophysical Observatory from January 2002 up to now, when the weather conditions permit.

We also use the daily information of the sunspot groups contained in the **Solar Region Summary** provided by NOAA.

Flare forecasting service

For each parameter, k, we compute the flare rate, FR, by calculating the ratio between the number of sunspot groups which hosted at least one flare and characterized by a specific value, x_k, of that parameter, $N_f(x_k)$, and the total number of sunspot groups characterized by the same value of that parameter $N(x_k)$:

$$FR_k(x_k) = \frac{N_f(x_k)}{N(x_k)}$$

The average among the flare rates for all parameters:

$$FR = \frac{FR_{AA}(x_{AA}) + FR_{SS}(x_{SS}) + FR_{t1}(x_{t1}) + FR_{t2}(x_{t2}) + FR_{t3}(x_{t3})}{5}$$

provides an estimate of the capability of hosting flares for sunspot groups characterized by a particular configuration, size and fragmentation.

Flare forecasting service

Assuming that the flare event frequency follows the Poisson statistic, the event probability is given by:

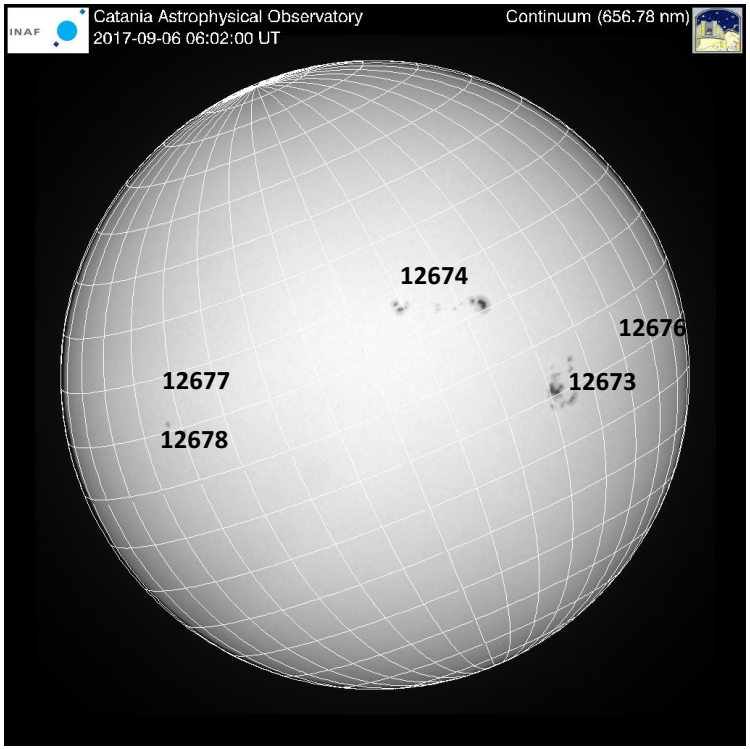
$$p_f = 1 - \exp(-FR)$$

We compute the flare probability for three different ranges of flare energies:

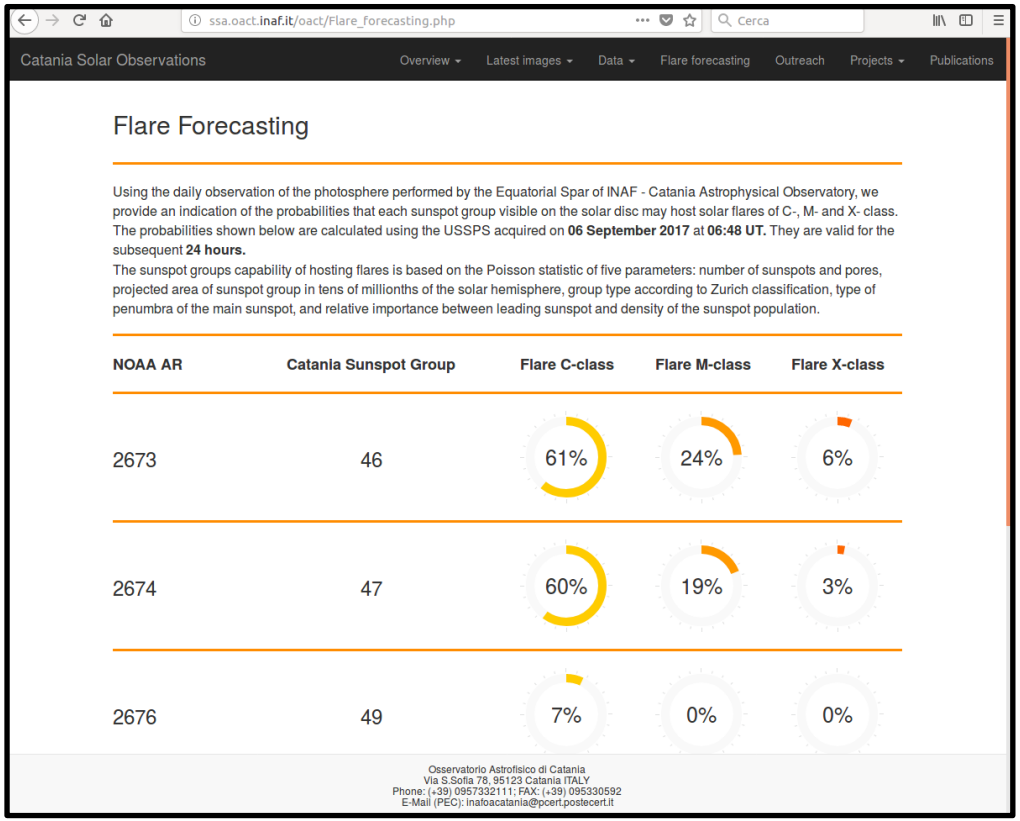
- C1.0 GOES class and greater (C1.0+),
- M1.0 GOES class and greater (M1.0+),
- X1.0 GOES class and greater (X1.0+).

Flare forecasting service

When weather conditions permit, we daily provide an indication of the probabilities that each sunspot group, visible on the solar disc, may host solar flares of C1.0+, M1.0+ and X1.0+ class at: http://ssa.oact.inaf.it/oact/Flare_forecasting.php



They are valid for the subsequent **24 hours**

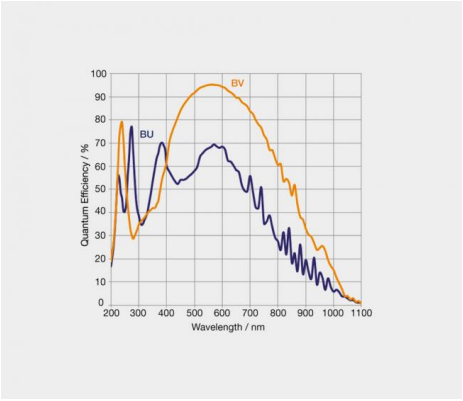


Our contribution to the SPRING project

Currently, due to the mechanical shutter of the Apogee camera, we have strong limits in the exposure times (0.2 - 0.6 s) and in the acquisition rate (at the moment we acquire images every 10 min).

However, we plan to upgrade our acquisition system in the next months thanks to an sCMOS camera.

This will allow us to reduce the exposure times to **5-50 ms** and to acquire about **one image per sec**.



Sensor Type	Back-Illuminated Scientific CMOS
Array Size	2048 (W) x 2048 (H) 4.2 Megapixel
Pixel Size	11 x 11 mm
Image Area	22.5 mm x 22.5 mm (31.9 mm diagonal)
Readout Modes Quantum	Rolling Shutter and simulated Global Shutter
Pixel Readout Rates	100 MHz (16-bit mode) 200 MHz (12-bit mode)
Efficiency	95% (max)
Dynamic Range	53 000:1
Data Range	16-bit (extended dynamic range) 12-bit (maximum frame rate)
Linearity	> 99.7%
Dark Current Air cooled (@-25°C) Water/liquid cooled (@ -45°C)	 0.4 e-/pixel/s 0.2 e-/pixel/s

WP8.3 Data recording and processing

- Hα images acquired at our telescope will be stored in local data archive that will be available online. Currently they are stored in: http://ssa.oact.inaf.it/oact/image_archive.php

- Our data sets will be available for testing coordinated observations, merging of series, and producing higher level data products taken by other telescopes (UNIGRAZ, ORB, ASU)

- We will contribute to develop and test Lucky imaging techniques to improve the effective resolution that can be obtained by Hα observations (**8.3.1**).

- We plan to provide science-ready data in near real-time (**8.3.2**).

- We plan to test algorithms on our data in order to homogenize the full-disk solar images acquired at different stations (**8.3.3**).