

# Synoptic observations in Ondřejov and the cloud detection

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# Full-disc synoptic observations in Ondřejov: test data sets for calibration and merging

## White light

Telescope 50/500 mm, Baader foil

Camera 1: Imaging Source DMK 51AG02

CCD 1600 x 1200, pixel 4.4  $\mu\text{m}$ , 8 bit

exp. < 1 ms, cadence 1 fps, max. 12 fps

$D_{\text{SUN}} = 1062 \text{ pix}$ , 1.8"/pix

Camera 2: Thorlabs Quantalux CS2100M

CMOS 1920 x 1080, pixel 5.04  $\mu\text{m}$ , 16 bit

exp. 1 ms, cadence 50 fps (rolling shutter)

$D_{\text{SUN}} = 957 \text{ pix}$ , 2.04"/pix

## H-alpha

Telescope 60/750 mm, Daystar 0.7  $\text{\AA}$

Camera: ZWO ASI174mm

CMOS 1936 x 1216, pixel 5.85  $\mu\text{m}$ , 12 bit

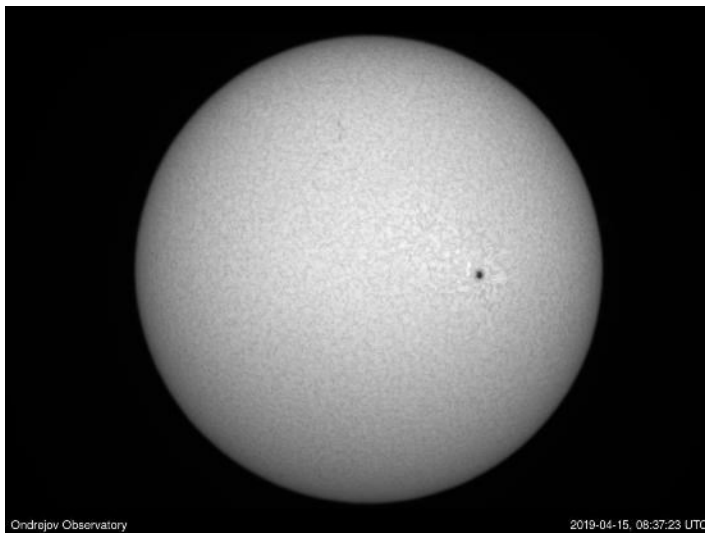
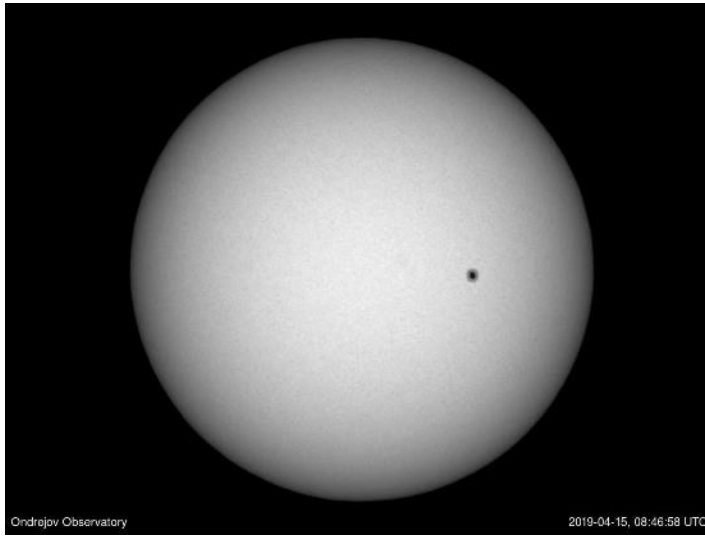
exp. 50 ms, cadence 12 fps (global shutter)

$D_{\text{SUN}} = 1195 \text{ pix}$ , 1.6"/pix



Web page:

[www.asu.cas.cz/~sunwatch/](http://www.asu.cas.cz/~sunwatch/)



Latest observation : 22. 04. 2019

Sunspot Drawing - Ondřejov 22.04.2019 Legend

White-Light Full Disk - Ondřejov 22.04.2019 Legend

H-alpha Full Disk - Ondřejov 22.04.2019 Legend

H-alpha Full disc - Úpice 22.04.2019

Ca Full disc \_ Úpice 22.04.2019

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ACTIVITY FORECAST

**VERY LOW**  
22/04 17:00 UTC

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There is a long tradition of the Solar Patrol (SP) service at the Ondřejov observatory (AI CAS). This service observes the Sun in white light and in the H-alpha line. The results are used in the scientific research of the Solar Department and they contribute to the world net International Space Environment Service (ISES) and their member the Regional Warning Centre Prague (RWC Prague) as station No. 31516, and to Solar Influences Data Analysis Center (SIDC) in Brussels. Sunspot drawings and synoptic white-light images are produced daily, depending on weather and technical conditions. The SP compiles and publishes a daily solar activity forecasts and weekly solar-activity forecasts. Weekly forecasts of the solar activity are made since 1978 and are distributed through public institutions in the Czech Republic and abroad.



INSTRUMENTS

OBJECTIVE	FILTER TYPE	WAVELENGTH / FWHM	CAMERA	REMARKS
63/840 mm	none	400 - 760 nm	none	sunspot drawings
50/500 mm	interference	536	DMK 51AG02	full disk
205/2801 mm	interference	590		partial FOV
60/750 mm	interference	656.28/0.07 Å	ZWO ASI174mm	full disk
210/3430 mm	interference	656.28/0.05 Å		partial FOV

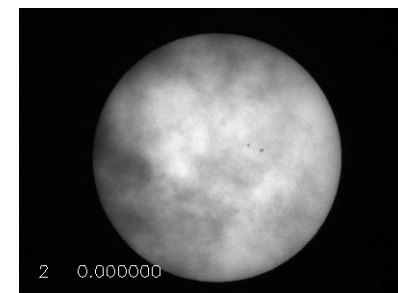
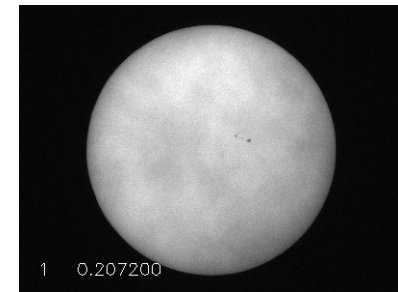
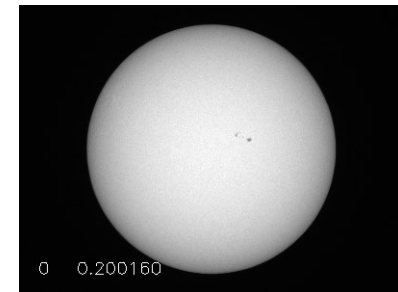
CONTACT: [sunwatch@at.sign.asu.cas.cz](mailto:sunwatch@at.sign.asu.cas.cz)

# Online cloud detection

For automated full-disc synoptic observations, there is a need to detect the presence of cloud shadows and to evaluate their effect on data degradation.

## Cloud score:

- 0 – Clean Sun, no clouds; the images can be used for automatic solar activity detection.
- 1 – Weak clouds; the images cannot be used for automatic detection but they are still useful.
- 2 – Strong clouds; the images are severely affected and it is not worth to store them.
- 3 – No Sun; the solar disc is completely obscured by clouds.



Feng et al. (2014, *New Astronomy*, 32, 24) published a method of automatic detection of cloud shadows in full-disc images, based on a comparison of observed images with a reference one. The method requires a centering of solar disc in the image and it is intended mostly for a post-processing.

We present a method that analyses each observed image individually and does not need a reference frame or a cross-comparison between the images. This makes it possible to determine the cloud score immediately after taking the image. Our IDL code **CLOUD\_TEST**, running on an ordinary PC, is capable to analyze of about 35 frames per second.

### **Data used to develop the code:**

White-light images obtained by the Ondřejov full-disc telescope (D = 5 cm, f = 50 cm), 8 bit, 1600 x 1200 pixels, 1.83"/pix, 10 series of 10–2500 images, cadence 1 s.

## Criteria of evaluation:

*Crit. 0:* Minimum brightness – the signal must be large enough for further evaluation. If not, the Sun is considered to be completely obscured.

*Crit. 1:* A ratio of average intensities of the solar disc and of the rest of frame;  $\text{crit1} = \text{mean}(I_{\text{disc}}) / \text{mean}(I_{\text{non-disc}})$  – A signature of weak clouds.

*Crit. 2:* A ratio of observed and calculated disc areas;

$\text{crit2} = N_{\text{pix\_obs}} / N_{\text{pix\_calc}}$ , where  $N_{\text{pix\_calc}} = \pi(r_{\odot}/\text{scale})^2$  is calculated for a given time by an ephemeris routine. – A signature of strong clouds.

*Crit. 3:* A normalized **standard deviation of the full-disc intensity**. After a smoothing to diminish the effect of sunspots and plages, its value depends on the center-to-limb variation and the perturbation by clouds (weak or strong).

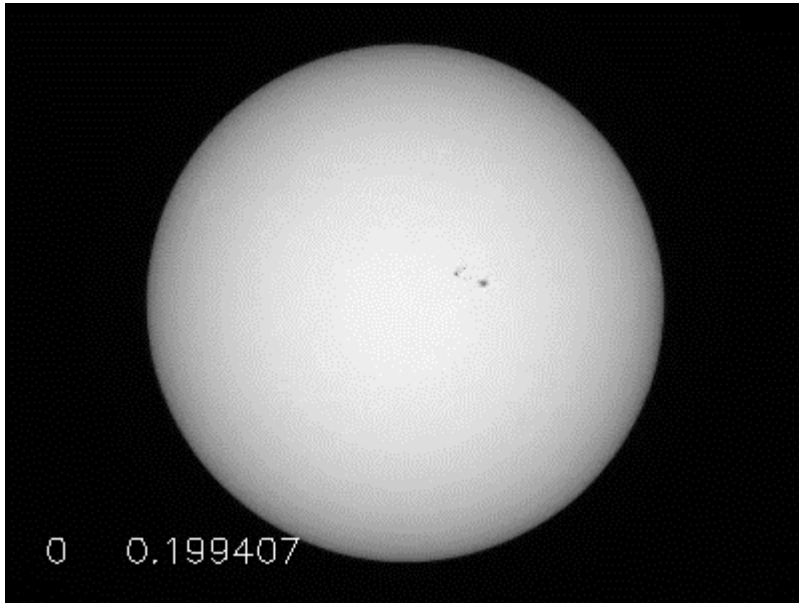
Parameters defining the criteria limits must be determined experimentally for a given instrument.

The cloud score is obtained from a combination of these criteria.

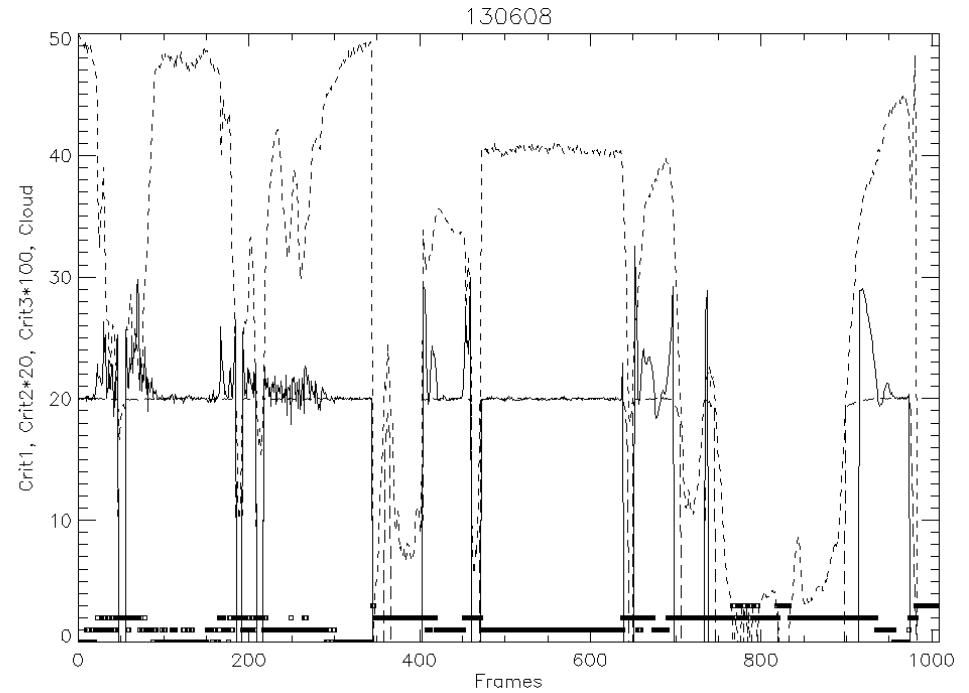
Cloud score	<i>cr0</i>	<i>cr1</i>	<i>cr2</i>	<i>cr31</i>	<i>cr32</i>
0 – clean Sun	1	1	1	1	1
1 – weak clouds	1	0	1	1	1
1 – weak clouds	1	0 or 1	1	0	1
2 – strong clouds	1	0 or 1	1	0	0
2 – strong clouds	1	0 or 1	0	n/a	n/a
3 – no Sun	0	n/a	n/a	n/a	n/a

**Table 1** – Cloud score and the corresponding combination of conditions. Filled cells show the decisive conditions for cloud scores 1–3.

# Results



Score, Crit. 3



Crit. 1 - dashed, Crit. 2 - long dash, Crit. 3 - solid

Compared to the visual assessment, the success rate of the code is 97 %.



## What to do

Testing, tuning, and verification of the cloud-detection algorithm on extended data sets:

- Collecting more WL full-disc images with clouds in Ondřejov,
- using also the 16-bit camera Quantalux CS2100M.
- Collecting WL full-disc images with clouds from other sites, instruments, cameras... we need your help.

Thanks for your attention

