

Past and Present of the Synoptic Observations of the Sun at the National Astronomical Observatory of Japan

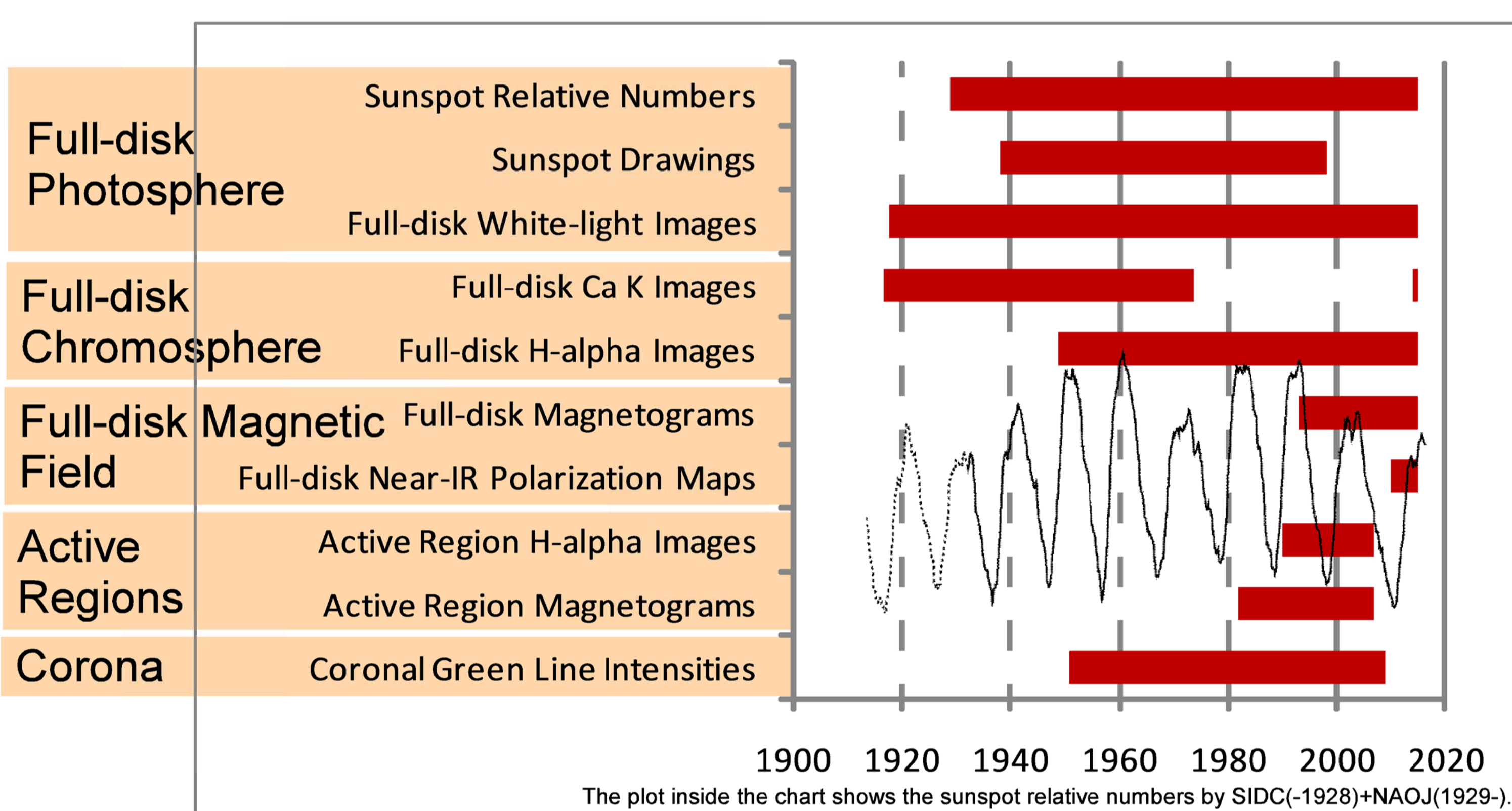
Yoichiro Hanaoka and the Solar Observatory of NAOJ
(National Astronomical Observatory of Japan)

The National Astronomical Observatory of Japan has a history of about 100 years of regular synoptic solar observations. It started with Ca K spectroheliographic and white-light imaging observations, and shortly afterward, sunspot count was started. Current imaging observations are being carried out in the $H\alpha$ line, the Ca K line, the green continuum, and the G-band. In addition, the NAOJ has a history of more than 30 years of magnetic field measurements, and now we are conducting full-Sun spectropolarimetry observations in the wavelengths of He I 10830/Si I 10827 and Fe I 15648.

These observational results contribute not only to the monitoring of solar active phenomena from the viewpoint of the space weather, but also to the study of the long-term variability of the solar activity, thanks to the long history. Most of historical photographic (plates and films) and hand-drawn data have been digitized and are now open at our web site as well as recently obtained data.

Here we introduce our data to promote the collaboration in the long-term solar activity study. Our data are open at our website: visit <http://solarwww.mtk.nao.ac.jp/en/solarobs.html>, and go to the *database* page.

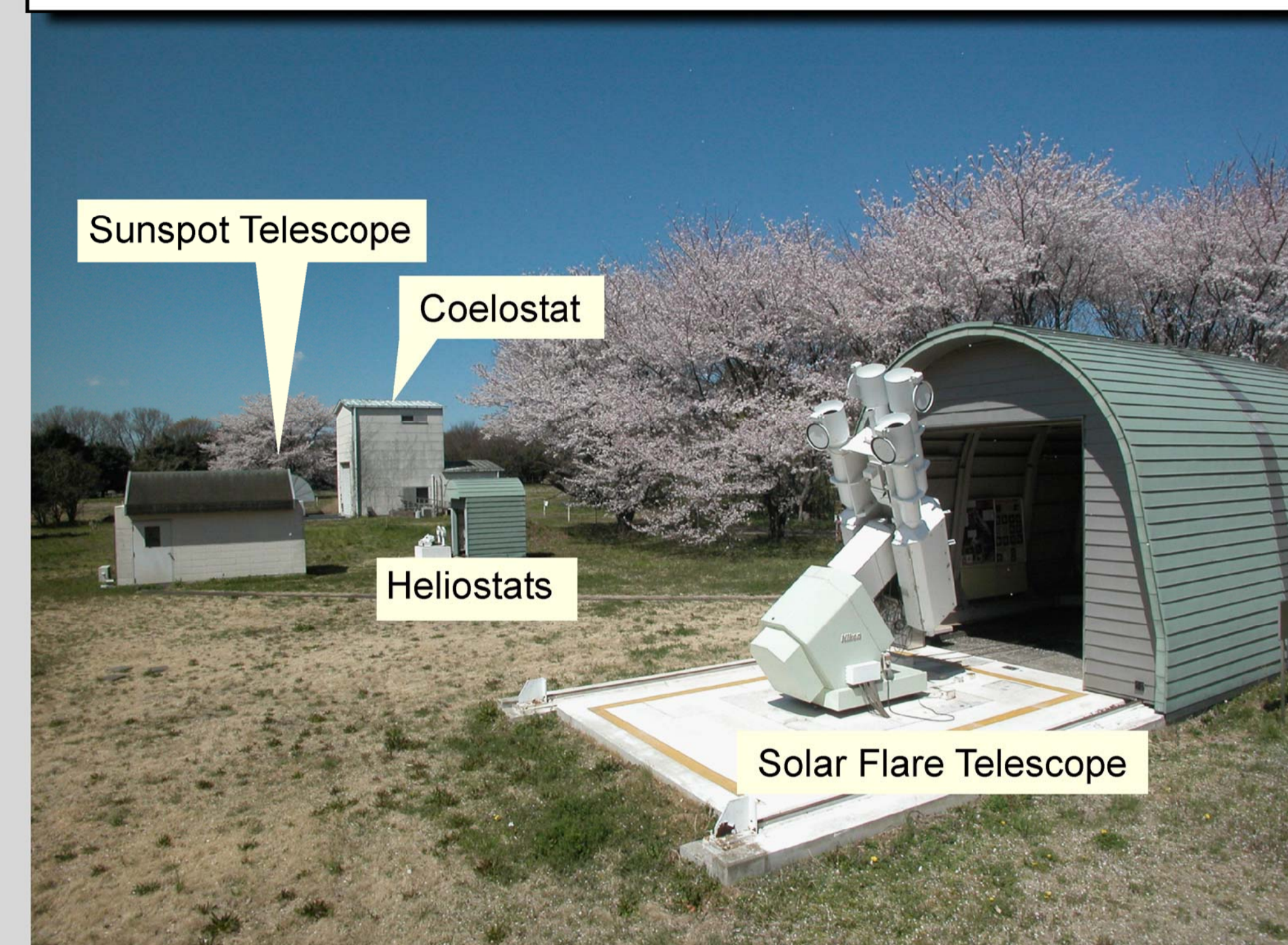
1. NAOJ History of Solar Observation



The first observation of the Sun by the NAOJ was done at the end of the 19th century (NAOJ was the Tokyo Astronomical Observatory at that time), and the regular solar observation started in the 1910's. Since then various types of observations have been conducted over a span of 9 solar cycles, as shown in the Figure left (Sakurai 1998 ASPC140; Hanaoka 2013 JPCS440).

The data are open at our web site. In addition to new, digitally acquired data, old photographs and drawings have been digitized. Most of the old data have been opened already.

2. Current Observing Facilities

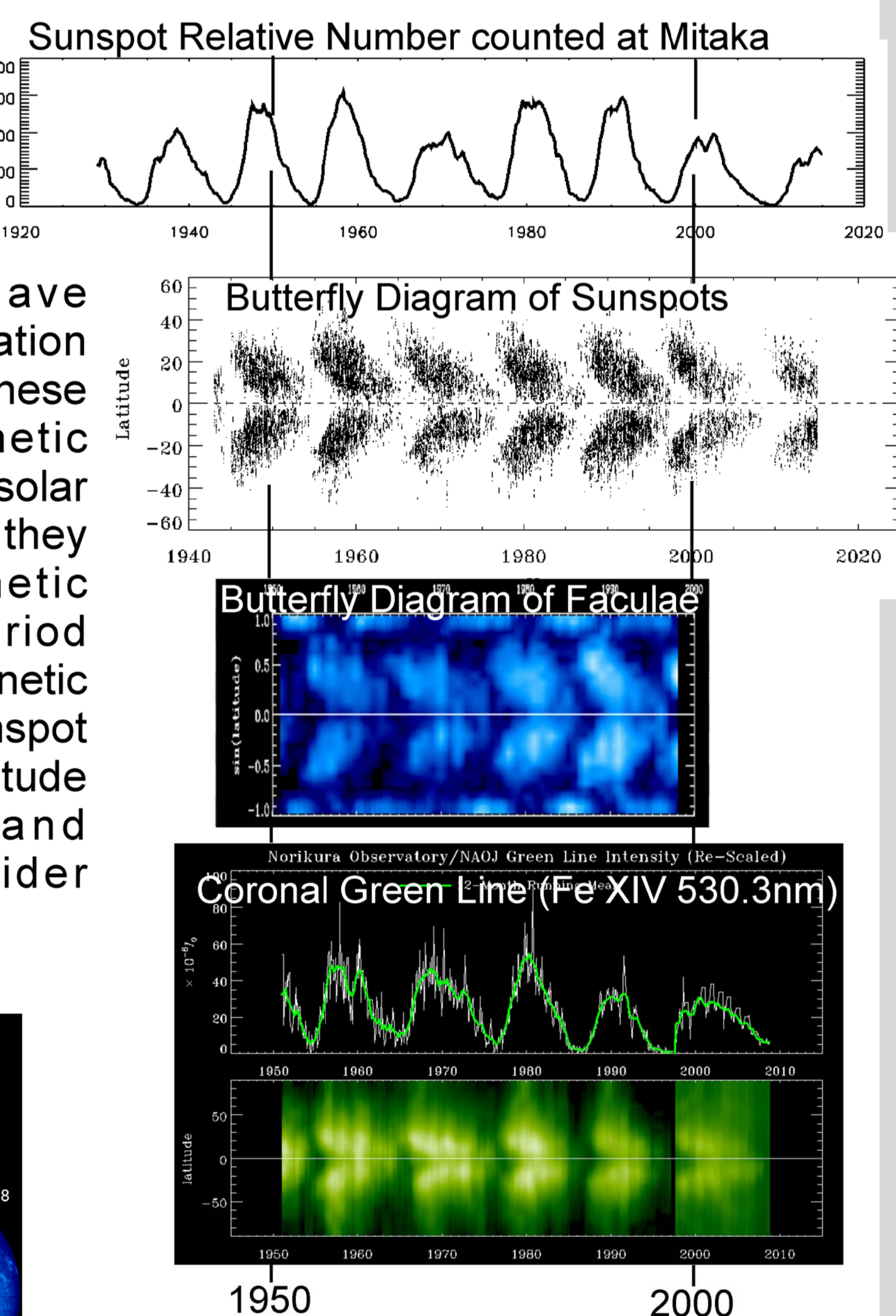


Currently we are operating some solar telescopes at the Mitaka campus of the NAOJ in Tokyo.

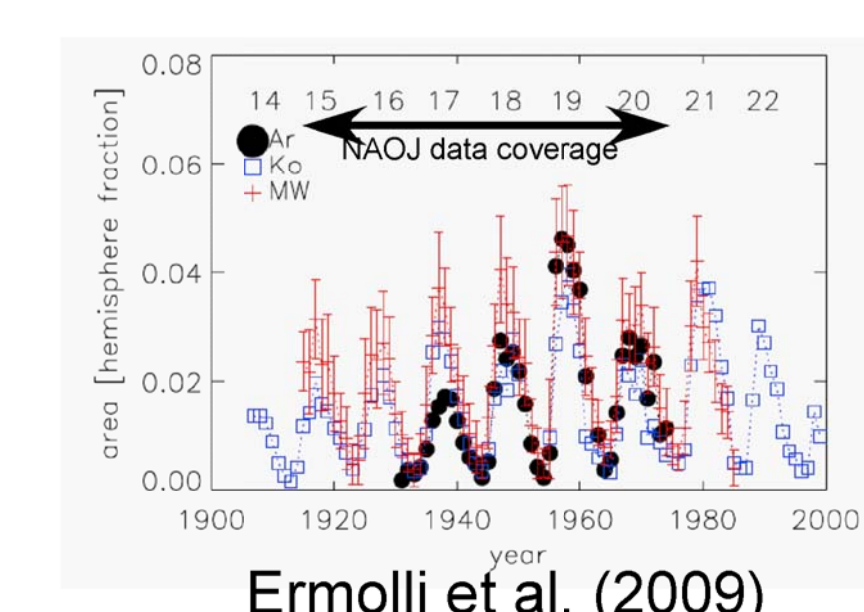
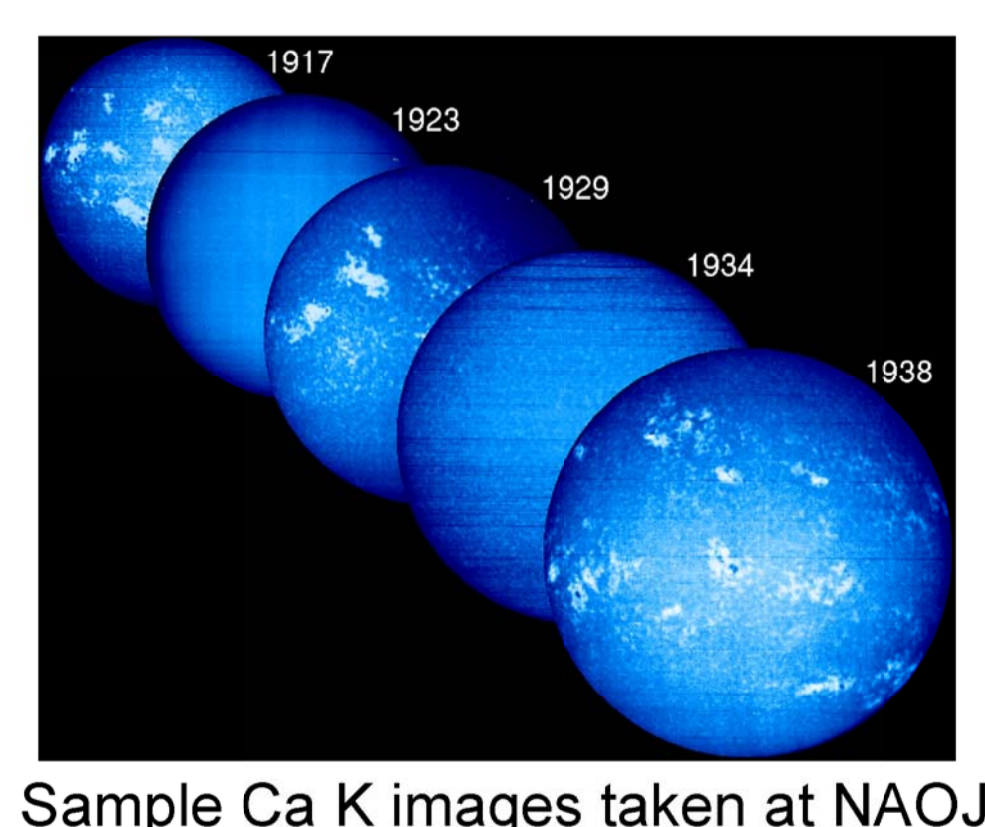
3. Data

Solar Activity Data back to the Pre-Magnetograph Era

Accumulation of the observational data contributes to studying the long-term variability of the solar activity. We have continued solar observation for about 100 years. These data reflect the magnetic field distribution on the solar surface, and therefore, they show the solar magnetic activity during the period when there was no magnetic field data. Although sunspot data cover a limited latitude range, the faculae and coronal data have wider coverages.



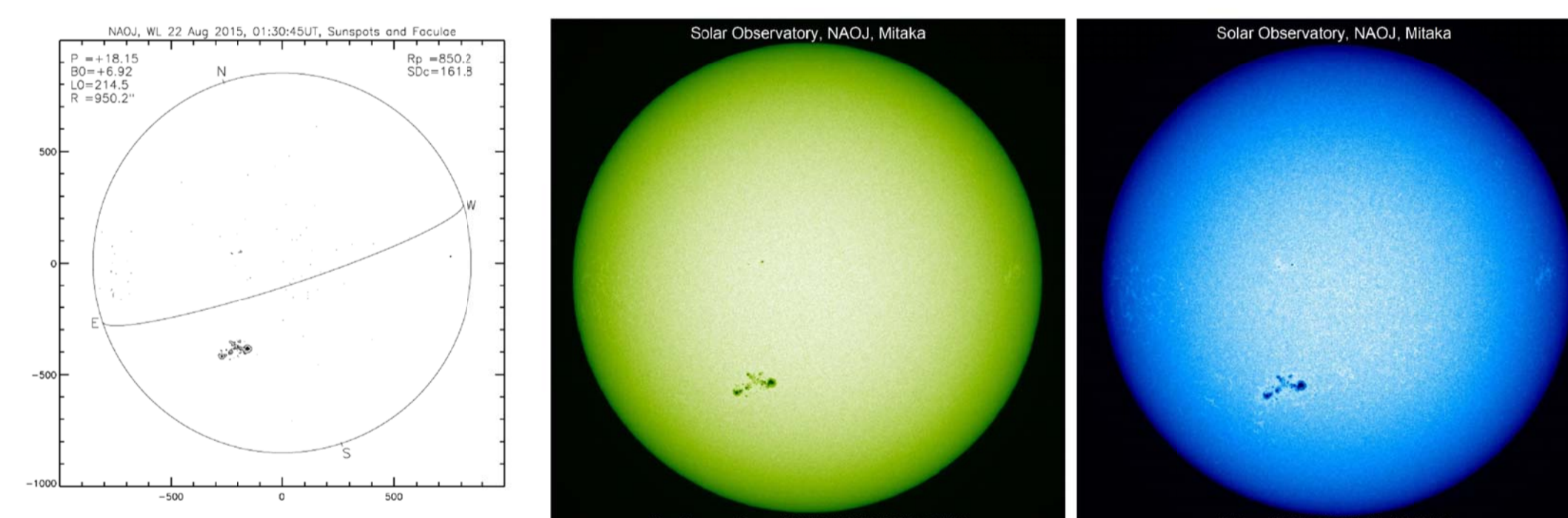
The Ca K observation with a spectroheliograph started in 1917, and continued until 1974. The 11-year cycle of the Ca K activity was shown by Ermolli et al. (2009) based on the Kodaikanal, Mt. Wilson, and Arcetri data. Our data will contribute more accurate estimation of the Ca K activity in the 20th century.



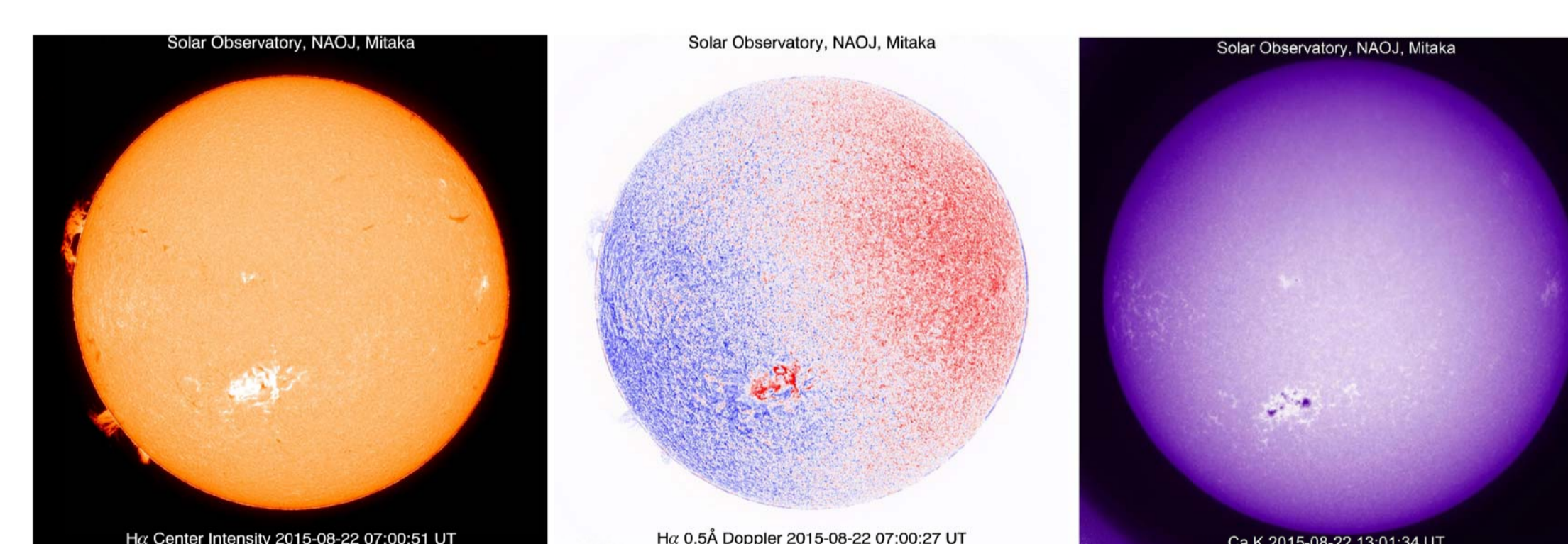
Current Observations

White-light imaging observation started in 1918, and now we are taking white-light images with a CCD camera. The sunspot relative number was formerly counted on the hand-drawings, but now images taken by the CCD camera are used to pick up sunspots. Recently we started G-band and another continuum imaging observations.

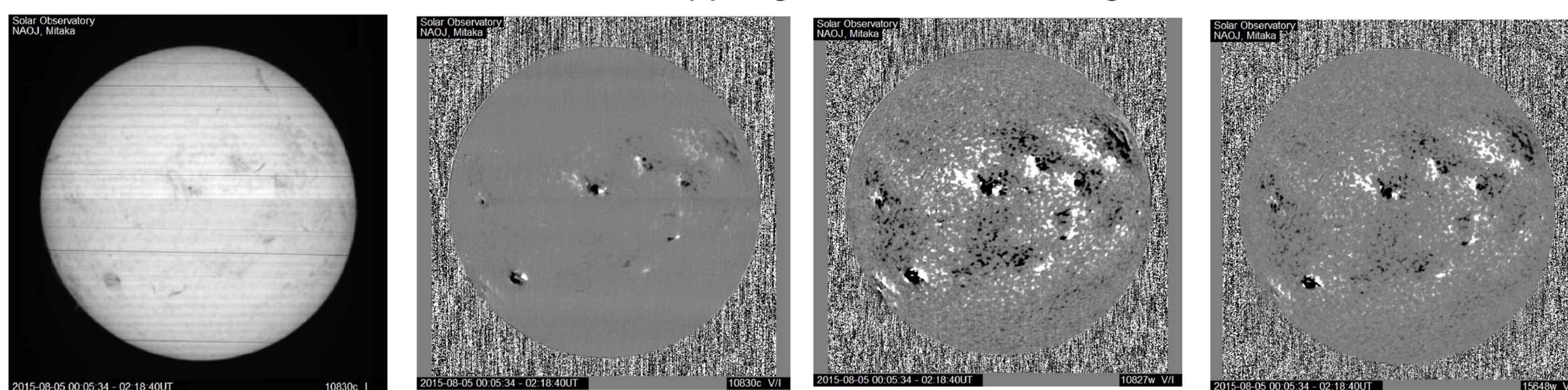
Since 1949, $H\alpha$ observation has been continued by drawing, photograph, and CCD imaging. Now high-resolution images taken at several wavelengths around the $H\alpha$ line contribute to catch flares and filament activities. Recently we (re-)started Ca K imaging.



Photospheric imaging observations: Sunspot count map, continuum and G-band images



Chromospheric imaging observations: $H\alpha$ center image, Dopplergram, and Ca K image



He I 10830 Stokes I and Stokes V/I, Si I 10827 Stokes V/I, and Fe I 15648 Stokes V/I images

NAOJ is the only institute which continues regular ground-base solar magnetic field observations in Japan. In 1982, magnetic field measurements of active regions started at the Okayama Observatory of NAOJ, and now we are operating full-disk near-infrared spectropolarimeter at Mitaka. Our current data show both the photospheric and the chromospheric magnetic fields (Sakurai et al. 2015 in prep).

This work was partly supported by a Grant-in-Aid for Scientific Research (No.15H05814, 2015-2019) from the Ministry of Education, Culture, Sports, Science and Technology of Japan.