SOP REPORT - MAY 2014

Contents

The SOP in its first year

National Astronomy Week 2014 Highlights
- Solar Observation Workshop - National Astronomy Convention
- FPV - Astronomical League of the Philippines
- Paper Presentation: Solar Flare and Sunspot Group Analysis of Solar Maxima for Solar Cycle 24

Equipment Acquisition

Technical Papers
- Solar Flare and Sunspot Group Analysis of Solar Maxima for Solar Cycle 24
- Sunspot Data Extraction Using 3D Isophote Rendering

SOP Data

International Sun-Day 2014

The Solar Observation Program in its first year

The SOP was proposed as a program in May of 2013 in order to turn casual solar observations and imaging into usable scientific data. It began with a handful of students and faculty members and has since grown in its productivity.

The program began with white-light solar data: McIntosh classifications, sunspot number, solar morphology; and has also grown to conduct studies using data from SOP and/or from on-line databases and archives. The first two research in solar astronomy in RTU was conducted by John Lequiron and Princess Tucio (BS AstroTech batch 2014) as their thesis after I recommended that they take advantage of the solar maximum of solar cycle 24.

Trainings on solar observation as well as data analysis have been given for students, as well as the development of a solar observation manual.

Furthermore, the SOP was represented during the International School for Young Astronomers (ISYA) 2013 in Indonesia. We were able to lead one of the solar groups and have also been able to make linkages for heliophysics and solar research with other participants.

In behalf of the leadership of the Solar Observation Program I wish to express my gratitude for the participation and the welcome reception of the students and the university for this particular endeavor. Thank you very much and I am looking forward to the continuous growth of the program.

-Norman Marigza
Head, Solar Observation Program

National Astronomy Week 2014 Highlights

Solar Observation Workshop - National Astronomy Convention

Among the topic highlights in RTU's 1st National Astronomy Convention is solar astronomy. Three of the plenary speakers had talks focused on the Sun. We have Solar Observation by Dr. Jett Aguilar, the vice-president of the Astronomical League of the Philippines (ALP); a solar observation workshop by Norman Marigza, head of the SOP; and Space Weather by Emannuel Sungging of Indonesia.

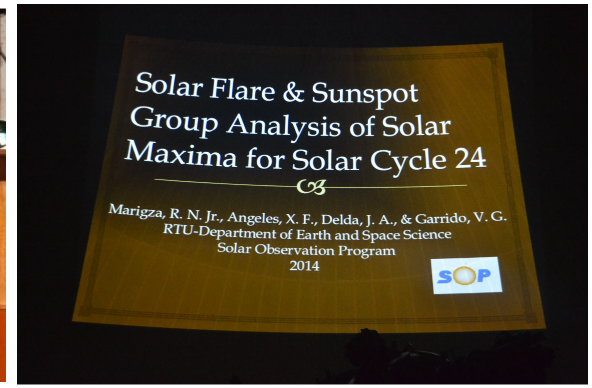
National Astronomy Week 2014 Highlights

FPV - Astronomical League of the Philippines

The SOP members participated in the opening of ALP's NAW celebration. Among the talks for that day at the National Museum Planetarium (NMP) was Dr. Jett Aguilar's lecture on solar observation. He was originally scheduled as the first speaker but was moved as the last speaker to allow the SOP members to catch up from their NSTP classes (We thank ALP for their special consideration). The program in NMP was then followed by a free-public viewing at SM-MOA. Participating members of the SOP were able to get solar glasses courtesy of the Charlie Bates Solar Astronomy Project.

National Astronomy Week 2014 Highlights

Paper Presentation:
Solar Flare and Sunspot Group Analysis of Solar Maxima for Solar Cycle 24

The 2nd year members of the SOP gave a research presentation as one of the talks in the closing ceremony of ALP's NAW celebration. The paper talks about the flaring and sunspot group properties during the year 2013. This is the first formal paper produced under the SOP.

Equipment Acquisition

Through the course of the SOP program we have been able to increase the number of equipment for our solar observations. We initially began with the 8-inch solar glass filter on loan to the department by Dr. Torres and a Baader filter from Celestron that unfortunately has been damaged. We were also borrowing the Coronado PST of Dr. Torres. The members have also provided their own cameras for use in gathering image data.

We then were able to receive two additional filters care of Engr. Ronald Tanco. He provided us with two 12x12 filters – an RG film and a Black Polymer film. Margareth Custodio was able to request for solar glasses from the Charlie Bates Solar Astronomy Project on her own and has shared some with the Astronomy students. Other SOP members got one from ALP during the NAW.

The newest acquisition to the Department is the two solar scopes that have been ordered in 2013. Dr. Torres has pushed for continuous solar observations and has graciously granted our request for additional solar telescopes. The university acquired two Lunt Solar Systems – one CaK and one Hα.

Other members have also purchased personal Baader AstroSolar Safety Films from James Kevin Ty to add to the

Solar Flare and Sunspot Group Analysis of Solar Maxima for Solar Cycle 24

Marigza, R. N. Jr., (MS AST), Angeles, X. F., Delda, J. A., & Garrido, V. G. (BS AstTech)

Abstract

The paper characterizes the solar maximum 2013 for the solar cycle 24 in terms of the analysis of X-ray solar flares and sunspot groupings. This study analyzes sunspot groups and corresponding flare rates for the year 2013 against historical flare rates and class frequencies.

Introduction

The Sun has a period of highest activity known as the solar maxima. During this time solar flares and sunspots have the highest frequency of occurrence. The increased output is a result of the twisted up magnetic energy stored in the Sun at the end of each 11 year cycle. The summer of the year 2013 corresponds to the predicted solar maximum for the solar cycle 24. National Oceanic and Atmospheric Association (NOAA) forecasts puts the solar minimum in December of 2008 and the maximum in May 2013.

This study attempts to test statistical rates for the period of 2013 over previously recorded flare distribution history. Testing statistical flare rates against the flare history for past solar cycles will help characterize the predicted weak solar maxima for solar cycle 24. The year 2013 corresponds to a period of increased solar activity brought about by the solar maxima. Flare rates over this period are compared to the statistical flare history to see if they match the frequency distribution and flare probability. This will also identify whether or not sunspot group associations and flare probability can be characterized over short periods within the cycle.

There are several studies conducted for the association of sunspot groups and flares. The researchers identify the studies by Kidahl (1980) and Norquist (2011), which is an extension of Kidahl's work, and that of Galagher, Moon and Wang (2002). Kidahl analyzed the flare frequency (M- and C- class X-ray flares) against the sunspot group class for the period of 1969-1976. Norquist analyzed sunspot groups and Hα and X-ray flares for the period of 1997 – 2007 (solar cycle 23). If the current data coincides with the historical frequency distribution then it may serve as basis for the development of a short period flare probability prediction.

Solar Flare and Sunspot Group Analysis of Solar Maxima for Solar Cycle 24

Marigza, Angeles, Delda, & Garrido

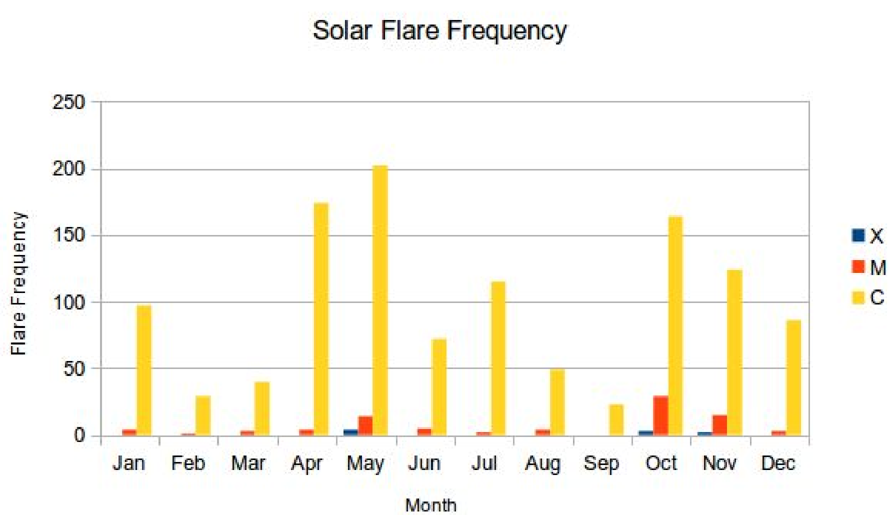
Data

Daily sunspot and flare information are archived in the Solar Monitor website that is managed by the Solar Physics Group, Trinity College Dublin and the e-INIS (Irish National e-Infrastructure). They provide a listing of the active region designation, location, area, hale class, sunspot count, flare occurrence, and McIntosh classification. The tabulated data is based on the NOAA/USAF Active Region Summary.

The data gathered by the researchers is for the period of 2013 only. Recorded are the frequency of X-, M-, and C- flares and the corresponding 63 possible McIntosh classes that generate them. Also recorded are the frequency of occurrence of each of the McIntosh classes, which are labeled as “sunspot group days” (SSG-Ds).

Analysis and Results

The researchers generated a flare frequency distribution table corresponding to each McIntosh class. There are 63 McIntosh combinations however 12 of which were not observed during the period of 2013. The classes that were not observed were Bxi, Drc, Ero, Eri, Erc, Fro, Fri, Frc, Fsi, Fsc, Fhi and Fhc. Among these, Drc and Erc were also not observed by Kidahl (1990). The most frequent sunspot groups are Hsx (347), Bxo (247), Axx (201), Dao (186), and Cao (175).



In Figure 1, we show the distribution of flare types per month. The month of May has the highest frequency of C-class flares (202) and X-class flares (4) recorded. The month of October has the highest frequency of M-class flares (29). The highest net frequency of solar flares happened during May with a total of 220 flares with 244 SSG-Ds observed. The month of May also has the highest SSG-Ds for the year. This month then characterizes the peak flare and sunspot group activity for the solar maximum. This matches the consensus made by the Solar Cycle 24 Prediction Panel of the NOAA Space Weather Prediction Center (SWPC) in 2008 that the solar maximum is expected to occur on May 2013.

Solar Flare and Sunspot Group Analysis of Solar Maxima for Solar Cycle 24

Marigza, Angeles, Delda, & Garrido

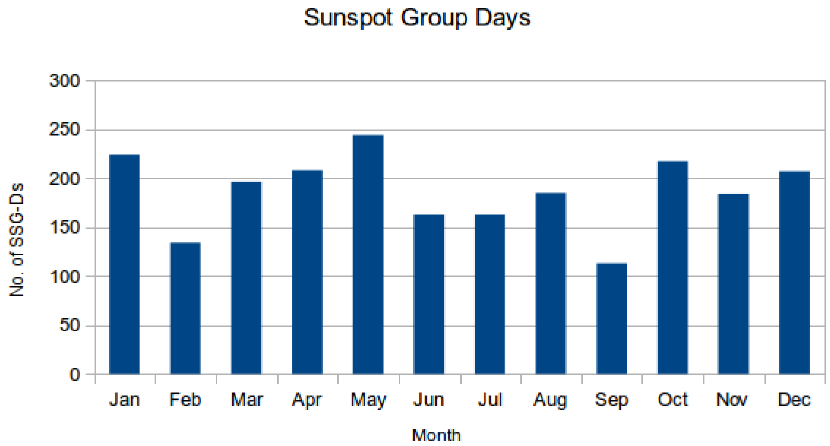
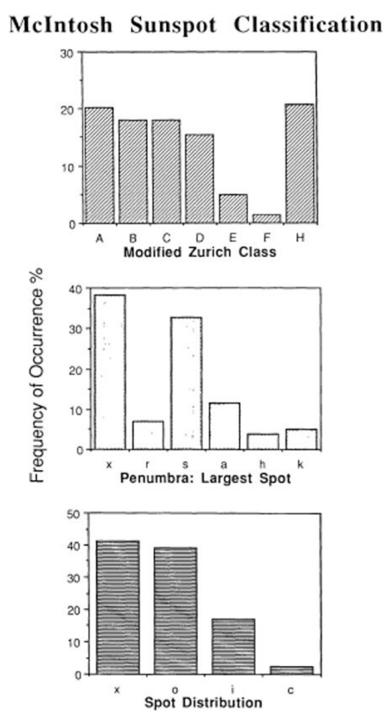
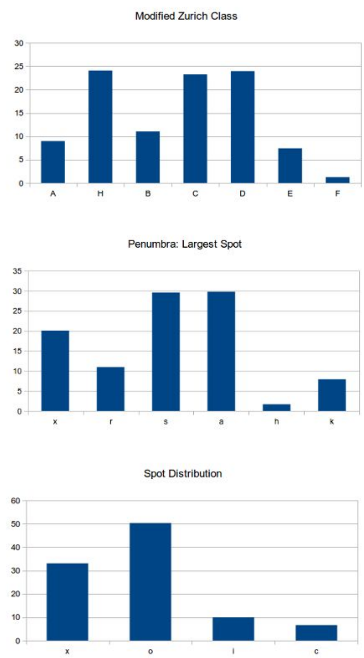


Figure 2 plots this study's monthly frequency of recorded sunspot group days. There is no observable trends in the rise or fall of sunspot group occurrence throughout the year. This suggests that evident patterns for the rise and fall of solar activity is only perceivable over yearly periods within each solar cycle.

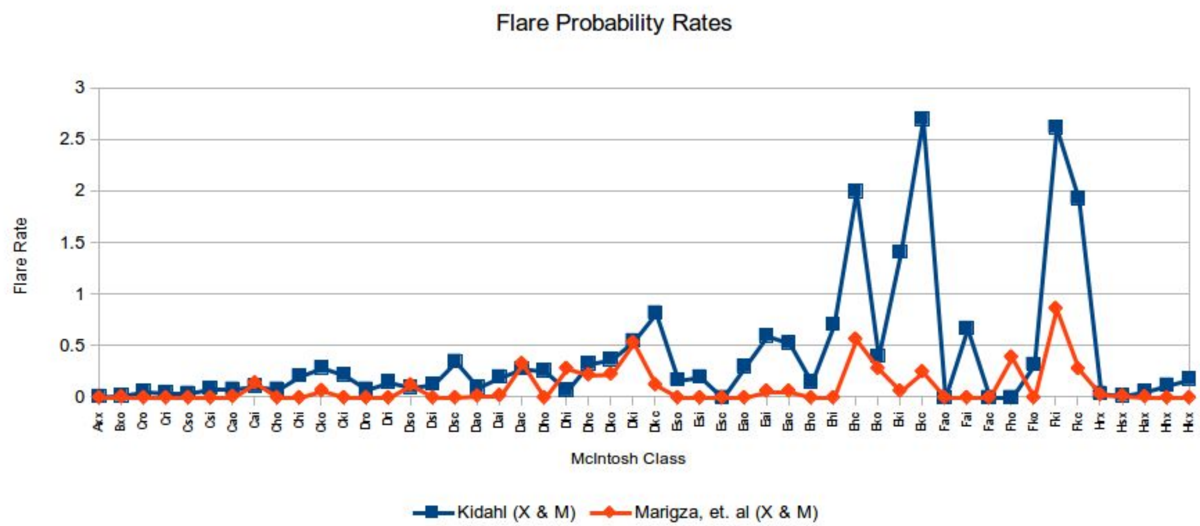




A table of percentage frequencies was also made for all of the individual McIntosh sub-classifications and compared against data from Kidahl (Figure 3). Among the unipolar groups there is a lower occurrence of class-A and a slightly higher occurrence of class-H Zurich sub-class. There is also a significantly lower percentage of bipolar groups with no penumbra. For the main spot, asymmetric penumbrae have a higher occurrence (37.69%) than symmetric penumbrae (31.27%) as compared to the previous data where symmetric penumbrae were more dominant. In terms of the spot distribution there are very few complex structures that formed compared to the few spot/no spot distribution (50.36%) between bipolar structure.

Flare frequencies for each of the McIntosh classes were used to compute for the daily flare rates of each class. Firstly, the average number of events expected μ in a given time interval was determined. This was then used to calculate the flare probability in a period of 24 hours.

The daily flare rates are plotted in Figure 4 and compared against computed flare rates from solar cycle 23 (Kidahl). The data shows that the sunspot groups with the highest net flare rate for X-, M-, and C-class flares are as follows Ekc (184), Dai (86), Dao (82), Eai (77), and Dac (76). Only the Ekc classification corresponds to the top 5 statistical flare rates by Kidahl (1980) and Norquist (2011). Kidahl identifies the classes: Ekc, Fki, Fkc, Eki and Dkc; while Norquist records: Fkc, Ekc, Fac, Fki, and Fko as classes with the highest flare rate.



In contrast to the flare probability rates by Kidahl, a z-test was applied to test for a significant difference with the computed flare probability rates. Kidahl has a sample of 57 flaring groups while the researchers have 51. Using the z-test we can see that there is a significant difference in the computed flare probability rates of Kidahl for the period 1969-1976 when used against the tabulated X- and M-class flare. The mean daily flare rate for X- & M-class flares by Kidahl corresponds to 0.43491 while that computed for 2013 is ~ 0.098069. This goes to show that the flare rates for 2013 is significantly lower than in previous solar cycles just as it was predicted.

Solar Flare and Sunspot Group Analysis of Solar Maxima for Solar Cycle 24

Marigza, Angeles, Delda, & Garrido

Conclusion

The computed flare rates for the period of 2013 shows the lower flaring activity with respect to statistical flare history from previous cycles. The sunspot class associations with flaring activity also do not match historical flare rates suggesting that flare frequencies cannot be characterized over short periods. There is also a low number of complex sunspot group structures evolving that would allow higher energy flares and higher flare frequencies. No trends can be seen in the rise/fall of solar activity throughout the year suggesting that such trends are only evident when analyzed over entire cycles.

References

Bornmann, P. L. & Shaw, D. (1994). Flare Rates and the McIntosh Active-Region Classification. Solar Physics 150: 127 – 146. Kluwer Academic Publishers: Belgium.

Gallagher, P. T., et. al. (2002). Active Region Monitoring and Flare Forecasting. Solar Physics 209: 171 – 183. Kluwer Academic Publishers: Belgium.

Hathaway, D. H. (2014). Solar Cycle Prediction. Solar Physics: Marshall Space Flight Center

Kidahl, K. (1980). In: Norquist, D. An Analysis of the Sunspot Groups and Flares of Solar Cycle 23. Solar Phys. Springer.

McIntosh, P. S. (1990). The Classification of Sunspot Groups. Solar Physics 125: 251 – 261. Kluwer Academic Publishers: Belgium.

Norquist, D. C. (2011). An Analysis of the Sunspot Groups and Flares of Solar Cycle 23. Solar Phys. Springer.

Sello, S. (11 October 2013). A General Method for the Determination of Duration of Solar Cycle Maxima. Elsevier: Italy.

SolarMonitor.org

Sunspot Data Extraction Using 3D Isophote Rendering

Marigza, R. N. Jr., (MS AST)

Abstract

The paper explores the use of three-dimensional isophote rendering from ImageJ to be used to analyze sunspot groups and extract sunspot count data and structural features. This technique allows increased accuracy in acquiring the Wolf number even with the use of low-resolution image data.

Introduction

The relative sunspot number (Wolf number) is one measure of determining the solar activity. It was established by Rudolf Wolf over 150 years ago. The relative sunspot number R is computed by identifying the number of visible sunspot groups g and the net sunspot count from all groups s.

For periods when the Sun is active (approaching maxima) there is a rise in the frequency of sunspot groups, and the reverse for periods when the Sun is inactive (minima).

The difficulty of sunspot counting, however, lies in the difference of each individual's independent count. A number of factors increase the amount of uncertainty in one's data: experience, seeing conditions, 24-hour counting period, equipment, resolution, pore-spot distinction, ranges in tonal gradation.

With the onset of the digital photography it is now possible to limit the difficulties of making sunspot counts. One such photographic technique is the creation of isophotal images. Isophote rendering is a useful tool in extracting undiscernable sunspot features in which areas are separated by density.

ImageJ

The software ImageJ was developed by Wayne Rasband of the National Institutes of Health, USA. It is an open source program used in different science fields and can be downloaded on the internet at http://imagej.nih.gov/ij. The program runs on a java platform and can be used to process and analyze images. It has a wide range of extensible plugin features, including the rendering of a 3D plot from the image data.

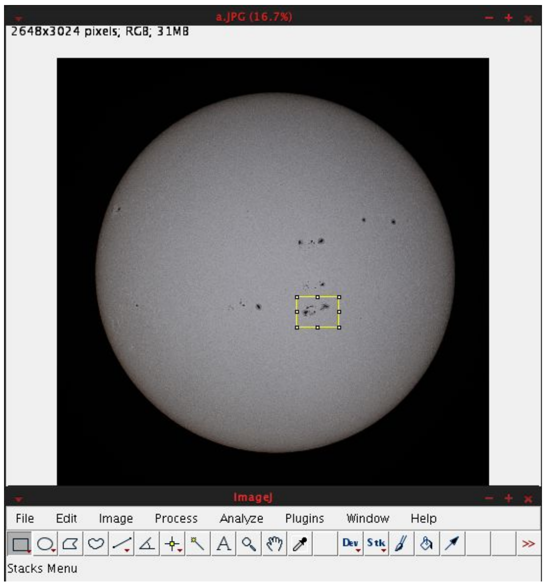
Technical Papers

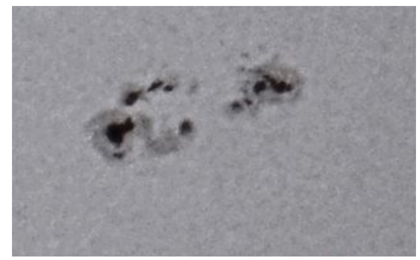
Sunspot Data Extraction Using 3D Isophote Rendering

Marigza

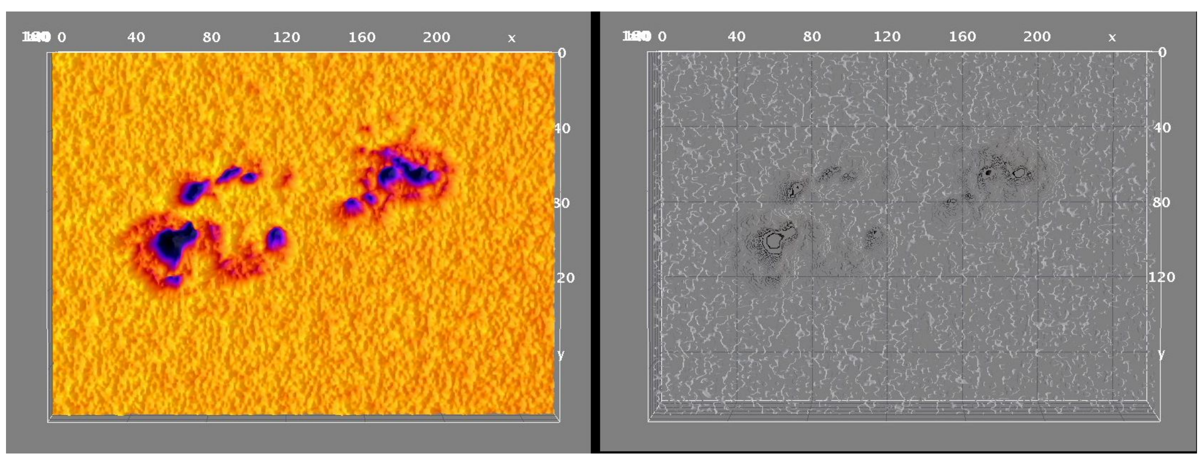
Sample Observation

This image analysis form is supplemental to regular sunspot observations. Here is a whole-disk image of the Sun taken on April 17, 2014 showing 10 active regions. The image is taken using a Nikon D3100 mounted on a 6-inch Newtonian reflector (Sky-Watcher Explorer 150PL) at prime focus and with a full-aperture Baader AstroSolar Safety Film.





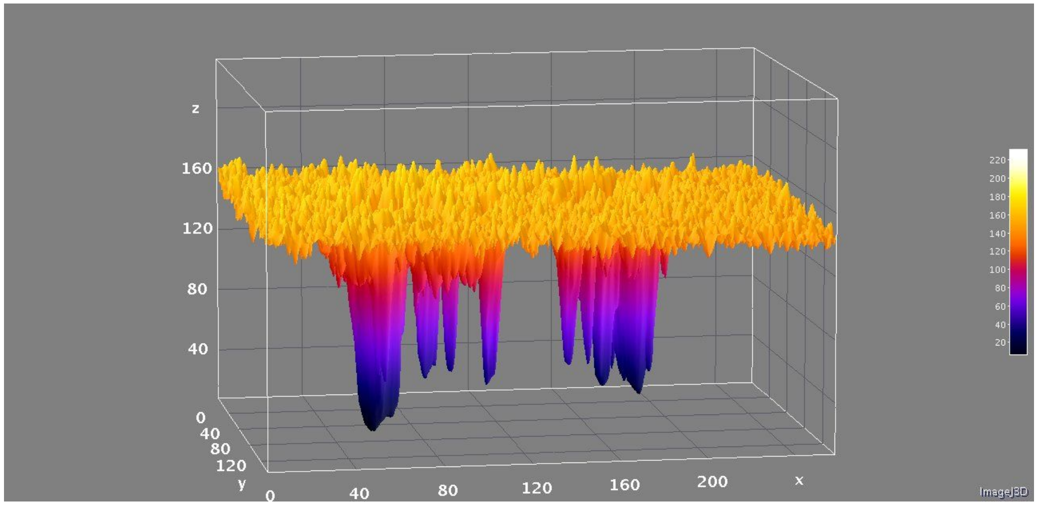
We select a particular active region for analysis (AR 2036). From the Plugins tab you can access the interactive 3D surface plot to do your isophotal analysis. There are a number of features in the plot that allows you to see your image isophote differently. To give it a solar surface look I set the plot to Filled and Fire LUT.



Technical Papers

Sunspot Data Extraction Using 3D Isophote Rendering

Marigza



The plot brings out details that are hard to detect from the original image such as better contrast to granular cells as well as faint spot features. The plot can be fully rotated and the depths of the different density areas changed to bring out other detail.

The sunspot count of AR 2036 from the original image is 42 but using the 3D surface plot and tweaking the density levels revealed 14 more spots making the count 56. The counting is also made easier since the image has better contrast from the original.

Other photographic methods rely on image processing to enhance light features but the risk is that the darker umbral features are lost. The interactive 3D surface plot allows both the dark and light features to be made out without loosing image data. This tool's ability to make out features also allows for better estimation of sunspot activity even for low-resolution images

Conclusion

The interactive 3D surface plot function of ImageJ is a useful isophotal tool in discerning sunspot features that are usually hard to see or bring out through conventional image processing methods. The availability of this software makes this image analysis tool accessible to everyone who wishes to improve their sunspot data.

References

Bray, R. J. & Loughhead, R. E. (1962). Isophotal Contour Maps of Sunspots. Australian Journal of Physics. 15(4) 482-489.

Jenkins, J. L[1]. (2003). Techniques for Viewing Sunspot Umbrae with Isophotes. The Strolling Astronomer. Association for Lunar and Planetary Observers. Vol 45, No. 1.

Jenkins, J. L[2]. (2009). The Sun and How to Observe It. Springer: New York.

Rasband, W. ImageJ. National Institutes of Health, USA.

SOP Data

Sunspot Data Summary 2013

Month	Obs	ΣGn	ΣSn	ΣGs	ΣSs	R	MDF
April	3	7	91	6	29	250	4.33
May	3	5	58	10	81	289	5
June	10	15	84.41	32	147.57	701.98	4.7
July	13	10	76.2	34	479.4	995.6	3.38
August	8	14	50	20	123	513	4.25
September	No Data						
October	5	6	160	19	154	564	4.17
November	6	12	42	28	280	722	5.71
December	Data Lost						

The data presented shows the total group and spot count for each of the monthly observations and not the averages. The month of September is absent of data due to poor weather conditions while the December data that was stored in the department's computer was lost and could not be retrieved from an unwanted formatting error.

SOP Data

Sunspot Data 2014 (January – May)

Unfortunately, not all data have been submitted yet and some data are merely image acquisitions and absent of sunspot count and group classification. We have yet to consolidate the data together to make it into a useful scientific archive. Some of the January data has been lost as well with last year's December data. We are requesting our members to please submit the rest of their solar data for archiving.

The following is only the number of observations for white-light that is currently logged into the archive.

Observers logged : Norman Marigza, Justine Garcia, Ralph Tiburdo, Kea Cabigao

January
No. of observations : 1

February
No. of observations : 6

April
No. of observations : 18

May
No. of observations : 30

International Sun-Day

The Solar Observation Program is one of the participating partners for the International Sun-Day 2014 to be held on June 22, 2014. It is a global event participated by over 100 astronomical groups from 20+ countries. The purpose of the event is to celebrate and share the Sun in their local communities and through social media. The event is organized by Pamela Shivak (founder) and Stephen Ramsden (Director, Charlie Bates Solar Astronomy Project).

The current planned activities for the SOP is a solar infographic campaign on various social media sites as well as a FPV of the Sun either in RTU or with the ALP.

Solar Observation Program
Rizal Technological University