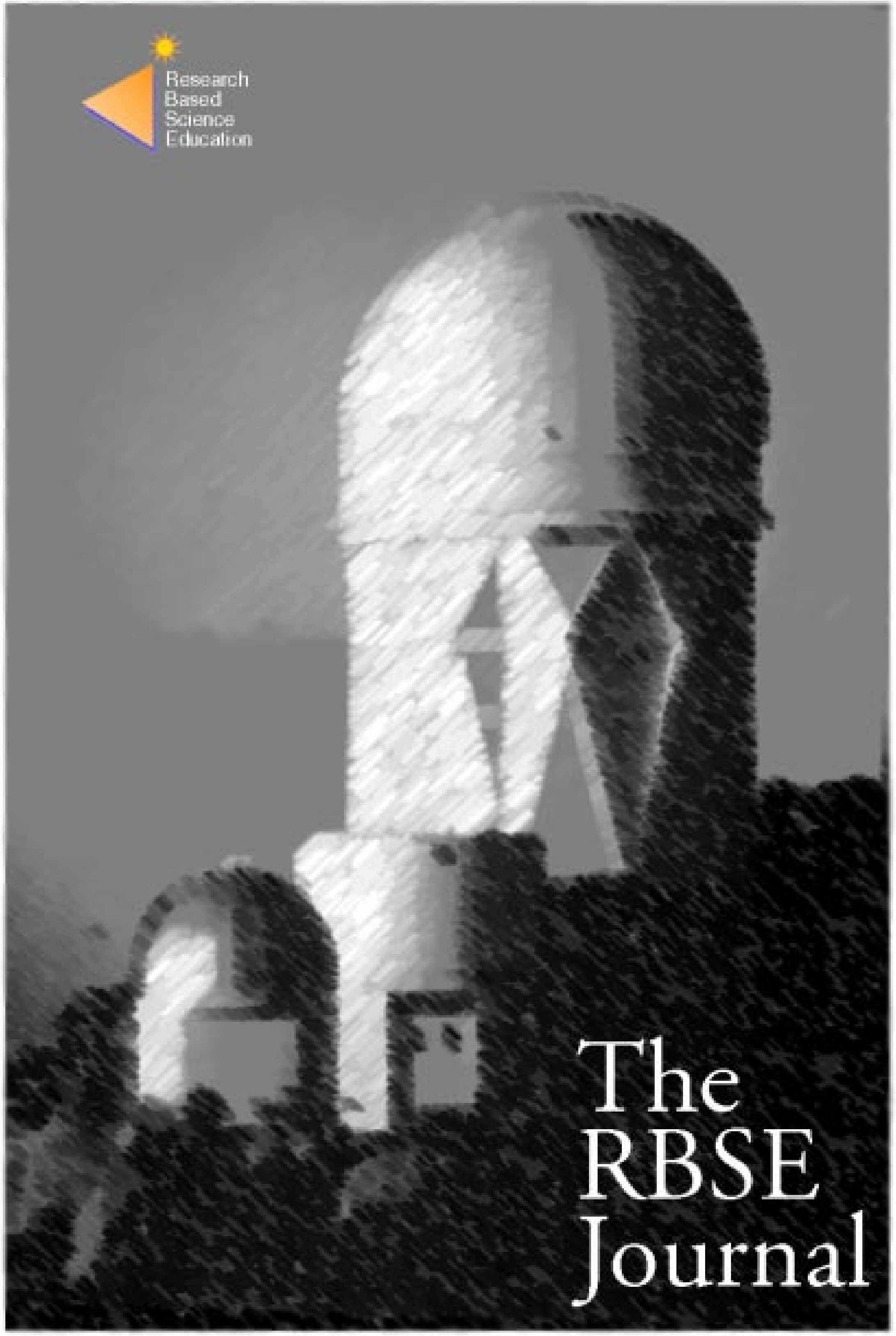

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A Search for Novae in the Andromeda Galaxy

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Abstract

The research team discovered 21 possible novae in the Andromeda Galaxy (M31). Sixteen data fields taken at Kitt Peak by the 0.9-meter telescope from 1995-98 were inspected for stars that showed sudden brightening in the hydrogen alpha portion of their spectrum. The magnitude and location of all candidates were determined, and light curves were developed for novae that appeared on consecutive fields. Of the 9 light curves analyzed, five appeared to be type NA "fast" novae, and two each of type NB and NC. Novae appeared to be distributed close to the galactic core, probably due to a density effect- more stars, more novae. "Fast" type novae were closer to the center and the slowest type farther out.

Purpose

The purpose of this research project was to search for novae in the Andromeda Galaxy, and, once identified and located, to observe their changes in magnitude as a function of time.

Procedure

The National Optical Astronomy Observatories supplied digital CCD images on CD-ROM. The CD's contained images of M31 taken on 16 nights, from September 1995 to November 1998. All were 10-minute exposures through a hydrogen alpha filter at 656.3 nm. The images were analyzed using a combination of two different software packages and computers: Scion Image Beta-3 on PC, and NIH Image 1.62 on Macintosh. Special macros written for both of these programs allowed for importing the FITS images, and determining magnitude and location by celestial coordinates.

In the search for nova each student received one of 16 subrasters. Each subraster was part of the original image of M31. In each subraster folder there was 16 epochs. Each epoch was the time that the pictures were taken. Approximately 40 students participated in searching for nova candidates by using software to stack the images and to "blink" them. Novae would appear in some images but not all. If seen in several images, their brightness would change from one image to the next.

A hydrogen alpha filter removes all but one specific wavelength of light for observing. Novae emit most of their light in this wavelength so the use of this filter makes it easier to detect them.

Once a possible nova was identified, its location was recorded using both the "x, y" pixel coordinates and a special macro that located the star by right ascension and declination.

The magnitudes of the novae were determined by using a special photometric macro routine and a set of "standard stars" for each subraster, supplied by the NOAO. The known magnitudes of these standard stars were entered, and the accuracy of the photometry was enhanced by using rescaling and aperture "sizing" routines. This proved to be the most complicated part of the project and most of this work was done by five people.

Rescaling the pixel range was a key consideration both in searching for novae and in getting the magnitude macro to perform properly. Images near the galaxy core, such as subrasters 6,7,10 and 11 were rescaled from 0-3000. Images at the edges of the galaxy were rescaled as small as 0-500. A rescale value of 0-2400 seemed to be a good place to begin.

For very faint novae, altering the star's effective aperture to "1-2-4" in the magnitude routines allowed the macro to be used to determine stars as faint as 17.6.

Controls and Error Analysis

Taking into consideration certain factors eliminated false nova candidates. One of the factors was weather. A bad weather field made it hard to tell if it was a nova or just a star that sometimes wasn't imaged. The edges of the pictures were also a factor when eliminating nova candidates. In some pictures there may have been jagged edges or missing data. One more thing that can also eliminate nova candidates is an artifact. When magnified, square or rectangular shapes indicate bad pixels in a CCD camera.

In scientific research it is important that one's data can be reproduced, proving that one's work was done with a high regard to precision. With this concern the Nova Search Team had to take some extensive measures to back up its findings. At least two students were assigned to each subraster with the duty of searching for novae. This led to the next step of comparing the results of students in the same subraster. This double check of data could result in a conflict, where a third person was then needed to recheck each student's claims. The rechecking of results was possible by the location of the nova's right ascension and declination.

Some additional debate concerned novae appearing in one picture, but gone in the next. The presence of a reoccurring nova takes a decade or longer, making it impossible to occur during this research project due to the time lapse of only a few years. This information allowed elimination of some of the suspected novae that repeatedly appeared and disappeared.

More than half of the nova candidates were seen only in one image. Due to the sporadic dates of the images, it is possible that the ones reported are novae, even though there is not enough data to develop a light curve.

The error for the novae magnitudes was determined by using the magnitude macro to calculate the magnitude of standard stars. At least two and usually three or four standard stars per image were checked. The largest deviation from known magnitude on each image was recorded as the "Image Error". Then the largest reported error range (by NOAO) of the standard stars from each image was referenced. This was recorded as the "SS (Standard Star) Error". These two errors were summed quadratically to create the "Combined Error" for each magnitude.

Data

The following chart shows all available data on each of the novae. Column 1 is the team designation for the nova discovered. The X and Y coordinate values reported are the numbers listed nearest the R.A. and Declination values in the dialog box- this clarification is necessary because the dialog box simultaneously shows two different sets of X,Y values.

Nova	Subraster	Epoch	Date UT	UT (h:m)	X	Y	RA	Dec	Magnitude
1	6	1	9/3/95	7:20	111	472	41:46	41:08:25	15.61
2	6	11	7/25/98	6:30	165	295	41:44	41:10:27	17.55
3	6	11	7/25/98	6:30	134	357	41:44	41:09:43	17.66
4	6	14	10/14/98	4:46	418	454	41:27	41:08:37	16.26
4	6	15	10/30/98	5:30	418	454	41:27	41:08:37	16.25
4	6	16	11/11/98	4:05	418	454	41:27	41:08:37	16.92
5	7	3	7/23/97	7:46	412	489	41:28	41:08:13	15.91
5	7	4	7/24/97	8:49	412	489	41:28	41:08:13	15.87
5	7	5	7/25/97	6:30	412	489	41:28	41:08:13	15.82
5	7	6	8/1/97	7:44	412	489	41:28	41:08:13	15.93
5	7	7	8/1/97	8:17	412	489	41:28	41:08:13	15.92
6	7	10	7/24/98	8:40	228	469	41:07	41:08:27	15.85
6	7	11	7/25/98	6:30	228	469	41:07	41:08:27	15.88
6	7	12	7/26/98	6:09	228	469	41:07	41:08:27	15.95
6	7	13	9/15/98	8:21	228	469	41:07	41:08:27	15.92
7	7	10	7/24/98	8:40	117	437	41:15	41:08:49	15.92
7	7	11	7/25/98	6:30	117	437	41:15	41:08:49	15.85
7	7	12	7/26/98	6:09	117	437	41:15	41:08:49	16.02
8	8	1	9/3/95	6:14	187	325	40:39	41:11:41	16.64
9	10	10	7/24/98	8:40	75	134	41:48	41:06:26	17.31
10	10	3	7/23/97	7:46	194	12	40:39	41:13:41	15.90
10	10	4	7/24/97	8:49	194	12	40:39	41:13:41	15.86
10	10	5	7/25/97	6:30	194	12	40:39	41:13:41	15.82
10	10	6	7/31/97	7:44	194	12	40:39	41:13:41	15.88
10	10	7	8/1/97	8:17	194	12	40:39	41:13:41	16.07
11	10	8	11/18/97	8:10	164	108	41:42	41:06:42	15.07

12	10	9	6/6/98	10:35	113	205	41:46	41:05:36	16.31
13	10	11	7/25/98	6:30	455	108	41:25	41:06:42	15.95
14	10	11	7/25/98	6:30	497	51	41:23	41:07:22	15.89
15	10	14	10/14/98	4:46	475	116	41:23	41:06:38	16.28
15	10	15	10/30/98	5:30	475	116	41:23	41:06:38	16.37
15	10	16	11/11/98	4:05	475	116	41:23	41:06:38	16.33
16	11	1	9/13/95	6:14	256	217	41:06	41:05:27	16.15
17	11	3	7/23/97	7:46	204	122	41:09	41:06:33	15.68
17	11	4	7/24/97	8:49	204	122	41:09	41:06:33	15.39
17	11	5	7/25/97	6:30	204	122	41:09	41:06:33	15.85
17	11	6	7/31/97	7:44	204	122	41:09	41:06:33	15.86
17	11	7	8/1/97	8:17	204	122	41:09	41:06:33	16.05
18	11	8	11/18/97	8:10	36	82	41:19	41:07:01	15.81
19	11	8	11/18/97	8:49	381	330	40:59	41:04:10	17.37
20	11	14	10/14/98	8:10	374	397	40:59	41:03:24	16.78
20	11	15	10/30/98	4:46	374	397	40:59	41:03:24	16.56
20	11	16	11/11/98	4:05	374	397	40:59	41:03:24	16.43
21	16	12	7/26/98	6:09	14	215	40:50	40:59:37	15.54
21	16	13	9/15/98	8:21	14	215	40:50	40:59:37	15.75
21	16	14	10/14/98	4:46	14	215	40:50	40:59:37	15.88
21	16	15	10/30/98	5:30	14	215	40:50	40:59:37	16.11
21	16	16	11/11/98	4:05	14	215	40:50	40:59:37	15.82

Analysis

Twenty-one nova candidates were located and verified on a total of forty-eight images. Nine of the 21 were identified on multiple images. Magnitudes were determined for each nova image, and light curves were calculated for the nine repeated novae, using Cricket Graph (figure 1). These were then analyzed by extrapolating the light curves to three magnitudes and/or 100 days past maximum light.

The light curves were tested and fit in the following way: Three different fits were tested: a first order polynomial (line), a second and a third order polynomial. The R^2 value for each calculated best fit equation was examined and the fit that gave the best correlation and a logical plot was chosen. A “logical plot” would approximate what would be typical of a nova- either a steady decline and/or rise or a fairly constant magnitude. Curves were rejected if, for example, they showed the nova brightening, then dimming, and then brightening again, even if that correlation was higher than other curve fits.

For all graphs, magnitudes were entered as negative values, so that brighter magnitudes appear as higher points. All magnitude values are actually positive.

The location and characteristics of each nova was noted, in order to develop a model for the typical nova observed. By definition, novae that fall by >3.0 magnitudes in less than 100 days are type NA or “fast” novae (Sterken and Jaschek 1996.) Type NB or NC novae decline more slowly. The decline of NC class nova is very slow, and the star’s light may be near maximum magnitude for years.

The following chart summarizes the findings of the team based on the above definitions. The Curve Fit shows P1 for a linear best fit and P2 for a second-order polynomial fit. The Correlation column shows the value for R^2.

Nova	Section	Epoch	Image Error	SS Error	Comb. Error	Fit Method	Fit Corr.	Nova Type
1	6	1	0.11	0.06	0.13			
2	6	11	0.37	0.06	0.37			
3	6	11	0.37	0.06	0.37			
4	6	14	0.22	0.06	0.23	P2	1.OOO	NA
4	6	15	0.22	0.06	0.23	P2	1.OOO	NA
4	6	16	0.22	0.06	0.23	P2	1.OOO	NA
5	7	3	0.17	0.09	0.19	P2	0.747	NA
5	7	4	0.17	0.09	0.19	P2	0.747	NA
5	7	5	0.17	0.09	0.19	P2	0.747	NA
5	7	6	0.17	0.09	0.19	P2	0.747	NA
5	7	7	0.17	0.09	0.19	P2	0.747	NA
6	7	10	0.10	0.09	0.13	P1	0.11O	NC
6	7	11	0.10	0.09	0.13	P1	0.11O	NC
6	7	12	0.10	0.09	0.13	P1	0.11O	NC
6	7	13	0.10	0.09	0.13	P2	1.OOO	NC
7	7	10	0.10	0.09	0.13	P2	1.OOO	NA

7	7	11	0.10	0.09	0.13	P2	1.OOO	NA
7	7	12	0.10	0.09	0.13	P2	1.OOO	NA
8	8	1	0.07	0.08	0.11			
9	10	10	0.17	0.11	0.20			
10	10	3	0.18	0.11	0.21	P3	1.OOO	NA
10	10	4	0.18	0.11	0.21	P2	0.847	NA
10	10	5	0.18	0.11	0.21	P2	0.847	NA
10	10	6	0.18	0.11	0.21	P2	0.847	NA
10	10	7	0.18	0.11	0.21	P2	0.847	NA
11	10	8	0.14	0.11	0.18			
12	10	9	0.17	0.11	0.20			
13	10	11	0.15	0.11	0.19			
14	10	11	0.09	0.11	0.14			
15	10	14	0.15	0.11	0.19	P1	0.386	NC
15	10	15	0.15	0.11	0.19	P1	0.386	NC
15	10	16	0.15	0.11	0.19	P1	0.386	NC
16	11	1	0.14	0.09	0.17			
17	11	3	0.24	0.09	0.26	P2	0.555	NA
17	11	4	0.24	0.09	0.26	P2	0.555	NA
17	11	5	0.24	0.09	0.26	P2	0.555	NA
17	11	6	0.24	0.09	0.26	P2	0.555	NA
17	11	7	0.24	0.09	0.26	P2	0.555	NA
18	11	8	0.18	0.09	0.20			
19	11	8	0.18	0.09	0.20			
20	11	14	0.14	0.09	0.17	P2	1.OOO	NB
20	11	15	0.14	0.09	0.17	P2	1.OOO	NB
20	11	16	0.14	0.09	0.17	P2	1.OOO	NB
21	16	12	0.20	0.10	0.22	P1	0.664	NB
21	16	13	0.20	0.10	0.22	P1	0.664	NB
21	16	14	0.20	0.10	0.22	P1	0.664	NB
21	16	15	0.20	0.10	0.22	P1	0.664	NB
21	16	16	0.20	0.10	0.22	P1	0.664	NB

The location of the 21 nova candidates was plotted on a mosaic of M31 images using PhotoShop. Each nova was plotted on a map of its subraster and then the images were transferred to the mosaic. Red dots represent solitary novae, while blue dots represent novae appearing in more than one field (figure 2).

Next, an image was generated that color-coded the repeating novae by type to analyze whether there was a relationship between type and location in the galaxy. Blue dots represent type NA novae, purple dots are type NB and red dots are type NC novae (figure 3).

Conclusions

The Nova Search research team discovered a total of 21 candidate novae, most in the high-density areas of the spiral arms of the Andromeda Galaxy. Of these, five were determined to be NA novae, two of type NB and two of type NC. The average magnitude of the novae was 16.46, and they ranged from 17.66 to 15.61.

By examining the locations of the novae, there is no obvious reason why they are distributed this way, other than to conclude that where there are more stars, there are likely to be more novae. However, all the fast (NA) novae tended to be located nearer the center, and the slowest (NC) ones were distributed farther away from the core.

Acknowledgments

The Nova Search team would like to thank the following people for their help with software or research issues: Joe Andreini, Jamie Elsila, Tom Gehringer, Larry Kendall and Travis Rector.

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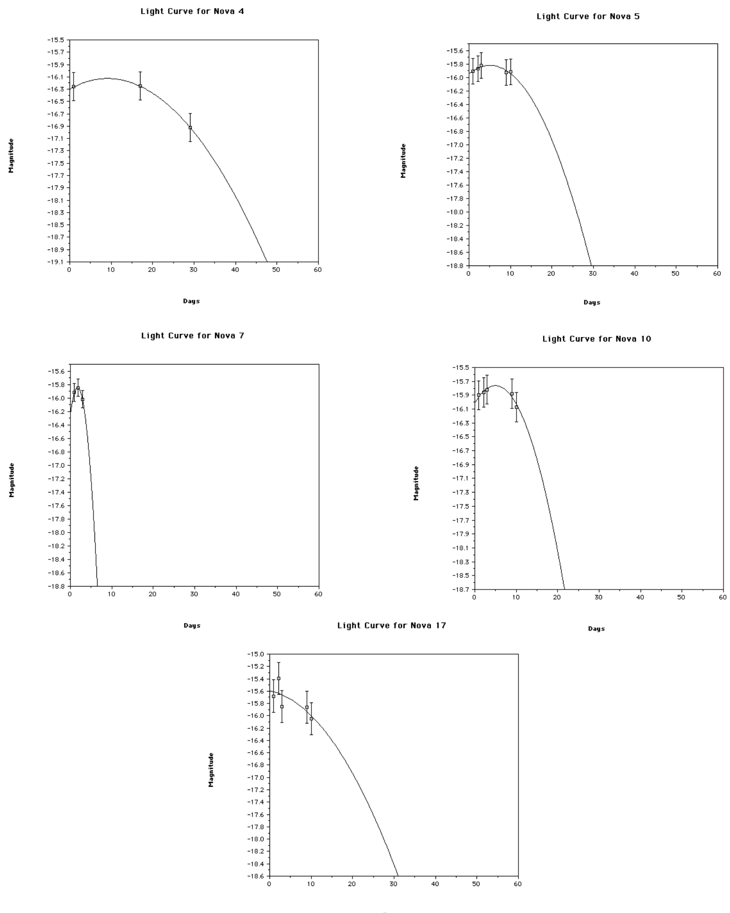
Scovil, Charles E., editor. The AAVSO Variable Star Atlas, 2nd edition. 1990.

Sterken, C. and Jaschek, C. Light Curves of Variable Stars. Cambridge University Press, 1996.

Figure 1:

Nova Light Curves - Type NA



Nova Light Curves - Type NB/NC

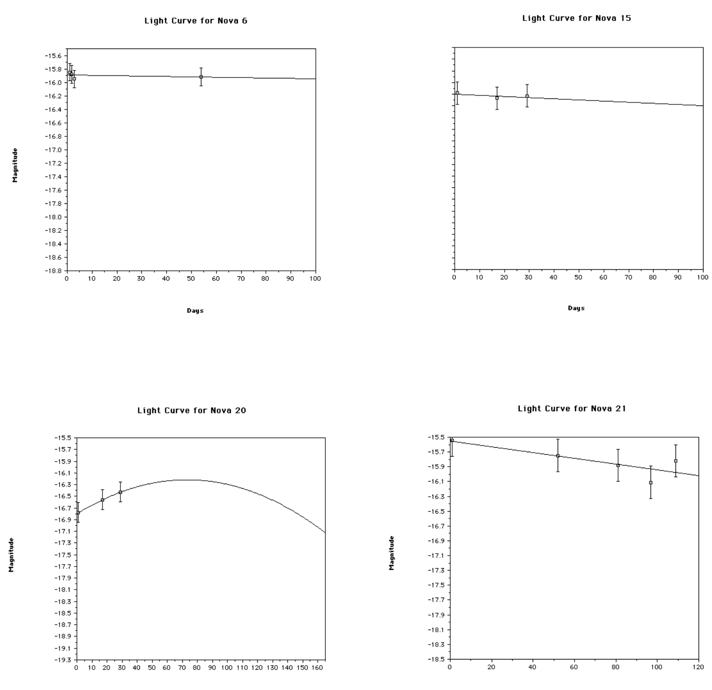


Figure 2:

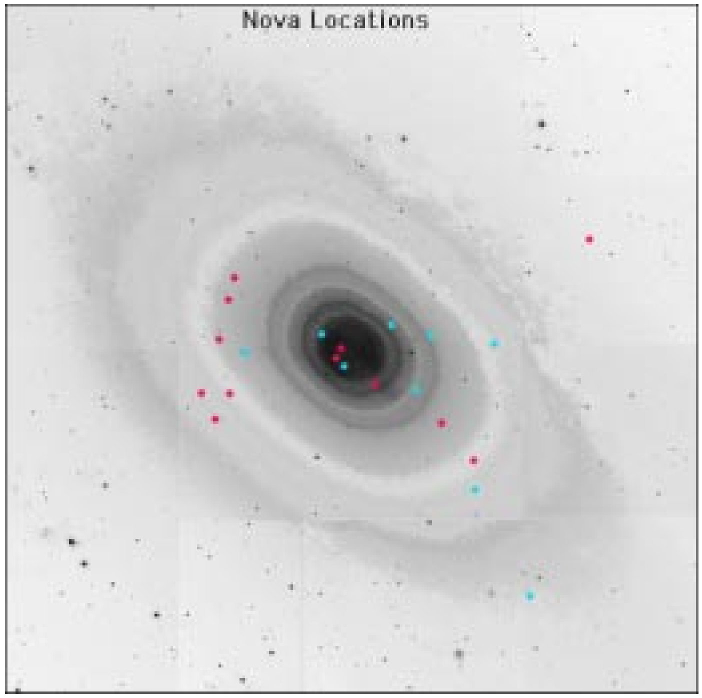
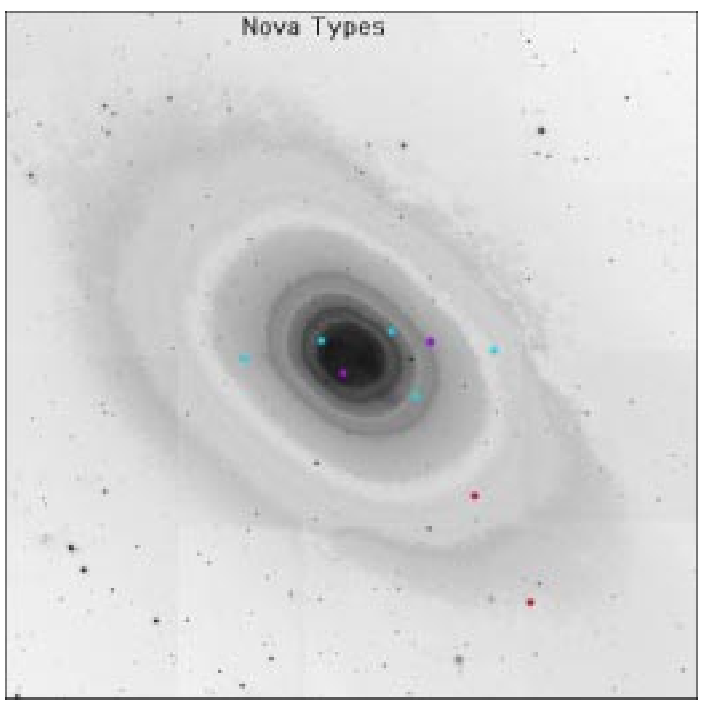


Figure 3:



Sunspots and the Ozone Layer

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Abstract

We studied whether there is a relationship between the thickness of ozone in the ozone layer and the number of sunspots on the sun. We tried to answer this question by comparing the sunspot indexes for several months in 1996 and 1998 to the amount of ozone in the Massachusetts atmosphere on the same days. Our data has shown that there is indeed a connection between ozone and sunspots.

Introduction

For this project, we studied the question of whether there is a relationship between the number of sunspots on the sun and the concentration of ozone in our atmosphere. We were interested in this question because we wanted to know just how the sun affects our earth. One of the most important natural pieces of "armor" for us is our ozone layer, and if sunspots affect it, it would have a major effect on all earth creatures. Because of this, and because we thought it would be relatively easy to get data which measures the ozone layer, we chose this topic.

This question **has** been studied before, and generally scientists believe there is a relationship. We wanted to verify this belief by looking at the raw data. We hypothesized that we would find a clear connection from the very beginning, based on research that had been done in the past about the chemical structure of ozone and how certain components are necessary for its creation.

Ozone, or O_3, is formed when an O_2 molecule bonds with an extra oxygen atom through exposure to ultraviolet radiation. It can also be created when hydrocarbons and nitrous oxides mix and are exposed to UV rays from the sun. In either case, the sun's ultraviolet energy is the most important component in this process. This relationship is proven.

Ultraviolet radiation comes from the sun and appears in greater quantities during the period of the sun's 11-year cycle that is the solar maximum. This solar maximum is when the sunspots on the sun are at a peak and the ultraviolet radiation is stronger. The most obvious of is the sunspot index, which can rise to extremely high levels during the maximum, but can fall to zero during the minimums. This, and other scientific research, seems to indicate that more sunspots create more ultraviolet radiation.

This argument convinced us of a connection, and we predicted that we would find a relationship based on this reasoning. Past research has, as we mentioned, shown this connection, and we hope to add to this research by supplying solid data to back up the theory.

Methods

To find a link between sunspots and ozone, we had to look at the two separately. At first we used experts' monthly average sunspot indexes, and compared them to an average of the Massachusetts ozone concentration of our own devising. However, when this failed to show a connection, we didn't think our averages were accurate. This was because the ozone averages were of only three days each month, and the sunspot averages were for every day, every month. We were also sure there would a connection, because of the past research. We had to reconsider the problem and approach it differently. The result was that we decided to study a day-to-day correspondence between sunspot index and ozone concentration.

First we found sunspot indexes for three days in each of several months in 1996, several months in 1997, and most of 1998. To find sunspot indexes we examined downloaded images with two computer programs called NIH Image and Scion Image. The images were compressed to fit in the computer's memory, and we had to decompress them with MacCompress software for the Macintosh computer or WinZip for the IBM computer before we could view them. We found the sunspot index by looking at the number of sunspots in the image and the number of sunspot groups. We counted the number of sunspot groups (we defined separate groups as being approximately twice the diameter of the earth or greater in distance away from each other), and multiplying by 10. We would then add to that the total number of sunspots visible in that image. Since all sunspots have centers which are significantly cooler that the rest of the spot, we decided that any spot with a visible center was a sunspot and not a speck. This process was tedious, but it gave a good estimate for the day's sunspot index.

To find the ozone concentration for a certain date, we had to use the Internet. After spending several days searching on our own, and having found nothing very useful, our teacher gave us a very good Web site which showed the ozone concentration anywhere in the world for any day from mid-1996 to early 1999. We began taking data from this site at Belmont High School's computer lab, where all the computers have Internet access. We finished getting our ozone data on our own over the next week-and-a-half.

The Internet was important for another major reason as well. It was where we turned to find a relationship between ozone and sunspots, and where we found the chemical connection discussed in the introduction. Without the Internet, this would have been a much harder and more inconvenient task, so it was a great help.

Once we had collected all of our data, we used several Windows 95 ™ ®© programs to process it and graph it. We also used a word processing program to produce the drafts and the final copy of this report. These programs were Microsoft Word 97, Microsoft Word 98, Microsoft Excel 97, and Microsoft Excel 98.

This research project was a long and complicated one, but we tried to use an organized process to make it easier to do and to understand.

Results

	1996	1998
Average ozone thickness in dobsons:	**294.9**	**314.0**
Average sunspot index:	**8.8**	**69.3**

Conclusion

From late July to December 1996, there was an average of 8.75 sunspots on the sun (figure 1). This is a relatively low figure, because 1996 was a period of time known as a solar minimum, when the number of sunspots on the sun is at a low point. During this period, the average thickness of the ozone layer was 294.875 Dobson Units, or about 3 millimeters. Interestingly, in 1998, the average number of sunspots on the sun was significantly higher, at 69.3. The average thickness of the ozone layer was also higher, at 314 Dobson Units. This increase in ozone that coincides with an increase in sunspots suggests that there is indeed a connection between sunspots and the ozone layer, and that our hypothesis was correct.

As you can see by looking at our graph (figure 2), many of the peaks in ozone thickness coincide with peaks in the sunspot index. In fact, out of the 14 ozone peaks, almost three fourths of them are at the same time as sunspot peaks (9 out of 14). This also supports our theory. However, when we compared low points on the graph, we found only 7 out of 15 ozone valleys match up with sunspot minimums. This is rather strange, but there still seems to be a connection.

There is more data that does not support our hypothesis, though. On April 30, 1998, when there were 37 sunspots on the sun, the ozone layer was 387 Dobson Units thick, while on May 31, 1998, when there were also 37 sunspots on the sun, the ozone layer was 337 Dobson Units thick. There are many cases of this throughout the data record, where there is a steady sunspot index but a changing ozone thickness. This does nothing to support our hypothesis.

As you can tell, there is data that supports our hypothesis, and data that does not. Regardless, we are still pretty certain that there is a connection between sunspots and the thickness of the ozone. This is because of our reasoning (see Introduction), which shows clearly that there is a relationship. So even though some of our data does not match up, we are still rather certain of a relationship.

We did have problems with this project. Most frustrating was the fact that the ozone layer is not an easy thing to find data about. Early on we decided that we would study the thickness of the ozone layer instead of the size of the ozone hole. This was because we understood that CFCs and other chemicals that deplete the ozone layer do more to affect the size of the ozone hole than to make the whole ozone layer thinner. However, finding **any** data, let alone the raw data that would be most useful to us, about the ozone was extremely difficult. What was most easily available was actually the data on ozone hole size that we had decided we would not use. In the end, with some help from Ms. Sanghavi, we did find a Web Site where we could, with a little work, find data on the thickness of the ozone layer. At this site, we had to look at pictures of the earth taken by a satellite and interpret the thickness of the ozone layer. This was not only difficult, but also tedious. We did get all the data we needed, but it was very time-consuming. Another simpler problem was graphing our data, or rather, making a computer to graph the data the way we wanted. We overcame this obstacle, too, with a little help from Michael's father.

Overall, this research project was very interesting, if not always fun. We did have our problems, and it was very tedious at times, but it was very informative and we learned a lot. If we were to do this project again in the future, we would change several elements. First, we would include a third data set in our project, namely the use of chemicals that deplete the ozone layer. This would make the whole data set more accurate. Another thing we would change is that we would take more extensive observations and records. For example, we would look at every day in a month as opposed to only three. A final thing we would change is that we would look at more years to get data, instead of only two. We would probably look at from 1979 to 1999 instead of 1996 and 1998. We would do things quite a bit differently if we were to do this project again.

So in conclusion, we learned a lot from this research, but we would do things rather differently if we were to do it again. This project was informative, and we hope we contributed useful information to the scientific community.

Figure 1:

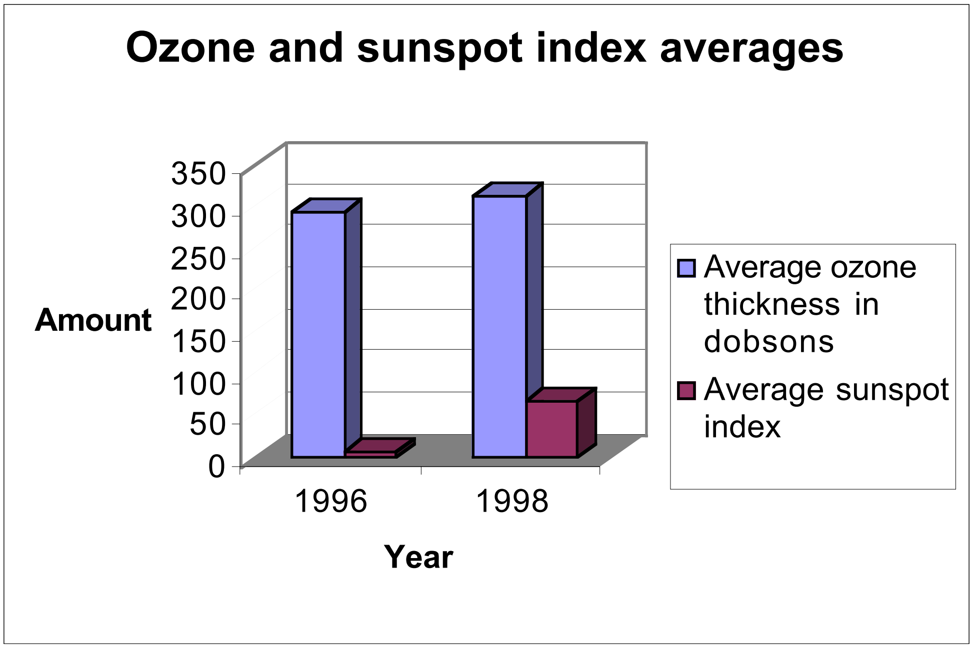
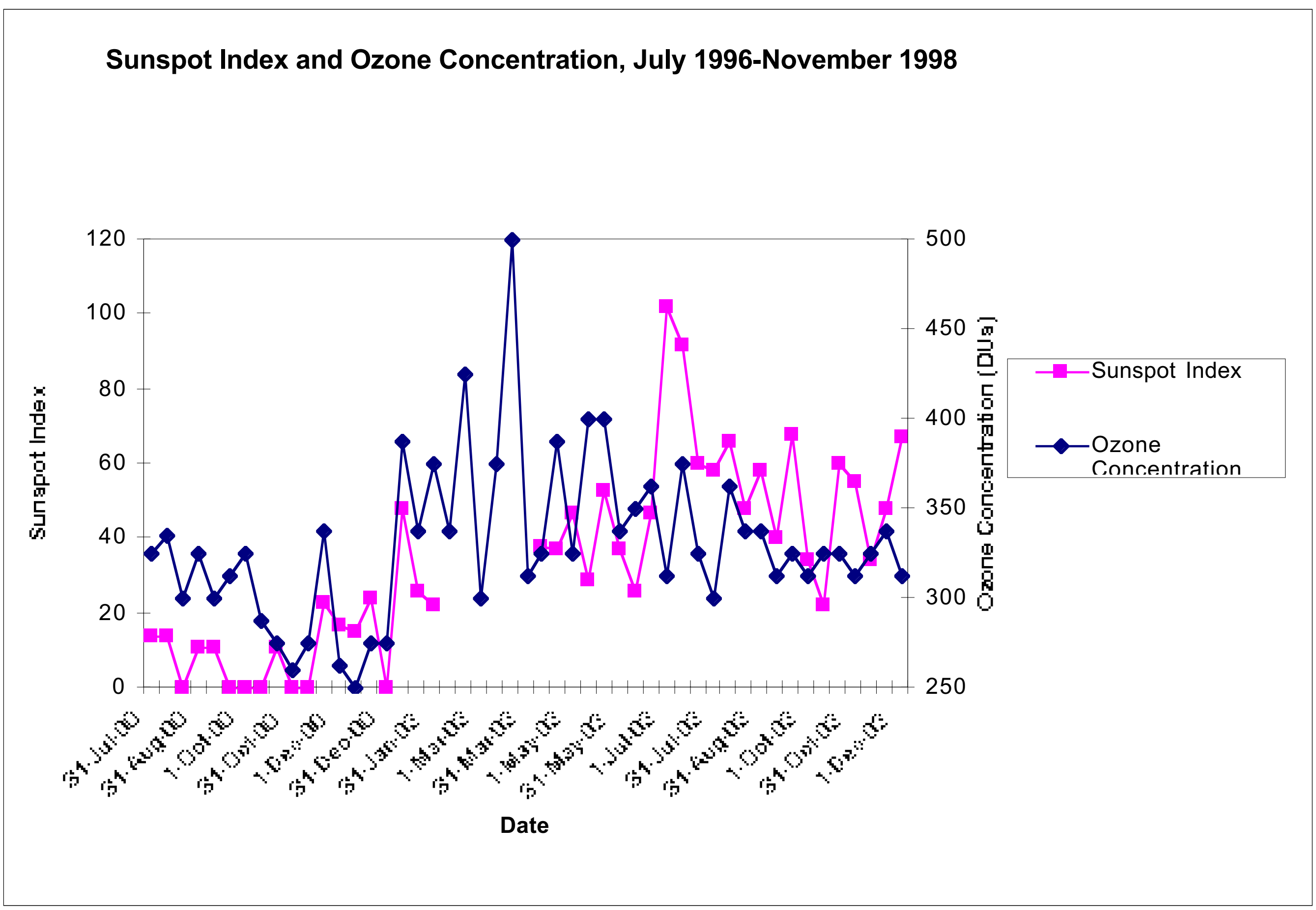


Figure 2:



How Do Sunspots Affect the Amount of UV Light?

Ed Caughlan
Project Sun SHINE, Grade 8
Eastchester Middle School
Teacher: Rick Donahue, RBSE '98

Overview

Project Sun SHINE is a three year research endeavor by the Eastchester Middle School. It shands for Students Help Investigate Nature in Eastchester. The leaders are Mr. Donahue and Mrs. Hugick. For this year and the next two years after that, the eighth graders in our school will study the sun in health, science, and computer technology classes. They study such factors as weather, sunspot count and area, visible light, and ultraviolet light. Equipment such as a program measuring sunspot area, sun sensors, weather equipment, and the Internet are used to collect this data. The results of the data are emailed to the NASA jet propulsion laboratory. It is the only such collaboration of students in the country. Project Sun SHINE recently won a Golden Apple Award as and outstanding project. The school will be awarded $20,000. The money will go towards a state of the art digital weather station. Hopefully this will allow the school to make important scientific discoveries and help the world.

Personal Experiences

I have played many roles in the project. In computer technology class I have tuned on the sun sensors connected to the computers. I had to boot up the computer, go into the program, and click the correct icon. It activated two line graphs on the screen that, throghout the day, tracked ultraviolet and visible light hitting our school. The other task I performed in computer class was collecting the morning weather. I would go to the weather station with my group member and collect air pressure and temperature, look out the window to determine cloud cover and precipitation, and go on the internet to find other information such as windspeed. In health class we had a general lesson on skin. We also went somewhat into UV light and its effects on skin. In science class we interpret the data from computer technology class. We sudy two factors each and make a graph. My group's factors were sunspot count and ultraviolet light. Another activity was to learn about the ingredients in sunblock and make a procedure to dedtermine which brand is most effective in blocking ultraviolet light. The procedure my other group and I made was to rub sunblock on the lens of a spectroscope and see if colors close to ultraviolet, such as purple and blue, could be blocked out. The culmination of my participation of this project is writing this abstract to sum it up.

Hypothesis

Because sunspots are weak spots on the sun, sunspots should hinder the sun's ability to make UV light.

Data

The data for one variable, the sunspot count, can be obtained via the Internet. Another variable, UV light, needs to be obtained via the sun sensors. Both data are needed over extended periods of time, which is any time between a few weeks and a few months.

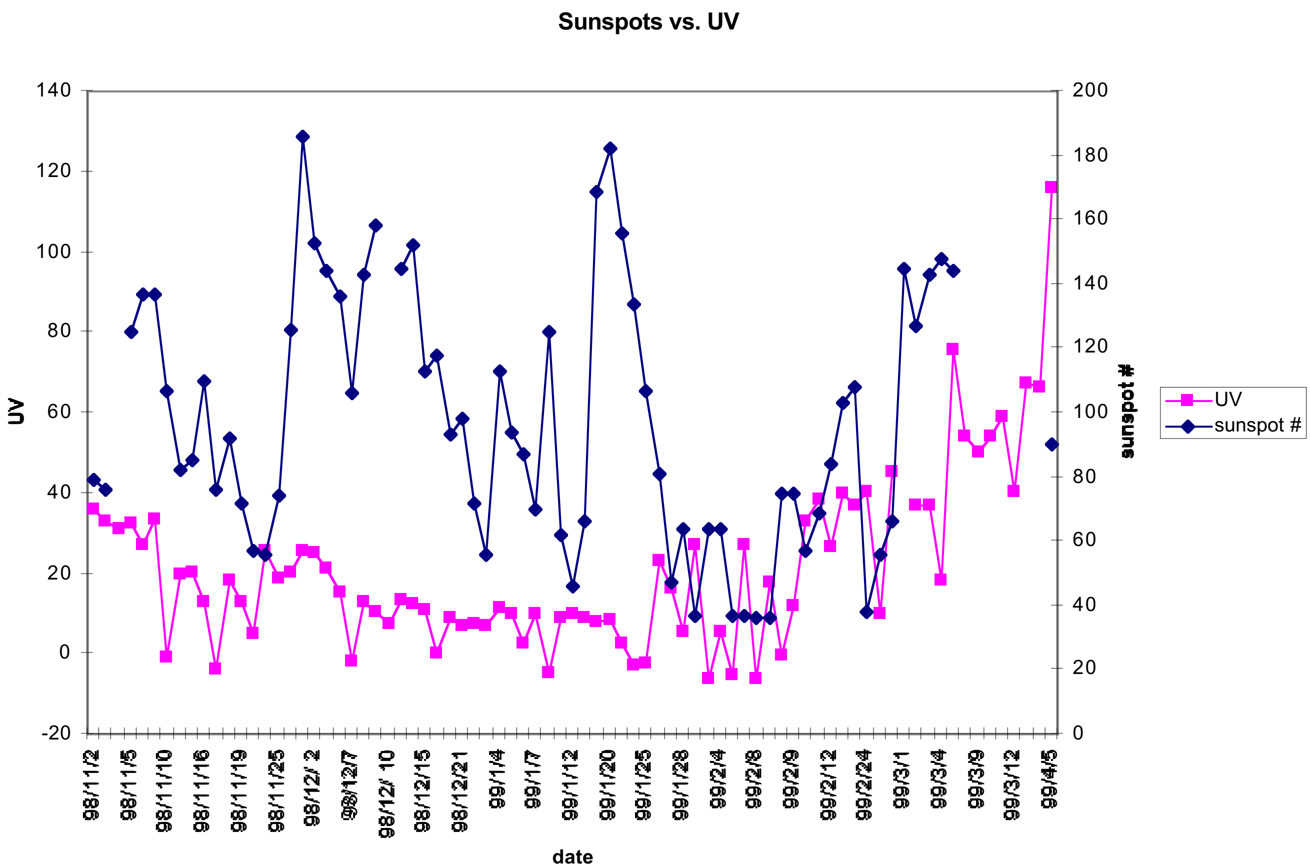
Conclusion

Although the lines of the graph do not match up completely, it appears that UV light and sunspot count have an inverse relationship (figure 1). As sunspots increase, UV light decreases. This is a very important solar discovery. As the 11-year sunspot cylce accelerates and weakens, UV light will weaken and accelerate. It is a good way to know when rates of skin cancer should be highest, and even when more outdoor events should be held. My hypothesis was correct. It is most likely for the same reason stated in my hypothesis, that the sunspots are weak spots on the sun that would hinder the UV light production. UV light was probably the most important factor studied, because it is a main cause of cancer.

Applications

Project Sun SHINE was an important and enriching experience for all students involved. We learned about scientific knowlege, such as UV light, the equipment we used, and skin types. We all collaborated on a single goal, often working in groups. We learned how to make scientific problems and hypothesises, and how to use the scientific method. We learned about variables and graphing with our data. This was also a way to learn how to do project like these. It was one of the most dynamic educational experiences given to the students of this school.

Figure 1:


Sunspots vs. UV
UV
sunspot #
date
UV
sunspot #
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98/11/5
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98/11/16
98/11/19
98/11/25
98/12/ 2
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99/1/28
99/2/4
99/2/8
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99/2/24
99/3/1
99/3/4
99/3/9
99/3/12
99/4/5

How Does Relative Humidity Affect Visible Light Levels?

Lindsey Elliott
Project Sun SHINE, Grade 8
Eastchester Middle School
Teacher: Rick Donahue, RBSE '98

Overview

Project SunSHINE is a program in which Eastchester Middle School works in partnership with NASAís Mission to Earth Program, Jet Propulsion Laboratory, and International Science Network. It is a multi-year project with the eighth grade students in many of their classes. Students collect, graph, and analyze weather data in science class, gather information about sunspot readings in computer, and learn the damages of sun exposure in health. The objectives are to study the changing amounts of ultraviolet and visible light in Eastchester and determine what causes these levels to vary throughout the year. The investigation will try to prove if they vary with sunspot activity or changing weather conditions.

Personal Experiences

I have been working with project SunSHINE throughout eighth grade. I worked together with many groups of students to gather and analyze the data and make inferences based on observations. In computer class we worked with images of the sun obtained on the computer to accurately measure the approximate area of these sunspot clusters. Using the known diameter of the sun and highlighting the spots, the computer used a certain scale to come up with a close number. I also worked in a group in science class accumulating data on weather relationships. Each month, I graphed and charted data on the relationship between relative humidity and visible light. We tried to figure out whether the relationship was inverse, direct, or constant and why. I also worked with sunscreens finding ways to safely test their effectiveness without the use of humans or lab animals. In an activity about skin types, we looked up our own skin type and decided how likely we each are to get skin diseases from the sun. In health class, we read articles that explain what the sun can do to your skin. We were able to come up with ways to prevent this damage.

Hypothesis

Relative humidity does affect visible light. They have an inverse relationship. As relative humidity increases that means that more clouds would be forming so the visible light will be less.

Data

The data for this scientific problem can be expressed using a double line graph to show the relationship. The data of visible light levels and relative humidity are both needed. See attached graph (figure 1).

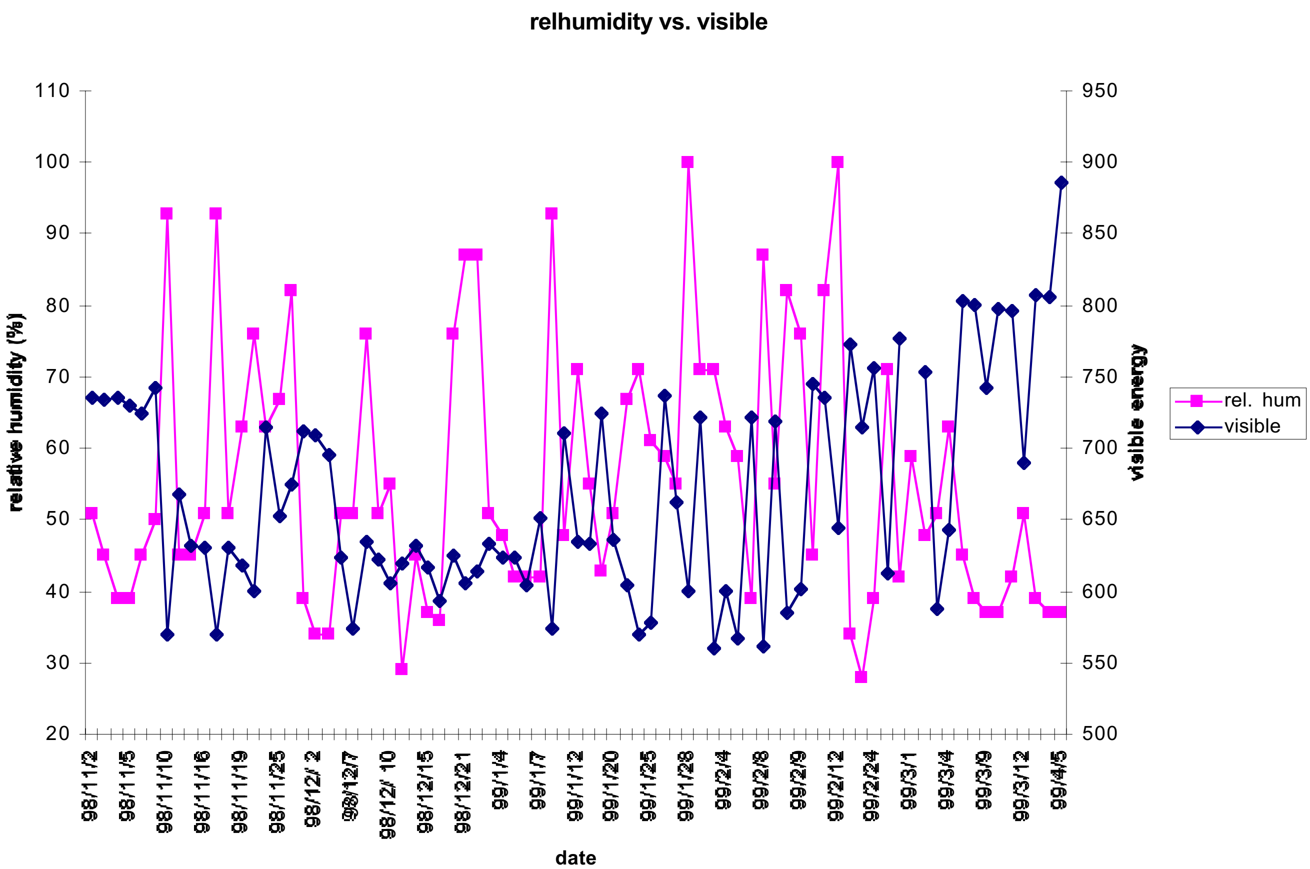
Conclusion

There is an inverse relationship between relative humidity and the amount of visible light that reaches the earth. As relative humidity increases, the visible light levels will decrease. This is true because if there is an increase in relative humidity it means that the atmosphere is holding a higher of amount water vapor compared to what it can hold. An increase in relative humidity occurs when the temperature becomes closer to dew point. When it lowers to dew point the air will rise and cause clouds to form. These clouds block visible light from reaching the earth during the day when the levels were recorded. Even though the sun is sending the same amount of light to earth, the levels are varying based on the weather because clouds block the light that is visible. The hypothesis was entirely correct the relationship is an inverse one. Every time the data was collected and graphed the correlation stayed the same because this rule never changes. Cloud cover always increases with relative humidity and clouds always block visible light.

Applications

I have learned many new vital research skills while working on Project SunSHINE. One of these skills is the collection of data for a long term project. Now I pick out only the necessary data from a data chart and graph just that information. I can read graph more efficiently and come up with more effective scientific conclusions base on what I read. I am also very good at determining the relationship that a graph shows Because this project involved a lot of group work, I can now work better as part of a team. I have most importantly learned about the sun. I know about my skin type as well as others and how they might decide whether or not I am very susceptible to sun damage. I now know how to protect my skin and eyes from the dangerous ultraviolet rays by wearing sunscreen, sunglasses, and avoiding the sun as much as possible on certain times of the day. From the report on the sun in computer I found out a lot about the layers of the sun and how big and hot each one is and about the sun as a star. I also learned of the vast amount of sunspots and how they cover an area extremely larger than earth.

Figure 1:



How Does Relative Humidity Affect the Amount of Visible Rays?

Lindsay Grubiak
Project Sun SHINE, Grade 8
Eastchester Middle School
Teacher: Rick Donahue, RBSE '98

Overview

Project SunSHINE stands for Students Help Investigate Nature in Eastchester. 175 eighth graders at EMS have been participating in an interdisciplinary solar research investigation this year with help from NASA's Mission to Earth program Project SUN and the International Science Network. This project was set up to attempt to answer the questions:

1. How do visible and ultraviolet light levels in this location vary throughout the school year?

2. How do visible and ultraviolet light levels correlate to daily weather conditions, if at all?

3. How do visible and ultraviolet light levels correlate to sunspot activity, if at all?

In various classes, the students were divided into teams for the purpose of gathering data, making hypotheses, interpreting data, and reporting the findings. The investigations will be continued in the following years.

Personal Experiences

This project involved the Computer Technology, Health, and Science classes. In Computer Technology I was part of the Sensor Activation Team. For two weeks every morning that I had Computer Technology class I turned on the sun sensors from the computer at exactly 8:15 am. I was also part of the Weather Team for two weeks. In the logbook I recorded the humidity, wind speed and direction, air temperature, air pressure and cloud cover and type from Yahoo Weather online. In Heath class we learned about how ultraviolet light can cause suntans and how too much light can cause skin cancer. We learned that you should always wear sunscreen SPF 15 or higher and to reapply. In Science class we learned about our skin types. We also split up into groups and picked a question to study.

Hypothesis

As relative humidity increases, the amount of visible rays decreases.

Data

For this question, relative humidity vs. visible light data was needed.

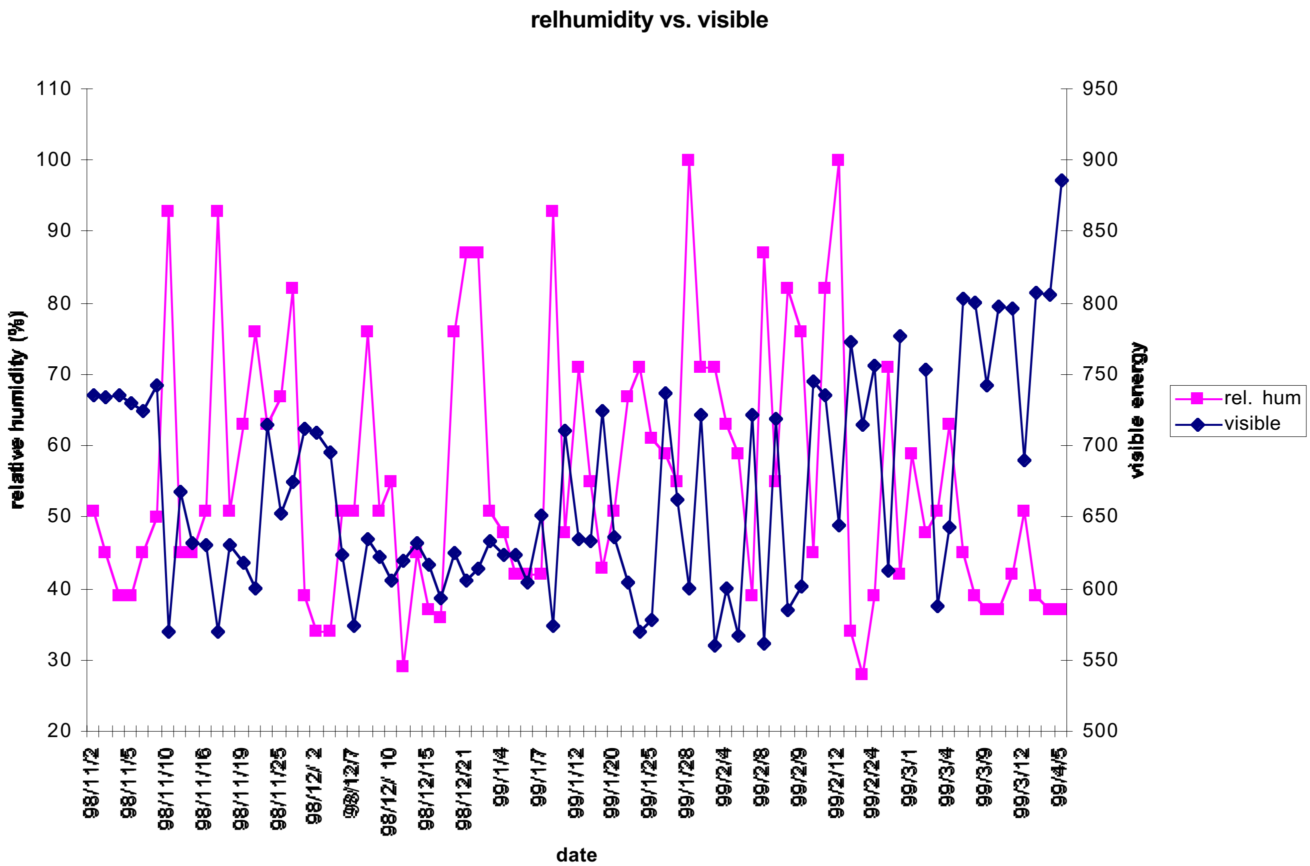
Conclusions

According to the graph (figure 1), in general, as the amount of relative humidity increases, the amount of visible light decreases. There is an inverse relationship. When the relative humidity is high the visible light is low, and when the amount of visible light is high the relative humidity is low. This proves that our original hypothesis was correct.

Applications

I learned that relative humidity has an inverse relationship with the amount of visible light. I learned how to collect and graph data. I learned how to work as a team to reach a common goal. I learned how to use the scientific method to organize. I learned that long term projects like this are a good learning process and take a lot of teamwork to happen. My skin type is number 3, which means that I burn moderately and gain an average tan. UV light is invisible and can not be easily detected without a scientific instrument. UV radiation is so powerful that it can penetrate clouds, mist and fog, so that you can get sunburn on a cloudy day. UV-B radiation is what affects human skin and it results in red skin and sunburns. The risk of skin cancer grows with every sunburn that you get. It is important to protect your skin for the first 18 years of your life because it reduces the risk of skin cancer by more than 50%. Staying in the shade does not provide complete protection from UV radiation. Some UV doesn't come directly from the sun. It is scattered by the atmosphere. UV is scattered by the atmosphere stronger than visible light. Heat is not connected to sunburn and you can get sunburned in the winter. Fresh snow reflects up to 80% of the sun's rays. I learned that the Sun's energy is very strong and without it life wouldn't be possible.

Figure 1:


relhumidity vs. visible
relative humidity (%)
visible energy
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rel. hum
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98/11/5
98/11/10
98/11/16
98/11/19
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98/12/ 10
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How will the Amount of UV Light that Hits Eastchester Affect the Relative Humidity?

Jeffrey Kauth
Project Sun SHINE, Grade 8
Eastchester Middle School
Teacher: Rick Donahue, RBSE '98

Overview

Throughout the 1998-99 school year, eight graders at Eastchester Middle School have been working with NASA to amass data about the sun. The students have collected amount of UV and visible light that hits Eastchester, sunspot area and number, and the daily weather conditions. Th objective of this project is to learn how the sun affect Eastchester, New York and to see how students can gather data that can help further research of the sun.

Personal Experiences

This year, I played a role in project SunSHINE. In computer technology class, I helped to calculate the sunspot area and sunspot number through the Internet and computer. In health class, we took many notes on the harmful UV rays. Mrs. Sokol taught the class about how sunburns from UV rays can lead to skin cancer. We also learned how to prevent UV rays from hitting out body. In science class with Mrs. Hugick, we did many labs on project sunshine. Groups were made and we picked two variables. We then made graphs of the two variables. In science class we also compared ingredients of sunscreens. We studied what ingredient blocks what ray. These activities are the way in which I participated in Project SunSHINE.

Hypothesis

I think that as UV light increases, relative humidity decreases.

Data

Two kinds of data are needed to reach a conclusion for the scientific problem. First, we must use the sensors outside Mr. Donahue's room to detect the amount of UV light that hits Eastchester. We must also use the weather station to gather the relative humidity each day. Using this data, we were able to put them together to answer our scientific problem (see figure 1).

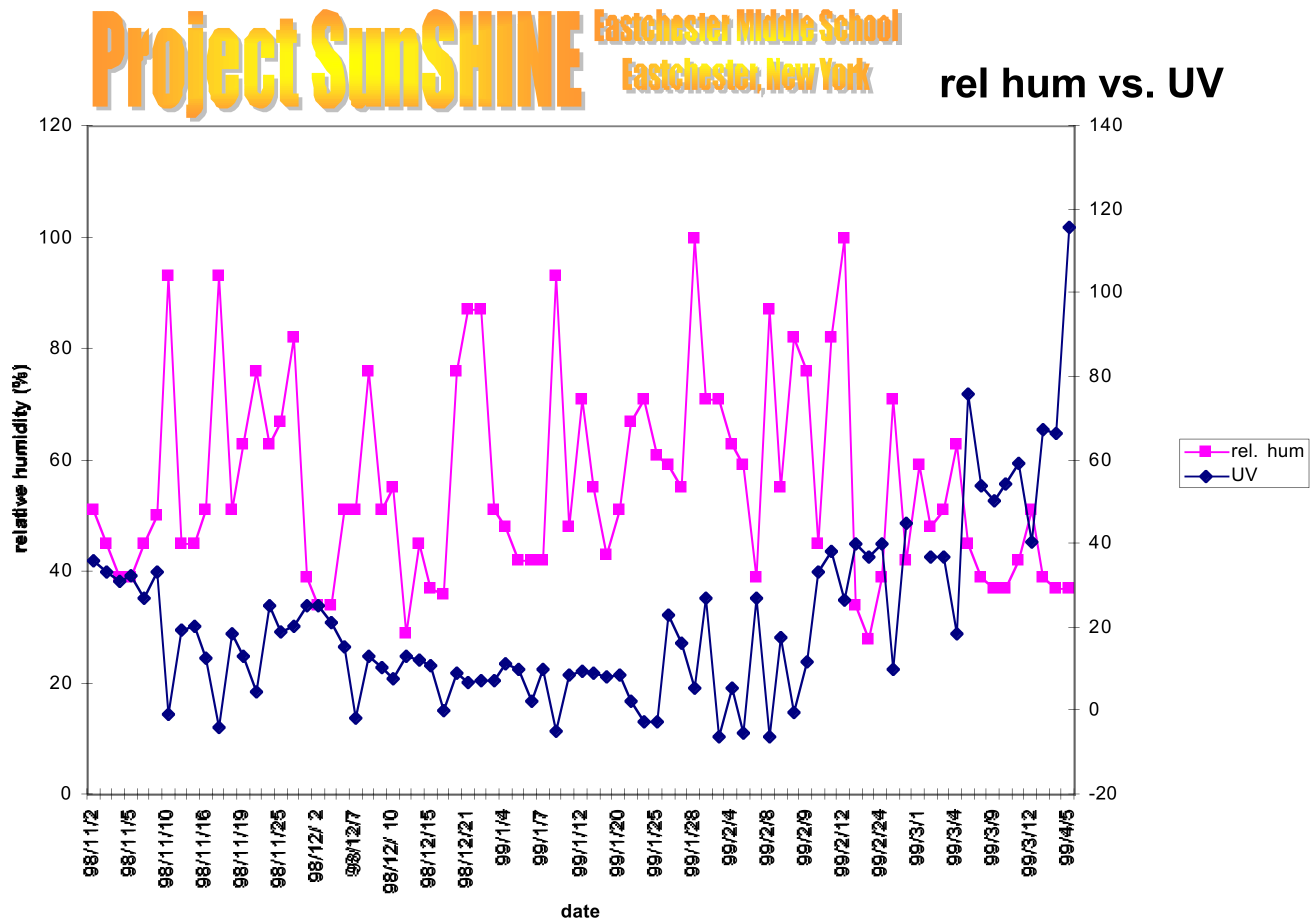
Conclusion

In conclusion, I have proved my hypothesis correct. As UV light increases relative humidity decreases. This creates an inverse relationship. The UV light must decrease the relative humidity by taking some of the moisture out of the air.

Applications

I have learned a large amount of information from Project SunSHINE. I have learned how to collect data over a long period of time using high-tech instruments. I have also become a better cooperative worker. For my own health, I have learned about powerful UV rays and how to protect my skin from them. I now know what ingredients I should look for when buying sun block. I have become more skillful on the computer in programs with graphing. I have learned a great deal about the sun itself. I was never familiar with sunspots on the sun until this project. Throughout this year I gained much information from Project SunSHINE.

Figure 1:



Project SunSHINE
Eastchester Middle School
Eastchester, New York
rel hum vs. UV
relative humidity (%)
date
rel. hum
UV
120
100
80
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20
0
140
120
100
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98/11/2
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99/2/12
99/2/24
99/3/1
99/3/4
99/3/9
99/3/12
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How does Relative Humidity Affect Visible Light?

Amanda Kosack
Project Sun SHINE, Grade 8
Eastchester Middle School
Teacher: Rick Donahue, RBSE '98

Overview

Project SunSHINE is a solar research investigation. Eastchester Middle School students have been involved in it for about one year. This project will continue for three years. This project hopes to answer some questions. Some questions include how visible and ultraviolet light levels differ throughout the year and if visible and ultraviolet levels affect the weather conditions of Eastchester. This project involves all the eighth graders from Science classes to Computer classes and even Health classes. The Science classes are involved with making graphs dealing with different variables. The Health classes deal with how ultraviolet light affects our skin. The data from Computer classes is sent to Dr. Gil Yanow of the Jet Propulsion Laboratory. He uses this data in his project dealing with light levels. The data is about the weather conditions of Eastchester and there is also solar data. This comes from the solar sensors which measure visible and ultraviolet light conditions. Overall Project SunSHINE is something that will go on for future years. It is a turning point in Eastchester's history. In future years students will look back on it and will be able to realize the effect it has on them. We could be starting a new breakthrough in the study of ultraviolet light and relative humidity.

Personal Experiences

The first experience that I had with Project SunSHINE was in Computer Technology class. Since I had this class first semester my class was one of few that started working on Project SunSHINE. I was involved in the weather team at 8:15 a.m. I recorded the weather for about two weeks. My job was to record the sky conditions, the temperature, and the wind speed. I used the Yahoo Weather website and the display panel outside the Computer Technology room. In Science class we developed a question that dealt with the data that was collaborated from the computer classes. I also wrote a journal entry dealing with the question that I was interested in. You will learn this question soon enough. I was able to develop a graph that showed the data relating to my question. We talked about Project SunSHINE all the time in Science class. We discussed the newest findings. This was very enthralling. These findings will help us determine the future. In health class we studied the effects of the Sun and UV rays on the skin. In Computer Technology class and Science class I got to work with data. This would always get me thinking about other questions that I would want to analyze.

Hypothesis

There is an inverse relationship between relative humidity and visible light. The greater the relative humidity the more clouds and the less visible light.

Data

The graph that was used to show how relative humidity affects visible light is attached (figure 1).

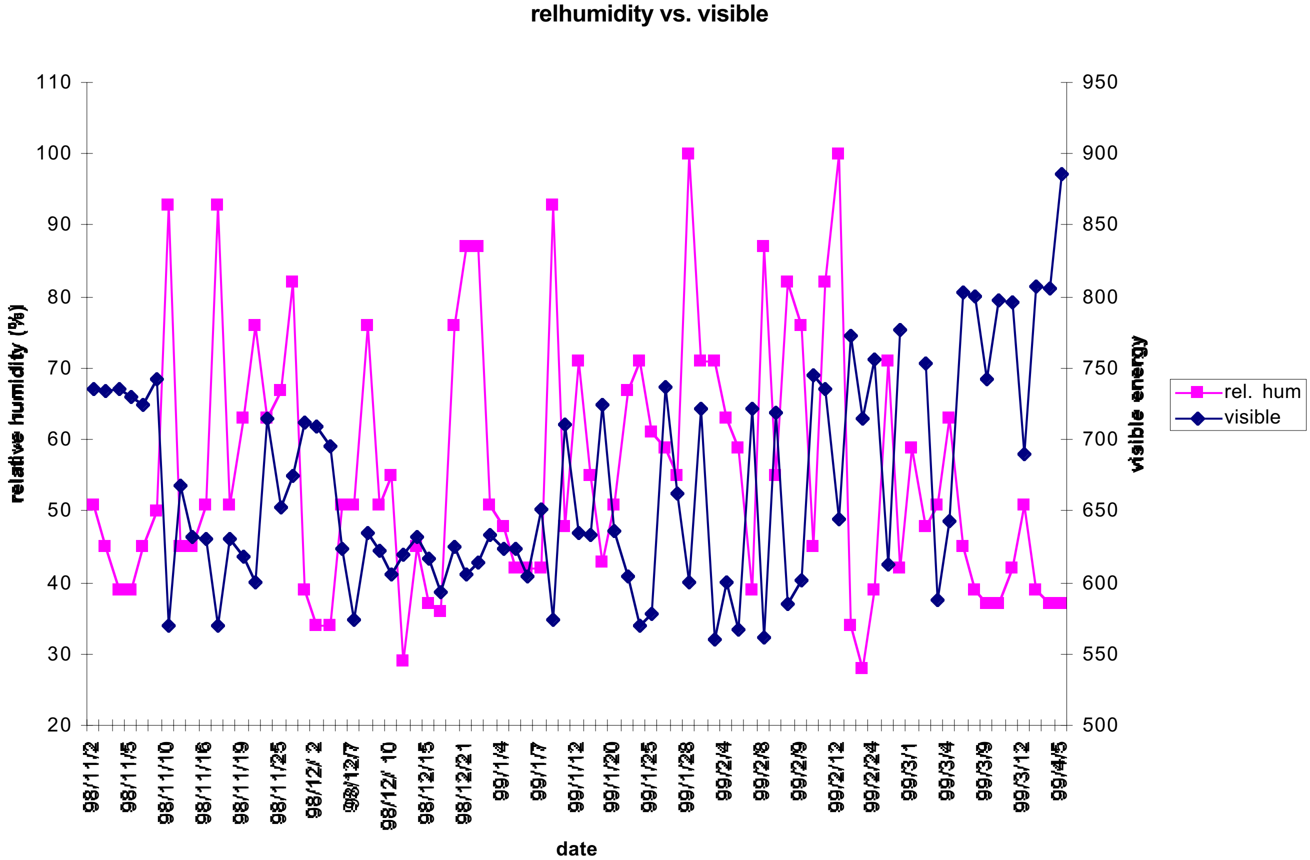
Conclusions

An inverse relationship exists between relative humidity and the amount of visible light. As the relative humidity increased the amount of visible light decreased and vice versa. The hypothesis was correct due in part to the fact that humidity increases the chance of cloud formation rises. The amount of visible light reaching the earth is low. On a clear day the opposite is true. It would be helpful if I would have dealt with the sky conditions each day to verify this relationship. Whenever I checked the data/graphs the relationship stayed the same.

Applications

I have learned a tremendous amount from Project SunSHINE. I have not only learned about relationships dealing with visible light, but also about long term projects and how interesting they are. They may take a long time but in the future the data results can be used successfully by future students. I will never forget Project SunSHINE because of all the time and effort that I have committed to this project. We continually spoke about it in my science class and I was always intrigued with the results that we had collected. I was able to expand my knowledge about graphing and variable relationships such as between relative humidity and visible light. I also learned that ultraviolet light can have a dangerous effect on our skin. It can endanger us for life.

Figure 1:



Does Time Affect Ultraviolet Light Levels?

Gary Levine
Project Sun SHINE, Grade 8
Eastchester Middle School
Teacher: Rick Donahue, RBSE '98

Overview

The mission of Project SunSHINE is to conduct a multiyear experiment in order to gather information on our sun. In Project SunSHINE we hoped to answer numerous questions from the years of data that will be collected. Some of these questions are; how do visible and ultraviolet light levels in this location vary throughout the school year? How do visible and ultraviolet light levels correlate to daily weather conditions, if at all? How do visible and ultraviolet light levels correlate to sunspot activity, if at all? These questions will be investigated by the use of data, graphs and charts to learn as much as possible about our sun in Project SunSHINE.

Personal Experience

In Project SunSHINE I was involved in numerous parts of making what Project SunSHINE is today. In my Computer Technology class I participated in recording some of the numerous data like the weather conditions and amount of cloud cover in the sky at a particular time. Also at times I was responsible for turning on the data collectors and making sure that it ran for the first few minutes of a class. These various yet small tasks that each person did were very important in making Project SunSHINE what it is today. Other tasks that we did were in other classes besides computer technology were in our Health and Science classes. In Health class we learned the full effects of what ultraviolet rays can do to the skin when we do not pay attention to them. In our Science class we came up with a specific scientific question on Project SunSHINE. We took specific data that came from the data collectors and classified what we needed for our experiment and what we did not. Then by using the specific classified data we made a graph to show our data. From Project SunSHINE we were able to use the data and information in many other classes and circumstances.

Hypothesis

My hypothesis for the question, does time affect ultraviolet light levels is that as time increases the amount of ultraviolet light will increase on the earth.

Data

See figure 1.

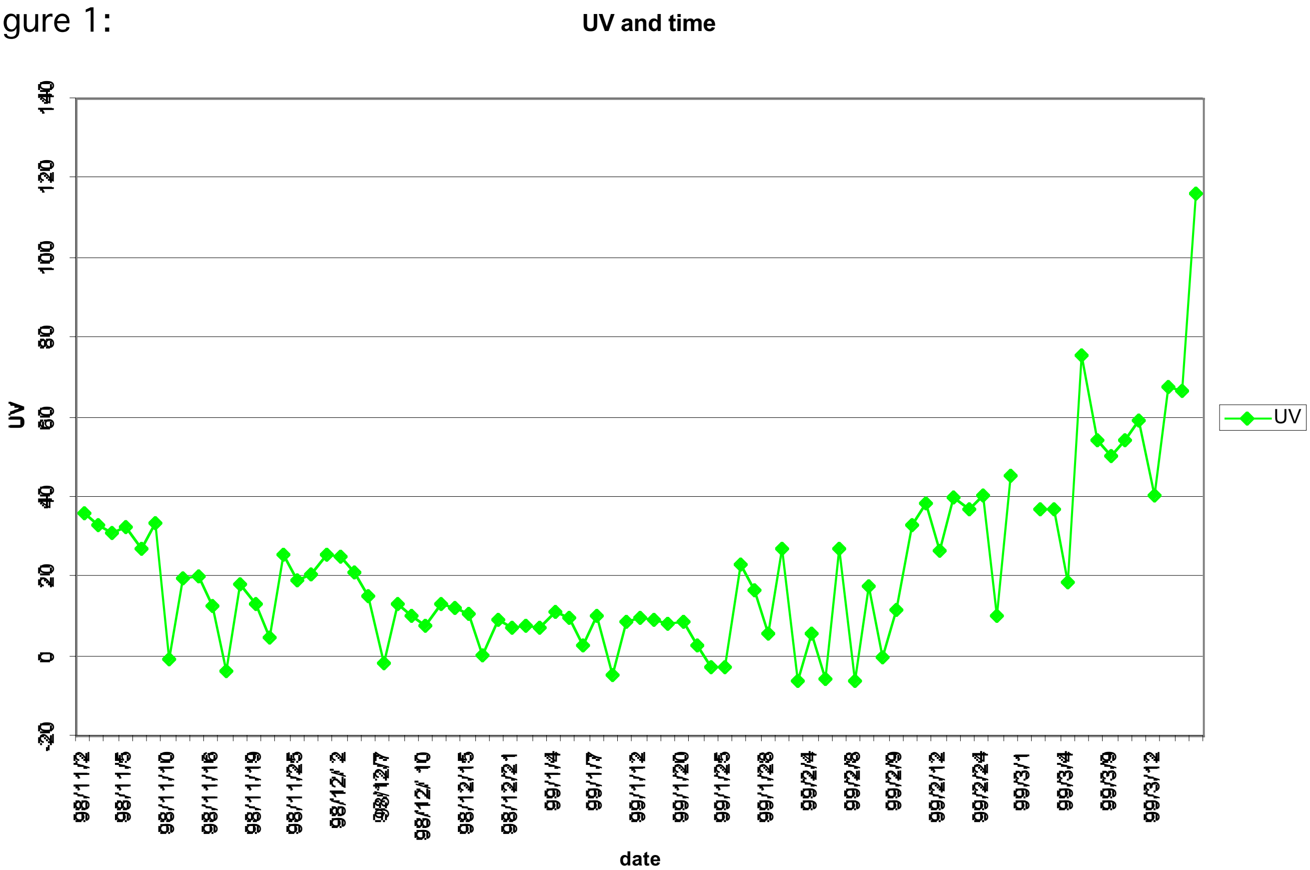
Conclusions

From the graph we were able to conclude that an increase in time had no affect on the amount of ultraviolet light. Although the ultraviolet gradually increased at times the ultraviolet light also decreased rapidly at times. It was concluded that it was not a direct relationship yet there was no relationship between time and the amount of ultraviolet light reaching the earth. My hypothesis though was wrong for there is no relationship between the ultraviolet light and time and in my hypothesis I predicted that there would be a direct relationship.

Applications

With this information there are many things that could be determined from this vital data. If our data was collected over a few years like Project SunSHINE is we would be able to make accurate assumptions of the relationship between time and ultraviolet light levels. With this data that we have collected in the past year a great number of things could be found. For the data in our specific scientific question it will be found whether or not ultraviolet light levels on the earth are increasing or if they are decreasing. This information is very important for us to figure out. From Project SunSHINE I have learned a great number of things. I have learned of sunspots, learned the full dangers of ultraviolet light, I have learned the proper use of sunscreen and what kinds are most effective in different areas. Also from this project I have learned the great effects of the sun: the numerous benefits of it and also the parts of the sun that we should be aware of in the near future. I have learned a great deal of information not just only about the full effects of the sun and sunspots but about teamwork and cooperation. Another important part of Project SunSHINE that I have learned something from is to go onto a computer and research a topic or topics. I have also learned how to make a graph on a computer with an appropriate scale. From Project SunSHINE I have learned a great deal of information and numerous things.

Figure 1:



How is Visible Light Affected by a Change in Date?

Joseph Marutollo
Project Sun SHINE, Grade 8
Eastchester Middle School
Teacher: Rick Donahue, RBSE '98

Overview

There are three major issues that one must confront for this project. The first deals with determining how visible and ultraviolet light levels vary in the town of Eastchester throughout the year. Secondly, it must be understood how visible and ultraviolet light levels correlate with weather conditions. Finally, it will be determined how visible and ultraviolet light levels are effected by sunspot activity. Ultimately, awareness about harmful rays can be raised.

Personal Experiences

I played many roles in Project SunSHINE. In computer technology class, I wrote a report about the heat index and sunspots, helped to activate solar sensors, and downloaded weather conditions off of the internet. Other classes contributed to my knowledge. In health class, I learned the medical effects of ultraviolet rays and some helpful UV protection tips. In earth science I worked on a sunshine lab for almost the entire school year with Gary Levine and Matt Romano. We studied graphs, charts and information reports about UV rays and the Sun.

Hypothesis

We intend to prove that from November to June, the presence of visible light will either increase or decrease based on the time of year.

Data

For our data, please see our attached graph (figure 1).

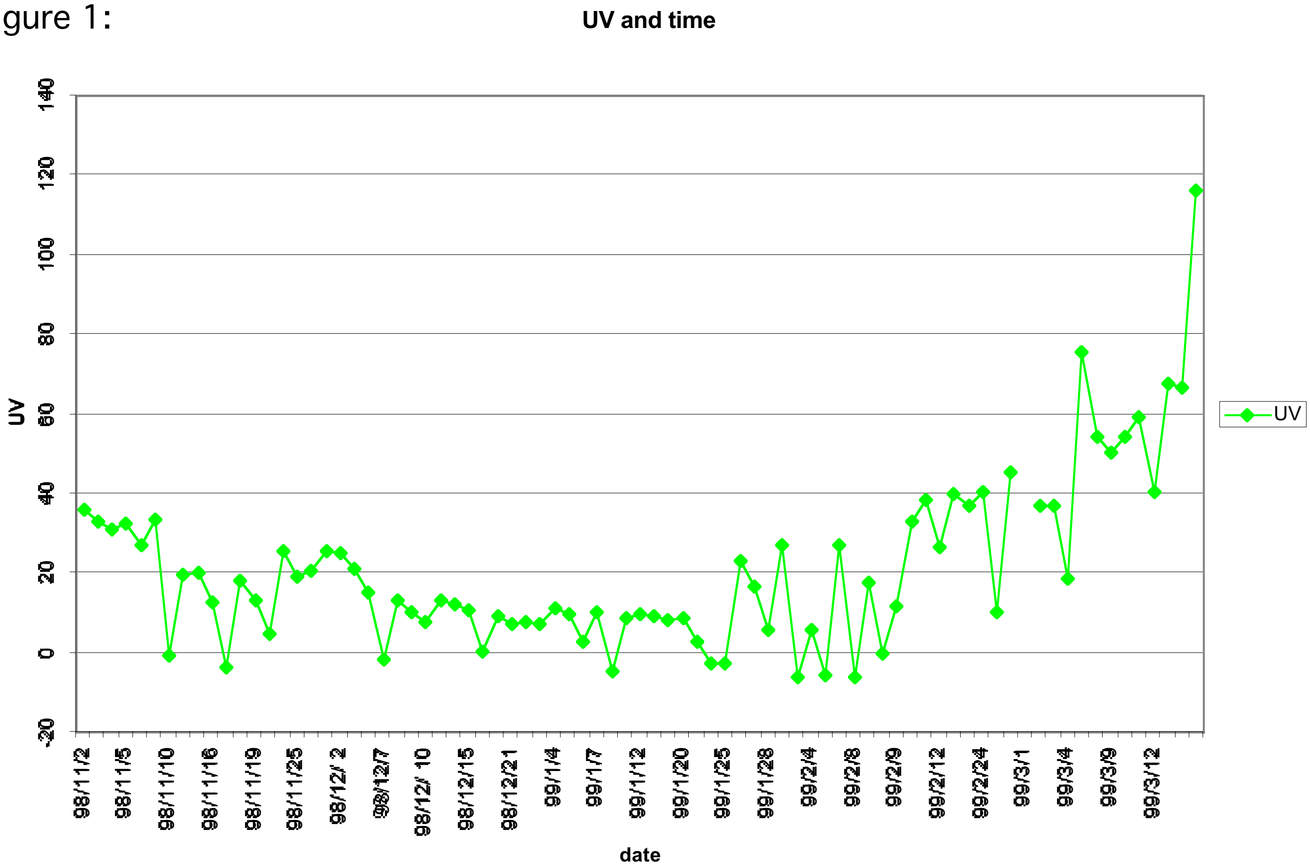
Conclusions

Based on our research, data and graphs, we can say that our hypothesis was proven correct. From November through December, the amount of sunlight per day was steadily decreasing. After December 21 however, the amount of daylight suddenly began to increase. It was steadily increasing for every day from December 21 to the day we stopped recording. Thus, our hypothesis seems correct in that the date effects the amount of sunlight. However, the problem which we intended to answer cannot be completely answered through this experiment. Based on research and personal experience the amount of daylight for our latitude does not steadily increase but rather should hit a maximum and begin to decrease. We feel safe in saying that after approximately June 21, the amount of visible light should begin to decrease. Thus the duration of insolation is linked directly to the time of year.

Applications

I learned quite a bit from Project SunSHINE both through my project and through what others were doing. I learned more about the duration of visible light. In other ways, I learned about the harmful effects of ultraviolet light and how to prevent the drastic effects of such rays with proper sunscreen and sunglasses. I also learned many practical applications such as using the internet to obtain weather forecasts and data, to activate solar sensors and to receive information in general. I continued to improve upon performing proper experiments, forming problems and logical hypotheses. Gary, Matt and I saw how cooperation can lead to good results. For the future, it would be interesting to continue our insolation duration project to see if theory matches with practical observation. I learned how powerful a star the Sun actually is and the great benefits that remain virtually untapped, such as solar energy. Overall, I feel this project was a success. I learned to appreciate the Sun for its strength and usefulness and also learned to be wary of the Sun and to think before stepping out into its blazing rays unprotected.

Figure 1:



How does Relative Humidity Affect Visible Light?

Elizabeth Pollice
Project Sun SHINE, Grade 8
Eastchester Middle School
Teacher: Rick Donahue, RBSE '98

Overview

Overview of Project SunSHINE: The mission of this school wide project was to get the kids involved with studying and learning about the sun and the way it works. For half of the year we tracked the sunspots on the sun in our computer classes and at other times we worked in our science classes recording and organizing the data collected. There were many different things for each student to do. Some activated sun censors while others took weather readings from the Internet.

Personal Experiences

During the times that I worked with Project SunSHINE I completed various activities. In my computer classes I first worked with activating the sun censors. This was not a difficult job except for making sure it was done at the right time each day, so that the data would not be messed up. After that I worked with a partner in class to collect weather data. This was a little bit more complicated and had more steps to follow. Each morning that we had class we had to record the temperature, relative humidity, wind speed and direction, what type of clouds were in the sky and about what percent of the sky was covered. Once computer class ended, I started to do other work in science. Working in a group of three we came up with a scientific problem statement and collected data to try to prove our hypothesis. Once the data was collected we worked to formulate a graph which would demonstrate our results and show them in a clear and organized fashion.

Hypothesis

I thought that the greater the percentage of relative humidity, the less visible light. I believed this because usually when the humidity is highest the weather is very cloudy and muggy and there is not a lot of sunshine or visible light.

Data

See attached graph (figure 1) for data and results.

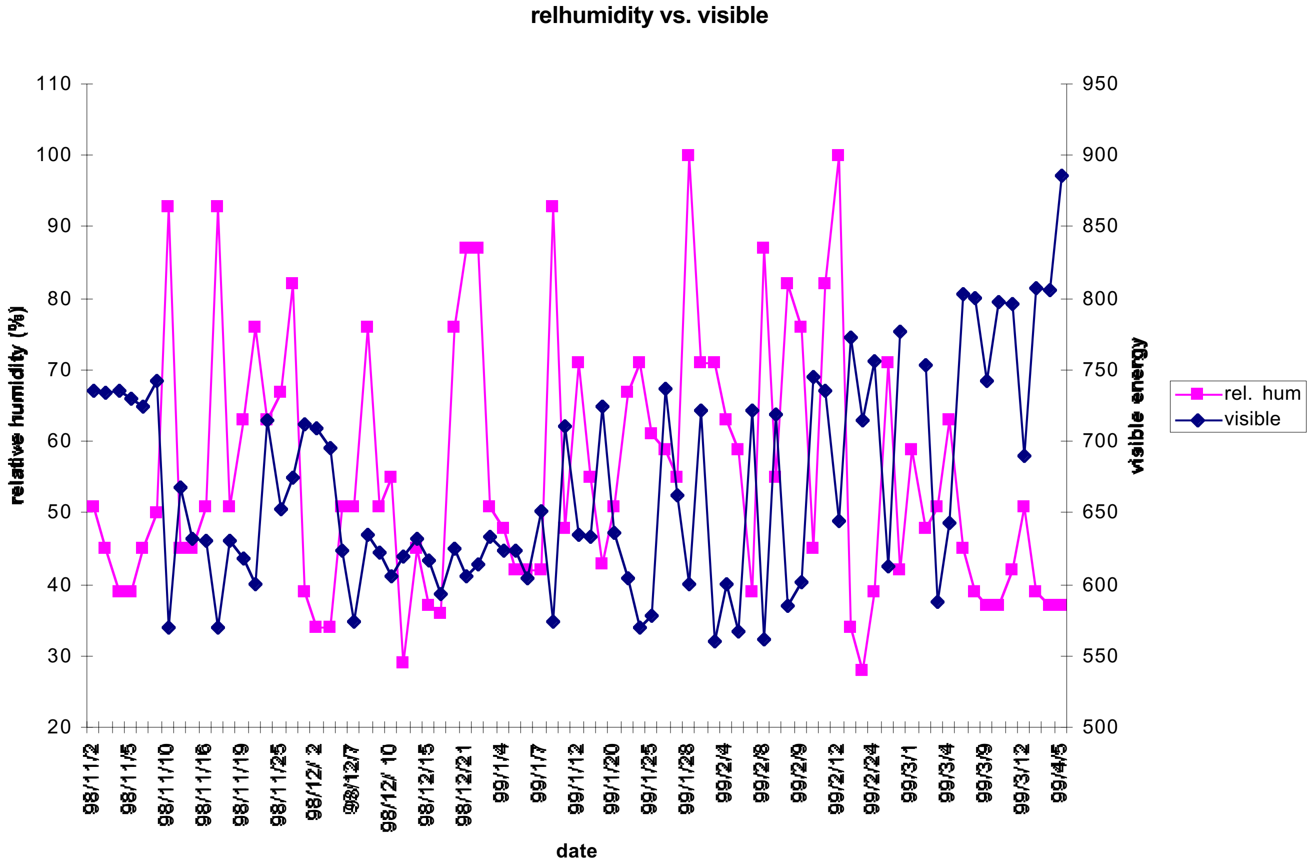
Conclusion

In conclusion, as relative humidity increases, visible light decreases. This proves my hypothesis to be right and these variables have an inverse relationship. The graph shows this because when the lines for relative humidity are up, the lines for visible light are down.

Applications

From doing this project I have learned a great deal. I have learned that the sun is much more complex then I ever thought. There is so much going on, on the sun that no one ever knows about until they study it very closely. I also learned about the effects of sunscreen. I learned that you should always wear sunscreen even if you are just going to be out in the sun for a little while, and that the sun's rays are very dangerous and can cause cancer if you don't have protection. We learned about UV rays and how extremely harmful they are. There was a lot of interesting information I had never seen before, and now I am much more careful when I go out into the sun. Skin cancer runs in my family so now, whenever I go out I remind myself to take the extra five minutes and apply a little sunblock. It might be a pain but I'm sure I'll appreciate it when I grow up.

Figure 1:



relhumidity vs. visible
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How does Relative Humidity Affect Visible Light?

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Overview

Project SunSHINE stands for Students Help Investigate Nature in Eastchester. In project SunSHINE, the eight graders at Eastchester Middle School performed a research investigation about the sun. EMS worked with NASA's Jet Propulsion Laboratory. The purpose of this investigation is to answer questions involving the sun and the UV light levels it gives off.

Personal Experiences

In project SunSHINE all of the students worked on the project in Computer Technology, Health and Science. My specific role in Computer Technology was that for a period of one week I made measurements involving the project. In Health, my role was that in my class we had a discussion about the sun's harmful UV rays and how it can affect your health. In science class, we discussed the sun and also evaluated the data that was collected.

Scientific Problem

The scientific problem that I chose to investigate was: How do sunspots correlate with UV rays?

Hypothesis

The Hypothesis is that the relationship between the sunspots number and UV rays will be direct.

Data

See attached data (figure 1).

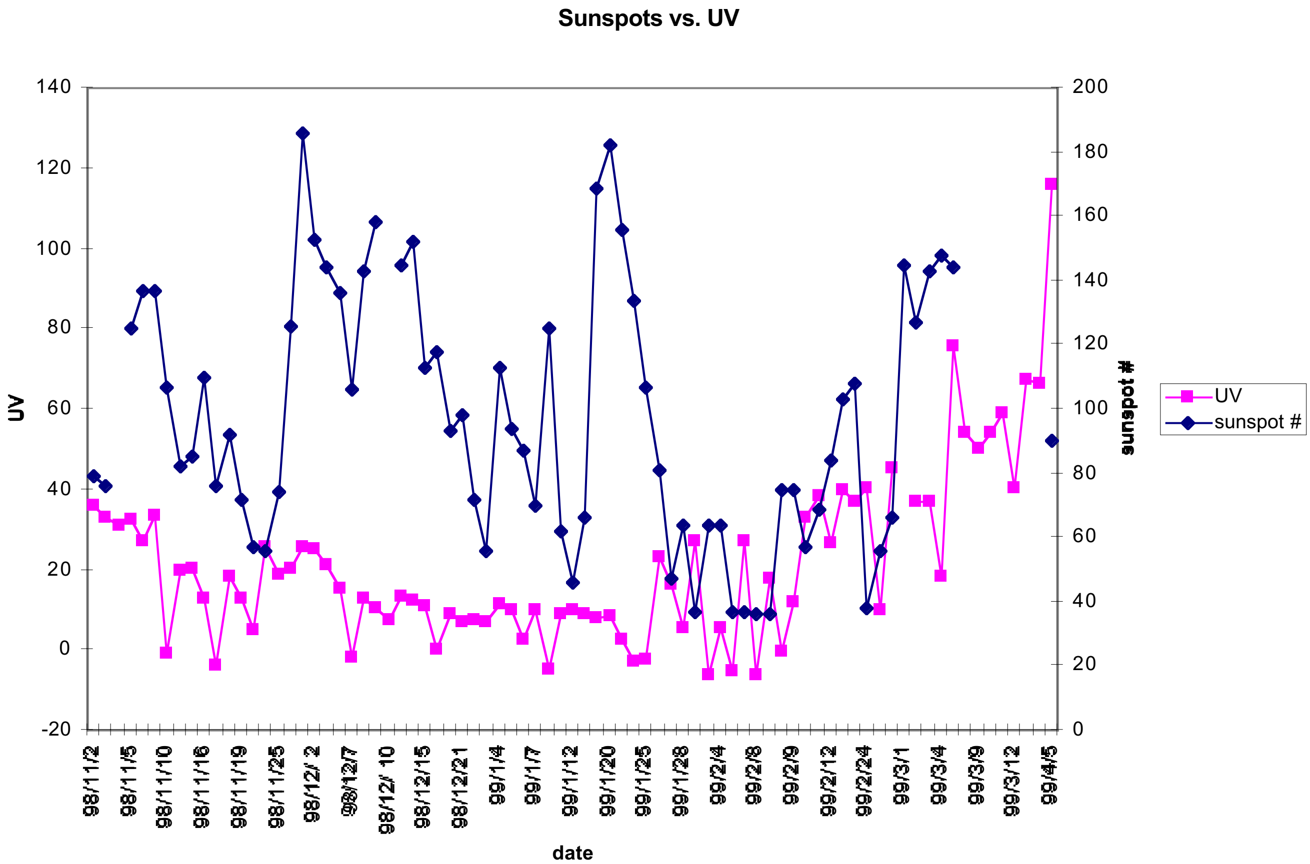
Conclusions

Based upon the data that had been collected, I have concluded that there is a direct relationship between the sunspot number and UV rays. I have also found that my original hypothesis was correct. The relationship between UV and sunspot number has been the same all year, so therefore this conclusion will most likely stay correct.

Applications

In project SunSHINE, I have learned many things. For the most part, I have learned about the sun and it's affect on the Earth and it's people. I have learned about skin type, skin protection, data collection, the scientific method and the sun in general. All of the knowledge I have learned can be applied to many things. The main thing that I can apply this knowledge to is by learning how to protect myself against harmful UV rays in order to prevent any skin diseases.

Figure 1:


Sunspots vs. UV
UV
sunspot #
date
140
120
100
80
60
40
20
0
-20
200
180
160
140
120
100
80
60
40
20
0
UV
sunspot #
98/11/2
98/11/5
98/11/10
98/11/16
98/11/19
98/11/25
98/12/ 2
98/12/7
98/12/ 10
98/12/15
98/12/21
99/1/4
99/1/7
99/1/12
99/1/20
99/1/25
99/1/28
99/2/4
99/2/8
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99/2/12
99/2/24
99/3/1
99/3/4
99/3/9
99/3/12
99/4/5