

A Student's Perspective on Building a Winning Science Fair Project

Katie Sloop

Tamke-Allan Observatory

Science Fairs

- Science fairs are the most in-depth school activity by which I have learned science
- Provide an ideal opportunity to work with and learn the scientific method, to use a variety of scientific instruments, and to meet and work with professional educators, scientists and engineers
- I've found that careful preparation, planning, and organization can lead to good science, a meaningful learning experience, and a winning project
(I have had four)

Middle School Science Successes



6th grade – “How Sweet Is It?”

A study of the sugar and moisture content of honey collected in East Tennessee

1st Place – St. Mary’s; Grand Champion – SASEF



7th Grade – “A Honey of a Question”

Identifying the floral sources of the E. TN fall honey crop

1st Place-St. Mary’s; Reserve Champion –SASEF;
Selected to the Final 40 of the DCYSC



8th Grade – “Tune Into This Station: A Solar Study at 20.1 MHz”

Discovered that solar radio emissions at 20.1 MHz are associated with phenomena that disrupt the surface of the sun

1st Place-St. Mary’s; Grand Champion - SASEF

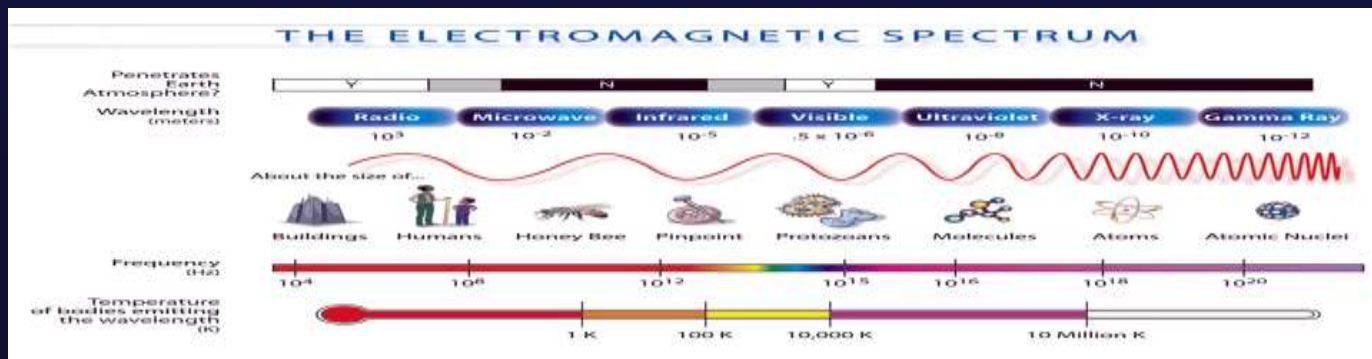
Selecting My Astronomy Project & Getting Started

- Wanted to do an astronomy project – our family were frequent visitors to the Tamke-Allan Observatory
- In my reading I had learned that solar output encompasses the entire electromagnetic spectrum – including radio waves
- NASA Radio Jove Project – receiver, antenna & software kits available for monitoring solar and Jupiter radio emissions
- Tamke-Allan Observatory already had such a system - contacted Dr. David Fields and began working on the TAO system while I ordered my own system & assembled it. Had to work through power reliability problems at TAO – finally got a back-up power system from Dr. Fields - powered by a battery from my Dad's truck



Background Research

- The energy output of the sun encompasses the entire electromagnetic spectrum from radio waves to gamma rays. The sun releases large amounts of energetic particles into space as well.
- Solar scientists have described a variety of solar radio emissions, each involving the movement of solar material from the sun into its corona and on into interplanetary space.



Defining the Project

- This study was undertaken to understand what solar phenomena are associated with the sun's low frequency radio emission seen at 20.1 MHz. Two automatic systems, one at the Tamke-Allen Observatory and one assembled at my home in Oak Ridge, were used to monitor and record solar radio output.
- It was necessary to monitor surface-disrupting solar physical phenomena. For that reason I collected data from internet accessible data sources about the presence of sunspots, their surface area and magnetic complexity, x-ray flares, coronal mass ejections, and other solar events.



The Hypothesis

- The solar phenomena associated with the fluctuating radio emissions of the sun will be shown to be solar features that disrupt the sun's surface

Building My Home System



Identify and sort parts



Necessary tools for assembly



Checking resistor with multi-meter



Inspecting solder connections



Completed electronics

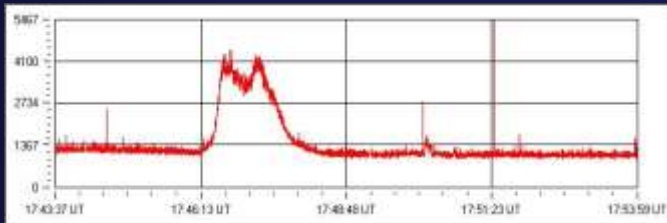


Fully assembled Jove Receiver

Bonus Learning Outcome: Reading schematics and assembling electronic components

The Data

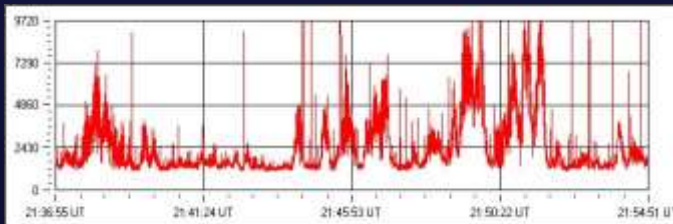
- Collected 319 radio signals over a 33 day period
 - 77 correlated by time with solar events
 - 196 tentatively identified as HAM radio and communications signals
 - 46 uncorrelated signals



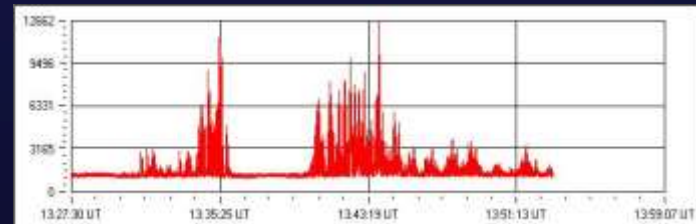
TAO-01.17.04



TAO-01.22.04



TAO-01.22.04



TAO-02.02.04

The Data

Master Data Table (partial)

Date (2004)	# of Sunspot Regions	Total Sunspot Area ^a	Sunspot Index ^b	# of Flares by X-Ray flux (total) ^c				# of Flares visible @ TAO				X-Ray Flare Index		# of Radio events	Total Time of radio events (minutes)	# of Coronal Mass Ejections ^d
				B	C	M	X	B	C	M	X	Day Total	TAO Total			
Jan 30	2	70	90	5	4			4	2			85.4	54.5	6	53	11
Jan 31	3	120	240	6	1			2				59.7	4.9	4	37	3
Feb 1	4	160	270	16	2			5				99	23.6	3	15	7
Feb 2	4	280	560	6	2			3				65.6	17.8	8	50	6
Feb 3	6	440	900	11	5			4	4			124.7	85.6	12	33	10
Feb 4	6	520	1170	8	1			7				167	33.2	4	16	11
Feb 5	5	440	880	6	2			2				60.6	7	7	29	8

^a Sunspot area is expressed as millionths of the solar hemisphere visible from the Earth.

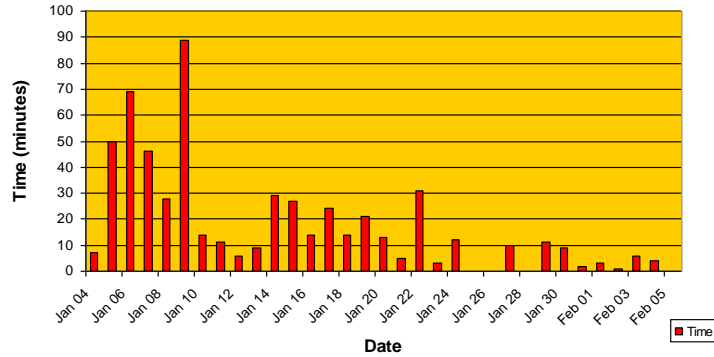
^b The magnetic classification of sunspots is alpha, beta, beta-gamma, and beta-gamma-delta. They are assigned a numerical value of 1, 2, 3, and 4 respectively. These values are then combined with the area to create a sunspot index.

^c Solar flares are classified according to their x-ray brightness. There are four (4) categories – B, C, M, and X, each of which has nine subdivisions (1-9). As the category ranking increases (B<C<M<X) the flare increases in power (W/m^2) by a factor of 10.

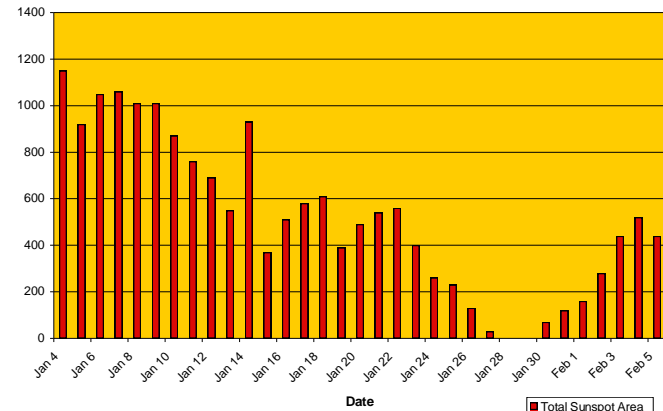
^d Coronal Mass Ejections are massive bursts of plasma that are ejected from the sun.

Solar Phenomena Data

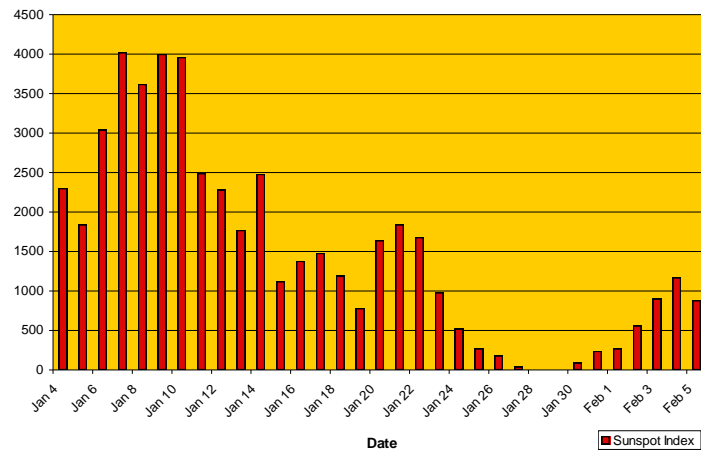
Daily Time of Solar-Related and Unknown Radio Events



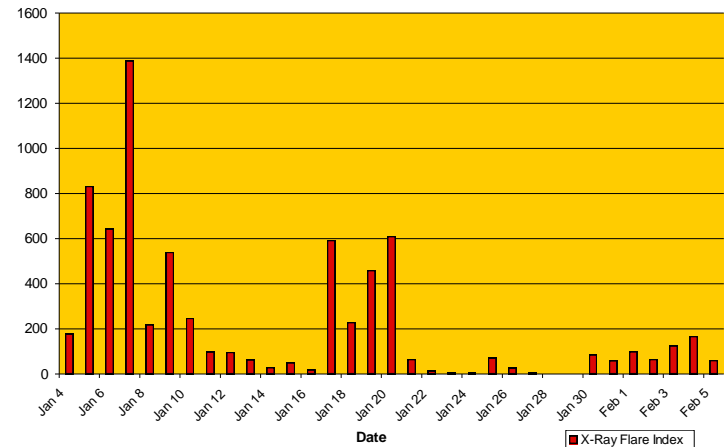
Total Daily Sunspot Area



Daily Sunspot Index

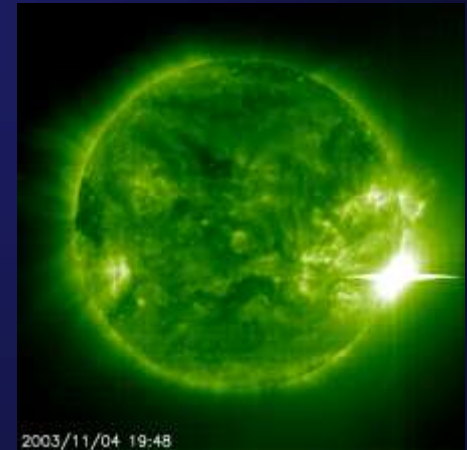


Daily X-Ray Flare Index



Data Correlated with Specific Solar Events

- Forty-eight signals occurred during x-ray flare events

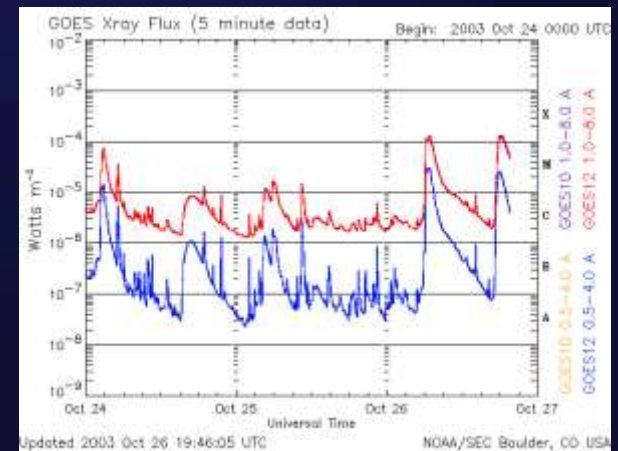
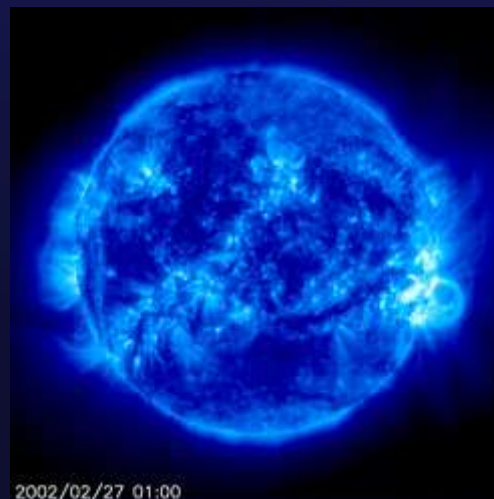


- Twenty-two events were related to streams of electrons moving into space as a consequence of coronal mass ejections



Statistics & Outcome

- Multiple regression analyses and one-way ANOVAs were applied to all data
- Statistical results indicated a significant relationship between the daily duration of radio signals, the total sunspot area and the spot's magnetic complexity. Furthermore, increases in x-ray flare output are related to increasing sunspot area and complexity.



Conclusions

- For a successful science fair project, extensive background reading is necessary
- The project needs to be based on the student's understanding of the topic and the available equipment and expertise that can be utilized
- Careful and thorough data collection and analysis yields scientifically sound results

Acknowledgements

- Tamke-Allan Observatory is an incredibly valuable public educational resource for persons of all ages, for engaging in both optical and radio astronomy
- As public school teachers, you might consider using TAO in support of your science programs

