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Does Solar Activity Affect Our Climate? by Bert Huneault

CAVEAT: I can state right off that this article will not definitively answer the above question, because the jury is still out on that relationship. However, we will explore possibilities and discuss promising developments.

Theories of climatic change

We all know that climate has changed drastically during the life of our planet. There have been very warm periods as well as ice ages. What caused these major changes? There are several possibilities:

1. Solar-activity cycles are one of them. There have been suggestions that climate is related to the appearance and disappearance of sunspots. Could these variations in solar output cause corresponding fluctuations in our climate?
2. Another possibility involves the size of the Earth's elliptical orbit around the Sun, as well as the tilt of the Earth's axis in relation to its orbit. These parameters slowly change over time. For example the orbital stretch goes through a cycle of about 95,000 years, and the axial tilt varies between 21.8 and 24.4 degrees over a 41,000-year cycle. Couldn't those cycles explain some of our climate variations in past eons?
3. How about the possibility of a volcanic eruption; or an asteroid or giant meteorite colliding with our planet, causing large amounts of ash and dust to increase the turbidity of the atmosphere, thus reducing insolation?
4. Another theory involves plate tectonics, i.e. the gradual movement of land masses over millions of years. Perhaps changes in climate take a long time, like the movement of continents. Might the redistribution of land and oceans be responsible for much of our planet's climate history?
5. And of course there's the current theory that recent global warming is due to human activity, i.e. the release of greenhouse gasses by burning fossil fuels. Even if that were so, how can we explain the Earth's warm cycles predating the Industrial Revolution?

Although all five of the above scenarios are quite interesting and worthy of further study, this article will only concentrate on the first one - - solar activity.

Is the Sun a variable star?

The prime source of the energy injected into our atmosphere is the Sun which is continually shedding part of its mass by radiating waves of electromagnetic energy and high-energy particles into space. But is this energy source constant?

Twenty-five years ago, astronomers and climatologists still did not have accurate data on the total amount of energy from the Sun that reaches the Earth's outermost atmosphere. But satellite measurements changed all that. Solar energy received at the top of the atmosphere on a surface perpendicular to the incoming radiation (for mean solar distance) is called the **solar constant** and is now known to be about 1,368 watts per square metre. Scientists know that only about 70% of this total irradiance is absorbed by the Earth and its atmosphere; the rest is reflected back into space. Interestingly, researchers have found that the "solar constant" doesn't remain constant after all, but varies slightly with sunspots and other activity such as solar flares.

The total solar irradiance varies just as regularly as the sunspot activity over the eleven-year solar cycle. Satellite measurements during the 1980s showed a small **decrease** in solar output as sunspot

(Continued on page 5)

In This Issue

Does Solar Activity Affect Our Climate?	Cover & Page 5
Calendar of Events / Maps / Submitting Articles / Membership	Page 2
Radio Waves and the Ionosphere	Page 3
January Meeting Minutes	Page 4 & 5
The Member's Guide to Renewing	Page 6

Calendar of Events

Our next meeting…

Tuesday, March 18, 2003
8:00 p.m.
at
St. Stephen's Church
Howard Road, 1.4 kms. south of
Hwy # 3

Main Speaker…

Juliana Grigorescu

Topic...

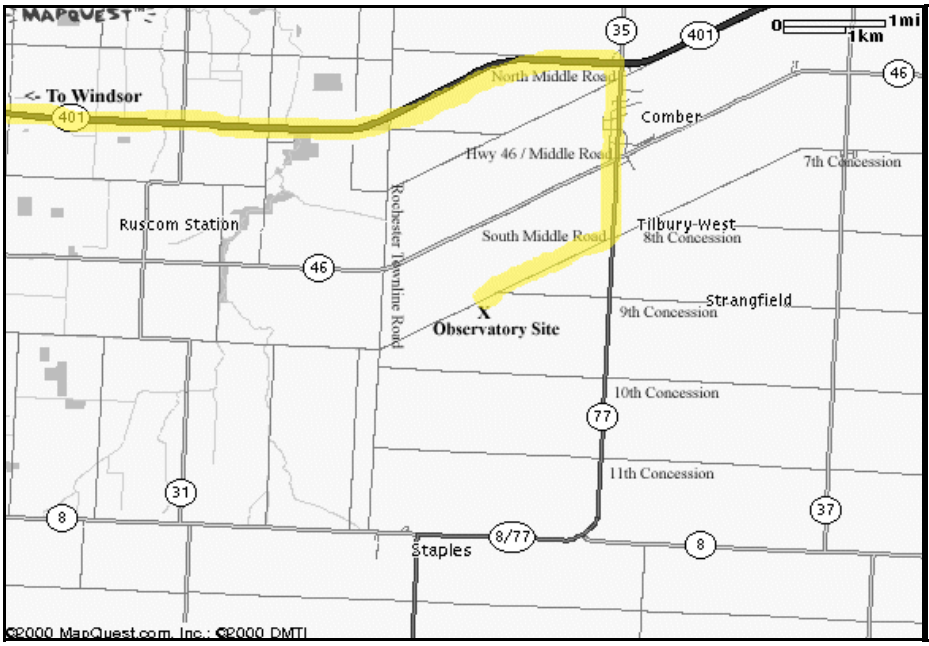
"Celestial Co-ordinates"

Activities...

Public Observing Night: Sunday March 9 from 7:30 - 10:00 p.m. members of the Windsor Centre will set up their scopes at Malden Park, the Riverfront and Forest Glade Park. You will get a chance to view the 1st quarter Moon, Saturn and Jupiter along with a few of the brighter deep sky objects.

Earth Day: On Sunday April 27 the Windsor Centre will have a display at the annual Earth Day celebrations at Ojibway Park. The event runs from Noon - 4:00 p.m. and setup will be from 10:00 - 11:00 a.m..

Centre Observing Night: We will be hosting a club observing night on Thursday May 15 at the Hallam Observatory site. Participants will enjoy the first of two total lunar eclipses visible from North America this year (the other is on November 8).



Hallam Observatory Site

At left is a map showing the Comber area and it includes the major highways (401, 77, 8 and 46) that are in the area of the observatory. I "highlighted" the most direct route from Windsor on this map which is to take 401 East to Highway 77 South to South Middle Road. While on South Middle Road you will cross some railroad tracks (they just removed the tracks) and just after the barely discernable point where Concession 9 joins it you will find the observatory site on the South side of the road. If you hit the Rochester Townline Road (i.e. you come to a stop sign and have to turn left or right) you have gone too far. On most clear nights someone is usually out there observing but if it happens to be a clear, moonless, weekend night you should have many observing buddies.

Submissions

Aurora is published monthly except for August. The September, November, January, March, May and July issues are full newsletters (usually 6 pages) with a number of member submitted articles. The October, December, February, April and June issues are short flyers (2 pages) with one short article. Submitted articles can be of any length from a paragraph to multiple pages. I can scan pictures and/or diagrams (both prints and film) to support your article and the originals will be returned to you.

Submission deadline is the 1st of the month. I will accept Emails at the address below, floppy disks, or written submissions.

Editor: Steve Mastellotto Email: mmastellotto@cogeco.ca

Membership

The Windsor Centre of The Royal Astronomical Society of Canada meets on the 3rd Tuesday of every month (except July and August) at St. Stephan's church. In addition to regular meetings the centre hosts a number of observing nights, a picnic and a December social. Members receive a copy of the Observer's Handbook, the RASC Journal, a subscription to SkyNews magazine and access to the Centre's library and telescopes.

Annual Membership Fees are Regular - $44.00, Youth - $27.50 and Life - $880.00.

Contact Ken Garber at (519) 966-3478 or visit our website at: www.mnsi.net/~rasc for more information.

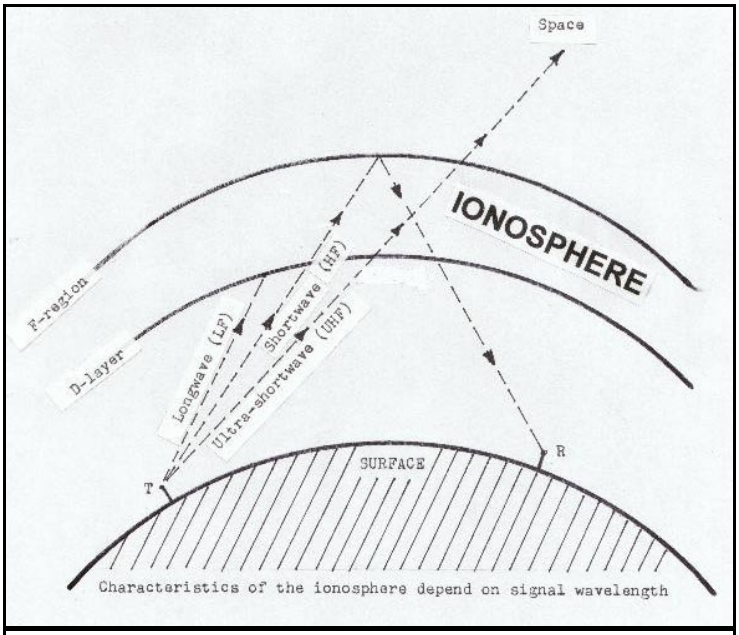
Radio Waves and the Ionosphere by Bert Huneault

One of our members recently asked me to explain how communications manage to pass from ground stations through the ionosphere to satellites or space shuttles in orbit, in spite of the fact that radio waves normally get reflected by the ionosphere. That got me thinking that a brief primer on the ionosphere might be of interest to many RASC members. After all, amateur astronomers are often concerned with radio waves, be it in connection with radio astronomy, or picking up shortwave time signals from WWV or CHU, or perhaps simply listening to shortwave broadcasts from the BBC, Radio Canada International, Radio Netherlands, etc.

What is the ionosphere?

In Earth's upper atmosphere, the region between approximately 40 and 300 miles above the surface gets ionized by incoming x-ray and ultraviolet radiation from the Sun. As a result this region is populated by electrons which have been freed from their parent atmospheric atoms, and by positive ions which are the atoms that have lost electrons. That region is called the ionosphere. The ionization is generally concentrated in four bands: D, E, F1 and F2, found at altitudes of about 50, 75, 150 and 250 miles, respectively.

The concentration of free electrons in those layers enables the ionosphere to act as a giant mirror in the sky, reflecting radio waves back to Earth; thus making long-distance radio communications possible. For example, shortwave radio transmissions from an airliner above the North Atlantic can bounce off the ionosphere and be received quite well here in Windsor. I'm a former airline radio operator and, as a hobby, I often monitor such air-to-ground communications between trans-Atlantic jetliners and Gander Aeronautical Radio. Were it not for the ionosphere, such long-distance radio communications would be impossible because the transmitted signals, being unable to bend around the curvature of the Earth, would be lost into space.



In order to simplify the diagram, the E-layer was omitted and the F1 & F2 layers were combined into the single F-layer into which they normally merge at night.

"Hello Enterprise, Houston calling!"

Now back to my friend's question - - If the ionosphere does indeed reflect radio signals, how can radio waves from, for example, NASA's Johnson Space Centre in Houston manage to punch through these ionized layers and reach the Space Shuttle or the International Space Station (ISS) orbiting above the ionosphere?

That's a good question, and the answer lies in the signals' wavelengths. The ionosphere reflects only relatively-long wavelengths and is virtually transparent to shorter ones. The radio spectrum is divided into several frequency bands ranging from VLF (very low frequency) through LF (low frequency), MF (medium frequency), HF (high frequency), VHF (very high frequency), UHF (ultra high frequency) and SHF (super high frequency). Frequency and wavelength are inversely related; therefore the lowest frequencies (VLF) have the longest wavelengths, and the highest frequencies (SHF) the shortest wavelengths. Radio signals in the so-called "shortwave" band occupy the HF portion of the spectrum, between 3 and 30 megahertz (MHz). These have relatively-long wavelengths and get effectively reflected by the ionosphere. For voice communications with the Shuttle, however, NASA uses **ultra-high frequencies** (the UHF band ranges from 300 to 3000 MHz) whose very-short wavelengths easily pass through the ionosphere.

A giant net way up above the Earth

To help my electronics students more easily visualize the above concept, I used to tell them that the ionosphere is like a giant mesh up in the sky, and the open spaces in this net are fairly small. Now think of radio transmitters being like guns shooting cannon balls up in the sky. In this analogy, the size of the cannon balls corresponds to the wavelength of the radio signal, i.e. big cannon balls = long wavelengths; and small cannon balls = short wavelengths. Since big cannon balls are too large to pass through the mesh, they bounce off the net and fall back down to Earth. But tiny cannon balls (bullets) being much smaller than the openings in the mesh pass right through the net and keep going. Thus UHF signals (small bullets) pass unimpeded, right through the ionosphere and easily reach the Shuttle or the ISS.

The D-layer complicates things

Because the D-layer is in a relatively-dense region of the atmosphere (only 50 miles up), it tends to **absorb** rather than reflect longer wavelengths such as MF radio signals in the A.M. broadcast band (540 to 1600 kilohertz). That's the reason why we normally can't receive broadcast-band signals from far away during daytime. However at night, in the absence of incoming solar radiation, ions and electrons in the dense D-layer recombine fairly quickly after sunset and the layer effectively disappears. But in the higher, more rarefied F-region of the atmosphere such recombinations occur very slowly, so that the ionosphere effectively retains its ability to reflect long radio waves all through the night.

Being a traditional country music lover, I often take advantage of the above phenomenon by tuning-in A.M. radio station WSM (650 kHz) from Nashville, Tennessee on Saturday nights, during broadcasts of the "Grand Ole Opry". Although WSM cannot be heard from Windsor in the daytime, it often comes in very well at night because that nasty absorbing D-layer conveniently disappears out of the way!

January Meeting Minutes

General Meeting Minutes
January 21, 2003

President, Randy Groundwater: Randy Groundwater opened the meeting and requested and received a motion to accept the minutes of the November 2002 meeting. Motion made by Steve Le Boeuf and seconded by Harry Brydon, the motion was carried.

Reports

Correspondence Secretary, Joady Ulrich: Joady reported he had no correspondence.

Treasurer, Ken Garber: Ken reported there is approximately $4,100 in the bank account. Meeting name tags in a new format were prepared by Ken and used this evening for the first time. Ken had the latest membership cards ready for pickup at break. Only two 2003 Observer's Calendars are left at $12.00 each.

Librarian, Tom Sharron: Tom was unable to attend the meeting.

Since Tom usually handles the break time donuts and kitchen set up Randy asked for a volunteer to pick up the essential donuts for future meetings.

Newsletter Editor, Steve Mastellotto: The new membership list has been e-mailed to members. Copies are also on hand at the meeting. Steve reported the newsletter is looking good and always has space for member's articles. He had a few newsletters from other RASC Centres on hand for the taking.

Public Relations, Robin Smallwood: Given the miserable observing season and current cold weather no public events have been held or even contemplated.

Public Education, Randy Groundwater: Five groups of Scouts are to visit the observatory during February. Randy noted "power observers" need not be concerned over telescope use since the scout troops will not stay late.

Director of Observing, Steve Pellarin: Steve highly recommended www.spaceweather.com for the latest information on coronal weather and mass ejections from the sun. He also showed a spectacular image of Uranus complete with ring and moons taken in infra red with a new 8 metre telescope.

Three additional moons orbiting Neptune have been found using similar large earth bound telescopes. Steve introduced the term "Trojan moon" for one appearing to have a strange orbit via being in a Lagrangian point with Neptune.

Two comets are currently visible for those able to dress well enough and courageously observe in our rare cold winter. Robin Smallwood observed M1 and Saturn from observatory site two weeks ago.

Steve suggested looking for objects along Eridanus. Several double shadow transits of Jupiter's moons have been visible on Jupiter and more are on the way this winter.

New Business

Council Meeting: Randy announced a council meeting will be held on February 11th at Steve Mastellotto's home.

Next Meeting: The regular February meeting will be held on February 25th and will feature our National President, Rajiv Gupta. Rajiv is editor of the Observer's Handbook and among other talents he is an accomplished astrophotographer.

50/50 Draw Winner: Randy announce the winner was Steve Le Boeuf.

Short Talk: Walter North - *"Diamonds from Space"*. Walter North, a retired professor of Mechanical Engineering from the University of Windsor did a first class presentation on diamonds found in Canada. Walter's son is a geologist involved in the search for diamonds. Via his son, Walter had lots of current information in the field of diamond prospecting.

Walter gave us a detailed presentation on the formation of diamonds from carbon in very ancient plant matter. He explained how the Earth's original single continent broke up, drifted apart and in later very gradual continental collisions forced carbon bearing strata deep into the earths mantle where heat a pressure transformed some of the carbon into diamonds.

Then he explained how various types of volcanic action can bring them to the surface. In some instances diamonds can be found on the surface and traced back to the eroded remains of source volcanoes. His son is involved in complex searches for cores of such volcanoes and the subsequent surveying and sample drilling in search of economic diamond deposits.

Micro diamonds, he noted are also found in minute quantities in some primordial meteorites. Another source of diamonds is man made industrial quality diamonds.

Main Speaker: Milica Rakic - *"The Aurora"*. Milica is a graduate in Astrophysics and new to Canada from Yugoslavia. She is currently a student at the University of Windsor. Utilizing the club's new projector she produced a very well illustrated and at times animated account on the causes of Aurora Borealis. First she went into some of the folk lore and superstition from the past. Then she began to bring more and more information into her presentation illustrating how early scientists began promulgating theories. A "magnetic effluvia" theory wasn't a bad start considering it's 1722 date.

In time it was learned the sun produces cosmic wind, a plasma of extremely low density capable of motion only when a magnetic field exists. When the sun produces strong cosmic winds, gener-

(Continued on page 5)

January Meeting Minutes

(Continued from page 4)

ally the result of storms on it's surface they flow outwards past the Earth. The Earth's magnetic field is deflected away from the sun and can even be folded back upon itself downstream of the flow. During Auroral displays this phenomenon is happening and ionization over the Earth's poles gives us our Northern lights.

Milica explained the phenomena is far more complex than the somewhat simplified version she presented (and greatly reduced in these minutes). She has studied the phenomenon in great detail but has not yet been fortunate enough to witness a display. Members were asked to notify her as soon as one is spotted locally.

Randy Groundwater thanked Milica and added some family history. His parents lived on the Orkney Islands during World War II. Northern Lights would sometimes allow German night bombers to improve their aim as they bombed the Orkneys. In those circumstances Northern Lights would be a very frightening sight.

Meeting adjourned 10:15 p.m.

Does Solar Activity Affect Our Climate

(Continued from page 1)

numbers approached **minimum**, and subsequently recovered. This might seem strange at first because sunspots are cool areas and one might expect **large numbers** of spots to reduce the Sun's energy output. However, sunspots are surrounded by bright areas of activity (faculae) that have higher temperatures; the net effect is for solar output to vary in parallel with sunspot numbers. Thus the solar constant decreases by about 1.4 watts per square metre from sunspot maximum to minimum. This represents only 0.1 percent of the total solar irradiance. Some climatologists theorize that the observed fluctuations of 0.1% would change the mean global temperature by less than 0.06°C. That's not much to write home about, is it? But who knows, Mother Nature doesn't always pay attention to theory!

Even greater variation occurs at shorter time scales as sunspot groups form and dissipate. I believe that there are also longer-term trends in solar weather activity that last anywhere from years to centuries to millennia and may have an impact on global warming.

Much still remains to be learned

Although scientists have learned a lot about sunlight since the launch of the Nimbus-7 satellite in 1978, their understanding of Sun-Earth relationships continues to be incomplete due to the limited amount of data. Furthermore, researchers have not been able to precisely determine what percentage of solar energy is absorbed by the surface or by the atmosphere. Also, they do not have complete measurements of the energy variation for the various wavelengths of incoming solar radiation; that's important because these different wavelengths (e.g. IR, visible light, UV, xrays, gamma rays) affect the various components of the Earth's atmosphere, land, and ocean in different ways.

This year, Earth scientists will move a step closer to a full understanding of the Sun's energy output with the launch of the **Solar Radiation and Climate Experiment** (SORCE) satellite. SORCE will be equipped with four instruments that will measure variations in solar radiation much more accurately than anything now in use and will also observe some of the spectral properties of solar radiation for the first time.

The new data should enable researchers to more accurately track how the Sun affects our climate **now and in the future**, and perhaps provide a definite answer the question posed in the title of this article.

The Member's Guide to Renewing by Ken Garber

Sitting at the Treasurer's table at every meeting, I receive a variety of requests for renewing memberships or subscriptions. Gathering up all my notes, I've put together this article.

Magazine Renewals

The Centre Treasurer can handle subscription renewals for **Sky & Telescope** and **Astronomy** magazines. Both magazines have club rates for individuals. The only 'catch' is that the renewal must be done through the club.

So to obtain the club-reduced rate, you must bring (or send) your renewal form and your payment to the Treasurer for forwarding to the magazine. Upon receipt of the form and payment, the Treasurer creates a covering letter on our letterhead that is then sent off.

Two small items to note: Get your renewal in to the Treasurer as soon as possible before the end of your subscription to make sure you don't miss an issue. Your payment should be a U.S. postal money order or cheque in U.S. funds drawn on a U.S. bank OR you can also throw your VISA/MC/AE account number on the form – which ever is more comfortable for you. And make sure all the information on the form is up to date.

RASC Membership Renewals

When it comes time to renew your RASC membership, there are four ways in which to do this. Renewals may be for one, two or three years.

The first and preferred method is to send your payment (cheque/money order or credit card) with the renewal form directly to National Office.

The second method is to go on-line to the RASC's E-store at http://www.store.rasc.ca/ and subscribe /renew directly. Follow the links through to the renewal section. Be sure to select Windsor as the Centre Affiliation. Payment is by credit card only.

The third method is to call National Office at 1-888-924-RASC (7272) and renew by phone. A credit card number is required for this method.

The fourth method is to bring your payment (in cash or cheque) to a meeting and the Centre Treasurer can forward it (with any other submissions – including NEW memberships) to National Office. Please include the renewal form that you received in the mail (which also has a section so that you can pay via a charge card).

If at the meeting you will be purchasing from the Centre, a calendar, paying the observatory fee, or something else, please provide, if possible or convenient, cash or a separate cheque (payable to 'RASC Windsor Centre') for these non-membership items.

A note about payments: Whether you pay National Office or Windsor Centre makes no difference. All payments are sent to National Office and we receive our local share at the end of the month. Use whatever method is convenient to you.

Donations

Besides making donations throughout the year at the meetings, you can also donate at the time of renewal. If you make a local donation at the meeting, please ask for a receipt.

If you include your donation in your renewal payment, you will need to specify on the form if it's for the local Centre or for the RASC generally. In either case, donations received with the renewal form will be tax receipted from National Office at the end of the year.

Hopefully this answers any questions you may have had. If not, please feel free to contact myself or anyone else on the council.