RSRS NEWSLETTER

No. 131

April 1972

TEN YEARS OF SOLAR ACTIVITY FORECASTING

Last month saw the 120th issue of RSRS forecasts of solar activity that have been made available to users of HF radio in the communication and broadcasting field. Such information has enabled the users to make ionospheric predictions of maximum usable frequency up to six months in advance and thereby not only to keep their radio links operational but to maintain them at maximum efficiency. Over the ten year period since March 1962 when the first issue was sent out there has been almost one complete cycle of solar activity variation, making it a fitting time to record this milestone. To those not familiar with the subject the following notes may be of interest.

The basic periodicity in solar activity is on average 11.1 years and the principal method which has been used to measure it has been the sunspot number derived from the number and grouping of dark spots on the sun. Thus the term sunspot cycle is frequency used synonymously for solar activity cycle or 11 year cycle (even though its length has varied from 7.3 to 17.1 years). Sunspots are regions on the sun's photosphere which are cooler by some 1000°K than their surroundings and they occur sporadically on the solar disc for periods usually less than ten days but sometimes remaining for three months. They are symptomatic of activity within the surface of the sun and, as we have found out, indicative of extra electromagnetic radiation sent out into space. At minimum activity the monthly mean number is zero or near zero while the number at maximum activity varies considerably from cycle to cycle; the 12-month running mean for smaller cycles sometimes does not reach 50 units while the largest has exceeded 200 units. The Zurich Observatory established the earliest reliable results and has good figures dating from 1749. It is from these figures covering 20 cycles that most of the statistical information used in forecasting

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has been derived. For instance the tendency for larger cycles to have a quicker rise from minimum to maximum and the smaller cycles to have a longer period between minima are two examples of useful factors employed when trying to anticipate the future trends of a cycle. However it is not possible to cater for the unusual which is liable to crop up at any time; in the current cycle (No. 20) it has been the extended time of 2 yrs 7 months during which the maximum has remained within limits of 106 $\pm$ 6 units. Another example of a remarkable period was in 1822-1823 when the sunspot number remained at zero for 13 months. It is for reasons such as these that it is difficult to make the forecasting of the sunspot cycle into a very quantitative procedure.

We are all aware that the heat and visible light from the sun remains virtually constant over the sunspot cycle so it is in other parts of the spectrum that the solar variations occur including those at ultra-violet wavelengths and UHF radiations. However at solar minimum when there are no spots on the sun such radiations do not cease. If we note how the ionosphere varies over a cycle we can deduce that there is approximately half the amount of radiation at solar minimum as there is at solar maximum. Thus there is always an ionosphere to support our radio signals even when the sun looks to be at its quietest. By using past measurements of F2-layer critical frequency and sunspot number it is possible to 'calibrate' the ionosphere in terms of sunspot number in order to obtain a 'corrected' sunspot number which more accurately reflects the radiation effective in producing the F2 layer. Effective sunspot numbers are derived regularly from 13 ionospheric observatories (including Slough and Port Stanley) and the median of them is termed IF2. It is this solar activity index IF2 which is the basis for the prediction scheme developed at RSRS many years ago and later taken up internationally by CCIR. It is forecasts of IF2 that are at present sent out to users to enable them to use the prediction system. Since IF2 values cannot be obtained for dates before regular ionospheric measurements were made there are only just over three solar cycles of IF2 results, hardly sufficient time to obtain any statistical facts such as exist for sunspot number. However the consistent similarities and differences between these indices that have emerged to date enable forecasts of IF2 with similar accuracy to be made, aided by the fact that IF2 is a smoother varying index than sunspot number.

Lacking any usable quantitative theory of solar activity empirical methods of forecasting the trend of a cycle have to be used and of those suggested and analysed in the past most rely on the use of certain statistical relationships derived for different parts of the cycle. The problem is then one of deciding

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at what point these relationships should be applied because it is not easy to determine for instance the exact time of minimum or maximum, it only being apparent in retrospect. Therefore a combination of methods is usually used to pin down these times more closely and much reliance is placed on plots of superposed cycles having magnitudes similar to the one being extrapolated. Before the issues of forecasts were begun it was estimated that over a long period the mean error and standard deviation would be 0 $\pm$ 12.5 units. In practice it has amounted to -5.3 $\pm$ 10.3 units, an accuracy sufficient for the purposes required since on average one unit is equivalent to .03 MHz in F2 critical frequency.

To help improve the forecasting of the magnitude of sunspot cycles in advance, studies have been made of longer periodicities in the sunspot numbers and an embarrassingly large number of these have been proposed. Periods of 33, 78, 81, 160, 178, 200, 312 and 450 years (among others) have been put forward as well as some periodicities within the 11 year cycle. A 4 cycle trend in solar activity has recently been put forward and it is well known that magnetic polarities of sunspots reverse in consecutive cycles giving a 2 cycle trend as well. All this goes to show that detailed solar activity is not a very well behaved phenomena and contains many irregularities. It is also of interest to note that the conjunction of the planets has been associated with the 178-year periodicity and that records of aurorae, earthquakes, hail and wine harvests as well as studies of tree rings have been seriously used to find out more about past solar activity. Using such ancient evidence the sequence of solar cycles has been traced back to 649 B.C. and on this basis we may expect solar cycles to continue much as they are for some while yet though their detailed nature will probably continue to pose problems for some time to come.

P. A. Smith

'SEARCH'

The Station will be one of the contributors to the above-named exhibition which can be seen at the Science Museum from 2nd May to 31st October.

The exhibition covers aspects of the work of the various Research Councils and in so doing will embrace a very wide field of scientific interests. Among the RSRS contribution is a solar radiometer display and associated equipment, a roll phase sensor device as used in Ariel IV, a Petrel rocket payload and an example of an electron detector used in the measurement of energetic particles by rocket-borne experiments.

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The Department of Education and Science have commissioned a number of films in connection with this event and in one of them, 'Talking of Science', the role of RSRS was described by Dr. Horner. On Tuesday, 18 April, they were shown to an audience including Mrs. Thatcher, Sir Brian Flowers and other Chairmen of the Research Councils.

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OBITUARY

MISS E. ROGERS

We are sorry to learn that Miss E. Rogers died recently at the age of seventy-seven.

The name of Edith Rogers will best be known to the older generation of workers at Ditton Park. Beginning in 1925, her career virtually spanned the life of the Radio Research Station, as it then was, from its original huts (destroyed by fire in 1928) through the time when it consisted of what are now the 'Old Buildings' to just prior to our move to the present site.

In her thirty years' service, Miss Rogers' work involved her chiefly in the ionospheric and atmospherics investigations originally carried out by such workers as Appleton, Naismith and Watson-Watt. In later years she was responsible for the handling of the Station's ionospheric data.

Among those attending the funeral were Miss E. M. Cottenham and Mr. R. Naismith.

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STATION NEWS

Dr. Horner left on 26 April to visit the National Radio Astronomy Observatory in Virginia and various laboratories in Boulder, Colorado.

Following these visits Dr. Horner will deputise for the Director, who is unable to attend, as leader of the U.K. delegation to the Scientific and Technical Sub-committee of the U.N. Committee on the Peaceful Uses of Outer Space.

STAFF NEWS

Congratulations to:

Alan Chipperfield on his engagement to Linda Ransome of Chiswick on 8 April

Susan and Francis Goodall on the birth of a daughter, Karen, on 13 February

Lyn Thomas on her marriage to Byron Kennedy at Slough Registry Office on 1 April.

Welcome to:

M. W. U. Haq	S.O.
B. T. Austin	Tech. II at ARU Culham
D. J. Blakes	A.S.O.

Resignations:

R. Bolgiano	Principal Research Fellow
Mrs. J. Adams	A.S.O.
F. H. J. Feldbrugge	Vacation Worker

Other Changes:

P. M. Gondhalekar	.Now H.S.O. from S.O. (Old Style)
W. J. K. White	" " " " "
M. E. Cleverley	" " " " "
C. J. Gibbins	" " " " "
A. J. Gibson	" " " " "
A. D. Smith	" " " " "
Miss Y. E. P. Dias	A.S.O. now Dep. Shift Leader

SPORTS AND SOCIAL CLUB NEWS

The annual S.R.C. Sports Day will probably be held this year on 26 June. Further details will be posted on the Notice Board.

The following have been elected to form the new committee of the Sports and Social Club:

Peter Hicks
John Halley
Yvonne Dias
Bob Walls
Doreen Baldwin
Ellen Scammell
Fred Salter
Tim Bevan
Carol Spears

Bridge Club

The D.S.I.R. Cup was won this year by the R.S.R.S. first team - Gus and Kitty Gordon-Smith, Barry Martin and Mike Johnson. Six teams took part, from N.P.L., Road Research, Warren Spring and R.S.R.S.

Table Tennis

The 1971-72 season is now over and proved to be a successful one for R.S.R.S. The 'A' team finished fifth in the Second Division and the 'B' team are Division Champions in the Fourth Division. Unfortunately the 'B' team dropped a point in almost the last match due to some determined opposition by their nearest rivals. With sufficient support it should be possible to enter three teams next season.

P. Muzlish
Hon. Secretary

Motor Club

The new portable jacking ramps are now available on loan to members. These are considerably lighter than the trolley jacks and perform a different but complementary function. They do, however, involve more work in jacking the wheels up to the full 17 ins. off the ground but this does enable one to work in comparative comfort (if such a word can be used in this context). Everyone's attention is drawn to the necessity for protecting the eyes when

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working underneath a car. Spectacle wearers are protected to a certain extent. Grit in the eye is potentially very serious. If it doesn't get blinked out immediately, medical attention is necessary.

P. Muzlish
Hon. Secretary

LETTER TO THE OUTSTATIONS

Dear Colleagues

The Spring, now come upon us, has brought about its usual surge of sap, shoots, and what-have-you. Early-flowering trees early flower, and those that don't, seem to have bits growing on them, which probably means that they are going on all right.

The Station, while not exactly in the throes of a Spring Clean, has not escaped completely the regenerative impulse; they are doing-up the entrance hall. That flood of staff, bent upon noon-tide refreshment, has been dammed, diverted and displaced a little whilst craftsmen practice their several skills, ripping-up, repainting and renovating.

Our Mural still remains unscathed, anyway that's no age as paintings go; the wooden panelling still panels. Transformation, though, awaits the rest, including the rather used-up-looking furniture suite which has served us well over the last decade and a half.

Safety and comfort have ever been the watchwords of those who have our welfare in their charge, the smallest details are a matter for consideration. Thus now, suspended from a chain, adjacent to every fire-alarm, is a small hammer for breaking glass with. Such a thing doubtless has a role to play in averting panic - it enforces ceremonial.

In the very act of frenzied signalling decorum asserts itself as one is reminded of ivory mallets and the naming of dead Popes. One isn't? Oh well, at any rate no more need we risk wear and tear on home-mailed fists or coat elbows already well-worn as those of

Yours sincerely

The Editor

STATION SAFETY COMMITTEE

Some of the staff will already know that there is a Safety Officer, advised by a Committee, responsible to the Director, for all safety matters appertaining to RSRS and its outstations. The terms of reference of this body have recently been more clearly defined and the purpose of this article is to acquaint the staff of the composition of the committee and the action the staff should take when any hazards to safety are encountered.

The Committee consists of the Safety Officer (appointed by the Director), a member of Administration Division who is the Secretary of the Committee, together with staff responsible for specific locations and those with specialised knowledge in particular fields. The members of the Committee and their fields of responsibility are as follows.

C. Clarke	Safety Officer	Administration block
L. Mitchell	Secretary	Kitchen and canteen facilities
G. E. Ashwell		Spurs C, D and E
G. E. Barnett		All rooms on south west side of main corridor excluding the tape store. Also South Uist installations
J. Cathrew		Rooms 121, 121A, tape store and all huts other than 6 and 7
I. R. N. Eyre		Stores, goods yard, first aid and fire precautions
P. Hicks		Photographic section and SRMU
J. McGivney		Chilbolton
A. J. G. Moorat		Old building
E. A. Oakman		Engineering workshop, garage, Spur workshops, dispatch bay, masts and towers
C. Samuel		Spurs A and B, Huts 6 and 7
D. Sandcroft		Winkfield
R. Thomas		Carpenters shop, outside installations excluding masts and towers

Although all safety Committee members will do their best to guard against hazards occurring in their areas, it is up to the staff themselves to co-operate by following good safety practices in their general work. For example by using guards on drilling machines in Spur workshops, in keeping corridors free from obstructions, and by observing the rules laid down controlling work on aerial masts and towers.

Any safety hazard should be reported immediately to the Safety Officer, to Office Services or to any member of the Safety Committee. By general co-operation we hope to avoid those tragic accidents which can so easily be avoided with a little care and attention.

C. Clarke

April 1972

APRIL 1972

List of Reprints

G. R. Thomas and D. M. Willis	Analytical derivation of the geometric factor of a particle detector having circular or rectangular geometry Journal of Physics E, 1972, Vol. 5, pp. 260-263
A. C. Gordon-Smith and C. J. Gibbins	A simple overall absolute calibrator for millimetre wavelength horn-radiometer systems Electronics Letters, Vol. 8, No. 3
J. R. Norbury and W. J. K. White	Microwave attenuation at 35.8 GHz due to rainfall Electronics Letters, Vol. 8, No. 4
D. T. Llewellyn-Jones and A. M. Zavody	Microwave attenuation due to rain at 110 GHz in S.E. England Electronics Letters, Vol. 8, No. 4

Internal Memoranda

I.M. 352	Calibrations of the ESRO 1 Satellite Experiment S71A	E. Hammond & G. R. Thomas