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NATIONAL SCIENCE FOUNDATION
Washington, D.C. 20550

SUMMARY OF COMPLETED PROJECT

Form Approved
OMB No. 99R0013

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1. INSTITUTION AND ADDRESS	2. NSF PROGRAM	3. GRANT PERIOD
University of Colorado Boulder, Colorado	Solar Terrestrial Research	from 4/15/75 to 9/30/77

4. GRANT NUMBER	5. BUDGET CODE (NSF)	6. PRINCIPAL INVESTIGATOR(S)	7. GRANTEE ACCOUNT NUMBER
DES -06540	24	Roberts	1707-42

8. SUMMARY (Attach list of publications to form)

TITLE: Tests of Physical Mechanisms Linking Solar Activity and/or Geomagnetic Disturbances with the Large-Scale Circulation of the Lower Stratosphere and Upper Troposphere

OBJECTIVES AND SCOPE: Our purpose was not primarily to prove that sun-weather connections exist. However, to the extent that our work was done with high scientific standards, we felt that any positive evidence we discovered would add to the credibility of the field. In view of the current widespread interest in sun-weather studies, we feel that our work has contributed toward making this field more scientifically respectable. Our primary objectives were to furnish additional empirical facts designed to help in selecting the most probable physical mechanisms and then at least speculate on the details of the mechanisms.

TECHNIQUES USED: The techniques must necessarily be statistical in nature, in view of the limited knowledge available. We employed many of the standard statistical techniques, such as spectral analysis and superposed epoch analysis. We employed significance testing techniques that were perhaps more stringent than necessary, in order to guard against accepting fortuitous results as real.

MAJOR FINDINGS AND IMPLICATIONS: The research accomplished may be summed up in the five papers attached to this report. Paper I is essentially negative in character. We report that we could not find any obvious 11-year or 22-year periodicities in the standard meteorological data sets on precipitation and surface temperatures. However, to demonstrate that we did not exhaust all the possibilities for solar periodicities in weather data, we attach Attach T; a commentary on some similar work that did have positive results. We believe, with Mitchell, that there are other techniques, such as tree-ring analysis, that will show periodicities of around 22 years in weather data. Paper II is also of a negative nature. We felt that, if the work of Xanthakis turned out to be valid, it would be of great importance in guiding our future work. However, we discovered that this work did not stand up to our testing on an extensive data set. After these two negative results, we felt that we should spend the bulk of our time pursuing more positive results. Paper III describes one of our principal results, i.e., a large solar flare has several effects on the atmospheric circulation: 1) At about the time of the flare, plus or minus a day or so, the cyclonic circulation of the Earth's atmosphere shows an increase of 5-10% above background; 2) By two or three days after the flare, at the same time as the geomagnetic storm that normally follows the flare, there is a sharp decrease in the same atmospheric parameter to a level 5-10% below background. This low level may persist for several days. In Paper IV we extend this analysis, using the central meridian passage of a large active solar plage as the solar signal. Again, we find almost the same picture, with the plage date playing the same role as the flare date did in Paper III. The effects are more clearcut in the case of the plages than in the case of the flares. In Paper V we present an analysis of some of the more useful research in sun-weather relations that have been discovered over the past several decades. For a reader who wants to get a general view of the field, we recommend reading this paper, perhaps in preference to the others which are more detailed but cover narrower subjects.

(Continued on separate sheet)

9. SIGNATURE OF PRINCIPAL INVESTIGATOR/PROJECT DIRECTOR	TYPED OR PRINTED NAME	DATE
Roger H. Olson	Roger H. Olson, Project Director	7 Dec 1977

NSF Form 98A (5-75)

University of Colorado
Boulder, Colorado

DES75-06540
1707-42

Solar Terrestrial Research

BIBLIOGRAPHY

Paper I: Gerety, Edward J., J. M. Wallace and C. S. Zerefos
"Sunspots, Geomagnetic Indices and the Weather: A Cross-Spectral Analysis between Sunspots, Geomagnetic Activity and Global Weather Data"
Journal of Atmospheric Science, 34, No. 4, April 1977
pp. 673-678

--- Attachment I: "The Sun and the Weather" by R. H. Olson
News and Views, Nature, Vol. 270, 3 November 1977, p. 11

Paper II: Gerety, Edward J., R. H. Olson and W. O. Roberts
"Analysis of a Possible Sun-Weather Correlation"
Submitted to Nature, November, 1977

Paper III: Olson, Roger H., W. O. Roberts and C. S. Zerefos
"Short-Term Relationships Between Solar Flares, Geomagnetic Storms and Tropospheric Vorticity Patterns"
Nature, 257, No. 5522, 11 September 1975, pp. 113-115

Paper IV: Olson, R. H., W. O. Roberts, H. D. Prince and E. R. Hedeman
"Short-Term Relationships Between Solar Plages, Solar Centimetric Radio Flux, and the Vorticity of the Earth's Atmosphere"
Submitted to Nature, November, 1977

Paper V: Roberts, Walter Orr
"Sun-Earth Relationships and the Extended Forecast Problem" in Science, Technology, and the Modern Navy," Office of Naval Research, ONR-37, 1976

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MAJOR FINDINGS AND IMPLICATIONS: (Continued)

With regard to isolating the more likely mechanisms, the progress made was only slight, as we expected would be the case. We concluded that increased electromagnetic radiation from the sun, possibly X-rays, is a probable cause of increased cyclonic activity in the Earth's atmosphere. The low energy particles, on the other hand, which cause auroral disturbances, seem to be associated with decreased cyclonic activity. We have concluded that the cirrus cloud mechanism which we have suggested, cannot be the only operative mechanism. The response to flares is a very immediate one, while the cirrus mechanism requires several days to be effective, if it is effective. We suspect that thunderstorm activity and/or ozone changes might be more likely candidates for explaining the more rapid responses.

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