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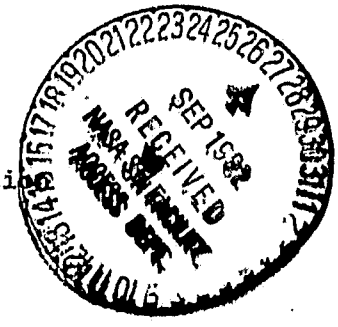
SP-82-39

SOLAR ANALYSIS OF SOLAR-CONSTANT MONITORING PACKAGE (SMM)

Final Report



National Aeronautics and Space Administration

Grant NSG-5322

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September 1982

Solar Analysis of Solar-Constant Monitoring Package (SMM)

Abstract

The ACRIM is supplying the first high-precision data on solar total irradiance at the Earth. We have identified the observed variations (up to 0.3%, on time scales of several days) with sunspot darkness. The data analysis can be expected to give information about the solar interior, as well as about the solar input to the terrestrial climate. We propose to analyze the effects due to solar activity, both spot deficits and facular excesses, and to study shorter-period variations.

LIST OF MAJOR PUBLICATIONS RESULTING FROM NSG-5322

Hudson, H.S., Silva, S., Woodard, M., and Willson, R.C. 1982, Solar Phys. 76, 211.

Willson, R.C., and Hudson, H.S. 1981, Adv. Space Res., 1, COSPAR (Printed in Great Britain), p. 285.

Hudson, H.S., and Willson, R.C. 1981, The Physics of Sunspots (eds. L.E. Cram and J.H. Thomas), p. 434.

Willson, R.C., and Hudson, H.S. 1981, Ap. J. (Letters) 244, L185.

Woodard, M., and Hudson, H.S. 1982, Solar Phys. (to be published).

1. Introduction

The variations of the solar constant provide several channels of information about the solar interior. It was therefore very appropriate to conduct analyses of the data obtained by the Active Cavity Radiometer Irradiance Monitor (ACRIM) on the Solar Maximum Mission (SMM) with an emphasis on the results pertinent to solar physics. This report sketches some of the key elements in this program (NSG-5322), but the detailed description of the results is left for the published papers, attached as an Appendix.

2. Measurements

The ACRIM instrument provided the first legitimate measurements of variations in the solar constant (the total solar irradiance) in the sense that the variations were oversampled sufficiently to permit a statistical analysis of the results. Our analyses only covered the period of "good" data, that is up until the failure of fine pointing reduced the coverage obtainable from SMM. The resulting time scales of variability therefore range from about ten months to two minutes, with the latter corresponding to the Nyquist frequency (3.815 mHz) of the basic shutter cycle of the ACRIM instrument. The designer of ACRIM, R.C. Willson of the Jet Propulsion Laboratory (JPL), has described the detailed layout of the instrument and the process of measurement elsewhere (Willson 1979).

3. Personnel and Research Plan

The personnel at UCSD consisted of H. Hudson (Associate Research Physicist) and M. Woodard (Research Assistant). R.C. Willson provided data tapes, and Woodard spent some time at JPL learning the data formats and gleaning what he could about the physics of the instrumental response. Analyses proceeded

both from the two-minute samples of data from about the first four months of the "good" period, plus the daily averages compiled by Willson. The two UCSD workers collaborated with each other and Willson on almost all of the items, but it was recognized quite early that results on solar global oscillations would constitute a very interesting Ph.D. thesis. This has worked out in practice as Woodard succeeded in detecting the 5-minute p-modes in the data; he is now engaged in final analyses and the writing of the thesis.

4. Results

Three classes of variability have been discovered: the "large" variations of amplitudes up to 0.2%, concentrated on time scales of days; small high-frequency variations in the form of a continuum in the periodogram, extending up to the Nyquist frequency; and sharp spikes at frequencies corresponding to the individual p-modes already known from radial-velocity measurements. The limited time and funding available did not permit us to carry out more than a fraction of the research implicit in these wholly new observations, in particular we have done no analysis of the high-frequency continuum. Extensive further analysis of the active-region effects should be performed. In particular the statistical approach outlined by Hudson and Willson (1981) will profitably be extended; both theory and data treatment are quite incomplete at present.

References

Willson, R.C. 1979, Applied Optics 18, 179.

Hudson, H.S., and Willson, R.C. 1981, The Physics of Sunspots (eds. L.E. Cram and J.H. Thomas), p. 434.

Appendix

Hudson, H.S., Silva, S., Woodard, M., and Willson, R.C. 1982, Solar Phys. 76, 211.

Willson, R.C., and Hudson, H.S. 1981, Adv. Space Res., 1, COSPAR (Printed in Great Britain), p. 285.

Hudson, H.S., and Willson, R.C. 1981, The Physics of Sunspots (eds. L.E. Cram and J.H. Thomas), p. 434.

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