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The Nimbus 7 Solar Total Irradiance: A New Algorithm for its Derivation

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Abstract

The Nimbus 7 satellite has measured the solar total irradiance from November 1978 to July 1991 (153 months). These measurements are important both in solar physics and for climate change. To insure that the Nimbus 7 measurements are capturing the true behavior of the Sun, it is essential that the properties of the radiometer and its changes over time be understood. The calibration of the radiometer can be viewed as a process of removing instrumental influences from the raw measurements, leaving the experimenter with an estimate of solar variability. In this paper the changing radiometer pointing, the zero offsets, the stability of the gain, the temperature sensitivity, and the influences of other platform instruments are all examined and their effects on the measurements considered. Only the question of relative accuracy (not absolute) is examined. The resulting derived solar irradiances are compared to previous analyses of the Nimbus 7 radiometer and to the Solar Maximum Mission (SMM) measurements. Compared to previous analyses, the newly derived values are higher and somewhat less variable than the older values. Removal of the off-axis pointing errors and a new treatment of the zero offsets are the major reasons for the changes. Compared to the SMM measurements, both agree quite well so long as any solar activity is present. When the Sun becomes quiet, so its irradiance variability is less than the Nimbus 7 radiometer resolution, the comparison to the SMM results breaks down. Between 1980 and 1988 the correlation of the daily values is 0.83, compared to 0.62 using previously published values from both satellites. The monthly means have a correlation of 0.90, indicating that about 80% of the longer-term

variance is in common. In 1980 when both satellites were operating without problems, Nimbus 7 was 0.3155% higher on average. For May 1984 to December 1988, Nimbus 7 was 0.3255% higher. Therefore if the Nimbus 7 satellite continues to operate properly until a period of about 1 year after the launch of UARS with its active cavity radiometer irradiance monitor (ACRIM), it appears that the differences between Nimbus 7, SMM ACRIM, and UARS ACRIM can be measured to within a few hundredths of a percent. A self-consistent set of solar irradiance measurements from several satellites over nearly two solar cycles appears feasible.

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