Heads Up! Sunspots Are Dragging Down Satellites

When solar activity surges toward a maximum, Earth satellites drift downward with potentially disastrous results

THE LAST TIME THE SUN cranked up to a maximum of activity, it expanded Earth's upper atmosphere enough—through the warming of ultraviolet radiation—to send the 85 tons of Skylab satellite to a premature end. The drag of the sun-swollen atmosphere pulled Skylab out of orbit by 1979 in a burst of fiery debris that littered parts of Australia.

Eleven years later, solar physicists again are struggling with the uncertain art of solar activity forecasting in an attempt to forestall problems with other satellites. It is still early, but there is a broad consensus that the next 11-year peak in sunspots and other solar activity will be considerably higher and earlier than average. Operators of at least three satellites, including the Hubble Space Telescope, are taking a keen interest.

George Withbroe of the Harvard-Smithsonian Center for Astrophysics in Cambridge, Massachusetts, has been paying particular attention to solar cycle forecasts as cochair of a committee advising the National Aeronautics and Space Administration (NASA) on current forecasts. At this stage, Withbroe sees limited utility in any of the forecasting methods. The problems include the extreme irregularity of the 12 cycles in the record, which means that "you don't really have a solid basis for making predictions. And we don't have a good theory for how the sun operates."

Last February the NASA committee found that eight independent predictions by various researchers ranged from a maximum sunspot number of 122 to 175. The committee could not conclude that any one prediction or group of predictions was better than another, so, given the uncertainties of ±30 or so, the sunspot number of the next solar maximum could fall anywhere between 100 and 200. Since sunspot maxima have a mean of about 110 and a range of 50 to 200, planners were left with a weak forecast of a larger than average but not record solar maximum occurring around 1990, assuming reality would be near the midpoint of the eight forecasts of 150.

A high but not extreme maximum was also the impression that forecasters had as early as the end of 1986, just after the last solar minimum, according to Joseph Hirman of the National Oceanic and Atmospheric Administration's Space Environment Laboratory in Boulder. By then researchers were "fairly confident that [the next maximum] would be larger than normal" on the basis of signs of future activity near the minimum.

These precursors take a variety of forms, from the level of solar-related geomagnetic activity at Earth to direct measurements of magnetic fields on the sun, but they all are assumed to be some measure of the strength of the polar magnetic field of the sun. This is where the next cycle can be thought to start, as the tendency of the sun's equatorial region to rotate faster than its polar regions begins to wrap embedded magnetic field lines around the sun. This wrapping stretches and twists the field lines, intensifying the magnetic field until bundles of it bob to the surface to form sunspots. The stronger the initial polar field, presumably, the stronger the subsequent solar activity.

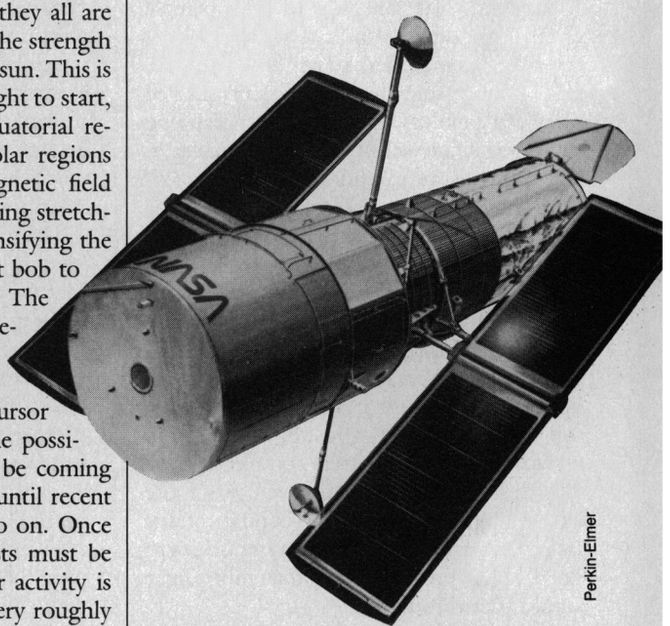
Forecasts based on such precursor methods alerted operators to the possibility that their satellites might be coming down faster than expected, but until recent weeks they had little more to go on. Once past the minimum, new forecasts must be based on the rate at which solar activity is increasing. The faster the rise, very roughly speaking, the higher the maximum tends to be. Although widely regarded as unreliable when applied any earlier than 2 years past minimum, or for this cycle September of this year, the rate of rise method has gotten a lot of attention early in recent cycles.

When solar activity began rising after the last minimum faster than during any cycle in the historical record, there was talk about a super cycle with sunspot numbers well above 200. As September approaches, however, rise rate forecasts are dropping below 200, toward forecasts made almost 2 years ago by the precursor methods.

Nothing as catastrophic as the loss of the Skylab is in the offing for this maximum, but solar activity is central to much NASA planning. The Challenger accident stranded the 16-ton Long Duration Exposure Facility, which will be used to study the effects of near-Earth space on materials, in an orbit that cannot be maintained beyond late 1990, according to orbital decay estimates based on the current forecasts of solar activity. NASA intends to retrieve it with the Shuttle before then, possibly in mid-1989.

The Solar Maximum Mission (SMM) satellite launched in 1980 and repaired by a Shuttle crew in 1984 is still gathering a variety of observations, but it will "deorbit" near the end of 1990. That would interrupt a 10-year record of solar brightness variations before the next satellite could take up its duties. SMM could be boosted to a higher orbit with or without refurbishment.

For a while, when rate rise methods predicted such a large maximum, it looked as if the Hubble Space Telescope (HST) would need a boost soon after launching to maintain its ability to point precisely. But a careful reconsideration of how much altitude could be squeezed out of the Shuttle reassured planners that HST could be lifted to 611 kilometers rather than the normally cited capability of 593 kilometers. At the new altitude, it should weather the largest maximum predicted by the precursor methods for 5 years without a boost, according to Albert Boggess of the Goddard Space Flight Center in Greenbelt, Maryland.



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Space Telescope *is being watched.*

The NASA prediction evaluation committee will meet again this fall, little more than a year before the next maximum may occur. That will be 2 years after the last minimum, a time when the sun itself should begin to give the best forecast.

■ RICHARD A. KERR