Eye on the Ionosphere

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The ultraviolet (UV) radiation from the sun produces the electrons in the earth's ionosphere, but the only long-term measure of UV emission has been a surrogate measure of visual sunspot number and sunspot area. Measurements of the sunspot activity on the sun have been made since the early 1700s, soon after the invention of the telescope, with consistent daily measurements of sunspot activity beginning in the mid-1700s, when the current method of numbering the 11-year cycles of solar activity began. In 1947, another indirect measure of solar UV activity began, namely, the solar radio emission at a radio wavelength of 10.7 cm. Neither of these surrogate measures of solar UV activity are good indicators of the day-to-day variability of the earth's ionosphere, but they are both excellent measures of the long-term 11-year solar cycle effects.

An instrument designed to actually measure UV flux is scheduled to fly on a future Geosynchronous Operational Environmental Satellite (GOES), the first of which is projected for launch in 2001. The extreme ultraviolet (EUV) monitor will make measurements of the emission in the 10–100-nm band every 30 s. It also measures lyman alpha (119–124 nm), encompassing both the EUV and UV, with those data being available in real time. The GOES-N spacecraft is the first of a series of satellites to carry this instrument, offering the promise of measuring this UV driver to the ionosphere, instead of having to use surrogates as substitutes.

Solar cycle number 22 officially ended in October 1996, and the new cycle, number 23, which at this writing is now 20 months old, is progressing to its projected maximum sunspot number of 160 ± 30 in the year 2000 or 2001. The increasing portion of the nominal 11-year cycle of solar activity is faster than the declining phase, so the maximum in solar activity in the present cycle should be reached in approximately four years from late 1996 or some time very early in the new century.

There have been a number of concerns raised recently about potentially harmful scintillation effects on GPS signals as the new solar cycle increases in activity. Although GPS did not become fully operational until July 1995, there were several anecdotal reports of various problems with GPS signals during the last solar maximum period, but no data apparently have been shown that would quantify the extent of this potential problem. Several groups are making studies of receiver susceptibility to scintillation fading and phase fluctuations, using receivers either in the field or in bench testing. Others are attempting to infer potential scintillation effects on GPS signals from L-band scintillation measurements from other satellites of opportunity, but no definitive serious effects have been found as yet.

Scintillation effects on GPS users in the CONUS region are expected to be very rare, happening a maximum of only a few times during an entire 11-year period of solar activity. However, in the equatorial anomaly regions of the world, those regions maximizing at approximately 15–20° on either side of the geomagnetic equator, scintillation will occur frequently in the local evening hours, beginning approximately 1 h after local sunset, and extending perhaps up to midnight local time. The entire sky is not covered with irregularities that produce scintillation, and the likelihood of more than one GPS satellite having simultaneous deep amplitude fading is very small, so that a well-engineered GPS receiver should have no problem in maintaining position.

In the auroral region the occurrence of scintillation is strongly correlated with magnetic storm activity, which will certainly increase with the solar cycle. However, because of the generally lower absolute values of ionospheric electron densities in the auroral region as compared with those in the equatorial region, the amplitude fading effects are expected to be smaller in the auroral region. The length of time when the auroral region is active can last for several days, so the severity of any scintillation effects in both the Northern and Southern hemispheric auroral regions is unknown at present. See Aarons (1997) and references therein for additional information. ■

REFERENCE

Aarons, J. 1997. 50 Years of Radio-Scintillation Observations, *IEEE Antennas Propagat. Mag.* 39(6), 7–12.

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