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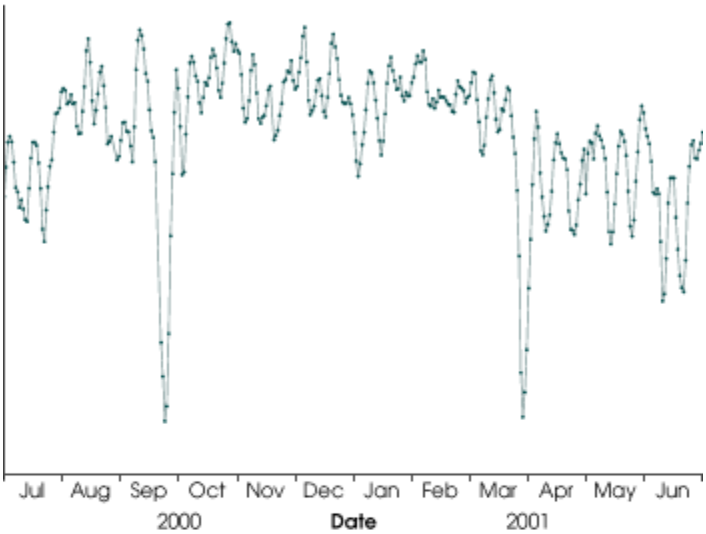
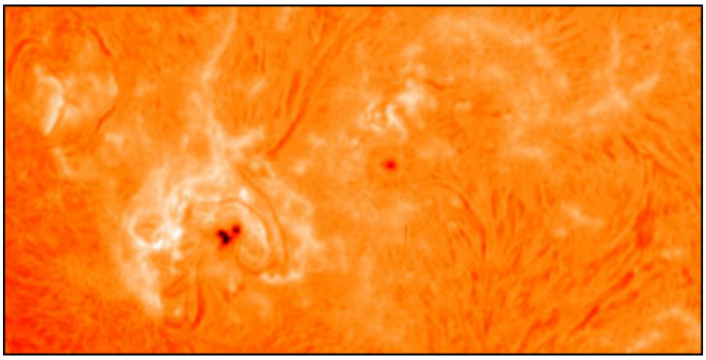
Solar Radiation and Climate Experiment (SORCE) Fact Sheet : Feature Articles



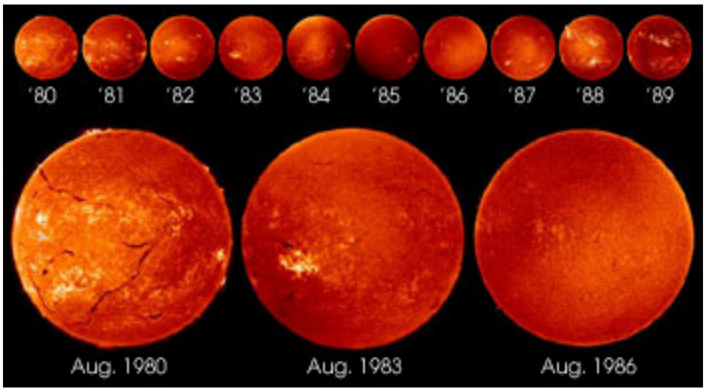
Daily variation in solar output is due to the passage of sunspots across the face of the Sun as the Sun rotates on its axis about once a month. These daily changes can be even larger than the variation during the 11-year solar cycle. However, such short-term variation has little effect on climate. The graph above shows total solar irradiance on a daily basis. The plot is based on data collected by the ACRIM III instrument, which is currently in orbit. (Graph by Robert Simmon, based on data from ACRIM III)

Variations in TSI are due to a balance between decreases caused by sunspots and increases caused by bright areas called faculae which surround sunspots. Sunspots are dark blotches on the Sun in which magnetic forces are very strong, and these forces block the hot solar plasma, and as a result sunspots are cooler and darker than their surroundings. Faculae, which appear as bright blotches on the surface of the Sun, put out more radiation than normal and increase the solar irradiance. They too are the result of magnetic storms, and their numbers increase and decrease in concert with sunspots. On the whole, the effects of the faculae tend to beat out those of the sunspots. So that, although solar energy reaching the Earth decreases when the portion of the Sun's surface that faces the Earth happens to be rife with spots and faculae, the total energy averaged over a full 30-day solar rotation actually increases. Therefore the TSI is larger during the portion of the 11 year cycle when there are more sunspots, even though the individual spots themselves cause a decrease in TSI when facing Earth.



The bright regions on the Sun that surround sunspots are called faculae. Although sunspots reduce the amount of energy radiated from the Sun, the faculae associated with them increase the radiated energy even more, so that overall, the total amount of energy emitted by the Sun increases during periods of high sunspot activity. (Image courtesy [Big Bear Solar Observatory])

The number of sunspots visible from the Earth not only changes from day to day, but also in cycles that can last from decades to centuries to millennia. The most well-known and well-analyzed of these cycles is the 11-year sunspot cycle. Over the course of 11 years, the yearly average number of sunspots and faculae slowly increases and then return to normal levels before rising again for the subsequent cycle. The change in the Sun's yearly average total irradiance during an 11-year cycle is on the order of 0.1 percent or 1.4 watts per square meter.



The 11-year solar cycle is manifested by the appearance and disappearance of large numbers of sunspots on the Sun's surface. The image series above shows the Sun at a wavelength of 656.3 nm, where Hydrogen emission just above the Sun's visible surface reveals increased energy coming from faculae. One image was taken every year from 1980 to 1989. 1980 was near a solar maximum and the Sun was active, while 1986 was near the minimum, and the Sun's surface was almost featureless. (Image adapted from The Sun: a pictorial Introduction by P. Charbonneau and O.R. White)

Another trend scientists have picked up on appears to span several centuries. Late 17th century astronomers observed that no sunspots existed on the Sun's surface during the time period from 1650 to 1715 AD. This lack of solar activity, which some scientists attribute to a low point in a multiple-century-long cycle, may have been partly responsible for the Little Ice Age in Europe. During this period, winters in Europe were much longer and colder than they are today. Modern scientists believe that since this minimum in solar energy output, there has been a slow increase in the overall sunspots and solar energy throughout each subsequent 11-year cycle.