THE SUNS OF M67

Dr. Mark Giampapa of the National Science Foundation's National Solar Observatory in Tucson, Arizona, has determined that the Sun is in a relatively moderate state of activity. Giampapa's observations of Sun-like stars in M67 suggest that about 40% of the time the Sun is likely to be either significantly more, or significantly less, active. A change to either of these states is likely to cause significant changes in the Earth's climate. These same observations also indicate excursions in the luminosity of the Sun from about 0.2% - 0.5% are possible, compared with the 0.1% variations that have been measured with modern satellite instruments during the 1980s and 1990s. Any variation in what is considered typical or normal solar activity must be taken into account in the study of long-term behavior of the global climate.

Using the WIYN (Wisconsin, Indiana, Yale, National Optical Astronomy Observatories) 3.5-meter telescope on Kitt Peak, Arizona, Dr. Giampapa and colleagues studied chromospheric emission lines in 106 Sun-like stars in the galactic cluster M67. Two fields of about 50 stars each in M67 were observed for nearly 20 hours from 1996 - 1998 with the Hydra multi-object fiber spectrometer. Interpreting the range of Ca II H and K emission observed in Sun-like stars in M67 as indicative of possible amplitudes of cycle-related variability that can occur in the Sun itself indicates about 42% of the solar-type stars in M67 exhibit levels of activity that are either greater than that seen at solar maximum or less than that seen at solar minimum. Giampapa's analysis shows that between 10-15% of the sun-like stars in M67 are distinguished by exceptionally quiescent levels of magnetic activity analogous to the so-called `Maunder-minimum' episode of the Sun during A.D. 1645 - 1715 when visible manifestations of solar activity vanished.
This period corresponded to a time of reduced average global temperatures on the Earth known as the "Little Ice Age." About 30% of the M67 Suns are in a state of enhanced activity compared to that seen at solar maximum. It is possible that the so-called 'Medieval warm period' during A. D. 900 - 1200 corresponded to a time of enhanced activity on our Sun.

M67 is an appropriate target of observations for the study of solar-type stars since it is approximately the same age and has the same chemical composition as the Sun. This method of observing a galactic cluster for variability in Sun-like stars allows us to efficiently gain insights on the potential long-term variability of the Sun that would not otherwise be possible with the modern solar Ca II synoptic database of just a few decades.

Variability on the scale observed could have consequences for the amplitude of irradiance variability that the Sun can exhibit and hence potentially influence global climate. Excursions in the activity itself could have an impact on the near-earth orbital environment with consequences for space operations.

In the Spring of 1999, Giampapa's team was allocated additional observing time at the WIYN telescope to monitor the solar-type stars in M67 in order to eventually obtain actual cycle periods, analogous to the 11-yr solar cycle. It would then be possible to directly compare and contrast the cycle properties of the solar twins with that of the solar cycle. A program of high-precision photometry is also planned, to directly measure luminosity variations in the M67 Suns, and to compare those variations with changes in activity as recorded with the WIYN observations.