Coronal Mass Ejections: The Long-Term Variation of Their Occurrence Rate and the Solar Wind Mass Flux

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Solar Coronal Mass Ejections (CMEs) from the Sun are an important aspect of coronal physics, and a potentially important contributor to the solar wind mass flux. However, despite significant progress in studies of CMEs since their discovery in the early seventies, questions remain about their effects on the interplanetary medium. ~~I report on a~~ study of the long-term variations of the occurrence rates of CMEs, of activity tracers related to CMEs, and of the solar wind particle flux. CMEs are most directly detected by scattered electron radiation in white light. To estimate their long-term occurrence frequency and their contribution to the in-ecliptic solar wind mass flux, observed CME rates must be corrected for instrumental duty cycles, detection efficiency out of the plane of the sky, mass detection threshholds, and geometrical considerations. ~~We evaluate~~ these corrections using data on solar CMEs from the spaceborne Skylab, SMM and SOLWIND coronagraphs and on interplanetary plasma clouds from the HELIOS white light photometers. ~~We then estimate~~ the variation in the CME rate and the contribution of CMEs to the solar wind mass flux over nearly a complete solar activity cycle. The main results are: 1) The occurrence rate of CMEs tends to track the activity cycle in both amplitude and phase; 2) The duty-cycle and visibility corrected CME rates determined with different instruments are not inconsistent; 3) In terms of long-term averages, no one class of solar activity tracer related to CMEs is better correlated with CME rate than any other; 4) Although the annual CME rate is not well correlated with the bulk solar wind mass flux, the ratio of the CME to the solar wind mass fluxes tends to track the solar cycle. The maximum proportion (at solar maximum) of 15-20% is considered potentially significant, since this applies to bulk, long-term averages and the short-term influence on the interplanetary medium of localized CME activity must be considerably greater.