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Long-Term Observations of Stream Interaction Regions and Interplanetary Coronal Mass Ejections: Venus, Earth, and Jupiter Orbits

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Two types of large-scale solar wind structures, stream interaction regions (SIRs) and interplanetary coronal mass ejections (ICMEs), can drive interplanetary shocks, generate or accelerate energetic particles, and affect the planetary ionosphere and/or magnetosphere. To quantify the properties of SIRs and ICMEs at different heliocentric distances, we have identified and characterized these structures based on consistent criteria using the in situ plasma and magnetic field observations. The data sets used are Pioneer Venus Orbiter at 0.72 AU (1979 – 1988), Wind/ACE at 1 AU (1995 – 2006), and three Ulysses aphelion passes at 5.3 AU (partial 1992, 1997 – 1998, 2003 – 2005, representing slices at different phases of the solar cycle). The long-term observations enable us to study the solar cycle variations of these two structures. The parameters relevant to space weather modeling, such as the structure duration, width, maximum dynamic pressure, maximum magnetic field intensity, average speed, speed variation, and other properties of SIRs and ICMEs are all examined at each distance. ICMEs can generally affect the planetary environment more than SIRs at Venus and Earth, especially around solar maximum. However, when they propagate to 5.3 AU, some ICMEs and SIRs merge and form hybrid events at Jupiter. In general, SIRs have greater dynamic pressure, interaction strength and field intensity than ICMEs at Jupiter, and therefore they affect the space environment more than ICMEs there.