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Predictions for Parker Solar Probe and Solar Orbiter: ICME evolution and GCR modulation in the innermost heliosphere

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Using observations from MESSENGER at Mercury, in conjunction with spacecraft at 1 AU and at Mars, we investigate how interplanetary coronal mass ejections (ICMEs) evolve and modulate galactic cosmic rays (GCRs) as they propagate through the inner heliosphere. MESSENGER, the first spacecraft since the 1980s to make in-situ measurements at distances < 0.5 AU, presents a unique opportunity for observing the innermost heliosphere and allows us to make testable predictions for the upcoming Parker Solar Probe and Solar Orbiter missions. We have cataloged shock-driving ICMEs at MESSENGER between 2011 and 2015; through statistical analyses and through case studies, we investigate key ICME property changes during propagation as well as changes with heliocentric distance in GCR modulation by ICMEs. Based on these studies, we hypothesize that: 1) ICMEs are less complex closer to the Sun, 2) ICME-driven GCR modulation is significantly stronger in the near solar environment than near 1 AU, 3) the size of Forbush decreases (Fds) diminishes exponentially with heliocentric distance in the inner solar system, and 4) 2-step Fds are more common closer to the Sun. The results from our studies give both a direct and indirect view of how ICMEs evolve during propagation as well as a glimpse of the inner heliosphere environment about to be explored by the Parker Solar Probe and Solar Orbiter missions.