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Identifying the source of multi-spacecraft SEP events

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With the launch of Solar Orbiter (SolO) together with STEREO A, and Wind it is again possible to study multi-spacecraft Solar Energetic Particle (SEP) events within 1 AU. Over the timespan from July 2020 up to June 2022, we identify 44 events for which a significant increase of ≥100 keV electrons has been observed for at least two spacecraft. The maximum longitudinal separation of the two furthest spacecraft ranges from ≥17 to ≥217 degree.

SEPs are expected to follow the Interplanetary Magnetic Field (IMF) which in zero-order approximation has the shape of Parker spirals. We investigate two different scenarios to identify the source of the widespread particle observation: (a) Particles are injected over a broad range of longitudes at the source surface without any perpendicular transport, hence by propagating along the IMF SEPs can be detected for distant observers. (b) Particles are injected over a narrow range of longitudes, but are distributed perpendicular to the nominal IMF by perpendicular diffusion. We discard events for which no unambiguously source location (e.g., flare) can be identified, or where an interplanetary coronal mass ejection is present. In order to investigate these scenarios a 2d SEP transport model is utilized. The simulated data are compared to selected SEP observations. We developed a χ^2 minimization code in order to determine the most probable injection and transport parameters.

Here, we present our first modeling results for a selected number of multi-spacecraft SEP events involving SolO. Furthermore, we note that the multi-spacecraft event observation can be a result of a combination of case (a) and (b).