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The roles of halo CMEs, solar energetic particle fluxes, and solar radio bursts in space weather forecasting

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The sporadic release of Coronal Mass Ejections (CMEs) from the Sun, and particularly halo CMEs having a significant Earth-directed motion, provides an important indication of upcoming disturbances in the interplanetary medium, potentially affecting the Earth. However, there is a wide spread of the intrinsic properties of CMEs, and not all are equally *geoeffective*. The observations of CMEs nevertheless plays a key role for space weather forecasts, but there are also important roles to play for other observables, particularly those indicating the presence of propagating shock waves in the solar atmosphere or in the interplanetary medium.

We have investigated the relations between halo CMEs for which alerts are issued, Solar Energetic Particle (SEP) fluxes, sweep-frequency solar radio bursts, and magnetic storms. We show that the usefulness of halo CMEs as predictors is strongly enhanced when combined with information on SEP fluxes, and a potential role for solar radio bursts in space weather forecast schemes is suggested. Results applicable to operational space weather forecasting are emphasized, and most of the work has been done as a part of the ESA Space Weather Applications Pilot Project.