El Niño-Southern Oscillation (ENSO) impacts on seasonal weather anomalies form the basis for skillful statistical seasonal weather prediction in the regions around the globe where the statistical links between ENSO and seasonal weather anomalies are strong. Amidst debate about how ENSO definitions might be improved for the purposes seasonal weather prediction, a warm-ENSO (El Niño) index based on outgoing longwave radiation (OLR) conditions in the tropical Pacific has recently been proposed and found to have a stronger statistical linkage to seasonal weather anomalies over the contiguous U.S. than the commonly used ENSO indices, which rely on sea surface temperature (SST) or sea level pressure (SLP) conditions. Here, a complimentary OLR-based cool-ENSO (La Niña) index is proposed and this pair of OLR-based ENSO indices is evaluated for their respective connections to global seasonal precipitation and atmospheric circulation anomalies using composite analysis. We find that over the period for which satellite-based OLR observations are available, almost all of the useful (statistically significant and consistent from event to event) ENSO impacts on seasonal precipitation are due to the years distinguished by the OLR-based ENSO indices ("OLR El Niño"; "OLR La Niña"). On the other hand, composites based on other years with ENSO status based on the current NOAA definition ("non-OLR El Niño"; "non-OLR La Niña") do not have nearly as robust or statistically significant anomaly patterns as the OLR ENSO events. Outside of some far western Pacific regions, their usefulness to continental seasonal precipitation forecasting efforts is much more limited than that of the OLR-events.