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Further Evidence for leaked Auroral Kilometric Radiation

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Auroral Kilometric Radiation (AKR), Earth's most powerful natural radio emission, has long been observed with satellites, but in recent years evidence has mounted that low intensities of this emission through some mechanism propagate downward, a component called "leaked AKR." AKR-like emissions were observed at South Pole Station on approximately half the nights during austral winters 2018-2020. The large number of events establish that ground-level "leaked AKR" has a similar magnetic local time distribution to that of escaping AKR. The distribution of intensities indicates a far lower power level. Observation at ground level requires darkness at ionospheric altitudes, and the frequency distribution of ground-level AKR-like emissions favors higher frequencies, as expected if "leaked AKR" comes from lower altitudes. Some events were correlated with escaping AKR observed with the Geotail and Cluster satellites at great distances from Earth. One mechanism for "leaked AKR" involves generation of both X-mode and Z-mode from the cyclotron maser instability depending on electron beta and wave frequency, with the Z-mode waves converting to whistler mode that can propagate to low altitudes. This mechanism suggests the possibility to observe identical fine structure in both leaked and escaping AKR. During 2018-2020, AKR was observed simultaneously at South Pole Station and with the high-resolution Cluster Wideband instrument during several conjunctions. The time and frequency variations of the simultaneously observed emissions sometimes show similar features. In these events, the estimated emitted power of the escaping AKR greatly exceeds that of the leaked AKR, suggesting that if the above mechanism applies, either the conversion from Z-mode to Whistler mode occurs via an inefficient process, and/or propagation conditions allow only a small fraction of the leaked AKR to penetrate the Earth-ionosphere boundary. Similar to satellite observations of escaping AKR, ground-level observations of leaked AKR may provide a tool for remotely sensing location, conditions, and processes in the auroral acceleration region.