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A perspective on substorm dynamics from 10 years of Auroral Kilometric Radiation

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Auroral Kilometric Radiation (AKR) is terrestrial radio emission that originates from high latitude magnetic field lines. The intensity of AKR increases when the magnetosphere is perturbed, and so can indicate the presence of driving from the solar wind. This is true for structures that can vary in scale such as pressure pulses, as well as substorm onsets that follow periods of negative turnings in the Z component of the interplanetary magnetic field. In the latter case, AKR intensification correlates with the strengthening of high-latitude current systems in the ionosphere as the magnetotail current is reconfigured. As well as this, morphological changes in the AKR source region have also been observed to coincide with substorm onset, with an intensification of the AKR emission often accompanied by a low frequency extension, interpreted as an expansion of the source region to higher altitudes along the field line. Although the directivity and source region localisation of AKR make the observations highly dependent on observer local time and latitude, we isolate AKR from Wind radio observations made over a decade and examine the observations with respect to the spacecraft viewing position, accounting for such effects. Using lists of substorm onsets, we examine the AKR power and the spectral extent of the emission with respect to the substorm timeline, expanding on previous studies of the AKR response. Results show a clear increase in AKR power that precedes substorm onset by approximately 20 minutes, and confirm a proportionally higher intensification in lower frequency AKR sources. This in turn indicates quantitatively the spatial response of parallel electric fields after the loading of magnetic flux during substorm growth phase. In characterising the typical AKR response during substorms, these results can inform observations of magnetospheric changes during sudden commencement events and those that are seperate from substorm dynamics.