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# Statistical study of oxygen ion cyclotron harmonic waves observed by Van Allen Probes

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We report the first statistical survey of the oxygen ion cyclotron harmonic waves observed by Van Allen Probes throughout the mission. An example event observed on 19 February 2014 after a strong magnetic storm and a substorm was first presented to demonstrate the general properties of OCH waves. The observed waves have multiple spectral peaks around harmonics of the oxygen ion gyrofrequency. During the event, oxygen ionsof 10s keV had a ring-like partial shell velocity distribution which might have driven the wave excitation through the oxygen ion Bernstein instability. On the other hand, the phase space densities of $He^+$ and $O^+$ less than a few hundred eV were larger around 90° pitch angle, indicating transverse heating of these ions. Our statistical study shows that the waves occurred over $2 < L < 6$ and across all magnetic local time. More than 50% of the events were observed just outside the plasmapause, and the typical wave amplitude is between ~0.1 and several nT. The frequency spacing between two consecutive wave harmonics decreases with increasing L but stabilizes when $L > 5$. The frequency spacing is larger than the local oxygen ion gyrofrequency for many events, especially those observed at larger L, suggesting that these waves propagated there from lower L shell regions. The waves are mainly on the dayside at $L > 4$ under quiet geomagnetic conditions, but can occur at lower L shells with a more uniform MLT distribution under more active geomagnetic conditions.