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► To cite this version:

Oleksiy Agapitov, Anton Artemyev, Didier Mourenas, Forrest Mozer, Vladimir Krasnoselskikh. Non-linear local parallel acceleration of electrons through Landau trapping by oblique whistler mode waves in the outer radiation belt. EGU General Assembly 2016, Apr 2016, Vienne, Austria. insu-03573523

HAL Id: insu-03573523

<https://insu.hal.science/insu-03573523v1>

Submitted on 15 Feb 2022

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Nonlinear local parallel acceleration of electrons through Landau trapping by oblique whistler mode waves in the outer radiation belt

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Simultaneous observations of electron velocity distributions and chorus waves by the Van Allen Probe B are analyzed to identify long-lasting (more than 6 h) signatures of electron Landau resonant interactions with oblique chorus waves in the outer radiation belt. Such Landau resonant interactions result in the trapping of $\sim 1\text{--}10$ keV electrons and their acceleration up to 100–300 keV. This kind of process becomes important for oblique whistler mode waves having a significant electric field component along the background magnetic field. In the inhomogeneous geomagnetic field, such resonant interactions then lead to the formation of a plateau in the parallel (with respect to the geomagnetic field) velocity distribution due to trapping of electrons into the wave effective potential. We demonstrate that the electron energy corresponding to the observed plateau remains in very good agreement with the energy required for Landau resonant interaction with the simultaneously measured oblique chorus waves over 6 h and a wide range of L shells (from 4 to 6) in the outer belt. The efficient parallel acceleration modifies electron pitch angle distributions at energies $\sim 50\text{--}200$ keV, allowing us to distinguish the energized population. The observed energy range and the density of accelerated electrons are in reasonable agreement with test particle numerical simulations.