Geophysical Research Abstracts
Vol. 17, EGU2015-9013, 2015
EGU General Assembly 2015

Understanding the theta aurora

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The theta aurora, first observed by Dynamics Explorer in the 1980s, is a configuration of the Earth's aurora in which auroral emissions extend into and across the polar cap in the form of a transpolar arc. It is well established that the theta aurora occurs predominantly when the interplanetary magnetic field has a northward component, but over the last thirty years various mechanisms have been put forward to explain this intriguing phenomenon. In the last couple of years, a range of evidence has accumulated which strongly suggests that the transpolar arc is formed as proposed by Milan et al. (2005): magnetotail reconnection occurs during intervals of northward IMF, which results in a local "wedge" of closed magnetospheric flux that remains trapped in the magnetotail. Precipitation on these closed field lines results in the transpolar arc analogously to the formation of the aurora in the main oval. Evidence for magnetotail reconnection as the cause of the theta aurora includes the timescales necessary to influence the location at which the transpolar arc forms, and the presence of characteristic ionospheric flows which are excited by magnetotail reconnection and which are statistically associated with transpolar arcs (Fear & Milan, 2012a,b). Most recently, direct observation has been made of a localised wedge of closed magnetic flux, "trapped" in the lobe, which was observed to move back and forth in a manner which (to our knowledge) can only be explained by the magnetotail reconnection mechanism (Fear et al., 2014). In this talk, we summarise the evidence for the formation of the theta aurora by magnetotail reconnection, and discuss the remaining challenges in obtaining a comprehensive understanding of this spectacular phenomenon.