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Expansion and Contraction of the Auroral Oval Area

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The aurora is a visible manifestation of Earth's coupling to near-Earth space. The emitted light is produced by charged particles that precipitate into the upper atmosphere. These particles are usually located on closed magnetic field lines that connect directly between the northern and southern hemisphere. As a result, Earth's aurora often appears in an oval shape surrounding the magnetic pole. Inside the oval, at high magnetic latitudes, is a region with open magnetic field lines that extend into the solar wind. This region of open magnetic flux is the polar cap and is a consequence of the Dungey cycle: Reconnection between the solar wind magnetic field and closed terrestrial field lines at the dayside magnetopause produces open field lines which are transported to the nightside where they are again closed by reconnection. A fundamental property of the magnetosphere-ionosphere system is that changes in the amount of open magnetic flux is equal to the net difference between the dayside and nightside reconnection rates. That is, the polar cap expands when dayside reconnection dominates and contracts when nightside reconnection dominates. This is known as the expanding/contracting polar cap paradigm, and has been studied extensively in the last few decades. The expansion and contraction of the aurora itself has received less attention. In this work, we use global auroral images to study the spatiotemporal evolution of the auroral oval. We investigate how the solar wind, open flux and auroral flux covary. Furthermore, we attempt to determine how well a pure fluid description of the auroral zone can explain the observed evolution.