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The Large-Scale Current System During Auroral Substorms

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The substorm process has been discussed for more than four decades and new empirical large-scale models continue to be published. The continued activity implies both the importance and the complexity of the problem.
We recently published a new model of the large-scale substorm current system (Gjerloev and Hoffman, JGR, 2014). Based on data from >100 ground magnetometers (obtained from SuperMAG), 116 isolated substorms, global auroral images (obtained by the Polar VIS Earth Camera) and a careful normalization technique we derived an empirical model of the ionospheric equivalent current system. Our model yield some unexpected features that appear inconsistent with the classical single current wedge current system. One of these features is a distinct latitudinal shift of the westward electrojet (WEJ) current between the pre- and post-midnight region and we find evidence that these two WEJ regions are quasi disconnected. This, and other observational facts, led us to propose a modified 3D current system configuration that consists of 2 wedge type systems: a current wedge in the pre-midnight region (bulge current wedge), and another current wedge system in the post-midnight region (oval current wedge). The two wedge systems are shifted in latitude but overlap in local time in the midnight region.
Our model is at considerable variance with previous global models and conceptual schematics of the large-scale substorm current system. We speculate that the data coverage, the methodologies and the techniques used in these previous global studies are the cause of the differences in solutions. In this presentation we present our model, compare with other published models and discuss possible causes for the differences.