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A new methodology for the development of high-latitude ionospheric climatologies and empirical models

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Many empirical models and climatologies of high-latitude ionospheric processes, such as convection, have been developed over the last 40 years. One common feature in the development of these models is that measurements from different times are combined and averaged on fixed co-ordinate grids. This methodology ignores the reality that high-latitude ionospheric features are organised relative to the location of the ionospheric footprint of the boundary between open and closed geomagnetic field lines (OCB). This boundary is in continual motion, and the polar cap that it encloses is continually expanding and contracting in response to changes in the rates of magnetic reconnection at the Earth's magnetopause and in the magnetotail. As a consequence, models that are developed by combining and averaging data in fixed co-ordinate grids heavily smooth the variations that occur near the boundary location. Here, we propose that the development of future models should consider the location of the OCB in order to more accurately model the variations in this region. We present a methodology which involves identifying the OCB from spacecraft auroral images and then organising measurements in a grid where the bins are placed relative to the OCB location. We demonstrate the plausibility of this methodology using ionospheric vorticity measurements made by the SuperDARN radars and OCB measurements from the IMAGE spacecraft FUV auroral imagers. This demonstration shows that this new methodology results in sharpening and clarifying features of climatological maps near the OCB location. We discuss the potential impact of this methodology on space weather applications.