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The Quantification of Auroral Patches: Musings of a Neuroscientist

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The aurora is a consequence of processes occurring in the near-Earth space environment. Details about auroral structure and behavior can provide clues about plasma processes occurring in regions of space that are rarely sampled by spacecraft. By using the aurora to indirectly measure aspects of plasma dynamics we can gain a system-level snapshot that would not otherwise be observable. One common type of aurora is patchy aurora, which refers to irregularly shaped "blobs" that form a characteristic patch pattern in auroral image data. Patches are most often observed at mid- to low-auroral latitudes, equatorward of the peak in the proton aurora. One of the remarkable features of patchy aurora is the apparent coherent and relatively consistent shape of the patches, which can be present for minutes at a time in the field of view of a single all-sky camera. The structure of an individual patch is often maintained as it drifts in longitude through a camera field of view. This behavior is thought to be a consequence of both plasma dynamics and structure in the region Earthward of the central plasma sheet. Here we describe a cross-disciplinary approach to quantifying auroral patches. Statistics are derived from a collaboration between the fields of neuroscience and space physics. Specifically, we employ a modified stereological approach to quantify length and orientation of patchy aurora. Stereological quantification has been successfully employed within the neurosciences to estimate the length, volume, or number of objects within a specific region of interest. One of the central tenets of stereology is the random, systematic sampling method, which has been demonstrated as both highly accurate and efficient. We adopt a modified stereological procedure, using random, systematic sampling to produce an unbiased estimate of patch length and orientation within the aurora. The output of this procedure can also be adapted to follow individual patches and produce velocity fields in a given image. These techniques allow us to quantify the evolution of both individual patches, and the patchy aurora region as a whole. We also discuss the future possibility of using this technique to produce a semi-automated convection map for specific events. We assert that these maps will provide a time-evolving picture of the 2D convection velocity in the ionosphere with excellent spatial and temporal resolution.