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Creation of Forward Modeling Algorithms for Optical Instrument Deployment Planning

Matthew Cooper[(1)], Joseph Hughes[(1,2)], Austin Egert [(1)], Jeffrey Steward[(1)], Ian Collett[1)], John Noto[(1)] anf Junk Wilson[(1)],
(1) Orion Space Solutions (an Arcfield Company), Louisville, CO, USA, https://orion.arcfield.com
(2) Northwest Research Associates, Boulder, CO, USA

The polar atmosphere's neutral component has historically been difficult to observe compared to its ionized companion which responds to electromagnetic measurement techniques. Most techniques for attaining information on the neutral component utilize naturally occurring emission lines from various neutral species and molecules such as nitrogen, oxygen, hydroxyl, and heavy metals. Such techniques require high precision instrumental components, making the instrumentation required to attain such measurements costly to build, field, and maintain. This constrains the size of such an instrument fleet, prompting a fundamental inquiry: Where are the most ideal locations these instruments should be fielded? At Orion Space Solutions, we've been developing a forward-modeling algorithm capable of predicting observations of aeronomic Fabry-Perot interferometers (FPIs). This forward-model begins with the output of first-principles models such as the Thermosphere-Ionosphere-Electrodynamics General Circulation Model (TIE-GCM) or the Global Ionosphere-Thermosphere Model (GITM). The GLobal airglOW (GLOW) model is then run utilizing the outputs from TIE-GCM or GITM to calculate the 3D emission rate for various emission lines. This emission rate grid, along with the zonal, meridional, and vertical wind speed output grids, are then interpolated onto the line-of-sight vector for the imager. It then calculates probability density functions for the particle speeds of the neutral gas as each interpolated point along the line-of-sight. Finally, these speed distributions and emission rates are integrated to get the probability density and brightness at the aperture. This should enable judicious deployments to maximize the contribution of such instruments for studying the ion-neutral ensemble gas response during high-latitude geomagnetic events.