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An automated framework for 3D data-constrained modeling of the coronal magneto-thermal structure of solar active regions[1]

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Data-constrained modeling of the coupling between the magnetic and thermal structures of solar active regions (ARs) is a crucial step towards understanding the source region of flares and coronal mass ejections. GX Simulator is a publicly available data-constrained 3D modeling package distributed through the SolarSoftWare (SSW) IDL repository, which has been developed for modeling multiwavelength emission in the microwave, X-ray, and EUV ranges from flaring loops (Nita et al. 2015, ApJ 799, 236) and solar active regions (Nita et al. 2018, ApJ 853, 66). To facilitate its use, a fully automatic GX Simulator-compatible model production pipeline (AMPP) has been developed. Based on minimal user input, provided as a script or through an intuitive graphical user interface (GUI), the AMPP downloads the required vector magnetic field data produced by the Helioseismic and Magnetic Imager (HMI) onboard the Solar Dynamics Observatory (SDO) and, optionally, the contextual Atmospheric Imaging Assembly (AIA) maps, performs potential and/or nonlinear force free field extrapolations, populates the volume with thermal coronal models that assume either steady-state or impulsive plasma heating, and generates non-LTE density and temperature distribution models of the chromosphere that are constrained by photosphere-level measurements. The standardized models produced by AMPP may be further customized through a set of GX Simulator interactive GUI tools, but the iterative search for the best model parameters for agreement between the model and observations is a time-consuming task that calls for a more efficient, automated approach. To this end, we have developed a coronal heating modeling pipeline (CHMP), which is a fully automated multi-threaded search engine that adaptively steps through a multi-dimensional parameter space to produce parametrized test models and generate synthetic maps, which are automatically compared with the reference observational data until the desired level of agreement is achieved, as measured by objective data-to-model comparison metrics. In this presentation, I will describe the architecture of the AMPP and CHMP components of the GX Simulator package and demonstrate their functionality in the case of a particular solar active region

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