Open-Source High-Performance Flux Transport

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The NASA-NSF sponsored Space Weather with Quantified Uncertainty (SWQU) project's main objective is to develop a data-driven, time-dependent, open source model of the solar corona and heliosphere. One key component of the SWQU effort is using a data-assimilation flux transport model to generate an ensemble of synchronic radial magnetic field maps as boundary conditions for the coronal field model. To accomplish this goal, we are developing a new Open-source Flux Transport (OFT) software suite. While there are a number of established flux transport models in the community, OFT is distinguished from many of these efforts in 3 key attributes: (1) It is based on modern computing techniques that will allow many realizations to be rapidly computed on multi-core systems and/or GPUs, (2) it is designed to be easily extensible, and (3) OFT will be released as an open source project. OFT consists of three software packages: 1) OFTpy: a python package for data acquisition, database organization, and Carrington map processing, 2) ConFlow: a Fortran code that generates super granular convective flows, and 3) High-Performance Flux Transport (HipFT): a modular, GPU-accelerated Fortran code for modeling surface flux transport with data assimilation. Here, we present the current state of the OFT project, key features and methods of OFTpy, ConFlow, and HipFt, and real-world examples of data-assimilation and flux transport with HipFT. Validation and performance tests are shown, including generating an ensemble of OFT maps.

Publication: AGU Fall Meeting 2022, held in Chicago, IL, 12-16 December 2022, id. SH15D-1508.

Pub Date: December 2022

Bibcode: 2022AGUFMSH15D1508T