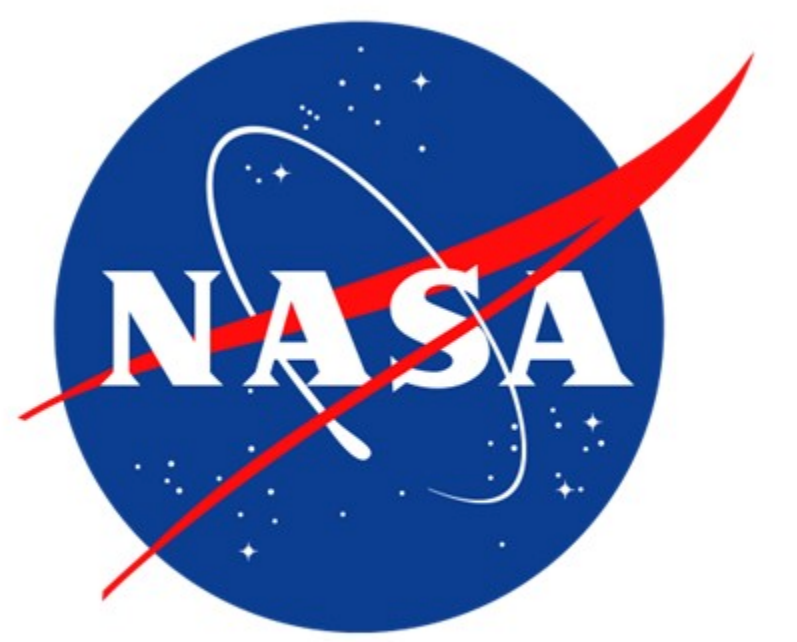


MissionDPT: Simulation and forecasting of radiation doses and health risks for space exploration missions

National Aeronautics and Space Administration



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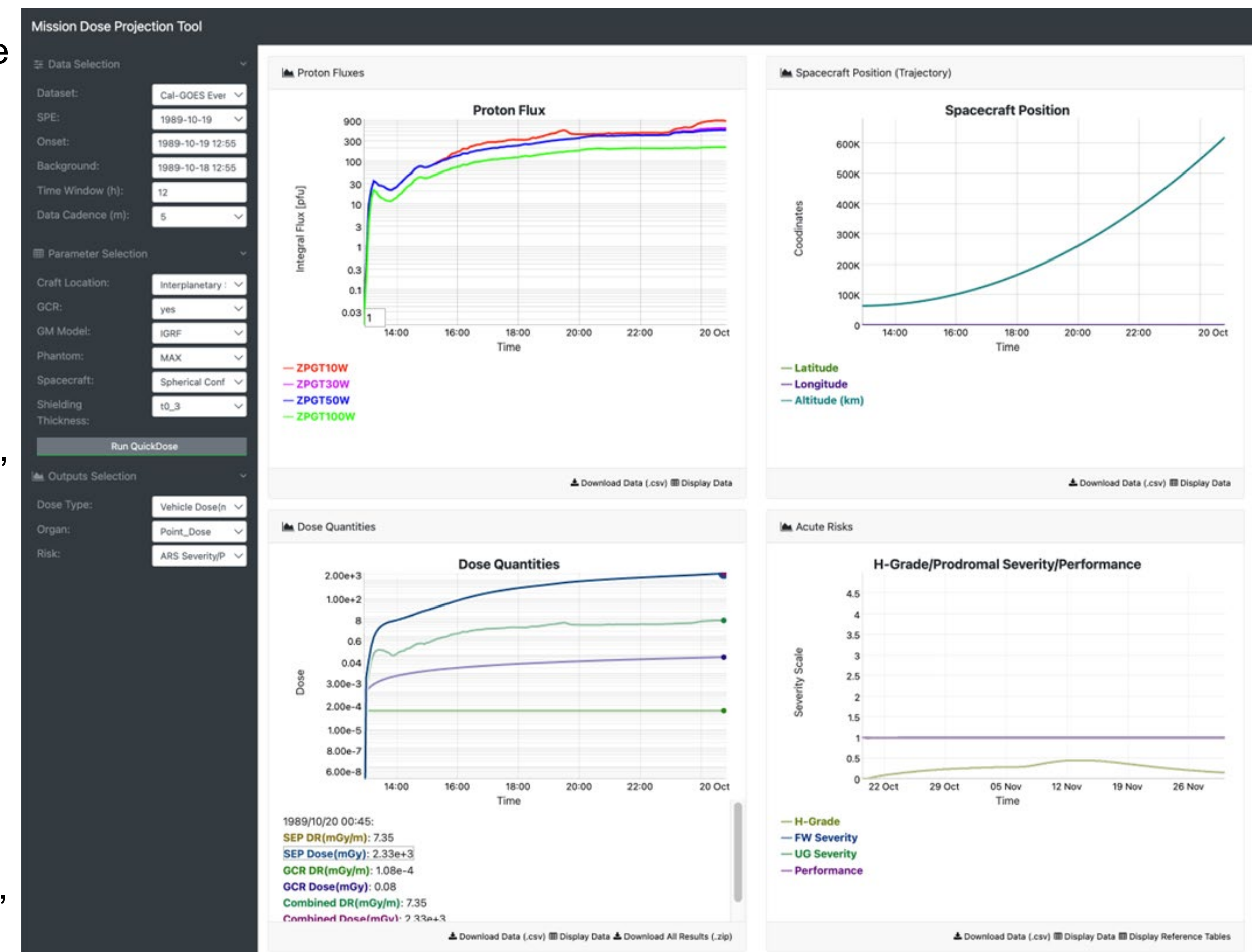
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Overview

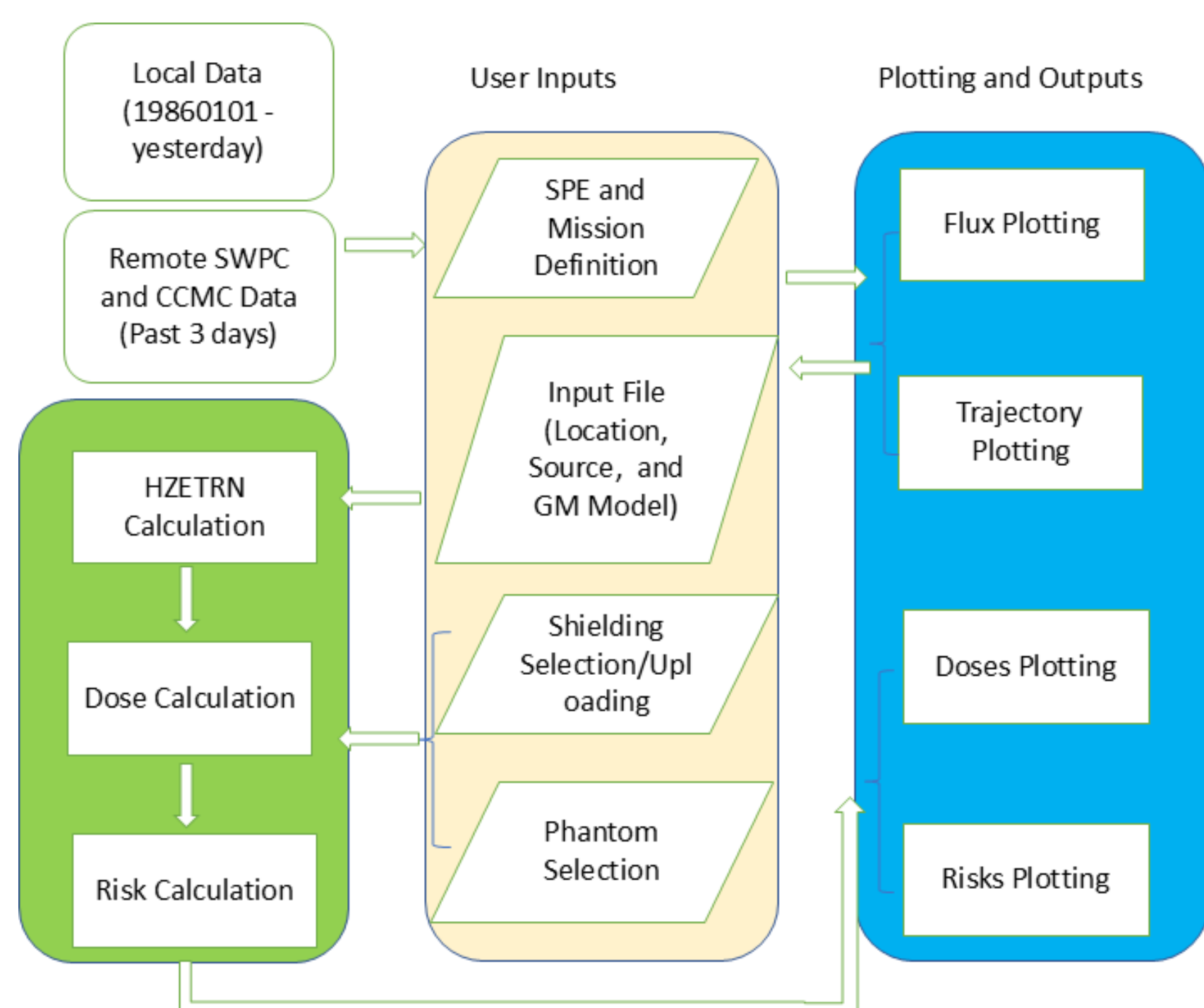
- Advances in space radiation environment, physics, transport models, and biological responses offer many established models and codes to describe the radiation field and risks in space.
- MissionDPT (Mission Dose Projection Tool) incorporates the most up-to-date space radiation models and codes with simple input and output interface, enables interested users to calculate dose quantities and estimate acute risks for various exploration missions.
- It also integrates the University of Malaga Solar particle Event Predictor (UMASEP) models to provide forecasting capability for dose and risk projection of solar particle events in real time or for historical cases.

Interface

- About 160 SPEs since 1986 with time profiles and updated in real time
- Proton flux retrieved from GOES 06-18 with energies calibrated with ground neutron monitors
- Craft locations: free space, lunar surface, LEO and transit
- Sources: GCR, SEP, trapped proton and electron
- 3 geomagnetic models: IGRF14, T96, TS05
- Phantom models: CAM, CAF, MAX, FAX, no phantom
- Shielding files of MPCV detectors, crew locations, ISS detectors, and user supplied.
- BFO, skin, and detector doses in Gy, Gy-Eq, and Sv
- Acute risks: fatigue and weakness, upper gastrointestinal, hematopoietic, and performance degradation.



Workflow

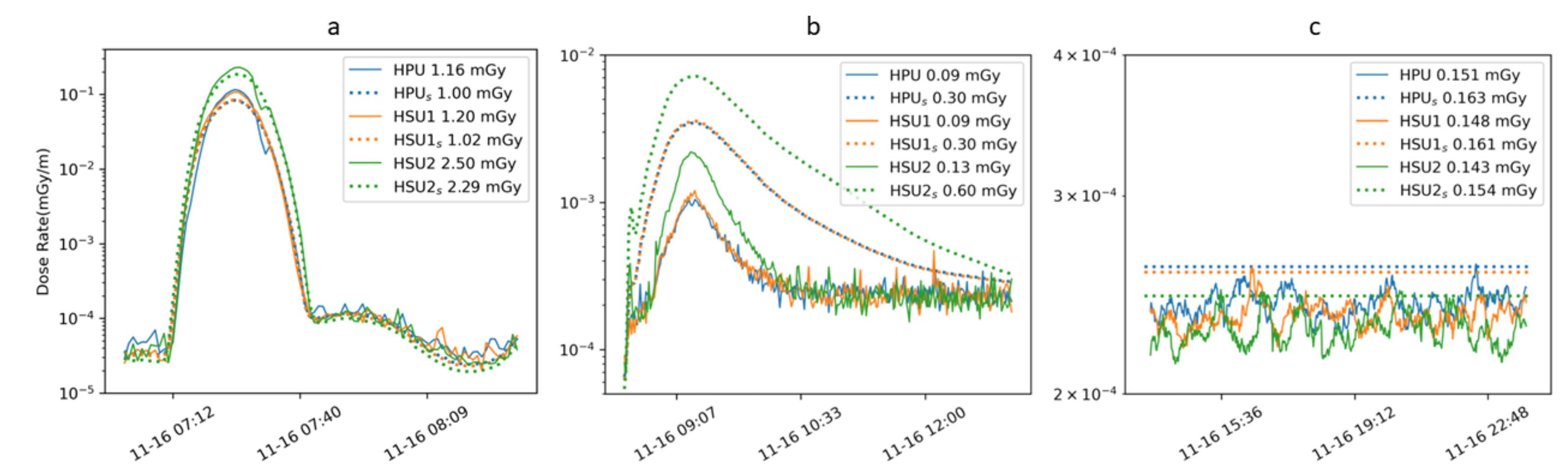


- 5-minute cadence differential proton flux are reprocessed with calibration energies and stored locally
- The calculation cadence can be 1, 5, 10, 15, 30, and 60 minutes
- All codes are modular and can be easily updated, with transport code HZETRN 2020, GCR code BON2020 and trapped code AP9/AE9 as default.
- All calculations run on slurm-managed cluster, each 1440 points run can be finished within minutes for any mission.

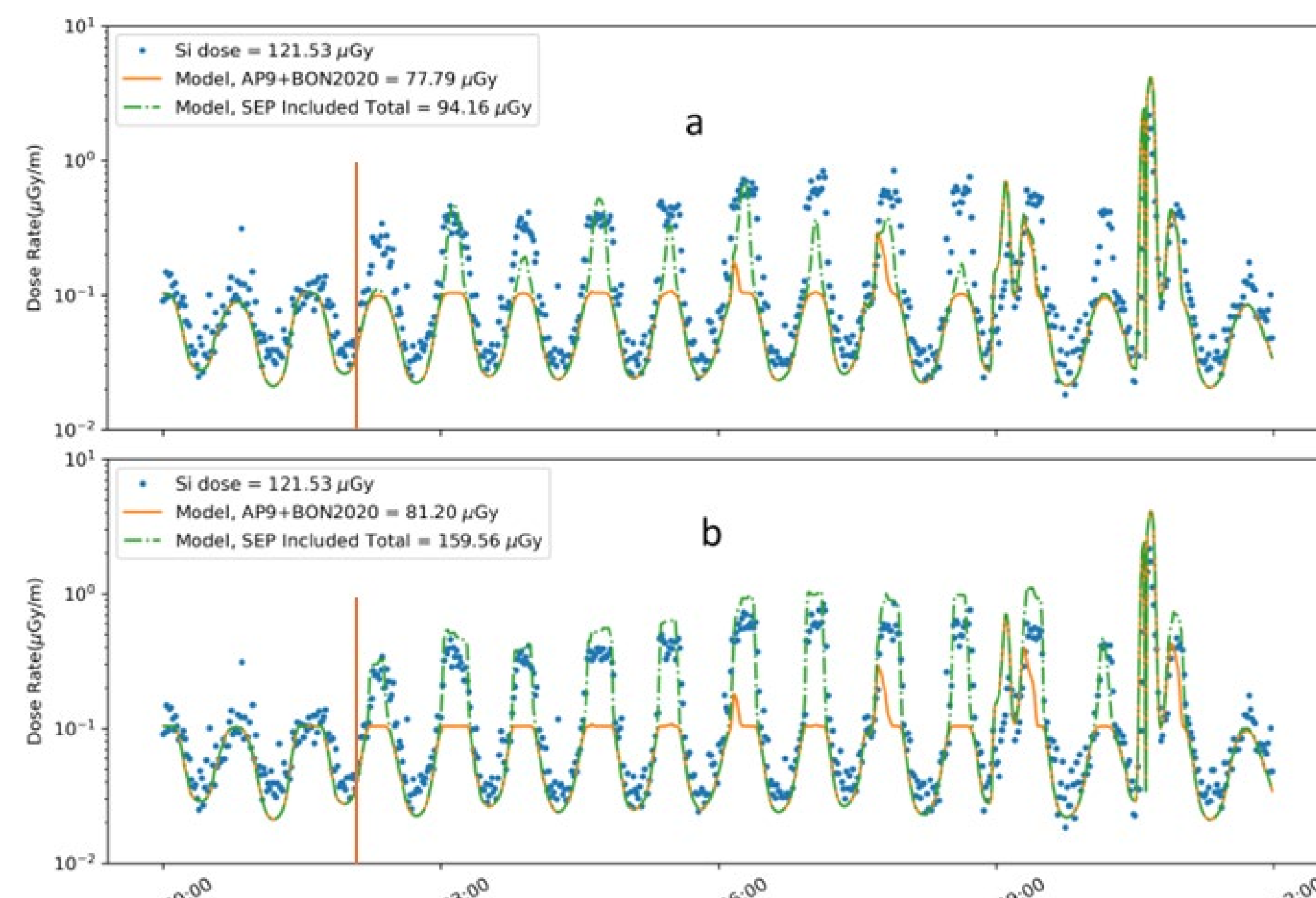
Advantages of using MissionDPT

- It allows engineers and scientists to run complete radiation analyses for exploration missions without being an expert in the various codes and models.
- Quick results can be obtained for dose rates of a user selected cadence that can be compared with dosimeter measurements in real time or after the missions.
- The continuous Cal-GOES dataset spanning over 40 years (1986-present) provides a library of SPEs to do analyses and compare various strategies to mitigate exposure and risk of severe SPEs for specific missions.
- The embedded UMASEP forecasting models can provide dose information before or near the onset of SPEs.

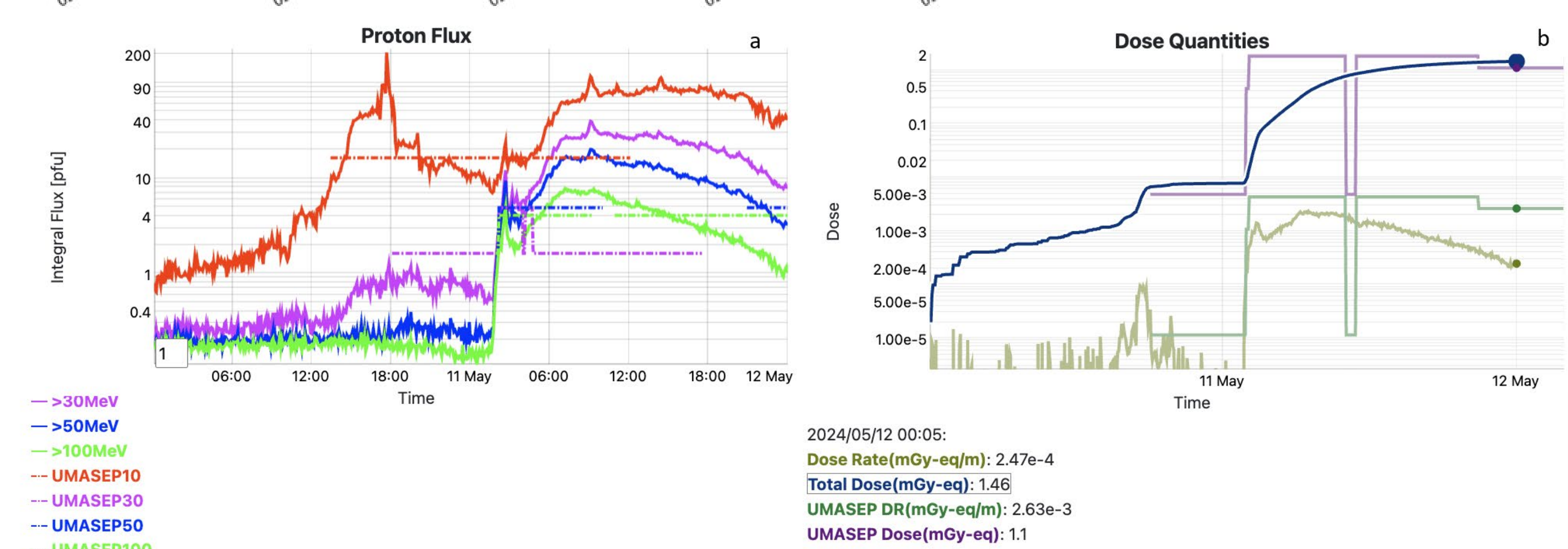
Mission dose simulations



Measurements and simulations of the dose rates of HERA sensors during the Artemis I inner proton belt pass (a), outer electron belt pass (b), and GCR only for the first day of the mission (c). Legends show the total Si doses for measurements (HPU, HSU1, and HSU2) and simulations by MissionDPT (HPU_s, HSU1_s, and HSU2_s).



ISS-RAD measurements for the first half day of the 2024-05-11 event and MissionDPT simulations with IGRF14 geomagnetic model only (a) and with IGRF14+TS05 models (b). The red vertical lines indicate the onset of the event (2024-05-11 02:05 UTC).



UMASEP forecasting of the 2025-11-10 event (a) and dose projection with MissionDPT (b).