COR System Error Estimation

cor.crmodels.org

Ján Villim[1], Pavol Bobík[2], Daniel Gecášek[1], Ján Genči[1]
Technical University of Košice[1], Institute of Experimental Physics SAS[2]

COR System

The COR (Cut-Off Rigidity) system provides models for simulating cosmic ray trajectories in the Earth's magnetosphere. It offers a service to run the calculations as well as an environment to do preliminary analysis and visualizations. COR system is available at: https://cor.crmodels.org/ [1].

COR Model

The COR system includes a program that produces calculated cut-off rigidities for CR trajectories. It solves the Lorentz force equation in the geomagnetic field calculated by Tsyganenko 05 and IGRF models to calculate the trajectory of a CR particle. Code is available on: https://github.com/COR-Cut-off-rigidity/Trajectories_IGRF_T04_C.

Error Estimation

We have developed a method that allows us to estimate results error in connection with the rigidity step size used in calculations. It involves running multiple calculations on the same place each with different rigidity step size. By lowering the step size, cut-off rigidity values should converge to a certain value (Fig. 1). Based on this we can choose maximal step size for 1% accuracy of the results (Fig. 2).

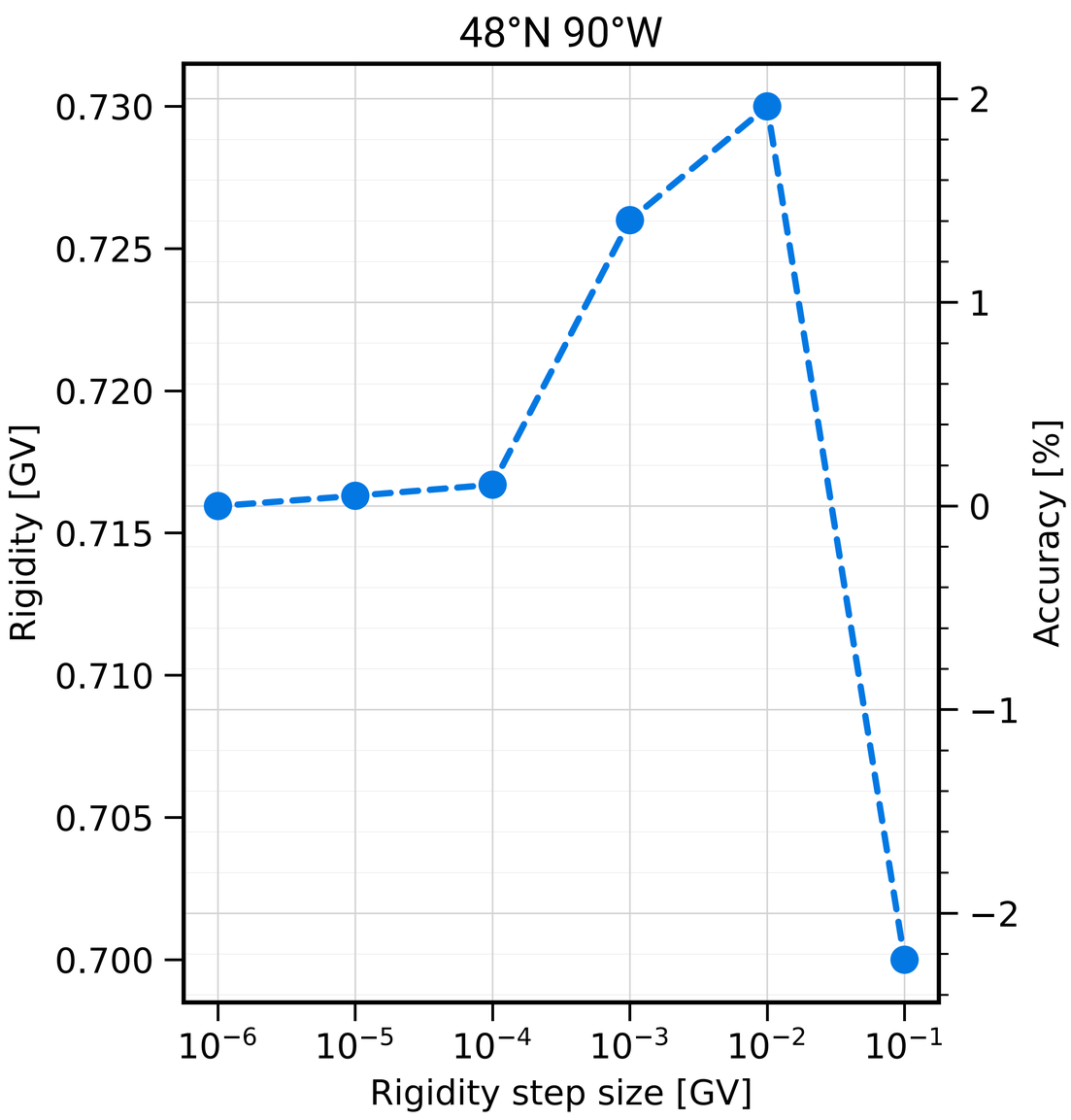

Fig. 1: Example of effective cut-off rigidity dependency on the size of rigidity step used in the calculation for the selected point. In this case, better than 1% accuracy is achieved with step size 10^{-4} GV.

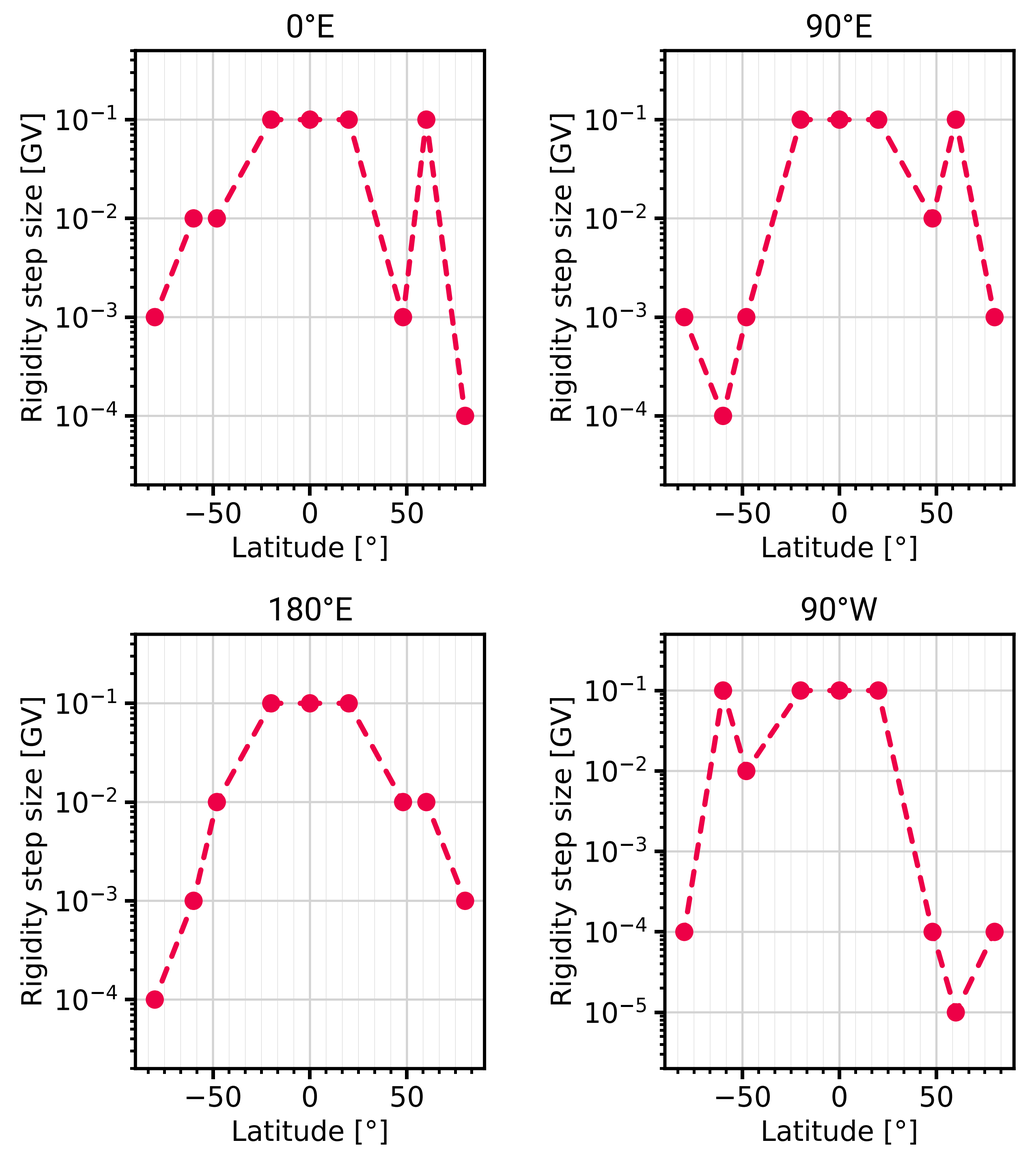

Fig. 2: Dependencies of error estimation on latitude for selected longitudes. This figure shows the optimal rigidity step size for given coordinates to achieve at least 1% accuracy of cut-off rigidity estimation.

Conclusion

We introduced the method to estimate the error of cut-off rigidity. We set a 1% error criterium in value of effective cut-off rigidity and estimate the maximal rigidity step needed to reach this criterium for different geographical locations. While for low latitude positions step 0.1 GV is sufficient, for middle latitude and polar regions smaller step is needed, with values reaching ~0.0001 GV.

References

[1] Daniel Gecášek, Pavol Bobík, Ján Genči, Ján Villim, Martin Vaško, COR system: A tool to evaluate cosmic ray trajectories in the Earth's magnetosphere, Advances in Space Research, 70, 4, 2022, 1153-1168, https://doi.org/10.1016/j.asr.2022.06.001.

Faculty of Electrical Engineering and Informatics

ÚEF SAV

jan.villim@student.tuke.sk