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Final Project Proposal

Auroral particle transport using Monte Carlo methods

(Following the process outlined by Solomen et al 1993)

Auroral particle transport is one of many important processes in that contribute to the peak ionization rate of particles in the atmosphere. There are a few different analytical methods used determine the ionization rate as a function of height. All methods are highly involved and require parameters measured in a wide range of experiments and observations, and a developed theoretical framework. I propose to use Monte Carlo simulations to measure the ionization rate using the work in *Solomon* [2001]. My version will be less involved in order to fit my time constraint for this project, but will still invoke same degree of randomization used in the paper.

The basics of the algorithm are as follows:

1. Use a random energy Gaussian distribution of particles which then enter the atmosphere at some altitude Zmax. Label this as the primary particle energy Ep.
2. Similar to optical depth (Beer-Lambert law), the "electrical depth" is the distance an electron travels based on the sum of interaction cross sections defined per species. The initial moved distance is based on a random variable fitted to an exponential parameterized by tabular values.
3. The type of interaction (ionization, elastic, dissociation, excitation) is determined randomly and weighted by the interaction cross section.
4. My project will simply use ionization and elastic collisions for simplicity. If the collision is elastic, it moves farther into the atmosphere a random distance as in Step 2 and continues again. If the collision is ionizing, we create a secondary particle with random energy Es and continue to Step 5.
5. Reduce Ep and complete the process back at Step 2 for the primary particle Ep until Ep<0.25 or it exits our atmosphere boundaries. Save all second generation particles with energy Es.
6. Continue the process one-by-one for second generation particles saving their tertiary generations until second generation particles reach the exit condition in Step 5.
7. Repeat for future generations

The project will fit the criteria listed below.

- **Generation of basic random variates, demonstrate their randomness.**

This project will use both uniform randomization and Gaussian distributions for the initial conditions and at individual steps in the algorithm.

- **Define the project system.**

Described above.

- **Model the system with a flow chart with sub-models or elements.**

The individual steps in the project can easily be modeled with a flow chart following the procedure described above.

- **Code the RB generators for the relevant stochastic processes using the random number generators available in ROOT.**
- **Code the Complete simulation package in your preferred programming language.**

I'd like to request that I complete the project with MatLab, since I am proficient with the language.

- **Build the criteria for a specific event to happen.**

Random variates are based on various parameters such as the Beer-Lambert law, defined by tabulated cross sections and the event of secondary electron generation is also based on a number of different cross sections.

- **Some comparative statistics analysis for the system being simulated in an adaptive fashion, and give some recommendations based on the analysis.**

I will compare ionization results with more recent studies and other ionization mechanisms in the atmosphere. Since my project will be simpler than the paper I'm following I will also visually compare with his results and determine how well a simplification of his model performs.