theRadiationProject

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Introduction

Earth's magnetosphere shields us from most of the cosmic radiations and the solar energetic particles that are constantly irradiated on the Earth from the Sun as well as other sources. However, this shielding effect is absent near the magnetic poles, which results in a lot of harmful radiation infiltrating to the higher altitudes in the atmosphere. Thus, polar or near-polar flights are exposed to this radiation, which may pose serious health issues for pilots, flight crew and other frequent fliers.

Our Objectives

- Finding the energy flux at the location of the flight
- Computing the effective dose rate for the human, according to our normalized scale.

Methodology

- Computing the energy flux at the atmospheric limit. Taking into consideration the absorption of particle energy by the atmosphere, and obtaining the reduced energies of particles to get the absorption of energy by various tissues in the human body.
- Computing the trajectory of a flight between endpoints and displaying flight path, computation results (effective dose rate and normalized dose vs time plot).

Calculation Flow

❑**$L=\theta'/(\sin\theta')^2$** *(where θ' is the colatitude of a point, L is the field line)*

❑**$\alpha o = \arcsin((4L^6 - 3L^5)^{(-1/4)})$** *(where αo is the loss cone angle, beyond which the particles fail to bounce back)*

❑**$P(\alpha<\alpha o)=\alpha o/90$** *(=probability of a particle entering the earth's atmosphere)*

❑**$S=-dE/dx$** *(where S is the stopping power, dE is the energy absorbed by a material, dx is the unit length of material through while the particle passes)*

❑**$E=Eo - Fk.P(\alpha<\alpha o).\int S(Eo).\rho(x).dx$** *(where S(Eo) is the stopping power of the atmosphere as a function of the gradually reduced energies; $\rho(x)$ is the density of the atmosphere; Fk is the particle flux recorded by the GOES satellite; E is the energy that the particle has when it reaches the airplane location)*

❑**Effective dose=sum(wT.S(T,E).Fk.P(α<αo))** *(where wT is the tissue weighing factor; S(T,E) is the stopping energy for penetrating energy E and tissue T; This value is summed over all tissues T to get the effective dose)*

[The above equations are taken over all types of particles with different energies to get the total effective dose.]

The highest and lowest values of energy flux at the location of the flight was estimated by considering extreme polar and equatorial regions, at sea level. This was used to normalize the effective dose to a 0-1 scale that was more comprehensible in layman terms.

Conclusion

❑ Our model predicts a layman-understandable measure of radiation exposure of a person.

❑ We derive real-time data for electron flux from the GOES satellites.

Future Work

❑ With more accurate data on all the tissue weighing factors, we could provide more accurate results for the effective dose computation.

References

❑Mertens, Christopher J., et al. "Geomagnetic influence on aircraft radiation exposure during a solar energetic particle event in October 2003." *Space Weather* 8.3 (2010): 1-16.

❑https://physics.nist.gov/PhysRefData/Star/Text/ESTAR.html

❑https://www.swpc.noaa.gov/products/goes-electron-flux