Pathways FALL 2017 Rotation Debriefing

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Pathways Internship / CoOp

The NASA Pathways Intern Employment Program (IEP) is open to current students and individuals accepted for enrollment in qualifying educational programs. The IEP provides opportunities to work and explore careers while still in school. Intern appointments may be for indefinite periods without not-to-exceed (NTE) dates or appointments with NTE dates of up to one year. If you successfully complete an Intern appointment without an NTE date at NASA, you may be converted to permanent employment or term employment of up to six years.

Pathways Internship / CoOp

About me:
B.S. Physics and Mathematics
M.S. Physics
Currently working on a PhD
in Materials Science Engineering

Pathways Rotation:
6 months at Marshall
6 months in Texas

Situation Task Action Result

Situation:
Paint a picture

↓

Task:
define the problem

↓

Action:
What steps were taken

↓

Result:
What happened

Intern Duties

Situation:
As a Pathways Intern classified as a Student Trainee one of my major assignments is to gain familiarity, skills and abilities required for a career at NASA in the space environments group.

Task:
Primary: To learn as much as I can, as quickly as I can, as best I can, related to the requirements of the job.
Secondary: To figure out a way to not lose all this learning in the LWOP times of my Pathways Internship.

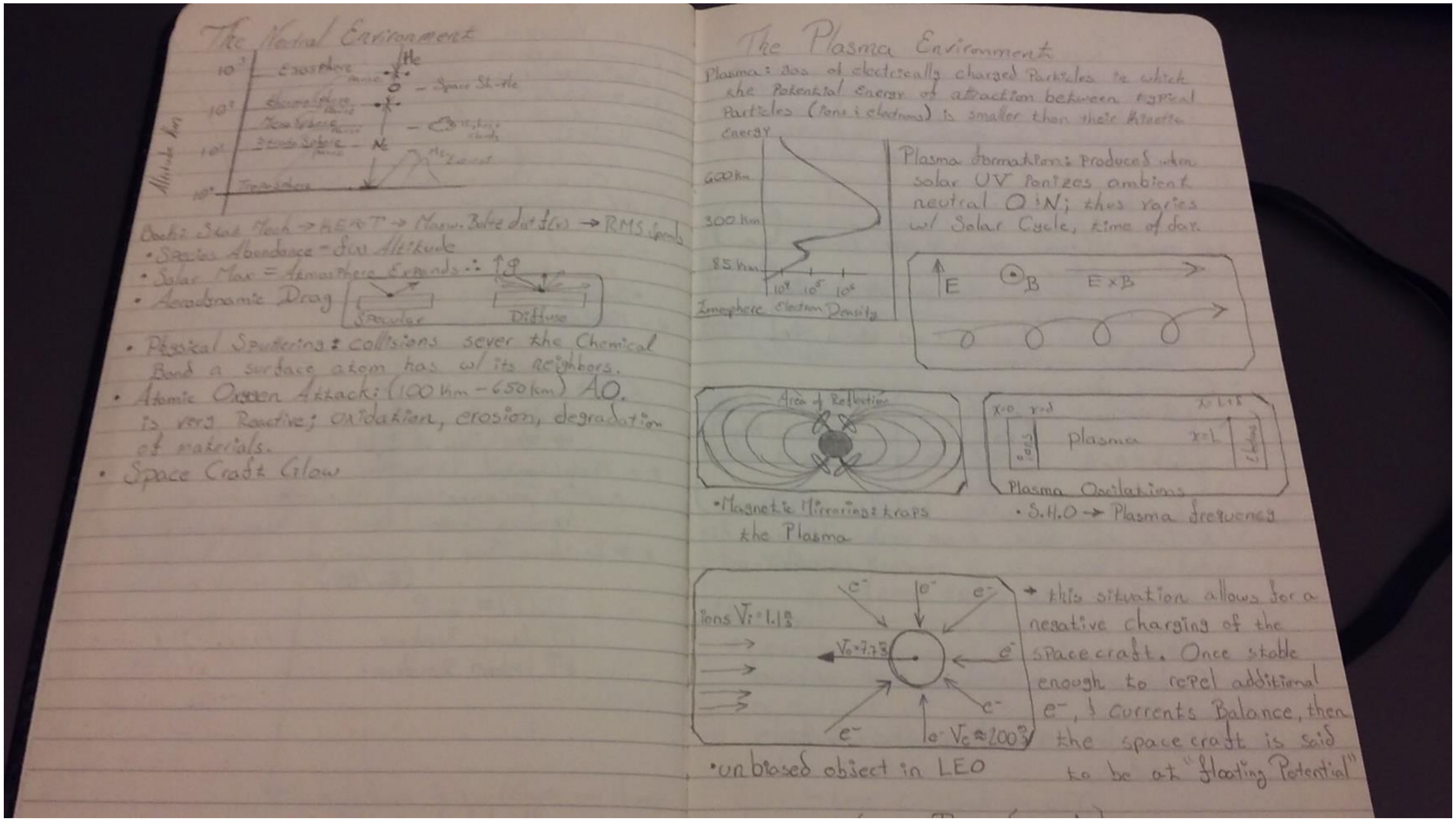
Intern Duties

Action:
Primary:
I ask my team lead and senior colleagues to recommend tools or books I should be learning about. This may require reading, taking a class, or simply use of the product.
Secondary:
Create a “Return to work Cheat Sheet”

Resolution:
>Cheat Sheet
>Book: The Space Environment, Alan Tribble
>Simple Thermal Environment Model
>Design Specifications for Natural Environments
Application: Simple Thermal Environment Model Fortran Code
Application: SPENVIS
Application: IRENE Ap8Ae8 and Ap9Ae9 GUI
Application: Integrated Tiger Series (ITS) software

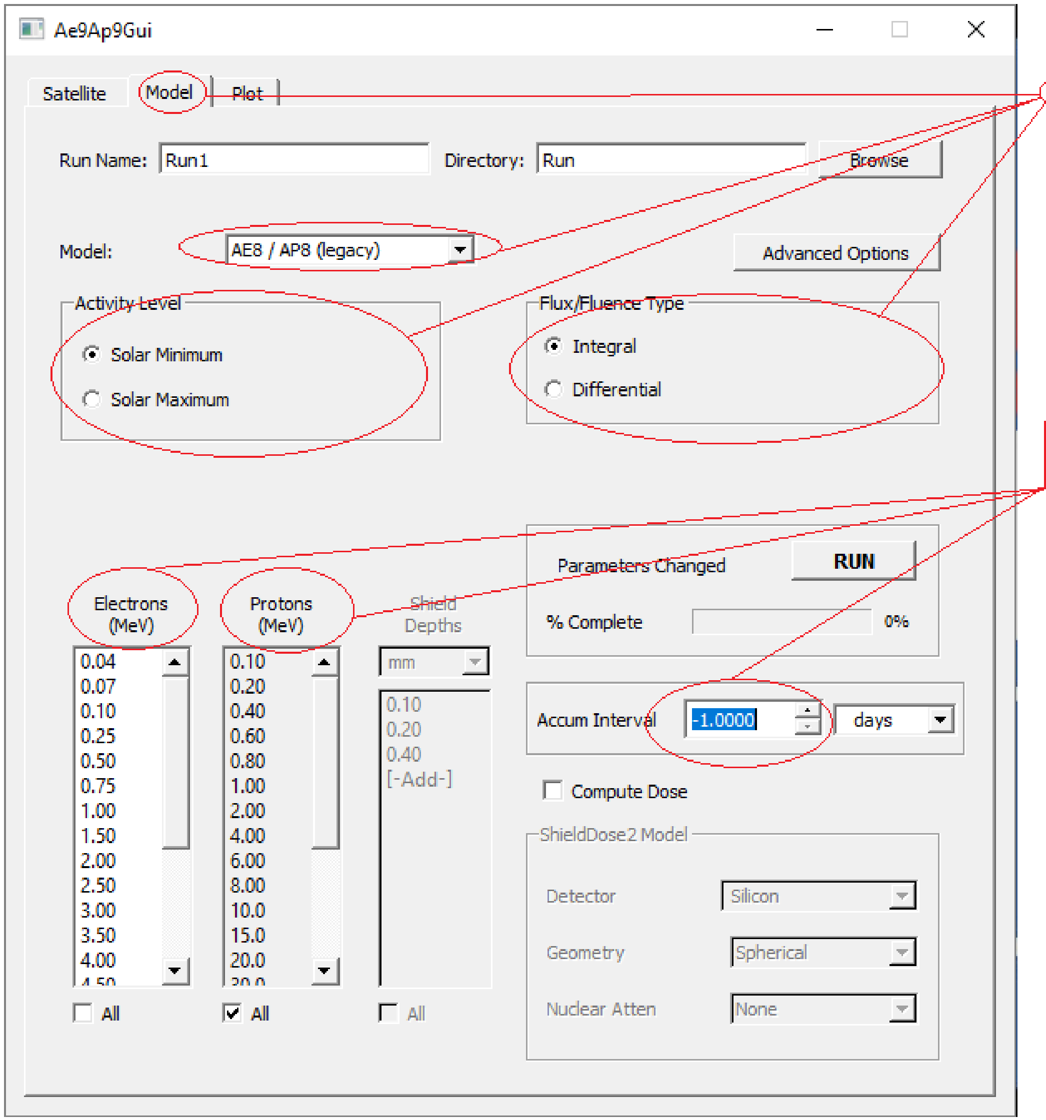
Task 1

Intern Duties



- Book: The Space Environment, Alan Tribble

Action 1: Daily Trapped Proton Fluences

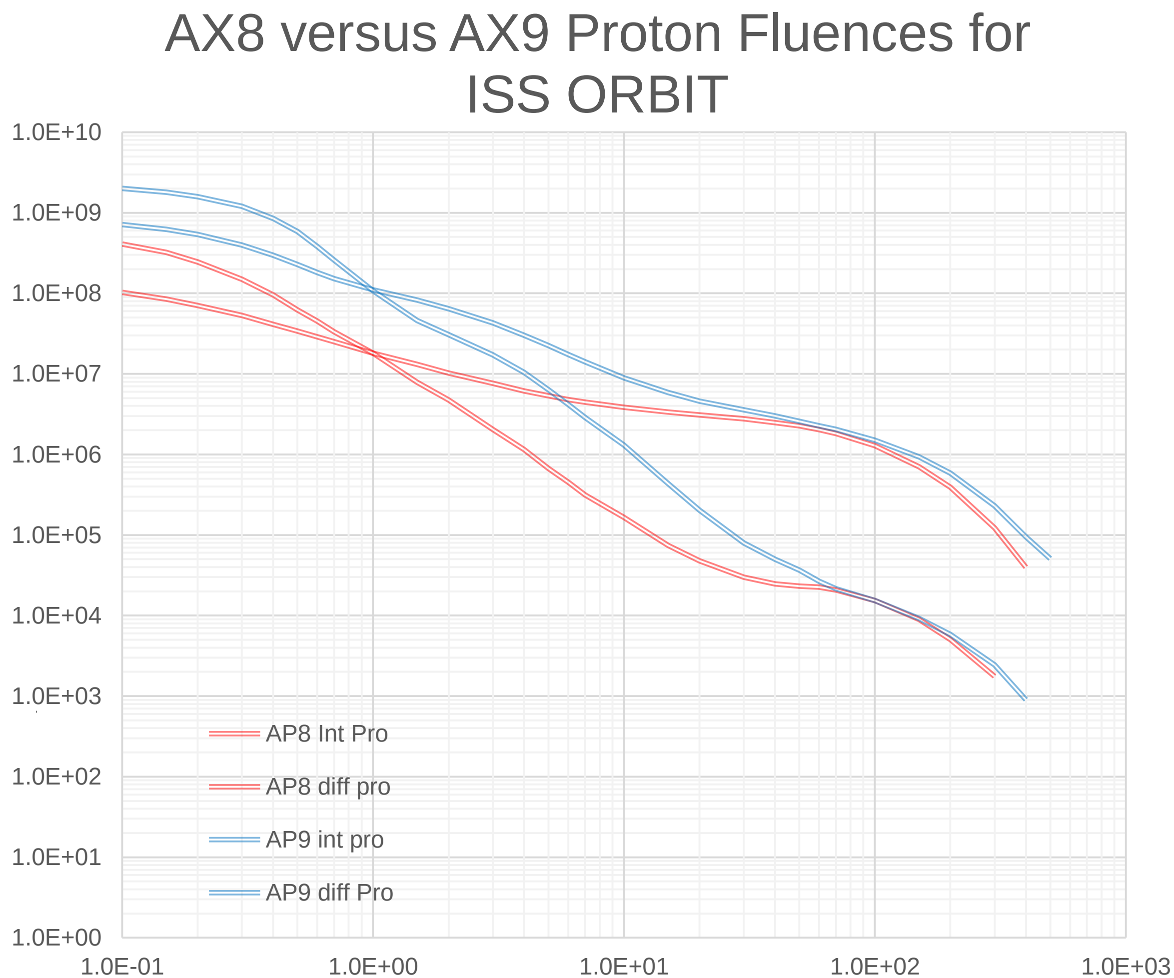


When running Ae9Ap9Gui, you will need to change these parameters depending on what you need.
-DSNE calls out Ae8MAX
-DSNE calls out AP8MIN
-Fluence type
-electron/proton

Accum Interval: Setting this option to -1.0 computes the fluence over the whole day specified under the satelite tab.

AX8 versus AX9

It is clearly shown that for the lower Proton energies, Ax9 is an order of magnitude greater than the Ax8 fluence.



Solar Zenith Angle Correction

Situation:
Help with a request for clarification of the Thermal Environments section of the DSNE. Specifically to clarify the Solar Zenith Angle (SZA) correction called out in DSNE, but not explained in the DSNE.

Task:
This required that I read through the DSNE's thermal environment predecessor, a technical manual called NASA/TM-2001-211222 the Simple Thermal Environment Model, and also understanding of the accompanying Fortran code

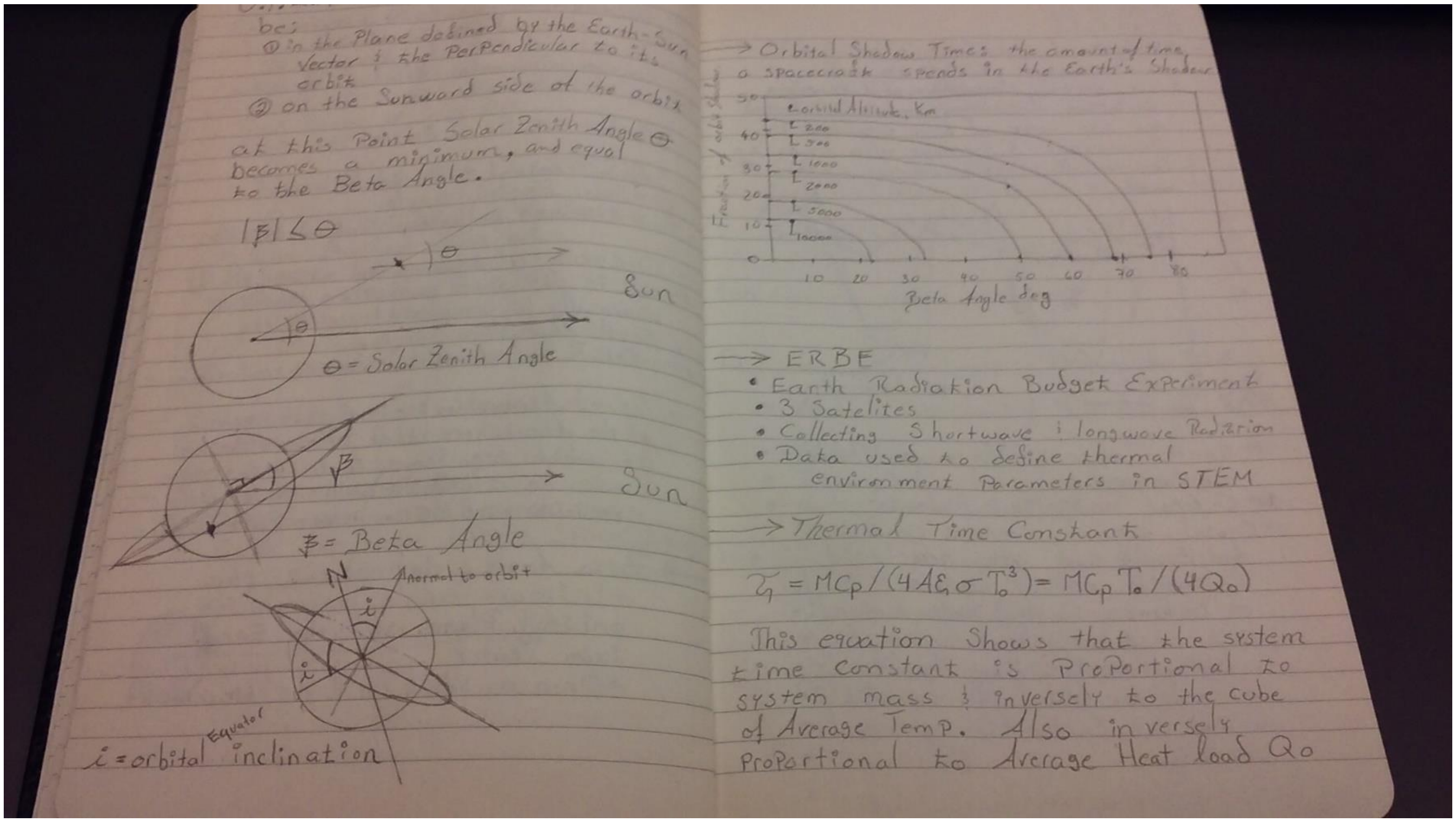
Solar Zenith Angle Correction

Action:
Upon reviewing the STEM document and combined Fortran code, I was able to develop a numerical solution to a complex integral required for the (SZA) correction. I was able to curve fit the data and create a polynomial fit that would allow for easier computation of the SZA correction.

Resolution:
Numerical Integral Solution to produce the following items, in order to clarify (SZA) correction in the DSNE.

1. **Table of Values**
2. **Figure of (SZA) correction curve**
3. **Polynomial fit for (SZA) correction**

Solar Zenith Angle Correction



•NASA TM-2001-211222 Simple Thermal Environment Model (STEM) User's Guide

Orbital average Albedo Integrals

The STEM user's guide has a section on the development of the S.Z.A. Albedo correction term. In order to create the adjustment term the following integrals must be solved for a given orbit's Beta and Zenith Angle.

$$< c > \; = \int_0^P c(\theta)\ \cos(\theta)\, dt \;/\; \int_0^P \cos(\theta)\, dt \quad (2.21)$$

$$\cos(\theta) = \cos(\beta)\ \cos(\varphi) \quad (2.22)$$

$$< c > \; = \tfrac{1}{2} \int_{-\pi/2}^{\pi/2} c\,(\theta)\, \cos(\varphi)\, d\varphi \quad (2.22)$$

•NASA / TM-2001-211222 Simple Thermal Environment Model (STEM) User's Guide

Python Code Written for numerical integration

```python
import numpy as np
import scipy.special
import matplotlib.pyplot as plt
import scipy.integrate
import cmath
from scipy import integrate
from numpy import cos, sin, exp, pi, arccos

# From Simple Thermal Environment Model
# Albedo correction calculation
# c(theta) = c1(theta) + c2 (theta^2) + c3 (theta^3) + c4(theta^4)
# cos(theta) = cos(beta)*cos(phi)
# <c> = 0.5 * integral [c(theta)*cos(phi)] dphi
#   limits of integration (-pi/2) --> (pi/2)

#This portion declares variable values and asks for input
c1 = 1.3798E-3
c2 = -2.1793E-5
c3 = 6.0372E-8
c4 = 4.9115E-9
theta = int(input('Please input an angle in degrees to compute Albedo correction for: '))
n = cos((theta)*pi/180)

#This portion displays for what angle is being computed.
print('-----------------------------------------------')
print('For the Angle:', theta, "degrees")

#This portion solves the <C> correction integral (2.23) from the STEM document
function = lambda x : 0.5*(c4*((arccos(cos(x)*n)*(180/pi))**4)+c3*((arccos(cos(x)*n)*(180/pi))**3)+c2*((arccos(cos(x)*n)*(180/pi))**2)+c1*(arccos(cos(x)*n))*(180/pi))*cos(x)
print('-----------------------------------------------')
print('<Orbital Ave Albedo Correction>  <Uncertainty>')
print(scipy.integrate.quad(function, -pi/2, pi/2))

#This portion solves correction for Min Solar Zenith Angle
z = c1*theta+c2*theta**2+c3*theta**3+c4*theta**4
print('-----------------------------------------------')
print('Correction at Min solar Zenith Angle')
print(c1*theta+c2*(theta**2)+c3*(theta**3)+c4*(theta**4))
print('-----------------------------------------------')
```

$$< c > \; = \int_0^P c(\theta)\;\cos(\theta)\,dt \;\Big/ \int_0^P \cos(\theta)\,dt$$

$$\cos(\theta) = \cos(\beta)\;\cos(\varphi)$$

$$< c > \; = \tfrac{1}{2} \int_{-\pi/2}^{\pi/2} c\,(\theta)\,\cos(\varphi)\,d\varphi$$

STEM S.Z.A. correction integrals solved numerically

•NASA / TM-2001-211222 Simple Thermal Environment Model (STEM) User's Guide

Polynomial for Orbital Average Albedo

--To avoid the user integrating the STEM expressions, a polynomial was fit to the output of the integration

$$\langle c \rangle \approx .03951 + (9.329\ E\text{-}4) * \beta^{o} - (2.936\ E\text{-}06) * \beta^{o\ 2} + (5.848\ E\text{-}07) * \beta^{o\ 3} \qquad \text{(eqn 1)}$$

* Polynomial values are within 0.5% of integral values; Polynomial valid for ($0^{o} < \beta < 90^{o}$)

Solar Irradiance Investigation

Situation:

Request for justification or clarification of a +-5 W/m^2 for Solar irradiance max and min values.

Task:

This required that I read through the DSNE's thermal environment predecessor, a technical manual called NASA/TM-2001-211222 the Simple Thermal Environment Model, and also a literature search to verify the solar irradiance question.

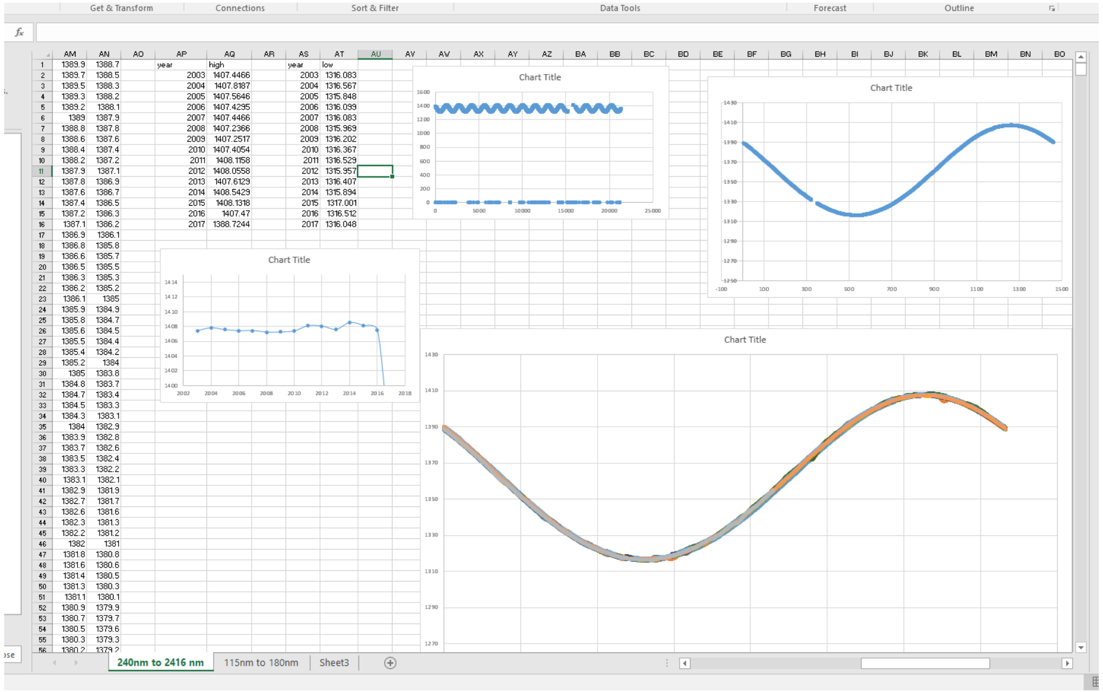
Solar Irradiance Investigation

Action:
Research revealed that better scientific equipment and design had lead to a lowering of the accepted average solar irradiance value. 14 recent years of solar data was processed.
SORCE satellite data (Solar Radiation and Climate Experiment).

Resolution:
Modern instruments, with updated sensitivities, have updated the Solar Constant to a number about 6-7 W/m^2 smaller than was previously thought. This does not impact the DSNE hot number. However, empirical data shows consistent lower irradiance than the DSNE cold number.

Reported Average

1. There are many instances of literature now reporting lower solar constants
   - From 1360.8 W/m2 to 1361.0 W/m2 (+- 0.5 W/m2)
2. Found the SORCE data
   - 4 measurements a day
   - Everyday
   - 2003 – present



3. Empirical data extrema:
   - Max: 1408.5 W/m2
   - Min: 1315.8 W/m2

4. DSNE outlined extrema:
   - Max: 1414 W/m2
   - Min: 1322 W/m2

Data taken from the SORCE Web page: http://lasp.colorado.edu/home/sorce/

Empirical Data Min Max 2003-2017

Year	Maxima	Minima
2003	1407.4	1316.0
2004	1407.8	1316.5
2005	1407.5	1315.8
2006	1407.4	1316.0
2007	1407.4	1316.0
2008	1407.2	1315.9
2009	1407.3	1316.2
2010	1407.4	1316.3
2011	1408.1	1316.5
2012	1408.1	1315.9
2013	1407.6	1316.4
2014	1408.5	1315.9
2015	1408.1	1317.0
2016	1407.4	1316.5
2017	1388.7	1316.0

Normalized for aphelion in 2005 and calculated for 1 AU gives 1360.2 W/m^2

Normalized for perihelion in 2014 and calculated for 1 AU gives 1361.9 W/m^2

-Standard Dev 1.87E-07 4.58E-07
-0.032% Uncertainty
-Maxima occur within a day of Perihelion
-Minima occur within a day of Aphelion

SORCE Web address: http://lasp.colorado.edu/home/sorce/

IXPE Radiation Environment

Situation:
A request to explain the Space Environment for the IXPE space based X-ray observatory, was received by EV44.

Task:
I was to take this project and create a full report on the space environment the IXPE would encounter. This includes a Power Point presentation, and Department Memo describing the environment in detail.

IXPE Radiation Environment

Action:
Created the environment by recreating what is shown in the (DSNE) handbook. This required the use of the following applications and documents;
>NASA Document: Design Specifications for Natural Environments
>Application: SPENVIS (IRENE, CREME96, ESP-PSYCHIC, SHIELDOSE-2)
>Application: IRENE Ap8Ae8 and Ap9Ae9 GUI
>Application: Python (minor code writing)

Resolution:
Complete radiation environment was created and given forward as a combination of PPT and memorandum.

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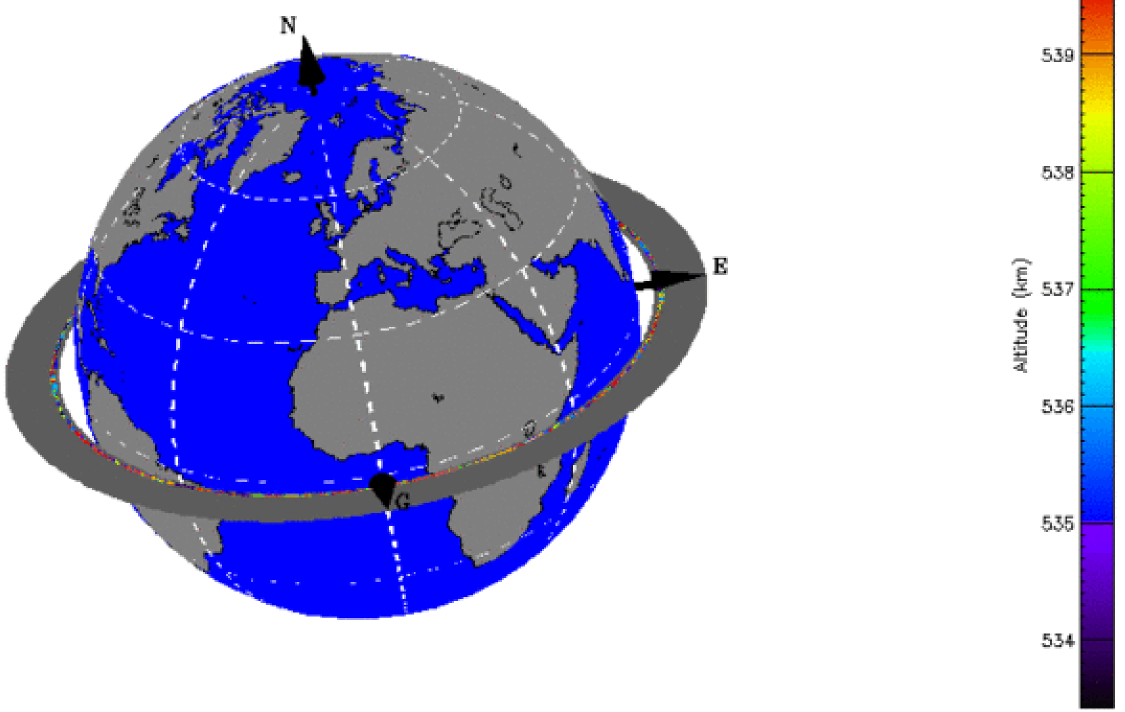
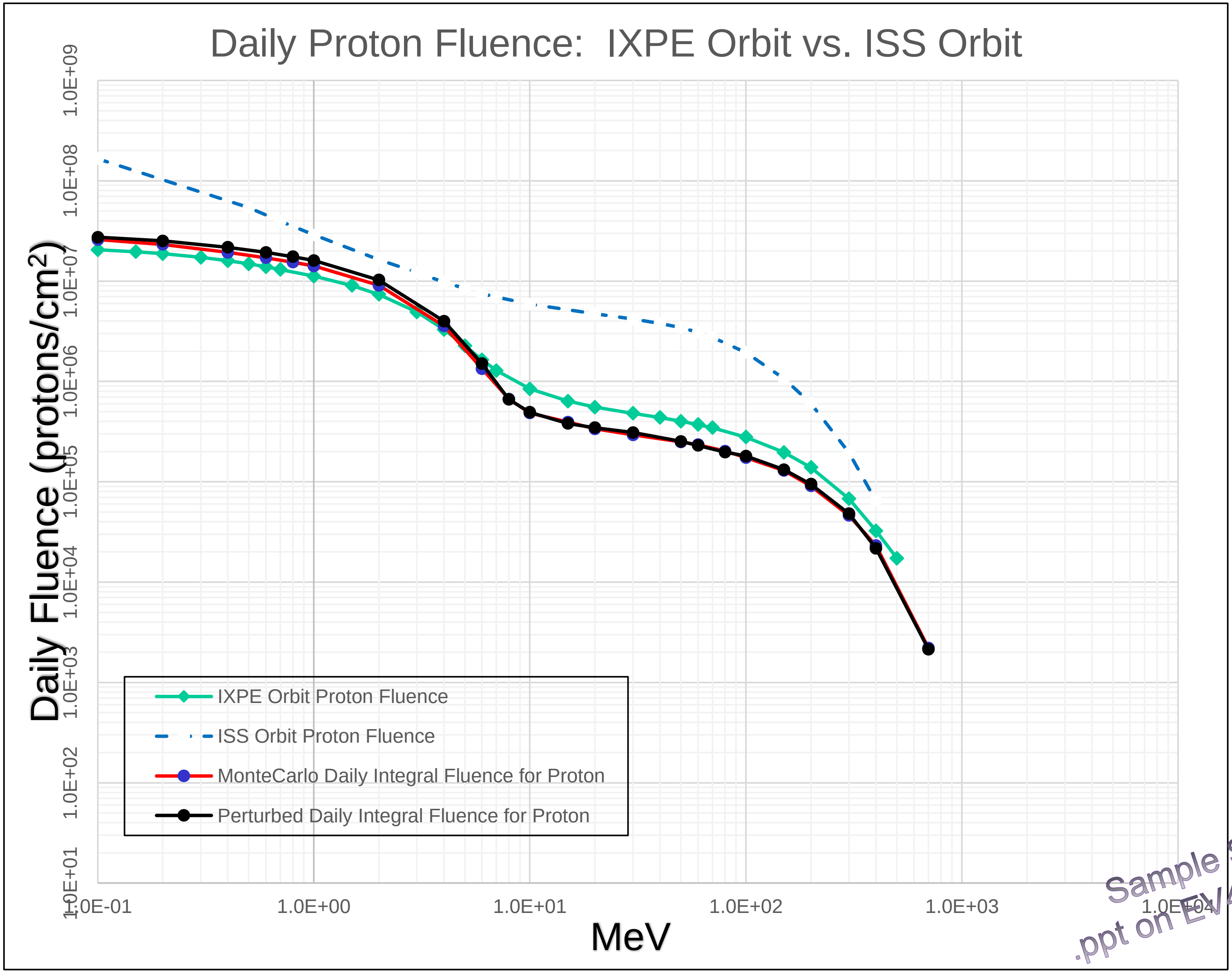
IXPE orbit

Orbit Parameters:
Circular Orbit
540 km Altitude
0^{o} inclination
Eccentricity = 0
Launch Date: Dec 2020
Mission Duration: 25 months
Period: 1.59 hrs
Orbits per day: 15.07



IXPE v. ISS Fluence Comparison



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Launch / Flight Availability Analysis

Situation:

Chief of the Space Environments team had concerns over a developing issue with a launch/flight availability analysis based on space weather with an unknown background or foundation.

Task:

A team was tasked with developing a presentation that would do the following:

1. Informational discussion of solar events, including the DSNE SPE environment
2. What the launch/flight availability analysis will and will not protect from
3. Probability of violating the launch/flight availability
4. Probability of exceeding the DSNE design environment

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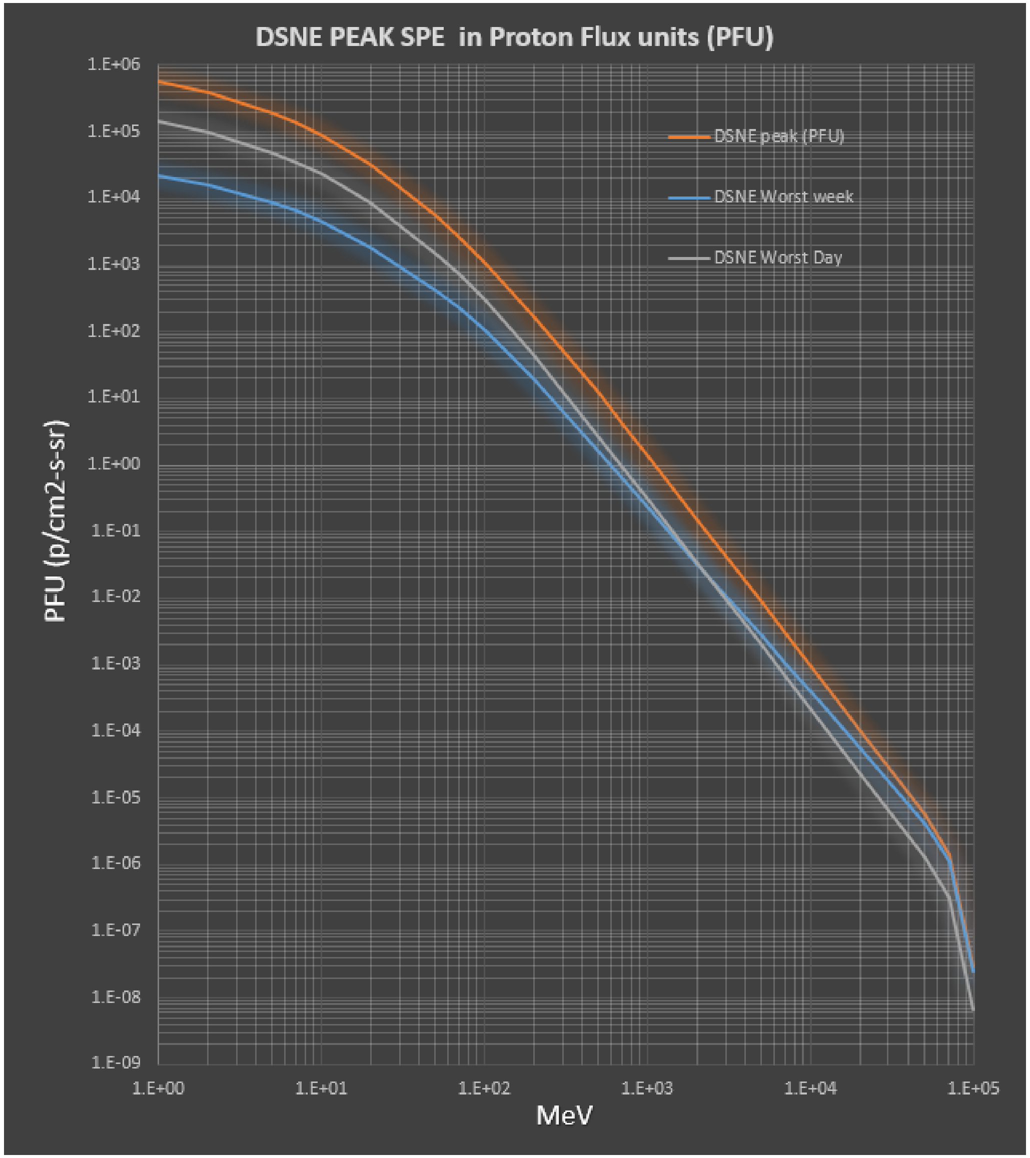
Launch / Flight Constraint

Action:
After a team discussion I took it upon myself to search for and acquire the data necessary for the analysis. Raw data for the GOES satellites provided us with continuous solar particle flux data from 1986 to present day. Filtered and extracted the relevant data with Python code.

Resolution:
*****Pending*****
Reduction of 1.5 gigs of data to a usable 100 megs Comparison Graph, DSNE vs. LCC

DSNE Peak 5 min, day, week



Sample Slide, .ppt on EV44 shared

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Thank you

End .ppt

Slide Title

Text box 1

SITUATION-task-action-result
situation-TASK-action-result
situation-task-ACTION-result
situation-task-action-RESULT

* Reference: Deus Ex Machina Matrix Neo Smith people inside robots; robots inside people.