Data Analysis for the Dynamic Ionosphere CubeSat Experiment (DICE)

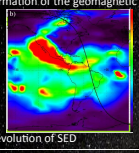
Lindsay McTague [2] Geoff Crowley [1] Irfan Azeem [1] Marcin Pilinski [1]
[1] ASTRA, LLC [2] Siena College
l23mcta@siena.edu

Background

The Dynamic Ionosphere CubeSat Experiment (DICE) mission consists of twin satellites, named Yahtzee and Farkle, which were specifically designed to allow scientists to understand the ionosphere's response to a geomagnetic storm. This mission was launched from Vandenberg Air Force Base aboard a NASA rocket ,on October 28, 2011. The Space Dynamics Laboratory and Utah State University built and operate both satellites.

The science objectives of the DICE mission include:

1. Investigate the physical processes responsible for formation of the geomagnetic Storm Enhanced Density (SED) Bulge
2. Investigate the physical processes responsible for the formation of the SED Plume at the base of the SED Bulge – and transport of high density SED plume across the polar region
3. Investigate the relationship between the penetration electric fields and the formation and evolution of SED



Personal Objectives

1. Assist ASTRA during the early operation phase of the DICE Mission
2. Investigate the quality of data from the satellite instruments
3. Assist ASTRA engineers in monitoring satellite health and status
4. Assist ASTRA scientists in producing various levels of scientific data
5. Give a seminar at the end of the REU assignment on my research work

Instrumentation and Spacecraft Design

- **Two, spinning 1.5U CubeSats (10 X 10 X 15 cm)**
- **Elliptical orbit (410 – 820 km altitude)**
- **Pearls-on-a-string (leader-follower)**

Each satellite is equipped with:

- **2 Langmuir probes to determine electron number density and temperature**
- **4 five meter electric field booms to gauge electric field**
- **1 science magnetometer to measure field-aligned currents**

Major Satellite Components	
A	DC Probe
B	E-Field Sensor Payload
C	GPS Receiver
D	Science / ADCS Board
E	C&DH Processor Board
F	C&DH Motherboard
G	Power Board w/ Batteries
H	Radio Electronics and Board
I	Turnstile Antennas
J	DC Probe

Power:
- ~1.7 W generated on-board
- ~200 mW payload

Mass: 1.5 kg

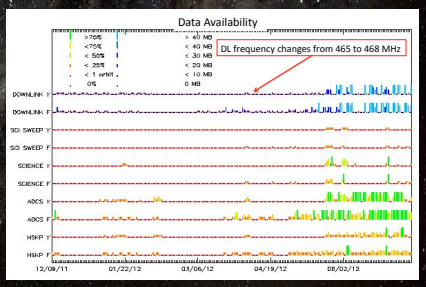
Communication:
- L3 Radio downlinks to ground-station at ~2 Mbits

References

[1] iri.gsfc.nasa.gov

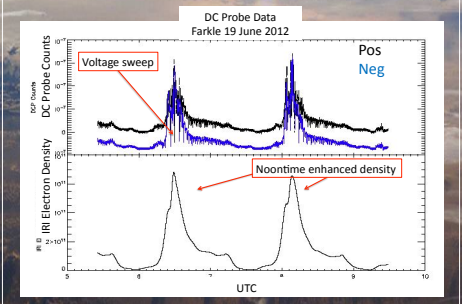
Data Availability Plots

- Help scientists and engineers visualize the amount of data they are collecting from each satellite
- Allows us to monitor spacecraft health
- DICE is the first NSF CubeSat to use high downlink rate (most student-built satellites use 9.6 kbps)



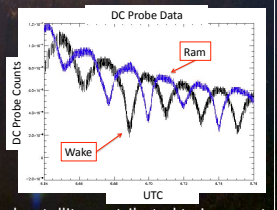
Langmuir Probe Data and the IRI Model

- International Reference Ionosphere model (IRI) is a model that displays electron density, electron temperature, ion temperature, and ion composition at altitudes ranging from 50 km to 2000 km [1]



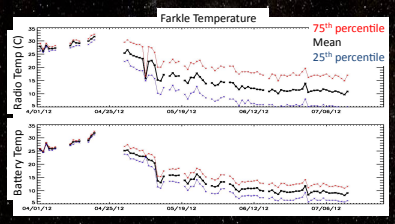
Early Satellite Operation Challenges

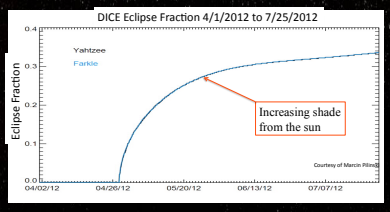
- Ram and wake effects due to satellite rotation

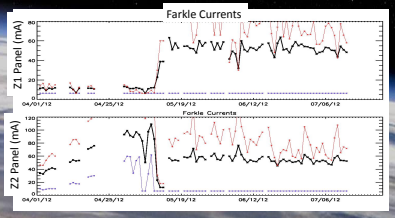


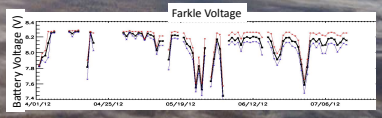
- Clock offsets on each satellite contributed to incorrect time stamping of data. This has since been corrected.

Plotting Temperature, Current, and Voltage









Conclusions

✓ Both satellites are successfully corresponding with their ground station

✓ Both Yahtzee and Farkle are collecting quality data when compared to the IRI Model

✓ After the download frequency change that occurred in April, there was an increase in the amount of data each satellite was downlinking

Acknowledgments

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