Space Radiation in Earth Environment with Radiation Data Portal

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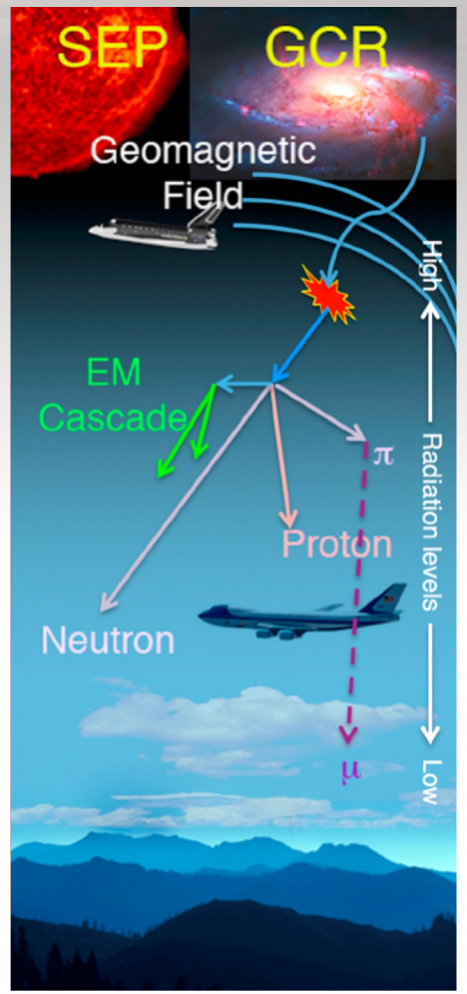
Radiation Onboard Aircrafts

- Passengers of a commercial aircraft at around 37,000 feet (~11 km) absorb about 30 times more ionizing radiation than people at sea level
- On average, the absorption onboard the aircraft is about 1 chest X-ray per each 10,000 miles flown
- Pilots and aircrew are classified as “occupational radiation workers”
- The Radiation Data Portal (RDP) provides an interactive web-based application for convenient search and visualization of in-flight radiation measurements.
- https://data.nas.nasa.gov/helio/portals/rdp/
- Mirror: https://solarflare.njit.edu/RDP/

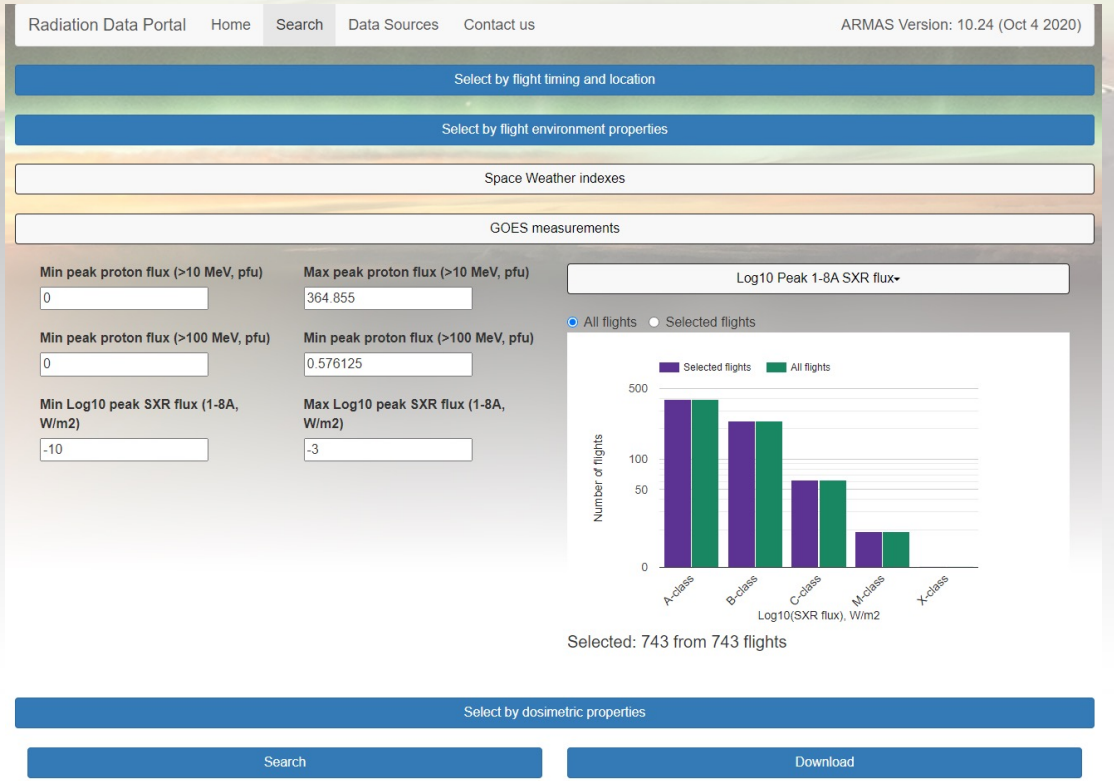


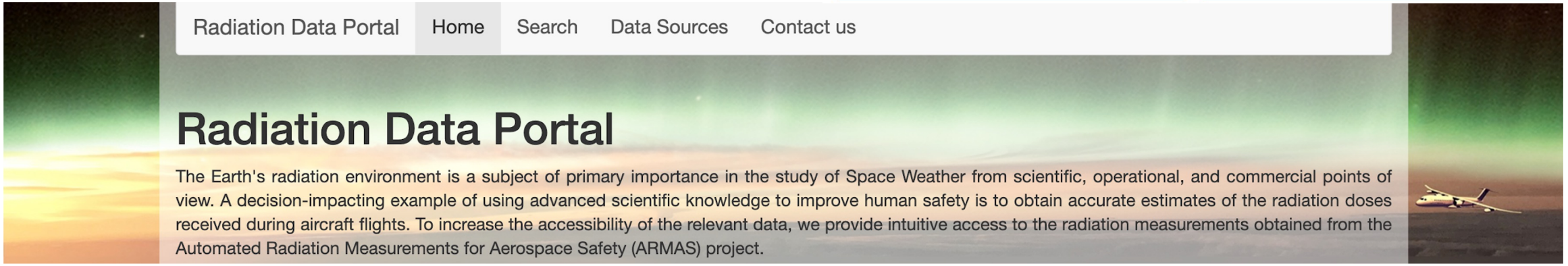
Integrated Data Sources

- The Automated Radiation Measurements for Aerospace Safety (ARMAS) augmented with the integrated properties of the flight and environment (more than 750 flights at the moment of deployment; more than 1000 after the updates in late 2024)
- Geostationary Operational Environmental Satellite (GOES) Soft X-ray (SXR) radiation measurements in the 0.5-4 Å and 1-8 Å channels.
- Integrated GOES/EPEAD proton flux measurements
- The data sources are loaded to MySQL relational database. The API is developed to handle the requests to the database.

Radiation Data Portal Front-End

- The search filters include flight time and location properties, environment characteristics, and dosimetry measurement properties
- The search results visualized in the form of dynamic histograms and quick-look light curves for the flight measurements are implemented using the Google Charts API.

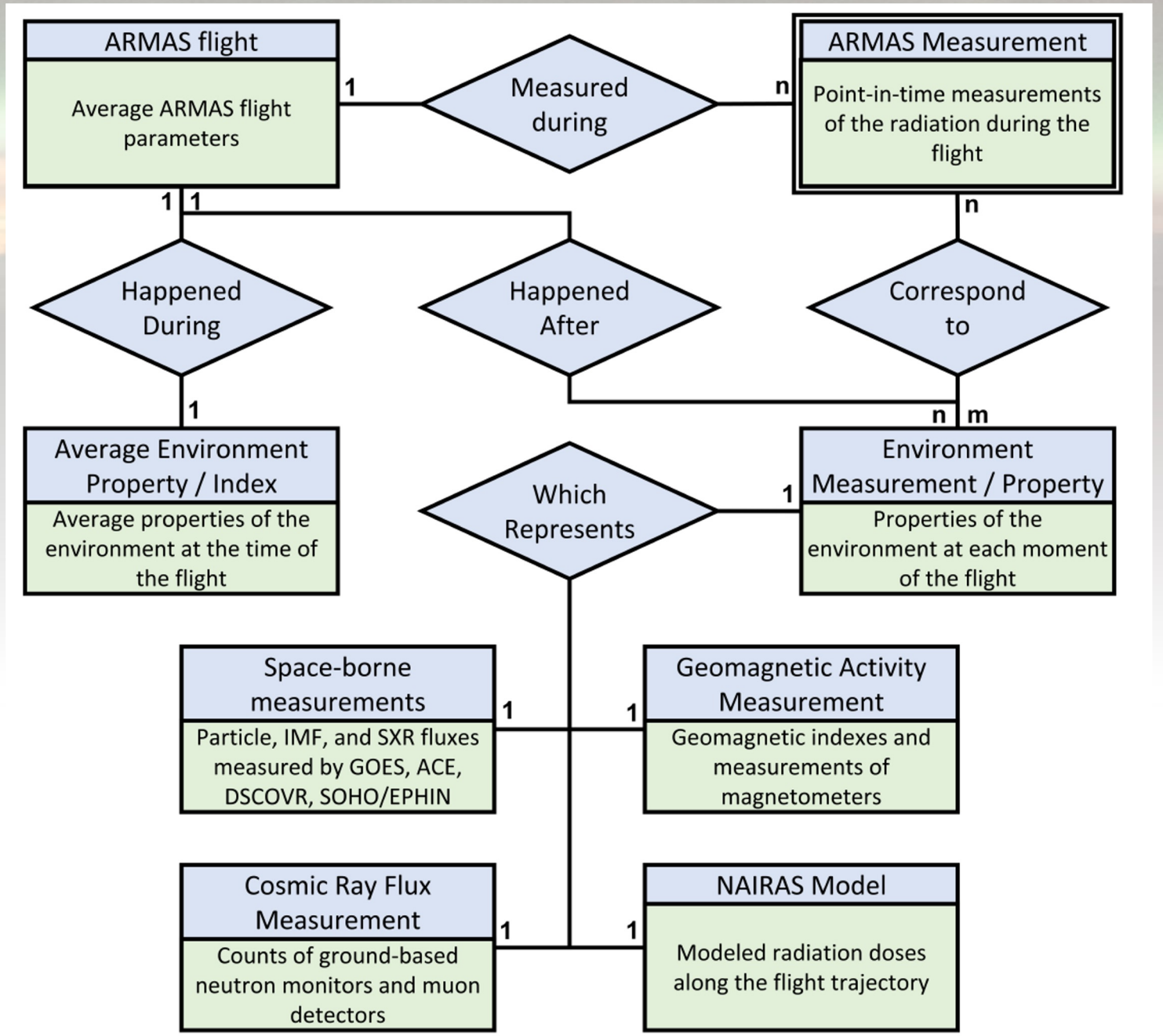




Expanding RDP

Within the new NASA HITS 2022 program grant, are expanding the portal:

- Inclusion of additional radiation measurement sources (measurements of radiation, solar wind, geomagnetic activity, etc.)
- Adapting the existing data visualization capabilities to the new data sets and improving the search engine
- Creating ML-ready data set for in-flight radiation prediction
- Including in-house GSU muon detector measurements in the portal

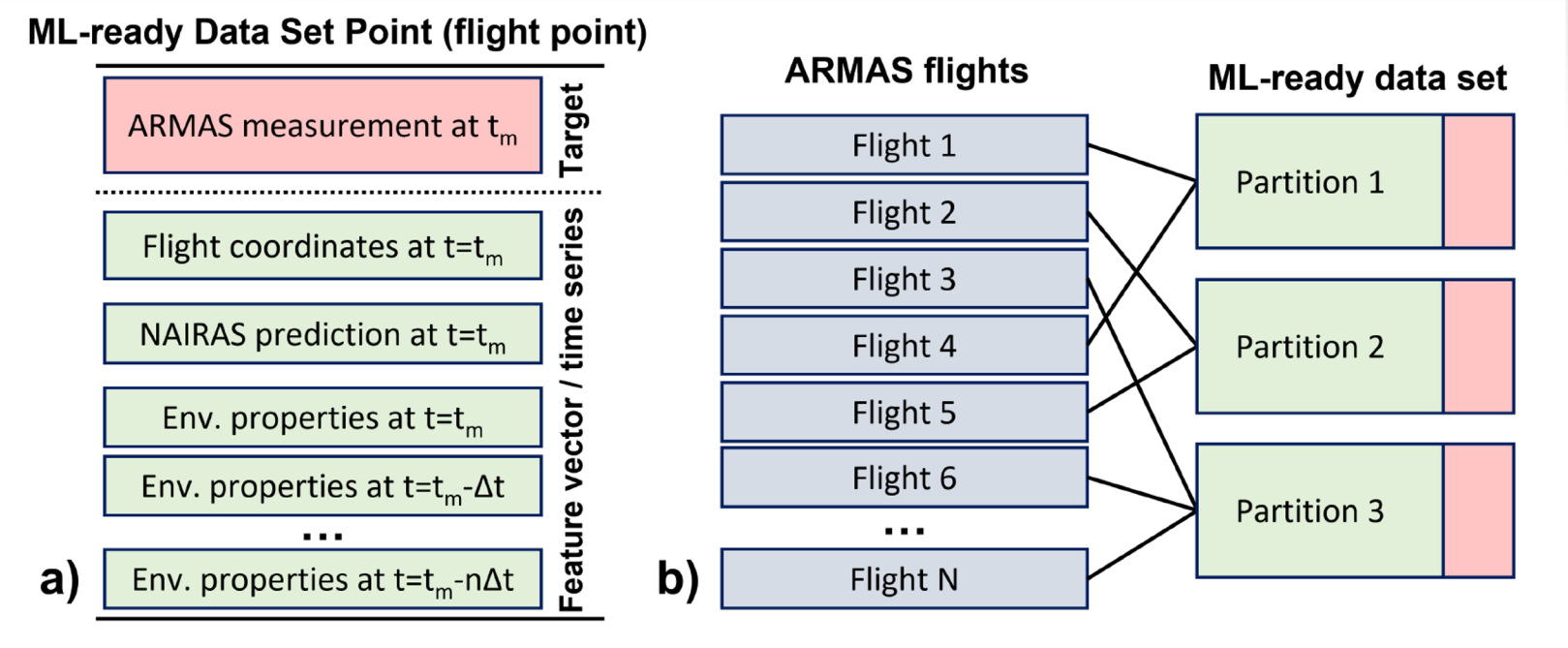


Expanding RDP: Current Status

- The data for the following sources have been uploaded (with the capability to update for the desired period, if applies):
  - Updated ARMAS flight data for more than 1000 flights
  - Updated SXR and proton flux data from GOES spacecraft series
  - SOHO/EPHIN proton and alpha particle flux measurements
  - Curated solar wind and geomagnetic activity data from OMNI Web
  - Ground-based neutron monitors (currently Oulu and Dome C)
- The RESTful API was developed to interact with the DB
- The related front-end updates are in progress

ML-Ready Data Set for Radiation Prediction

- To enhance the efforts targeted on the prediction of the radiation environment, we propose to arrange the data which is directly suitable for the ML applications
- The data set structure is presented below. The ML-ready data set versions will be available via the Radiation portal website.



A schematic representation of the flight partitioning

ML-Ready Data Set for Radiation Prediction

- Large dataset with many features
- Cannot split flight between different partitions
- Large variation in data quality
- Dense clusters of data

ML-Ready Data Set for Radiation Prediction

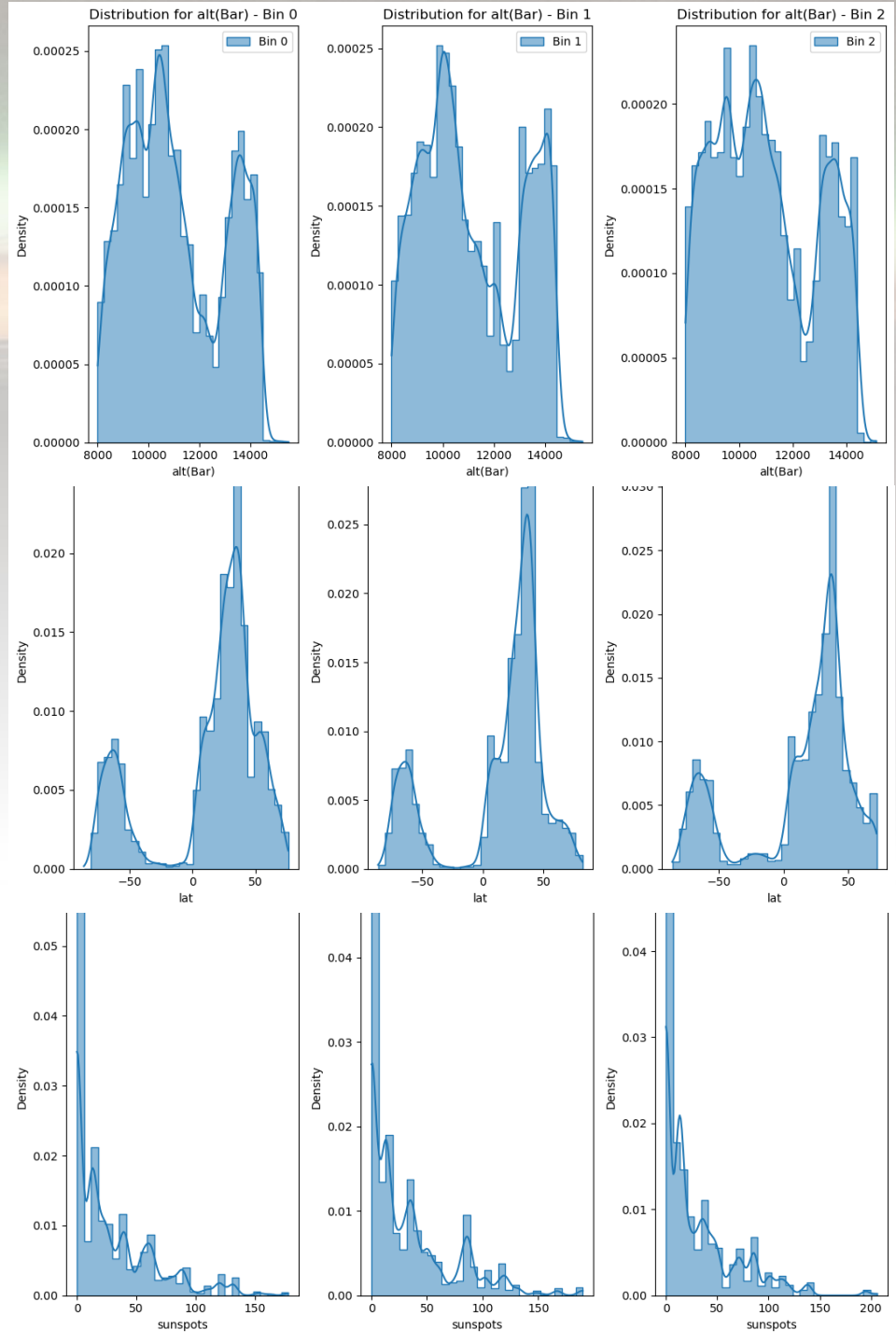
- Large dataset with many features
    - Find independent features and divide along those lines
- Cannot split flight between different partitions
    - Keep flights together through splitting algorithm
- Large variation in data quality
    - Use curating algorithm based on known valid data
- Dense clusters of data
    - Use probabilistic data so that points that pass through dense cluster aren’t automatically considered part of that cluster

Testing Partitioning Algorithm

- Testing how good the data has been partitioned:
  - Good sign #1: the distributions of the parameters (flight locations and solar/geo activity properties) look alike (right)
  - Good sign #2: the data point cannot understand what data set it belongs to!

Predicted	0	1	2
Actual			
0	21973	21898	21979
1	22250	22216	22228
2	21512	21444	21442

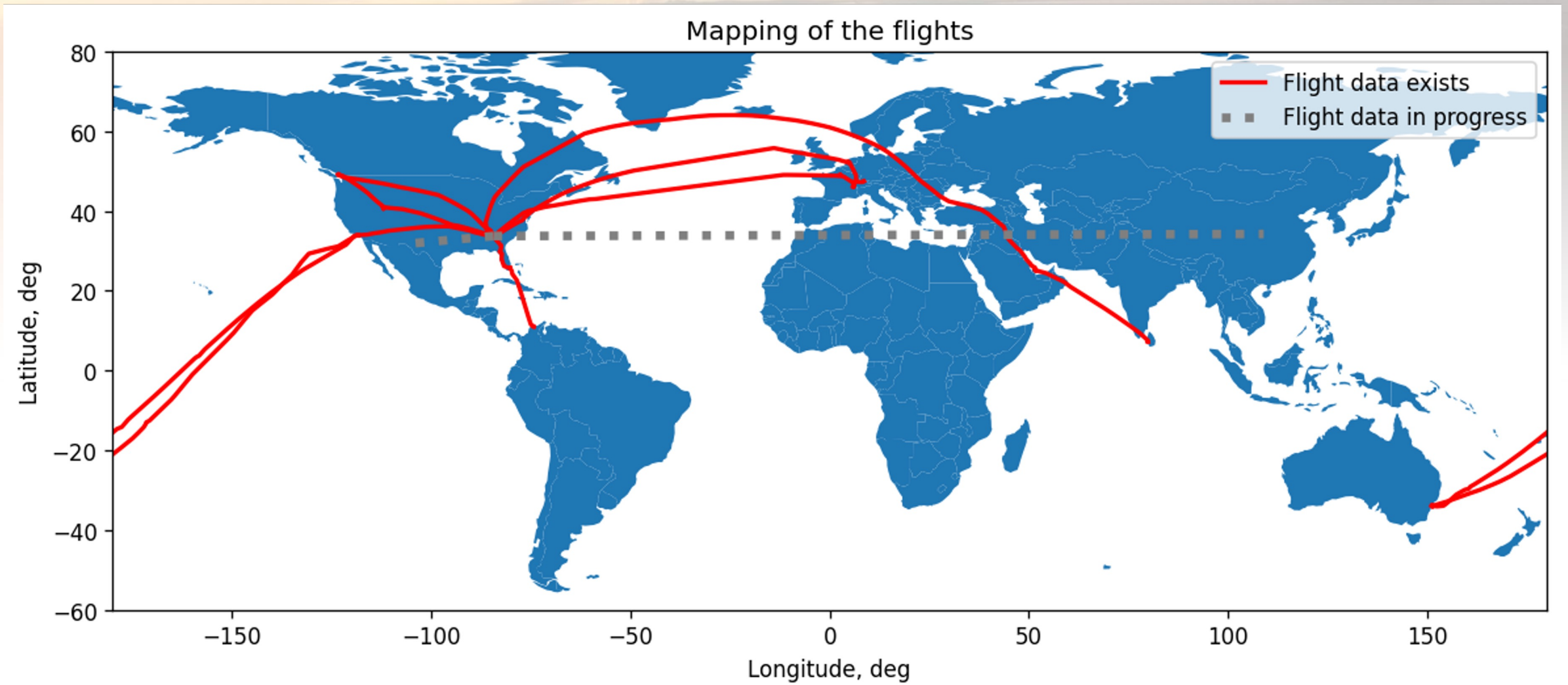
Accuracy: 0.3343
Precision: 0.3343
Recall: 0.3343
F1 Score: 0.3343



In-Flight Muon Measurements at GSU

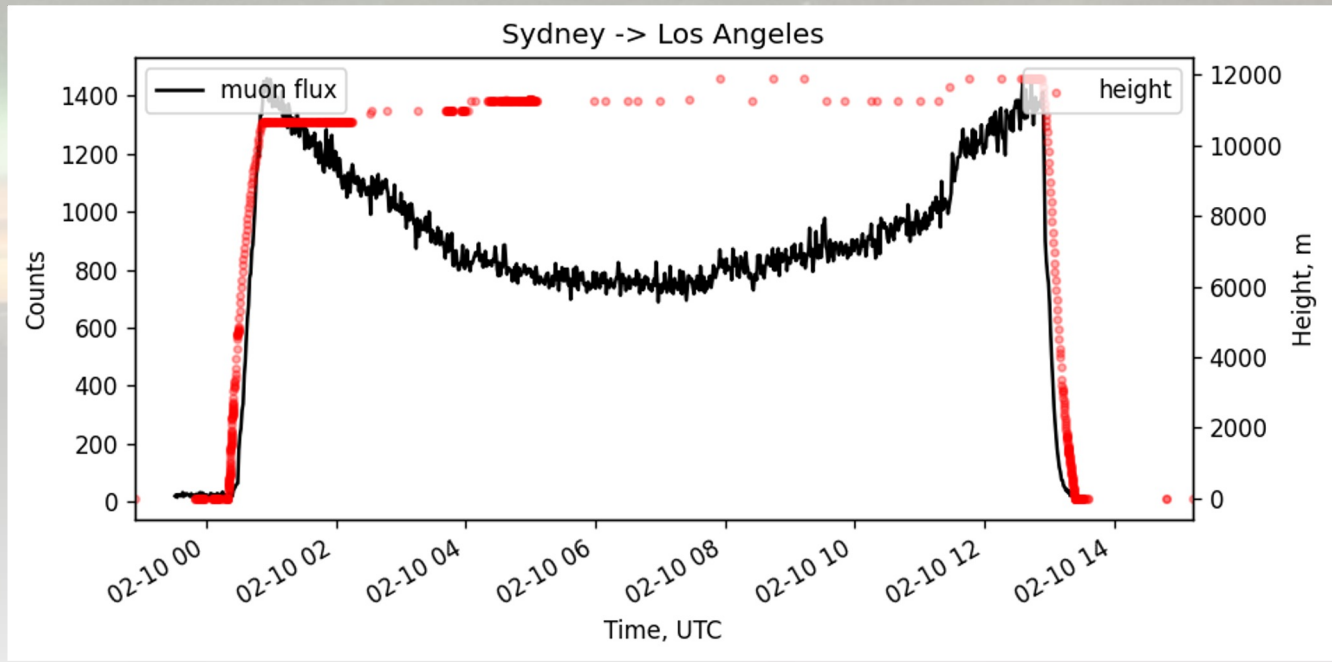
- A CubeSat-size prototype of the cosmic ray muon detector was developed by Nuclear physics and CS colleagues at GSU
- The prototype was taken on more than 15 commercial airplane flights. The data analysis is ongoing.
- The measurements are planned to be featured at the portal at the designated page

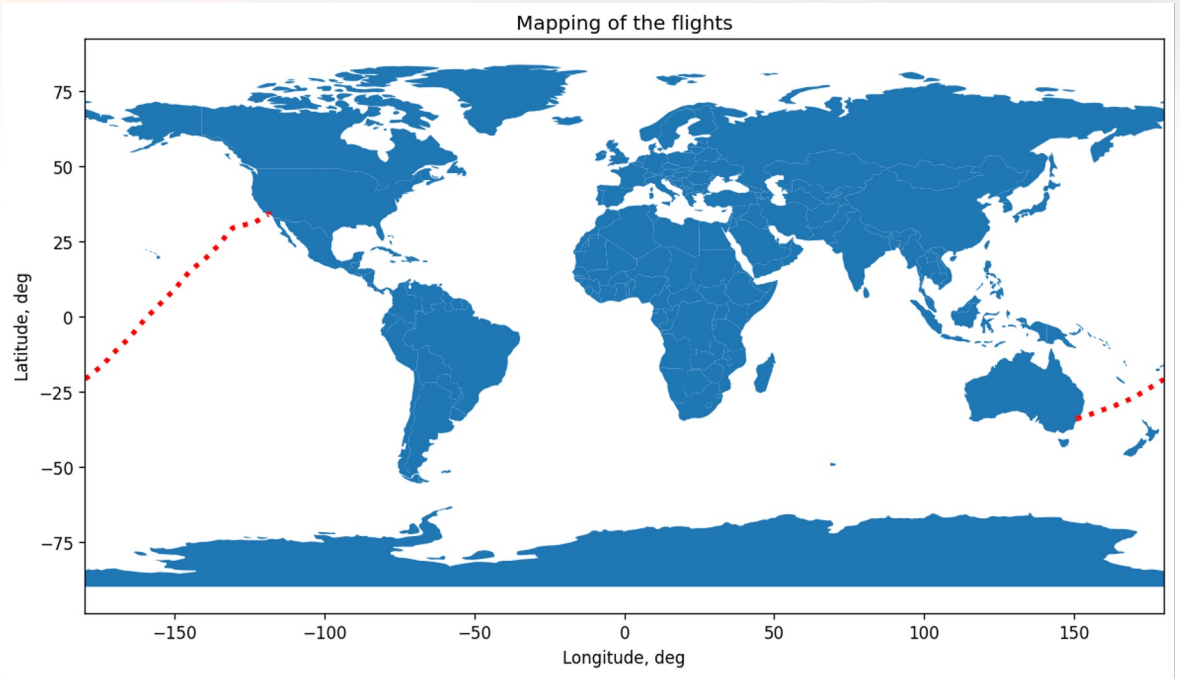
Flights Completed

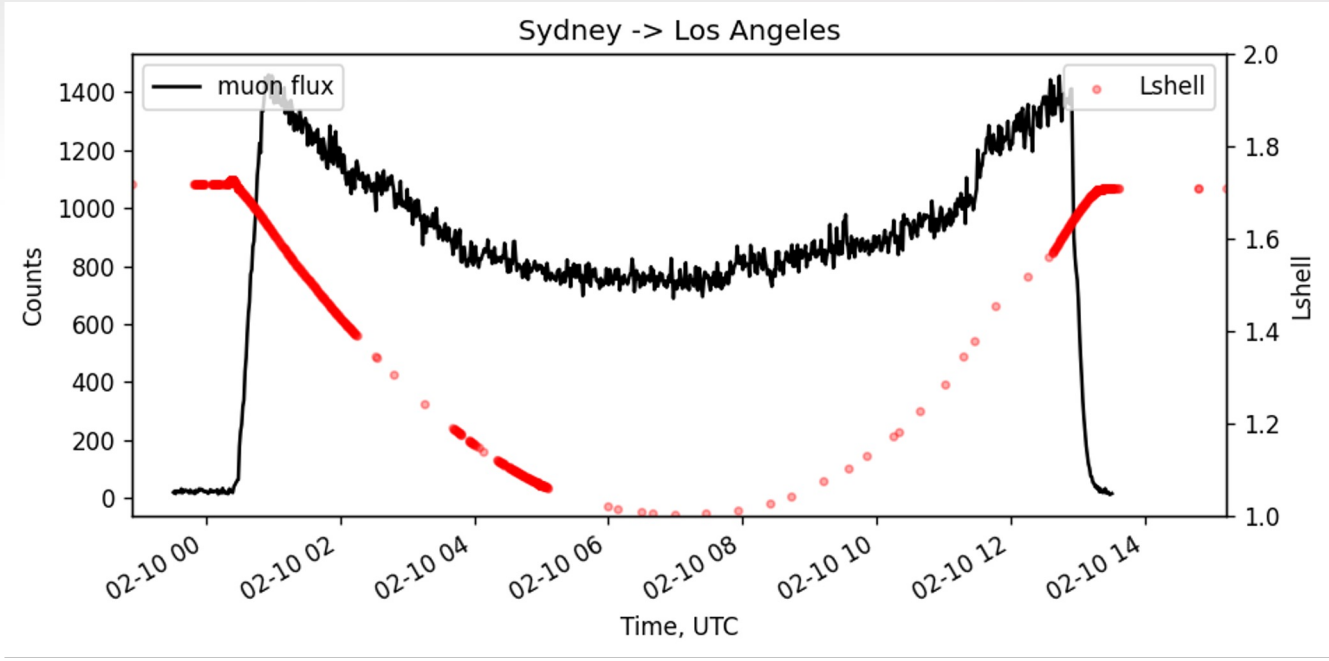


Example measurement: Sydney to Los Angeles

- One of the most interesting flights in the data set: crosses the equator
- The muon counts are sensitive to the geomagnetic cutoff / Lshell







Summary

- Radiation Data Portal enhances the discoverability of the radiation measurements at the airplane flights
- We are expanding the portal by providing more data sources and visualization capabilities, including GSU measurements of cosmic ray muons
- We are preparing a comprehensive ML-ready data set for the prediction of radiation during airplane flights
- We are collecting the muon measurements on the airplane flights. Measurements along 14 routes have been completed, more are coming!

Thank You for Your Attention!