



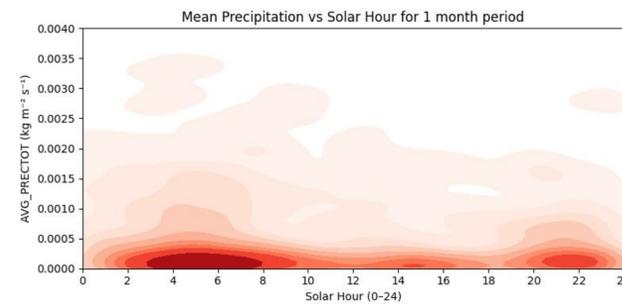
## Introduction

In an attempt to make the conventional system of scheduling for Earth science observations autonomous, dynamic targeting has been a highly discussed topic of interest. Enabling satellites to autonomously determine the priority observations in space reduces costs, labor and improves efficiency of Earth science Missions. The project during this Summer, focuses on preparing training datasets for RL techniques to train on and achieve high precision in determining observations worth observing. The prepared datasets considers the EarthCARE (Earth Clouds, Aerosol and Radiation Explorer) Mission to use the measured cloud-cover data by the onboard Multi-Spectral Imager (MSI) to instruct the Cloud-Profiling Radar (CPR) to prioritise making an observation for measuring convective precipitation. In the long term, the research aims to achieve a near optimal way to prioritize areas with high atmospheric activity, precisely observing convective precipitation, resulting in enhanced environmental monitoring and providing deeper insights to Earth's atmospheric dynamics.

## Tools and Technologies

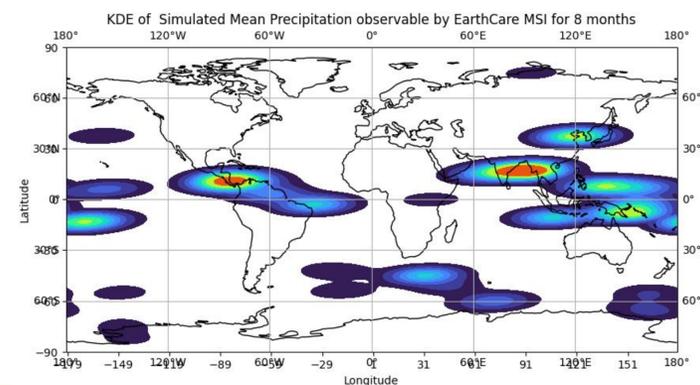
- ❖ 2-D 1-monthly time-averaged, coarsened to 0.5 deg surface-level diagnostics data from NASA GEOS-5 Nature Run (G5NR) for simulated mesoscale data from 2005-06.
- ❖ Celestrak for orbital two-line sets. WMO OSCAR for data on satellite's and its instruments' capabilities.
- ❖ Matplotlib, Seaborn and Cartopy for graphing visuals.
- ❖ Geopandas for dataframes with polygonal geometries.
- ❖ TAT-C (Tradespace Analysis Tool for Constellations) for simulating instrument orientation and ground tracks.
- ❖ Xarray, Rioxarray for extracting data from OpenDAP servers

EarthCARE is responsible for cloud, aerosol and radiation observation. The onboard instruments MSI and CPR measure cloud-optical depth and precipitation respectively. Due to sufficient observational area of MSI as well as less power requirement comparatively, the instrument's capabilities was modeled using TAT-C on simulated data from the G5NR dataset in order to train an RL agent for turning on CPR during a priority observation.

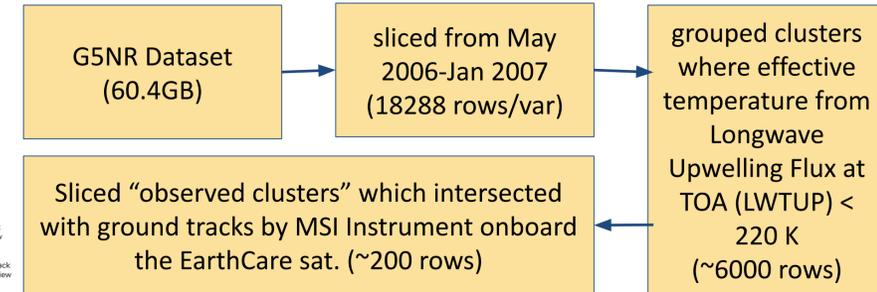
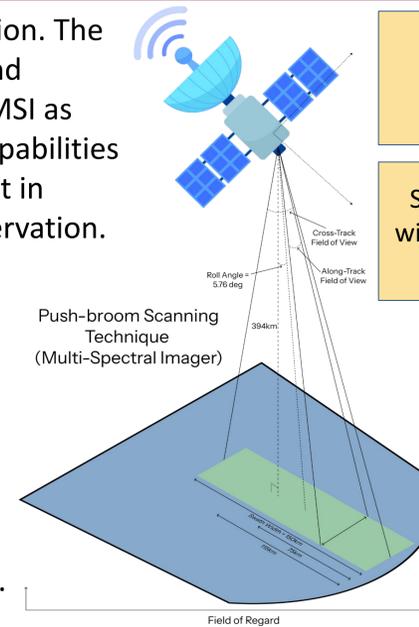


The Kernel Density Estimation Plot indicates probability of average precipitation during 24 hours across the globe over July 2007.

Using the simulated data from G5NR's "Total Cloud Optical Thickness (TAUTOT)", EarthCARE MSI was modeled to measure the cloud cover between May 2006 - Jan 2007 with most frequent measurements made near the Caribbean and between -40 to -60 deg latitude in Pacific Ocean.



## Methodology



## Conclusion

On using intersecting polygonal clusters with EarthCARE's orbital tracks and G5NR's simulated data about Cloud Optical Thickness and Convective Precipitation between May 2006 - Jan 2007, a training dataset, having 5923 rows is prepared. The datasets consist of 7 main features - longitude, latitude, total cloud cover, total precipitation, solar hour, observed, ground\_track. Therefore the data measured in one time step by EarthCARE MSI could be used more gratuitously in order to make a priority observation by the CPR that takes significantly much more power.

## Future Work

Using these datasets, reinforcement learning techniques could be better deployed and tested to achieve higher recall in determining priority observations in real-time in space, involving more features, more suitable reward function and a bigger dataset to run the training loop on.

## Acknowledgements

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