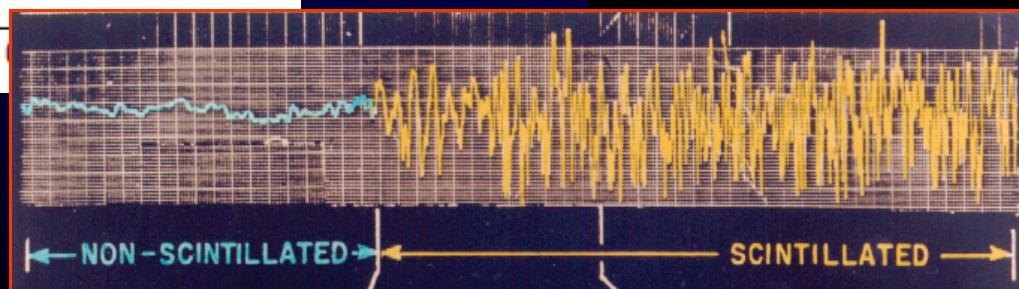
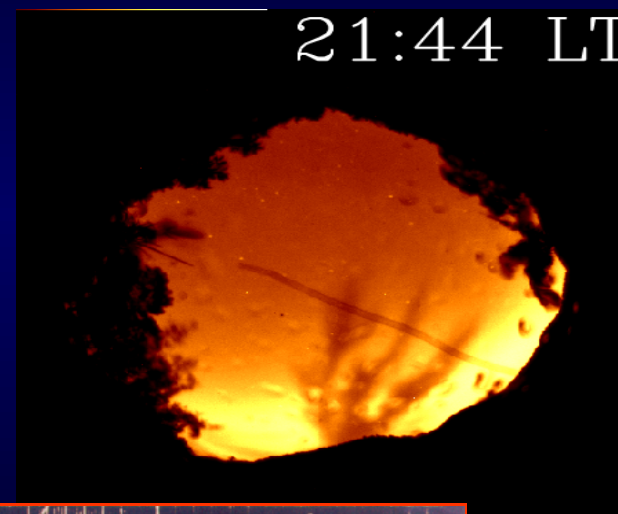
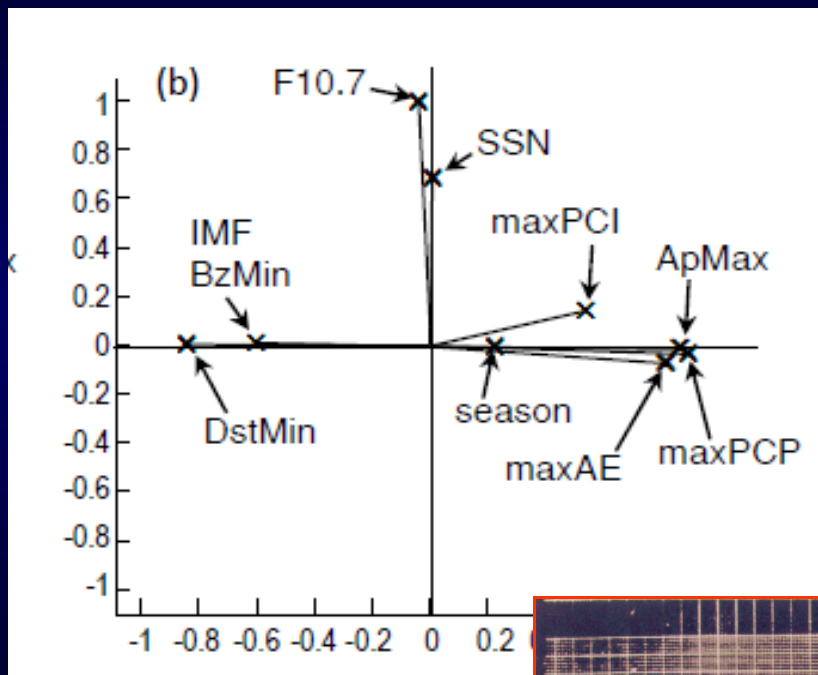




Eigenanalysis of Space Weather Climate Data: Discovering Structure within Large Multivariate Data Sets



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Solar/Solar-Terrestrial Physics





Presentation Overview



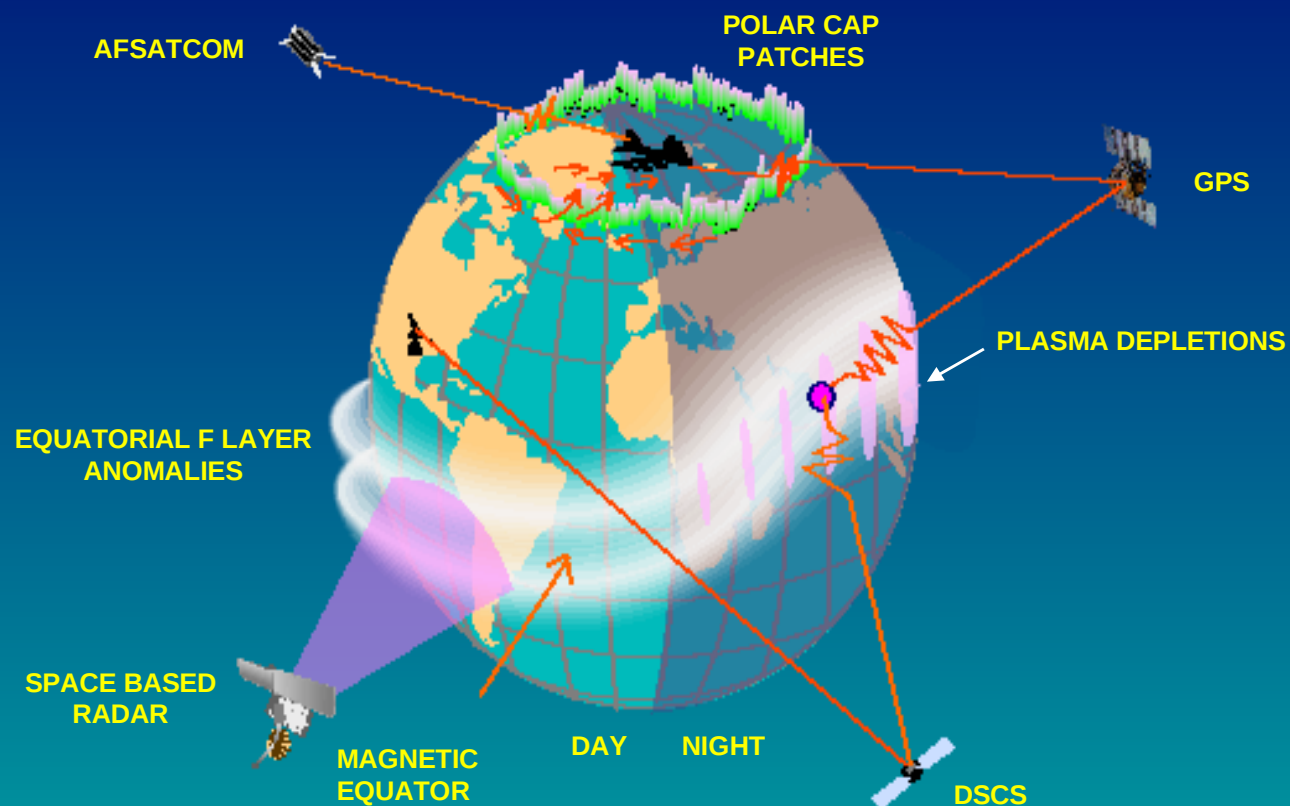
- Study Motivation
- Introduction to Exploratory Data Analysis (EDA) Techniques
- EDA of Space Weather Indices
- EDA of Electron Density Profiles (Jicamarca Digisonde Data)
- Recommendations for Future Work



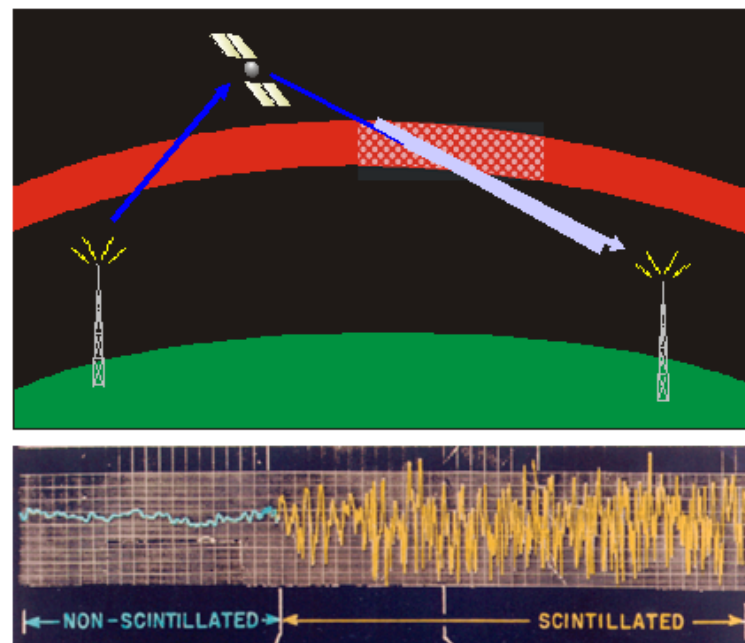
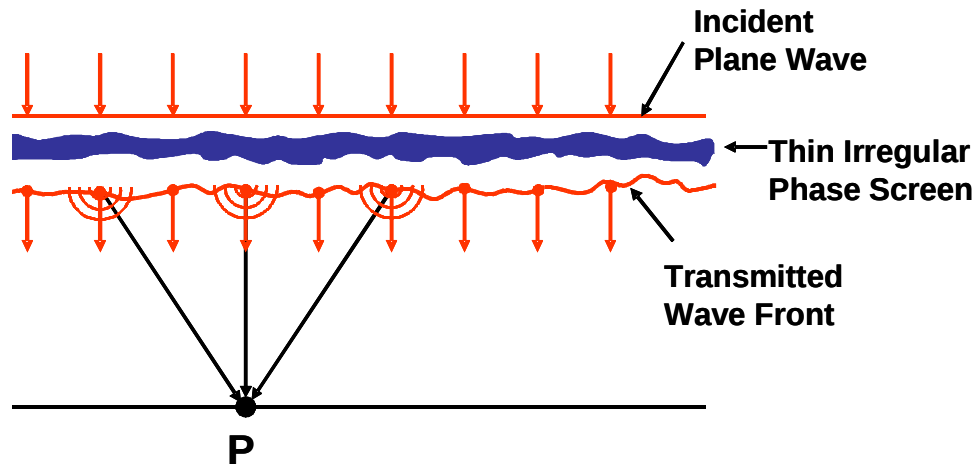
Experiment Motivation: Communications/Navigation Outages



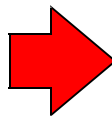
GLOBAL COMM/NAV OUTAGE REGIONS



Scintillations disrupt signals important for communications/navigation systems.



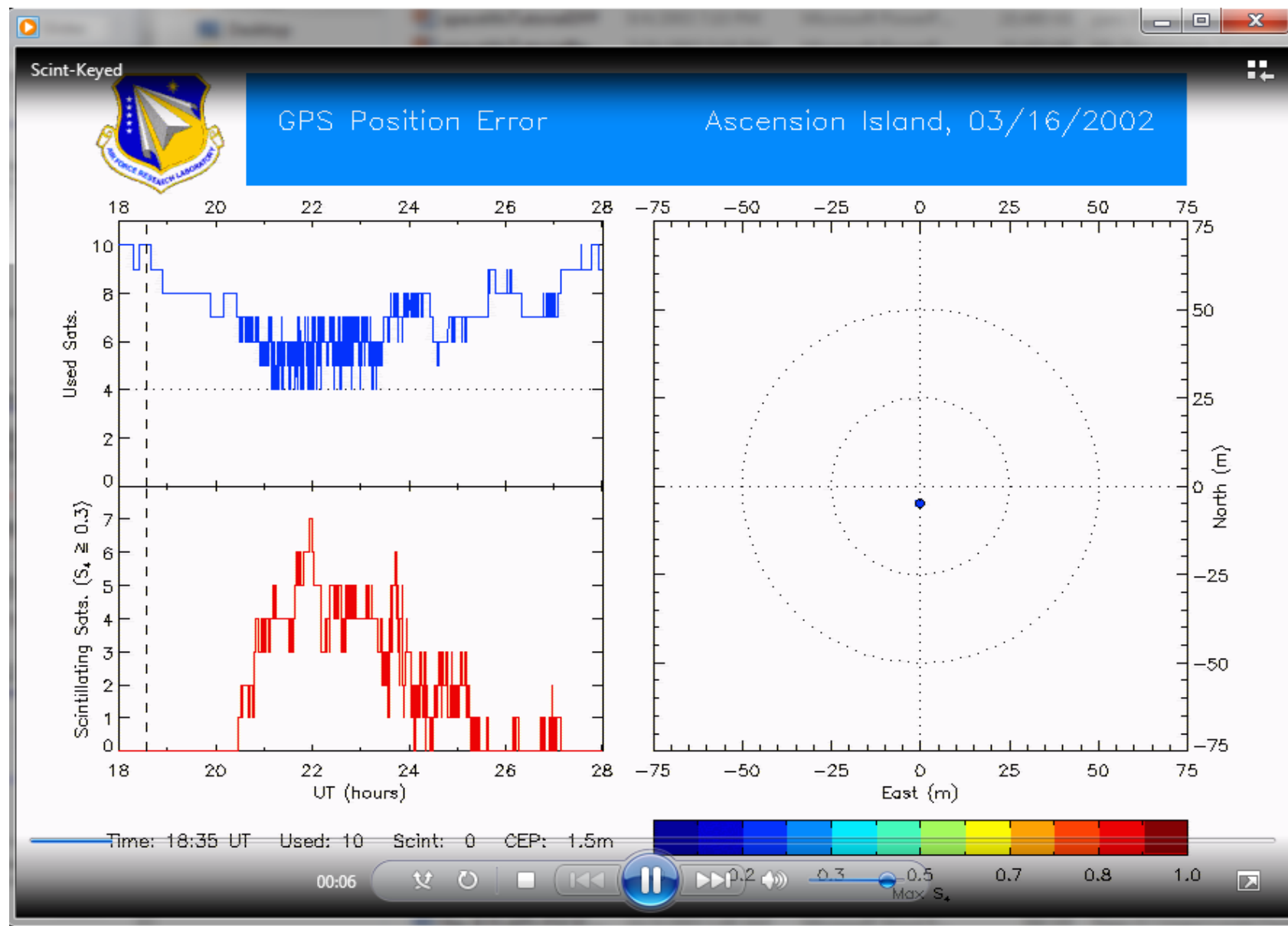
Unstable plasma within the Earth's low latitude ionosphere results in irregularities in refractive index



Scintillations occur when radio waves pass through a turbulent ionosphere, reducing signal quality



Motivation: Space Weather Effects on Communications



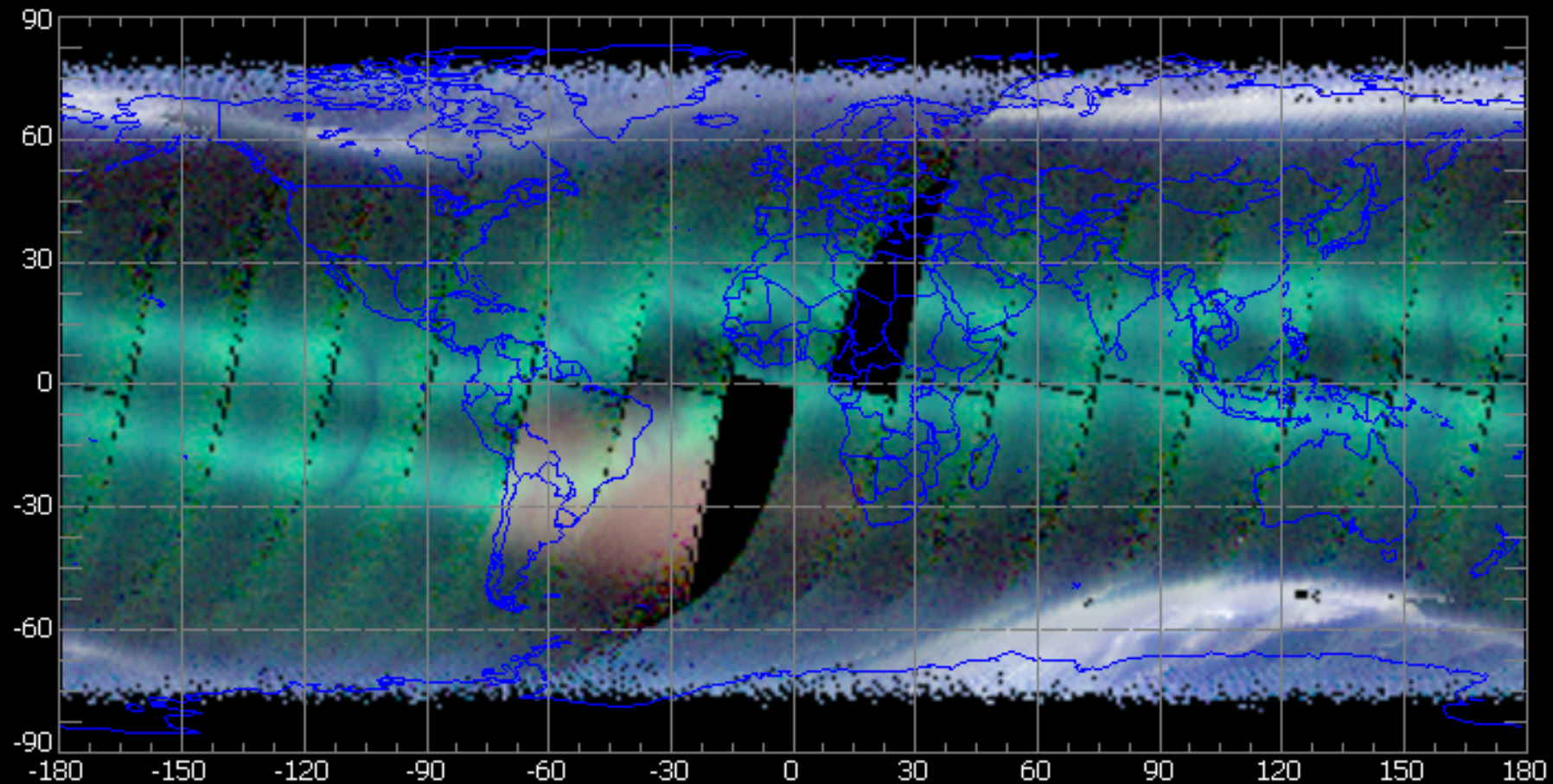


Example Data Set: Thermosphere, Ionosphere, Mesosphere Energetics and Dynamics/Global Ultraviolet Imager (TIMED/GUVI)



GUVI Composite Image

OI 1304 (blue ,10820.0 R max), OI 1356 (green,4068.83 R max), LBH short (red,5021.34 R max)



Start Filename = GUVI_im_disk_v003r00_2002082_REV01559.L1B

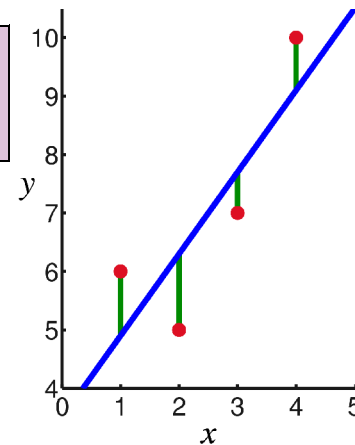
Stop Filename = GUVI_im_disk_v003r00_2002082_REV01572.L1B



How can we improve climate/nowcasting models?
USE Exploratory Data Analysis as a diagnostic

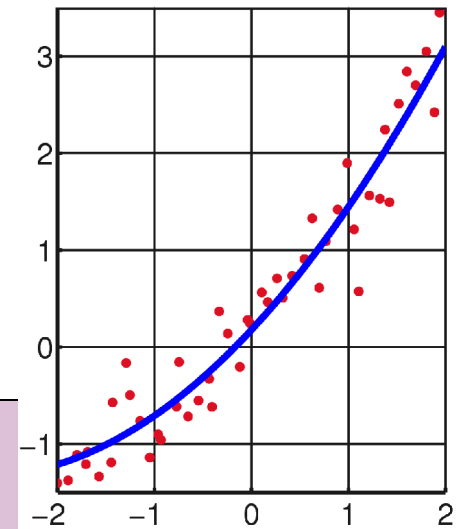
Confirmatory Data Analysis

- Start with hypothesis
- Collect data
- Perform statistical test to confirm hypothesis



Exploratory Data Analysis

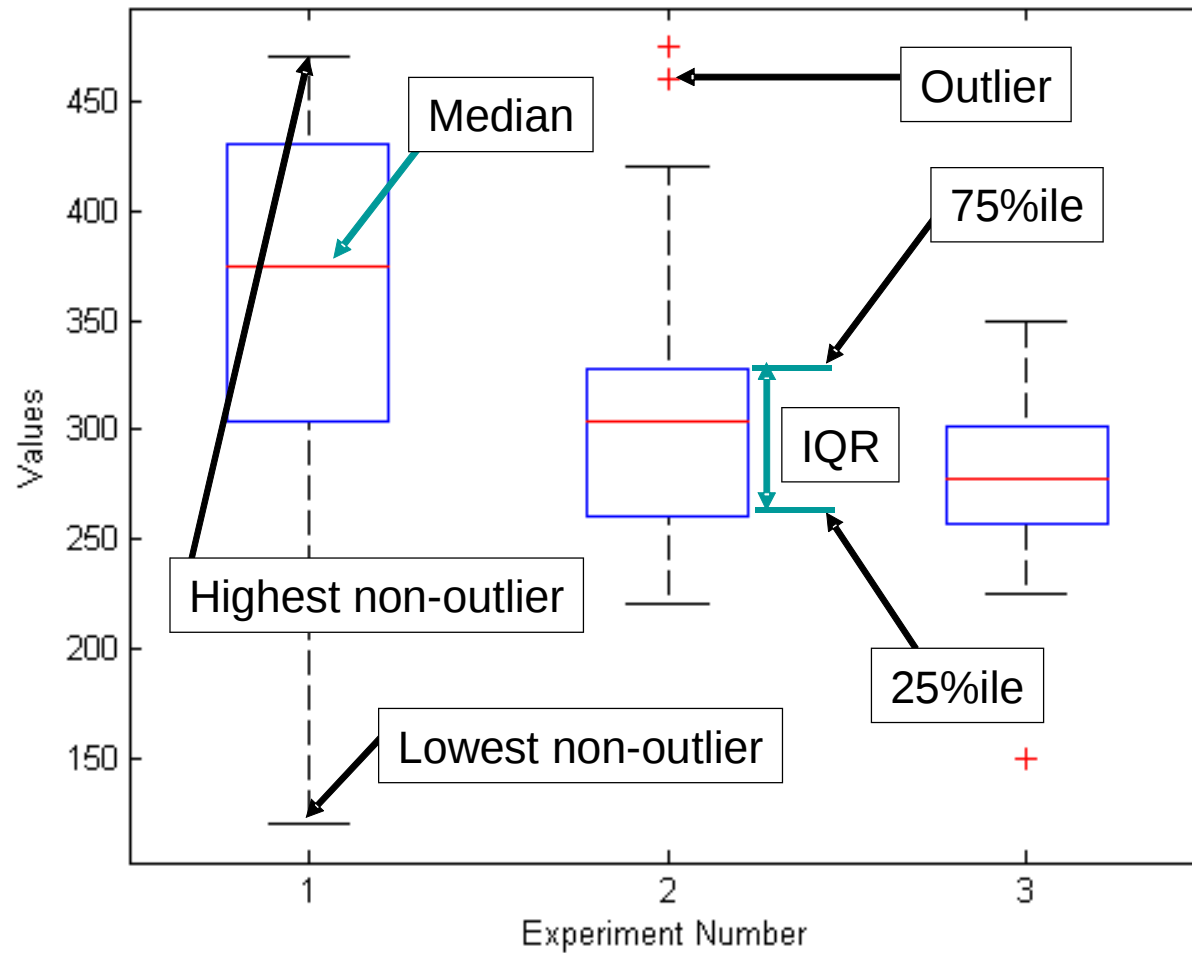
- Start with large data set
- Perform statistical test to seek significant relationships
- Establish hypothesis
- Design new experiment to test hypothesis



Example EDA Techniques

- Histogram-like Representation
- Common Factor Analysis
- Principal Components Analysis (PCA)/Karhunen-Loève Spectral Decomposition

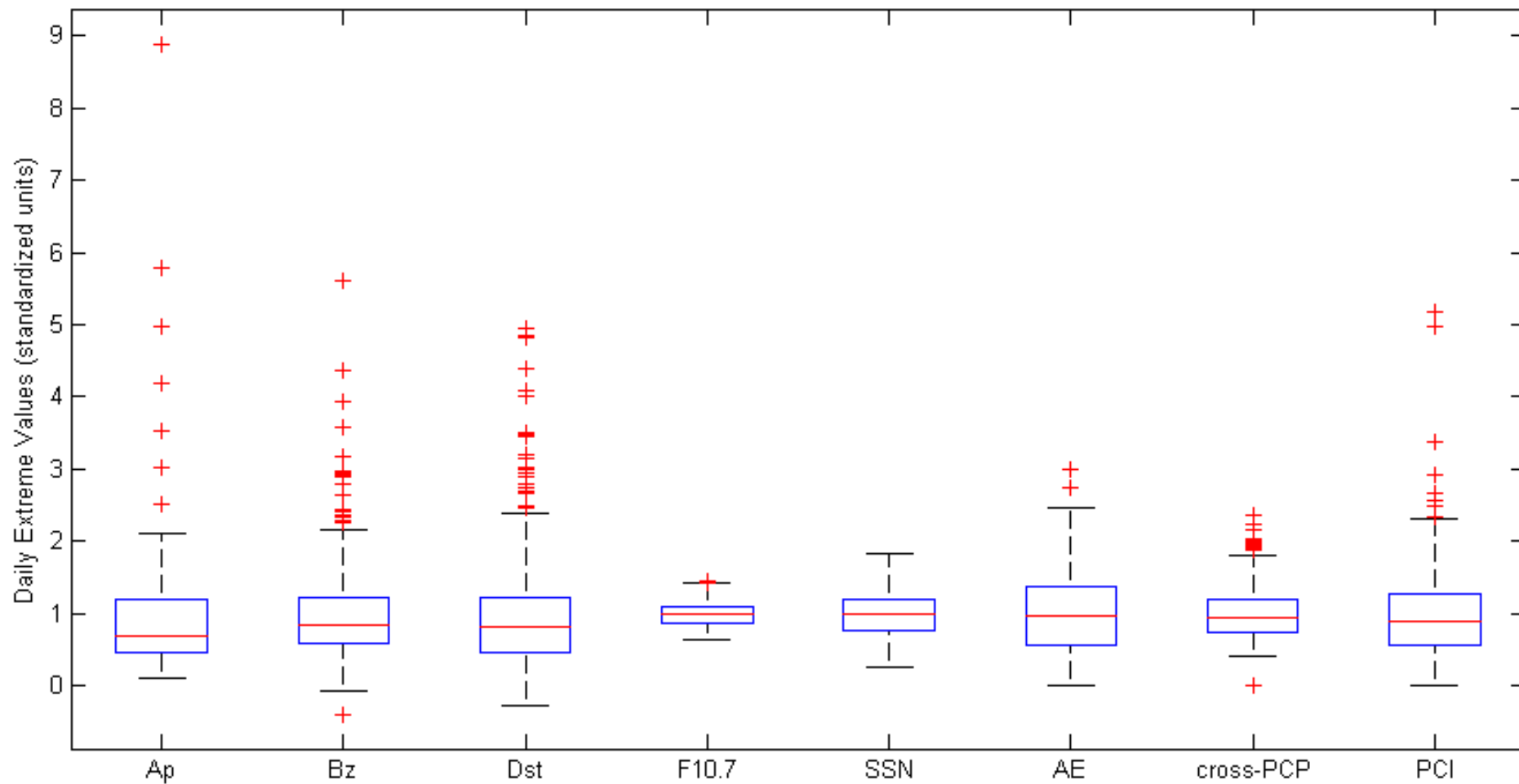
Data Representation: The Box Plot



Description of the Box Plot. Each box represents a data set for one of three experiments illustrated here.



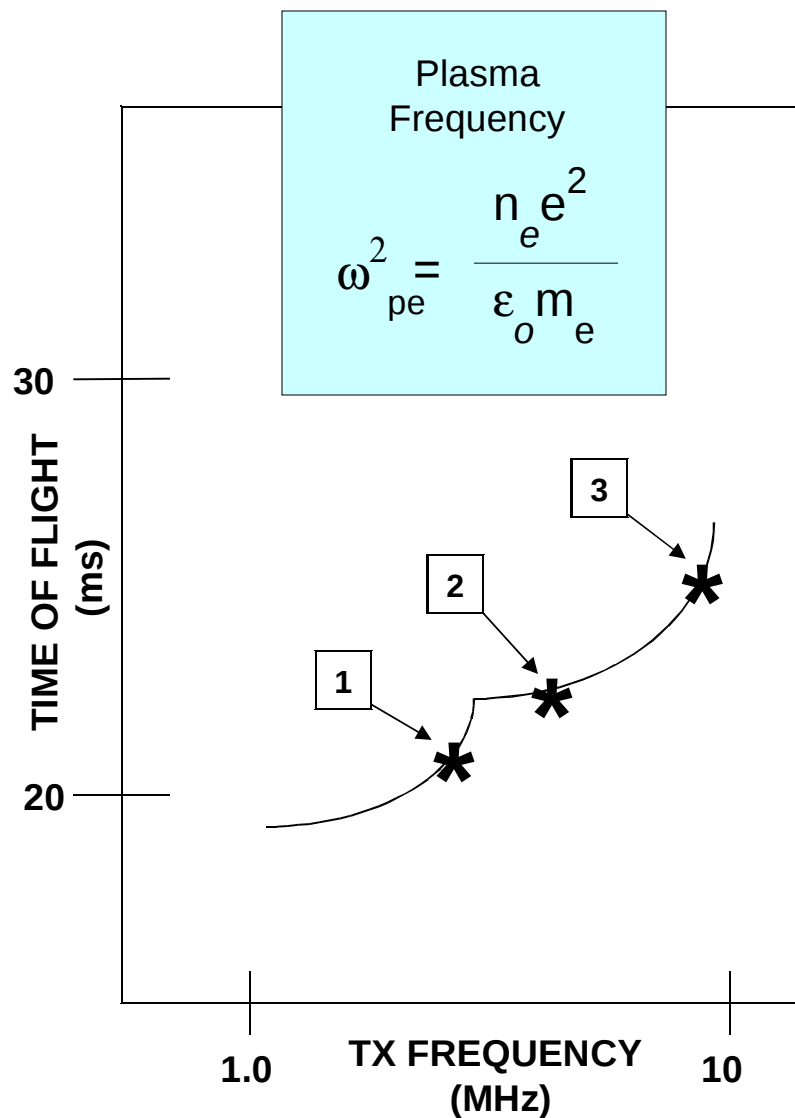
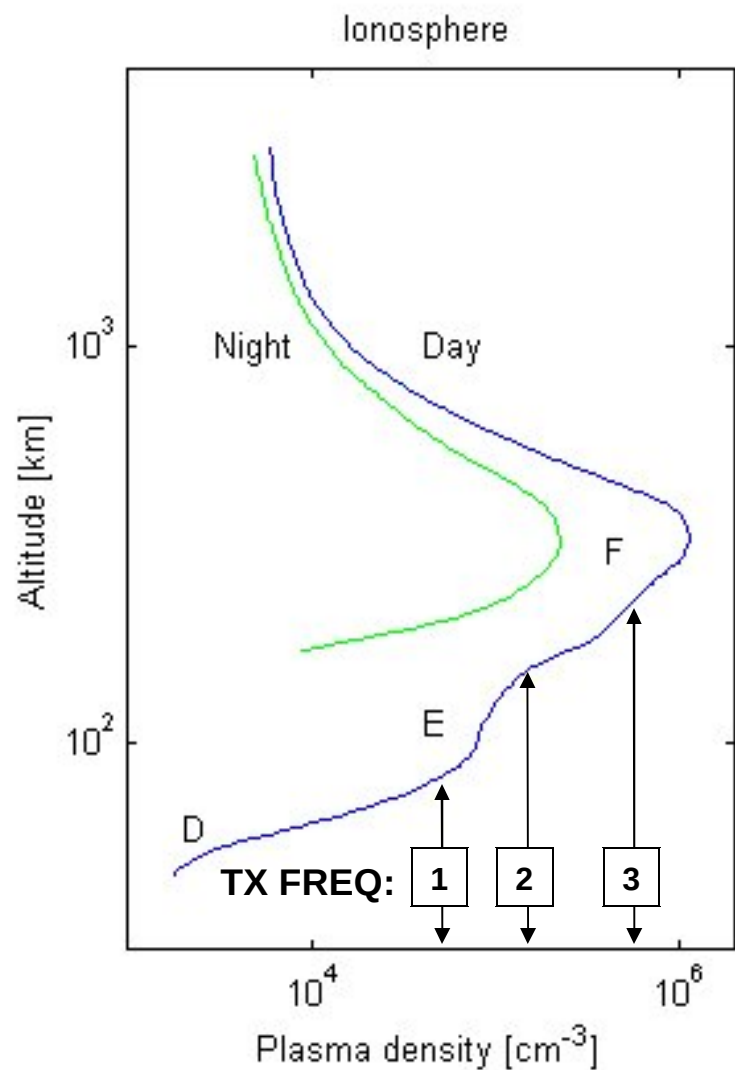
Box Plot of Space Weather Activity Indices



Box plots for the eight space weather activity indices. Values are standardized z-scores (i.e., the number of standard deviations from the mean). Daily extreme values for 2002 are represented in this data set.



Diagnostics with Ionospheric Sounding: Time-Of-Flight vs Frequency



- Investigate EOFs and coefficient time series of ionosonde profiles for clues into ionospheric plasma instability triggers (compare impulses in time series with ionospheric storm event data)
 - SIMILAR to ECG to look for heart defects
- Investigate Solar Vector Magnetograms and associated data for optimization of a free energy proxy for flare prediction
- Combine EDA techniques with those of data assimilation for space weather forecasting models (long term goal)

THANK YOU FOR COMING!!

