The Profile Envision and Splicing Tool (PRESTO): Developing an Atmospheric Wind Analysis Tool for Space Launch Vehicles Using Python

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Background

- Tropospheric winds are important in the design and day-of-launch operations of space launch vehicles
  - Calculate loads
  - Develop trajectories
- Flight vehicle programs require a vertically complete profile with consistent effective vertical resolution (EVR)
- Multiple measurement systems exist at the Eastern Range (ER)
  - High Resolution (HR) and Low Resolution (LR) Balloons
  - Boundary Layer (915-MHz) and Tropospheric (48-MHz) Doppler radar wind profilers
- However each source provides different EVR, vertical coverage, and temporal coverage
- In order to create a vertically complete profile, aspects of each system must be captured
PRESTO Introduction

- MSFC Natural Environments Branch has developed the Profile Envision and Splicing Tool (PRESTO) to produce vertically complete profiles from available sources

- Designed with cost, safety, flexibility, and usability in mind
  - PRESTO coded using Python 3
  - Has few dependencies
    - Numpy – array handling
    - Scipy – mathematical functions
    - Matplotlib – data visualization
    - Tkinter – create and execute the Graphical User Interface (GUI)
  - Consists of two modules
    - PRESTO.py – handles the GUI, arrangement of data, and visualization
    - PRESTO_Qcsplice_functions.py – handles the splicing and filtering of the data
  - PRESTO is operated through a GUI that allows the operator to select search dates and times, change file directories, change the filtering wavelength, and select profiles to view or splice
  - PRESTO contains fault tolerance/recovery processes
    - Alerts for any non-fatal errors and returns to a safe state
    - Protects against vulnerabilities such as incorrect date, time, and filter wavelength input, incorrect input files, etc. and stops the process
    - Contains realistic values check of input/output data
  - Capable of incorporating new measurement systems
Overview of generating spliced profile with PRESTO
Splicing & Filtering Procedures

• PRESTO can splice up to three profiles
• Profiles are fared using a Gaussian weighting scheme if overlap exists
• If there is no overlap between profiles being spliced, then the gap is interpolated using a linear interpolation scheme
• The spliced profile from measurement sources are then fared into a monthly mean profile above the highest measurement
• Finally a low-pass, six-pole, forward-backward Butterworth filter is applied to the spliced profile
PRESTO Design

Example of the screen where the operator enters the desired date range, initiates the search of the database, and loads the found files.
PRESTO Design

- The main window where the splicing and filtering are performed.
Summary

• Launch vehicle programs require vertically complete atmospheric profiles
• Many systems at the ER to make the necessary measurements, but all have different EVR, vertical coverage, and temporal coverage
• MSFC Natural Environments Branch developed a tool to create a vertically complete profile from multiple inputs using Python
• Forward work
  – Finish Formal Testing
    • Acceptance Testing
    • End-to-End Testing
  – Formal Release
Questions?