Gravity Waves Analysis Tool

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Our Vision Statement

- For individuals with at least a sophomore-level education in atmospheric sciences or physics who would like to view the effects of gravity waves in radiosonde data
- Easy to use UI with no installation or programming required
- Output graphs and gravity wave parameters in one PDF
- Completely free and open source, unlike IDL

What Our Software Accomplishes

- Parses any radiosonde data with the standard format where the line of variables is the first line under “Profile Data:”, followed by the units, then the data
- Also parses the V2 and V3 data
- Robust in handling some un-QC’d data (like data collected after the balloon popped or small sections of missing data)
- Gives users option to preview and download data in a PDF
- 17 graphs in total in the PDF
- Only user requirement is internet connection

All Graphs

Troposphere

- Temperature with altitude
- U wind component with altitude
- V wind component with altitude

- Temperature perturbation
- U wind component perturbation
- V wind component perturbation

- Hodograph
- Ascension rate

Stratosphere

- Temperature with altitude
- U wind component with altitude
- V wind component with altitude

- Temperature perturbation
- U wind component perturbation
- V wind component perturbation

- Hodograph
- Ascension rate

- Dr. Barber’s Weather Balloon Path Graph

Several Challenges & Solutions

Challenge 1: Get variables and units from radiosondes since there are so many different formats (some variables missing or in different order while some radiosondes like the QC'd files have no units).

Old Solution: Originally hard code formats into program.

New solution: Dynamically parse line of variables right under "Profile Data:" and then parse units. Issue arose of variables with two words like "Virt. Temp" though special cases were created to handle them. Also hard coded units for QC'd files since they didn't have any

Challenges & Solutions

Challenge 2: Validate graphs and output

Solution: Use degree of 3 for polynomial (from GDL code) and for tropopause, calculate lapse rate of 1.5°C/km and do not take values less than 5.5km.

Future Plan: Take into account thickness of tropopause to further remove background noise

Challenges & Solutions

Challenge 3: Backend limiting number of users and security (One user at a time can upload)

Solution: In progress

Future Plan:

1. Implement user session management in Flask to differentiate between users (each user's uploads and outputs can be handled separately)
2. Modify the upload and output directories to be unique per session
3. Clear session-specific folders so the folder clearing functions are updated to only clear files related to the user's session
4. Modify the PDF retrieval endpoint to only access the PDFs from the user's session-specific output folder
5. Will use environmental variables for password (instead of hard coding)

Final Product UI

Gravity Waves Analysis Tool

Upload File

Preview PDF

Download PDF

Authors Page

GitHub Repository

Files We Support

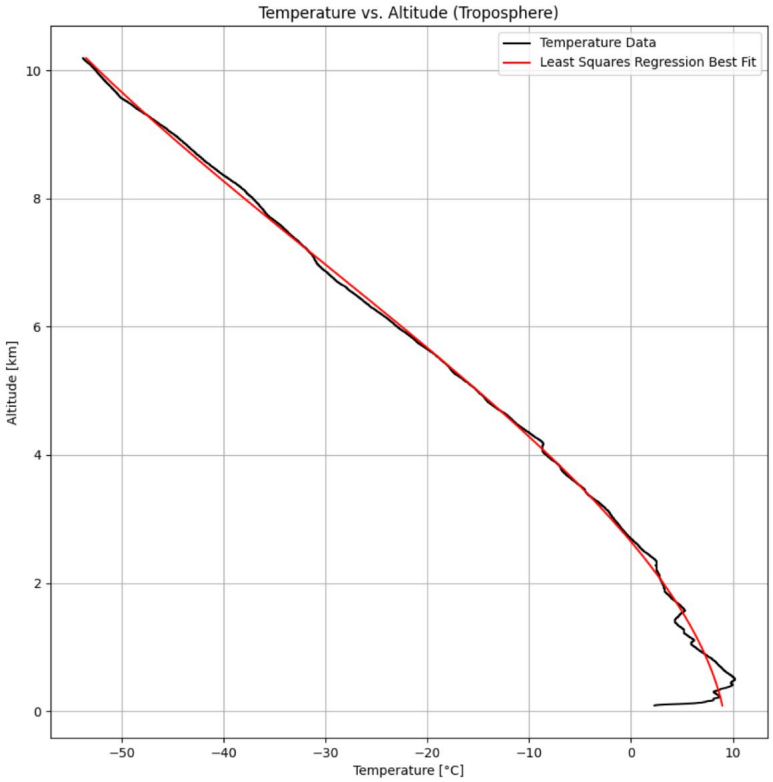


Figure Description: This graph displays temperature with respect to altitude in the troposphere. The polynomial regression line of temperature is plotted in red.

Future of GWAT

- The official deadline Dr. Tenbergen set for making any adjustments to the Software (both stakeholder requests and student modifications) was April 20th

- We would like to continue working with you over the summer to get it fully functional

- Finals week is next week

Thank you very much Dr. Gong, Dr. Kanbur, and Dr. Barber

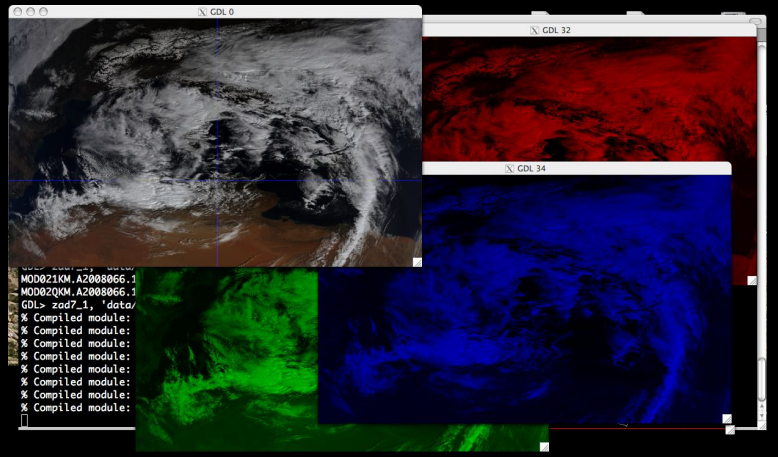
Key Stakeholders

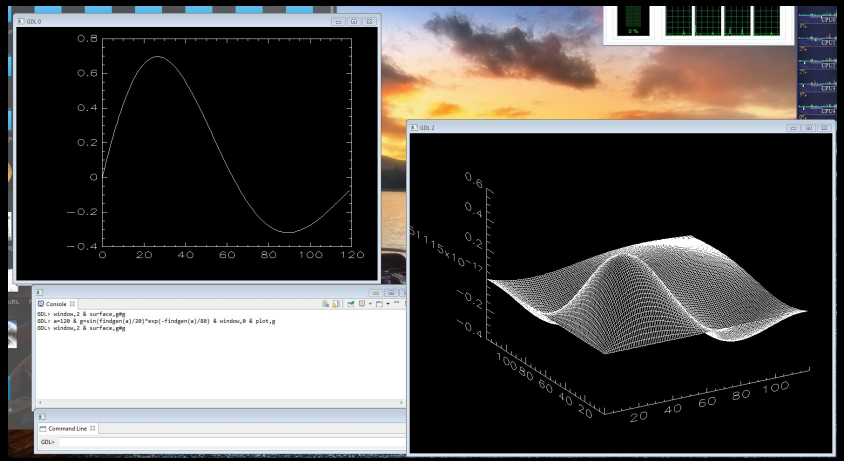
Stakeholders: Dr. Gong, Dr. Kanbur, Dr. Barber, Dr. Tenbergen

- NASA Goddard Space Center
- Suny Oswego Physics Department
- The Atmospheric and Geological Sciences Department

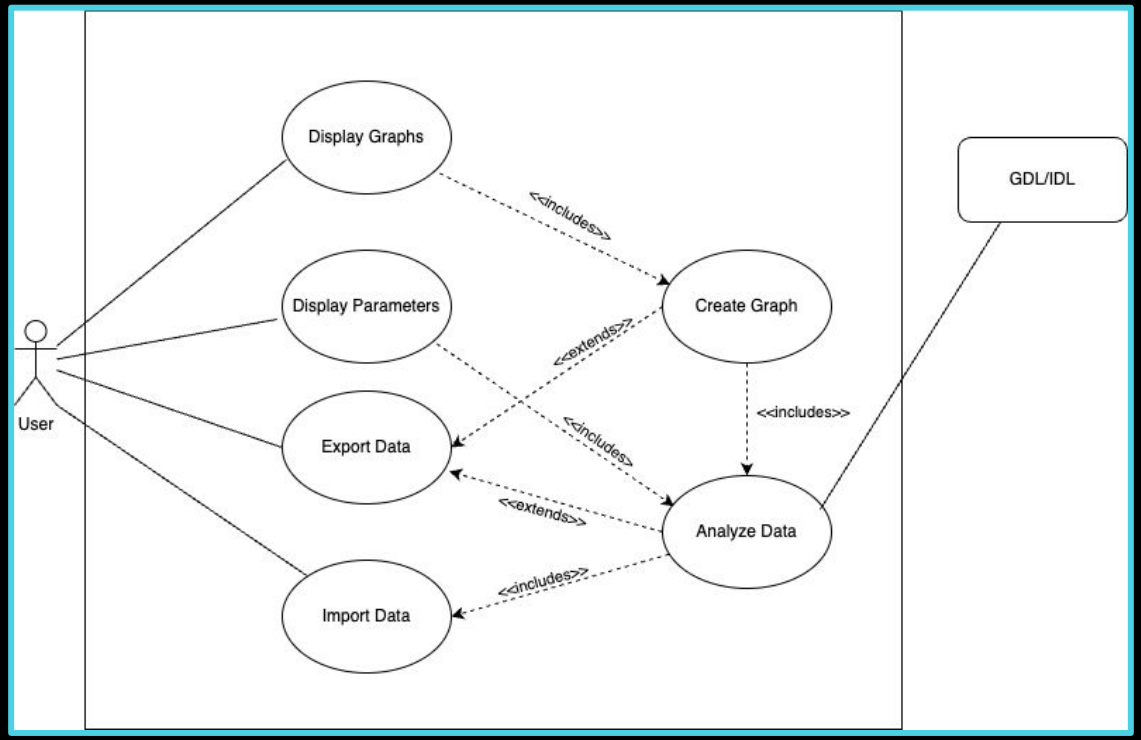
Why this Program?

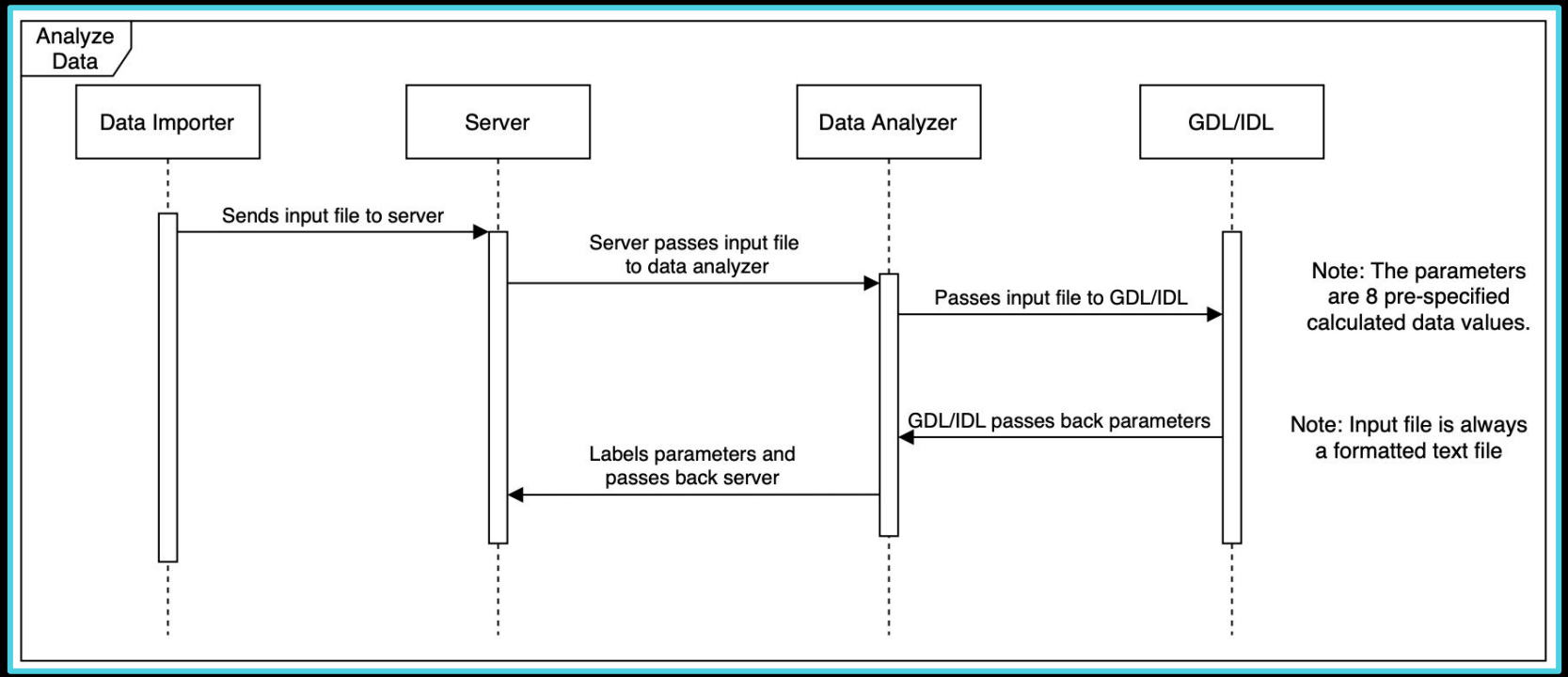
- Easy access to IDL/GDL
  - Unbelievable data analysis capabilities
- For learners and professionals studying:
  - Meteorology, Atmospheric/Geological Sciences, Physics
- Converts a text file with radiosonde (weather balloon) data into several visual graphs
  - Better for data relationship analysis
- Integrated into a web application

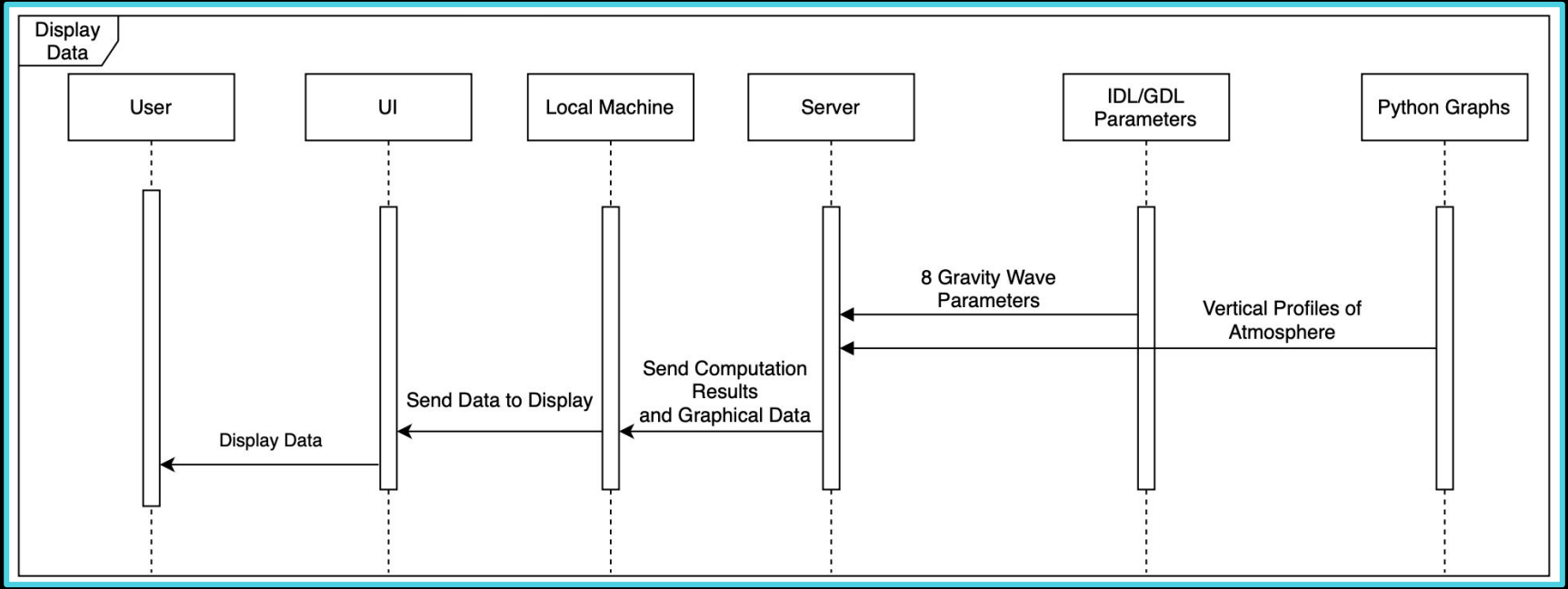


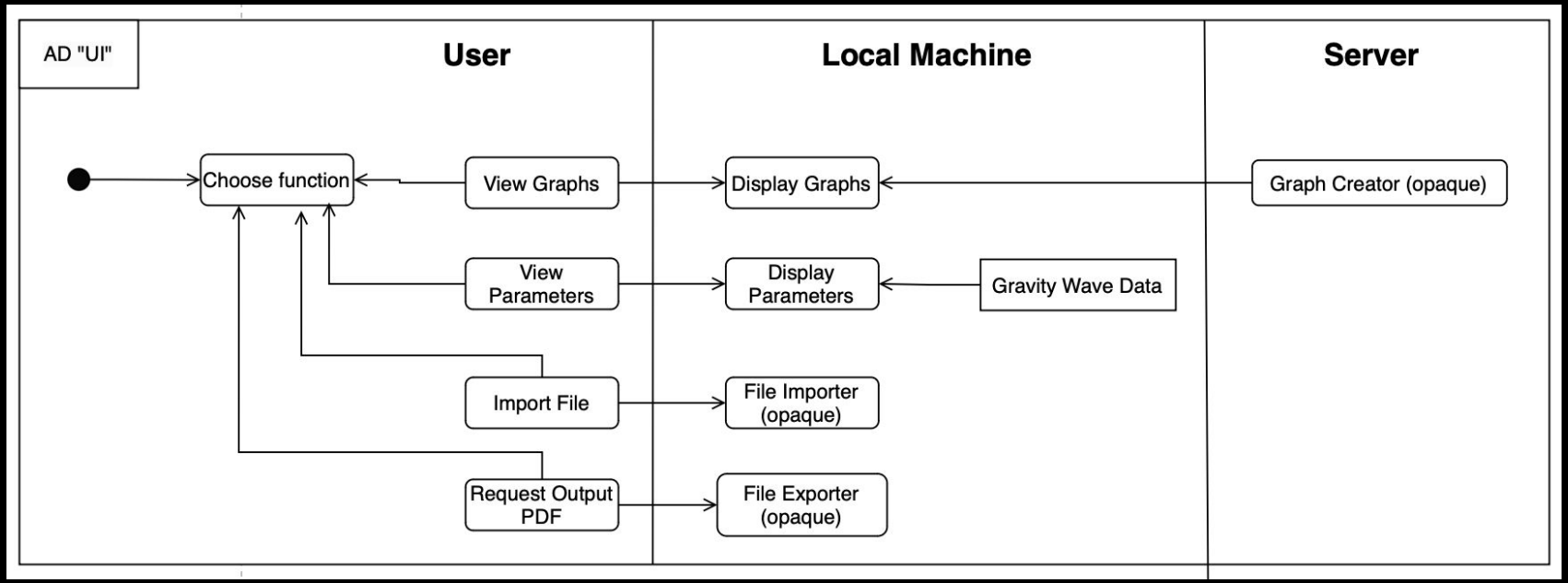


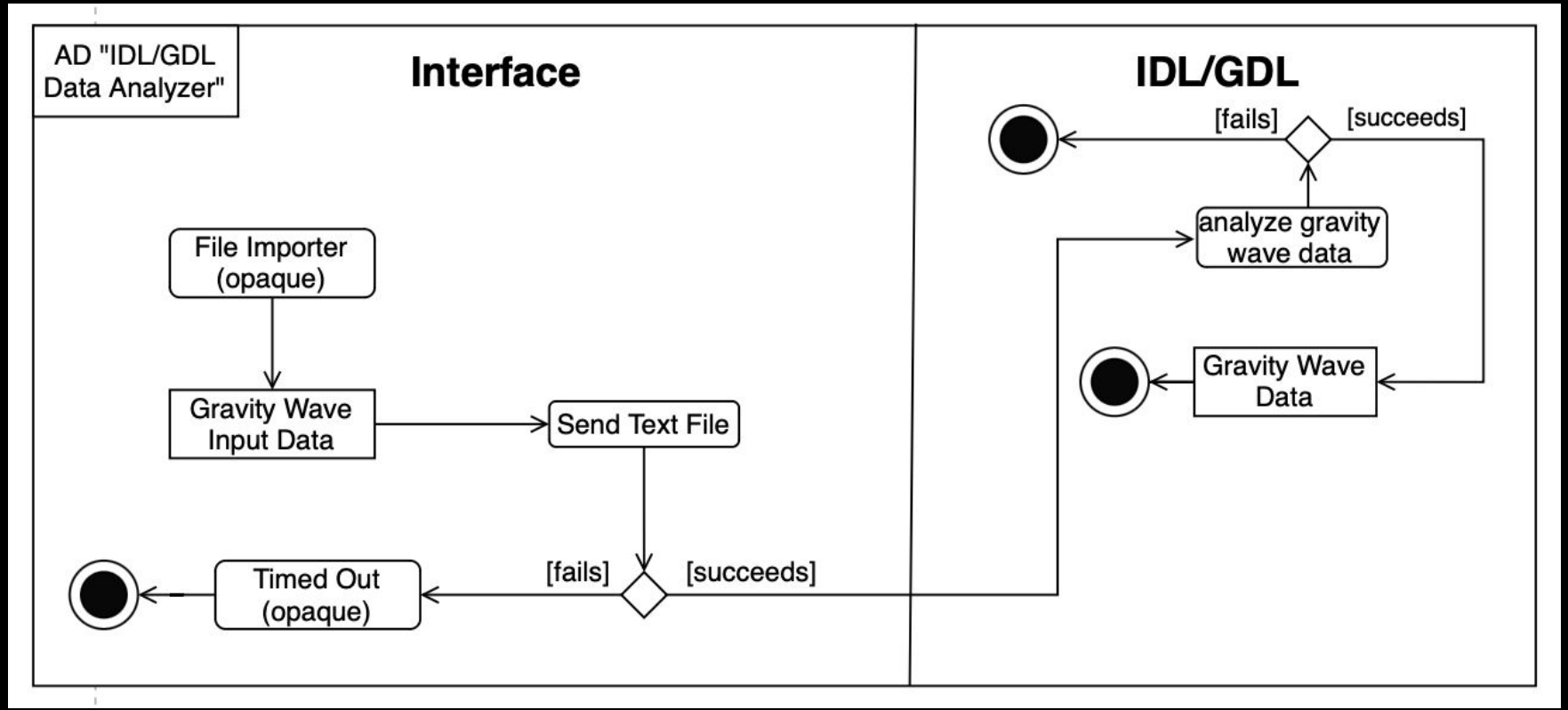
Method Behind the Madness

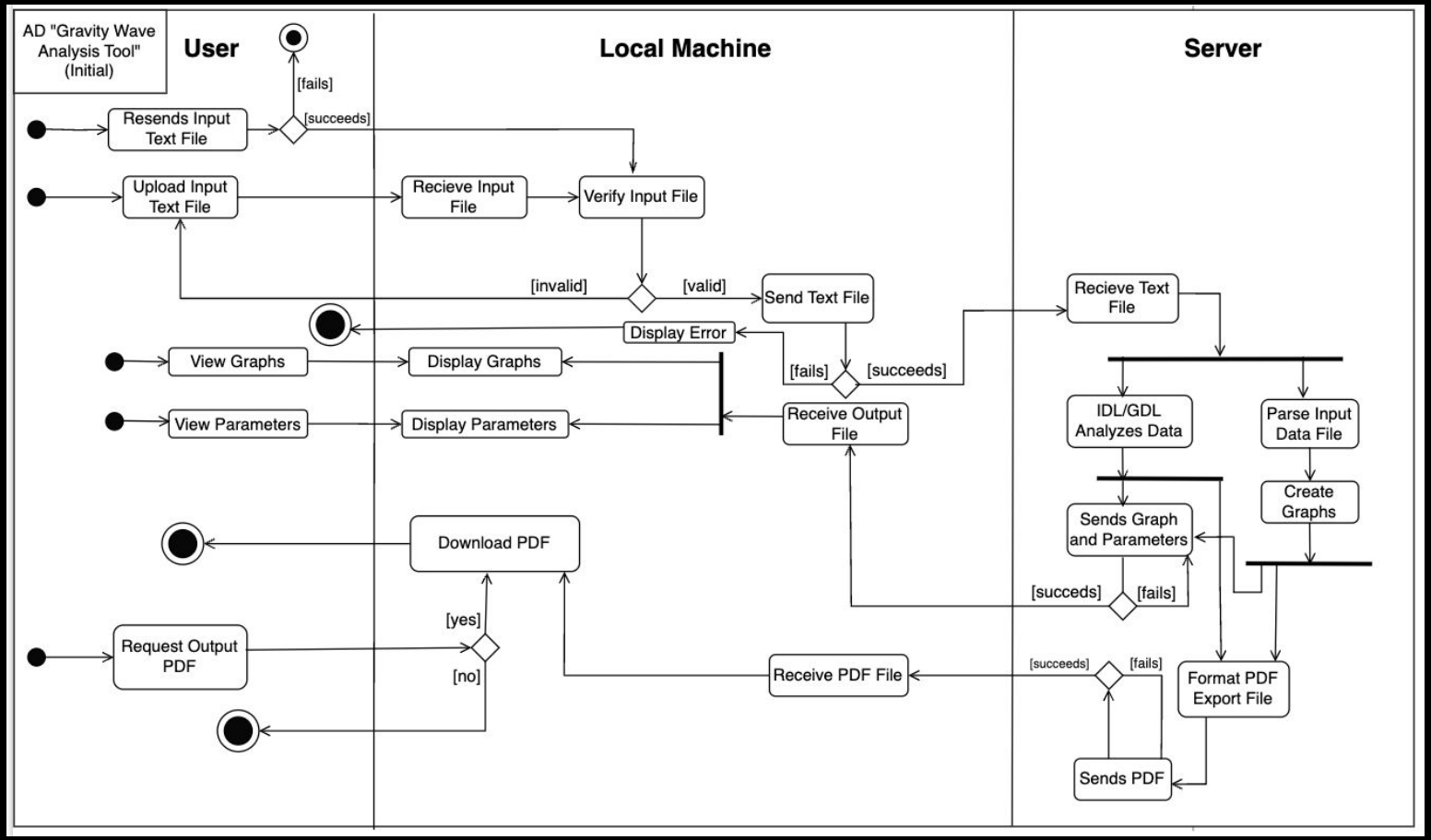



Analyze Data
Data Importer
Server
Data Analyzer
GDL/IDL
Sends input file to server
Server passes input file to data analyzer
Passes input file to GDL/IDL
GDL/IDL passes back parameters
Labels parameters and passes back server
Note: The parameters are 8 pre-specified calculated data values.
Note: Input file is always a formatted text file


Display Data
User
UI
Local Machine
Server
IDL/GDL Parameters
Python Graphs
8 Gravity Wave Parameters
Vertical Profiles of Atmosphere
Send Computation Results and Graphical Data
Send Data to Display
Display Data

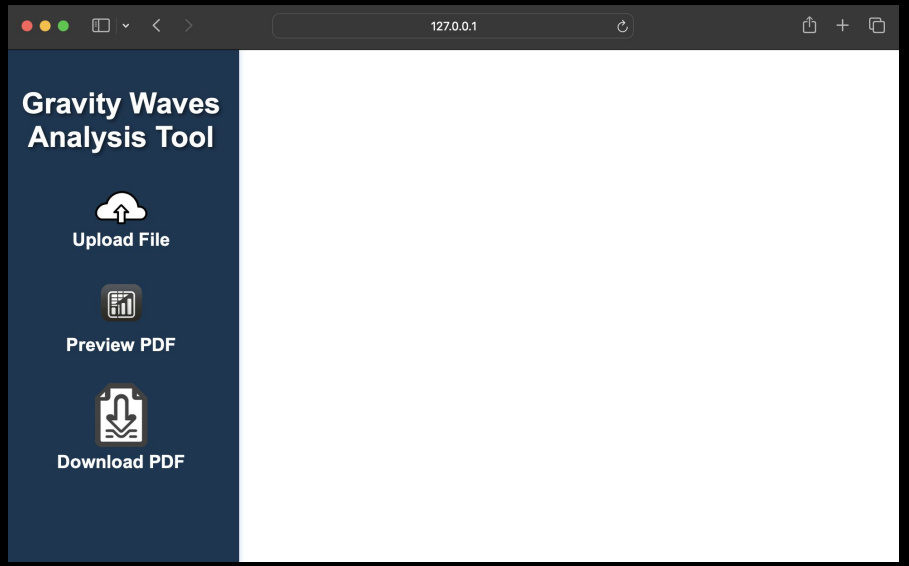

AD "UI"
User
Local Machine
Server
Choose function
View Graphs
Display Graphs
Graph Creator (opaque)
View Parameters
Display Parameters
Gravity Wave Data
Import File
File Importer (opaque)
Request Output PDF
File Exporter (opaque)


AD "IDL/GDL Data Analyzer"
Interface
IDL/GDL
[fails]
[succeeds]
analyze gravity wave data
File Importer (opaque)
Gravity Wave Data
Gravity Wave Input Data
Send Text File
[fails]
[succeeds]
Timed Out (opaque)


AD "Gravity Wave Analysis Tool" (Initial)
User
Local Machine
Server
[fails]
[succeeds]
Resends Input Text File
Upload Input Text File
Recieve Input File
Verify Input File
[invalid]
[valid]
Send Text File
Display Error
View Graphs
Display Graphs
View Parameters
Display Parameters
[fails]
[succeeds]
Receive Output File
Recieve Text File
IDL/GDL Analyzes Data
Parse Input Data File
Create Graphs
Sends Graph and Parameters
[succeds]
[fails]
Download PDF
[yes]
[no]
Request Output PDF
Receive PDF File
[succeeds]
[fails]
Format PDF Export File
Sends PDF

Ingredients to the Recipe

- Defining requirements and use cases
  - What does the user need to do in order to get the expected output?
- Website for easy access
  - Developed with a straightforward, “click-and-forget,” UI
- Easy deployment
  - Backend code - Python
  - Frontend code - HTML, CSS, and JavaScript
  - Combined together with Flask and deployed with Docker
- Common graphs
  - Variables for troposphere and stratosphere: Temperature, altitude, wind components, and ascension rate
- Analyzed data
  - Latitude and longitude, tropopause altitude, wavelength, energy, intrinsic frequency, and many more



Github/User Guide

DEMO

References

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3. Moran, David (Jan 24, 2018).*Transverse and longitudinal waves review*. National Weather Service. (n.d.). https://www.weather.gov/source/zhu/ZHU_Training_Page/Miscellaneous/gravity_wave/gravity_wave.html#:~:text=In%20a%20gravity%20wave%2C%20the%20upward%20moving%20region%20is%20the,stable%20layer%20of%20the%20atmosphere.
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5. https://en.m.wikipedia.org/wiki/File:NASA_logo.svg
6. https://svs.gsfc.nasa.gov/10648/
7. https://ww1.oswego.edu/communications-and-marketing/brand/logos