

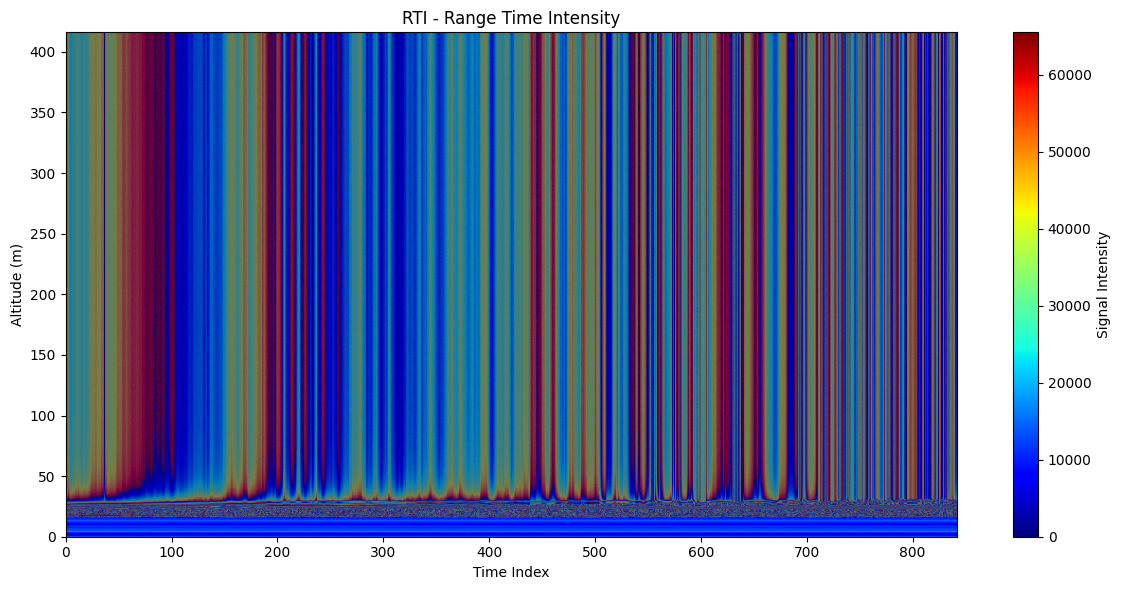
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| **Title** | Detection of Convection-Triggered Gravity Waves in the Atmospheric Boundary Layer Using LiDAR Observations |
| **Name** | Mr. Sudhan R |
| **Application Number** | ENGS1672 |
| **Candidate’s Institute** | Sri Eshwar College of Engineering, Affiliated to Anna University |
| **Name of the Guide** | Dr. Y. Bhavani Kumar |
| **Name of the Institute** | National Atmospheric Research Laboratory (NARL) |
| **Report** | 8 – Week Report |

**1. WORK CARRIED OUT AFTER THE FIRST FOUR WEEKS**

After completing the initial understanding of LiDAR data structure and preliminary range-time visualization, the second phase of the project focused on deeper signal extraction, frequency analysis, and interpretation.

* The dataset provided contained over 850 LiDAR profiles in Licel .C14 binary format, each corresponding to a 30-second vertical scan.
* All files were read using Python and converted into a structured format. A NumPy 2D array was generated where rows represented vertical bins (altitude) and columns represented time.
* The total vertical resolution was ~7.5 m per bin, and the data extended up to ~3.1 km altitude.



**Figure 1: RTI - Range Time Intensity**

**2. SELECTION OF ALTITUDES AND TIME SERIES ANALYSIS**

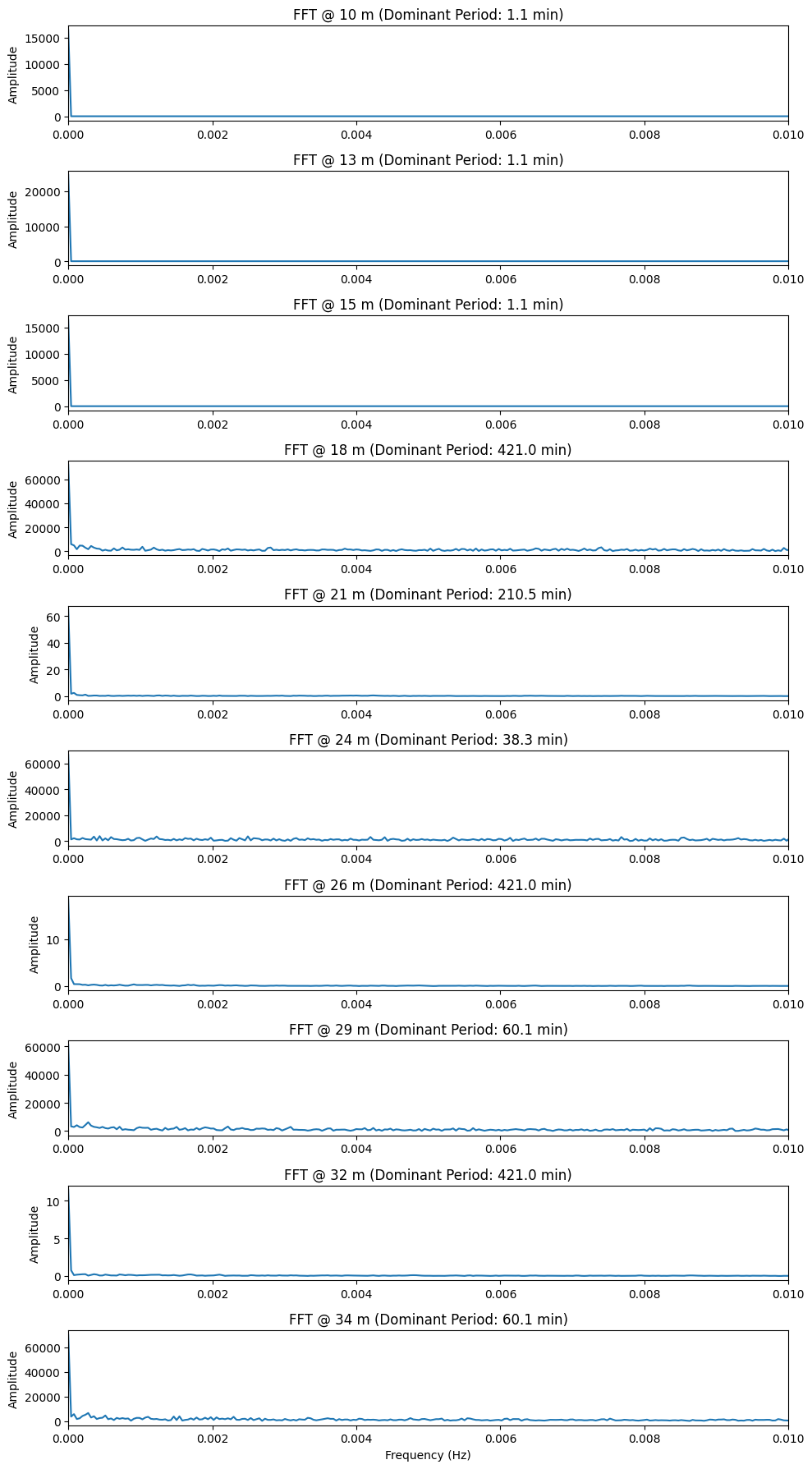
Based on RTI visual inspection, altitude bins between **750 m and 2600 m** showed clear periodic signal variations. Ten specific bins were selected at 200–250 m intervals for detailed time-series analysis.

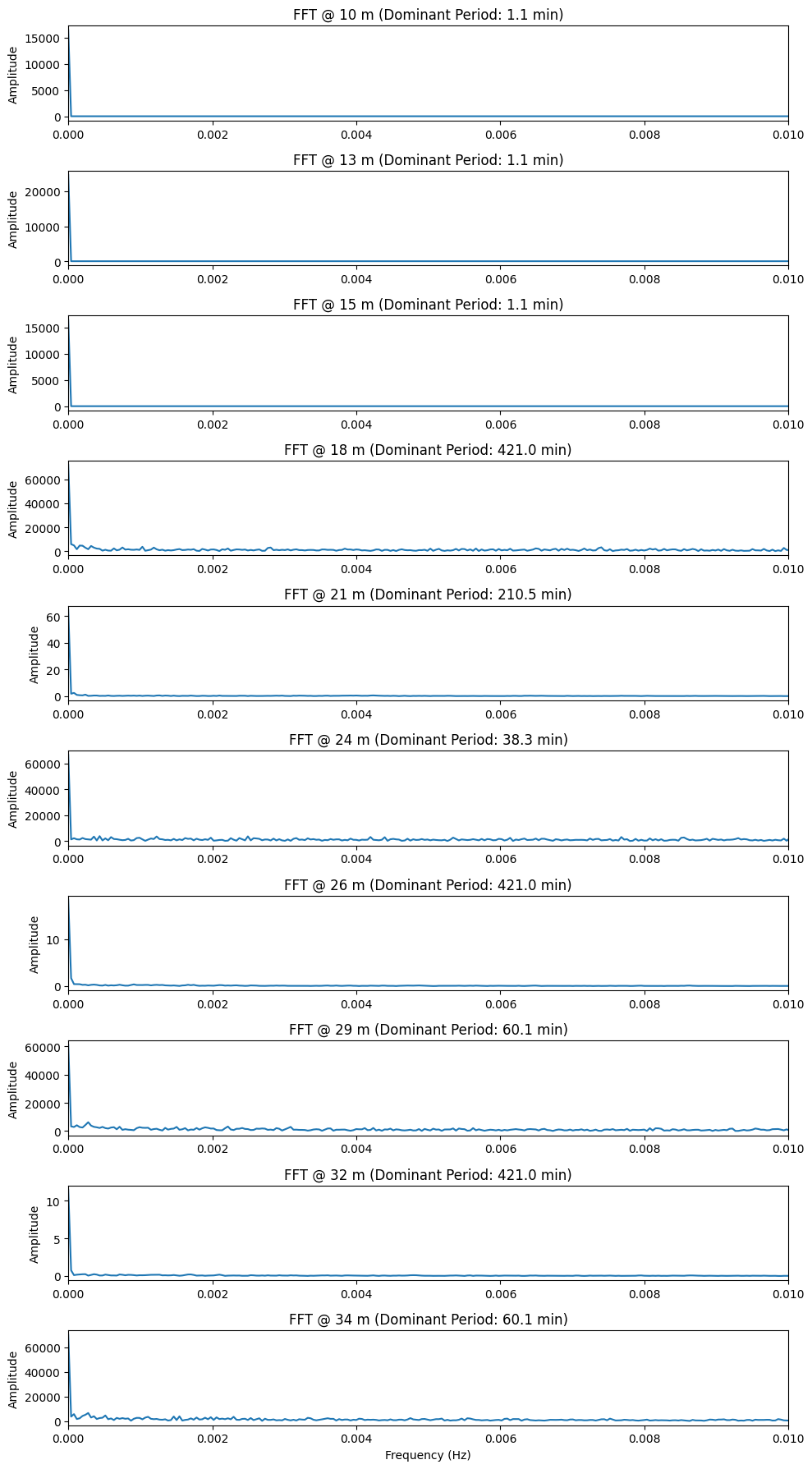
* Time-series plots were generated for each altitude to observe visual oscillations.
* These plots helped in identifying potential regions where convection-triggered gravity wave activity was visible.

**3. SPECTRAL (FFT) ANALYSIS**

Fast Fourier Transform (FFT) was applied to each time series to detect dominant frequencies.

* Dominant peaks were identified in the range of **0.00027 to 0.00043 Hz**, corresponding to wave periods of **38 to 60 minutes**.
* These values match theoretical expectations for gravity waves generated by convective activity in the ABL.





**Figure 2: Fast Fourier Transform (FFT)**

**4. SIGNAL INTENSITY VS TIME**

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**Figure 3: Signal Intensity vs Time**

**5. INTERPRETATION OF RESULTS**

* Dominant gravity wave signatures were observed at **~1762.5 m, 2167.5 m, and 2572.5 m**.
* These layers showed both visual periodicity and matching frequency peaks.
* Above 2700 m, the signal dropped significantly, and below 500 m, wave signatures were weak or noisy.

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| **Bin Index** | **Altitude (m)** | **Dominant Frequency (Hz)** | **Wave Period (min)** |
| 100 | 750.0 | 0.015044 | 1.10 |
| 127 | 952.5 | 0.015044 | 1.10 |
| 154 | 1155.0 | 0.015044 | 1.10 |
| 181 | 1357.5 | 0.000040 | 421.0 |
| 208 | 1560.0 | 0.000079 | 210.5 |
| 235 | 1762.5 | 0.000435 | 38.2 |
| 262 | 1965.0 | 0.000040 | 421.0 |
| 289 | 2167.5 | 0.000277 | 60.1 |
| 316 | 2370.0 | 0.000040 | 421.0 |
| 343 | 2572.5 | 0.000277 | 60.1 |

**Table 1: FFT Summary Table**

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| --- | --- | --- |
| **Altitude (m)** | **Wave Period (min)** | **Interpretation** |
| 750–1155 | ~1.1 mins | Could be **high-frequency noise** or local turbulence, not gravity waves |
| 1357–2370 | 210–421 mins | This is in the **long-period gravity wave** or **convective plume** range |
| 1762.5 | ~38 mins | This is **very relevant**! Likely a **gravity wave signal** |
| 2167.5, 2572.5 | ~60 mins | Classic **CBL convection-triggered wave periods** |

**Table 2: Interpretation**

**6. TOOLS AND METHODS USED**

* **Google Colab (Python)**: For binary file reading, reshaping, plotting, FFT
* **NumPy, Matplotlib, SciPy**: For signal processing
* **Licel Binary Format Decoding**: Using manual specs
* **Manual RTI Inspection + Programmatic Filtering**
* **FFT + Time-Domain Overlay Interpretation**

**7. CONCLUSION**

This project successfully demonstrated the use of LiDAR signal profiles to detect convection-triggered gravity waves within the atmospheric boundary layer. The chosen methodology — combining time-series analysis with frequency domain inspection — confirmed the presence of periodic wave patterns in the 1.7 km to 2.6 km altitude band.

**8. REFERENCES**

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