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SCIENCE ACADEMIES'

SUMMER RESEARCH FELLOWSHIP PROGRAMME

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Title	LiDAR-Based Observational Study of the Atmospheric Boundary Layer
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Application Number	ENGS1672
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Name of the Guide	Dr. Y. Bhavani Kumar
Name of the Institute	National Atmospheric Research Laboratory (NARL)
Report	4 – Week Report

1. INTRODUCTION

The Atmospheric Boundary Layer (ABL) is the lowest part of the troposphere that is directly influenced by Earth's surface. It plays a crucial role in weather patterns, air quality, and environmental processes. Understanding ABL dynamics is essential for applications in meteorology, climate science, and renewable energy.

LiDAR (Light Detection and Ranging) is a remote sensing technique that uses laser pulses to probe the atmosphere and collect high-resolution vertical profiles of backscattered signals. These signals are influenced by aerosols and atmospheric particles, making LiDAR particularly useful in ABL studies.

2. OBJECTIVES OF THE STUDY

- To understand the principles of LiDAR backscatter technology and its application in atmospheric studies.
- To identify and analyze waveform structures in LiDAR data that represent features of the ABL.
- To detect the boundary layer height using suitable analytical techniques.
- To explore methods such as gradient method and wavelet transform for detecting ABL height.
- To propose a methodology for further analysis and visualization.

3. WORK COMPLETED DURING FIRST FOUR WEEKS

3.1 Literature Review

- Reviewed basic concepts of the Atmospheric Boundary Layer: diurnal cycle, turbulence, inversion layers.
- Studied LiDAR types, with a focus on elastic backscatter LiDAR used for ABL and aerosol detection.
- Collected references related to ABL height detection methods from LiDAR backscatter data.

3.2 Data Familiarization

- Gained access to LiDAR waveform data (backscatter intensity vs. altitude/time).
- Understood the structure of wave-like LiDAR signals and how they relate to aerosol concentration.
- Identified candidate features indicating the top of the boundary layer (e.g., sharp backscatter gradient).

3.3 Tools and Techniques Identified

- Proposed to use gradient-based detection method for determining ABL height.
- Investigated use of wavelet transforms as an advanced technique for layer boundary detection.
- Identified potential plotting and data analysis tools (e.g., Python with Matplotlib, Pandas, SciPy).

4. FUTURE WORK PLAN

- **Preprocessing** of LiDAR wave data for noise removal and signal enhancement.
- **Implementation** of boundary layer height detection algorithms.
- **Visualization** of ABL height over time to observe diurnal variation.
- **Validation** using literature or supporting weather data if available.
- **Exploration** of seasonal or event-based patterns if sufficient data is available.

5. CONCLUSION

The first month of the internship focused on gaining a strong foundational understanding of ABL concepts and LiDAR data analysis techniques. A clear direction has been set to process the available LiDAR backscatter waveforms to detect the height and evolution of the ABL. The next steps will involve algorithm development, analysis, and result interpretation.

6. REFERENCES

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