

**Project Title:** A Pilot Study for the Detection and Prediction of Climate and Extreme Events over the North American Rail Network using Multimodal Sensor Fusion

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### Overall Project Goal:

This project will develop a novel hardware-software system for the monitoring and detection of climate-related disaster events and emergency weather conditions that could adversely impact the safety and operation of traveling trains in realtime. The primary focus of this pilot study is realtime detections and warnings.

### Key Project Tasks/Approach/Objectives:

A pilot study will develop a system equipped with advanced sensors, such as long-range LiDARs, cameras, and radars, to detect realtime events (e.g., falling rocks, flash floods, fires, etc.) that are potentially hazardous for trains. The system can be installed on moving trains or on fixed platforms. More specifically, we plan to develop two novel platforms for *multimodal sensor data collection, fusion, realtime analysis, and communications* for deployment on trains and over the rail network. The Transportation Technology Center (TTC) in Pueblo, CO will play a pivotal role in testing the platforms prior to their deployments on operational trains.

The two platforms we plan to develop are:

1. *A Multimodal Analyzer of Railroad Climate and Extreme Events (MARCEE) System*: Data collected by sensors within a given MARCEE unit will be fused and analyzed using advanced artificial intelligence (AI), computer vision, signal processing, machine learning, and deep learning methods. The MARCEE units can be developed for installation and deployment on trains and in selected fixed locations on the railroad network. MARCEE is intended to detect conditions in realtime to alert train operators of potential safety issues.
2. *A Realtime Communication and Diffusion (RCAD) System*: The RCAD system is intended to enable the sharing of time-critical data among MARCEE units distributed throughout the system. The shared information will include Railroad Safety Messages (RSMs) regarding detected hazardous conditions. For example, if such event is being detected by the MARCEE system of a moving train, then the RCAD system installed on that train would communicate, in realtime, an urgent message and related sensor data to other trains that could be traveling toward the impacted area.

### Project Outcomes/Benefits:

The focus of the pilot study is the establishment and demonstrations of technologies to support realtime detections and warnings pertaining to extreme events and other conditions posing risks to rail operations. The developed systems should improve the operational safety of trains traveling at different speeds and enable operators to take action in realtime.