Feasibility and Prospects of the High Resolution Rapid Refresh Model For Dynamic Line Rating

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BACKGROUND

The ampacity of transmission lines is defined as the maximum amount of current the conductor can safely carry. It is necessary for transmission line operators to apply ampacity limits due to the thermal properties of the conductor. Dynamic Line Rating (DLR) is a technology and technique that uses the environmental conditions or a set of the conditions to calculate the ampacity of the conductor. The way the DLR is calculated has depended upon some amount of physical technology to implement the solution.

OBJECTIVE

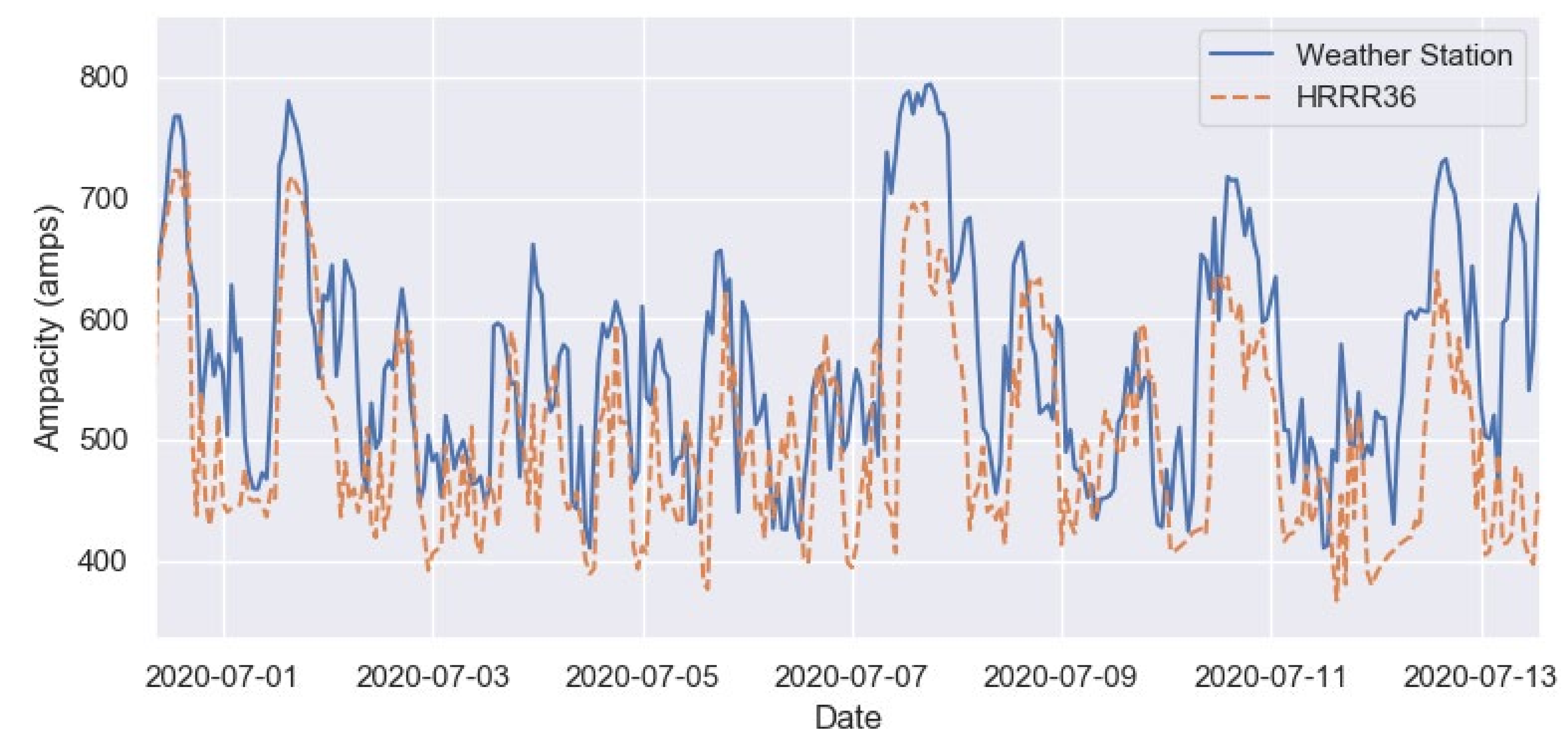
The High Resolution Rapid Refresh (HRRR) Model is an atmospheric model that may provide enough resolution to perform dynamic line rating without any hardware at all. The objective is to use this model to perform Dynamic Line Rating. This will solve two of the most pervasive problems in Dynamic Line Rating, how to instrument a transmission line hundreds of miles long and then how to predict near future ampacity sufficient for transmission operators to effectively use, This technique will use the Idaho National Laboratory site as the test location for analysis.

METHODS

- Find archived data for region of interest
- Find GIS data for the region of interest
- Find archived data from the High-Resolution Rapid Refresh Model
- Create a computational fluid dynamics model of the terrain that maps weather stations and HRRR points to the mid points of the transmission line
- Utilize an engine that runs IEEE 738 to calculate the ampacity of the points that have been modelled for both measured and predicted data
- Compare the results of the ampacities for archived real data and archived HRRR data

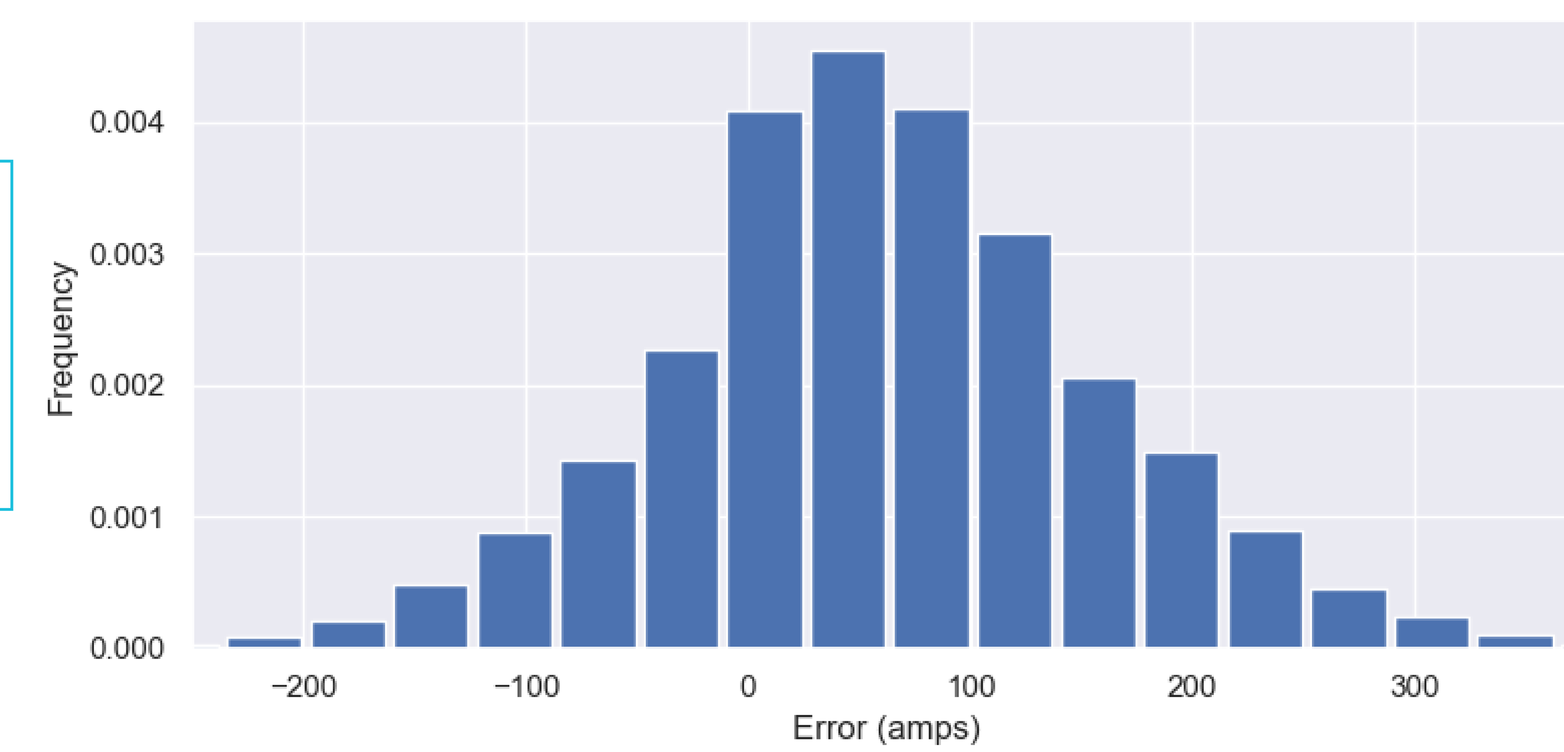
RESULTS

Plot of HRRR 36 Model Versus Weather Based Ampacity



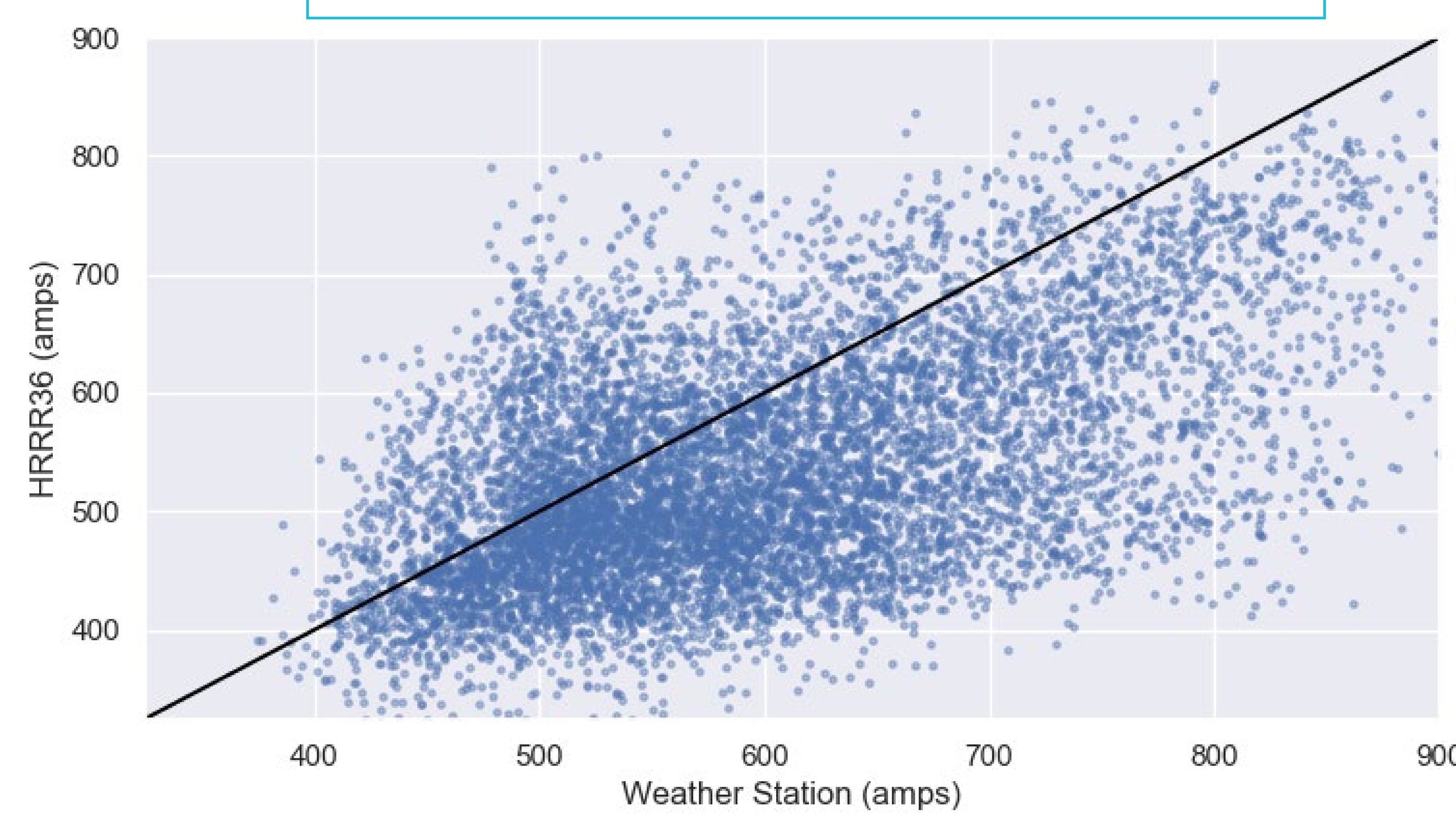
This data shows the ampacity calculated through weather data and through the HRRR36. The plot shows that the data from the HRRR36 is following the pattern of the weather station. This allows for a reasonable expectation that a larger implementation of the system would also follow the real weather data.

Plot of frequency of error between HRRR and Weather



The error between the real measured weather data calculated ampacity and the HRRR36 calculated ampacity shows a bias for the real data to give a higher ampacity than the HRRR36. Higher available ampacity from real measurements implies that the HRRR36 calculated ampacities will not overload the line.

Plot of frequency of error between HRRR and Weather



This scatter plot reiterates that the ampacity from the weather stations is higher than the HRRR calculations. There are very few calculations from the HRRR that result in a high ampacity temporary transient. These high ampacity transients are impossible to utilize in a practical manner.

CONCLUSIONS

The High Resolution Rapid Refresh model is a reliable, freely available, and well-maintained weather forecasting model for the entire United States of America. The model provides enough special resolution that additional local weather monitoring devices at location are not necessary to conduct dynamic line rating. The HRRR ratings are lower on average than the locally measured ratings which allows for an additional margin of safety. The adoption of using purely digital methods for dynamic line rating could allow for wide scale adoption of the technology with very little overhead expenditure of implementation.

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