# Characterization of soil electrical conductivity from Chicken Creek Catchment using deep learning inversion of geophysical data

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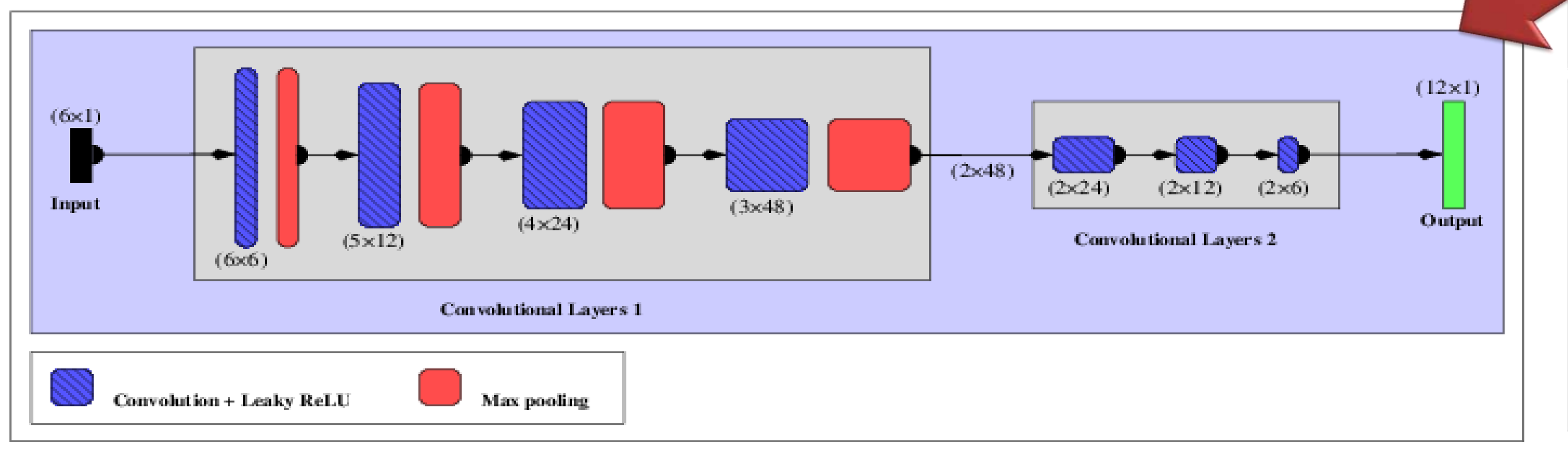
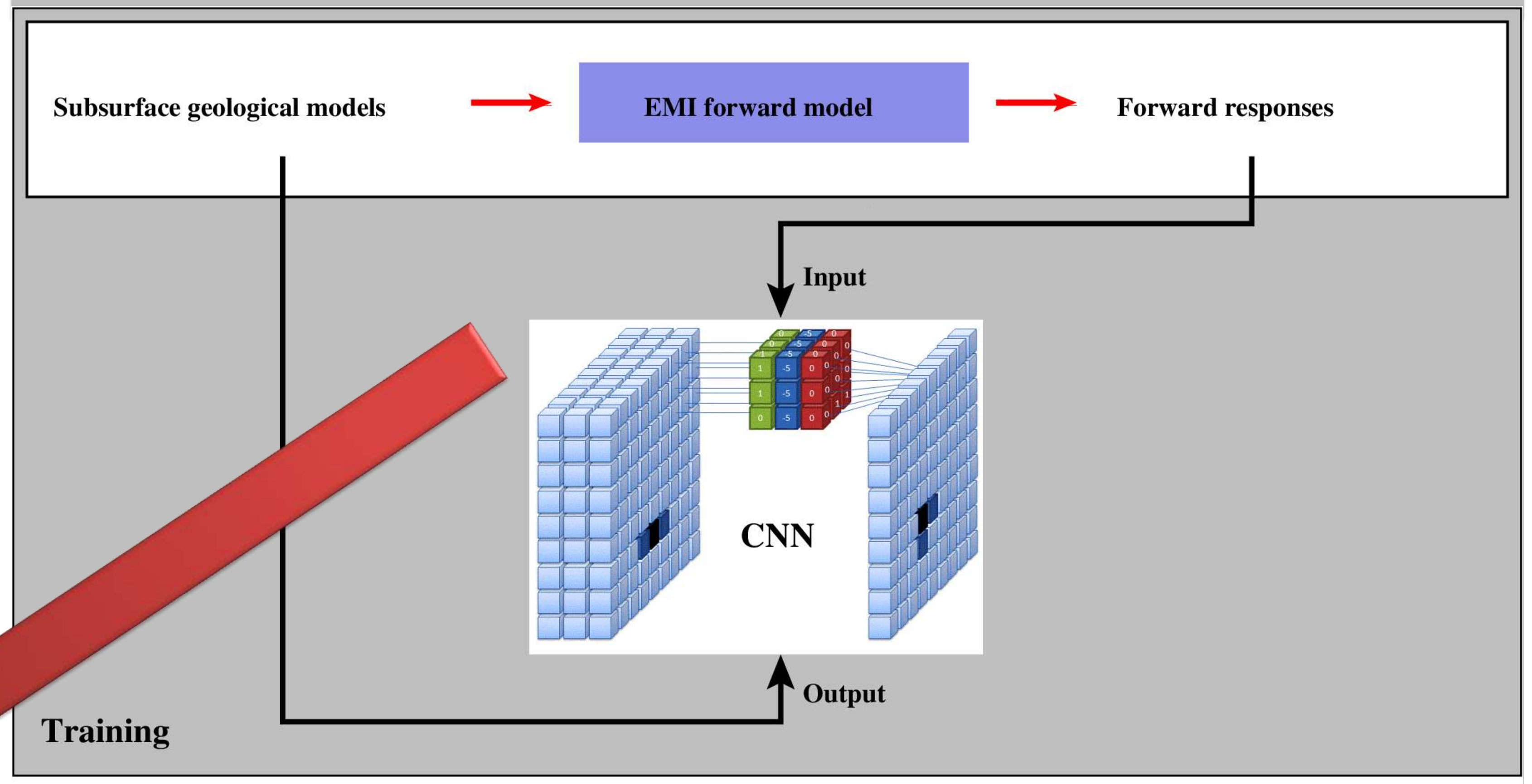
## Introduction

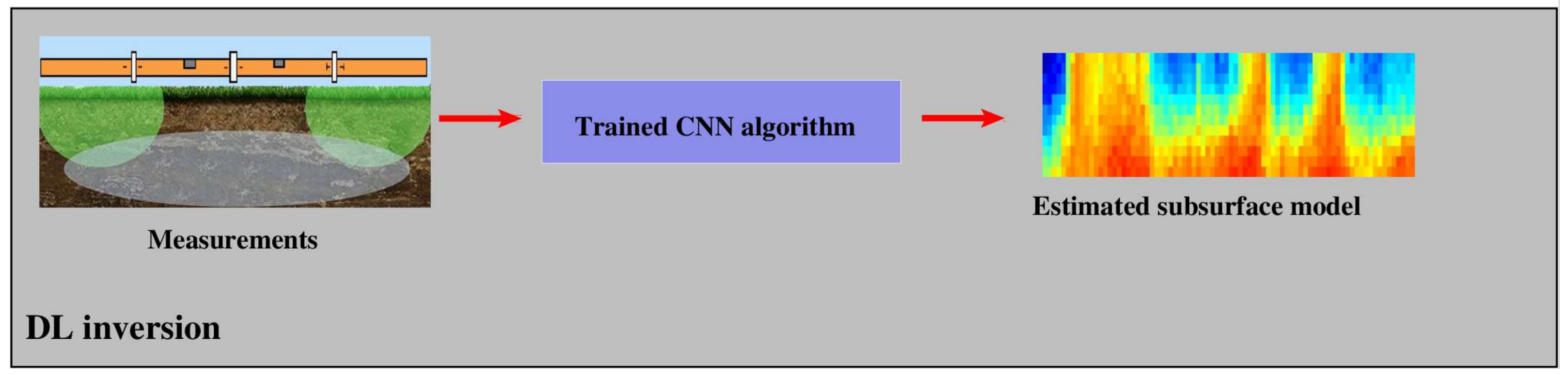
Conventional geophysical inversion techniques suffer from several limitations including computational cost, nonlinearity, non-uniqueness and dimensionality of the inverse problem. Successful inversion of geophysical data has been a major challenge for decades. Here, a novel approach based on deep learning (DL) inversion via convolutional neural network (CNN) is proposed to instantaneously estimate subsurface electrical conductivity (EC) layering from electromagnetic induction (EMI) data. In this respect, a fully convolutional network was trained on a large synthetic data set generated based on one-dimensional (1D) EMI forward model. The trained network was used to find subsurface electromagnetic conductivity images from EMI data measured along two transects from Chicken Creek catchment (Brandenburg, Germany). Dipole-dipole electrical resistivity tomography data were measured as well to obtain reference subsurface EC distributions down to a 6 m depth. The inversely estimated models were juxtaposed and compared with their counterparts obtained from a spatially constrained deterministic algorithm of AarhusInv as a standard code.



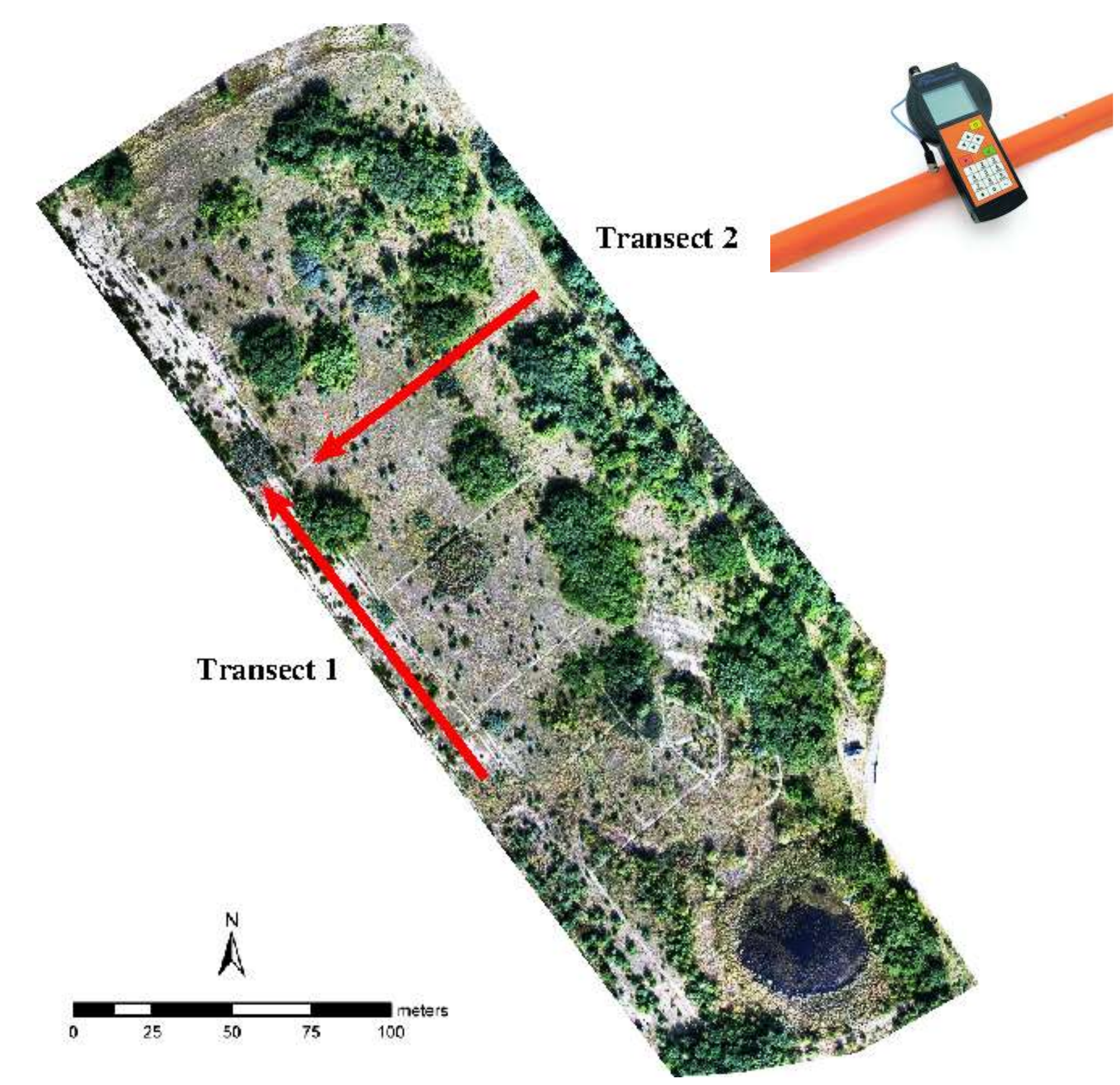

## Deep learning inversion

Randomly generate 20,000 1D subsurface models
A soil column with 12 layers
Calculate forward responses considering CMD-Explorer configuration
After training, the algorithm receives as input multi-configuration ECa data and returns subsurface conductivity distribution
Conductivity range: 1-100 mS/m

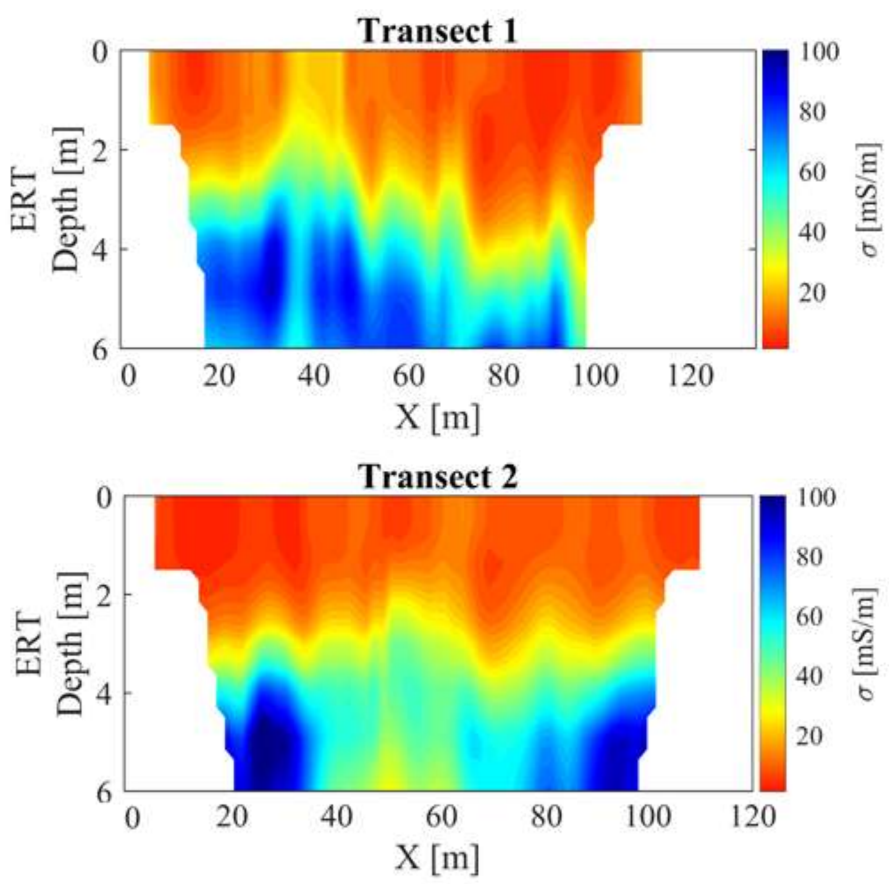


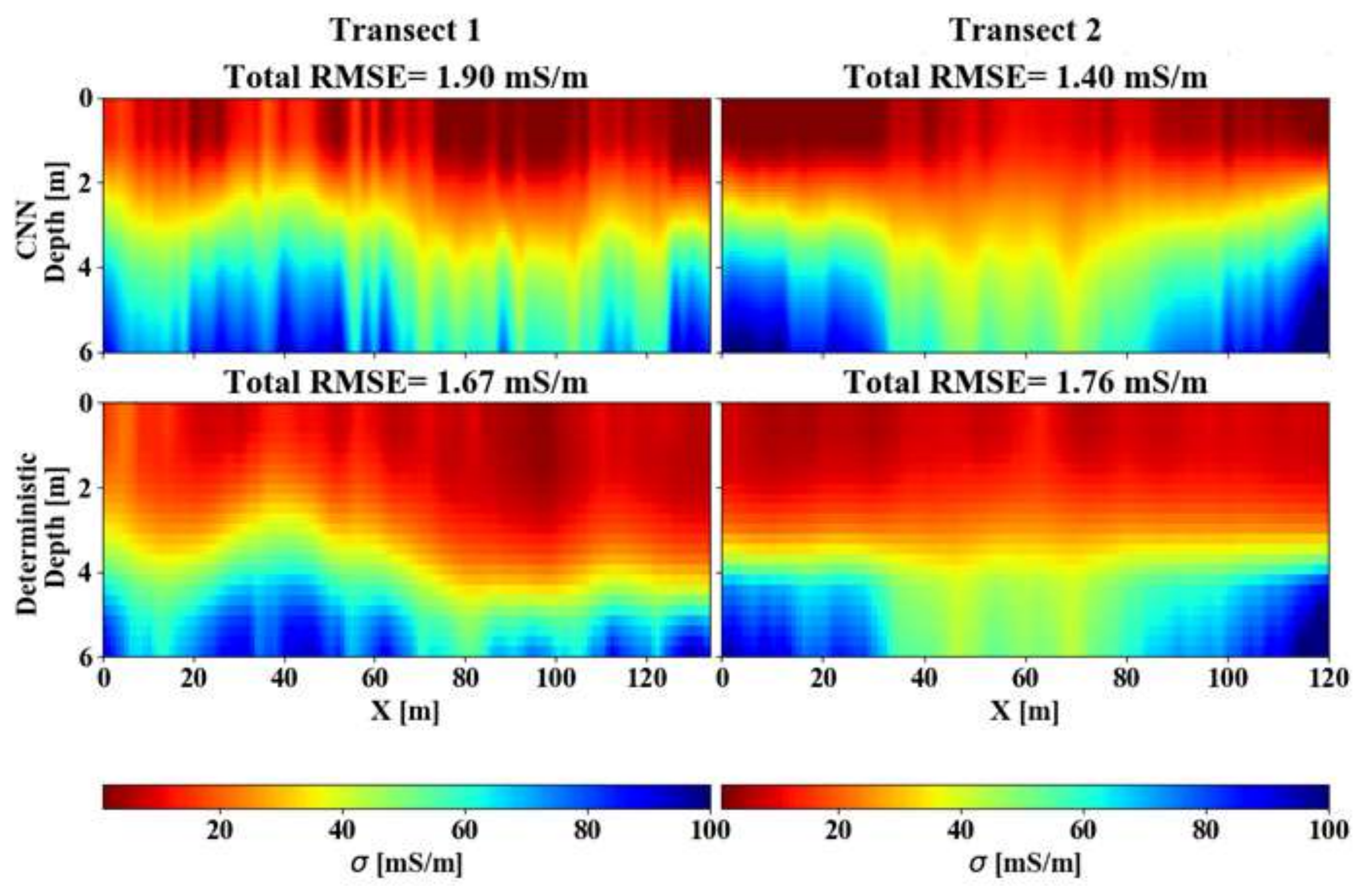




## Measurements




## Results




The CNN-derived subsurface EC of both transects match closely with their counterparts from ERT data. The AarhusInv employed vertical and lateral constraint and consequently the deterministic solutions are rather smoother than the CNN results. The RMSE values between the measured and modelled data for all scenarios demonstrate a well performance of both inversion strategies.

## Conclusions

Here, a novel approach was proposed for 1D inversion of EMI data using convolutional neural network. In comparison with the existing conventional inversion techniques, the proposed approach offers several key advantages. This technique estimates subsurface EC distributions from geophysical data in a few milliseconds without any iterations. Moreover, the trained algorithm returns subsurface conductivity distribution without using any initial model. Consequently, this approach does not suffer from non-uniqueness issue that is typically encountered using classical inversion techniques. The proposed DL inversion strategy can be applied to the other existing geophysical techniques for delineation of the subsurface structures.

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