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# Subsurface Scattering

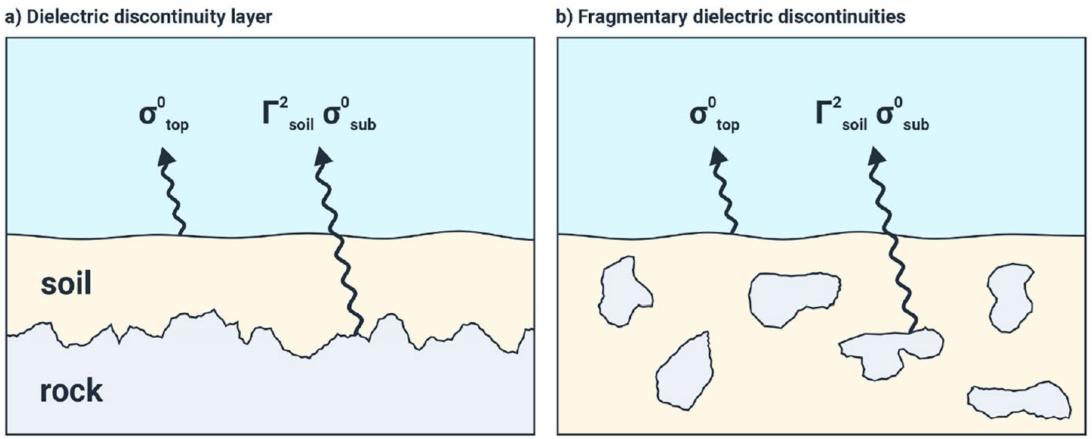
## Individual Project in Remote Sensing

Johannes Pfennigbauer | 19902046

# Background

Microwave backscatter signals are a reliable estimate of soil moisture content and are generally **positively correlated** with it.

Among other factors, *subsurface scattering* causes anomalous behaviour resulting in an **inverse relationship**.




Rock surfaces beneath the top soil layer (a) and dispersed stones (b) are the main causes of the phenomenon.

Source: W. Wagner et al. Widespread occurrence of anomalous c-band backscatter signals in arid environments caused by subsurface scattering, 2022.

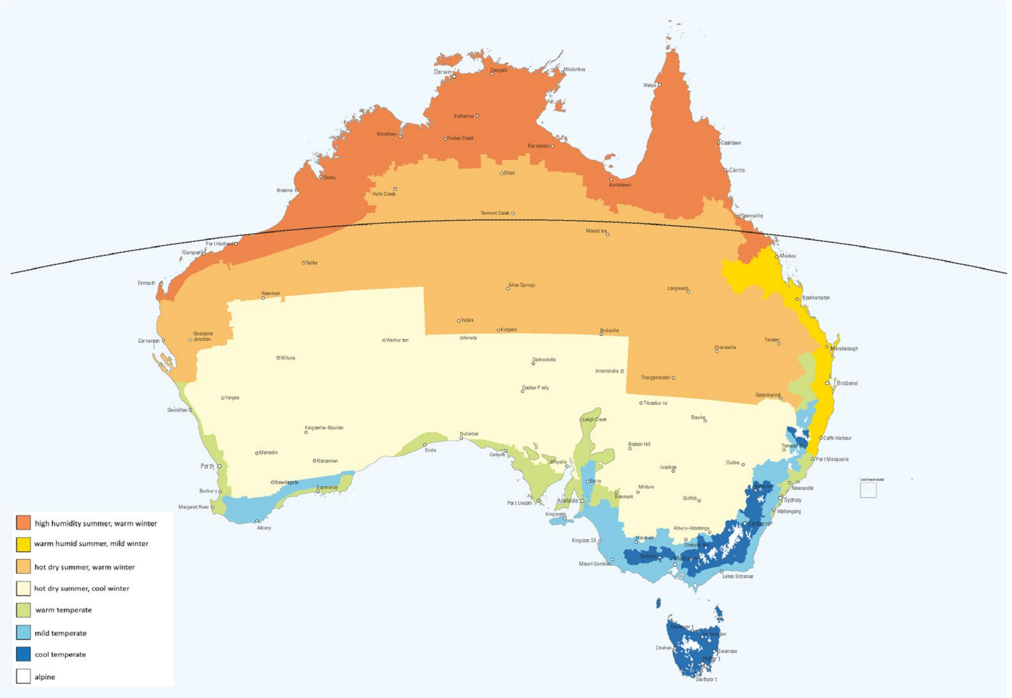
# Research Question

What are the main drivers of the subsurface backscattering anomaly in dry, arid regions under the presence of rocks or distinct horizons?

# Data

## Target variable

- **Rsub**: Correlation of Sentinel-1 backscatter and reference soil moisture data (ERA5Land)




The study area is a strip along the 21 southern latitude spanning across Australia, covering climatic zones from wet at the coast and dry in the interiors.
Source: Australian Building Codes Board. Climate zone map, 2024.

## Input Data

- Soil composition, Coarse fragments, Soil moisture, Organic Content from ERA5Land
- Terrain Elevation and Slope (DEM)
- Precipitation (CHIRPS) and Land Surface Temperature (MODIS)

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# Methods

Comparison of coefficients:

- Multiple Regression
- Ridge Regularisation
- Partial Least Squares Analysis

Well suited for highly correlated data!

Evaluation of models: RMSE, R2, MAE

# Challenges

- Collecting & Merging Data
- Handling large Datasets in Memory

- Comparison, feature importance

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# Attention-layer based Crop Yield Prediction

Individual Project in Applied Deep Learning

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# Background

Deep Learning methods are well-established in Crop Yield Prediction. While CNNs handle connected data well, they might not dynamically adjust to the changing relevance of attributes across different plant growth stages. An attention layer might be beneficial to guide its focus.

The available data and original model used focuses on soybeans.
Source: Plantura Magzine. Soybean: growing, harvest & uses, 2019.

# Research Question

How can an attention mechanism improve the CNN-RNN models ability to predict crop yield?

# Data

## Target Variable

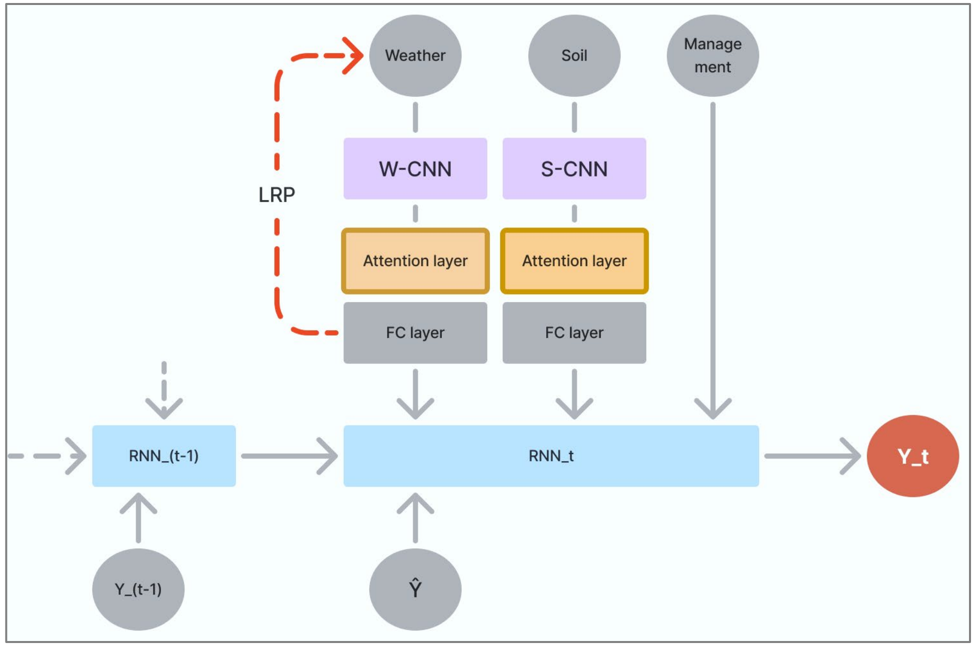
- **Yield**: Average outcome per location and year

## Input Data

- Environment: Weekly average of min/max temperature, precipitation, solar radiation, snow-water equivalent and vapor pressure
- Soil: bulk density, pH, soil organic density, total nitrogen, soil composition and more at 6 levels of depth (0-120cm)
- Management: Weekly cumulative percentage of planted fields per state

# Methods

- Existing CNN-RNN framework
- Enhanced by **Attention Layer**
- Extended by
  **Layer-wise Relevance Propagation**



Proposed model architecture.

Comparison of performance before and after enhancement.
LRP used for explainability.

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# Challenges

- Outdated Code, Need to manually upgrade to TensorFlow2.x
- Implementation of Attention Layer