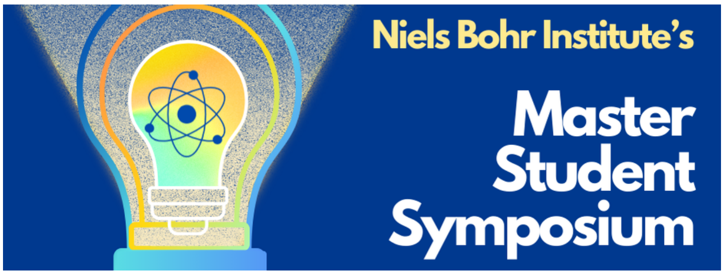

Contribution ID: **12** Type: **Poster**

Understanding Denmark's Changing Precipitation Through Explainable Machine Learning

Friday 14 March 2025 16:05 (1h 55m)

Precipitation in Denmark arises from different mechanisms across seasons. In winter, large-scale dynamics driven by the North Atlantic storm track dominate, while summer precipitation involves large-scale systems and local convective processes. Current climate models predict changes in these patterns, but since 2000, Denmark has experienced precipitation exceeding model predictions. Suggesting a gap in our understanding.

The North Atlantic Oscillation (NAO), characterized by pressure differences between Iceland and the Azores, represents the dominant mode of atmospheric variability in the North Atlantic. While traditional analysis shows its strong influence on European precipitation patterns, particularly in winter, its signal appears muted in the normalized CMIP6 data used for this study.

Using Feed-Forward Neural Networks analyzed with Layerwise Relevance Propagation (LRP), my research investigates which atmospheric patterns drive precipitation anomalies. The analysis reveals distinct seasonal behaviours in the model's predictions. The LRP analysis shows that local pressure patterns are important predictors across seasons. However, contrary to traditional understanding, the NAO pressure patterns are not prominently used by the neural network in either winter or summer predictions. For summer precipitation, the model additionally identifies connections to local temperature variations, suggesting different driving mechanisms between seasons. These findings highlight the potential and current limitations of using explainable machine learning to understand precipitation patterns.

My thesis demonstrates the potential and limitations of explainable ML methods in climate science while highlighting gaps in our understanding of precipitation drivers in a changing climate. These findings suggest we need to dig deeper into explainable machine learning to use it for precipitation analysis.

Field of study

Earth & Climate Physics

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