Seminar
Institute of Environmental Physics (IUP), Univ. Bremen
Date: 16-Jul-2025, 10:00
Place: Building NW1, Room S1360

Connecting surface warming, radiative feedback, and radiative forcing with convolutional neural networks

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Recent research has highlighted that radiative feedbacks — and thus climate sensitivity — are not constant in time but depend sensitively on surface temperature patterns ("pattern effect"). First, I will review physical drivers of the effect and explain how it matters for near-term projections of climate change. Then, I will discuss two implications we have recently gained:

(1) I will introduce how a non-linear convolutional neural networks (CNN) can be trained on climate model output to learn the pattern effect and predict global-mean TOA radiation from surface warming patterns. We use explainable artificial intelligence methods to visualize and quantify where the CNN draws its predictive skill. Remarkably and different from traditional approaches, we can predict radiation under strong climate change from training the CNN on internal variability alone. This out-of-sample application works only when feedbacks are allowed to be non-linear or equivalent, changing in time.

(2) We train CNNs on internal variability of climate models alone, to avoid the need to rely on their erroneously simulated surface warming patterns and uncertain implementation of greenhouse gas and aerosol emissions. We then derive a new estimate of the Earth's radiative forcing over the last decades (which is unobservable), by combining the radiative effect learned in this minimalistic way in combination with the observed energy imbalance. Our forcing estimate is substantially higher than traditional ones and points to a strong aerosol radiative effect.