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Understanding cloud systems structure and organization using a machine's self-learning capability

Content

Our work aims to understand the structure and organization of cloud systems by exploiting the self-learning capability of a deep neural network. The neural network utilizes deep clustering and non-parametric instance-level discrimination for decision-making at any learning stage.

The data augmentation in the data pipeline, multi-clustering of the dense vectors, and Multilayer perceptron projection at the end of CNN help the network learn a better representation of images. We avoid the noise and bias from human labeling in a purely data-driven approach.

Over Central Europe, we use high-resolution cloud optical depth (COD) images post-processed and retrieved at a higher spatio-temporal resolution (2 km,5 min), equivalent to future MTG satellite. The retrieved COD is unaffected by high-frequency variations below SEVIRI standard resolution of 3kmX3km because of using High-Resolution Visible(HRV) as a constraint while downscaling.

We show how advances in deep learning networks are used to understand the cloud's physical properties in temporal and spatial scales. We investigate two spatial domains and two-pixel configurations (128x128,64x64). We demonstrate explainable artificial intelligence (XAI), which helps gain trust for the neural network's performance. The work also explores the uncertainties associated with the automatic machine-detected patterns and how they vary with different cloud classification types.

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Comments about the attached picture -

As an introduction, we show what the deep neural network has learned to distinguish cloud systems into ten categories based on their distribution pattern and structure. Each image has a colored box as a boundary, representing a separate cloud organization.

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