Contribution ID: **26** Type: **Talk**

Spatio-temporal downscaling of rainfall fields using a conditional generative adversarial network

Thursday 22 June 2023 15:05 (15 minutes)

Climate models are limited in their ability to accurately represent highly variable atmospheric phenomena on small scales. Downscaling techniques are employed to resolve fine-scale physical processes and reveal local impacts.

We present spateGAN, a conditional generative adversarial network for spatio-temporal precipitation downscaling in Germany. As a so-called video-superresolution approach, it simultaneously enhances the resolution of coarsened gauge-adjusted weather radar data from 32 km to 2 km and from 1 hour to 10 minutes.

Power Spectral Density analyses demonstrate that the ensembles of generated rainfall fields exhibit plausible and temporally consistent structures, hardly classifiable as artificially generated. The Fractions-Skill-Score indicates that spateGAN provides high skill regarding localization and reconstruction of high precipitation intensities.

The ability of the 3D-convolutional model to downscale arbitrary domain sizes and time sequences with high computational efficiency makes spateGAN a fundamental framework for our ongoing endeavors to advance AI-based global climate model downscaling techniques.

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Session Classification: Deep/Machine learning and data science

Track Classification: Deep/Machine learning and data science