Title:

Fog detection through full exploitation of satellite observations using machine learning

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Abstract:

Fog defined as water droplets suspended in the vicinity of the earth's surface reducing visibility to below 1 km affects life in various ways. Aside from problems in air, land and sea traffic, fog imposes limitations for power production of photovoltaic installations which can endanger the net stability and maintains situation of bad air quality within urban areas. On the other hand, it can be a valuable source of fresh water for certain ecosystems.

Despite these impacts, no operational ubiquitous fog product which does not require a situation-specific interpretation by a specialist is available to date. Furthermore, fog and low clouds pose the greatest source of uncertainty in weather and climate prediction models. Monitoring spatiotemporal variability of fog presence and potential changes in a warming climate would help to understand the associated atmospheric processes better which could ultimately lead to improved weather and climate modeling of fog.

The increasing spatial, temporal and spectral resolution of modern satellite-based observations cannot be exploited anymore by conventional analysis tools. Means of machine learning have proven to be computationally effective and to achieve superior results in related image classification problems. Here, we present the potential of a new machine learning approach suitable to explore all four dimensions (spatial, spectral and temporal) offered by satellite imagery to detect and distinguish fog and low clouds.

In a first step, the capabilities of a multi-layer perceptron to make use of all spectral information from available emissive channels to detect fog are demonstrated for a hyperarid desert environment. To additionally exploit the spatial and temporal dimensions of satellite observations, multidimensional convolutional neural networks are applied and the benefits are investigated. For this purpose, level 1.5 SEVIRI data are processed for the European continental area together with visibility measurements from a ground-based network of weather stations (METAR).