Classifcation of daily precipitation patterns on the basis of radar-derived precipitation rates for Saxony, Germany

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Abstract

We present a radar-based climatology of precipitation fields summarised into characteristic daily precipitation patterns. These patterns were derived by temporal classiffcation, applying a neural network and data from Saxony during the period from 2004 to 2010. The properties of the dataset (RADOLAN rw-product) are discussed in detail and reviewed with respect to their adequacy for the intended application. The analysis showed a systematic dependence of the precipitation error on the altitude and aggregation period. Accordingly, for future applications of the considered radar product, we recommend the use of a maximal aggregation time step of 24 hours. The classiffcation reveals signifcant precipitation patterns. Comparison of the qualitative features exhibited by the precipitation patterns, such as the synoptic scale f ow direction, pressure distribution and atmospheric humidity, showed general trends as well as distinct spatial and atmospheric properties in dependence of the incidence rate. The lowest statistical qualities were shown by the patterns with the most distinct spatial characteristics due to a low incidence rate and high standard deviations. Nevertheless, the applied method led to a robust classiffcation and the derived patterns appropriately summarized the mean daily precipitation behaviour in Saxony.

1 Introduction

Knowledge of the spatial and temporal distribution of precipitation plays a crucial role for the prediction of foods, control of sewer systems and calculation of potential and effective soil erosion in agriculture (KRÄMER et al., 2005; REGGIANI and WEEERTS, 2007; ZHANG and GARRECHT, 2003). These tasks can be performed using measured (gauge, satellite, radar, etc.) or modelled precipitation data. The increasing availability of radar-derived precipitation data motivates more and more studies to investigate the spatial and temporal distribution of precipitation (OVEREEM et al., 2010; WECKWERTH et al., 2011). In addition, through better processing, these data increasingly satisfy the demand for precipitation data with high spatial as well as temporal resolution (GOUDENHOOFDT and DELOBBE, 2009; KRÄMER et al., 2005).

OVEREEM et al. (2010) used a 11-year time series of radar-derived rainfall data to deduce extreme value statistics for precipitation related to water design problems in the Netherlands. In this case, the advantage was a higher spatial consistency of rainfall f elds than the one that can traditionally be derived from point measurements and their interpolation. Because small-scale convective rainfall events dominate extreme rainfall, WECKWERTH et al. (2011) derived a climatology (2000–2006 and 2008) of convective initiation (CI) and convective enhancement (CE) for the Central European region of Germany, Switzerland and France. On the basis of a certain limit of reflectivities, CI and CE events were classifed. Thus, the term climatology can be defned from different perspectives. Another way to investigate the spatial distribution of precipitation is to classify characteristic patterns (ROMERO et al., 1999). Traditionally these patterns were derived from gauge stations. HILL et al. (1981) analysed various precipitation patterns in Wales and showed that heavy precipitation is related to predefined precipitation zones. In an advanced analysis of rainfall over Wales, a cluster analysis found statistically signifcant precipitation patterns depending on the season and weather conditions in a study by SUMNER (1996). This approach was extended by a principal component analysis and an additional cluster analysis by ROMERO et al. (1999) for a 30-year period in Spain. They emphasized the meaning of topography for the tendency of daily rainfall to form principal spatial patterns. Similar correlations have been found for South Korea through the same combination of approaches (MIKA et al., 2006). FRAGOSO and TILDES GOMES (2008) applied a similar methodology on extreme precipitation (separated by a threshold), revealed spatial patterns and investigated through the frequency of occurrence the linkage of these patterns to large scale weather patterns. They could not f nd a clear linkage between atmospheric and precipitation patterns for South Portugal. Especially the last study shows that the aim of identifying situations of extremes in rainfall distributions is closely linked to these analyses.

The f rst climatological studies were performed using radar data, precisely because these records contain information about the high variability of precipitation patterns, which are rarely described on the basis of standardised station measurements. The availability

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