Application of Self-organizing maps to define weather types for the analysis of trace gas distribution over the eastern United States

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Approaches of generalizing and categorizing synoptic-scale circulation patterns are mostly dealing with multi-dimensional input domains. Recognizing groups of similar patterns within this input domain is still a challenging task and requires a suitable method to identify similar features. In this study self-organizing maps (SOM) were used in order to detect and classify regularities and correlations in the data. SOMs reduce the input vector domain to a low-dimensional grid which displays the essential features of the high-dimensional data. Since no assumptions regarding the underlying data are required, SOMs present an objective unsupervised clustering procedure which is able to map any arbitrary linear or non-linear data distribution. The proposed technique was applied to classify the synoptic-scale weather patterns for the eastern United States covering the region from 26°-65°N and 67°-110°W. Input data were daily resolved NCEP/NCAR Reanalysis pressure data for different altitude levels covering the time period from August 1994 until August 2005. For this time period an extensive set of trace gas data is available obtained from the MOZAIC-project (Measurements of ozone, water vapour, carbon monoxide and nitrogen oxides aboard Airbus in-service aircraft). Within the scope of this EU-funded project, measurements made since 1994 aboard five A-340 long range aircraft on scheduled flights around
The time series of six significantly different weather types for the region was assigned to the chronologically corresponding trace gas data, especially ozone and its precursors carbon monoxide and nitrogen oxides. The influence of weather types on trace gas distribution compared to tempered zone seasonal classification is investigated at different airports in the region. The geographical influence of orographic effects and the location of industrial areas is considered. It was found that there is a connection between weather types and trace gas concentrations. Carbon monoxide concentrations depend more on the wind flow direction, ozone concentrations are rather influenced by the pressure system. Statistical tests prove the difference in trace gas concentrations with different weather types especially in case of ozone.