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Seasonal forecast of cooling water problems in the River Rhine

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Summer low flows and high water temperatures in the River Rhine may endanger power supply in the Netherlands and Germany. Critical situations arose in the recent hot and dry summers of 1996 and 2003. Seasonal forecast of high water temperatures and low flows would give the energy sector and responsible authorities time to anticipate to cooling water scarcity. This research investigated statistical models that use winter large-scale oceanic and atmospheric patterns as predictors to forecast cooling water problems. Large-scale patterns in sea surface temperatures (SST) and atmospheric pressure fields have a long timescale of variation, which makes them suitable predictors for seasonal forecast. A well known example of a large-scale pattern is the North Atlantic Oscillation Index (NAO). This research evaluated the predictive skill of NAO, and patterns in the SST and 500 hPa geopotential height fields, applying two pattern recognition techniques: Principal Component Analysis (PCA) and Singular Value Decomposition (SVD). Predictors were selected with a correlation analysis. Multiple linear regression models containing the selected predictors were tested in a pseudo-operational context. Model results are significant ($p<0.05$), but explained variance is small ($r<0.5$). Model results are less than what could be expected from the correlation analysis, because of instable predictor-response relationships. Forecasts can be used for indicative purposes, but no decisions should be made based on these model predictions only. The communication of uncertainties in model results to the end-user is important to enable for risk calculations by these stakeholders.