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Using conditional probability for short-range forecasting of visibility at Zagreb Airport

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Long-lasting fog events at major airports can cause significant delays. Therefore, studies of fog are important for aviation meteorology, as improved forecasts can lead to considerable savings. The aim of this study is to test a simple statistical model for probabilistic short-range forecasting (nowcasting) of visibility at Zagreb Airport. It was originally proposed by Juras and Pasarić in 2006. The model should provide operational forecasters with a tool that could be helpful in forecasting low visibility.

The data used consists of METAR half-hourly reports spanning the period from Jan 1, 1994 to Dec 31, 2016. A first-order autocorrelation process is the theoretical foundation of the model, which in essence combines climatology and persistence (hence the amalgam CLIPER). From that, a relatively simple forecast equation for a given meteorological element, such as visibility (developed by Gringorten, 1971), can be defined. It links the correlation between values of the meteorological element at different time steps with conditional probability for onset of pre-defined values.

Hourly correlation coefficients, which describe the climatological persistence of visibility, are calculated for each month from cumulative frequencies of visibility (which are converted to normalized values). The correlation coefficients are then used to forecast visibility for each successive hour, 6 hours in advance. In addition to the median forecast of visibility (which is basically the 50th percentile), 50 % and 80 % confidence intervals are calculated as well. These provide a measure of forecast uncertainty. The forecast by percentile, which is assumed to be more suitable for very rare events, is also provided for comparison.

The model is tested on four selected cases of fog initiation and dissipation, for which forecasts of visibility 6 hour in advance are calculated. The results for fog dissipation show promise, while forecasts of reduced visibility leading to fog formation are quite inaccurate. In these cases, forecasting by percentile appears to be the more suitable approach. However, forecasts of fog formation are useful when climatology shows significant reducing of visibility. Moreover, forecasting by percentile appears to be even better especially for rare events.