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Assessment of reanalysis-derived parameters as dichotomous predictors and neural network inputs for forecasting thunderstorms in Finland

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The efficiency of over 30 stability indices and other parameters for predicting thunderstorm occurrence in Finland has been assessed. The ECMWF ERA-Interim reanalysis provided pseudo-soundings for the calculation of the parameters while thunderstorm activity over the 12-year period (2002-2013) was determined using lightning location data. Various methods were utilized to assess the parameters in a dichotomous and probabilistic forecasting setting; including skill score tests, thunderstorm probability as a function of the parameters, and an Artificial Neural Network (ANN) experiment.

For making threshold-based yes/no forecasts, the most unstable Lifted Index (MULI) proved to be the best index overall. Thunderstorm probabilities a function of one or two parameters (a stability index and vertically integrated mass or moisture flux convergence) revealed that the reanalysis-derived convergence parameters had high association with thunderstorm occurrence and improved the probability forecasts. Mass convergence integrated over most of the troposphere worked particularly well as supplementary forecasting parameter.

Based on the neural network experiment, the ANN represents a promising tool for forecasting deep, moist convection, owing to their inherent non-linearity. The ANN output reached a maximum True Skill Score of 0.69 in a threshold-based forecasting scheme for making yes/no predictions, compared to 0.61 with the best stability index (MULI). However, the final ANN's were quite complex and utilized many inputs, including up to three measures of moisture. Where the ANN excelled was a probabilistic forecasting setting: thunderstorm probability as a function of the ANN output reached values of over 90%, much higher than any stability index.