**Title**

Lightning forecast using the Lightning Potential Index in the HARMONIE-AROME model

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**Abstract**

Rain and lightning associated with thunderstorms can cause damage to crops, cars, houses and other properties. As the climate is warming, it is expected that the frequency of lightning will increase, but it is highly uncertain to what degree. For the KNMI'23 climate scenarios, it becomes essential to make reliable statements on future thunderstorm scenarios. This research evaluates a new thunderstorm predictor, the LPI, proposed by Yaïr et al. (2010), that uses the vertical velocity and presence of hydrometeors for thunderstorm prediction. Both are important for the formation of a thunderstorm. This study generates LPI results for the Netherlands using hourly output data from the operational weather prediction model HARMONIE. The results are compared to the results of other widely used indices, the Modified Jefferson index, the K-index, the MUCAPE (Most Unstable Convective Available Potential Energy) and evaluated with historical observations. The period over which the study is done is the 15th of April to the 15th of October of 2016 and 2017. The different indices are compared using case studies and objectively by deriving logistic regression equations using the indices as a single predictor. The resulting probabilistic forecasts are compared using the Brier Skill Score and reliability plots. Besides, scatter plots have been made to study the relationship between the indices and the number of discharges.

The LPI as a thunderstorm predictor was found to perform worse than the other indices. The case study showed that the instability of the atmosphere is modelled correctly by HARMONIE but that precipitation and vertical velocity are often modelled at the wrong place by the HARMONIE model. The LPI output is strongly related to this model output of the precipitation and vertical velocity. Therefore, the LPI is wrong if the model output is wrong. Furthermore, the case study showed that the LPI gives a very local, discrete result, which makes it prone to uncertainties. The other indices have a much smoother and continuous result. This smoothness makes them less prone to, for example, phase errors. Although this result was only seen in the case study, it is very well possible it is true for more cases. Therefore, apart from improving the LPI formulation itself, a future study could use the LPI as an extra potential predictor to improve probabilistic forecasts of thunderstorms.