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Challenges in training neural networks for global lightning probability forecasts

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Forecasting lightning is generally challenging for numerical weather models with parameterized convection. Nonetheless, for the aviation industry reliable lightning forecasts are needed for larger domains for which running convection permitting models is not feasible yet. For models with coarser resolution, parameterizations exist that derive the potential for lightning based on the model's convection scheme. One example is the subgrid-scale lightning potential index (LPI, Schröder et al. 2022). However, this index inherits model biases such as a biased onset of convection. Furthermore, for ensemble prediction systems, the spread of the LPI is not calibrated either. Baumgartner et al. (2023) have shown that applying a neural network within the European domain can correct model errors like the wrong timing as well as the ensemble spread. Nevertheless, applying this approach to the global domain leads to further challenges, e.g. the different behaviour of the numerical model in different climatological regions of the world. From a technical point of view, a global product needs to be trained on significantly larger datasets. Furthermore, after an update of the numerical model usually only a few months of data are available for (re-)training which is inherently a biased dataset.

In this work it is shown how to deal with these challenges by using the global ensemble prediction system of ICON. The global lightning data of Vaisala (GLD360, 3) serves as ground truth. A key component of the neural network is a climate feature that allows the neural network to differentiate between the different climatological regions. This is accompanied by features like solar elevation and local time. The benefits of these new features/predictors are shown using the Brier score. The diurnal cycle, as well as region dependent climatological biases, are corrected. It is also shown that even without the availability of training data for a whole year, the neural network can learn corrections e.g. from the northern hemisphere summer and apply them to the southern hemisphere summer and vice versa.

References:

(1) Schröder et al., 2022: Subgrid scale Lightning Potential Index for ICON with parameterized convection. Reports on ICON (10), DOI: https://doi.org/10.5676/dwd_pub/nwv/icon_010 .

(2) Baumgartner, M., Schröder, G., and Primo, C.: Forecasting lightning probabilities derived from the Lightning Potential Index using neural networks, EMS Annual Meeting 2023, Bratislava, Slovakia, 4–8 Sep 2023, EMS2023-34, https://doi.org/10.5194/ems2023-34, 2023.

(3) https://www.vaisala.com/en/products/systems/lightning/gld360