Geophysical Research Abstracts
Vol. 19, EGU2017-5573, 2017
EGU General Assembly 2017

Estimation Methods for Non-Homogeneous Regression – Minimum CRPS vs Maximum Likelihood

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Non-homogeneous regression models are widely used to statistically post-process numerical weather prediction models. Such regression models correct for errors in mean and variance and are capable to forecast a full probability distribution. In order to estimate the corresponding regression coefficients, CRPS minimization is performed in many meteorological post-processing studies since the last decade. In contrast to maximum likelihood estimation, CRPS minimization is claimed to yield more calibrated forecasts. Theoretically, both scoring rules used as an optimization score should be able to locate a similar and unknown optimum. Discrepancies might result from a wrong distributional assumption of the observed quantity.

To address this theoretical concept, this study compares maximum likelihood and minimum CRPS estimation for different distributional assumptions. First, a synthetic case study shows that, for an appropriate distributional assumption, both estimation methods yield to similar regression coefficients. The log-likelihood estimator is slightly more efficient. A real world case study for surface temperature forecasts at different sites in Europe confirms these results but shows that surface temperature does not always follow the classical assumption of a Gaussian distribution.

KEYWORDS: ensemble post-processing, maximum likelihood estimation, CRPS minimization, probabilistic temperature forecasting, distributional regression models