Smoothing Applications for Irregular Time Series with Measurement Errors

Jonathan Rathjens*[1,2], Eva Becker[1,2], Arthur Kolbe[2], Katharina Olthoff[3], Michael Wilhelm[2], Katja Ickstadt[1], and Jürgen Hölzer[2]

[1]TU Dortmund University
[2]Ruhr-University Bochum
[3]NRW State Agency for Nature, Environment and Consumer Protection

Workshop of the Working Group „Bayes Methods“ (IBS, German Region)

02.12.2016

We analyze concentrations of perfluorooctanoic acid and related substances measured in drinking water after a contamination incident in North Rhine-Westphalia prior to 2006 (Wilhelm *et al.*, 2008; LANUV, 2011). Depending on the water supply station considered, these non-equidistant time series show different patterns of decreasing trends, some with possible change-points and extremely high values. We assume measurement errors depending on scale. Some values are censored below the limit of quantification.

In order to estimate mean and variance functions – and to extrapolate to past and future periods if possible – we incorporate informative priors based on expert knowledge. Apart from parametric and semiparametric regression approaches, we test a conjugate Gamma model, which reflects the measurement errors. This model is estimated pointwise with weighted observations based on a kernel smoother. Another possibility is to categorize the data, thereby modelling the rate of increased water pollution without the quantitative, possibly inaccurate values.

As in previous frequentistic analyses, we observe antagonistic aims and results of global and local fits, depending on the method. Due to the different patterns, an optimal model has to be found individually for each supply station.

Extensions we are currently working on are the joint modelling of series from stations related to the same supply area, incorporating their spatial dependence along rivers and additional water network samples; the simultaneous estimation of further model parameters, such as for the relative error and the kernels bandwidth; and Gaussian random field approaches. For epidemiological application, we develop a model of the actual human internal exposure, taking the biological half-life into account.

LANUV (2011). Verbreitung von PFT in der Umwelt: Ursachen – Untersuchungsstrategie – Ergebnisse – Maßnahmen. LANUV-Fachbericht 34, Landesamt für Natur, Umwelt und Verbraucherschutz Nordrhein-Westfalen.

Wilhelm, M., Kraft, M., Rauchfuss, K., and Hölzer, J. (2008). Assessment and Management of the First German Case of a Contamination with Perfluorinated Compounds (PFC) in the Region Sauerland, North Rhine-Westphalia. *Journal of Toxicology and Environmental Health – Part A*, **71**(11–12), 725–733.

*rathjens@statistik.tu-dortmund.de