1 Introduction

In a typical longitudinal study, a number of variables are measured on a group of individuals and the goal is to analyze the relationships between the trajectories of the variables. In recent years, functional data analysis has provided efficient ways to analyze longitudinal data. In many cases the variable trajectories are discretized continuous curves that can be reconstructed by smoothing, and functional linear regression methods can be applied to study the relationship between the variables (Ramsay and Silverman, 2005). But in other situations the data is observed at sparse and irregular time points, which makes smoothing difficult or even unfeasible. Therefore, functional regression methods that can be applied directly to the raw measurements become very useful.

Methods for functional data analysis of irregularly sampled curves have been proposed by a number of authors, for the one-sample problem as well as for the functional regression problem (Chiou et al., 2004; James et al., 2000; Müller et al., 2008; Yao et al., 2005a, 2005b). Outlier-resistant techniques for the functional one-sample problem have also been proposed (Cuevas et al., 2007; Gervini, 2008, 2009; Fraiman and Muniz, 2001; Locantore et al., 1999), and two recent papers deal with robust functional regression for pre-smoothed curves (Zhu et al. 2011; Maronna and Yohai, 2012). However, outlier-resistant functional regression methods for raw functional data have not yet been proposed in the literature. In this paper we address this problem and present a computationally simple approach based on random-effect models. Our simulations show that this method attains the desired outlier resistance against atypical curves, and that the asymptotic distribution of the test statistic is approximately valid for small samples.

As an example of application, we will analyze the daily trajectories of oxides of nitrogen and ozone levels in the city of Sacramento, California, during the summer of 2005.