Validating remotely sensed rainfall estimates by using nonlinear mixed models and geographically weighted regression

Yiannis Kamarianakis[1], Haralambos Feidas[2], George Kokolatos[2], Nektarios Chrysoulakis[1], and Vassilis Karatzias[1]

[1] Institute of Applied & Computational Mathematics,
Foundation for Research and Technology-Hellas,
GR 71110, Vassilika Vouton, Heraklion, Crete, Greece
(e-mails: kamarian@iacm.forth.gr, zedd2@iacm.forth.gr,)
[2] Department of Geography,
University of the Aegean,
Building of Geography, University Hill, Mytilene, GR 811 00, Greece
(e-mails: xfeidas@geo.aegean.gr, kokolatos.g@envcart.aegean.gr)

Abstract. This article validates an infrared-based satellite algorithm for rainfall estimation, the Convective-Stratiform technique, using nonlinear mixed models and geographically weighted regression. Ground truth data are obtained during a three-month period from a large set of rain gauges located at the central-eastern Mediterranean and compared to their corresponding remotely sensed estimates. First, observations that correspond to different measurement locations are considered independent, and in situ data and satellite rainfall estimates are compared on the basis of their fit to a zero-inflated lognormal distribution. Inflation, location and shape parameters are allowed to vary per measurement location according to a Gaussian density; estimations of the resulting nonlinear mixed models are performed via using the Gaussian quadrature method. Our results indicate that the CST algorithm grossly overestimates mean rainfall levels in the study area and underestimates the probability of no rain. Moreover we observe that the significant variability for the location/shape parameters of the lognormal distributions that were fit to the ground truth data is not captured by the remotely sensed estimates. Next, we test for the spatial homogeneity in the relationship between ground truth data and CST estimates. Monte Carlo tests applied to local coefficients estimated by geographically weighted regression reveal the presence of spatial nonstationarity.

Keywords: Rainfall estimation; remotely sensed estimations; zero- inflated lognormal distribution; nonlinear mixed models; geographically weighted regression.