IAG Young Authors Award 2016 – Olga Didova

The IAG Young Author Award 2016 is given to Olga Didova for her paper "An approach for estimating time-variable rates from geodetic time series", which has been published in the Journal of Geodesy (2016) 90:1207-1221. The paper is co-authored by Brian Gunter, Riccardo Riva, Roland Klees, and Lutz Roese-Koerner representing 3 different scientific institutions.

The original article considers the problem of estimating trends in mass loss over Antarctica from GRACE and GPS time series in the presence of inter-annual and seasonal variability. The traditional approach parameterizes the time series using a bias, trend, and harmonic constituents, which are considered as being deterministic. The main weakness of this approach is that the distinct components of mass loss (as those of many other geophysical processes) are not deterministic, but fluctuate in time around some reference values. The idea to model them stochastically using a state space model and estimating the state parameters using a Kalman filter was introduced to the geodetic community in a paper by Davis et al (2012), though state space analysis is a well-established methodology for treating a wide range of problems in the analysis of econometric time series as documented in the excellent books by Harvey (1989) and Durbin and Koopman (2012). Davis et al (2012) assumed that the parameters, which determine the stochastic movements of the state variables ("hyperparameters"), are known. Moreover, little is known in econometric literature about the robust estimation of hyperparameters, which is a non-convex optimization problem.

In her paper, Olga considers the hyperparameters as unknowns and estimates them using Maximum Likelihood. The optimization problem is solved using a gradient-based local solver, which can deal with non-convex problems. To increase the probability of finding the global minimum, Olga suggests to define a random set of uniformly distributed starting values and selects the starting values that provides a solution which has the smallest log likelihood objective function. To improve the chance of finding the global minimum, Olga suggests several measures to limit the parameter search space. Moreover, she introduces inequality constraints on some of the hyperparameters, and suggests a method, involving among others a likelihood ratio test and an algorithm for determining the degrees of freedom for this test, to verify whether the constraints are supported by the data.

The suggested methodology is applied to the analysis of real GRACE and GPS time series, both representing vertical deformations due to elastic and visco-elastic responses of the solid Earth to surface loading. The data analysis reveals that compared to the classical deterministic model using least-squares, the proposed methodology provides more reliable trend estimates, because it accounts for any long-term evolution in the time series and avoids any contamination from seasonal variability.

The proposed methodology may become a standard tool in time series analysis of geodetic data, in particular when long time series comprising years of data are involved.

Olga Didova studied Geodesy and Geoinformation at the University of Bonn, Germany. She received her Bachelor of Science in 2009 and her Master of Science in 2011 under supervision of Karl Heinz Ilk and Juergen Kusche, respectively. Between 2012 and 2016, she was a PhD candidate at Delft University of Technology in the Department of Geoscience and Remote Sensing working on "Separating GIA and ice mass change signals in Antarctica using satellite data". She will defend her PhD thesis at Delft University of Technology in fall 2017. Since March 2017, she is a Postdoctoral Fellow at the University of Bonn and involved in the assimilation of remote sensing data in a hydrological model.

References:

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