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Improvement in the DORIS position time series through years: reaching velocity error of 0.5 mm/yr

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This research focuses on the investigation of the deterministic and stochastic parts of the DORIS (Doppler Orbitography and Radiopositioning Integrated by Satellite) weekly time series aligned to the newest release of ITRF2014. A set of 90 stations was divided into three groups depending on when the data was collected at an individual station: from 1993 to 2003, from 2003 to 2010 and the latest observations. To reliably describe the DORIS time series, we employed a mathematical model that included the long-term nonlinear signal, linear trend, seasonal oscillations and a stochastic part, all being estimated with Maximum Likelihood Estimation (MLE). We proved that the values of the parameters delivered for DORIS data are strictly correlated with the time when observations were collected. The quality of the most recent data has significantly improved comparing to the previous observations. For a few sites, the non-linearities change between different groups of observations. A clear shift in phase in annual signal was noticed for different stations operating at the same site but classified to different groups, revealing an impact of additional satellites and an improvement in the quality of observations with time. The amplitudes of draconitic oscillation are much higher for stations situated in equatorial area than they are for high latitudes. They were also greater for observations collected in the 90s than they were for the 2000s and for recent times. This can be clearly observed for all components. The noise level and its type changed significantly. Among several tested models, the power-law process may be chosen as the preferred one for most of the DORIS data. Moreover, the preferred noise model has changed through the years from an autoregressive process to pure power-law noise with few stations characterised by a positive spectral index. Also, the standard deviation of noise, meaning a dominant noise, decreased when the oldest observations are compared to the newest. We conclude, that (by omitting some outliers) it is possible to determine the velocity from the DORIS-derived time series with a reliability of c.a. 0.5 mm/yr. For the latest observations, the medians of the velocity errors were equal to 0.3, 0.3 and 0.4 mm/yr, respectively, for the North, East and Up components. In the best cases, a velocity uncertainty of DORIS sites of 0.1 mm/yr is achievable when the appropriate coloured noise model is taken into consideration. This finding is really important under the assumption of 0.1 mm/yr which is going to be achieved within the Global Geodetic Observing System.