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Recursive adjustment approach for the inversion of the Euler-Liouville Equation

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Earth rotation is physically described by the Euler-Liouville Equation that is based on the balance of angular momentum in the Earth system. The Earth orientation parameters (EOP), polar motion and length of day, are highly precise observed by geodetic methods over many decades. A sensitivity analysis showed that some weakly determined Earth parameters have a great influence on the numerical forward modeling of the EOP. Therefore we concentrate on the inversion of the Euler-Liouville Equation in order to estimate and improve such parameters. A recursive adjustment approach allows the inversion of the Euler-Liouville Equation to be efficient.

Here we concentrate on the estimation of parameters related to period and damping of the free rotation of the Earth (Chandler oscillation). Before we apply the approach to the complex Earth system we demonstrate its concept on the simplified example of a spring mass damper system. The spring mass damper system is analogous to the damped Chandler oscillation and the results can directly be transferred. Also the differential equation describing the motion of the spring has the same structure as the Euler-Liouville Equation. Spring constant and damping coefficient describing the anelastic behavior of the system correspond to real and imaginary part of the Earth's pole tide Love number. Therefore the simplified model is ideal for studying various aspects, e.g. the influences of sampling rate, overall time frame, and the number of observations on the numerical results. It is shown that the recursive adjustment approach is an adequate method for the estimation of the spring parameters and therewith for the parameters describing the Earth's rheology. The study is carried out in the frame of the German research unit on Earth Rotation and Global Dynamic Processes.