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Earth Rotation from Large Ring Lasers - Modeling of Episodic-Transient Signals

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The application of large ring lasers for the measurement of the global rotation rate of the Earth provides a direct reference to the instantaneous Earth rotation axis and a high temporal resolution of the dataset. At the same time this measurement concept is independent and complementary to the VLBI technique. While periodic geophysical signals with distinct frequencies are readily obtained from the measurements, irregular transient signatures in the time-series are difficult to associate with corresponding geophysical mechanisms. Models for the sensor itself, the sensor orientation and superimposed local rotations have been developed in order to gain access to an unperturbed global Earth rotation quantity.

The sensor model could be significantly improved by a newly installed optical frequency monitoring system, which allows for correction of the cavity length variations induced by air pressure and temperature fluctuations. However a signature typical for meteorological processes still remains in the residuals.

In order to generate atmospherically driven local rotations of the Earth's surface, a finite element model of central Europe has been loaded by atmospheric pressure series taken from operational weather models. While the resulting displacements are correctly modeled, the rotations computed from horizontal displacements are an order of magnitude below the observed level.

It is concluded that the ring laser model is currently not able to fully explain the observed patterns, or the ring laser signal contains contributions from other mechanisms being not identified so far.