

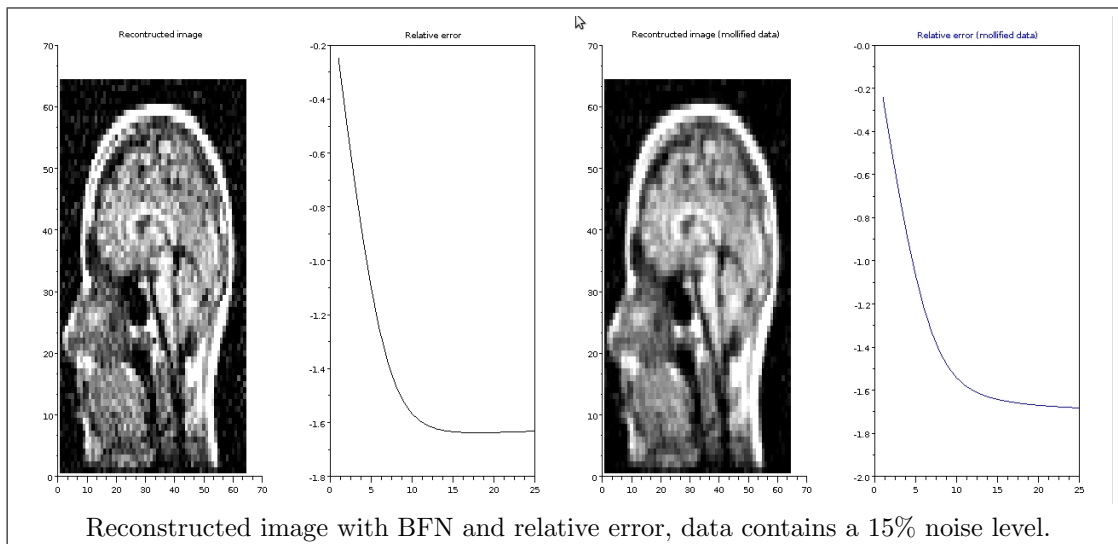
# The Back and Forth Nudging method applied to ThermoAcoustic Tomography

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ThermoAcoustic Tomography (TAT) is a non invasive hybrid imaging technique which uses ultrasound waves emitted from a body submitted to a radio frequency impulse. The absorption of this initial energy causes an amount of thermal expansion, leading to the propagation of a pressure wave outside the body to investigate. This wave is then measured all around the body and the absorption of the initial impulse is highly related to the physiological properties of the tissue, as a result the magnitude of the ultrasonic emission (i.e. thermoacoustic signal), which is proportional to the local energy deposition, reveals physiologically specific absorption contrast. See [1] for an interesting overview.

Most of recent works dedicated to TAT requires approximations of the model (no attenuation of the wave, measurement all around the body, etc) which may not be appropriate to real-life measurement conditions. The particular data assimilation method proposed in this paper is based on a nudging technique : given a evolution model of the state and direct observation (our data), it consists in adding, inside the model equation, a newtonian recall of the state solution to the observations (or data), which is usually called the recall, feedback or nudging term. Different forms of nudging terms can be found in the litterature, and most of them has been used to assimilate data in physical oceanography. Fondamental articles offer the basis of most popular techniques as Kalman filter and asymptotic Luenberger observer. Since the method showed its limits in real conditions by using the data only one time, Auroux and Blum proposed to extend the method in [2] with the Back and Forth Nudging (BFN) algorithm, then tested it with excellent results in comparison with traditional data assimilation methods as optimal filters (from extended Kalman's to particular filters) or else optimal minimisation techniques (variational methods), which appears costfull respectively in memory needs or computing time.



## Références

- [1] P. KUCHMENT AND L. KUNYANSKY, *Mathematics of Thermoacoustic Tomography*, arXiv:0704.0286v2, 2007.
- [2] AUROUX D., BLUM J., *A nudging-based data assimilation method: the Back and Forth Nudging (BFN) algorithm*, *Nonlinear Processes in Geophysics*, 15, 305-319, 2008.

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