4ARTIC (4A Radiative Transfer Inversion Code) is a tool developed at CNES for retrieving gaseous or temperature profiles from atmospheric spectra and estimating the performance of an inversion. This tool has been designed for the Microcarb mission and then has been extended to the thermal infrared domain to analyze the IASI-NG performances at level 2.

For several months, an operational version of 4ARTIC with a Graphical User Interface is developed by Thales Services, under the direction of CNES.

The inversion performed by 4ARTIC is coupled with the very accurate radiative transfer model 4A/OP:
• A line-by-line radiative transfer model, adapted to high spectral resolution (5.10^-4 Å)
• A rapid computation due to a prior creation of an optical thickness database (ATLAS)
• A spectral domain applied to SWIR/TIR (600 – 13000 cm^-1)
• Based on GEISA spectroscopic parameters, regularly updated

The 4A/OP-subroutine is used in 4ARTIC. Specifically designed for inversion algorithms, it distinctly reduces computation time during iterative call to radiative transfer calculation.

4ARTIC software and Graphical User Interface

**Algorithms**

The inversion performed by 4ARTIC is based on the optimal estimation method (OEM). This method gives the maximum probability of the a posteriori solution of an inverse problem. The goal is to retrieve a state vector \( \mathbf{x} \), which contains geophysical products to retrieve, from a priori information, an observed spectrum \( \mathbf{y} \), a measurement noise and the Jacobian derived from radiative transfer calculation.

Optimal estimation formalism (Bayesian approach):

\[
\mathbf{x}_{a \text{ posteriori}} = \mathbf{x}_{a \text{ priori}} + (\mathbf{J}^T \mathbf{R}^{-1} \mathbf{J} + \mathbf{K}^T \mathbf{K})^{-1} \mathbf{J}^T \mathbf{R}^{-1} (\mathbf{y} - \mathbf{H} \mathbf{x}_{a \text{ priori}})
\]

\( \mathbf{J} \): state vector at iteration \( i \)
\( \mathbf{y} \): measurement vector
\( \mathbf{H} \): Jacobian matrix at iteration \( i \)
\( \mathbf{R} \): error covariance matrix of measurement noise
\( \mathbf{R}^{-1} \): inverse of the error covariance matrix
\( \mathbf{K} \): a posteriori error and gain

**ქთისტობა**

4ARTIC has been used in many applications for IASI-NG:
- Evaluation of the a posteriori error of the state vector for different values of instrumental noise
- Impact of the instrumental noise on the estimation of temperature and water vapor profiles
- Estimation of the a posteriori error and gain compared to the a priori values for several pressure levels

IASI-NG applications