Summary of the Final Report of Research Results

1) Title of the proposed research

Atmospheric corrections for fluorescence signal retrieval using GOSAT/TANSO-FTS products

2) Principal Investigator (PI) and Co-Investigators (Co-Is)

PI:

Dr. Samuele Del Bianco

Co-I:

Dr. Bruno Carli

Dr. Ugo Cortesi

Dr. Marina Mazzoni

Dr. Franco Miglietta

3) PI's affiliation

Institute for Applied Physics "Nello Carrara" of the Italian National Research Council (IFAC-CNR)

**4) Summary of the Final Report of Research Results**

Objective of the "Fluorescence Signal Retrieval" study was the definition, implementation and validation of a prototype software system aimed at the atmospheric corrections for the retrieval of solar-induced fluorescence and reflectance of vegetation from measurements of top of the atmosphere radiance in the visible and near-infrared spectral regions. The TANSO/GOSAT RA Joint Research Agreement, which was executed on 08/31/2009, was terminated in April 2013 due to the lack of national funds to support these activities and the relative missions, and to the great efforts employed in the project 'Application of KLIMA algorithm to CO2 retrieval from IASI/METOP-A observations and comparison with GOSAT/TANSO-FTS products' in which the research group was involved. In this summary the main research results reached are reported.

A new software named Multi-purpose Atmospheric Radiative Transfer Algorithm (MARTA), was developed at IFAC-CNR for forward modelling of remote-sensing observations of the planetary atmospheres. The design, development, implementation and testing of the MARTA radiative transfer code was one of the tasks of the project CTOTUS, funded by Regione Toscana and coordinated by IFAC-CNR (project web site: http://ctotus.ifac.cnr.it/). As reported in the Revised Work Plan Document, the objective of the task was to develop and to validate a multi-purpose software for radiative transfer simulations in the Earth's atmosphere aiming at the generation of synthetic measurements acquired by remote-sounders using different viewing geometries (nadir, zenith and limb-sounding from ground-based, airborne and satellite payloads) and with spectral coverage from

the mm-wave to the near-infrared and visible regions. MARTA code has been implemented and it is able to simulate the atmospheric radiance from the mm-wave to the near-infrared. Also the polarization effects have been implemented in the code, while the multiple-scattering module has yet to be included.

The current version of MARTA was used to perform some calculations in order to check the correct connection between the various modules as well as to test the functionality of the main program. For example, the code was used for the calculation of vertical transparency in clear sky condition. This test was carried out over a wide spectral range for the purpose of 'debugging' of the program and, in addition, to highlight the feature of flexibility relative to the spectral coverage.

We then used MARTA code for the simulation of the spectral radiance measured by some actual instruments (MARSCHALS on board of Geophysica; REFIR-PAD from stratospheric platforms and at ground level; IASI on board of METOP-A; and TANSO-FTS SWIR and TIR bands) in order to verify the code in various geometries of observation in spectral bands. Some calculated radiances are shown in the following figures.
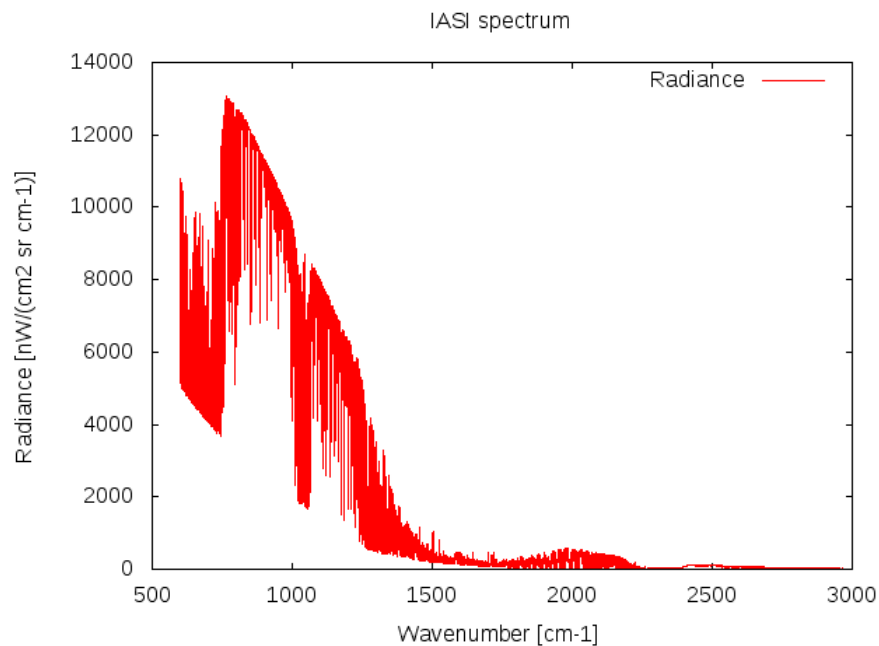
Radiance simulated with MARTA in a spectral region that covers the wide-band measured by IASI instrument aboard the METOP-A satellite. The simulation was performed with the instrument to an altitude of 800 km and with an angle pointing at nadir. In the simulation were not considered the instrumental effects. The IASI measurements provide information both on the atmosphere and on the surface. MARTA, in this case, has also simulated the surface contributions in the spectral region of IASI taking into account the emissivity and the reflectivity effects.
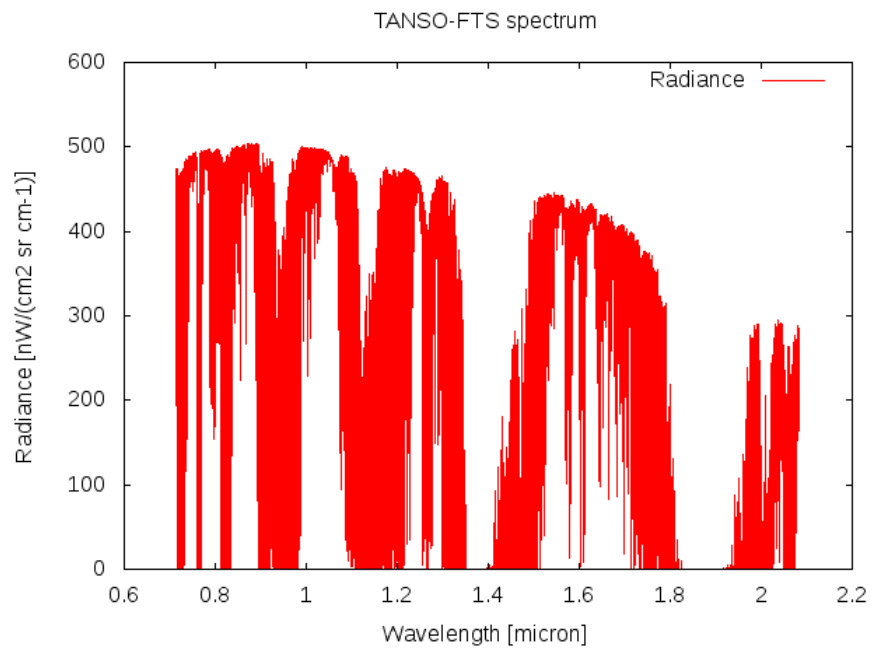
Radiance simulated by MARTA in a spectral region that covers the three SWIR bands measured by TANSO-FTS. In this simulation the instrumental effects have not been included.

5) List of publications relating to the proposed research

N/A.