Air quality is a societal concern, since it has impacts on human health and environment. Laws have been established to protect citizens and ecosystems, through monitoring of harmful pollutants and implementation of emissions reduction measures. Currently, air quality is monitored at the surface. However dense are operational networks in Europe, large areas are not covered and little information is available on low altitude levels of pollutants. Such pollutants can accumulate aloft, be mixed during the day within the atmospheric mixing layer, and thus affect surface concentrations. There is indeed a recognized need for additional information, to be assimilated in Air Quality forecast models that are used to take steps (information of the public, reduction of emissions via e.g. limitation of car circulation…) in anticipation of polluted episodes. The solution may be a dedicated sensor onboard a geostationary platform, which could provide the needed high spatial and temporal sampling over Europe.

The purpose of my PhD is to define a future geostationary Air Quality Sounder, named AQS hereafter, measuring in the thermal infrared, in collaboration with industry (Astrium-EADS). Numerical model simulations are used to optimize the specifications of the AQS for the targeted species ozone (key harmful pollutant) and carbon monoxide (tracer of all combustion sources).

The first step was to generate synthetic observations taking into account different possible characteristics for the AQS (spectral resolution, signal to noise ratio…) and using a numerical radiative transfer and retrieval suite. Several sets of observations were generated for different instrument parameters and atmospheric cases (surface and altitude temperature, humidity, day and night scenes). AQS characteristics are then discussed with the collaborating industrial team, in order to assess technology readiness level for embarking onboard a geostationary platform and to provide elements for a cost/benefit analysis.

The second step was to perform observing system simulation experiments (OSSE). This well-established methodology in meteorology has seldom been used for atmospheric composition, which is thus a novel aspect for my work. My OSSEs consist in assimilating AQS synthetic datasets (cf phase 1) into a state-of-the-art air quality forecast model to quantify their impacts on resulting analyses and forecasts. We evaluate the capacity of the AQS to correct the model trajectory regarding errors on initial conditions, on meteorological forcings, on emissions, or on its own parameterizations. As a first result, we confirm that the characteristics of Meteosat Third Generation Infra-Red Sensor (IRS) are not meeting the requirements for air quality. Quite the contrary, our AQS provides promising firs results.

In the final year, I will do sensitivity tests to precise and quantify the expected impacts of the AQS. Also, we will test two types of retrieved synthetic observations (L2): partial columns or profiles with averaging kernels, in order to determine which data is best suited for air quality assimilation objectives.

After finishing my thesis, I intend to work in the R&D area in the domain of aerospace. Indeed, I chose this research subject to have the opportunity to work at the interface between the aerospace industry and academic research.