A Different View of Atmospheric Carbon Monitoring

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In 2013 Harris and Atmospheric and Environmental Research (AER) were selected by the Department of Energy (DOE) National Energy Technology Laboratory (NETL), Carbon Storage group to develop a new measurement approach for continuous monitoring of CO_2 over an entire storage field for verification of ground carbon storage facilities. The result of that effort was the Greenhouse gas Laser Imaging Tomography Experiment (GreenLITE). The GreenLITE system consists of two Laser Absorption Spectroscopy (LAS) transceivers and a number of reflectors used to establish a grid of overlapping CO_2 density measurements. GreenLITE hardware and operational software leverages many years of prior work done by Harris, then ITT, on an airborne demonstrator for the NASA Decadal Survey Active Sensing of CO_2 Emissions over Nights, Days, and Seasons (ASCENDS) mission. Both systems utilize the synchronous transmission Intensity Modulated (IM) Continuous Wave (CW) LAS approach, but GreenLITE uses it in a new and unique way. The retrieval approach also leverages many years' of work by AER for multiple programs. The differential transmission is measured along each line (chord) and is then used along with locally measured temperature, pressure and relative humidity via a cloud-based processing environment to drive retrieval to dry air-mixing ratio through the comparison of a Line-By-Line Radiative Transfer Model (LBLRTM) and the observed data. The intersections of the multiple chords also serve as a means to constrain an estimate of the 2D spatial distribution of the gas over the area of regard.

In 2015 Harris designed and built an expanded version of the transceivers to work over a 5 km path length enabling coverage of ~30 km2 in the current configuration and got the system deployed over the city of Paris, France in November 2015. AER advanced the user interface, made the retrieval algorithms capable of retrieval over the long slant path by including layered weather data, and implemented a more robust cloud-based data storage and dissemination architecture. The system has been operating over the city of Paris continuously and provides real-time concentrations and maps via a web-based interface, as shown in the figure. Harris and AER have been working with Climate and Environment Sciences Laboratory (LSCE) and Laboratoire Atmospheres, Milieux, Observations Spatiales (LATMOS) on evaluation of the data using both model and *in situ* measurements to evaluate the performance and utility of the system in complex urban environments.

Figure 1. Prototype GreenLITE transceivers in side-by-side comparison (left), Example of the near-real time data for the GreenLITE system as deployed in Paris (right). Red dots are the transceivers and magenta dots are the reflectors. The red lines indicate the lines for a single 10 second measurement. The heat map shows the estimated concentration distribution.