A BROAD BAND LIDAR FOR PRECISE ATMOSPHERIC CO_2 COLUMN ABSORPTION MEASUREMENT FROM SPACE

Georgieva, E.M[1], Heaps, W.S.[2], Huang, W.[3]

[1]Goddard Earth Sciences and Technology Center, UMBC, Baltimore, MD 21228, USA

e-mail: Elena.M.Georgieva@nasa.gov

[2] NASA, Goddard Space flight Center, Greenbelt, MD 20771, USA

[3] Science Systems and Applications, Inc., Lanham, MD 20706

1. ABSTRACT

Global measurement of carbon dioxide column with the aim of discovering and quantifying unknown sources and sinks has been a high priority for the last decade. In order to uncover the “missing sink” that is responsible for the large discrepancies in the budget the critical precision for a measurement needs to be on the order of 3 ppm. That number comes from the transport inversion model experiments, which indicate that global column data with a precision better than 1% (3ppmv on the 380 ppmv background) on a time scale of one month is the science requirement to improve surface flux estimates [1]. No species has ever been measured from space at such a precision. In recognition of the importance of understanding the CO_2 budget and in order to evaluate its impact on global warming the National Research Council (NRC) in its recent decadal survey report (NACP) to NASA, recommended planning for a laser based total CO_2 mapping mission in the near future [2]. That’s the goal of Active Sensing of CO_2 Emissions over Nights, Days, and Seasons (ASCENDS) mission -to significantly enhance the understanding of the role of CO_2 in the global carbon cycle. Existing passive sensors suffer from two shortcomings. Their measurement precision can be compromised by the path length uncertainties arising from scattering within the atmosphere. Also passive sensors using sunlight cannot observe the column at night. Both of these difficulties can be ameliorated by lidar techniques.

Our current goal is to develop an ultra precise, inexpensive new lidar system for column measurements of CO_2 changes in the lower atmosphere that uses a Fabry-Perot

interferometer based system as the detector portion of the instrument and replaces the narrow band laser commonly used in lidars with the newly available high power SLED as the source. This approach reduces the number of individual lasers used in the system and considerably reduces the risk of failure. It also tremendously reduces the requirement for wavelength stability in the source putting this responsibility instead on the Fabry-Perot subsystem.

This paper describes the development, initial testing and preliminary experimental results for our novel CO_2 lidar instrument under development. In our initial setup we are using superluminescent light emitting diodes (SLED) as a source and our previously developed Fabry-Perot interferometer subsystem as a detector part [3], [4], [5].

The detector part (Figure 1) has been developed over the last five years at Goddard as a passive sensor to measure CO_2 column using scattered solar flux and was tested at two flight campaigns. This system employs Fabry-Perot etalons to create a differential response to the absorption of sunlight by carbon dioxide absorption lines near 1.57 microns.

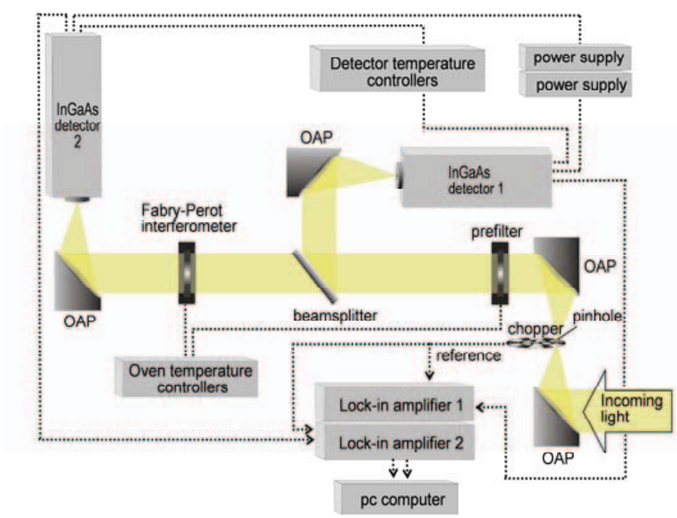

Figure 1 Incoming light passes through the bandpass filter and is split into two paths. The first path (reference channel) is detected while the second passes through the Fabry-Perot before detection (FP channel). The ratio of the signal in the two channels responds differentially to the atmospheric CO_2

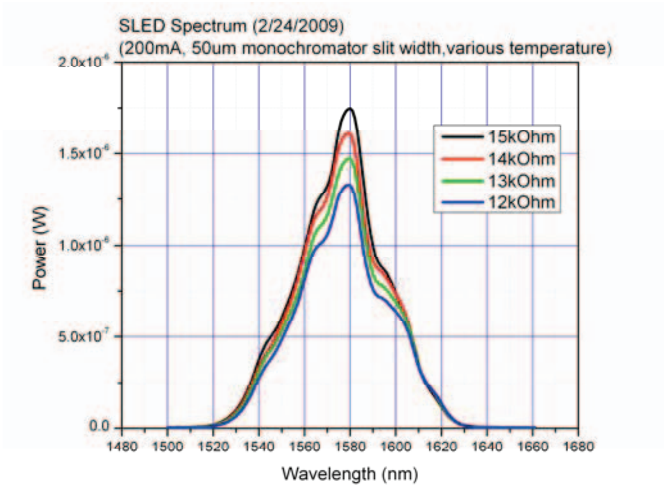

Figure 2 shows our measurement of the output of a commercially available SLED manufactured by EXALOS

We will discuss the details of amplifying the SLED with OPO and the results from our preliminary testing of this new broadband lidar system.

Keywords: Instrumentation, measurement and metrology (120.0120), remote sensing (280.0280), atmospheric composition (010.1280), optical instruments (120.4640), absorption (300.1030), interferometry (120.3180), Fabry-Perot (120.2230), lidar, OPO

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