OVERVIEW OF OCO VALIDATION

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ABSTRACT

The Orbiting Carbon Observatory is a NASA ESSP mission that is scheduled for launch in September 2008 [*Crisp et al.*, 2004]. The space-based observatory will sample the dry air, column averaged mole fraction of CO_2 (X_{CO2}) based on analysis of reflected solar radiation, between ~0.78 and 2.0 microns, acquired by three grating spectrometers. To fulfill the mission's science objectives, the OCO validation activities are focused on demonstrating that space-based retrievals of X_{CO2} have random errors no larger than 0.3% (1 ppm) over a network of ground based validation sites on monthly time scales [*Miller et al.*, 2005]. Furthermore, space-based retrievals of X_{CO2} will be compared to measurements from this network of ground-based stations to detect and mitigate geographically coherent biases on regional to continental scales. We describe plans and progress to date of the OCO validation program, which consists primarily of a series of ground-based, Fourier Transform Spectrometers (FTS), that measure X_{CO2} in the same spectral regions as the space-based spectrometers.

At least 9 ground-based FTS stations for validation of X_{CO2} will be established. The site selection has been based on criteria such as environmental conditions (flat terrain removed from local CO_2 sources is preferred), the availability of ancillary observations (measurements of aerosols and CO_2 mixing ratio are crucial), the availability of a local liaison, accessibility and security, and the need to establish sites at a variety of latitudes. Sites will consist of both new, dedicated FTS instruments (mainly Bruker 125HRs) as well as upgrades to existing FTS instruments that are part of the Network for Detection of Stratospheric Change (NDSC) program. The table below describes the location of selected sites (denoted by **boldface**) and other sites under consideration:

Site	Lat.	CO_2 Obser. (Flask/Tower/Contin.)	Aerosol Obser.	Local Liasion
Ny Alesund, Norway	79°N	**Yes**	**Yes**	Notholt
Kiruna, Sweden	68°N	No	No	Blumenstock
Poker Flat, Alaska	65°N	**Yes**	No	Murcray
Bremen, Germany	53°N	No	No	Notholt
Park Falls, Wisconsin	46°N	**Yes**	No	Wennberg
Moshiri, Japan	44°N	No	No	Nagahama
Billings, Oklahoma	37°N	**Yes**	**Yes**	Wennberg
Tsukuba, Japan	36°N	No	**Yes**	Nakane
Tenerife Island	28°N	**Yes**	No	Blumenstock
Mauna Loa	19°N	**Yes**	**Yes**	Murcray
Paramaribo, Surinam	6°N	No	No	Notholt
Christmas Island	2°N	**Yes**	**Yes**	To be determined
Darwin, Australia	12°S	**Yes**	**Yes**	Griffith & Connor
Wollongong, Australia	34°S	No	No	Griffith
Lauder, New Zealand	45°S	**Yes**	**Yes**	Connor
Arrival Hts, Antarctica	78°S	**Yes**	No	Connor

The measurements of X_{CO2} from some of the ground based FTS systems will be compared to values of column CO_2 based on aircraft overflights. This provides an assessment of the accuracy and precision of the ground-based measurements of X_{CO2}, as well as a means to ultimately tie the space-based measurements of column CO_2 to the NOAA/CMDL/WMO standards that are used for the aircraft, in-situ observations of CO_2. Initial results for overflights of the Park Falls, Wisconsin FTS station that occurred during the summer of 2004 show agreement to better than 1% between the in-situ and FTS measurements of column CO_2 [*Washenfelder et al.*, 2005]. This comparison suggests that column CO_2 measurements from a network of ground-based FTS stations will provide measurements suitable for the validation of space-based CO_2. Further aircraft overflights of the Park Falls, Wisconsin and Darwin, Australia sites will occur in the next few months.

During the OCO mission, the performance of each FTS system will evaluated by continuous monitoring of: a) the instrument line shape (ILS) via an HCl gas cell, b) instrument pointing via examination of Doppler shifts of telluric versus solar features; c) the ratio of column O_2 measured by the FTS to ground pressure. The retrievals of X_{CO2} from the FTS systems that will be used for validation of the space-based data will be achieved using the same software applied to the space-based retrievals, to assure the integrity of line-lists and other physical assumptions. One hallmark of the measurement of X_{CO2} from a ground-based FTS system is that the measurement is essentially insensitive to aerosol scattering, given the geometry of the observation (viewing of the direct sun) and the high spectral resolution of the FTS instruments. Hence, the ground-based measurements of X_{CO2}, combined with ancillary observations of aerosols, provides a means to quantify biases in space-based measurements in X_{CO2} due to inaccuracies in the treatment of aerosol scattering.

The validation of space-based X_{CO2} will be achieved via close collaboration between the validation and retrieval teams, and successive improvement of the retrieval algorithm. Data mining and data visualization tools will be used to define the dependence of offsets between ground-based and space-based X_{CO2}, as a function of parameters such as aerosol loading, aerosol optical properties, viewing angle, humidity, temperature, albedo, etc. “Physics-based” approaches (e.g., modifications to line shape and broadening parameters; modifications to aerosol scattering parameters) will first be employed to improve the retrieval algorithm. If, upon successive improvements to the retrieval algorithm, it is determined that biases persist in the space-based retrievals of X_{CO2} that might affect inferences of carbon sources and sinks, then the validation team will propose “engineering-based” approaches to obtain a global data set that, over the validation sites, has minimal biases with respect to factors such as aerosols, humidity, and viewing angle.

REFERENCES

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