The Spatial Sampling Approach for Orbiting Carbon Observatory Measurements: Strategies of Validation of OCO Measurements Against Surface Networks

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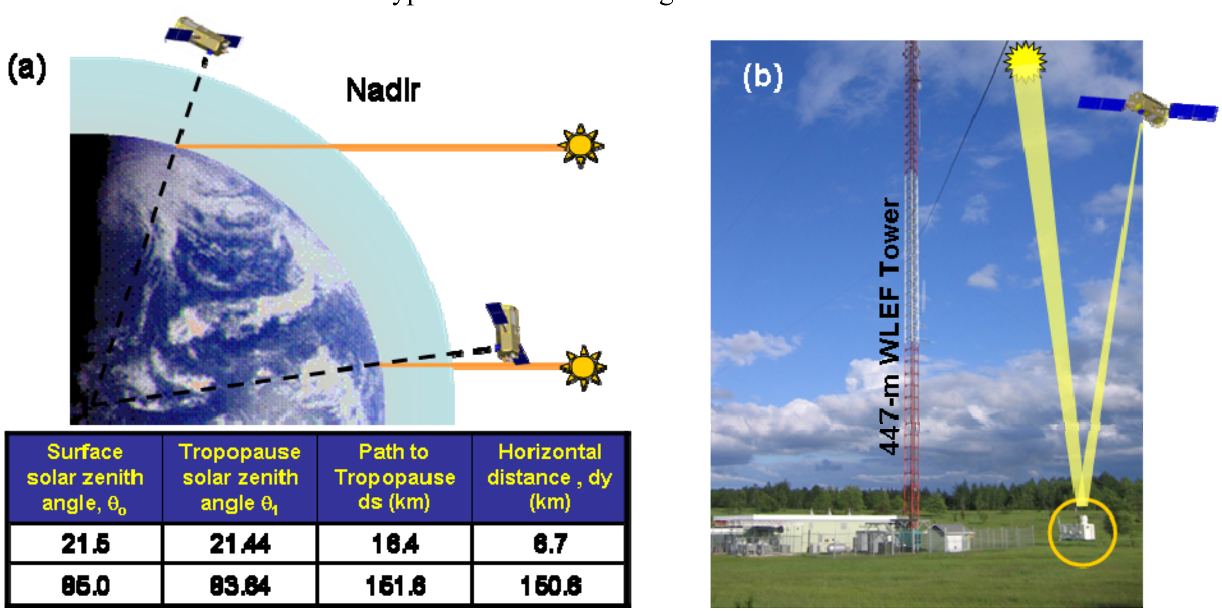
The Orbiting Carbon Observatory (OCO) will make global, space-based, measurements of the column-averaged atmospheric CO_2 dry air mole fraction, X_{CO2}. These measurements must be validated against results from the existing global network to ensure that their accuracy is adequate to quantify regional scale surface sources and sinks of CO_2. A few aspects of the X_{CO2} soundings will pose challenges to routine comparisons with surface *in situ* data. In particular, the atmospheric optical path associated with each X_{CO2} sounding extends along the incoming solar beam from the top of the atmosphere to the surface footprint, and then back to the top of the atmosphere in the direction of the spacecraft. At high latitudes, where the solar zenith angles are large, these paths can extend the spatial sampling well beyond the extent of the surface footprint (Fig. 1). To address this issue, the OCO team will use ground-based, solar-looking Fourier Transfer Spectrometers (FTS's) as a transfer standard. These systems are being deployed as part of the Total Carbon Column Observing Network (c.f. Washenfelder et al. 2006). Each FTS uses the same CO_2 and O_2 bands as the space-based OCO instrument, and can acquire simultaneous observations along the same incoming solar beam. However, because they stare directly at they sun, they have greater the signal to noise and greater spectral resolution than the space-based system. Their measurements are also less susceptible to pathlength errors associated with scattering by thin clouds and aerosols. X_{CO2} results from the FTS systems at Park Falls, Wisconsin and Darwin Australia have been validated directly against aircraft *in situ* measurements of the CO_2 column (Fig 1b). While the TCCON network is continuing to grow, it will always be much smaller than the CO_2 surface and tower networks. Advanced data fusion methods will be needed compare and combine the space based data with the data from those networks. One of the primary challenges will be representing the sampling footprints associated with each measurement type without introducing biases.



Surface solar zenith angle, θ_0	Tropopause solar zenith angle θ_1	Path to Tropopause ds (km)	Horizontal distance , dy (km)
21.5	21.44	16.4	6.7
85.0	83.84	151.8	150.8

Figure 1. (a) Horizontal scale of atmospheric soundings for Nadir observations at low and high latitudes. Even though the OCO surface footprint is only 3km^2 at nadir, the atmospheric footprint associated with the incoming solar beam can extend 100's of km. (b) The FTS adjacent to the WLEF tower near Park Falls, Wisconsin. These stations will facilitate comparisons of OCO data to the surface network.