



Calibration of TCCON observations on Ascension Island with aircraft profiles from the NASA ATom campaigns

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The Total Carbon Column Observing Network (TCCON) provides the most precise column-averaged dry-air mole fraction observations of CO₂, CH₄, CO, N₂O and several other atmospheric trace gases. This is vital for satellite observations of greenhouse gases (GHGs) like CO₂ or CH₄ as the precision requirements for these GHGs are on the sub-percent level. Consequently, all current and (foreseeable) future satellite instruments for CO₂ and CH₄ rely on TCCON for calibration and validation.

However, to link TCCON (and thus satellite) observations to the established WMO GHG scale, TCCON itself must be calibrated with respect to in-situ GHG measurements. Otherwise, the accuracy of spectral parameters needed for the TCCON retrievals does not match the achievable precision. The standard procedure is to measure atmospheric profiles with aircraft in-situ instruments above the TCCON stations and compare these to the total column TCCON observations derived at the same time. Jet aircraft are needed for this to cover as much of the tropospheric column as possible. The results from many aircraft profiles derived over many TCCON stations are used to calculate network-wide calibration factors for all major TCCON target species.

Each TCCON station is required to have at least one aircraft calibration before it can become a full member of the network. However, the logistical constraints at some sites can be very limiting. It took more than four years of operation before the TCCON station on Ascension Island was visited by the NASA DC-8 aircraft during the Atmospheric Tomography (ATom) mission in August 2016 to receive its first aircraft calibration. Among many other species and parameters, altitude profiles of CO₂, CH₄, CO, and N₂O were measured by instruments from NOAA and Harvard University on board. Two more visits took place during ATom-2 in February 2017 and ATom-3 in October 2017. The results are now used to improve TCCON's in-situ calibration factors. The station itself was promoted to full TCCON status in mid 2017 as a result.