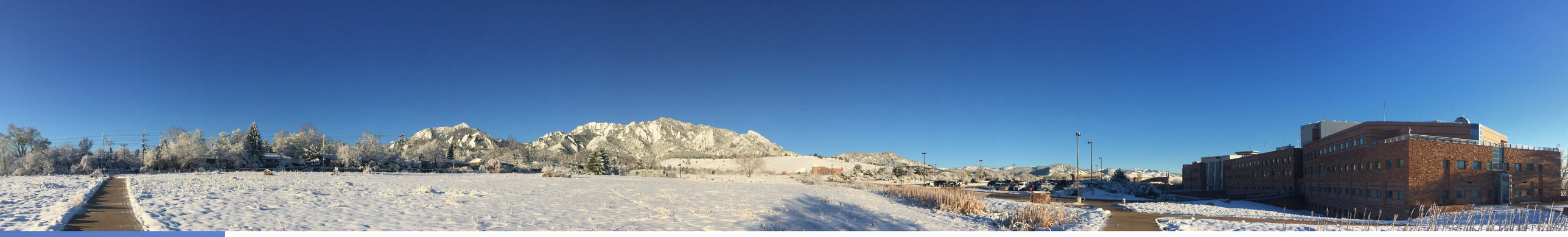

The AirCore: The Gold Standard for atmospheric profiles

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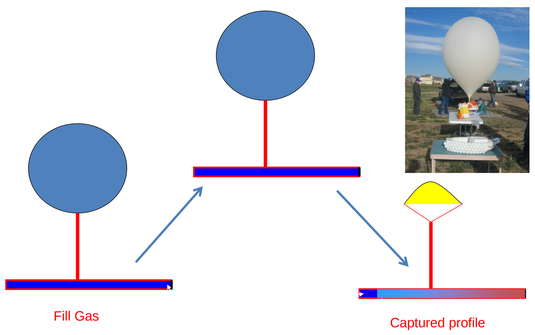
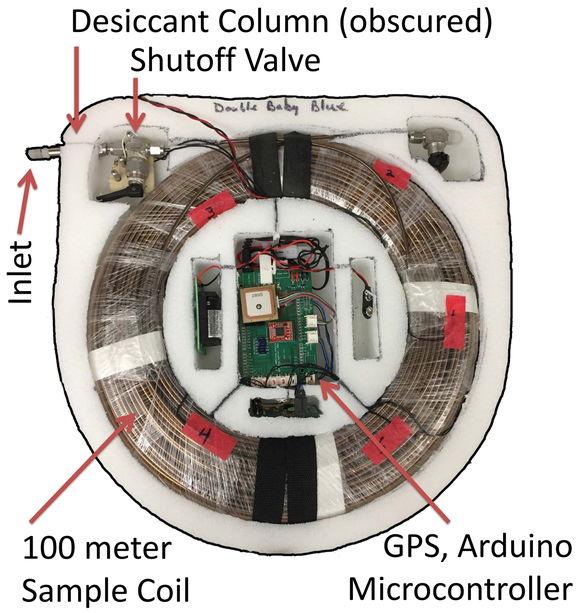
The NOAA /GMD AirCore

Overview: Over the last decade the NOAA/GMD Carbon Cycle Group has leveraged the simple idea that a long stainless steel tube could be used to "core" the atmospheric column utilizing the fact that length scales of diffusion for atmospheric trace gases in a tube are only a few meters per day relative to the long length of a 100m tube. Using a balloon launching system, the 100m-long SilcoSteel coated stainless steel tube is deployed with one end closed and one end open. As the tube rises into the atmosphere air flows out of the tube until the balloon is either cut away or bursts. During the descent surrounding air flows back into the AirCore replacing the "fill gas" which is spiked with 10 ppm CO to easily identify the exact volume of air that was left in the AirCore before air starting flowing back into the AirCore. The air captured by the AirCore can be measured by any kind of analyzer to provide measurements of the dry mole fraction of a trace gas in the atmospheric column. The NOAA/GMD Carbon Cycle Group has taken advantage of highly stable and highly precise cavity-ringdown spectrometers with relatively small sample cell volumes to measure CO_2, CH_4 and CO in an atmospheric column sampled by the AirCore. The AirCore package is typically recovered and analyzed within 3-4 hours after launch allowing for resolutions in the atmospheric boundary layer of 75 m and increasing up to 1000 m in the mid stratosphere.



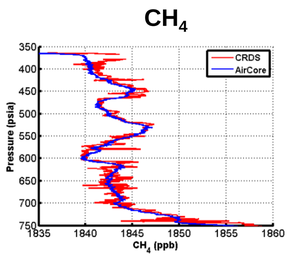
Conceptual schematic showing replacement of the fill gas with a sampled atmospheric profile in the AirCore which is then later analyzed.



Current AirCore design, with a 100 m 1/8" SS tubing coil.

Is it really to gold standard?

Excellent comparison with insitu profiles

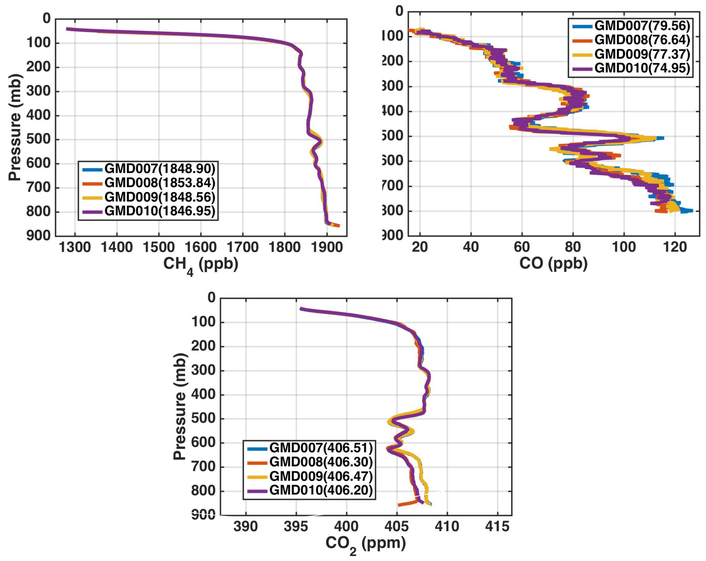


Column Mean offset

CO_2 (ppm)	-0.07 ± 0.04	(±0.02%)
CH_4 (ppb)	-0.1 ± 0.4	(±0.01%)

Direct comparison of AirCore with insitu measurements shows excellent agreement. Dividing the comparison into 20 mbar increments shows an average offset of 0.07 ppm and 0.1 ppb for CO_2 and CH_4, respectively.

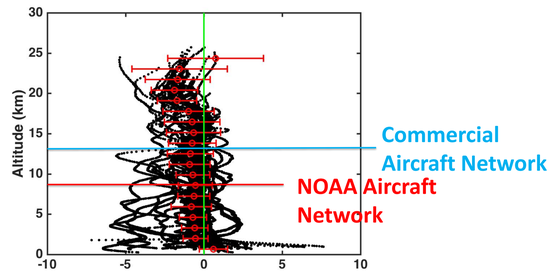
Duplicate profiles show consistent results



AirCore flight to 27 km on July 14, 2017 comparing CO_2, CH_4 and CO profiles for 4 different AirCores. For each of two balloon launches two AirCores were flown together (AirCore 07 together with AirCore 09 and AirCore 08 together with AirCore 10).

Scientific Results

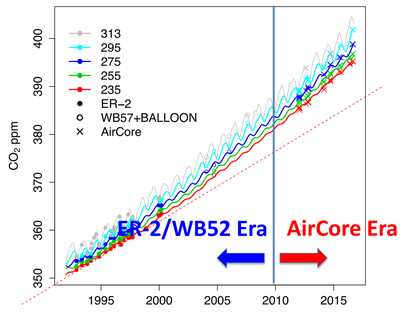
Models consistently predict higher CO_2 in stratosphere



AirCore – CarbonTracker (ppm)

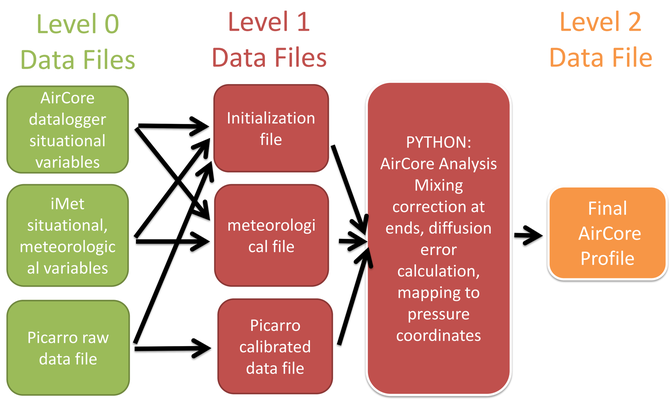
Several comparisons of AirCore and inverse and forward models of CO_2 and CH_4 suggest that models consistently over estimate the CO_2 mole fraction.

Consistent with older stratospheric measurements



Measurements of stratospheric CO_2 on N_2O isopleths using known free troposphere CH_4/N_2O relationships and CH_4 measurements from the AirCore.

Data Archive



Data processing requires multiple levels of analysis and the data is now available to the public.