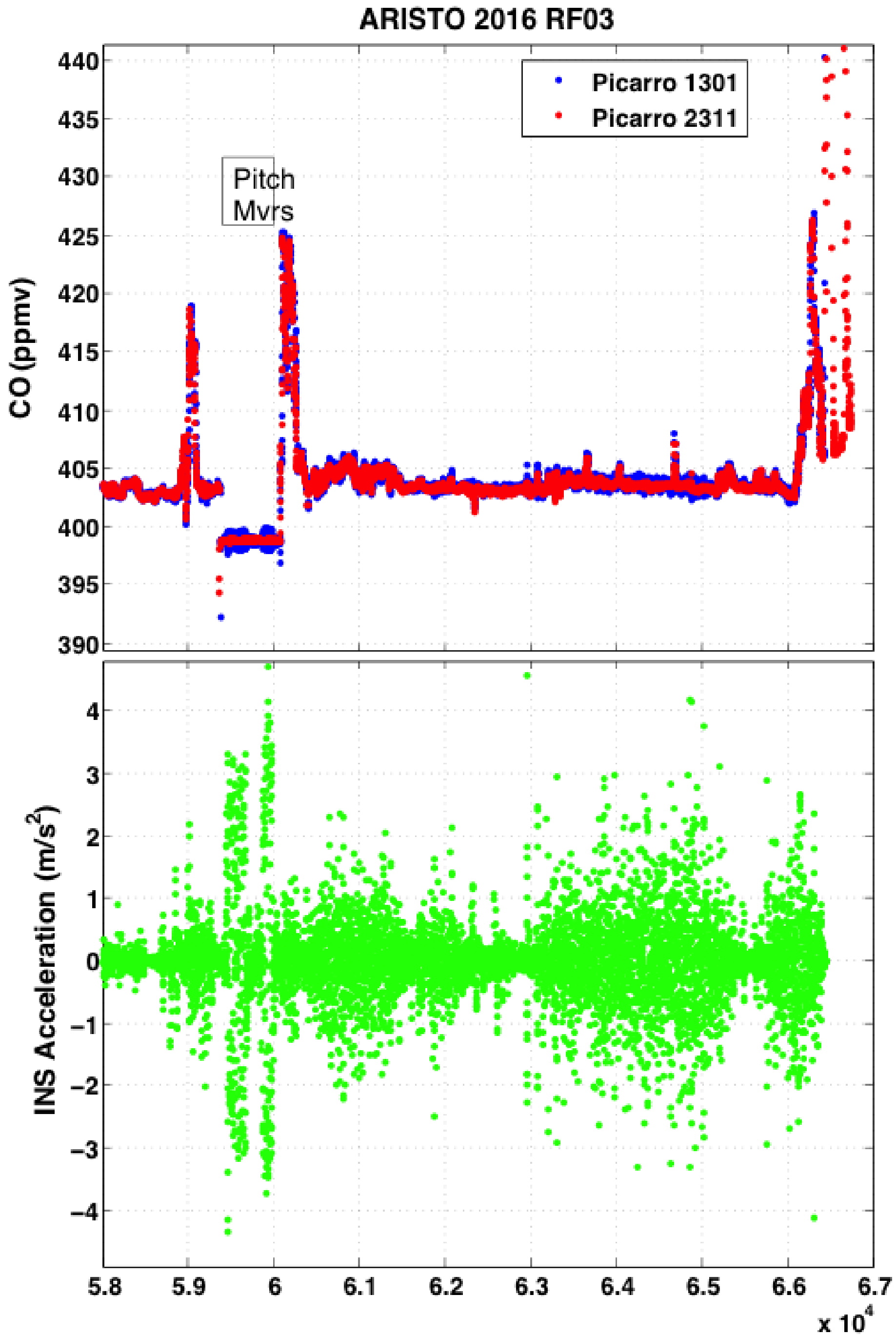
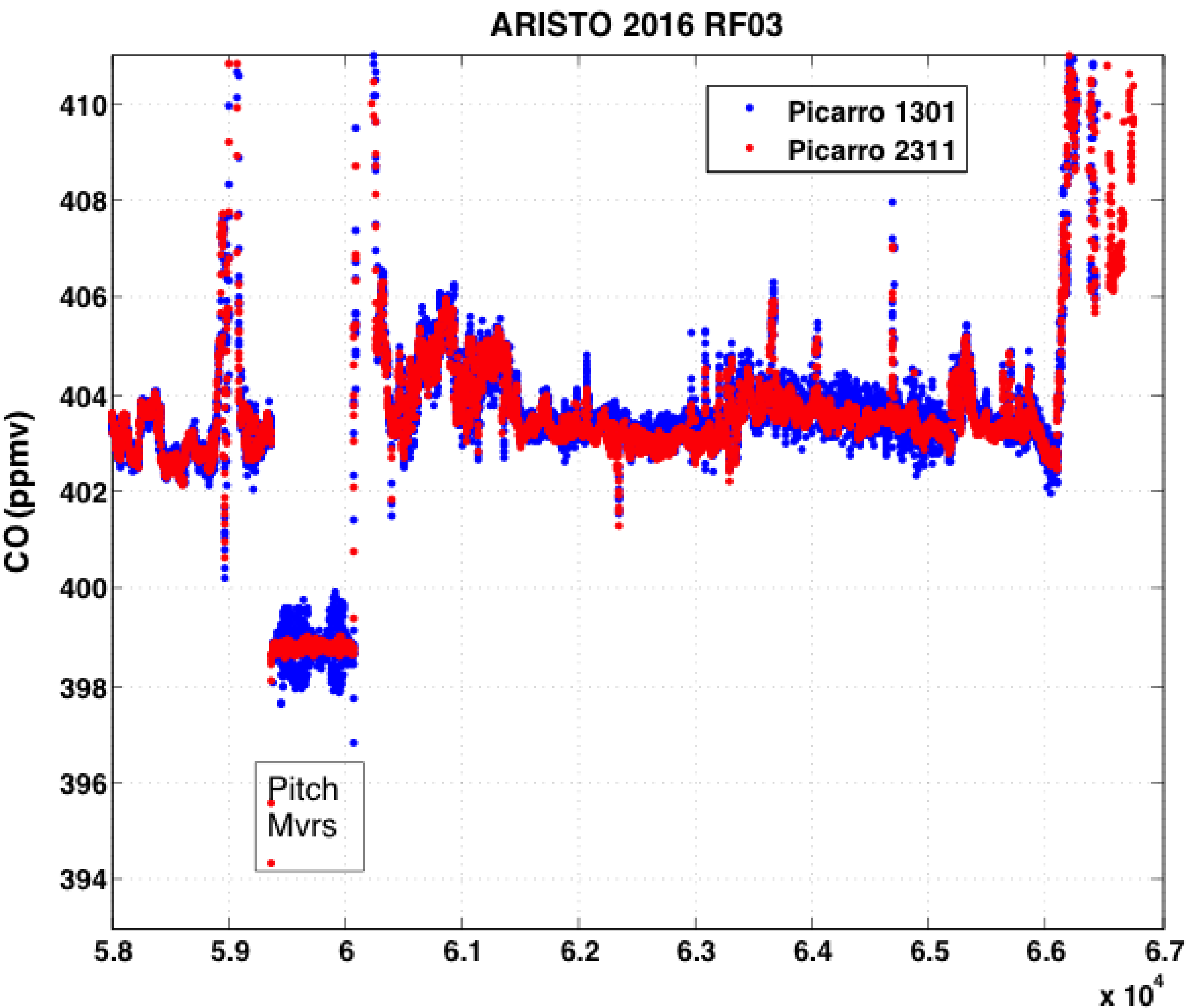
# Picarro $CO_2$ Measurement Accuracy and Stability: A First Look at Preliminary Results from ARISTO-2016

Objectives: 1) Characterization of Picarro CO2 and CH4 instrumentation temporal, flight environment, and cabin pressure impacts on humidity correction factor; and 2) aircraft acceleration impacts on signal variance while sampling calibration gas during maneuvers

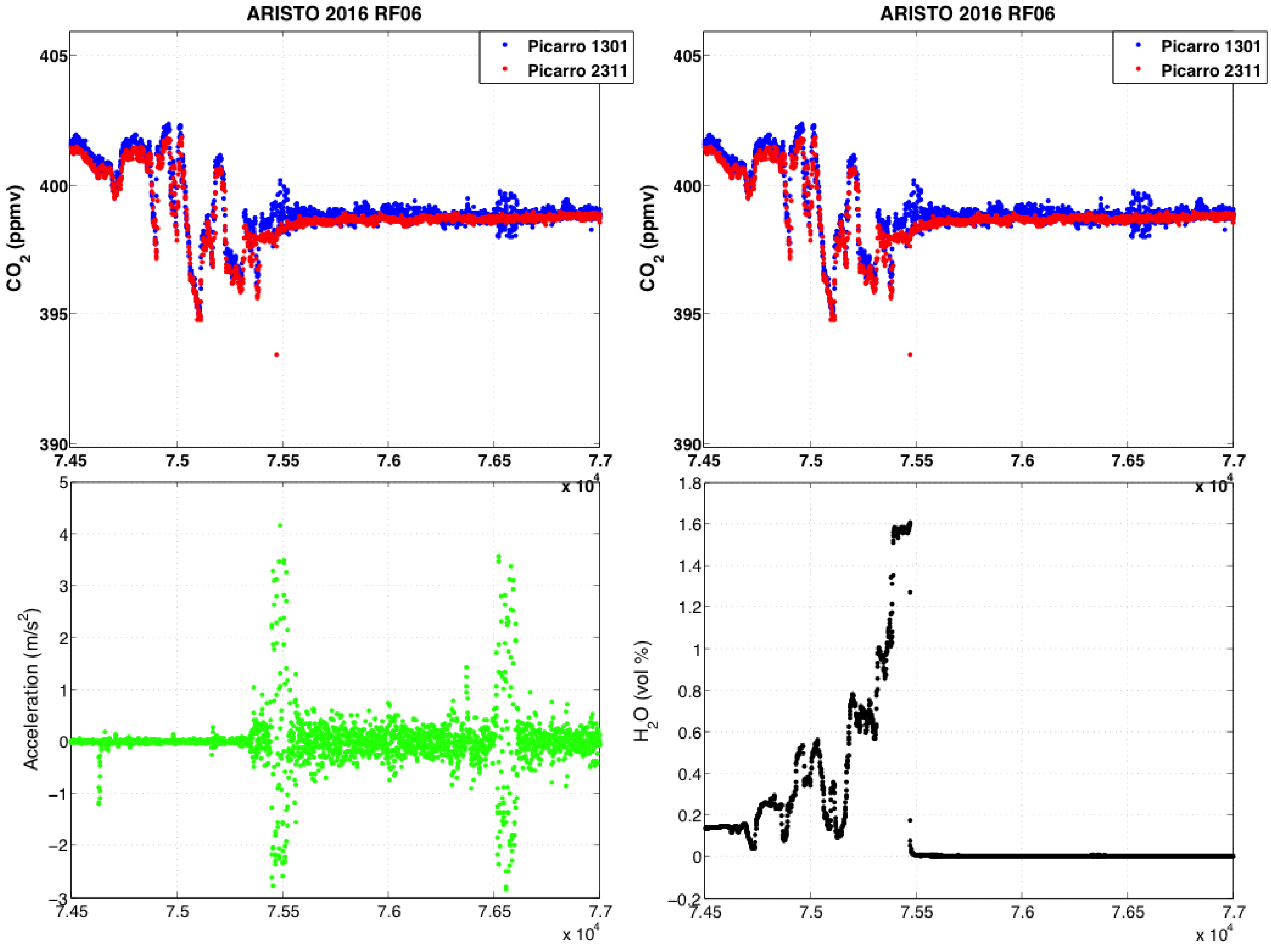
| Flight/Expt | Configuration | |
|---|---|---|
| ARISTO-16; clear sky | Water removed from both Pics; multiple cal checks | Air motion artifact quantified; drying time; confirm accurate dry mole fraction measurement |
| ARISTO-16; cloud sampling, MBL | Water removed from G1301 only (2-ch); multiple cal checks | Air motion artifact quantified; Cryotrap ahead of 1301 used to evaluate 2311 water correction algorithm |
| ARISTO-16; clear sky | No drying for either instrument; multiple cal checks | Infer upper limit of 1301 water correction algorithm uncertainty |
| CONTRAST and ARISTO-16 | 2311 water correction algorithm compared to updated 2016 correction algorithm measurements | Evaluate temporal stability of water correction algorithm (lab and flt) |



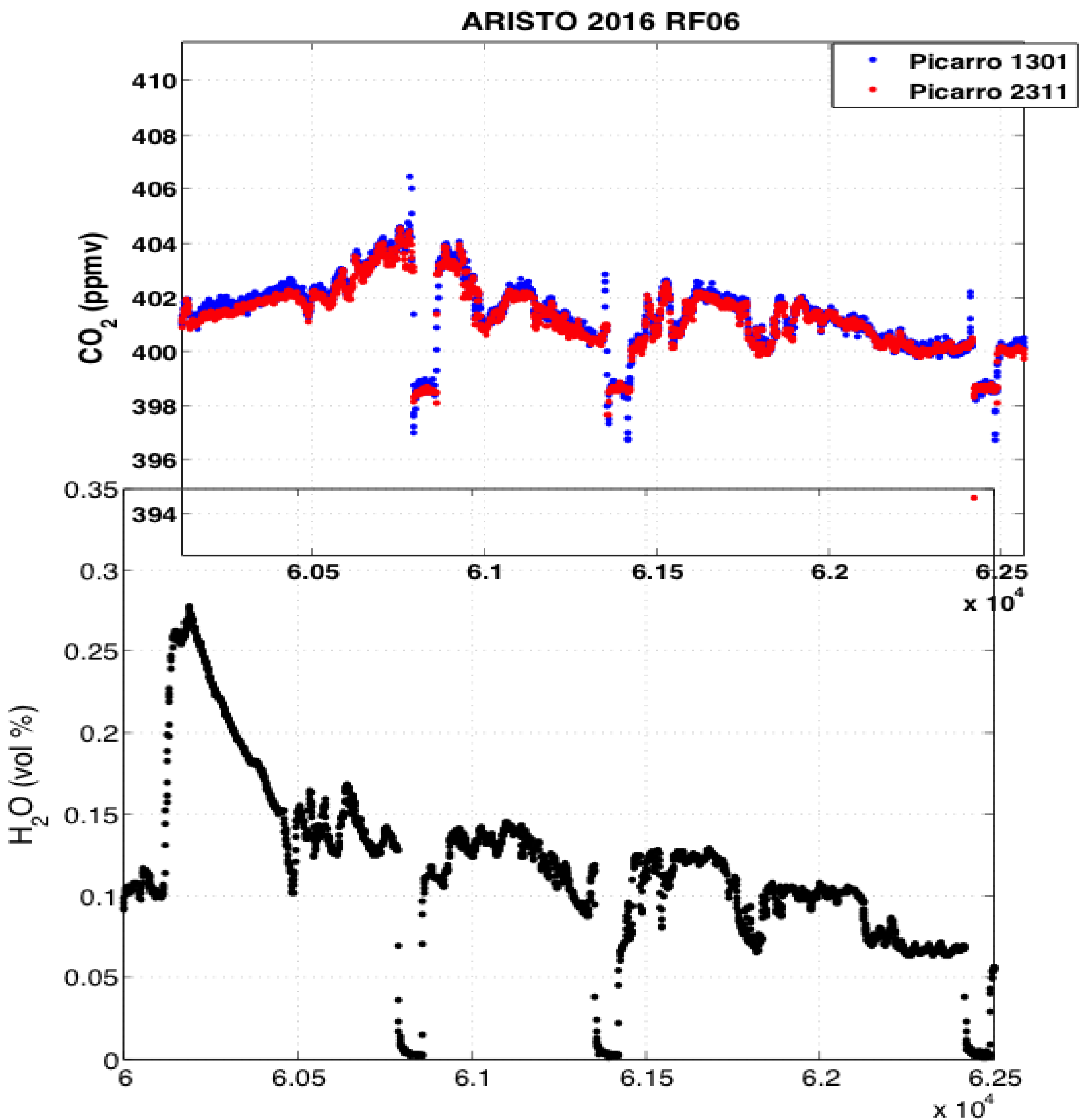
ARISTO 2016 RF03
Picarro 1301
Picarro 2311
Pitch
Mvrs
CO (ppmv)
440
435
430
425
420
415
410
405
400
395
390
INS Acceleration (m/s$^2$)
4
3
2
1
0
−1
−2
−3
−4
5.8
5.9
6
6.1
6.2
6.3
6.4
6.5
6.6
6.7
x 10$^4$



ARISTO 2016 RF03
Picarro 1301
Picarro 2311
CO (ppmv)
410
408
406
404
402
400
398
396
394
Pitch
Mvrs
5.8
5.9
6
6.1
6.2
6.3
6.4
6.5
6.6
6.7
x 10^4



ARISTO 2016 RF06
Picarro 1301
Picarro 2311
$CO_2$ (ppmv)
405
400
395
390
7.45
7.5
7.55
7.6
7.65
7.7
x 10^4
ARISTO 2016 RF06
Picarro 1301
Picarro 2311
$CO_2$ (ppmv)
Acceleration (m/s^2)
$H_2O$ (vol %)



ARISTO 2016 RF06
Picarro 1301
Picarro 2311
$CO_2$ (ppmv)
410
408
406
404
402
400
398
396
394
6.05
6.1
6.15
6.2
6.25
x 10^4
$H_2O$ (vol %)
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
6
6.05
6.1
6.15
6.2
6.25
x 10^4

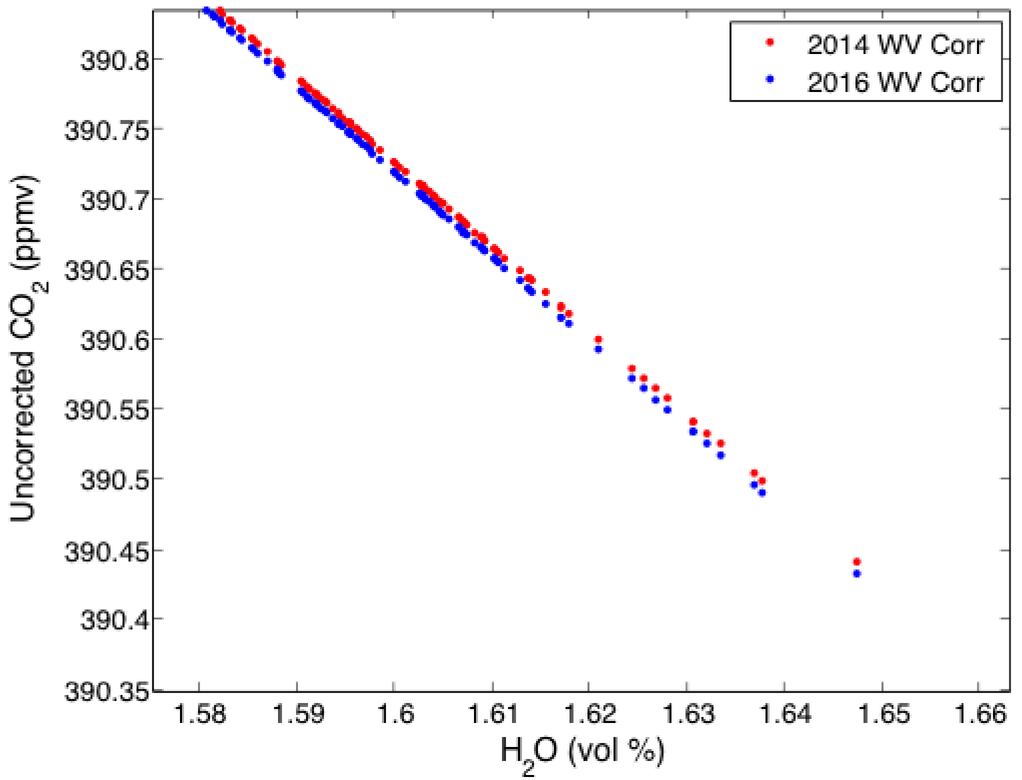
Temporal stability of model 2311 humidity correction factor empirically determined from calibration data:

| Correction Coeffs | CONTRAST | ARISTO-2016 |
|---|---|---|
| $a_o$ | -0.01392 | -0.0003521 |
| $a_1$ | -0.01388 | -0.0003874 |

$$CO2\ wet = CO2\ dry\ (1 + a_o H + a_1 H^2)$$

H = water vapor concentration (vol %)

# Water Correction Fit Consistency over 2 Years



## Preliminary conclusions:

We were successful at acquiring data to meet our objectives
The G1301 model suffers from significant air motion sensitivity, and the 2311 model seems immune.
The temporal stability of the model 2311 humidity correction factor is excellent; it has been essentially invariant over a 2 year span.

## Remaining Steps

Qualitatively constrain the added uncertainty due to the 1301 water correction algorithm. (First look plots of RF04)

Quantify the RMS added uncertainty due to WV correction for both 2311 and 1301 Picarro instruments.

Quantify the added uncertainty due to vertical acceleration, especially for the 1301.
Evaluate the suitability of the 2311 for vertical flux measurements by eddy correlation method.

Quantify the temporal stability of the 1301 Picarro humidity correction factor (NOMADSS 2013 and ARISTO-2016).

Evaluate the time response of each using spectral analysis of ambient sampling in the boundary layer. Compare