Correction of topography related biases in XCO2 measurements from OCO-2

14th International Workshop on Greenhouse Gas Measurements from Space

Toronto, Canada, May 8-10, 2018

**Matthäus Kiel[1], Brendan Fisher[3], and Paul O. Wennberg[1,2]**

1: Division of Geological and Planetary Sciences, California Institute of Technology, Pasadena, CA, USA
2: Division of Engineering and Applied Science, California Institute of Technology, Pasadena, CA, USA
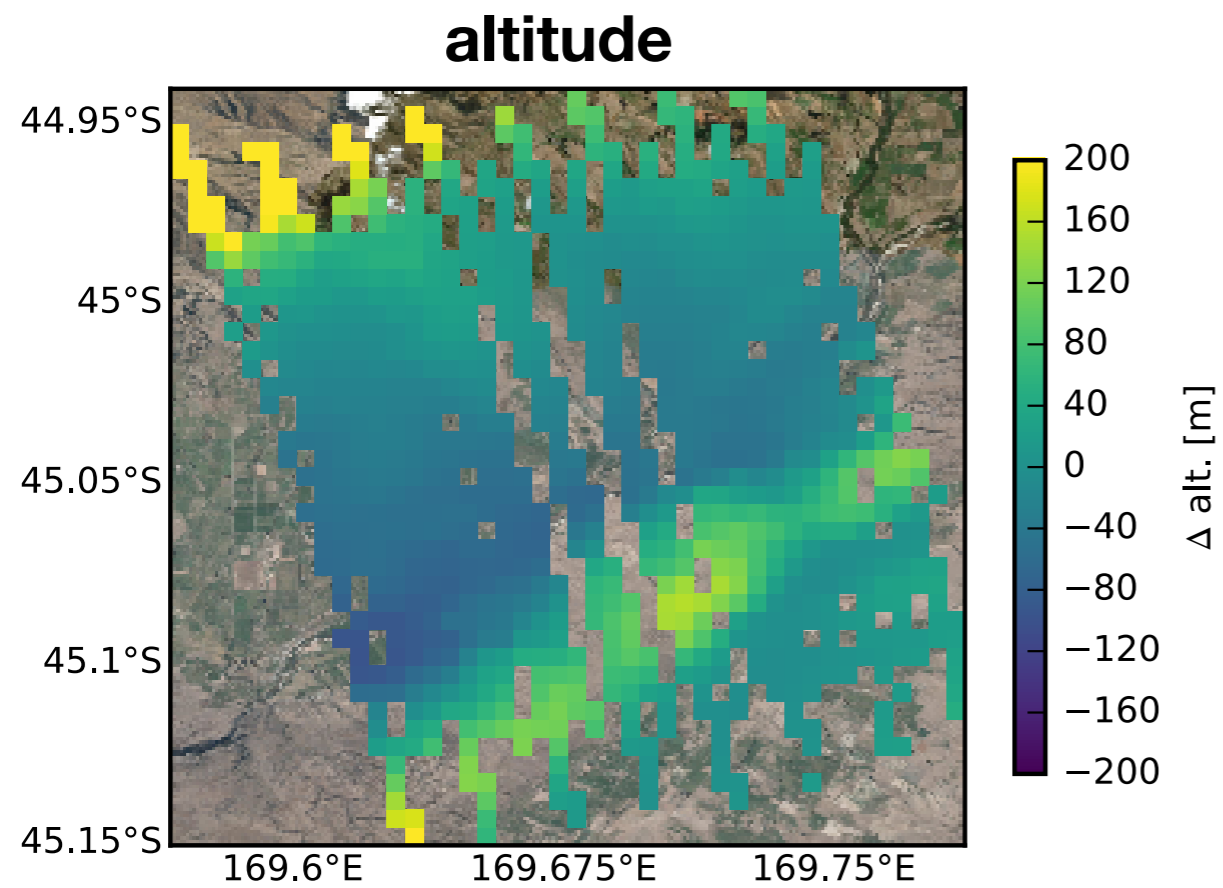3: Jet Propulsion Laboratory, California Institute of Technology, Pasadena, CA, USA

Topography related bias
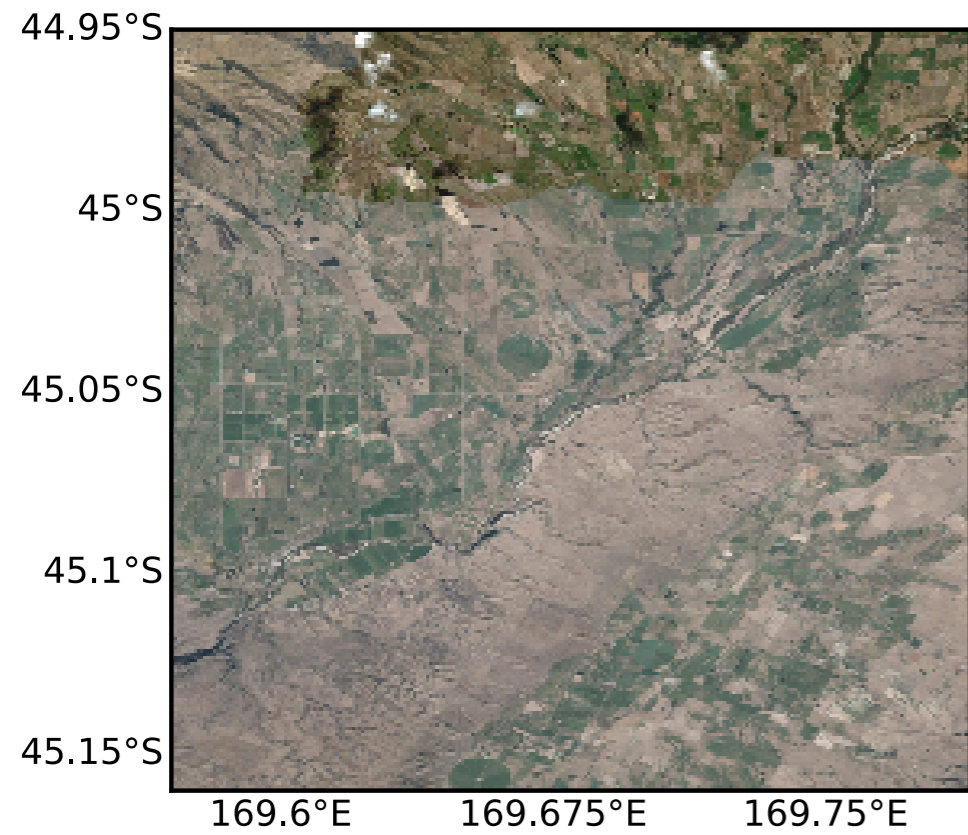
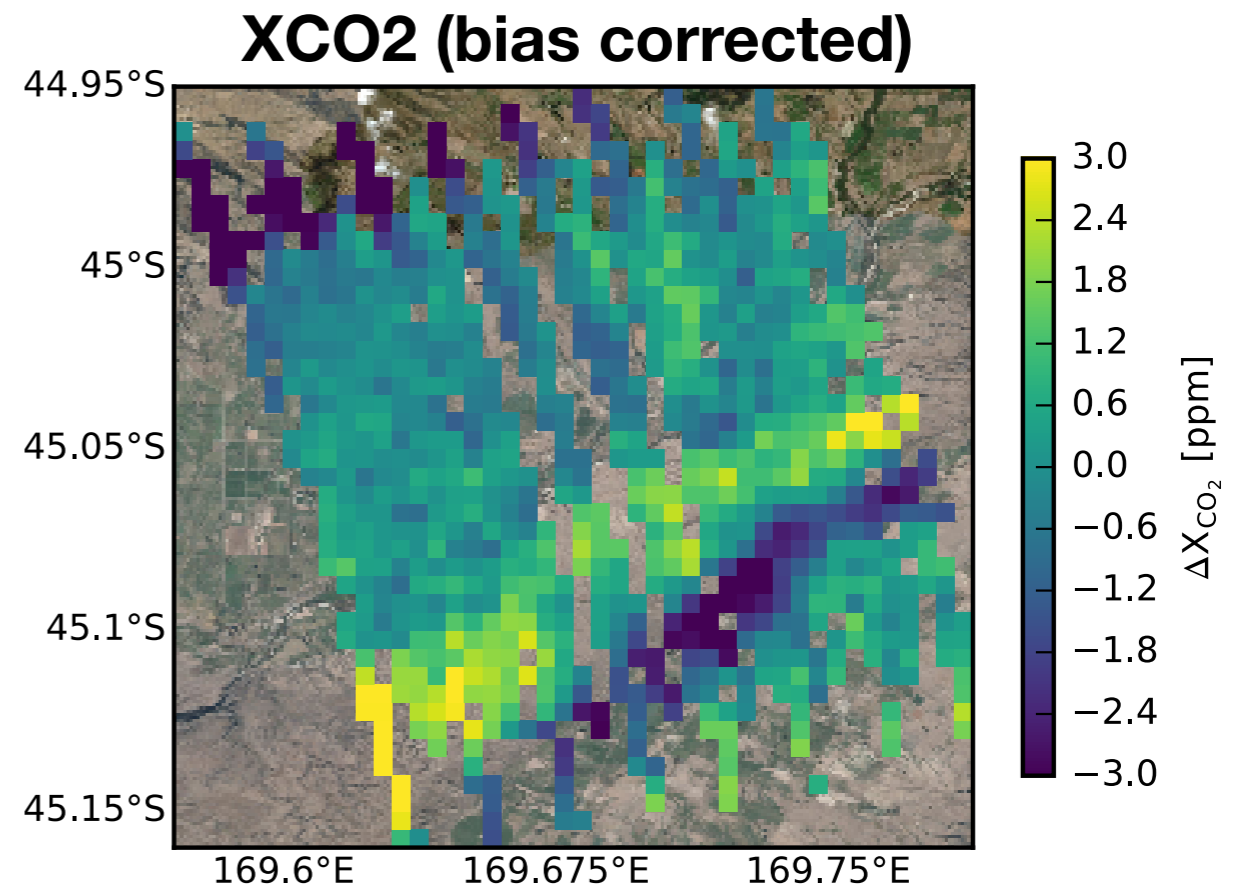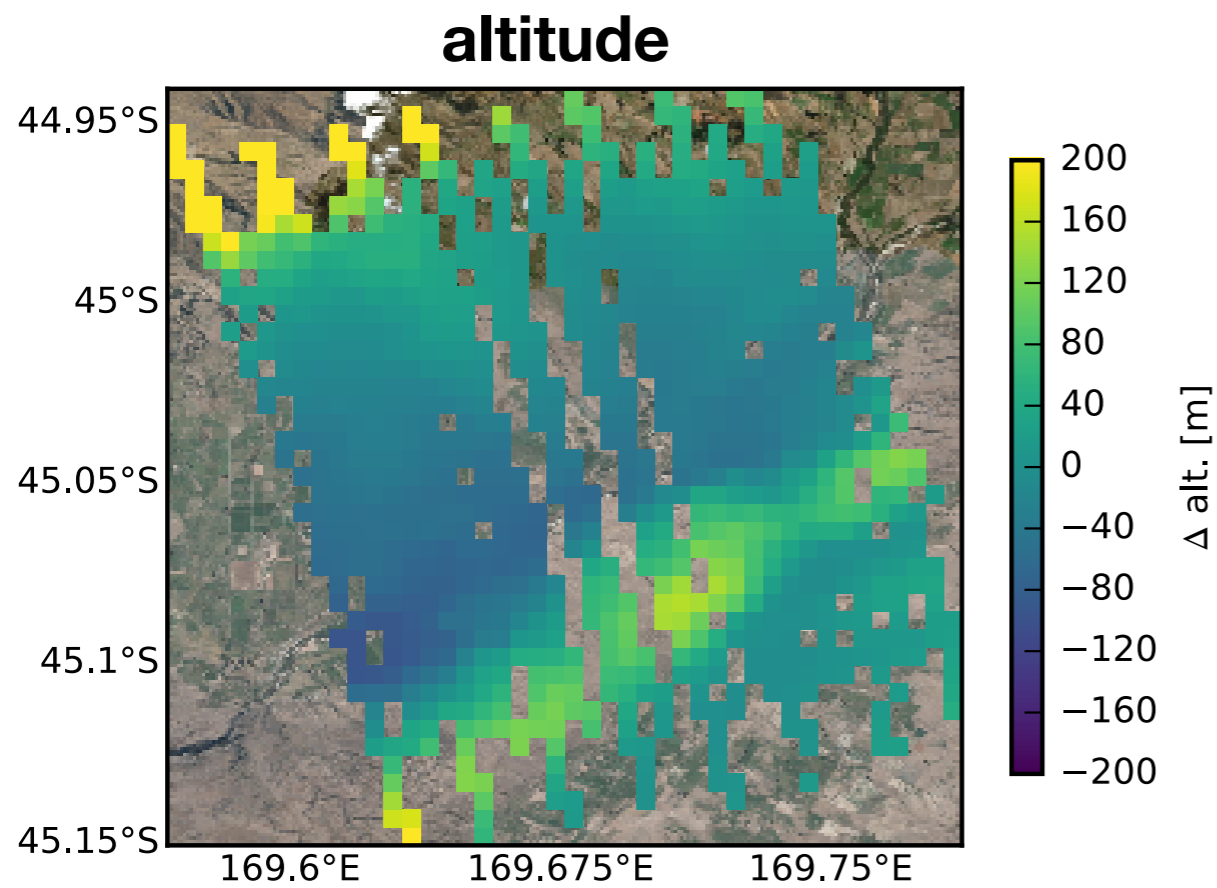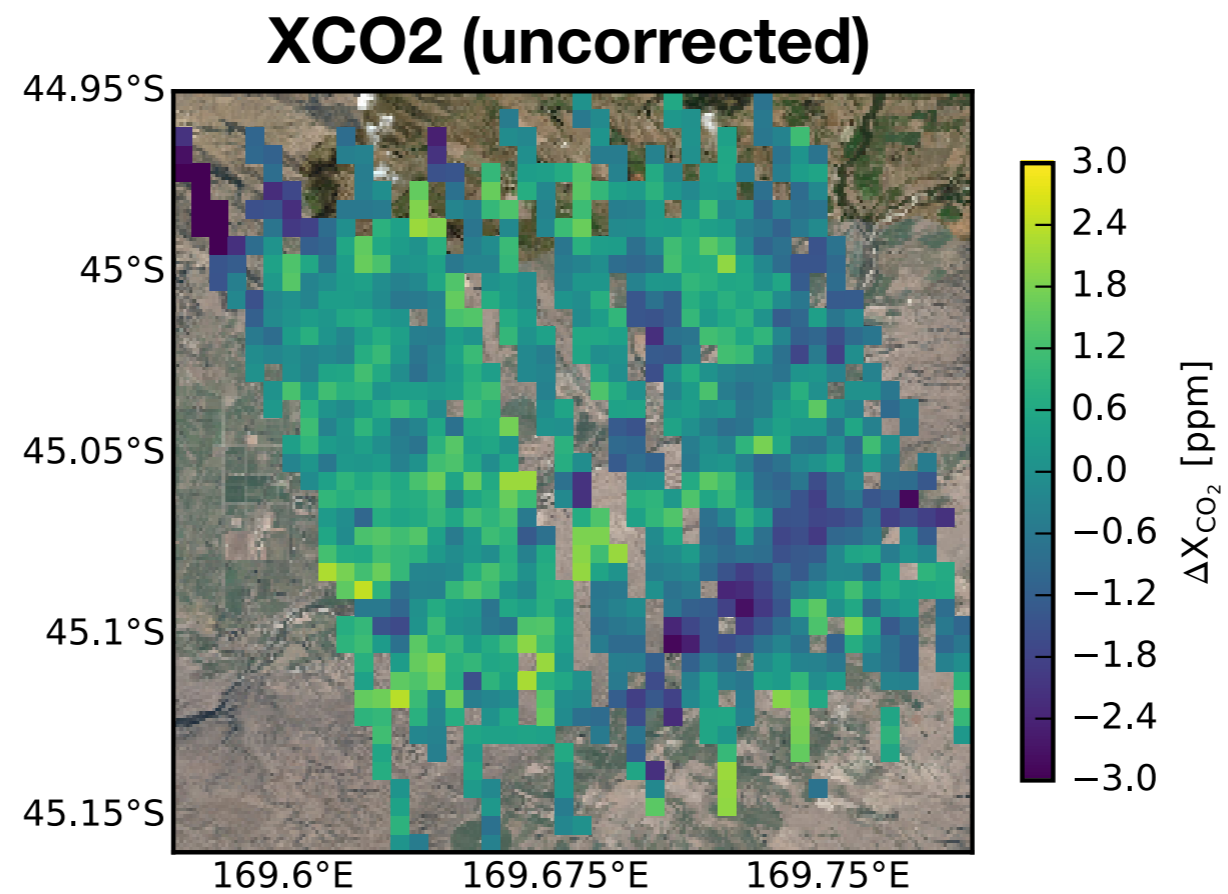## OCO-2 target mode observation at Lauder (New Zealand)

Topography related bias

OCO-2 target mode observation at Lauder (New Zealand)

Topography related bias
OCO-2 target mode observation at Lauder (New Zealand)

altitude

XCO2 (bias corrected)

Topography related bias

OCO-2 target mode observation at Lauder (New Zealand)

XCO2 (uncorrected)

V8 Bias Correction (target mode)

$$XCO_{2_{BC}} = XCO_{2_{raw}} + 0.36 \cdot dP + 0.029 \cdot (co2\_grad\_del - 15.0) + 8.5 \cdot DWS$$

$$dP : p_{surf} - p_{surf,apriori}$$

$$DWS : AOD_{dust} + AOD_{water} + AOD_{salt}$$

$co2\_grad\_del$: Change between retrieved and prior profile of the CO_2 dry air mole fraction difference from the surface minus that at level 13.
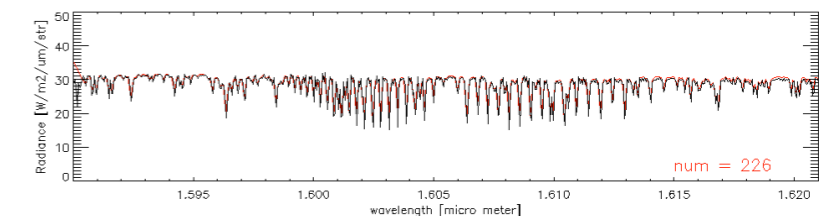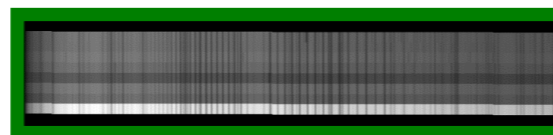
V8 Bias Correction (target mode)

$$XCO_{2_{BC}} = XCO_{2_{raw}} + 0.36 \cdot dP + 0.029 \cdot (co2\_grad\_del - 15.0) + 8.5 \cdot DWS$$

$$dP : p_{surf} - p_{surf,apriori}$$

$$DWS : AOD_{dust} + AOD_{water} + AOD_{salt}$$

$co2\_grad\_del$: Change between retrieved and prior profile of the CO_2 dry air mole fraction difference from the surface minus that at level 13.
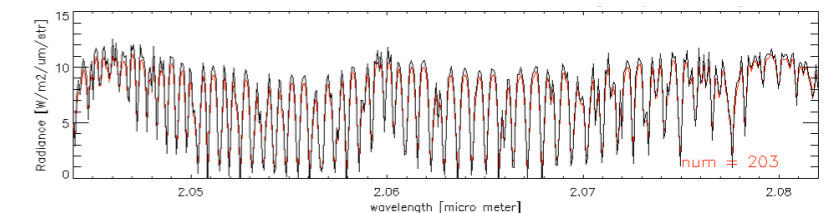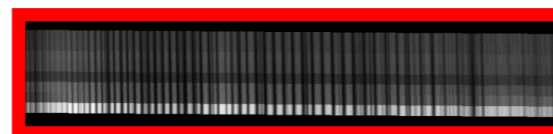
OCO-2 - three different spectrometer
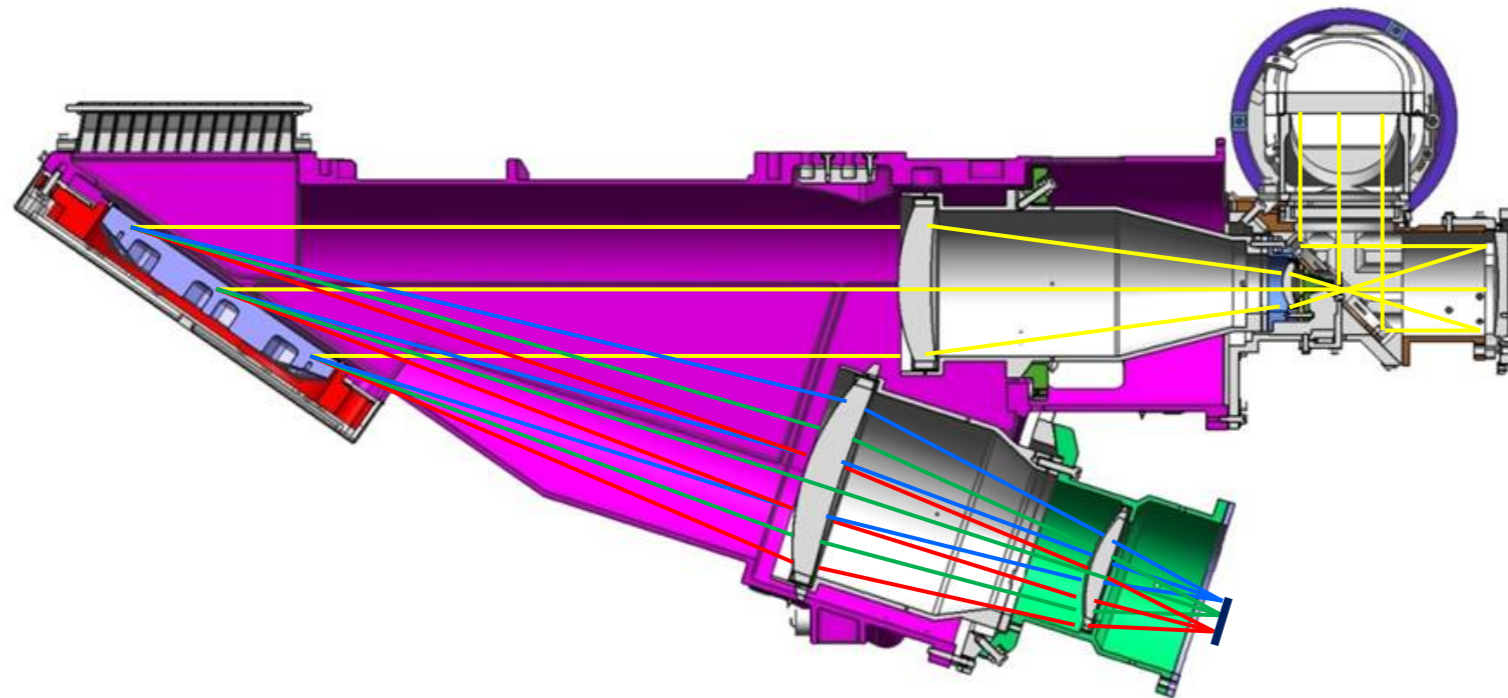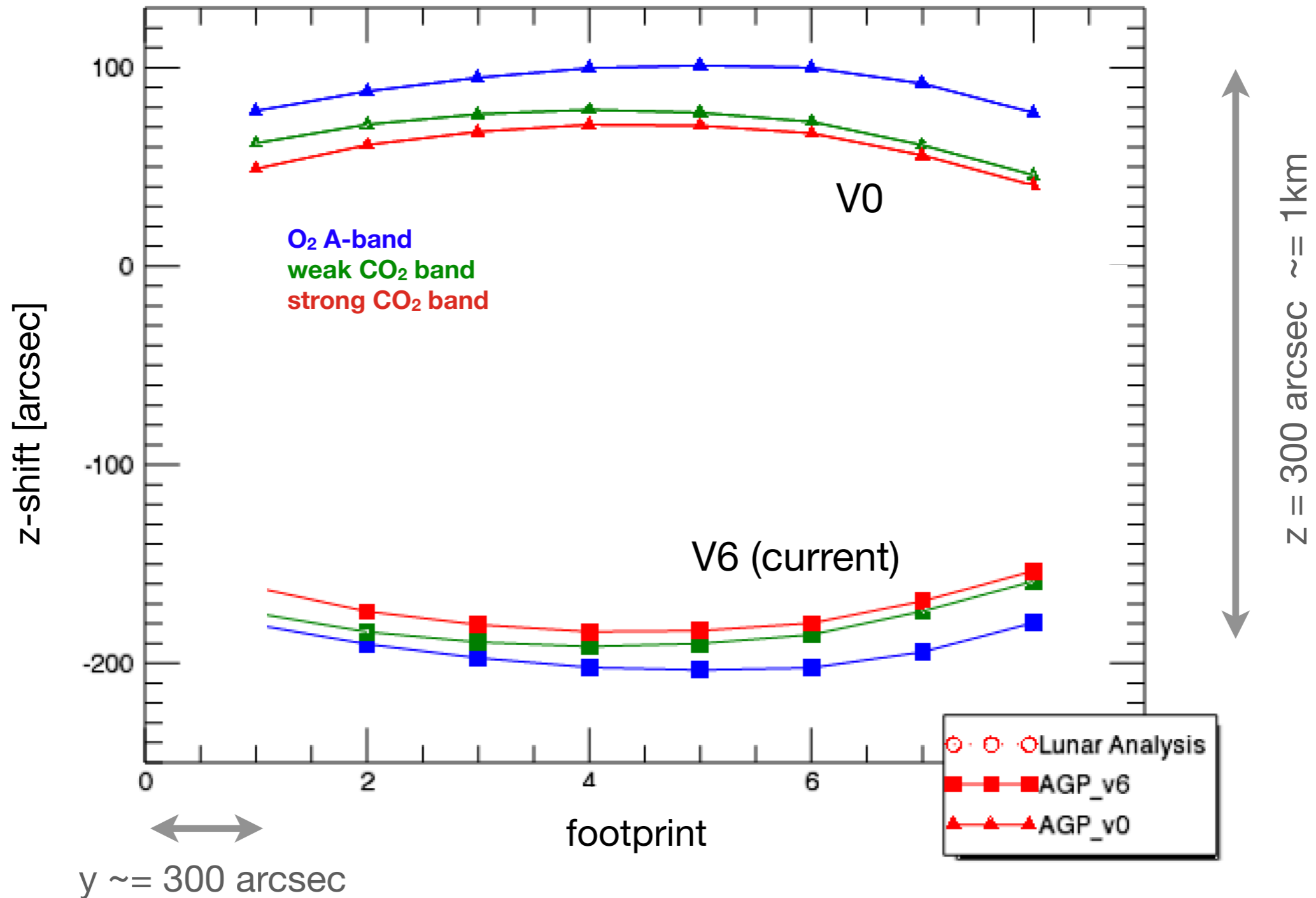

- O$_2$ A-Band (0.765 μm)
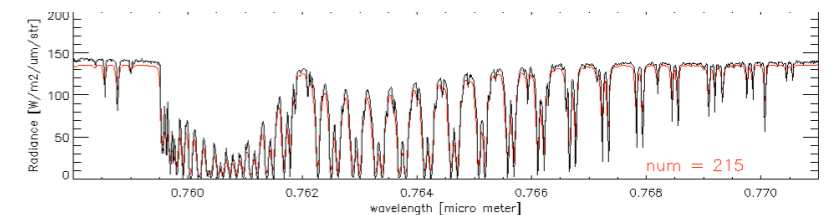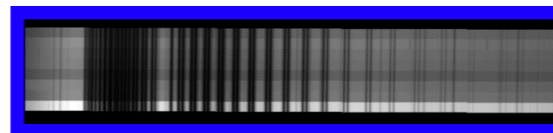
- weak CO$_2$ (1.61μm)

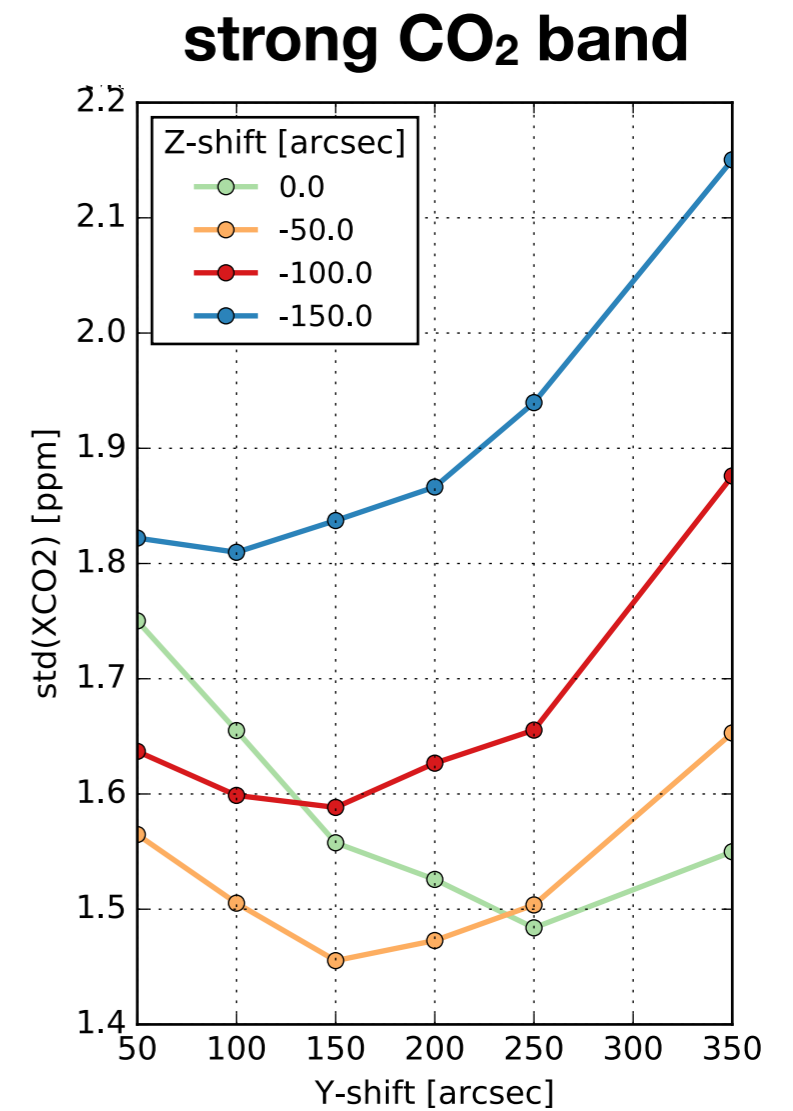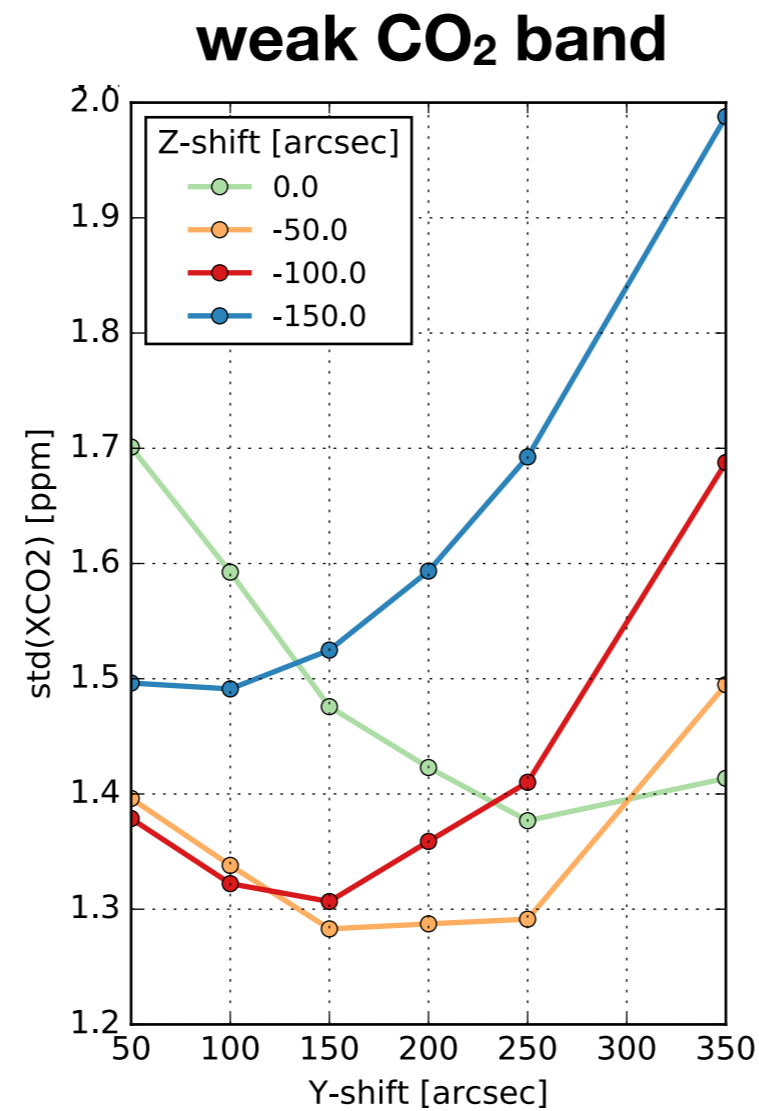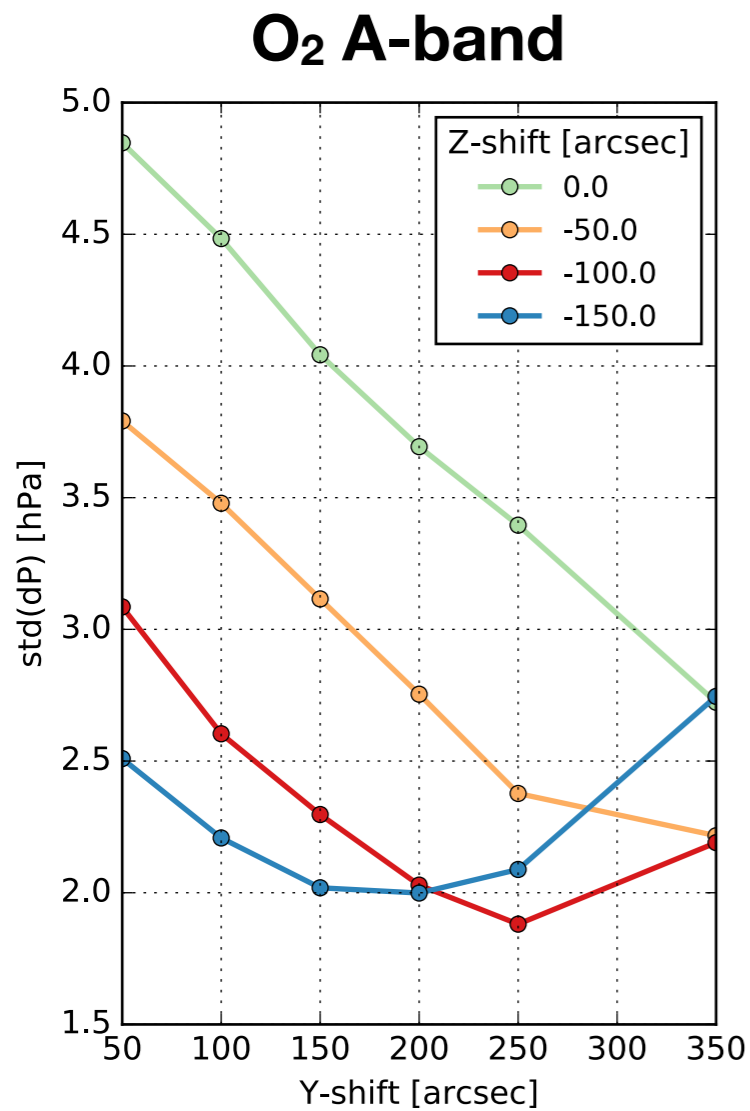- strong CO$_2$ (2.06 μm)

Pointing

- The Y-axis is the footprint axis and the Z axis is the other axis, nominally along the spacecraft path
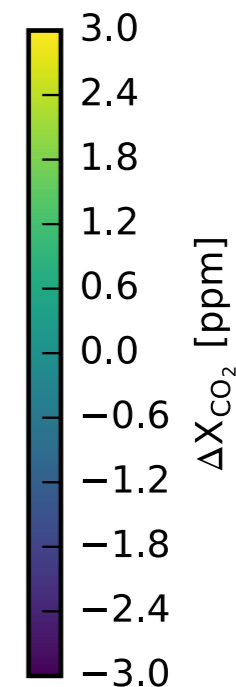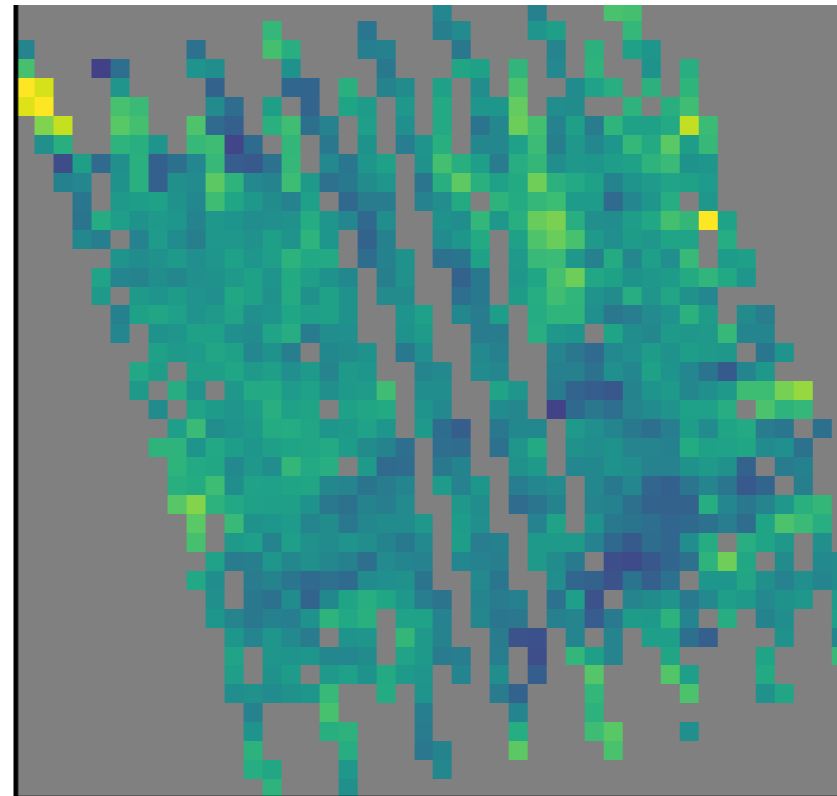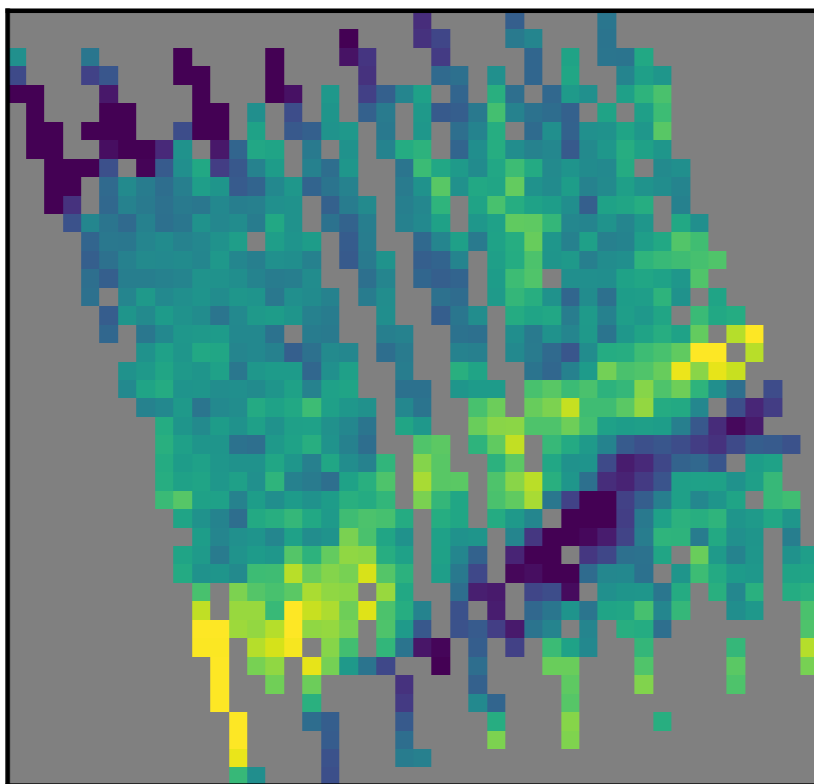
Pre-processor single band retrievals

XCO2 - pointing shifted

V8 operational

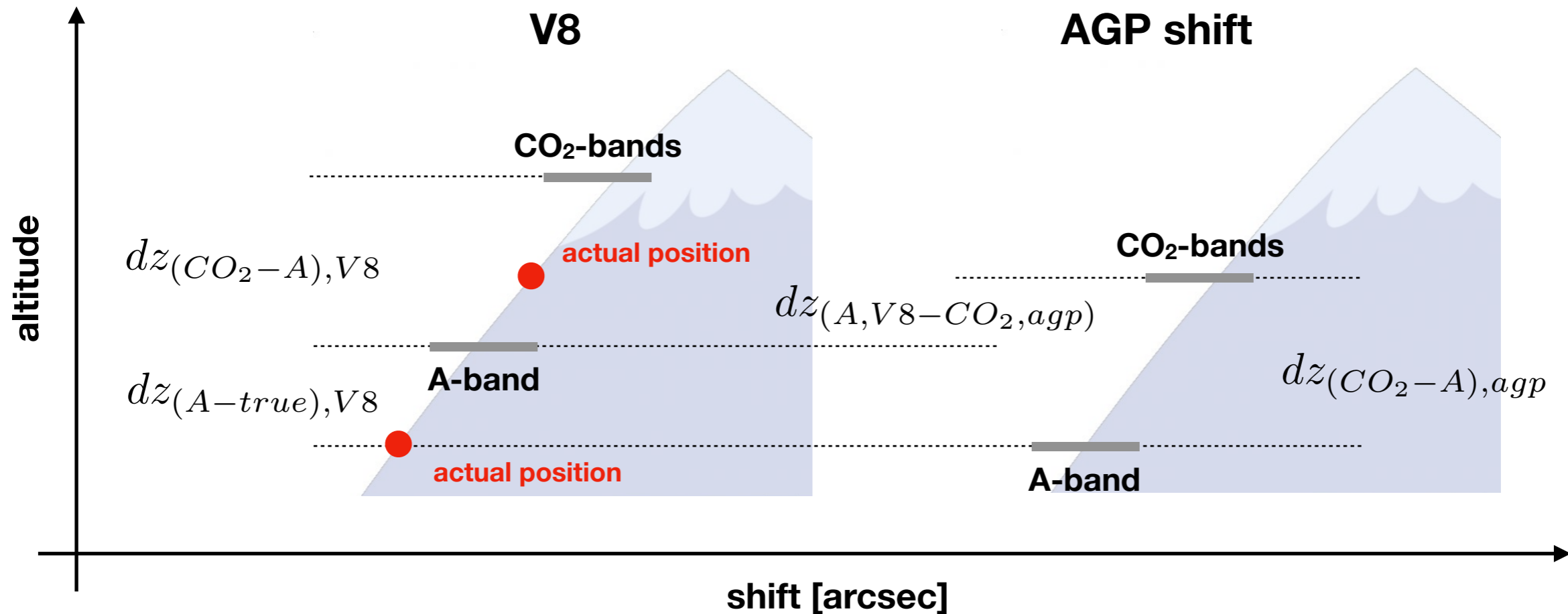AGP@min[std(XCO2)]

Z=-202.1 arcsec, Y=222.4 arcsec

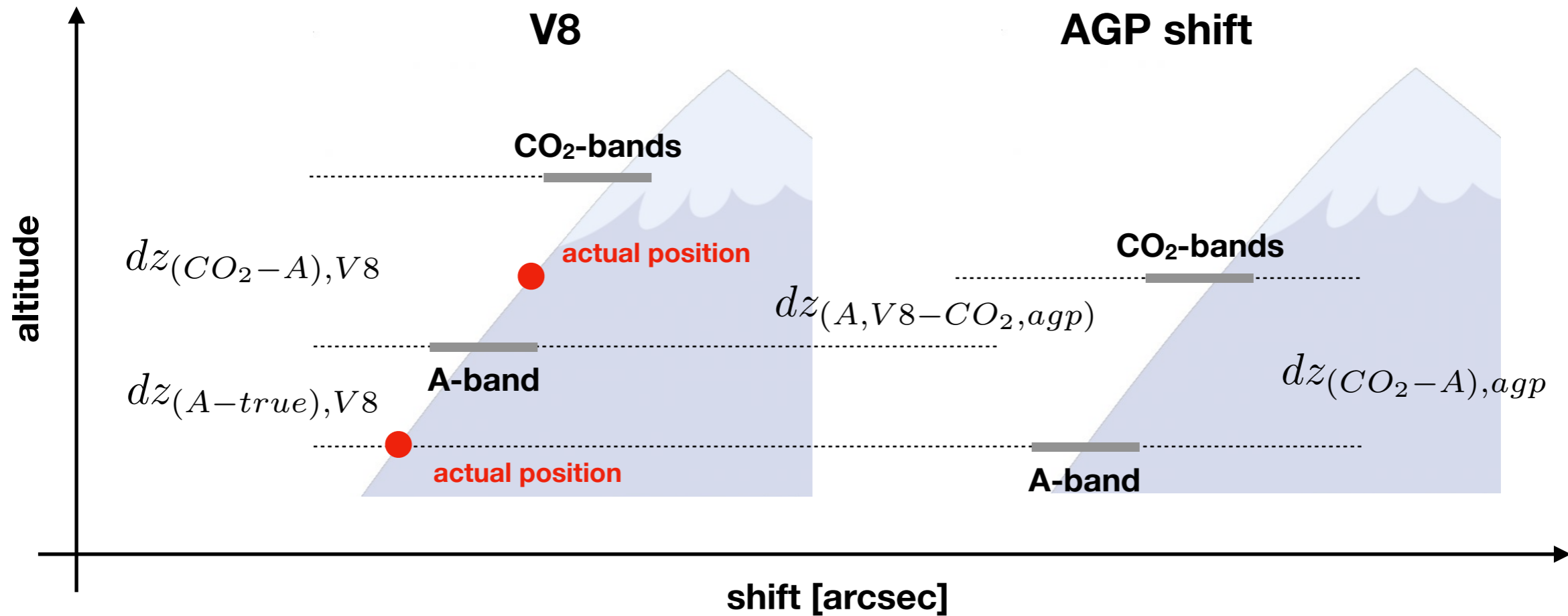**Z=-50.0 arcsec, Y=200.0 arcsec**

std: 1.59 ppm

std: 0.68 ppm

Pointing offset post correction

$$dP = \underbrace{\left(P_{r,V8} - P_{prior_{std(dP)_{min,agp}}} \right)}_{\text{general pointing offset}} + \underbrace{\left(P_{prior_{std(dP)_{min,agp}}} - P_{prior_{std(XCO_2)_{min,agp}}} \right)}_{\text{band mismatch}}$$
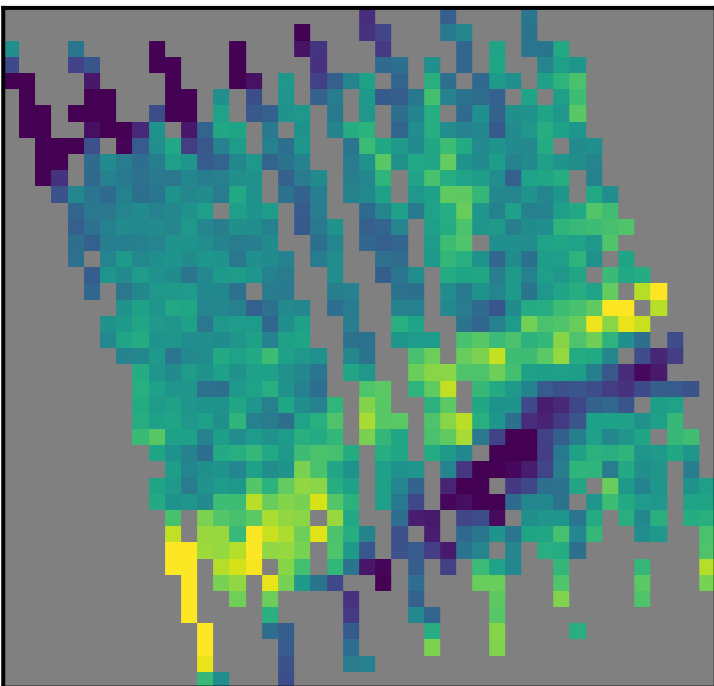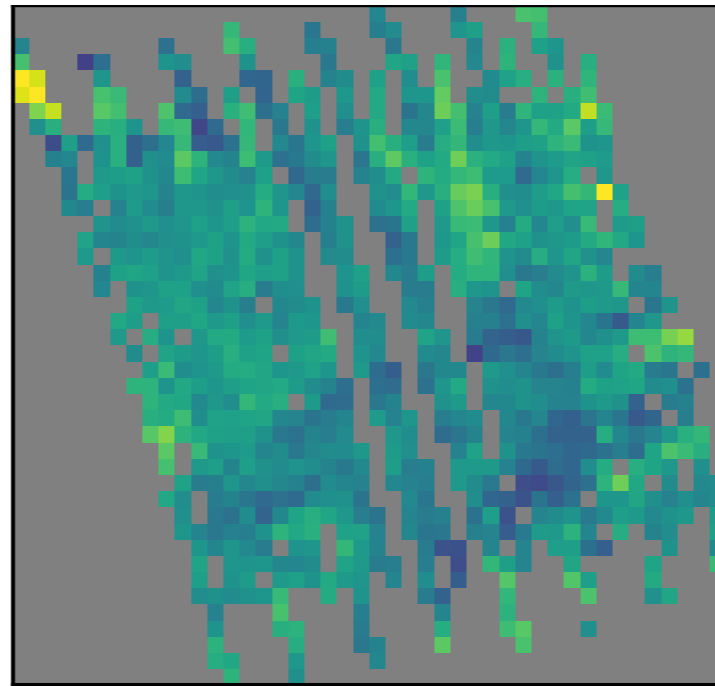
Pointing offset post correction

Pointing offset post correction

V8 operational

Z=-202.1 arcsec, Y=222.4 arcsec

std: 1.59 ppm

AGP@min[std(XCO2)]

Z=-50.0 arcsec, Y=200.0 arcsec

std: 0.68 ppm

post corrected
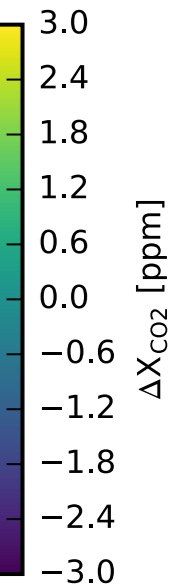
Z=-202.1 arcsec, Y=222.4 arcsec

std: 0.67 ppm

ΔX_{CO2} [ppm]

Death Valley - Nadir/Glint mode

V8 operational
Z=-202.1 arcsec, Y=222.4 arcsec
std: 2.56 ppm

AGP@min[std(XCO2)]
Z=-150.0 arcsec, Y=200.0 arcsec
std: 1.25 ppm

post correction
Z=-202.1 arcsec, Y=222.4 arcsec
std: 1.17 ppm
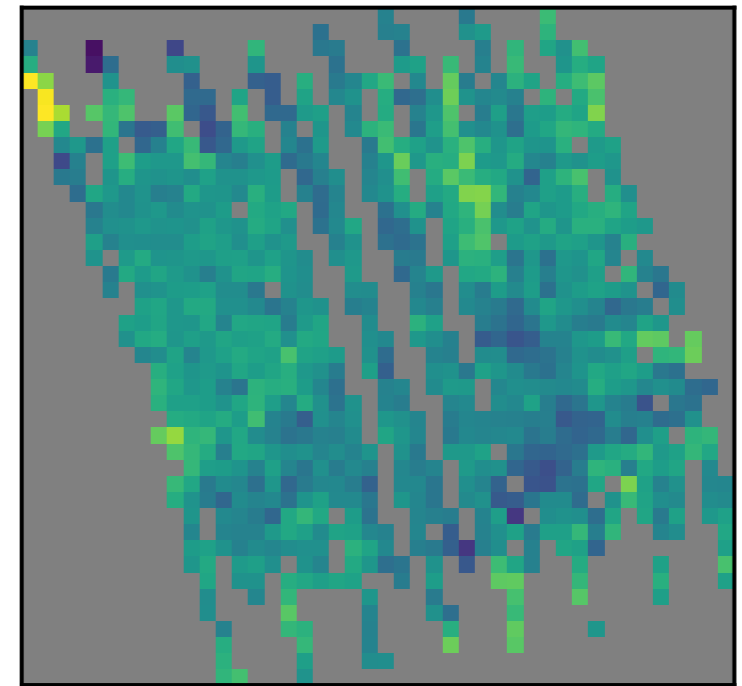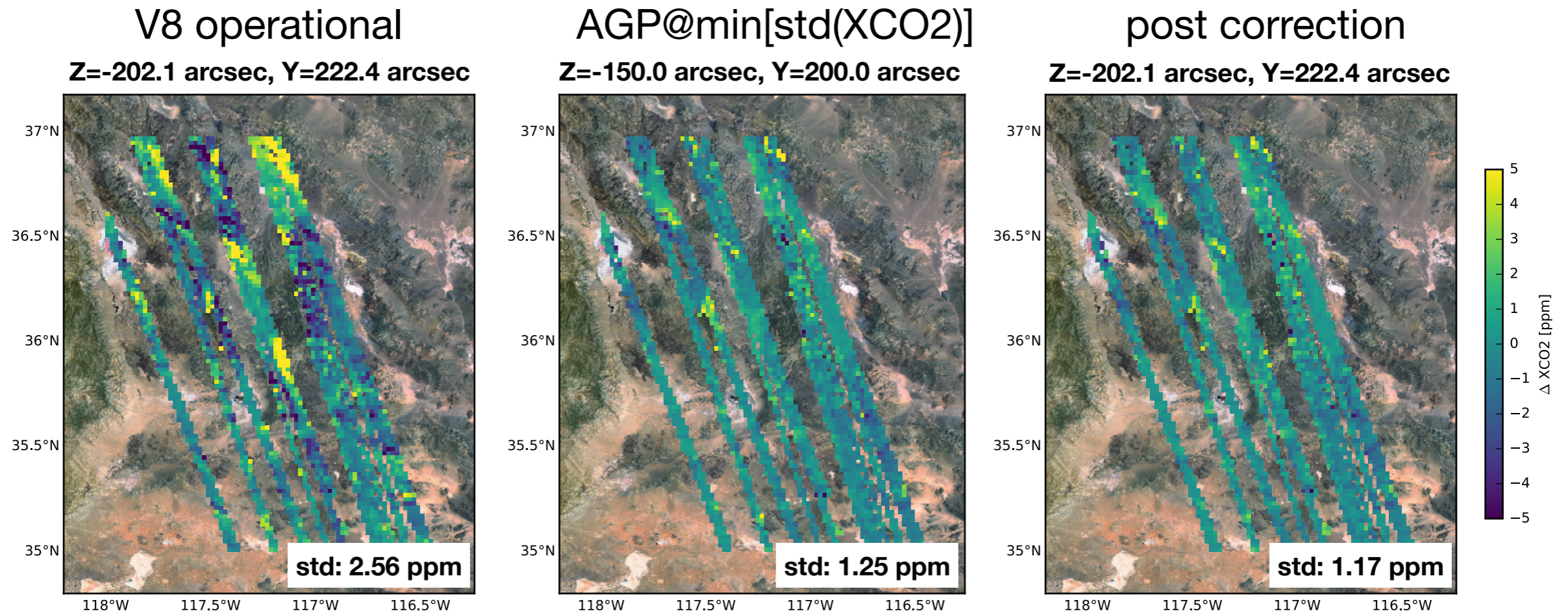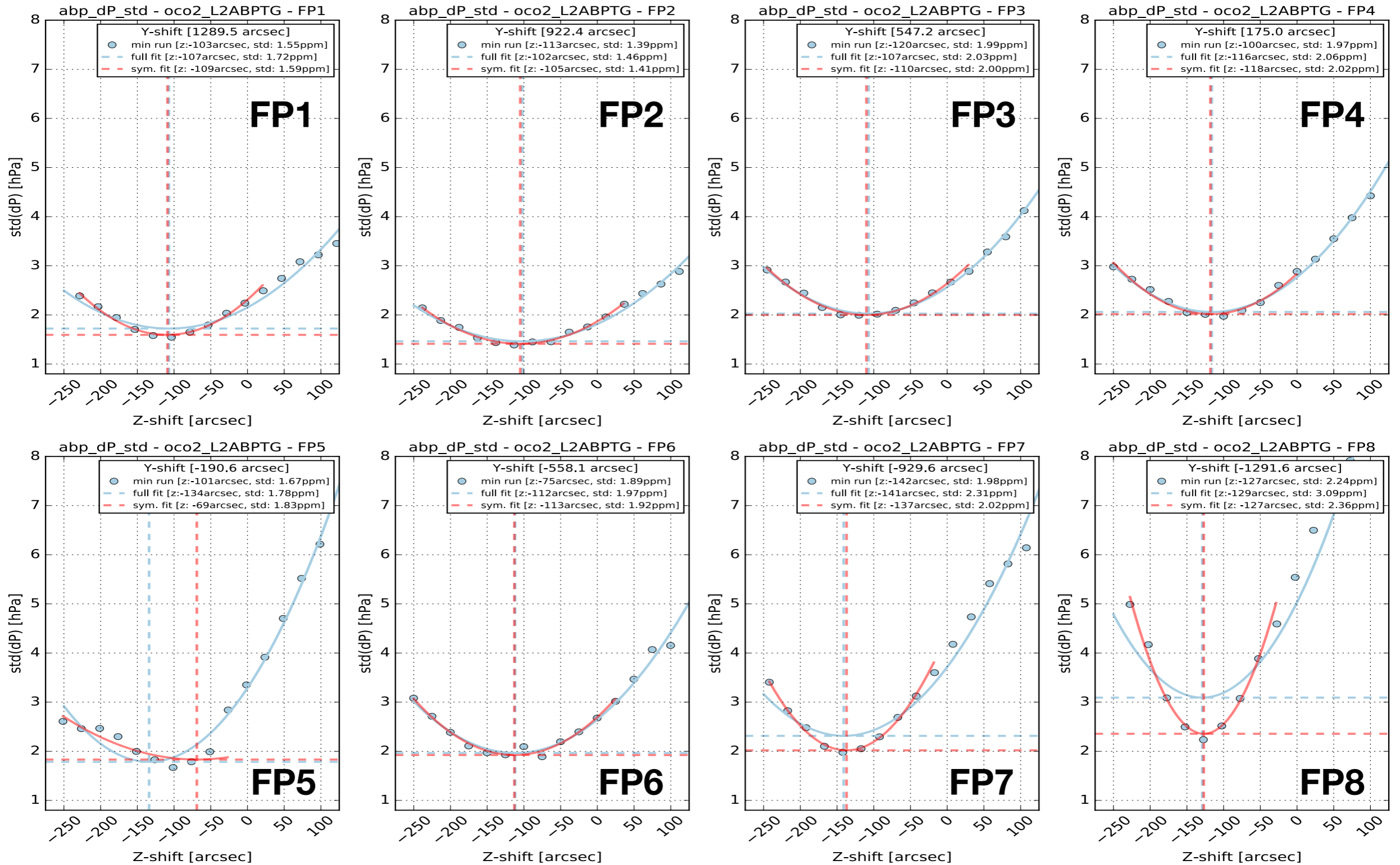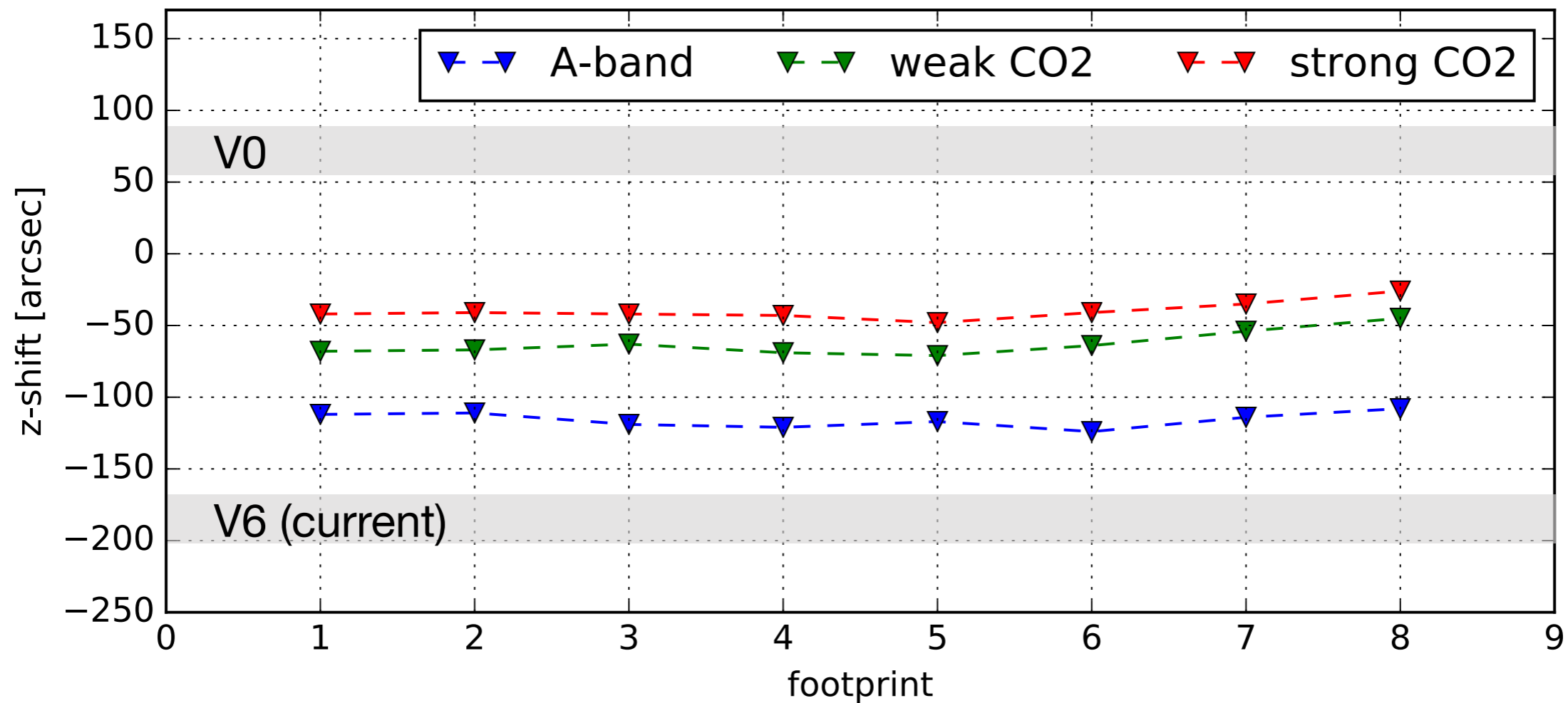
Refined pointing offset tests
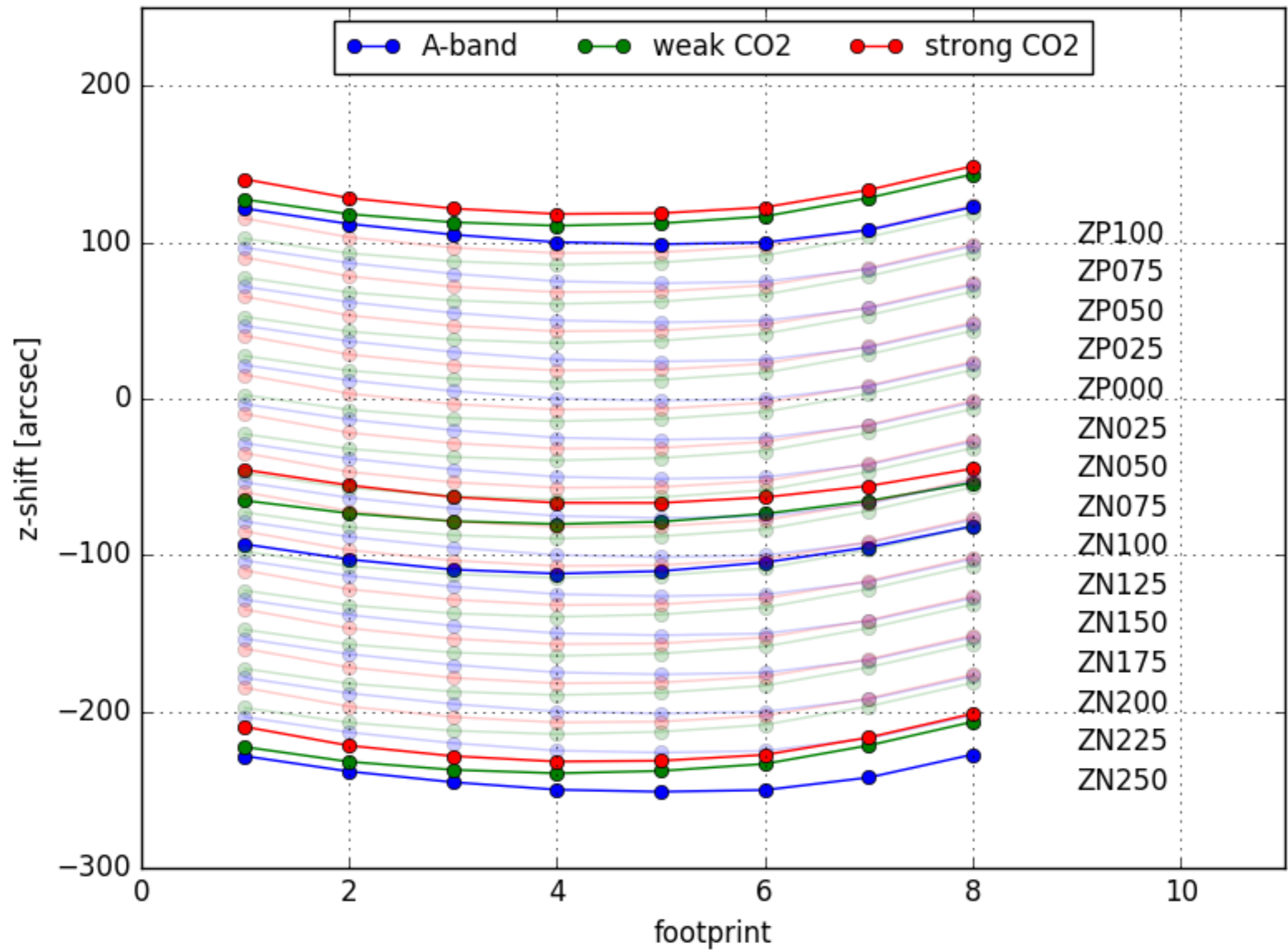
Single footprint analysis

Preliminary pointing results

Conclusion and Outlook

- Topographic influence on XCO_2 is primarily a reflection of the assumption that we know the surface pressure. It appears that the retrieval algorithm is working well and is not very sensitive to prior pressure.

- Of secondary importance, misalignment of the slits (A-band vs CO_2 bands) introduces an error that depends on the elevation *difference* between where these spectrometers are looking.

- We can substantially reduce the XCO_2 bias that results from both the error in knowledge of the pointing of the observatory and due to the slit alignment error by simply resampling the DEM (w/o rerunning L2). We are currently refining our estimates of these offsets.

- Pointing correction will be included in next data version.

Thank you!

Pre-processor single band retrievals
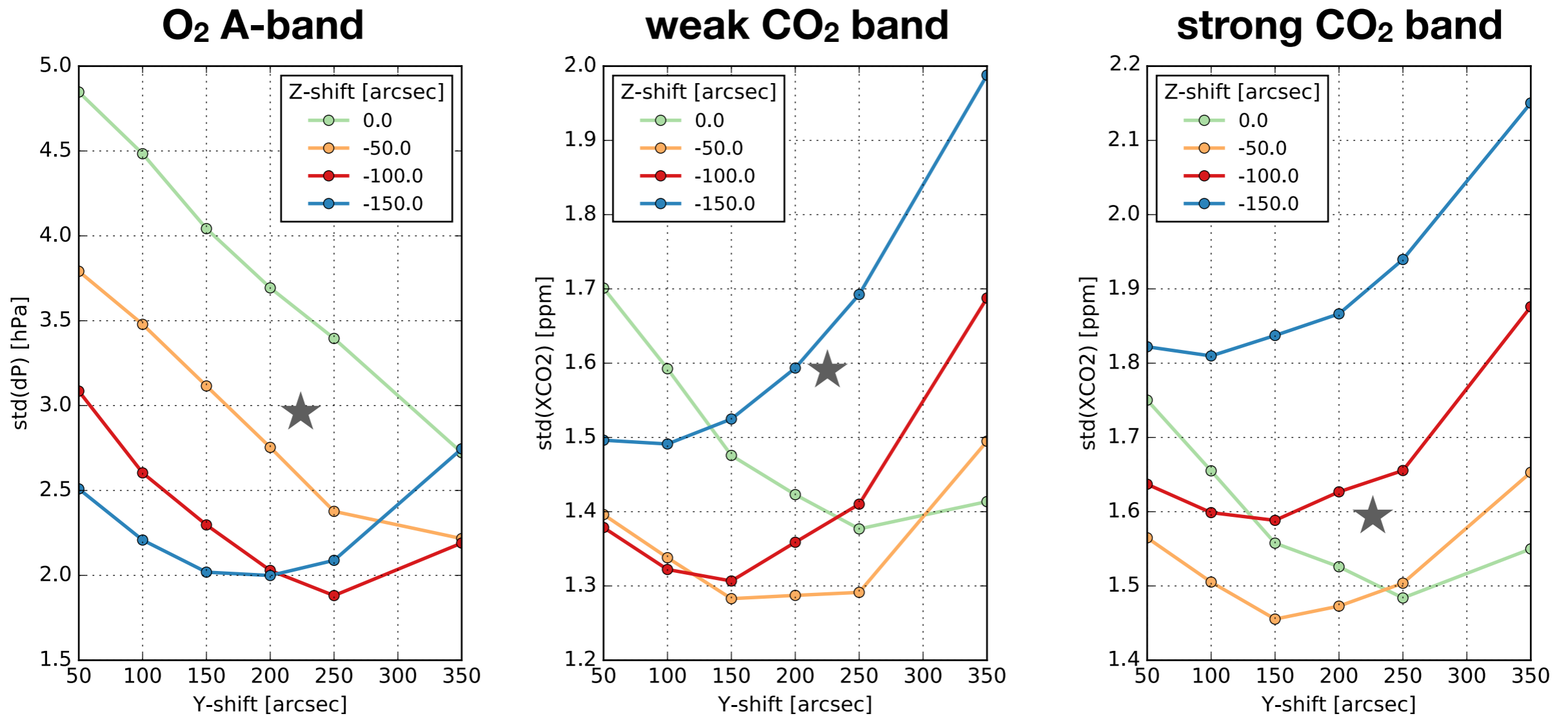
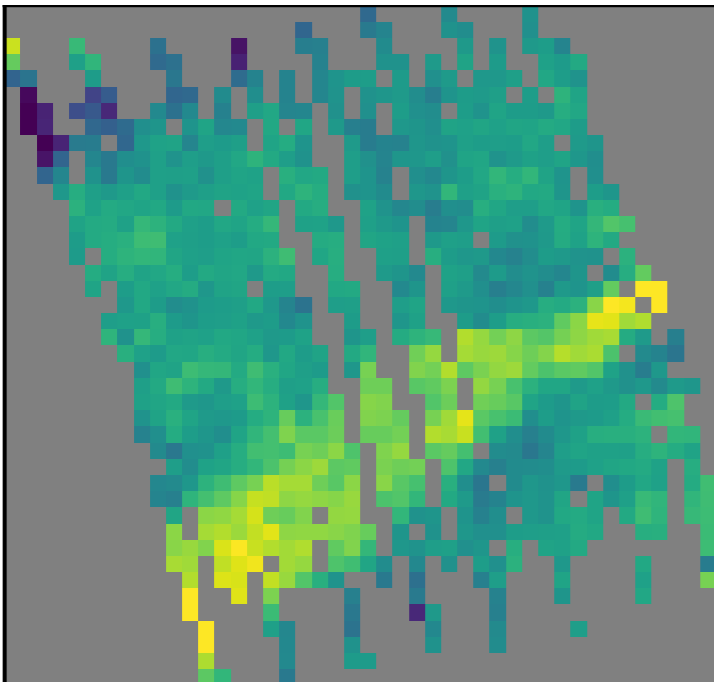$\bigstar$: V8 operational (z = -202 arcsec, y = 222 arcsec)
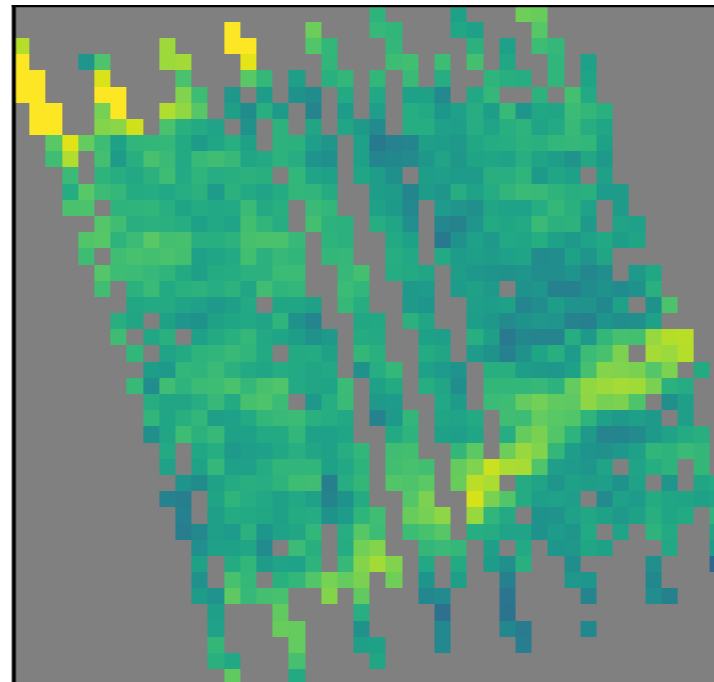
dP - pointing shifted

V8 operational

Z=-202.1 arcsec, Y=222.4 arcsec

std: 2.94 hPa

AGP@min[std(XCO2)]

Z=-50.0 arcsec, Y=200.0 arcsec

std: 2.68 hPa

AGP@min[std(dP)]

Z=-100.0 arcsec, Y=250.0 arcsec

std: 1.98 hPa

dP [hPa]

XCO2 - pointing shifted
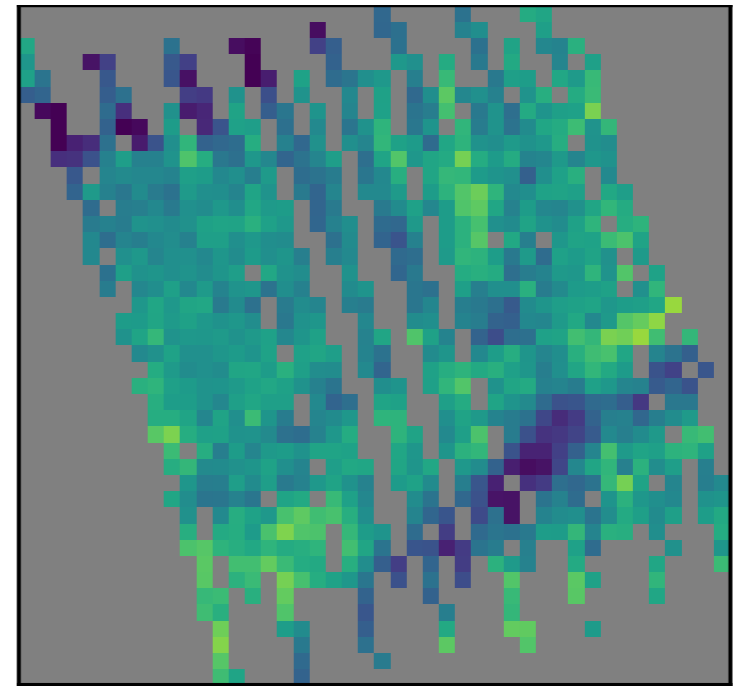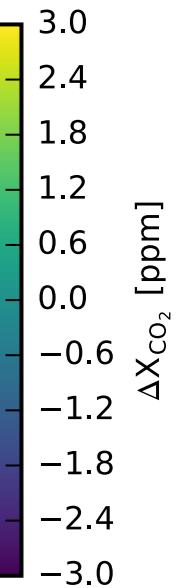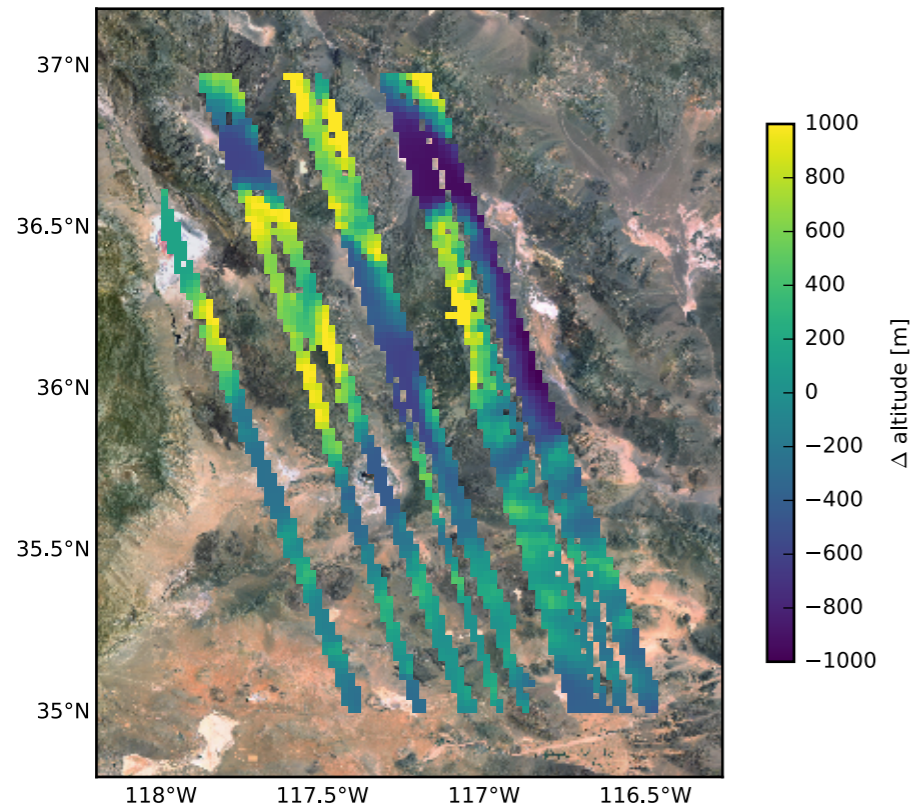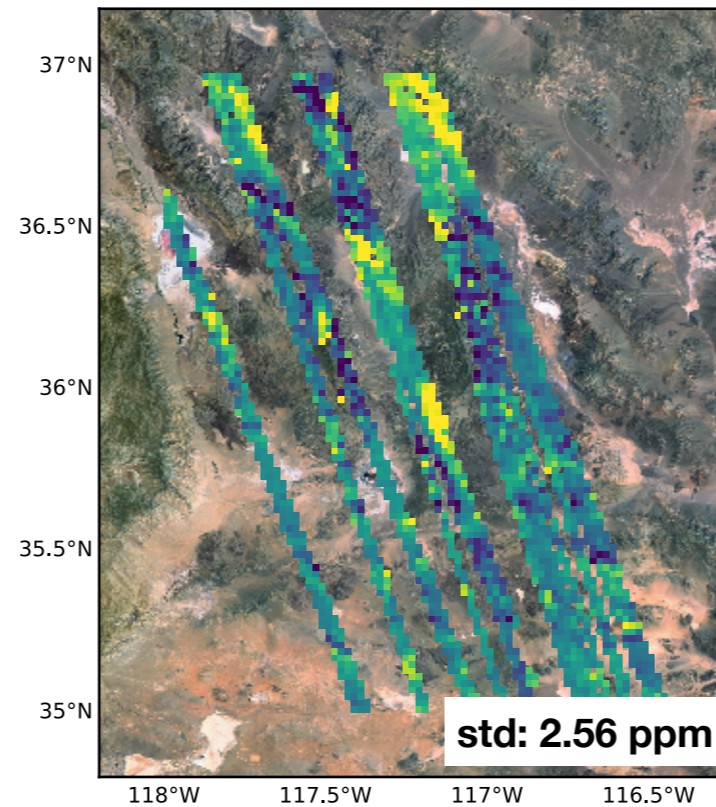
Death Valley - Nadir/Glint mode

Δ altitude

Z=-202.1 arcsec, Y=222.4 arcsec

V8 Ops

Z=-202.1 arcsec, Y=222.4 arcsec

std: 2.56 ppm

AGP@min[std(XCO2)]

Z=-150.0 arcsec, Y=200.0 arcsec

std: 1.25 ppm

Δ XCO2

Δ XCO2