AIRS and CrIS sampling comparisons

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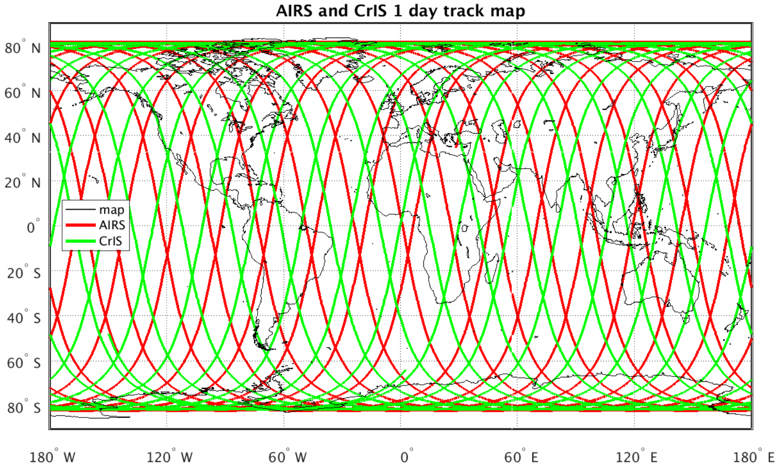
introduction

- we compare AIRS and CrIS sampling and PDFs,
- look at orbital parameters including secants of zenith angles, describe our test data, define equal area bands and bins and our latitude weighted subsetting,
- do AIRS and CrIS sampling comparisons, show some long-span AIRS and CrIS PDFs, and
- look at sampling variation for CrIS FOVs 1 and 9.

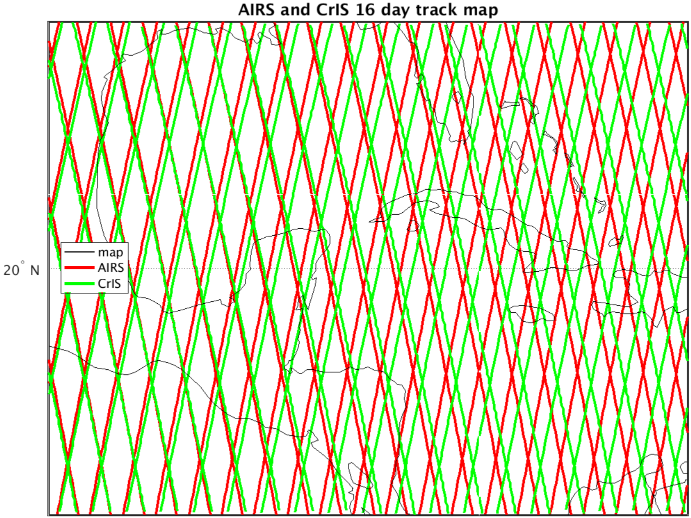
orbital parameters

- we want to compare AIRS and CrIS obs coverage. Both are in sun-synchronous polar orbits
- the CrIS orbital period is 101.5 minutes ± 0.2 seconds, giving 227 orbits every 16 days
- the AIRS orbital period 98.8 minutes, giving 233 orbits every 16 days
- 227 and 233 are both prime; there are no common factors and so no repeating subpatterns
- the scan patterns and in particular the secant of zenith angles are relatively close, as shown in a subsequent slide

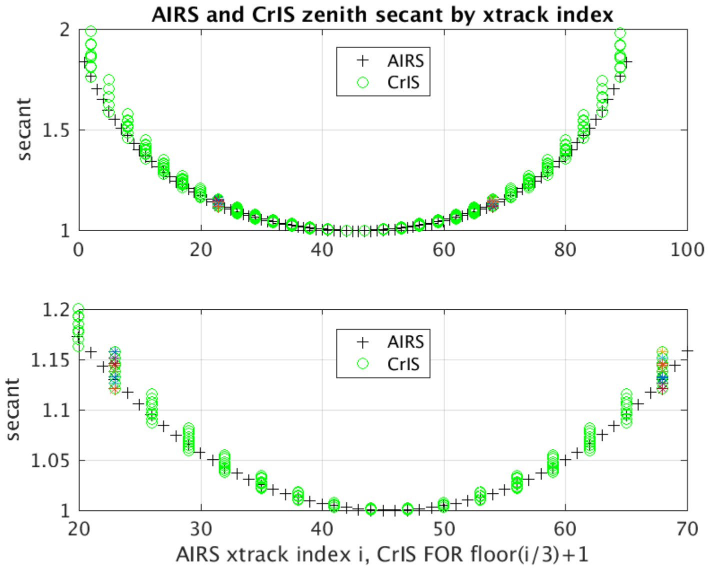
one-day track map



16 day track maps



AIRS and CrIS secant of zenith angles



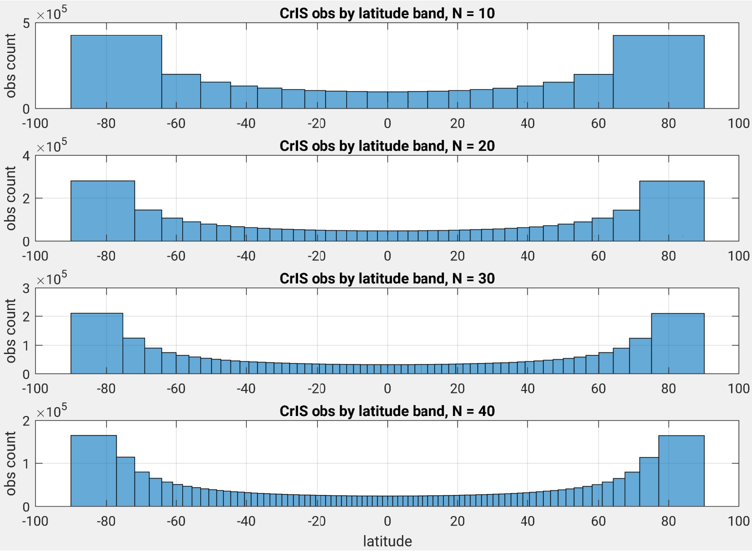
test data

- most comparison tests of orbital parameters shown here are done with a 16 day data set from 20 Apr to 5 May 2016, chosen for no missing AIRS or CrIS obs
- PDFs are shown for the 16 day set, the 2016 seasons, and all of 2016 broken out by land and ocean
- aside from some of the final CrIS-only FOV comparisons, all tests and PDFs shown here were done with both ascending and descending orbital phase
- tests shown here are with either near-nadir or full scans. near-nadir for AIRS is cross-track indices 43–48, and for CrIS fields of regard 15 and 16

equal area bands and bins

- we use latitude bands to test our latitude weighted subsetting, and equal area bins to examine obs and mean times per bin to compare AIRS and CrIS sampling
- equal area bins are formed from 24 equal area latitude bands from pole to equator (and so 48 bands total) and longitude steps of 4 degrees
- we have looked at other binning parameters; smaller bins give greater variation. The values chosen may be reasonable for evaulating samping for long span tests
- the equal area subsetting is not actually used in the tabulation of PDFs; the bins there are brightness temperature obs counts

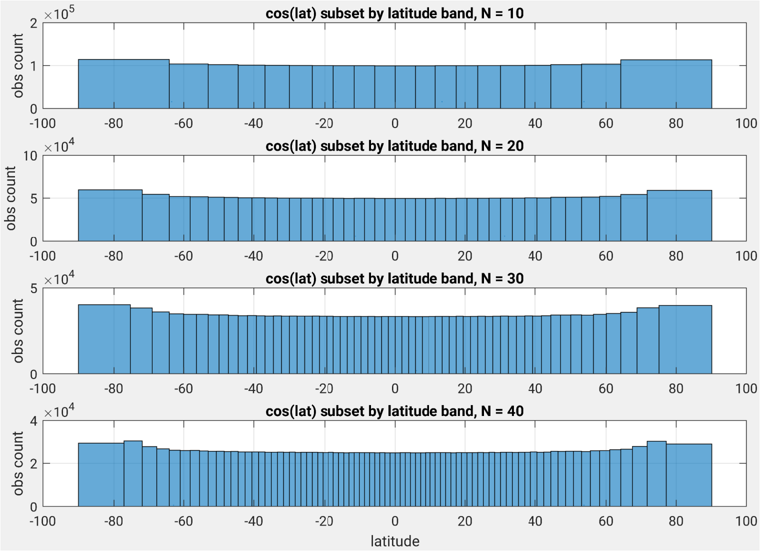
CrIS 16–day near-nadir obs count by latitude band



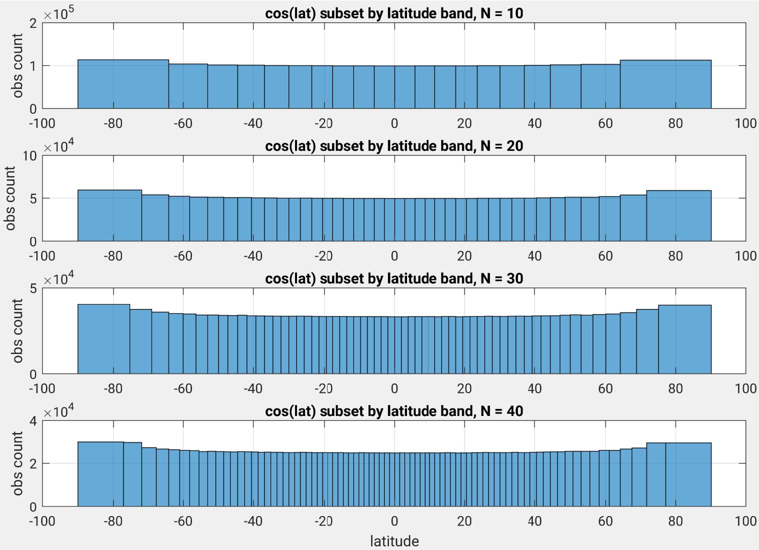
latitude weighted subsetting

- we want to do global stats with equal area sampling
- AIRS and CrIS oversample significantly towards the poles, so we want to drop some of those obs
- a simple heuristic is to keep all obs such that $X < \text{abs}(\cos(\text{lat}))$, where X is a random variable from the uniform distribution $[0, 1]$
- as shown on subsequent slides, this works fairly well. It is not hard to do better; for example $X < \text{abs}(\cos(\text{lat})^{1.1})$ gives more uniform sampling for N up to around 40. But that is a hack.
- all subsequent results here, and in particular all the PDFs, are done with the simple cosine heuristic unless otherwise noted

CrIS cosine of latitude subset



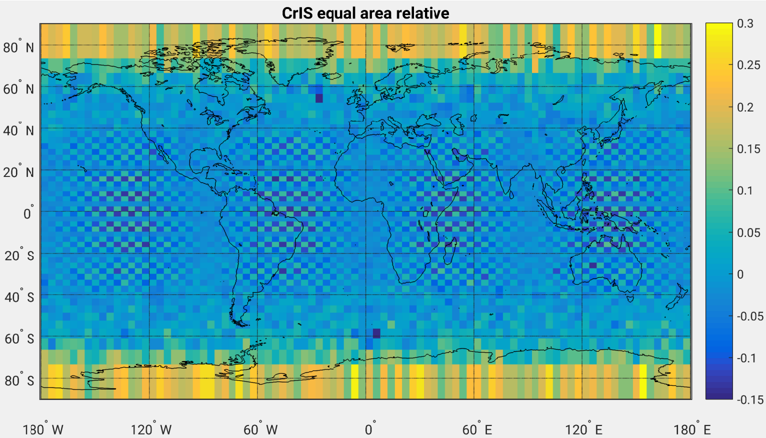
AIRS cosine of latitude subset



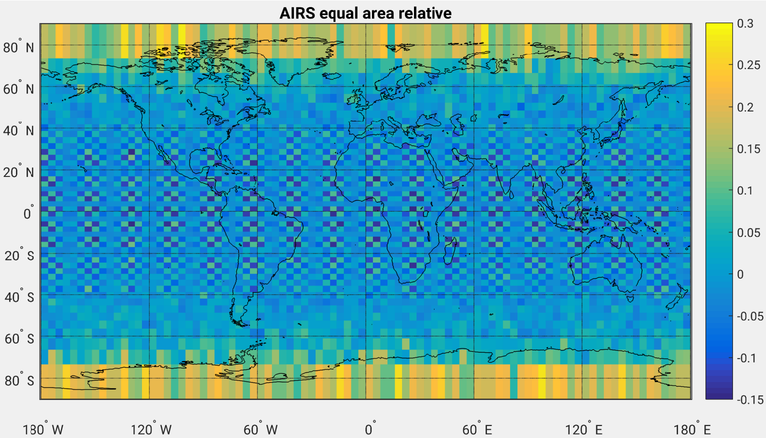
AIRS and CrIS sampling comparisons

- we compare obs counts and time differences per equal area bin for AIRS and CrIS near-nadir and full scan obs
- Let c_i be the obs count for bin i, and m the mean of c_i over all bins for a particular instrument and test. Then $(c_i - m)/m$ is the relative count for bin i. This is what we show for the single-instrument maps. We also consider the difference of two such maps
- similarly, let t_i be the mean obs time for bin i and n the mean time over all obs in the test; then $t_i - n$ is the time difference for bin i. This is what we show for the single-instrument maps. As with relative obs counts, we also consider the difference of two such maps. In both cases the units for the colormaps are days.

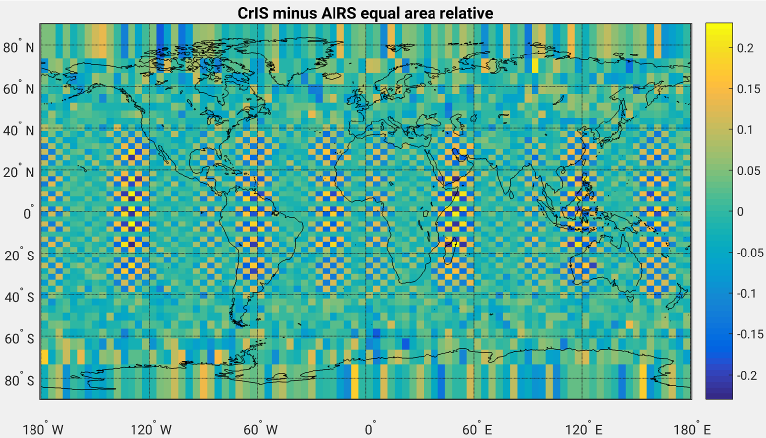
CrIS near-nadir relative obs count by equal area bin



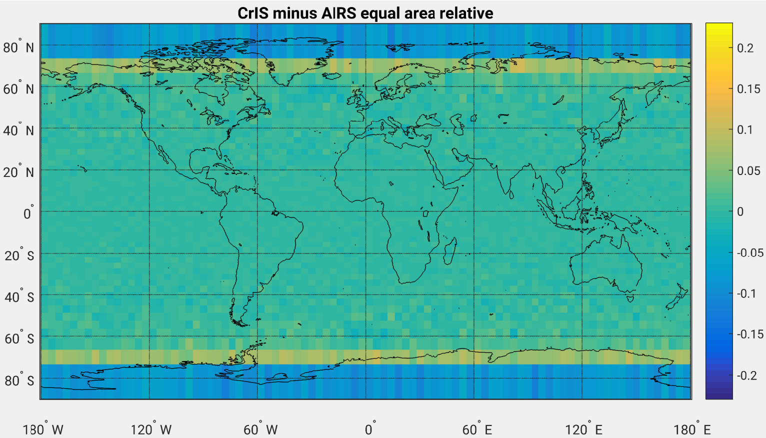
AIRS near-nadir relative obs count by equal area bin



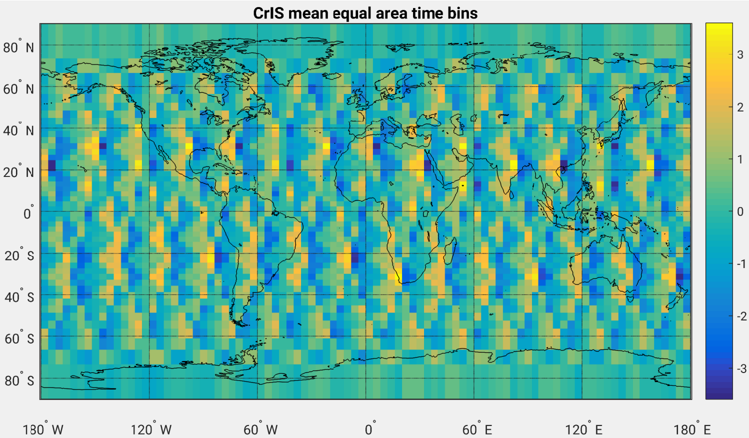
CrIS minus AIRS near-nadir relative obs difference



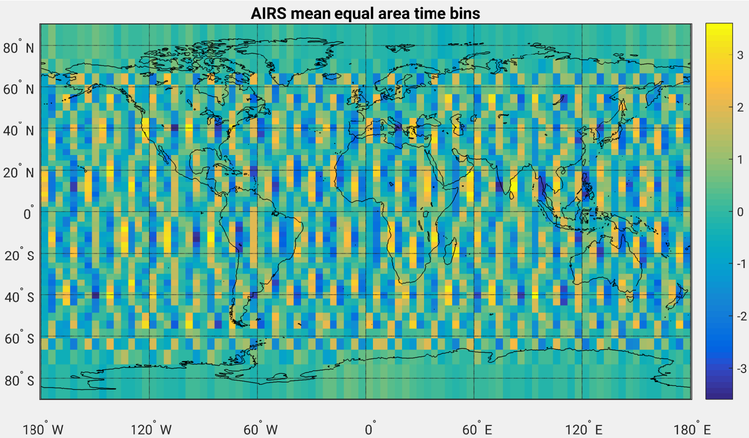
CrIS minus AIRS full-scan relative obs difference



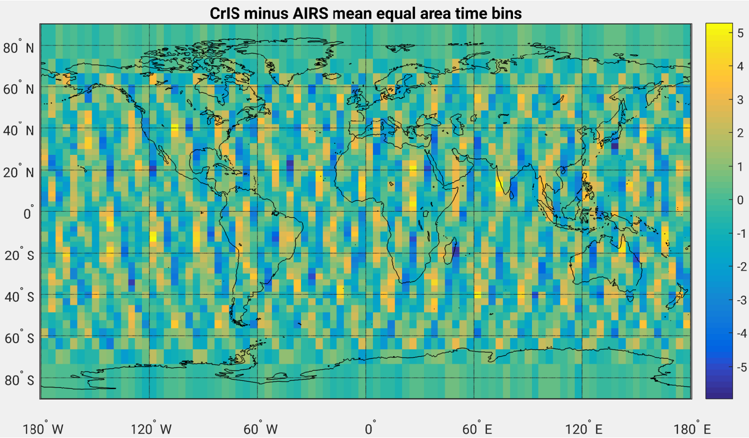
CrIS near-nadir mean time by equal area bin



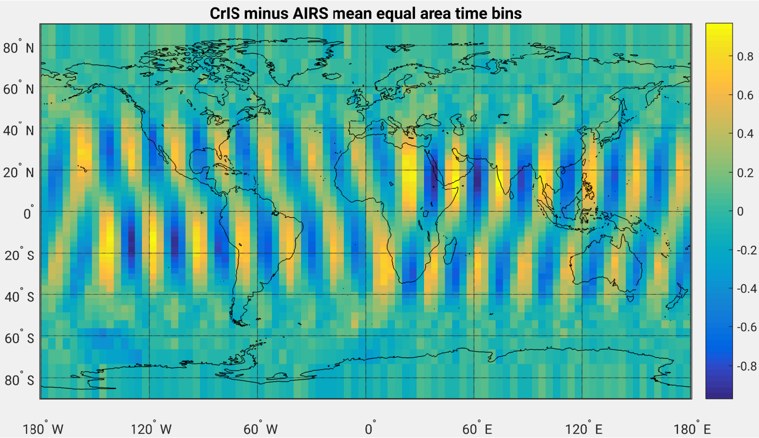
AIRS near-nadir mean time by equal area bin



CrIS minus AIRS near-nadir time difference



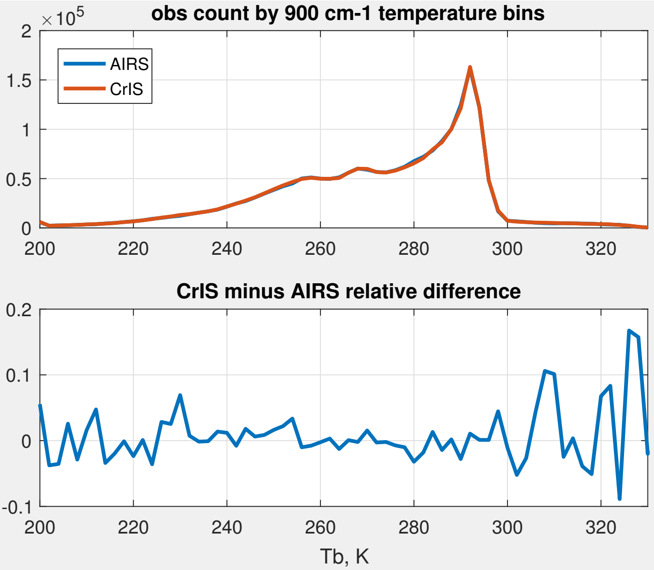
CrIS minus AIRS full-scan time difference



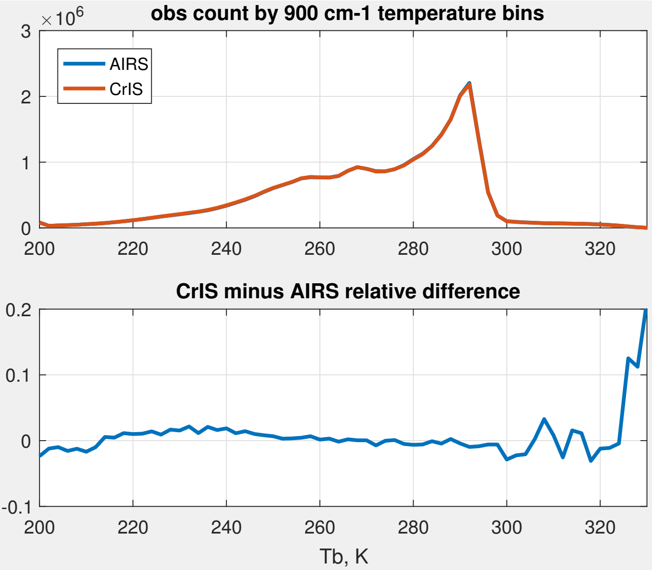
AIRS and CrIS PDFs

- we create PDFs (or PDF-like unnormalized artifacts) for AIRS and CrIS as follows
  1. choose a test period and any subsetting options
  2. tabulate obs by T_b bin the test periods, for both AIRS and CrIS. Let n_a be the total number of AIRS and n_c the total number of CrIS obs. Continue only if n_a and n_c are close, typically within about 1 pct
  3. normalize the CrIS counts to AIRS, multiplying by n_a/n_c.
  4. examine the relative difference of the normalized counts. If k_a and k_c are AIRS and CrIS counts for T_b bin K, this is $(k_c n_a/n_c - k_a)/k_a$.
- to increase the sample space, we would like to work with full scans, if possible

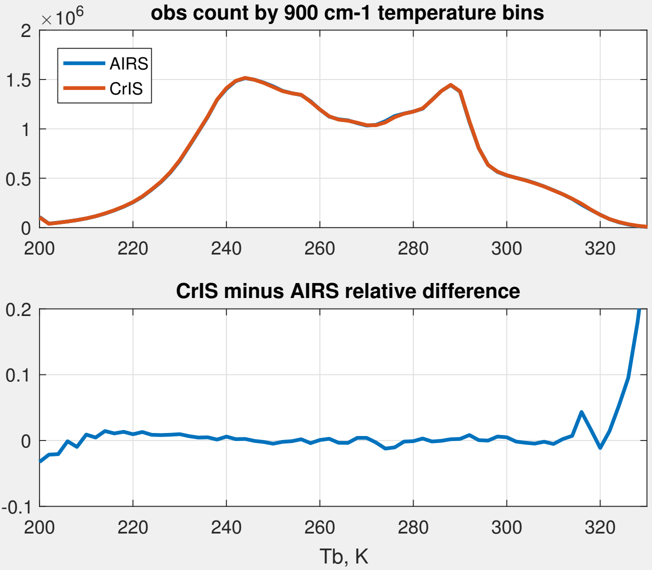
16 day near-nadir obs by Tb bin



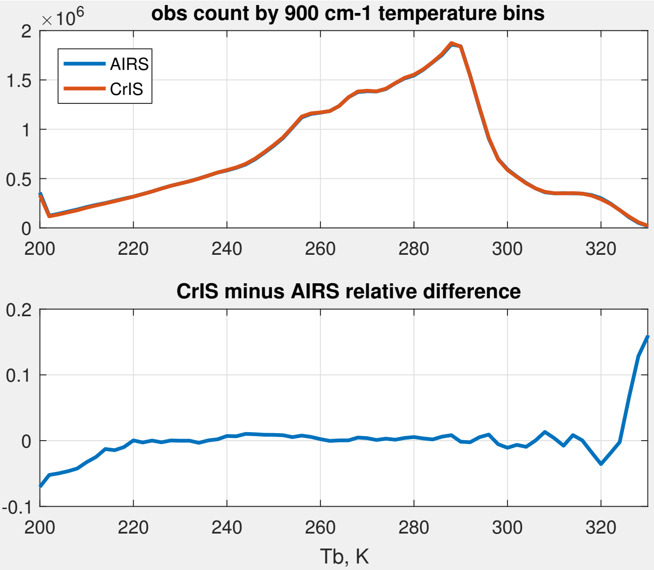
16 day full scan obs by Tb bin



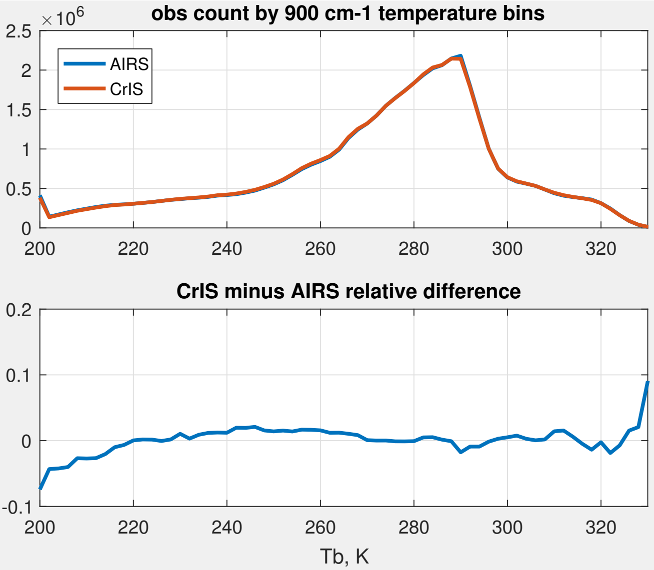
2016 winter full-scan land only



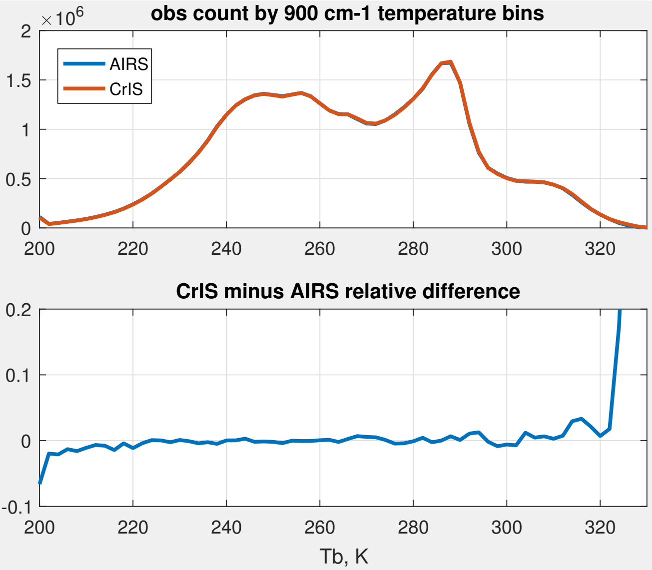
2016 spring full scan land only



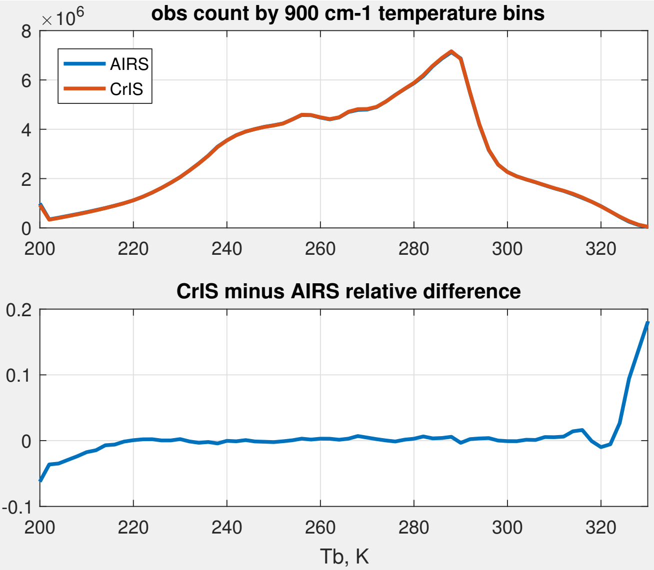
2016 summer full scan land



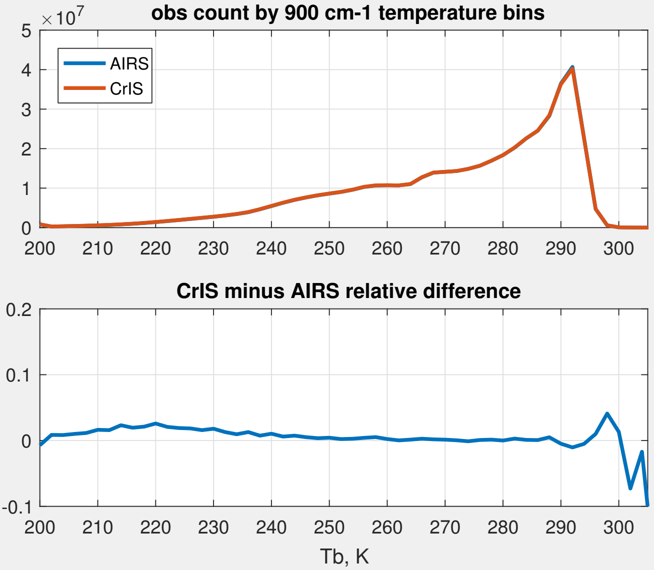
2016 fall full scan land



2016 full year full scan land



2016 full year full scan ocean



conclusions

- with the switch to extended res, we have seen a significant convergence in calibration algorithm performance
- the NOAA “SA-1 first” algorithm does slightly better when compared with reference truth convolved with responsivity, while the CCAST “ratio first” algorithm does slightly better when compared with reference truth convolved with a flat passband
- this may be because responsivity cancels out more completely in the ratio-first method
- because reference truth convolved with a flat passband is a more conventional and non instrument-specific standard, the ccast algorithm, or some similar ratio-first method, may be preferable